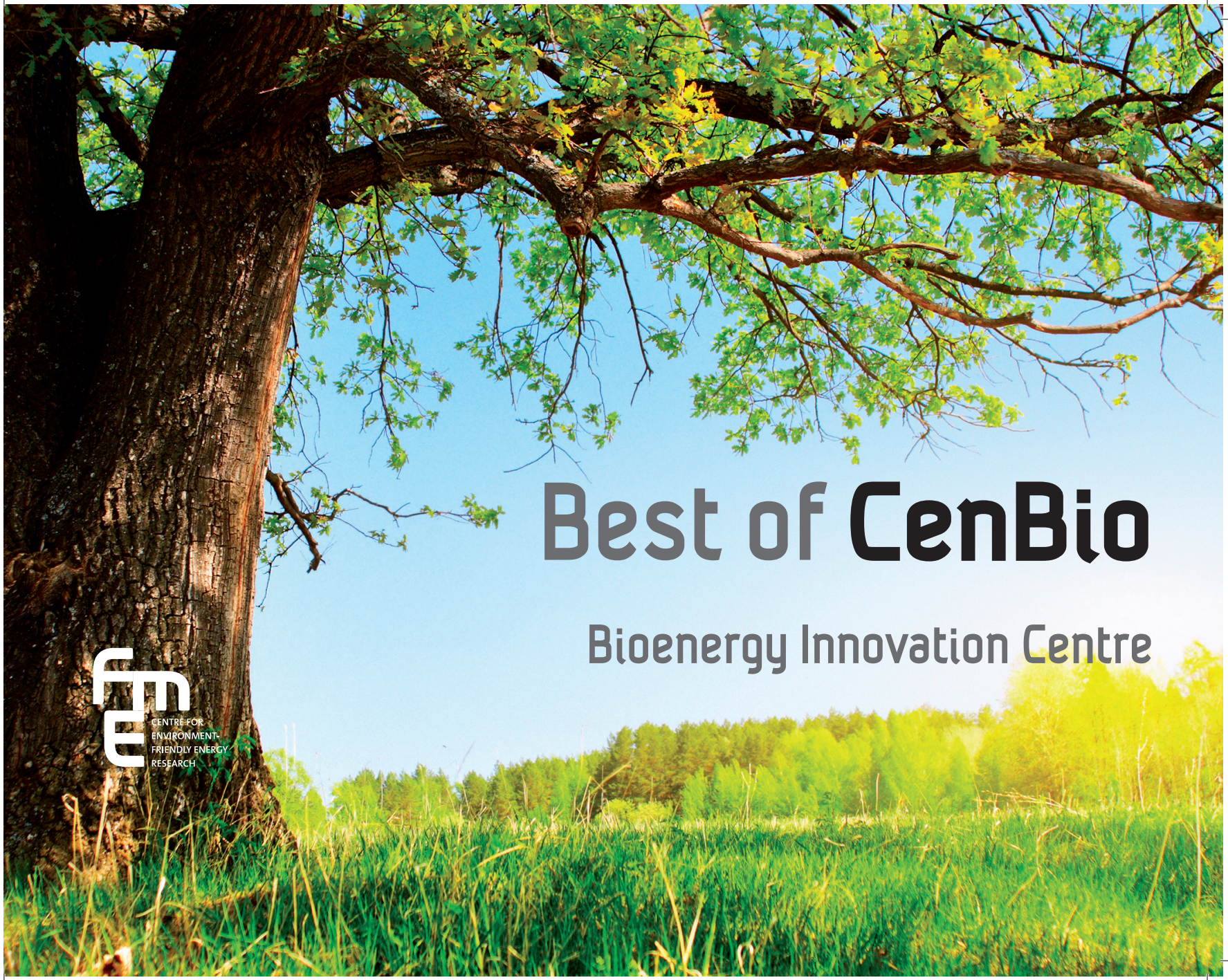
Best of CenBio
Bioenergy Innovation Centre
CENTRE FOR
ENVIRONMENT-
FRIENDLY ENERGY
RESEARCH

Objective

The objective is to develop the basis for a sustainable, cost-effective bioenergy industry in Norway in order to achieve the national goal of doubling bioenergy use by 2020.

