

Final report

1. Project details

Project title	IEA Bioenergy Task 32 - Biomass Combustion and Cofiring - Danish representation 2019-2021
File no.	64018-0093
Name of the funding scheme	EUDP
Project managing company / institution	Ea Energy Analyses
CVR number (central business register)	28 98 58 27
Project partners	-
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2. Summary

English

The purpose of the project is to ensure Denmark access to knowledge about progress in combustion of biomass from other IEA Bioenergy Task 32 member countries and to contribute with Danish knowledge and experience to the work in Task 32. The purpose is achieved by participation in Task 32's projects and through communication of results, including news from the member countries. Main activities:

- Participate in task meetings and associated workshops or conferences
- Prepare for these meetings and workshops/conferences
- Plan, prepare and hold task meeting and workshops in Denmark
- Report from task meetings and workshops via newsletters to Danish network etc.
- Prepare country reports on developments in Danish technologies and plants for biomass combustion
- Participate in (contribute actively to) the group's ongoing activities and projects.

Denmark is also the leader of Task 32.

Ea has participated in all meetings and relevant project activities on the dissemination of knowledge about biomass combustion, including especially on emissions from small combustion plants, national strategies to reduce emissions from biomass combustion plants and high-temperature heating for industry.

During the project, the dissemination of the collected knowledge took place via four e-mail newsletters to around 200 recipients in Danish companies and two articles in the FiB magazine. In addition, there has been

bilateral knowledge dissemination on biomass combustion and on Danish energy issues to Danish and foreign actors, and presentations on Task 32 have been held for stakeholders.

The project follows the schedule that has been extended over the period, dictated by the group's program internationally. Despite consequences of the pandemic, the budget has been sufficient to complete the project. Two deliveries are pending, a case on industrial heating and a seminar for the Danish stakeholders. Both are expected in 2022.

Newsletters can be seen [here](#), Task 32 reports can be downloaded [here](#).

Danish

Projektets formål er at sikre Danmark adgang til viden om fremskridt indenfor forbrænding af biomasse fra andre IEA Bioenergy Task 32 medlemslande og bidrage med dansk viden og erfaring til arbejdet i Task 32. Formålet opfyldes gennem deltagelse i Task 32's projekter og gennem formidling af gruppens resultater, herunder nyt fra de øvrige deltagende lande. Hovedaktiviteterne består i at:

- Deltage i to årlige arbejds møder og tilknyttede workshops eller konferencer
- Forberede disse arbejds møder og workshops/konferencer
- Planlægge, forberede og afholde arbejds møde og workshop i Danmark
- Rapportere fra arbejds møder og workshops via nyhedsmails til dansk netværk mv.
- Udarbejde materiale til gruppen om udviklingen inden for danske teknologier og anlæg til biomasseforbrænding
- Deltage i (bidrage aktivt til) gruppens løbende aktiviteter og projekter.

Danmark er desuden leder af Task 32.

Ea har deltaget i alle møder og relevante projektaktiviteter om formidling af viden om biomasseforbrænding, herunder særligt om emissioner fra små fyringsanlæg, nationale strategier for at reducere emissioner fra biomassefyringsanlæg og højtemperaturvarme til industrien.

I projektførelsen er formidlingen af den indsamlede viden foregået via fire e-mail-nyhedsbrev til omkring 200 modtagere i danske virksomheder samt to artikler i FiB magasinet. Desuden er der foregået bilateral videnformidling om biomasseforbrænding og om danske energispørgsmål til danske og udenlandske aktører samt holdt præsentationer om Task 32 for interessenter.

Projektet følger tidsplanen, der er blevet udvidet i løbet af perioden, dikteret af gruppens program internationalt. Trods tydelige konsekvenser som følge af pandemien, har budgettet været tilstrækkeligt til at fuldføre projektet. Der udestår to mindre leverancer, en case om industrivarmer samt et seminar for de danske interessenter. Begge er undervejs og ventes fuldført i 2022.

Nyhedsbreve kan ses på Ea's [hjemmeside](#), mens Task 32 rapporter kan hentes [her](#).

3. Project objectives

IEA Bioenergy Task 32 works to monitor, review and exchange information on advances in research, development, demonstration, and implementation of biomass combustion and cofiring technologies and to promote cooperation between the participating countries and industries to break down technological barriers in order to improve technology and promote the transition from fossil fuels to renewable biomass.

