



**NIBIO**

**NIBIO**

Wood Technology Laboratory



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# 1 Treatment and durability of wood

## 1.1 Treatment of wood

### Vacuum cabinet

**Purpose:**

Drying of specimens. Small scale wood modification studies.

**Details:**

- Inner chamber volume: 53L
- Temperature range: ambient to 200 °C
- Vacuum pump: ME 8SI, max pumping speed 7.8 m<sup>3</sup>/h



### Pilot-scale impregnation plant

**Purpose:**

Wood-based products can be pressure- or vacuum-treated in the pilot-scale autoclave.

**Details:**

- 430 litres
- 2.10 m length



### Industrial scale impregnation plant

**Purpose:**

Wood-based products can be pressure- or vacuum-treated in large scale.

**Details:**

- 6 m length
- 80 cm diameter



## 1.2 Surface fungi

### Fungal colonization on wood surfaces

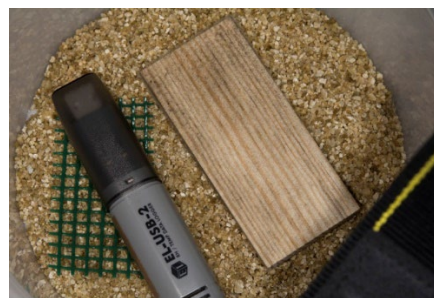
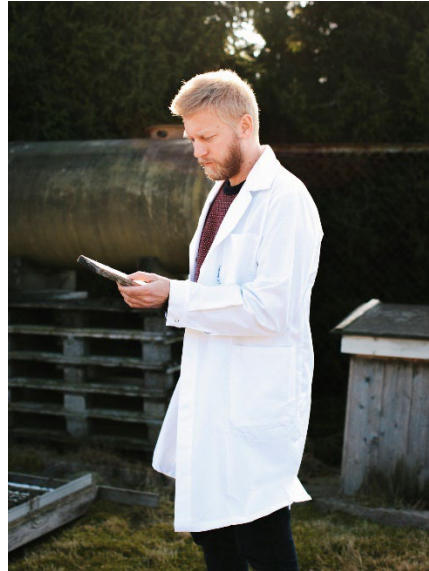
#### **Purpose:**

Analysis of fungal growth (mould and blue-stain fungi) on coated or non-coated wood-based substrate in field- or lab-trials.

#### **Details:**

Testing according to several standardized and non-standardized tests.

- EN 927-3, natural weathering test for exterior wood coating systems.
- BS 3900-G6, fungal resistance of paints, varnishes and lacquers after application, performed in laboratory conditions using mixed spore suspension is prepared from selected fungal species.
- EN152, specifically developed for the determination of the protective effectiveness of a preservative treatment against blue stain in wood in service, test is performed in laboratory conditions.
- EN 15457 targets to determine the protective effectiveness of a preservative treatment against blue stain in wood in service. This test method is designed to assess the biocidal/biostatic efficacy of film preservatives in a coating against fungal growth. The coating material is applied to a cellulose filter paper, placed on an agar surface, and inoculated with a standard fungal spore suspension.



## 1.3 Brown- and white rot fungi

### Durability of wood (according to standard)

**Purpose:**

European standard test for determining the protective effect of wood protection systems against wood decaying fungi.

**Details:**

- According to EN 113
- Sample dimensions: 50 x 25 x 15 mm
- Exposure to wood decaying fungi in Kolle flasks with malt/agar-medium
- Duration: 16 weeks



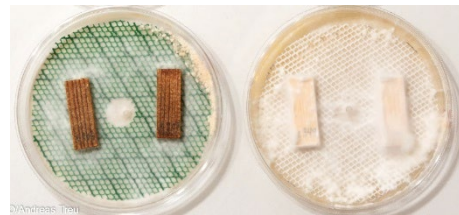
### Durability of wood (non-standard)

**Purpose:**

Non-standardized fast test giving indications whether a new wood protecting system is worth testing any further (miniblock test).