CenBio addresses the entire value chains of virgin biomass and biodegradable waste fractions, including:

- production
- harvesting and transportation
- conversion to heat and power
- upgrade of residues to valuable products

CenBio researchers develop effective and environmentally sound ways of utilizing more biomass and waste for energy purposes. Educating and training the next generation of bioenergy researchers and industry players are essential to attain these ambitious goals.

As a result, consumers and society will be supplied with more renewable and CO_2-cutting energy. By further developing the Norwegian bioenergy industry, a substantial number of new jobs, especially in rural districts, will be created.

Project period: 2009-2017
Total budget: Approx. 265 MNOK

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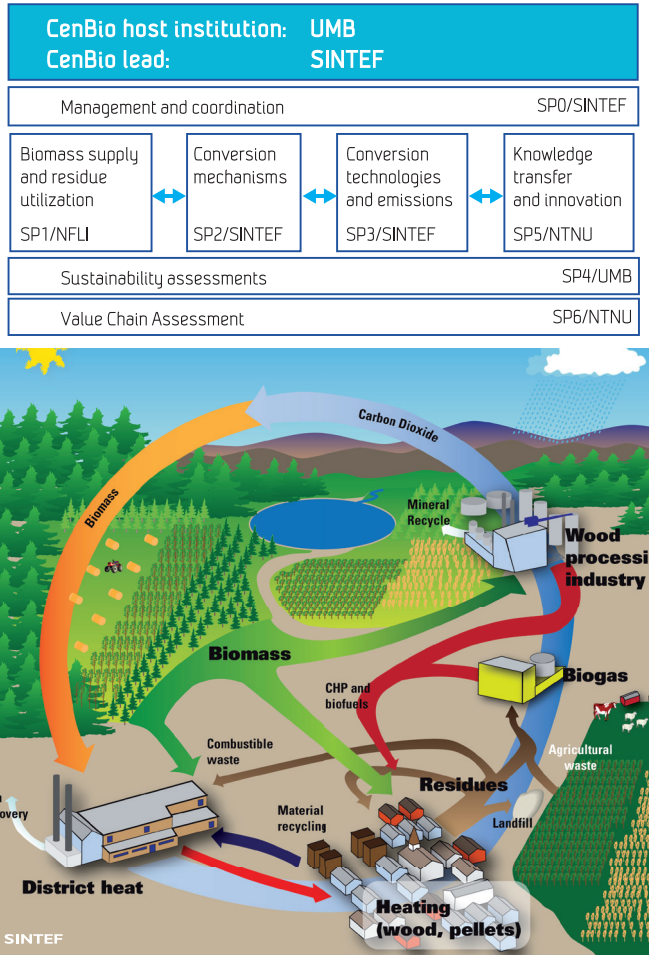
CenBio structure



Fruitful hunt for small trees

A doctoral study financed by the CenBio programme could help to reduce the costs of "first thinning" of forests, which would be good news for forestry and the bioenergy industry.

Forest owners have always dreamt of being able to thin their trees at an early stage of growth, in order to enable the remaining stock to develop optimally and produce high-quality timber. However, in Norway, as in other countries, there has been a lack of customers for the small trees that are extracted in an early first thinning, with the result that the operation has been postponed to a later stage.

"But now, bioenergy could become a market for this assortment", says Helmer Belbo, PhD, a researcher at the Norwegian Forest and Landscape Institute.

If this turns out to be true, the result will mean a win-win situation; improved growth conditions for timber production, and greater availability of energy-rich raw material for the bioenergy industry. However, one problem does remain; how can we make this small tree harvesting cost-effective? Belbo's doctorate, financed by CenBio and defended in 2011, focused on just this question.

"Sweden and Finland take out large amounts of small timber for energy production, but even there, subsidies are essential", says Belbo.

In his doctoral study, Belbo collaborated with Sweden's Skogforsk forestry research institute and carried out field studies of current technology. Subsequent computer simulations enabled him to draw up a theoretical foundation for the design of more efficient solutions.

"Has the industry taken your results on board?"

"In our practical studies we identified relationships that are important for product yield, in terms of both tree-felling equipment and methods of employing such equipment. New equipment that I have since seen, shows that equipment manufacturers have begun to adopt our findings. But in my opinion, both the technology and the methods involved have not yet matured sufficiently. There is still more to be done, and we are working on a number of concrete ideas that could help to improve productivity yet further."