The project aims to increase Denmark's access to knowledge about advances within biomass combustion and co-firing from other IEA countries and to contribute with Danish knowledge and experiences to the work of Task 32. The purpose has been achieved through participation in Task 32 and through the dissemination of the group's results, including results from the other participating countries.

Main activities consist of:

- Participation task business meetings and workshops or conferences
- Preparation for business meetings and workshops / conferences
- Reporting from business meetings and workshops via newsletters to Danish network
- Report to the group about advances in Danish biomass combustion activities and plants
- Participate in (actively contribute to) the group's current activities
- Organise one business meeting/workshop in Denmark.

Additionally, Task 32 has been managed by Denmark in the 2019-2021 triennium.

4. Project implementation

The project evolved as planned, however with changes to the task meeting format and a slight delay of reports and dissemination activities due to the pandemic. The delay has not fully been overcome as some deliverables are pending:

- A Danish case study on biomass based high temperature process heat in industry has been prepared but not yet finalised
- A seminar for Danish stakeholders has been planned but not yet held.

It is expected that the activities will be finalised before the end of 2022.

Milestone 1 focuses on reporting news from task meetings and workshops. Six occasions were anticipated throughout the project. We have distributed four newsletters to the list of stakeholders that has been kept for this purpose and we have edited two articles in the FiB magazine (online and printed).

Milestone 2 focuses on the administrative reporting, anticipating three annual reports and one final report. Two annual reports have been delivered. It has been agreed to merge the third annual report with this final report.

Due to a lower travel and meeting activity as a result of the pandemic, a part of the budget anticipated for travel and subsistence was allocated to hours to enforce the Danish contribution with a case study on high temperature heat for industry. At the same time, the finalisation date of the project was postponed allowing more time to contribute to the "Inventory of national strategies for reducing the impact on air quality from residential wood combustion" that has now been published, as well as to planning the seminar for Danish stakeholders.

5. Project results

Preparation and participation in work meetings and associated workshops or conferences

Ea has participated in all Task 32's work meetings during the period.

The Danish contribution to the meetings in Task 32 includes a status report/country report on news within the energy field in general and especially about biomass combustion. In addition, an overview of current Danish news within politics, energy planning and activities with conversion or new construction of large and small biomass-fired plants is maintained, as well as an overview of current projects within research, development, and demonstration of biomass combustion. Danish country reports have been submitted at four task meetings.

The Danish Technological Institute has participated in several task meetings, with DTI playing the main role in the project to develop a design guide for wood stoves. Please, see a later section for details.

Due to the pandemic, Task 32 only managed to hold two physical meetings during the period – in Oslo, Norway in June 2019 and in Graz, Austria in January 2020. Other task meetings have been virtual, initially via GoTo Meeting and subsequently via the MS Teams account that Ea has set up. It has not been possible to hold workshops or achieve synergies by holding the meetings in connection with conferences, which is otherwise typically strived for. All physical meetings, including the expected final meeting in Sydney in connection with the End-of-Triennium conference, have been cancelled/postponed until the next triennium.

In total, six virtual meetings were held, each consisting of one to three sessions to allow coverage of both current activities, future work programme and presentation on country reports. In order to accommodate participants from both Japan and Canada, the virtual meetings have been able to be held from 12-14 CET. This has been the practical reason for letting each meeting consist of several sessions.

2019

- A virtual kick-off meeting was also held on 25 April 2019, where the group started the projects
- One physical task meeting has been held in Hurdal near Oslo, 18 June 2019. The meeting included study visits on 19 June 2019 to Fortum's wood pellet-fired district heating plant in Haraldsrud in Oslo, as well as to Arbaflame near Kongsvinger, which produces brown and weather-resistant wood pellets from steam exploded wood
- A virtual working meeting has been held on 10 October 2019 focused on organizing Task 32's workshop on residential biomass combustion.

2020

- On the 21-24 January, a physical working meeting was held in Graz in Austria in connection with the Central European Biomass Conference (CEBC 2020). The event included a study visit on 21 January to the company KWB, which manufactures advanced biomass boilers, a working meeting on 22 January and the holding of the above-mentioned workshop on 23 January as a parallel session of the conference. On 24 January, the undersigned also participated in a workshop organized by Task 44 on Bioenergy flexibility and system integration with a presentation of Task 32's report "The future role of Thermal Biomass Power in renewable energy systems-study of Germany"
- On June 30, a virtual working meeting was held focusing on the progress of the various projects that Task 32 is working on
- Further working meeting sessions were held on 8 and 17 December. Here, activities since the last meeting in June were followed up and a status of the group's work program and projects was made, as well as work on the proposal for the work program for the next triennium, 2022-2024, continued. Finally, several countries presented their country reports, and the next meetings were planned.

