

# BioCarb+ Enabling the biocarbon value chain for energy



## Newsletter 2-2014

### BioCarb+ project workshop in Trondheim

A BioCarb+ project meeting was arranged 2-3 December in Trondheim. A project workshop was held the first day, with presentations to update the project partners with the latest research results and presentations from the industry partners on their biocarbon related activities. The second day started with a steering committee meeting and ended by a tour in the NTNU-SINTEF thermal engineering laboratory. A range of biocarbon related experimental facilities and instruments were introduced to the tour participants.

### Green shift in Norway towards a low carbon economy

A report has been published by the Norwegian Environment Agency about how Norway will move towards a low carbon economy. In the 346 page long report, specific actions are mentioned, which will be taken in different sectors and industries to help achieve the 'green shift' in Norway. Norwegian ferroalloy industries were explicitly mentioned in the report, and have been working hard to move further in the development of new green technologies. Increasing utilization of biomass produced charcoal as the reducing agent in metallurgical industry processes will be one of the key contributions from the ferroalloy industries to develop a low carbon economy in Norway. The report points out that the ferroalloys sector in Norway should be able to use 20% charcoal by 2030, which will reduce CO<sub>2</sub> emission due to replacement of the current use of coke in their production processes. The main constraints for realizing this goal will be the price and availability of sustainable charcoal.

### BioCarb+ PhD position filled

The PhD position within "Biocarbon production modelling" has been filled by a German candidate, Kathrin Weber, who started in the position in October. The topic is "modelling of biocarbon production processes" and the aim is to model the biomass carbonization process, and further use the model as an efficient tool in the selection/design and optimization of biocarbon production processes.

Kathrin graduated from RWTH Aachen University (Germany) with a MSc degree in Fuel Engineering. She has spent three years as a researcher at RWTH within the Unit of Technology of Fuels (TEER), with a focus on the combustion of herbaceous biomass. In 2013, Kathrin joined the Association of German Engineers (VDI) workgroup 3933, working on guidelines for the production of biocarbon.

Kathrin's PhD work will start with a literature review to get an overview of available biocarbon production processes, characteristics and applications, and more focus will be given to assess biomass carbonization modelling work previously performed, and identify different mechanisms that have been used. Furthermore, a model will be developed for modelling biocarbon production processes. Additionally, experimental work might be carried out to validate the model and to improve it as well.

### BioCarb+ work presented at The American Institute of Chemical Engineers (AIChE) Annual Meeting in Atlanta, USA

The American Institute of Chemical Engineers (AIChE) is the world famous and leading organization for chemical engineers interested in innovation and professional growth. AIChE arranges meeting annually to provide a forum for academic and industry experts to disseminate and share cutting-edge research results and new technologies in areas of chemical engineering. This year, the AIChE annual meeting was held 16-21 November in Atlanta, USA. An oral presentation on "Thermogravimetric studies of charcoal formation from cellulose under different pyrolysis conditions" was given in the meeting to present the latest research results achieved in the BioCarb+ project.

This work investigated charcoal formation from cellulose under different pyrolysis conditions. Cellulose is the major constituent of most biomass materials and accounts for 40-50% of woods. The studied cellulose samples were pyrolyzed in two different thermogravimetric analyzers (TGA) under different heating rates and purge flow conditions. It was found that low heating rate, combined with low purge flow rate, favored formation of char from the pyrolysis of cellulose in nitrogen. As the pyrolysis of cellulose occurred in a crucible, covering of the crucible with a lid significantly enhanced cellulose char yields under the tested conditions. Variations

in morphology and microstructure were observed for the cellulose chars produced under the different conditions. Cellulose char produced in open crucibles have a porous structure as shown in Figure 1(a) below. On the other hand, cellulose char produced in a crucible covered with a lid has more compact structure and is partially melting, with a smooth surface. Using low heating rate and a crucible with lid covering prolong the residence time of pyrolytic vapors in the char matrix and promote secondary char formation, enhancing cellulose char yields consequently.

