



Newsletter 1-2017

Progress in 2017

In 2017, the last year of the project, focus is on selected specific studies and concluding and summarizing studies connected to the resource base and biocarbon production, properties and end use, also in a value chain perspective.

In 2016 focus was on further studies connected to the resource base, carbonization experiments under different conditions, biocarbon combustion and gasification reactivity and techno-economic studies connected to biocarbon production and use. This is in sum extensive studies that contributes with significantly increased knowledge regarding how Norwegian biomass resources can be utilized in an optimum manner in the biocarbon value chain.

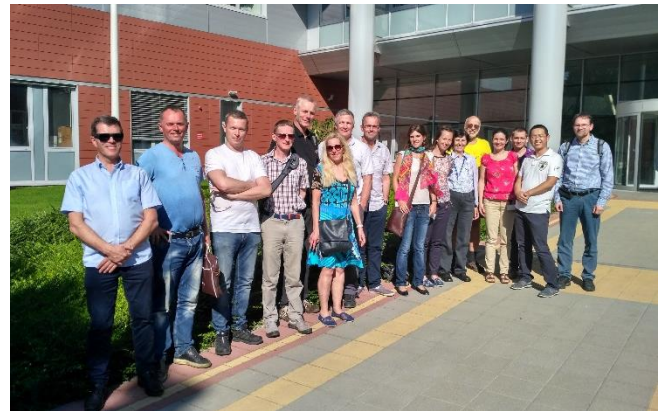
In 2015 focus was on further work connected to the resource base, biocarbon production and logistics, as well as biocarbon end use properties.

In 2014 focus was on startup of the project and the planned activities and deliverables for 2014. Various studies were started connected to the resource base and costs of these, fuel properties, feeding solutions, carbonization technologies and biocarbon conversion applications. The PhD position on modelling of biocarbon production was also announced, and filled.

BioCarb+ Steering Committee meeting at the Hungarian Academy of Sciences in Budapest

The 9th BioCarb+ Steering Committee meeting was arranged 2 June at the Hungarian Academy of Sciences in Budapest. The project leader, Øyvind Skreiberg, reported status of the project and progress of deliverables. The Steering Committee members are in general satisfied with what have been achieved in

the project and provides constructive feedback regarding the project activities, which is especially important in this the last year of the project. At the end of the meeting, all participants discussed a possible follow-up project after BioCarb+, and there is still a great researcher and industry interest in terms of R&D activities related to biocarbon production and utilization. The steering committee meeting was hosted by the BioCarb+ collaborative research partner the Hungarian Academy of Sciences. The day before the steering committee meeting, a laboratory visit was arranged for the participants to know more about the extensive experimental facilities and competences of the Hungarian Academy of Sciences.



Participants at the BioCarb+ Steering Committee meeting in Budapest, in front of the meeting location at the Hungarian Academy of Sciences

BioCarb+ at 25th European Biomass Conference & Exhibition

Seven BioCarb+ works were presented at the 25th EUBCE conference in Stockholm, Sweden, 12-15 June 2017:

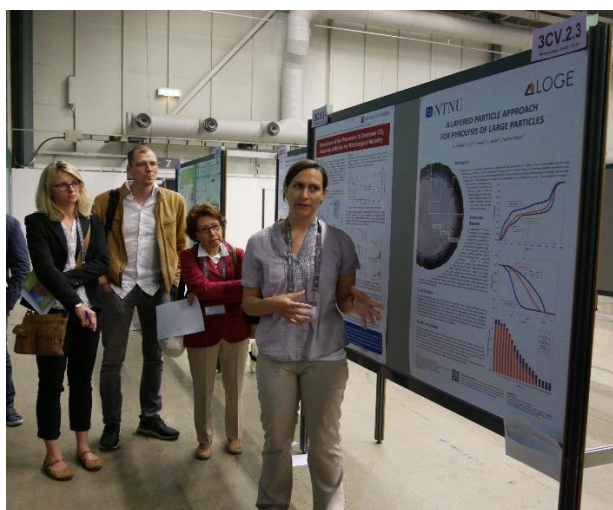
- 1) The pressure influence on biocarbon yield and quality, presented by Øyvind Skreiberg