Studies of technology for extracting small trees formed the basis of a doctoral study that could lower the cost of harvesting the first thinning of forests. Photo: Helmer Belbo

Green heat from soapstone

From Brussels came a new standard that could have cast a dark cloud over the future of Norwegian stove manufacturer Granit Kleber. However, the company kept up its spirits by tackling the problem head-on, and managed to reduce its stoves' particle emissions.

Granit Kleber and its 18 employees, based in the little town of Otta, make stoves and fireplaces of massive soapstone.

Unlike most wood-burning stoves, these stoves also store heat, and in other countries, such stoves are usually large and heavy. The new European Union regulation would only let heavy models through the eye of the needle, so Granit Kleber, with its relatively lightweight models, needed to find another way.

The solution was to redesign the stoves so that they instead satisfied the requirements of the Norwegian standard for wood-fired stoves, by fitting them with afterburners. These feed preheated secondary air into the flue gas through holes in the burn-plate, thus enabling the uncombusted gases to burn up completely.

The afterburners for the Otta stoves were designed by the CenBio programme as a cooperative project involving the company itself and SINTEF's Edvard Karlsvik, the "grand old man" of Norwegian wood-stove research and CenBio Innovation Award winner in 2011.

According to Granit Kleber's managing director Torbjørn Randen, the result was a "win-win" situation; particle emissions were reduced while the combustion efficiency of the stoves actually increased.

"For a small company like ours, it is vitally important to be able to collaborate like this with a research group", says Randen

Ovens like these store heat. A CenBio project has allowed them to burn more cleanly. Photo: Granit Kleber

Direct from the plant world to the fuel market

The world is crying out for more – and more environment-friendly – fuel.

CenBio has accepted the challenge by looking at the potential for generating biogas from cellulose-rich raw materials such as birchwood, willow and straw.

Biogas is generated by the microbial breakdown of organic material in oxygen-free environments. When the gas is scrubbed of CO_2 and then compressed, it can be used for fuel.

Until recently, most biogas production plants have used food waste and sewage sludge as input.

"The production of biogas is the most direct route from biomass to fuel. We decided to study cellulose as a potential raw material because of its high energy content, and because this is the biomass that nature produces most of", says Odd Jarle Skjelhaugen, Centre Director at Norway's University of Life Sciences (UMB).

CenBio's industrial partner in the project is the Norwegian company Cambi AS, which supplies biogas plants worldwide.

The company's technology for steam-based pre-treatment of raw materials is regarded as highly relevant to the research activity in CenBio.

"Efficient raw material harvesting and distribution of the bio-fertiliser by-product is also important in cellulose-based production of biogas. That's why it is useful for us that CenBio is looking at the whole value chain", says Cambi's research and development director Paal J. Nilsen.

One of the latest plants from Cambi AS (Cardiff, UK). Photo: Cambi AS

The "dream fuel" is already here!

Not all types of biomass are equally easy to use as fuel in terms of combustion technology; now, "torrefaction" offers a promising solution to this problem.

There are plenty of inexpensive fuels to be found in nature; some examples are branches and tree-tops (GROT in their Norwegian acronym), and straw. However, these types of raw materials are difficult to handle, and they can damage furnaces and reduce combustion efficiency.

"However, torrefaction transforms logging residues and straw into a homogeneous fuel with high energy density", says SINTEF senior scientist Øyvind Skreiberg. Moreover, this fuel can be easily stored and transported, and just like coal, it can tolerate getting wet.

In the torrefaction process, the raw material is heated to 200 – 300 ^{0}C, thus breaking down its fibrous structure. This makes the fuel easier to handle, as it can easily be ground down to a powder and then moulded into pellets.

In CenBio, SINTEF is using a specially constructed laboratory setup to study how different production conditions affect the quality of the end-product fuel. These combustion characteristics are checked in an instrumented pellet stove.

"Won't torrefaction make the energy from such fuels too expensive?"

"Our hope is that torrefaction will make cheap, and until now problematic, biomass fuels easier to handle and improve their combustion properties, while the low price of the raw material itself is precisely what should make this method competitive", says Øyvind Skreiberg.