2021 - 2022

- Three working meeting sessions were held on 25 March, 8 April, and 4 May. Here the discussions continued about the upcoming work programme, as well as work was done on adjusting the budget for the current period (2019-2021) and work was done on planning Task 32's contribution to the End-

of-Triennium conference, to be held in Q4 2021. Originally the conference was planned to take place in Sydney but had been converted to a virtual event. At the meeting, country reports were also presented from the countries that did not make it at the meeting in December 2020, including Denmark, and the status of the ongoing work program and projects was again made

- Three working meeting sessions were held across the turn of the year on 16 December and 11 and 19 January 2022. The first session was focused on fitting the work programme proposal for 2022-2024 to the 8 countries that had committed to Task 32. In January, the first session was focused on finalisation of the current work programme including a proposal for budget adjustment as a result of the pandemic. It also covered following up on the proposal. The second session was devoted to country reporting
- The next meeting was held physically in Denmark in September 2022 outside this project, however planning of the event was partly in the project.

Although it has not been possible to organize workshops during the period, Task 32 with the help of IEA Bioenergy and ETA Florence (which in practice handles a large part of the communication from IEA Bioenergy) held the webinar "Residential Wood Combustion – Towards Low Emission Systems" on 6 May 2021 where a general introduction to air pollution from biomass combustion was given, and the results of the projects on the design of low-emission stoves and realistic test methods for pellet stoves were presented. The webinar can be seen, and presentations downloaded [here](#).

At the virtual IEA Bioenergy (End-of-triennium) conference in 2021, Task 32 hosted a session "Biomass and renewable heat" on the 7th of December. The topics of the session were biomass for high temperature heat generation in industry respectively strategies to reduce the impact on air quality from wood combustion. The session can be seen, and presentations downloaded [here](#).

The two workshops on combustion experiences in large CHP plants that were planned for the triennium had to be postponed several times due to the pandemic. While there was always a hope to hold the workshops within the triennium - potentially in the beginning of 2022 - it was in December 2021 decided to postpone the workshops and the attempt from Task 32 to create a high-profile event by pooling the two workshops and site visits to new and remarkable combustion units (at ARC and HOFOR), until the next triennium. Through the triennium, resources have been spent on planning the event in Copenhagen. The work has been carried out in coordination with the Canadian country representative and with Task 40, which would be co-organizer of the one workshop, as well as with HOFOR as host and DI Bioenergi as potential host. The Canadian representation no longer has the same interest in participating, as the country is now more focused on biomass heating on a small scale for distant urban communities rather than co-firing. Thus, the workshops have now been merged into one and the agreement on co-organising with Task 40 remains to maintain focus also on BECCUS.

Reporting from task meetings and workshops via newsletters etc. to Danish network (M1)

Dissemination to interested Danish stakeholders takes place via a newsletter sent out per mail to around 200 recipients who represent plant suppliers, plant owners, advisers, the RD&D area, authorities, students, and other private individuals. Dissemination also takes place through other media, including articles and lectures as well as bilateral information for interested stakeholders. The communication concerns discussions at the meetings and developments in other member states but can also be scheduled before the meetings in order to inform the network about the possibility to participate in workshops, webinars and conferences or for industry players about the possibility to participate as observer in the task meetings and decision-making processes.

Along the project, four newsletters have been sent out and two articles have been published in the FiB magazine (online respectively printed). Newsletters and articles can be downloaded from the [website of Ea](#). Furthermore, the progress of Task 32 and the development in member countries were presented at two seminars in the

Bioenergy Group of the Danish Export Association. Task 32 was also presented at various occasions for the EUDP coordinators as well as for industry representatives.

2019-2020

During the period, a newsletter was sent out prior to the working meeting in Graz in order to orientate the network about the workshop, which was relevant for Danish stakeholders. An additional newsletter focusing on the status in the countries and with information about the upcoming workshops was prepared but was postponed. Parts of it was expected to be sent out only in the coming period sent out - after summer 2020.

In January 2020, the FIB magazine carried an article about the work of Task 32. The article described the latest activities and reports as well as the ongoing work program.

In March 2019, Ea gave a presentation of the Task 32 report "Options for increased use of ash from biomass combustion and co-firing" at the Danish Biomass Ash Workshop.