- 2) Gasification behaviours of different biomass charcoals under CO₂ atmosphere, presented by Liang Wang
- 3) CO₂ gasification reactivity of biocarbon produced at different conditions, presented by Liang Wang
- 4) Technical and economic feasibility of combusting biocarbon in small scale pellet boilers, presented by Pietro Bartocci
- 5) A Layered Particle Approach to Model the Conversion of Thermally Thick Particles, presented by Kathrin Weber
- 6) Constant Volume Pyrolysis of Biomass for the Production of Char with High Fixed-Carbon Content, presented by Mainer Legarra Arizaleta
- 7) Performance evaluation of a modern wood stove when using charcoal, presented by Alexis Sevault

- 1) Towards a Meaningful Non-isothermal Kinetics for Biomass Materials and Other Complex Organic Samples, presented by Gábor Várhegyi
- 2) Thermoanalytical characterisation of torrefied stem wood, stump and bark of Norway spruce, presented by Zsuzsanna Czégény

BioCarb+ at 2nd International Bioenergy (Shanghai) Conference and Exhibition

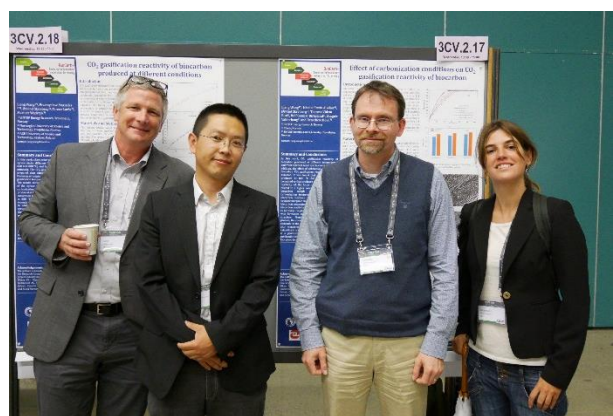
Liang Wang gave a plenary lecture at the 2nd International Bioenergy (Shanghai) Conference and Exhibition in Shanghai, China, 19-21 April 2017. The title of the presentation was "Biocarbon production and utilization".



Kathrin Weber, the BioCarb+ PhD candidate, at her poster.



BioCarb+ researcher Liang Wang giving his plenary lecture at the 2nd International Bioenergy (Shanghai) Conference and Exhibition



Right: BioCarb+ researchers Scott Turn, Liang Wang, Øyvind Skreiberg and Mainer Legarra Arizaleta at Liang's BioCarb+ posters

BioCarb+ at 1st Journal of Thermal Analysis and Calorimetry Conference

Two BioCarb+ presentations were given at the 1st Journal of Thermal Analysis and Calorimetry Conference in Budapest, Hungary, 6-9 June 2017:

BioCarb+ at INFUB 2017

Two BioCarb+ presentations were given at the 11th European Conference on Industrial Furnaces and Boilers (INFUB) in Algarve, Portugal, 18-21 April 2017:

- 1) A kinetic study on simultaneously boosting the mass and fixed-carbon yield of charcoal production via atmospheric carbonization, presented by Khanh-Quang Tran
- 2) Techno-economic assessment of integrated hydrochar and high-grade activated carbon production for electricity generation and storage, presented by Khanh-Quang Tran

BioCarb+ at 253rd American Chemical Society National Meeting & Exposition

Mainer Legarra Arizaleta gave a presentation at the 253rd American Chemical Society National Meeting & Exposition - Advanced Materials, Technologies, Systems & Processes in San Francisco, USA, 2-6 April 2017. The title of the presentation was "The manufacturing of charcoal in sealed vessels".

BioCarb+ at CenBio Final Conference

Øyvind Skreiberg gave a presentation at the CenBio Final Conference in Ås, Norway, 13-14 March 2017. The title of the presentation was "[Biomass upgrading for improved combustion processes](#)".

BioCarb+ at 2016 IEEE International Conference on Sustainable Energy Technologies

Khanh-Quang Tran presented a paper at the 2016 IEEE International Conference on Sustainable Energy Technologies (ICSET) in Hanoi, Vietnam, November 14-16. The title of the presentation was "[Hydrochar slurry fuels and high-grade activated carbon for electricity production and storage - Conceptual process design and analysis](#)." The paper has now been published in IEEE proceedings.