**Details:**

- Sample dimensions: e.g. 30 x 10 x 5 mm or smaller
- Duration: 8 weeks (on malt/agar-medium) or longer (on soil)
- Exposure to decay fungi in Petri dishes with malt/agar-medium or in glass containers with soil



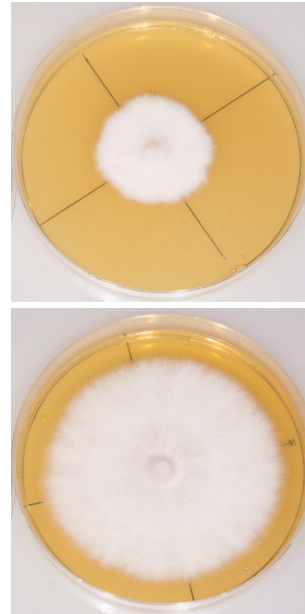
## Radial growth on growth medium

### **Purpose:**

Non-standardized fast test giving indications whether a new wood protecting system is worth testing any further.

### **Details:**

- Exposure to decay fungi in Petri dishes with malt/agar-medium or in glass containers with soil
- Radial growth in agar plates.
- Direct effect on growth rate of decay fungi.
- Duration: 1-2 weeks



## 1.4 Field testing

### Wood in-ground and above-ground contact

#### **Purpose:**

Service life of wood products depends on biotic and abiotic factors and can be predicted using exposure test sites.

#### **Details:**

- **EN 252** - European standard for testing of protective effect of wood protection systems in soil contact with sample size of 500 x 50 x 25 mm.
- Annual inspection/evaluation.
- Duration: Minimum 5 years, or until the samples fail during inspection.
- **ENV 12037** Lap-joint - European standard for testing of protective effect of wood protection systems above ground.
- Two test specimens (300 x 85 x 38 mm) are joined by a strip and a water trap is created. The samples are end sealed and exposed horizontally, minimum 1 m above ground.
- NIBIO also performs non-standard field tests, both in soil contact and above ground, adapted to the specific needs of the customer.



## 2 Physical properties of wood

### 2.1 Mechanical properties

#### Universal testing machine

**Purpose:**

Strength properties are important physical properties of wood. Solid wood and wood-based panels can be tested according to standards under quasi-static load.

**Details:**

The use of strength measurement equipment is ensured by NMBU. Further technological details can be acquired by the faculty of environmental sciences and natural resource management (MINA).



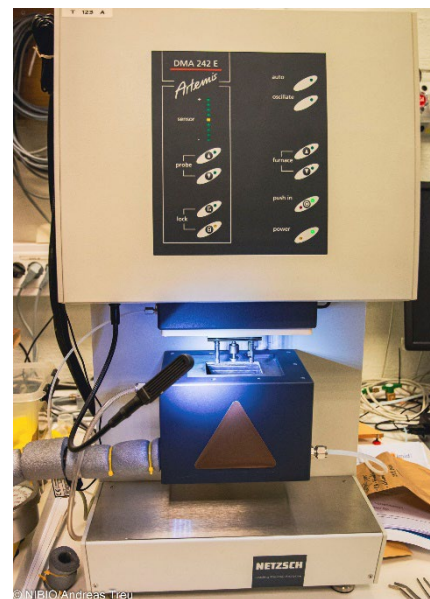
#### Dynamic mechanical analyzer (DMA)

**Purpose:**

To characterize the viscoelastic properties of wood as a function of frequency, temperature, and time.

**Details:**

- Netzsch DMA 242 E
- Temperature range: -170 to 600 °C
- Heating rates: 0.01 to 20 K/min
- Relative humidity range: 5 to 90 % (in temperature range from RT to 70 °C)
- A wide variety of sample holder systems is available to accommodate a broad range of sample geometries and consistencies



## 2.2 Wood-water relations

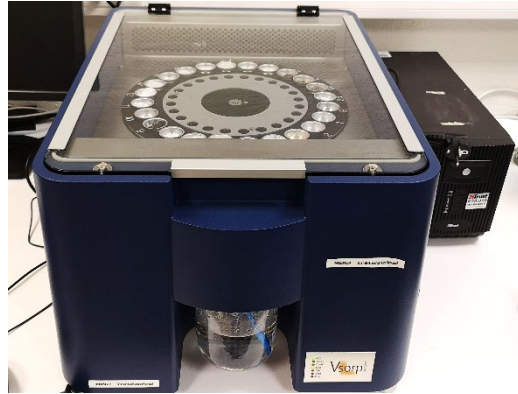
### Automated sorption balance

**Purpose:**

Gravimetric analysis of moisture sorption dynamics within the hygroscopic range.