In May 2019, Ea gave a presentation of the Task 32 report "The future role of Thermal Biomass Power in renewable energy systems - a study of Germany" at the VGB Powertech biomass group meeting.

In November 2019, Ea gave a presentation concerning experiences with biomass-based district heating and straw combustion technology with focus on Danish experiences at the 2019 Global Biomass Energy Innovation Development Summit Forum in Beijing that was co-organised by IEA Renewable Energy Division and BEIPA.

At the end of February 2020, the undersigned gave a presentation of the work in Task 32 for the Danish Export Association's bioenergy group. The focus was, among other things, on the development of energy policy in the member countries and the markets that may be relevant for Danish players in these countries. As mentioned above, we have also contributed to Task 44 with a presentation on the project that Ea Energianalyse carried out for Task 32 on the future of biomass-based power production.

The dissemination activities have also included answering inquiries about biomass combustion-related topics from interested parties in Denmark (11) and abroad (9).

2020-2021

In general, the pandemic dampened the level of activity a bit. During the period, a newsletter was sent out in October 2020 prior to an e-workshop on the Task 32-managed intertask project on biomass for high-temperature heating in industry, and in April 2021 prior to the above-mentioned webinar on residential wood combustion in order to inform the network about the webinar that was relevant for Danish players. Both emails also provided information on news from IEA Bioenergy as well as the status of Task 32's ongoing projects and the outline of the work program for the coming triennium.

The dissemination activities have also included answering professional inquiries about biomass combustion-related topics from interested parties in Denmark (13) and abroad (7).

2021-2022

During the period, a newsletter was sent out in November 2021 prior to the End-of-Triennium conference to be held online in December 2021.

The project has budgeted hours to plan an open seminar on the results of the work in Task 32 for interested Danish actors. Early in the project, there were discussions with EUDP about the form and content of the seminar, as the seminar - in addition to being a great idea - is a generic requirement from EUDP. Among other things, it has been discussed whether the seminar should be held as a joint event across all the tasks that

Denmark participates in. The pandemic situation has slowed down further progress with the seminar, but the seminar has been planned and is expected to be held before the end of 2022.

The dissemination activities have also included answering inquiries about biomass combustion-related topics from interested parties in Denmark (13) and abroad (4).

Participate in (contribute actively to) the ongoing Task 32 activities

Task 32 works with a number of project activities that are described in more detail in the work programme. Ea has actively contributed to the projects with Danish knowledge, and participants in the Danish network or other relevant actors are continuously informed and encouraged to contribute with Danish experiences to the projects. The pandemic has delayed the planned progress of the project activities slightly, and several projects have not been finalised/reports published until well into 2022. The following summarises the project activities/deliverables. Details and information on Danish contributions are given further below.

Efficient combustion in small plants - furnaces and boilers

- D1.1 Test methods and real-world performance of pellet stoves (AT)
- D1.2 Guideline for wood stove design (DK)
- D1.3 Inventory on national strategies to reduce emissions from biomass combustion plants (DE)
- D1.4 Workshop on improved combustion in small plants (AT).

Biomass in industry

- D2.5 High temperature heating for industry (Task 32 in lead) (NL) – incl. extra Task 32 case studies.

Biomass-fired cogeneration plants

- D3.6 Flexibility and integration, input to Task 44 (SE)
- D3.7 Workshop on experiences with dust firing of cheap fuels (CA)
- D3.8 Workshop on experiences with chip firing in large plants (DK).

Additional project

- Study of the Nitrogen Cycle in Biomass Combustion Plants (Phase I)

Overall, Denmark had the main responsibility for:

- The design guide for wood-burning stoves carried out by the Danish Technological Institute
- A new, Danish case study about biomass in industry, which is carried out partly with EUDP funding
- Input as to the inventory national strategies to reduce emissions from biomass combustion plants, which is carried out partly with EUDP funding
- Workshops on experiences with chip firing in large plants and on experiences with dust firing cheap fuels, which Ea organises in collaboration with HOFOR, Task 40 et al.

By virtue of the management task for Task 32, Denmark is involved in all the tasks. In the following, the projects of Task 32 are described in greater detail. Funding for the projects come from IEA Bioenergy (i.e., the member countries) and via other national contributions. Danish contributions co-funded by Ea and this project are specifically mentioned.

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

Following the work on standards and advanced testing methods for firewood stoves, Task 32 has produced a report on automatic testing methods for pellet stoves.