BioCarb+ at ICAE 2016. Papers now published in Energy Procedia

Five BioCarb+ papers were presented at the 8th International Conference on Applied Energy in Beijing, China, 8-11 October 2016. The papers have now been published in Energy Procedia. The paper titles are:

- 1) [CO₂ Gasification of Charcoals in the Context of Metallurgical Application](#)
- 2) [Techno-economic assessment of thermal co-pretreatment and co-digestion of food wastes and sewage sludge for heat, power and biochar production](#)
- 3) [Simultaneously boosting the mass and fixed-carbon yields of charcoal from forest residue via atmospheric carbonization](#)
- 4) [Biocarbonization process for high quality energy carriers: Techno-economics](#)
- 5) [Biomass Charcoal Properties Changes during Storage](#)

BioCarb+ in Applied Energy

A manuscript entitled "[Comparative study on the thermal behavior of untreated and various torrefied bark, stem wood, and stump of Norway spruce](#)" has been accepted for publication in Applied Energy. The abstract is given below.

"In this work, the torrefaction of different parts of Norway spruce (stem wood, bark, and stump) was studied. Three different torrefaction temperatures were applied: 225, 275, and 300 °C with 30 and 60 min isothermal periods. The thermal stability as well as the

evolutions of the decomposition products of the untreated and torrefied samples were measured by thermogravimetry/mass spectrometry (TG/MS). The TG/MS results are interpreted in terms of the chemical composition, namely the cellulose, hemicellulose and Klason lignin content. The inorganic components of the samples were measured by inductively coupled plasma-optical emission spectroscopy (ICP-OES) technique. It was found that the effect of torrefaction temperature was greater than the effect of residence time up to 275 °C, while at 300 °C the residence time had a significant influence on the composition of the torrefied samples due to the intensive decomposition of cellulose. Principal component analysis has been applied to find statistical correlations between the torrefaction temperature, the residence time, the chemical composition and the thermal parameters of the samples. The results of the principal component analysis confirmed that the chemical composition and hence the thermal properties of the studied samples changed to a greater extent at higher torrefaction temperature than at lower torrefaction temperature."

BioCarb+ in Energy & Fuels

A manuscript entitled "[Thermal Decomposition Kinetics of Wood and Bark and their Torrefied Products](#)" has been published in Energy & Fuels. The abstract is given below.

"The pyrolysis kinetics of Norway spruce, its bark, and their torrefied products was studied. Thermogravimetry (TGA) was employed with linear and stepwise heating programs. Altogether 36 TGA experiments were evaluated simultaneously by the method of least-squares. Part of the kinetic parameters could be assumed common for the studied samples without a considerable worsening of the fit quality. This process results in better defined parameters and emphasizes the similarities between the studied materials. Three pseudocomponents were assumed. Two of them were described by distributed activation energy models (DAEM), while a simpler kinetics was assumed for the pyrolysis of the cellulose content of the samples. The pyrolysis kinetics of the wood and the torrefied wood showed remarkable similarities to the bark and torrefied bark, though essential differences were also observed."

BioCarb+ in Journal of Analytical and Applied Pyrolysis

A manuscript entitled "[Stochastic reactor modeling of biomass pyrolysis and gasification](#)" has been published in Energy & Fuels. The abstract is given below.

"In this paper, a partially stirred stochastic reactor model is presented as an alternative for the modeling of biomass pyrolysis and gasification. Instead of solving transport equations in all spatial dimensions as in CFD simulations, the description of state variables and mixing processes is based on a probability density function, making this approach computationally efficient. The virtual stochastic particles, an ensemble of flow elements consisting of porous solid biomass particles and surrounding gas, mimic the turbulent exchange of heat and mass in practical systems without the computationally expensive resolution of spatial dimensions. Each stochastic particle includes solid phase, pore gas and bulk gas interaction. The reactor model is coupled with a chemical mechanism for both surface and gas phase reactions. A Monte Carlo algorithm with operator splitting is employed to obtain the numerical solution. Modeling an entrained flow gasification reactor demonstrates the applicability of the model for biomass fast pyrolysis and gasification. The results are compared with published experiments and detailed CFD simulations. The stochastic reactor model is able to predict all major species in the product gas composition very well for only a fraction of the computational time as needed for comprehensive CFD."