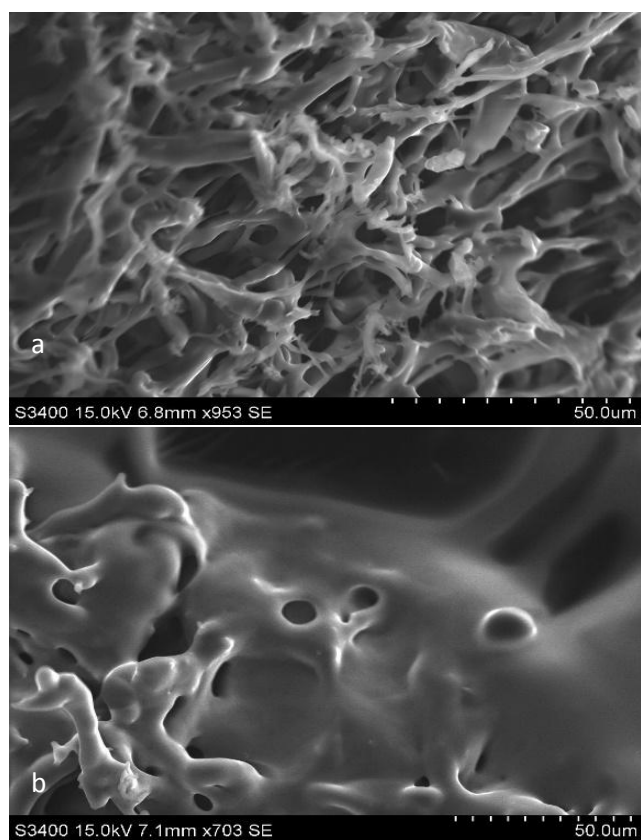


Figure 1 Scanning electron microscopy (SEM) image of cellulose char produced in (a) open crucible and (b) crucible covered by a lid.

### International collaboration within BioCarb+

Two students, Charissa Higashi (graduate student) and Kathryn Hu (undergraduate student), from the University of Hawaii (UH) at Manoa, visited SINTEF/NTNU and worked as summer research assistants from May until August. Their visit is a continuation of the international collaboration between UH, SINTEF and NTNU, which was sponsored by the National Science Foundation (NSF) in USA. The two students were linked to the BioCarb+ project and were involved in different biocarbon related research activities. Two abstracts summarizing main results from these research activities were submitted to the 23<sup>rd</sup> European Biomass Conference and Exhibition that will be held 1-4 June 2015 in Vienna, Austria. Earlier, two high quality journal publications resulting from

this international collaboration have been published in the journal *Energy & Fuels*.



Figure 2 Two students from the University of Hawaii at Manoa worked as research assistants at SINTEF/NTNU. From the left: Kathryn Hu and Charissa Higashi

### New publications

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

### Three abstracts submitted to 23<sup>rd</sup> European Biomass Conference and Exhibition

The European Biomass Conference and Exhibition is the largest international conference focusing on research, industry, policy and business of biomass. The 23<sup>rd</sup> European Biomass Conference and Exhibition (EUBCE) will be held 1-4 June 2015 in Vienna, Austria. Call for submission of abstracts to the EUBCE 2015 was announced August 2014, which received great responses from scientists, specialists, professionals and industrial actors all over the world. Three abstracts were submitted to the EUBCE 2015, for presenting Intermediate research results achieved in the BioCarb + project. The first paper deals with charcoal production from forest residues under different conditions. Effects of carbonization process parameters on forest residues char yields are assessed, aiming for maximizing the yield and quality of biocarbon produced from GROT (branches and treetops), through optimizing key process parameters. The second paper focuses on studying combustion relevant characteristics of biocarbon produced at different carbonization conditions from the GROT. Combustion of biocarbon is conducted in a high sensitivity thermogravimetric analyzer (TGA) under well-controlled conditions. The biocarbon reaction rate and key kinetic parameters are extracted through kinetic evaluation. The third paper reports effects of storage time and conditions on the properties of woody charcoal. This work has great relevance to industries using large amounts of biocarbon in

e.g. metallurgical industry processes. Results of the work suggest that measures should be taken to avoid change in charcoal properties during long time storage time at unfavorable conditions.

Liang Wang, Gábor Várhegyi, Øyvind Skreiberg, Morten G. Grønli, Michael J. Antal, Jr. **Combustion Characteristics of Biomass Charcoal Produced at Different Carbonization Conditions.**

Liang Wang, Charissa Higashi, Øyvind Skreiberg, Morten G. Grønli, Michael J. Antal, Jr. **Charcoal Production from Forest Residues.**

Liang Wang, Kathryn Hu, Charissa Higashi, Øyvind Skreiberg, Viktor Myrvågnes, Morten G. Grønli, Michael J. Antal, Jr., Gábor Várhegyi. **Effect of Storage Time and Conditions on Biomass Charcoal Properties.**

## 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 kvær blir edelt kull. [Gemini](#). Reproduced on [forskning.no](#), [Aftenposten nett](#) and [Adresseavisen nett](#).