Pellet stoves gain more and more relevance on the direct heating market as they are convenient, economically competitive and “environmentally cleaner” compared to firewood stoves. Testing standards for pellet stoves have been established in several regions worldwide (e.g., Europe and the U.S). Recent research projects had shown that the performance of pellet stoves could differ significantly between constant load laboratory testing and real-life conditions. New testing concepts had been proposed recently which include typical real-life operation phases.

The report summarizes and discusses current and proposed testing methods for pellet stoves and summarises existing data about real life performance and the connection to lab testing results. The report addresses manufacturers, research and (notified) testing bodies, standardization groups, regulation bodies (international, national, regional) and interested end users.

The work has been carried out by Austria with contributions from Germany, Norway, Canada, Switzerland and Denmark. The main results were presented at the workshop in Graz in January 2020 while the final results were presented at the webinar on residential wood combustion in May 2021. Reporting had experienced some delay due to the pandemic. The final report has been published in October 2022.

D1.2 Technical guidelines for design of low emission stoves

Under this theme, a guideline for the design of woodstoves has been produced following the previous work in Task 32 and giving an overview of available primary design measures and emission abatement technologies as well as suitable control concepts for small-scale applications. The guide is based on the existing work in ERA NET and focus is on characteristic properties measured under real-life conditions but also on Eco Design values.

The guideline focuses on primary measures such as fire chamber design, ignition principles, load, air control and automation while secondary measures such as catalysts and filters (ESP, bag filters, chimney fans) are described in general terms. This gives a basis for the decision for combining primary measures with secondary technologies to obtain almost zero emission combustion products.

The guideline is aimed at manufacturers but also at funding agencies or regulation bodies to set up the legal and funding framework of these emerging technologies.



Testing combustion chamber design at a woodstove. (Photo: Danish Technological Institute)

The work has been carried out by Denmark (*Danish Technological Institute*) with contributions from Germany, Austria, Norway, and Switzerland. Preliminary results were presented at the workshop in Graz in January 2020

while the results were presented at the webinar on residential wood combustion in May 2021. The guideline has been published in October 2022.

D1.3 Inventory of national strategies for reducing the impact on air quality from residential and commercial wood combustion

Many countries are working on strategies for reducing the impact on air quality from small scale wood combustion. Their individual approaches may bear interesting measures, ideas or experiences which are useful for others.

The procedure suggested was that each interested member in Task 32 would prepare a dedicated Country Report for an internal Task 32 workshop from which a structure of a "National Strategy Report" should be derived. The internal workshop has been replaced by virtual discussions partly due to the pandemic.

A comprehensive template has been prepared and task members have collected and reported national data during 2021. An additional country report has been prepared by a colleague from Italy (AIEL). The country reports have formed the basis for the main synthesis report.

The primary work has been carried out by Germany with contributions from Austria, Canada, Denmark, The Netherlands, Norway, Sweden, Switzerland, and Italy. The Danish contribution was conducted by Ea in collaboration with the Danish EPA and funded partly by the EUDP funds.

The work has involved extensive collaboration within the task and outside IEA Bioenergy with Italy as well as with stakeholders such as national environment protection agencies and others in the member countries. It has been described as the ever most ambitious collection and comparison of emission strategies across countries.

The work was presented in draft at the Task 32 session on biomass and renewable heat at the IEA Bioenergy Conference on the 7th of December 2021. The synthesis report has been published in October 2022.

Task 32 aims at continuing the work in the new triennium with a series of expert workshops to discuss strategies, exchange experiences and benefit as much as possible from the collected data and potentially with new contributions from other countries.

D1.4 Workshop: Improved combustion in stoves and small biomass boilers

Results of the ongoing projects on small scale combustion and the previous work of Task 32 have been disseminated in a workshop aimed at developers, engineers, manufacturers, scientists and/or associations who would hear about the newest achievements, techniques, and knowledge to improve the design of log wood stoves and pellet stoves including those with water jackets for central heating as well as small biomass boilers. The workshop also updated participants on societal strategies for reducing the impact on air quality from residential wood combustion.

The workshop was organised by Austria with contributions or participation from member countries. It was held in connection with the Central European Biomass Conference 2020 (CEBC) in January in Graz, Austria. The workshop was a parallel event at the conference on the 23rd of January and benefited from the abstracts sent to the conference on small scale biomass combustion. CEBC proved to be a great opportunity to disseminate news and findings from Task 32 to a wider group. Presentations and a workshop report are available on the task website.