Book publication by the BioCarb+ PhD candidate

Kathrin Weber, the BioCarb+ PhD candidate has co-authored a book in German language with the title "[Biokohle - Herstellung, Eigenschaften und Verwendung von Biomassekarbonisaten](#)", or in English: Charcoal - Production, properties and applications of biomass carbonization.

BioCarb+ at the upcoming 9th International Conference on Applied Energy

Several BioCarb+ manuscripts have been submitted to 9th International Conference on Applied Energy in Cardiff, United Kingdom, Aug 21-24, 2017, for possible presentation and publication in Energy Procedia.

BioCarb+ students

A number of students have been or are connected to BioCarb+. In 2014 two students (**Charissa Higashi** and **Kathryn Hu**) from Hawaii, **USA**, visited Trondheim during the summer. In 2015 a summer student from **Norway** (**Benedicte Hovd**) financed by BioCarb+ within the SINTEF summer job program was working with aspects connected to biocarbon CO₂ reactivity. This work was continued by a master student (**Hau-Huu Bui**) from **Vietnam** and a project

student (**Maria Zabalo Alonso**) from **Spain**. Also in 2015, a PhD student from **Hungary** (**Eszter Barta-Rajnai**) visited Trondheim Aug-Sept, as well as an assistant professor (**Zsolt Barta**) from Hungary in September. A master student from **Belgium** (**Sam van Wesenbeeck**) at University of Hawaii worked in the BioCarb+ project and there is also a link to a PhD student from Spain (**Maidier Legarra**) at University of Hawaii, who now is part financed by BioCarb+. In 2016 Maria Zabalo Alonso continued and finished her master thesis within BioCarb+, **Przemyslaw Maziarka** from **Poland** carried out his master thesis work within BioCarb+, also connected to CO₂ reactivity of biocarbons, and **Maciej Olszewski** from Poland carried out his master thesis connected to techno-economics of biocarbon production. Also in 2016 a summer student from Norway, **Nicolai Alsaker**, was financed by BioCarb+, working with CO₂ reactivity of densified biocarbon. In addition the BioCarb+ PhD student from **Germany** (**Kathrin Weber**) is continuing her work. Connected to her work, **David Lüdecke** from Germany carried out his master thesis, as did **Sophie Kloepper** from Germany before him. Hence, a very significant educational activity is connected to BioCarb+.

Publications

Øyvind Skreiberg, Liang Wang, Morten Grønli (2017). The pressure influence on biocarbon yield and quality. Presented at the 25th European Biomass Conference & Exhibition (**EUBCE**), 12-15 June 2017, Stockholm, Sweden.

K. Weber, T. Li, T. Løvås, C. Perlman, F. Mauss (2017). A Layered Particle Approach to Model the Conversion of Thermally Thick Particles. Presented at 25th EUBCE.

M. Legarra Arizaleta, S. Van Wesenbeeck, S. Turn, T. Morgan, M. Antal, Ø. Skreiberg, L. Wang, M. Grønli (2017). Constant Volume Pyrolysis of Biomass for the Production of Char with High Fixed-Carbon Content. Presented at 25th EUBCE.

Liang Wang, Nicolai Alsaker, Øyvind Skreiberg, Therese Videm Buø, Rolf Gunnar Birkeland, Aasgeir Valderhaug, Benedicte Hovd (2017). Gasification behaviours of different biomass charcoals under CO₂ atmosphere. Presented at 25th EUBCE.

Liang Wang, Przemyslaw Maziarka, Øyvind Skreiberg, Terese Løvås, Mariusz Wądrzyk (2017). CO₂ gasification reactivity of biocarbon produced at different conditions. Presented at 25th EUBCE.

P. Bartocci, R. S. Kempegowda, F. Liberti, G. Bidini, Ø. Skreiberg, F. Fantozzi (2017). Technical and economic feasibility of combusting biocarbon in small scale pellet boilers. Presented at 25th EUBCE.

Alexis Sevault, Roger Khalil, Bjørn Christian Enger, Øyvind Skreiberg, Franziska Goile, Liang Wang, Morten Seljeskog, Rajesh Kempegowda (2017). Performance evaluation of a modern wood stove when using charcoal. Presented at 25th EUBCE.