SINTEF Research Scientist Roger Khalil working on the torrefaction reactor. Photo: SINTEF/Thor NIelsen

Different climatic effects of bioenergy from the forest

Did you know that in some parts of the world, people can actually contribute to global cooling by burning wood or woodchips?

Official climate accounting defines bioenergy as a "climate-neutral" source of energy. "Both the European Union and the USA are beginning to consider this in new ways. CenBio research has shown that such innovative thinking is essential", says NTNU scientist Francesco Cherubini.

Cherubini explains that the climatic consequences of CO_2 emissions from burning timber products are largely determined by a single circumstance: the length of time it takes before the emissions are reincorporated into new forest growth, a process that can take several decades.

"Current European and US policy overlooks not only the time aspect. It also ignores the fact that local effects of felling trees can either reinforce or counteract the effects of CO_2 emissions. On a felled site with a significant amount of seasonal snow cover, the increase in reflected solar radiation can affect the climate in ways that largely compensate for the effects of the emissions from combustion", the NTNU scientist points out.

Together with colleagues Anders H. Strømman and Ryan M. Bright, Cherubini has demonstrated that the use of biomass from central Canada for energy production can actually contribute to global cooling.

"There is no universal relationship as far as this effect is concerned. Climatic effects are dependent on location. But we need to remember something important, which is that in the long term, bioenergy derived from forest products will always have a smaller direct effect on the climate than fossil fuel does. In Norway, it is also more climate-friendly in the short run to use energy derived from wood than from fossil sources. The same is true of other regions which, like us, experience a strong cooling effect from felled areas because they reflect a great deal of solar radiation", says Francesco Cherubini.

Open country, including felled areas that have not yet regrown, reflect more solar radiation than woods and forests. This has a cooling effect on the climate that is particularly powerful in snow-covered areas. Photo: Helmer Belbo

Partners

Research institutes:

- Norwegian University of Life Sciences
- SINTEF Energy Research
- Norwegian University of Science and Technology
- Bioforsk
- Norwegian Forest and Landscape Institute
- SINTEF
- Vattenfall Research and Development AB

International collaborative research institutions:

- EFI – European Forest Institute
- University of Innsbruck (Austria)
- UFRN - Federal University of Rio Grande do Norte (Brazil)
- German Federal Forest Research Institute (D)
- University of Freiburg (D)
- Aalborg University (DK)
- Technical University of Denmark (DK)
- University of Copenhagen (DK)
- IREC - Catalonian Institute for Energy Research (ES)
- Åbo Akademi (FI)
- METLA - Finnish Forest Research Institute (FI)
- University of Lappenraanta (FI)
- Hungarian Academy of Sciences (Hungary)
- Skogforsk - Forestry Research Institute of Sweden (S)
- Swedish University of Agricultural Sciences (SLU) (S)
- University of Belgrade (Serbia)
- Makerere University (Uganda)
- University of Hawaii at Manoa (USA)
- University of Minnesota (USA)
- University of North Carolina (USA)

Industries / User partners:

- Akershus Energi AS
- Norges Skogeierforbund
- Agder Energi AS
- NTE Holding AS
- Hafslund ASA
- Statkraft Varme AS
- Norske Skogindustrier ASA
- Norsk Protein AS
- Avfall Norge
- Norges Bondelag
- Oslo Kommune Energigjenvinningsetaten
- Vattenfall AB Nordic Heat
- Energos AS
- Cambi AS
- Jøtul AS
- Granit Kleber AS

CenBio - Bioenergy Innovation Centre:

Research and development for a sustainable, cost-effective bioenergy industry in Norway in order to achieve the national goal of doubling bioenergy use by 2020.

Norwegian University of Life Sciences (UMB) is the host institution and SINTEF Energy Research is the coordinating institution. A number of Norwegian and international industrial companies and R&D institutes are partners in the centre.

The centre, co-funded by the Research Council of Norway and the partners, is one of the eleven centres of the FME scheme (Centre for Environment friendly Energy Research). The scheme seeks to develop expertise and promote innovation through focus on long-term research in selected areas of environment-friendly energy, transport and CO_2 management in close cooperation between prominent research communities and users.

More information about the FME scheme can be found at:
www.forskningsradet.no/energisenter

The Research Council of Norway

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