Residential biomass boilers from KWB exhibited at the CEBS 2020 in Graz, Austria. (Photo: Morten Tony Hansen)

D2.5 Bioenergy for high temperature heat in industry

Task 32 has been leading a strategic intertask project on how bioenergy can play a role in providing high temperature heat for industrial purposes. The project provides information to industry stakeholders about options of supplying process heat from renewable resources in a straightforward and effective manner.

Within the intertask project four separate case study reports elaborated by Tasks 32, 33, 34 and 36 describe examples of biomass process heat applications, based on different conversion technologies combustion, gasification, pyrolysis oil and waste incineration. During 2021, the policy report "Decarbonizing industrial process heat: the role of biomass" was finalised by Task 40 and published on the project website as well as on the general IEA Bioenergy website. The report concluded the intertask project and provides information on market deployment opportunities/potential and effective ways to address existing technical and non-technical barriers.

The project coordination and combustion case study has been carried out by the Netherlands and has involved close collaboration with other tasks. The four case studies were presented at the ExCo eWorkshop in October 2020. The policy report and the two Task 32 cases were presented at the Task 32 session on biomass and renewable heat at the IEA Bioenergy Conference on the 7th of December 2021.



Wood chips and grain residues-fired boiler (KCO Kohlbach) with SNCR (ERC) (left) and electrostatic precipitator (Scheuch) (right) for process heat supply in the largest bakery in Switzerland. Photo by Verenum.

Task 32 has decided to use the template for additional case studies on biomass combustion-based generation of process heat. One new case study from Switzerland was published on the website next to the existing four cases. The remaining case studies from Austria and Denmark have faced challenges with the hosts but are being prepared and will expectedly be published before the end of 2022. Preparation of the Danish case has been funded by the EUDP funds.

Task 32 has experienced high interest in the project and options for replacing fossil fuels from industry and especially in easy ways for stakeholders to find cases that match their own industry. Task 32 has planned that the seven cases will form the beginning of the searchable list of cases that Task 32 will establish during the new triennium as inspiration for interested industry decisionmakers. The list will take in already existing cases from the success stories part of the IEA Bioenergy website as well as further cases from boiler manufacturers. If funding allows, further case studies should be produced for the list based on the same template.

D3.6 Bio based CHP for balancing an energy system with a large portion of uncontrollable production

Prior to the triennium, Task 32 planned to take part in the collaborative project of the newly emerged Task 44 "Flexible bioenergy and system integration" focusing on how biomass combustion can play a role in supporting the balancing needs in future energy systems with a higher share of variable renewable energy (VRE) sources. Task 32 would contribute to the collaborative project with technical specialist knowledge on biomass combustion plants such as cost effectiveness of various solutions including technical opportunities and limitations for biomass power and biomass CHP such as full load hours, robustness of currently implemented combustion systems in a changing energy landscape with more VRE.

Task 32 expected that the study would describe the potential of using biomass-based CHP as a regulating power in a future system dominated by intermittent power in different countries and under what market situation conditions this might be economically feasible.

The lead was with Sweden and with contributions from Switzerland, the Netherlands and Denmark. Task 32 has contributed with a presentation by Ea of the results of the Task 32 project "The future role of Thermal Biomass Power in renewable energy systems – a study of Germany" to the Task 44 workshop that was held at the CEBC in January 2020 in Graz, Austria.

The primary work has been pending due to the pandemic and other reasons including relatively limited funding compared to the other projects. Despite involvement of new resources and additional funding, it was towards the end of the triennium concluded that the contribution to Task 44 would not be possible. Instead, Task 32 has suggested that the funding would be used to enable a contribution to the new inter-task project proposed by Task 44 "Synergies of green hydrogen and bio-based value chains deployment".

D3.7 + D3.8 Workshops: Experiences with combustion of pulverised non-woody solid biofuels and with combustion of wood chips for CHP production

Task 32 anticipated to organise two open workshops on experiences with large scale biomass combustion.

In an increasing competition to lower operational costs of biomass-based electricity generation from partly or fully converted condensing or CHP units it is of interest to plant operators to seek for cheaper fuels. Other fuels than wood may be more challenging than pulverised wood to handle and combust in terms of grinding, transporting, and igniting and in relation to corrosion, slagging, and fouling, keeping a stable flame, amount of unburnt fuel in the ash etc. and staying below the emission limits. The first workshop should build on previous discussions in Task 32 on options and limitations for using cheaper fuels in existing plants and aim at gathering researchers, suppliers, and industry to further share experiences on this topic.