E. Barta-Rajnai, L. Wang, Z. Sebestyén, Z. Barta, R. Khalil, Ø. Skreiberg, M. Grønli, E. Jakab, Z. Czégény (2017). [Comparative study on the thermal behavior of untreated and various torrefied bark, stem wood, and stump of Norway spruce](#). Accepted for publication in Applied Energy.

Gábor Várhegyi, Liang Wang, Øyvind Skreiberg (2017). Towards a Meaningful Non-isothermal Kinetics for Biomass Materials and Other Complex Organic Samples. 1st Journal of Thermal Analysis and Calorimetry Conference, 6-9 June 2017, Budapest, Hungary.

Eszter Barta-Rajnai, Liang Wang, Zoltán Sebestyén, Zsolt Barta, Roger Khalil, Øyvind Skreiberg, Morten Grønli, Emma Jakab, Zsuzsanna Czégény (2017). Thermoanalytical characterisation of torrefied stem wood, stump and bark of Norway spruce. 1st Journal of Thermal Analysis and Calorimetry Conference, 6-9 June 2017, Budapest, Hungary.

Liang Wang, Øyvind Skreiberg, Morten Grønli (2017). Biocarbon production and utilization. 2nd International Bioenergy (Shanghai) Conference and Exhibition, 19-21 April 2017, Shanghai, China.

Maria Zabalo Alonso, Khanh-Quang Tran, Liang Wang, Øyvind Skreiberg (2017). A kinetic study on simultaneously boosting the mass and fixed-carbon yield of charcoal production via atmospheric carbonization. INFUB 2017, 18-21 April 2017, Algarve, Portugal.

Rajesh S. Kempegowda, Khanh-Quang Tran, Øyvind Skreiberg (2017). Techno-economic assessment of integrated hydrochar and high-grade activated carbon production for electricity generation and storage. INFUB 2017, 18-21 April 2017, Algarve, Portugal.

Maidar Legarra Arizaleta, Scott Turn, Trevor Morgan (2017). The manufacturing of charcoal in sealed vessels. 253rd American Chemical Society National Meeting & Exposition - Advanced Materials, Technologies, Systems & Processes, 2-6 April 2017, San Francisco, USA.

Peter Quicker, Kathrin Weber (2017). [Biokohle - Herstellung, Eigenschaften und Verwendung von Biomassekarbonisaten](#). Springer Vieweg. ISBN 978-3-658-03688-1

Øyvind Skreiberg (2017). [Biomass upgrading for improved combustion processes](#). CenBio Final Conference, 13-14 March, Ås, Norway.

Eszter Barta-Rajnai, Gábor Várhegyi, Liang Wang, Øyvind Skreiberg, Morten Grønli, Zsuzsanna Czégény (2017). [Thermal Decomposition Kinetics of Wood and Bark and their Torrefied Products](#). Energy & Fuels 31(4):4024-4034.

K. Weber, T. Li, T. Løvås, C. Perlman, L. Seidel, F. Mauss (2017). [Stochastic reactor modeling of biomass pyrolysis and gasification](#). Journal of Analytical and Applied Pyrolysis 124(March 2017):592-601.

Khanh-Quang Tran, Terese Løvås, Øyvind Skreiberg, Rajesh S. Kempegowda (2016). [Hydrochar slurry fuels and high-grade activated carbon for electricity production and storage - Conceptual process design and analysis](#). 2016 IEEE International Conference on Sustainable Energy Technologies (ICSET) Proceedings, pp. 251-255.

Liang Wang, Øyvind Skreiberg, Sam Van Wesenbeeck, Morten Grønli, Michael Jerry Antal, Jr. (2016). [Experimental Study on Charcoal Production from Woody Biomass](#). Energy & Fuels 30(10):7994-8008.

L. Wang, E. Barta-Rajnai, K. Hu, C. Higashi, Ø. Skreiberg, M. Grønli, Z. Czégény, E. Jakab, V. Myrvågnes, G. Várhegyi, M. J. Antal, Jr. (2017). [Biomass Charcoal Properties Changes during Storage](#). Energy Procedia 105(May 2017):830-835.

Rajesh S. Kempegowda, Øyvind Skreiberg, Khanh-Quang Tran (2017). [Biocarbonization process for high quality energy carriers: Techno-economics](#). Energy Procedia 105(May 2017):628-635.