(<http://gemini.no/wp-content/uploads/2014/05/SintefBioCarbon-6879-Copy.jpg>)

In comparison with other fossil fuels, charcoal emits low levels of sulphur and nitrogen oxides. This would result in lower local air pollution. Photo: Thor Nielsen

## Lopwood and brushwood make high-grade charcoal

When the forestry machines have finished extracting timber, what is left are tops and branches – waste which cannot be used. However, according to researchers, it is possible to turn these heaps of lopwood into high-quality charcoal.

By Lars Martin Hjorthol (<http://gemini.no/en/author/lars-martin/>)  
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## Other news

### CenBio events

#### CenBio Days 2014

The annual CenBio conference, the CenBio days, was held 26-28 March in Lillestrøm. CenBio researchers and user partners

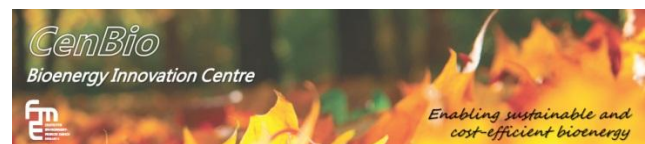
joined the three days event for communicating and discussing technical topics, innovations and challenges of bioenergy research and industry and bioenergy value chains. SINTEF Energy Research was represented at this workshop with 3 presentations for updating participants with latest research results about: 1) wood stoves value chain, 2) numerical simulations of NO<sub>x</sub> emissions during staged biomass grate combustion, 3) ash related research activities.

### CenBio Ash Workshop

A CenBio-sponsored ash workshop was arranged at Værnes 27 May. The workshop is the first one addressing ash related industrial challenges and R&D opportunities in Norway. During the workshop, the Norwegian "biomass and waste ash community" from both industry and research institutes was gathered for sharing knowledge and experience and discussing future cooperation on ash related topics.

### CenBio Strategic Days 2014

The annual CenBio Strategic Days was arranged at Gardermoen 29-30 October. The focus was on the road ahead regarding the work to be carried out in 2015 as well as presentation of the first results for the value chain work that has been carried out for the current Norwegian bioenergy system. After the current system has been analyzed, the work will continue with analyses of improvement potentials in the different parts of the various value chains.



### EERA Bioenergy

The European Energy Research Alliance (EERA) is one of the most important initiatives in the public research domain in Europe. The EERA contributes to coordinate and align activities of energy research organizations in 15 Joint Programmes (JPs) to develop more efficient and cheaper renewable energy technologies. Senior research scientist Michael Becidan from SINTEF Energy Research is working as the coordinator of sub programme Stationary Bioenergy in the Joint Programme on Bioenergy. In December, EERA Bioenergy Joint Programme was proposed to the European SET-Plan (Strategic Energy Technology) for obtaining support (stage 1 proposal) in an upcoming Horizon 2020 call. The title of the proposal is "Developing challenging alternatives to promote EU leadership in the fields of Sustainable Bioenergy and Bioeconomy". It is centered on two topics: 1. Mobilisation of new biomass resources 2. Development of advanced and innovative biofuel production pathways.

### IEA Task 32 Biomass Combustion and Cofiring

The last Task 32 meeting this year was arranged in South Africa. During the year three workshops have been arranged

in connection with the task meetings, see <http://www.ieabcc.nl/>.

### Conference and workshop participation

1st International Workshop on CFD and Biomass Thermochemical Conversion, 30<sup>th</sup> September, 2014, DBFZ, Leipzig, Germany

SINTEF Energy Research and NTNU was represented at this workshop with 6 presentations/papers, as well as giving a plenary lecture on "Biofuels of the future and modelling implications". CFD is a priority research area and is increasingly applied as a development tool in different projects.

International Conference on Applied Energy (ICAE) 2014, 30 May - 2 June, Taipei, Taiwan

SINTEF Energy Research and NTNU were represented in this conference with three papers for disseminating latest research results of: 1) Sintering of rye ash and effect of additive, 2) Wet torrefaction of forest residues, and 3) Effects of CO<sub>2</sub> on wet torrefaction of biomass.

International conference on biomass (iconBM) 4-7 May 2014, Florence, Italy

SINTEF Energy Research and NTNU were represented in this conference with three papers for presenting research results of: 1) Characterization of ashes from different wood parts of Norway spruce tree, 2) Effect of Sewage Sludge Addition on Potassium Release and Ash Transformation during Wheat Straw Combustion, and 3) Torrefaction kinetics of Norwegian biomass fuels.

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

[BioCarb+](#)

[SKOG22](#)

[Energi21](#)

[Renewable Heating and Cooling technology platform](#)

[EERA Bioenergy](#)

[IEA Task32 Biomass Combustion and Cofiring](#)



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