Wood chips at CHP plant in Assens, Denmark. Photo by Torben Skøtt.

In some member countries, forest wood chips are currently booming for energy generation in utilities, district heating and in industrial applications. With Värtanverket, Sweden had the largest wood chip CFB combustion plant in the World. Denmark followed in 2019 with unit 4 at Amagerværket and also sees an increase in wood chip consumption in other large plants as well and in smaller DH plants and in industries. The second workshop would focus on the advancements of wood chip combustion to learn from experiences and considering aspects from the whole supply chain - security of supply, fuel specifications, logistics, suppliers, price fluctuation, technology aspects, different applications etc.

The first workshop was supposed to be organised by Canada, the second by Denmark. Collaboration was anticipated both externally with utilities, industry, other IEA TCPs as well as external groups, universities and associations. The first workshop would feed in to the collaborative project "Low-quality feedstocks / waste" that was proposed by Task 36. The second workshop should be co-organised with Task 40 and include presentations on BECCUS.

Planning steps had been taken early within the task as well as with external stakeholders and it was decided to organise the two workshops at one event in Copenhagen and include more site visits. The event involved collaboration with Task 40 as well as with members of IEA CCC and members of VGB Powertech. Due to the pandemic the two workshops had to be postponed multiple times. As uncertainty remained in the beginning of 2021, it was decided to hold the workshops and site visits in Q2 2022 - still as a part of the 2019-2021 triennium which was approved by ExCo. However, as the pandemic continued creating uncertainty for the first half of 2022 it was decided to postpone the event for the 2022-2024 triennium aiming at updating the concept to respond to the potential new focus in industry and holding it in the fall of 2022 in Copenhagen. The new focus is more on BECCUS and less on alternative fuels as Canada has meanwhile lost interest in large scale thermal biomass combustion and co-firing, the main responsibility for the event has been shifted to Denmark.

Additional project: Study of the Nitrogen Cycle in Biomass Combustion Plants (Phase I)

Due to the pandemic, only a minor part of the triennium budget for travel costs and meeting costs had been spent as anticipated. This development has enabled Task 32 to already in 2021 initiate new activities that were planned for the 2022-2024 work programme. Task 32 has initiated a study of the nitrogen cycle in biomass combustion plants based on research carried out by BEST in Austria. The project is led by the representatives from Austria and the Netherlands and aims at quantifying reactive nitrogen flows along the whole biomass combustion cycle. The result of phase I is a scoping report based on the Austrian study defining the work and data collection to take place in phase II. The report will be published before the end of 2022. Phase II will be carried out during the 2022-2024 triennium.



Tight emission thresholds in the NL require extensive flue gas cleaning at small scale district heating CHP plant: 2 x SNCR + cyclone + SCR + economiser + bag filter + condenser. Photo by ProBiomass BV.

Administrative tasks, collaborations, dissemination

Via the leading role in Task 32, Ea is involved in various subtasks regarding administration, collaboration with other entities and dissemination etc. In these cases Ea naturally promotes biomass combustion based on Danish experiences, interests and priorities. This includes contributions with Danish examples to IEA Bioenergy's newsletters and bulletins, planning of the next work programme and assistance to the IEA HQ on the renewable energy market report.

The Task collaborates directly with industry and through industrial networks such as VGB Powertech. Within the IEA family, interaction also takes place with the Renewable Energy Division and with other TCPs such as the International Centre for Sustainable Carbon (previously Clean Coal Centre) and IEA Combustion. The pandemic has somewhat decreased collaborative initiatives. This has e.g. limited the interaction with industry at site visits and at conferences.

The following are selected collaborations that have taken place during the triennium.

Danish Biomass Ash Workshop:

- Presentation of the Task 32 report "Options for increased use of ash from biomass combustion and co-firing" (March 2019)

VGB Powertech:

- Presentation of the Task 32 report "The future role of Thermal Biomass Power in renewable energy systems - a study of Germany" (May 2019)

IEA International Centre for Sustainable Carbon (previously CCC):

- Contribution to biomass co-firing report
- Suggestion of speakers and announcement on website of IEA CCC co-firing workshop in Japan in February 2020

IEA Combustion TCP:

- Contribution to generation of ideas for potential new task topics

IEA Renewable Energy Division and BEIPA:

- Presentation concerning experiences with biomass-based district heating and straw combustion technology with focus on Danish experiences at the 2019 Global Biomass Energy Innovation Development Summit Forum in Beijing (November 2019)

IEA Renewable Energy Division:

- Supporting the division with inquiries on the flexibility of bioenergy plants and data residential heating systems
- Collaboration to assist with country specific data on investment costs (incl. subsidies) and maintenance costs for pellet stoves and pellet boilers and assisting the division with designing and testing their [online heat economics calculator](#) that was launched with the Renewable Energy Market Report 2021.