Khanh-Quang Tran, Maria Zabalo Alonso, Liang Wang, Øyvind Skreiberg (2017). [Simultaneously boosting the mass and fixed-carbon yields of charcoal from forest residue via atmospheric carbonization](#). Energy Procedia 105(May 2017):787-792.

Rajesh S. Kempegowda, Øyvind Skreiberg, Khanh-Quang Tran, P.V. P. Selvam (2017). [Techno-economic assessment of thermal co-pretreatment and co-digestion of food wastes and sewage sludge for heat, power and biochar production](#). Energy Procedia 105(May 2017):1737-1742.

Hau-Huu Bui, Liang Wang, Khanh-Quang Tran, Øyvind Skreiberg, Apanee Luengnaruemitchai (2017). [CO₂ Gasification of Charcoals in the Context of Metallurgical Application](#). Energy Procedia 105(May 2017):316-321.

David Lüdecke (2016). Kinetic modelling of biomass pyrolysis. RWTH Aachen University Master thesis. Main supervisors: Peter Quicker, Terese Løvås, Co-supervisor: Kathrin Weber

Przemysław Maziarka (2016). Reactivity of biochar with CO₂ using thermogravimetric analysis. AGH University of Science and Technology Master thesis. Main supervisors: Mariusz Wądrzyk, Terese Løvås, Co-supervisors: Liang Wang, Øyvind Skreiberg

Maciej Pawel Olszewski (2016). The techno-economics of biocarbon production processes. AGH University of Science and Technology Master thesis. Main supervisors: Karol Sztekl, Terese Løvås, Co-supervisors: Rajesh S. Kempegowda, Øyvind Skreiberg

Nicolai E. Alsaker (2016). Biocarbon for use in metallurgical industry. SINTEF Summer Job Project report. Supervisors: Liang Wang, Øyvind Skreiberg

Eszter Barta-Rajnai, Emma Jakab, Zoltán Sebestyén, Zoltán May, Zsolt Barta, Liang Wang, Øyvind Skreiberg, Morten Grønli, János Bozi, Zsuzsanna Czégény (2016). [Comprehensive compositional study of torrefied wood and herbaceous materials by chemical analysis and thermoanalytical methods](#). Energy & Fuels 30(10):8019-8030.

Maria Zabalo Alonso (2016). A thermogravimetric and kinetic study on devolatilization of woody biomass. NTNU Master thesis. Main supervisor: Khanh-Quang Tran, Co-supervisors: Liang Wang, Øyvind Skreiberg

Hau-Huu Bui, Liang Wang, Khanh-Quang Tran, Øyvind Skreiberg (2016). [CO₂ gasification of charcoals produced at various pressures](#). Fuel Processing Technology 152:207-214.

Sam Van Wesenbeeck, Liang Wang, Frederik Ronsse, Wolter Prins, Øyvind Skreiberg, Michael J. Antal, Jr. (2016). [Charcoal 'mines' in the Norwegian woods](#). Energy & Fuels 30(10):7959-7970.

Liang Wang, Benedicte Hovd, Hau-Huu Bui, Aasgeir Valderhaug, Therese, Videm Buø, Rolf Gunnar Birkeland, Øyvind Skreiberg, Khanh-Quang Tran (2016). [CO₂ reactivity assessment of woody biomass biocarbons for metallurgical purposes](#). Chemical Engineering Transactions 50:55-60.

Rajesh S. Kempegowda, Zsolt Barta, Øyvind Skreiberg, Liang Wang (2016). [Value chain analysis of biocarbon utilisation in residential pellet stoves](#). Chemical Engineering Transactions 50:7-12.

Rajesh S. Kempegowda, Øyvind Skreiberg, Khanh-Quang Tran, Pagandai V. Pannir Selvam (2016). Bio-carbonization process integration for high quality energy carriers: charcoal, biomethane, biocrude, and biofertilizer. 24th European Biomass Conference and Exhibition (**EUBCE**), 6-9 June 2016, Amsterdam, The Netherlands.

Kathrin Weber, Tian Li, Terese Løvås (2016). Carbon Yield Predictions in Biochar Based on Stochastic Reactor Modelling. 24th EUBCE.

Liang Wang, Hau-Huu Bui, Benedicte Hovd, Aasgeir Valderhaug, Therese Videm Buø, Rolf Gunnar Birkeland, Øyvind Skreiberg, Khanh-Quang Tran (2016). Reactivity assessment of biocarbons for metallurgical purposes. 24th EUBCE.

Rajesh S. Kempegowda, Zsolt Barta, Øyvind Skreiberg, Liang Wang (2016). Energy efficiency, environmental aspects and cost-efficiency of small-scale biocarbon conversion applications – value chain analysis. 24th EUBCE.

Hau-Huu Bui, Liang Wang, Khanh-Quang Tran, Øyvind Skreiberg, Apanee Luengnaruemitchai (2016). CO₂ Gasification of Norwegian Charcoals Prepared at Different Pressures. Proceedings of The Petroleum and Petrochemical College International Symposium, Chulalongkorn University, 24 May 2016, Bangkok, Thailand, pp. 49-55.

Khanh-Quang Tran, Hau-Huu Bui, Apanee Luengnaruemitchai, Liang Wang, Øyvind Skreiberg (2016). [Isothermal and non-isothermal kinetic study on CO₂ gasification of torrefied forest residues](#). Biomass and Bioenergy 91(Aug 2016):175-185.

Kathrin Weber, Tian Li, Terese Løvås, Lars Seidel, Cathleen Perlman, Fabian Mauss (2016). Stochastic reactor modelling for biomass pyrolysis. **Pyro 2016** (21st International Symposium on Analytical and Applied Pyrolysis), 9-12 May 2016, Nancy, France.

Morten Grønli, Liang Wang, Øyvind Skreiberg (2016). Towards the maximum theoretical yields of charcoal from biomass pyrolysis. Pyro 2016.

Charissa Rachelle Mika Higashi (2016). A study on the theory, generation, and retention of charcoal quality by thermochemical equilibrium calculations, efficient

microcrystalline cellulose carbonization, thermogravimetry, and psychrometric experiments. University of Hawaii Master thesis. Supervisor: Michael J. Antal, Jr.

Liang Wang, Gábor Várhegyi, Øyvind Skreiberg, Tian Li, Morten Grønli, Michael J. Antal, Jr. (2016). [Combustion Characteristics of Biomass Charcoal Produced at Different Carbonization Conditions: A Kinetic Study](#). Energy & Fuels 30(4):3186-3197.

Hau-Huu Bui (2016). CO₂ gasification of charcoals produced from Norwegian stem wood and forest residues. Chulalongkorn University Master Thesis. Main supervisor: Apanee Luengnaruemitchai, Co-supervisors: Khanh-Quang Tran, Liang Wang, Øyvind Skreiberg

Sam Van Wesenbeeck, Charissa Higashi, Maider Legarra, Liang Wang, Michael Jerry Antal Jr (2016). [Biomass pyrolysis in sealed vessels. Fixed-carbon yields from Avicel cellulose that realize the theoretical "limit"!](#). Energy & Fuels 30(1):480-491.

Maria Zabalo Alonso (2015). Use of charcoal as reductant in metallurgical industry. NTNU Project thesis. Main supervisor: Khanh-Quang Tran, Co-supervisors: Liang Wang, Øyvind Skreiberg

Øyvind Skreiberg (2015). [BioCarb+ Verdikjeden for biokarbon: Fra biomasse til energi](#). Bioenergidagene 2015, 18-19 November 2015, Gardermoen, Norway.

Kathrin Weber, Tian Li, Cathleen Perlman, Lars Seidel, Fabian Mauss, Terese Løvås (2015). Modelling of wood devolatilization using a stochastic reactor approach. Nordic Flame days 2015, 6 October 2015, Copenhagen, Denmark.

Øyvind Skreiberg (2015). [BioCarb+](#). Presented in the session "Grensesprengende forskning" at Energiforskningskonferansen, 21 May 2015, Oslo, Norway.

Sam Van Wesenbeeck (2015). Charcoal in a nutshell: Biocarbon production from cellulose, Norwegian wood, Macademia nutshells and sewage sludge. University of Hawaii Master thesis. Supervisor: Michael J. Antal, Jr.