Industry stakeholders

- Collaboration with process industries on their respective industry case stories
- Visits to industries and mutual exchange of ideas (e.g. KWB (Austrian boiler manufacturer), Arbaflame (Norwegian steam exploded pellet manufacturer))
- Discussion with boiler manufacturer to list relevant industry cases where biomass has replaced fossil fuels as a supplement to the produced case stories

AIEL, Associazione Italiana Energie Agroforestali

- Collaboration on the Task 32 project on national strategies

Through the years, Task 32 has supported several project proposals on combustion issues as well as responded to several inquiries from parties around the world as mentioned above.

6. Utilisation of project results

The work of Task 32 aims at increasing the substitution of fossil fuels with solid biomass in many sectors in the member countries and elsewhere while improving efficiencies and reducing emissions of harmful substances. The aim of exchanging experiences is to avoid making mistakes that have already been made.

All results of the work of Task 32 are publicly available and reports can be downloaded freely from the task website. Task 32 utilises the results as a basis to build on for continued work on improving the performance of biomass combustion plants.

7. Project conclusion and perspective

During the triennium, Task 32 members have identified important challenges for the future deployment of biomass combustion and for the future work that form the basis for the proposed work to be carried out in the 2022-2024 triennium:

- Emission reductions remain important - small and larger scale
 - PM important in small scale - residential heating
 - NOx important in small to medium sized district heating
- Transition away from fossil fuels in industry
 - Becoming even more important
 - Electrification not always desired
 - Efficiency improvement and co-generation could be included
- Integration and flexibility of biomass combustion
 - Role of biomass combustion in energy systems

- Role of biomass combustion in a CCS and PtX future
- Public perception and sustainability
 - Carbon neutrality of woody biomass
 - Biodiversity in large scale supply chains
 - Negative campaigns currently prevailing in some countries–

Task 32 proposes to continue supporting the deployment of boilers for domestic heating and district heating, industrial boilers and utility size units while addressing the above topics with a technical approach focusing on these key technical, economic, environmental, and social issues that impede market dissemination of biomass combustion technologies. The proposed work programme consists of the following four work packages:

WP1: Substituting fossil fuels in industry

- 1.1 Substituting fossil fuels in industry - new case studies
- 1.2 Substituting fossil fuels in industry - searchable list of cases

WP2: Sustainable biomass CHP with net negative CO₂ emissions

- 2.1 Biomass combustion and BECCUS, technical options, cases, workshop (T40 ITP)“
- 2.2 Biomass combustion and synergies with hydrogen – tech options and case study (T44 ITP)
- 2.3 Workshop on BECCUS and experiences with large-scale biomass combustion (Collab. T40)
- 2.4 CO₂-neutrality and sustainability - contribution to knowledgebase (of T45)

WP3: Innovative low emission biomass heating plants

- 3.1 State-of-art low emission biomass combustion district heating plants
- 3.2 Study of the nitrogen cycle in biomass combustion plants (Phase II)
- 3.3 Smooth operation and low emissions

WP4: Low emission residential boilers

- 4.1 State-of-the-art residential biomass boiler systems and workshop at biomass conference
- 4.2 Series of expert workshops on emission policy strategies - disseminate findings in inventory
- 4.3 Webinar on sustainable low emission wood stoves - recent developments.

8. Appendices

Task 32 technical reports are available from the website of Task 32 and IEA Bioenergy as well as from the project website of the intertask project on high temperature heat for industries.

Danish newsletters, articles and presentations are available from the Ea Energy Analyses website.

- Task 32 website: <http://task32.ieabioenergy.com/>
- IEA Bioenergy website: <https://www.ieabioenergy.com/>
- Intertask industry heat website: <https://itp-hightemperatureheat.ieabioenergy.com/>
- Ea Energy Analyses website on Task 32: <https://www.ea-energianalyse.dk/da/projekter/1656-iea-bioenergy-forum-biomasseforbraending/>