Benedicte Hovd (2015). Biocarbon for energy - Biocarbon CO₂ reactivity. SINTEF Summer Job Project report. Supervisors: Liang Wang, Øyvind Skreiberg

Liang Wang, Gábor Várhegyi, Øyvind Skreiberg, Morten G. Grønli, Michael J. Antal, Jr. (2015). [Combustion Characteristics of Biomass Charcoal Produced at Different Carbonization Conditions](#). Proceedings of 23rd European

Biomass Conference and Exhibition (**EUBCE**), 1-4 June 2015, Vienna, Austria, pp. 1196-1199.

Liang Wang, Charissa Higashi, Øyvind Skreiberg, Morten G. Grønli, Michael J. Antal, Jr. (2015). [Charcoal Production from Forest Residues](#). Proceedings of 23rd EUBCE, pp. 1184-1187.

Liang Wang, Kathryn Hu, Charissa Higashi, Øyvind Skreiberg, Viktor Myrvågnes, Morten G. Grønli, Michael J. Antal, Jr., Gábor Várhegyi (2015). [Effect of Storage Time and Conditions on Biomass Charcoal Properties](#). Proceedings of 23rd EUBCE, pp. 1180-1183.

Sophie Kloepfer (2015). Prozesse und Anlagen zur Herstellung von Biomassekarbonisaten. RWTH Aachen University Bachelor thesis. Main supervisor: Peter Quicker, Co-supervisor: Kathrin Weber

Liang Wang, Øyvind Skreiberg, Morten G. Grønli, Michael J. Antal, Jr. (2014). Thermogravimetric studies of charcoal formation from cellulose under different pyrolysis conditions. AIChE Annual Meeting in Atlanta, GA, 16 - 21 November, 2014.

BioCarb+ in the media

Lars Martin Hjorthol, Øyvind Skreiberg (2014). Lopwood and brushwood make high-grade charcoal. [Gemini](#).

Lars Martin Hjorthol, Øyvind Skreiberg (2014). Kvist og kvas blir edelt kull. [Gemini](#). Reproduced on [forskning.no](#), [Aftenposten nett](#) and [Adresseavisen nett](#).

Other news

IEA Task 32 Biomass Combustion and Co-firing

An [IEA Bioenergy Task 32](#) meeting was arranged in connection with the 25th European Biomass Conference and Exhibition in Stockholm, Sweden, 12-15 June 2017. For information about IEA Bioenergy Task 32 activities, see this [newsletter](#), and for IEA Bioenergy news, see this [newsletter](#). Øyvind Skreiberg from SINTEF Energy Research is the Norwegian participant in IEA Bioenergy Task 32.

EERA Bioenergy – SP5 Stationary Bioenergy

The effort this year has been focused on revising the SP focus and the description of work. For more info on EERA Bioenergy, visit the [website](#), and see the [newsletters](#). Berta Matas Güell from SINTEF Energy Research is leading SP5 Stationary Bioenergy in EERA Bioenergy.

RHC technology platform

The activity level of the [RHC platform](#) has picked up, after a period where new financing solutions were sought and the originally planned strategy documents had been delivered. The "new" European Technology and **Innovation** Platform on Renewable Heating & Cooling (RHC-ETIP) brings together stakeholders from the biomass, geothermal and solar thermal sector - including related industries such as District Heating and Cooling, Thermal Energy Storage, Hybrid Systems and Heat Pumps - to define a common Research, Development and Innovation strategy for increasing the use of renewable energy technologies for heating and cooling.

Previously concrete work has been carried out by the Biomass Panel in the RHC-ETIP connected to giving input to the SET-plan issues paper on renewable fuels and bioenergy, as well as work connected to the Implementation of the biomass technology roadmap of the Biomass Panel. The aim of the latter was to update the progress in R&I priorities identified by the Biomass technology roadmap.

This work continues through different efforts, whereof a Biomass Panel steering committee meeting was arranged 20 June in Brussels.

Øyvind Skreiberg from SINTEF Energy Research is a member of the Biomass Panel Steering Committee and the leader of Issue group 2: Residential/small scale heating devices and building integration.

See the RHC [newsletters](#) for other news.

Links (click on the links or logos to get there)

[BioCarb+](#)

[SKOG22](#)

[Energi21](#)

[Renewable Heating and Cooling ETIP](#)

[EERA Bioenergy](#)

[IEA Task32 Biomass Combustion and Cofiring](#)