**Details:**

- proUmid Vsorp moisture sorption analyser
- Multi-sample capability: up to 23 samples
- Balance resolution: 1 µg (up to 22 g of sample)
- 100 µg (up to 220 g of sample)
- Humidity range: 0 to 95% RH
- Sample mass range: 30 µg to 220 g



### Low-field nuclear magnetic resonance spectrometer

**Purpose:**

Determines water states and dynamics in different confined environments in wood and other materials.

**Details:**

- Low field Bruker NMR mq20 spectrometer
- 0.47 T permanent magnet
- Proton resonance frequency of 20 MHz
- Temperature range: -20 to +30°C



### Climate chambers

**Purpose:**

Used to maintain controlled humidity and temperature conditions.

**Details:**

- Temperature range: +5 to +70 °C
- Humidity range: 10 to 90%
- Capacity: 240, 384 and 749 liters





## 2.3 Wood surface characterisation

### Colour and gloss of surfaces

**Purpose:**

Analysis of gloss and colour on different surfaces



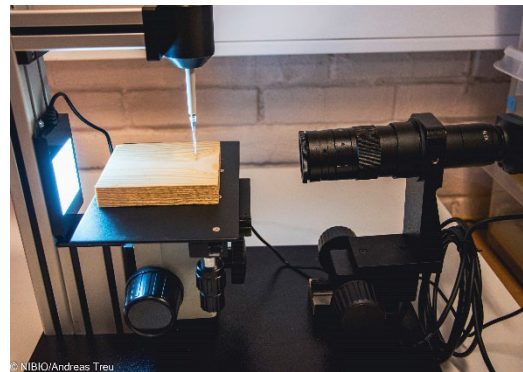
### Contact angle measurement

**Purpose:**

The contact angle that a droplet of water (or other probe liquids) form on a substrate surface gives insights into the wettability and can be used to determine the surface free energy of a material.

**Details:**

- Droplets are recorded over time using the video function.
- Contact angle is measured automatically by the software.



### Surface roughness

**Purpose:**

Surface roughness can influence various surface properties such as glueability, adhesion and aesthetics.

**Details:**

- Measuring length  $L_m$  0.48 mm to 26 mm
- Measuring speed  $v_t$  0.2 mm/s; 0.5 mm/s; 1.0 mm/s



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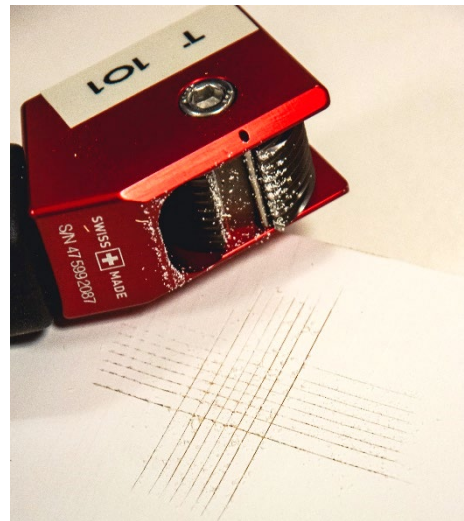
## Coating thickness and adhesion

### **Purpose:**

Thickness and adhesion strength are important factors in the performance and service life of coated wood products.

### **Details:**

- **Dry coatings thickness** is determined by the wedge cut method and a visual analysis with a paint inspection gauge.
- **Adhesion strength** is measured by the pull-off test following ISO 4624: 2002. A pull stub is glued to the coating and its pull-off force provides information of the strength of adhesion between coating and substrate.
- **Resistance of a coating** to separation from the substrate is measured by the cross-cut test according to ISO 2409: 2020. An X-cut pattern is made through the coating down to the substrate. Tape is placed on the centre of the intersection of the cuts and then removed rapidly. The X-cut area is then inspected for removal of coating from the substrate or underlying coating and rated.



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## Artificial weathering

### **Purpose:**

Exposes the wood surface to different cycles of water spraying and UV light irradiation to simulate weathering effects.

### **Details:**

- Atlas UV Test
- **EN 927-6** Artificial weathering of wood coatings using fluorescent UV and water



### 3 Calorific value of wood

#### Oxygen bomb calorimeter

**Purpose:**

Determination of calorific value of wood and other oxygen combustible materials

**Details:**

- 6300 Oxygen bomb calorimeter, Parr Instrument
- Specimen mass: <1.5 g
- Moisture content of specimen: up to 20%



## 4 Fire properties of wood

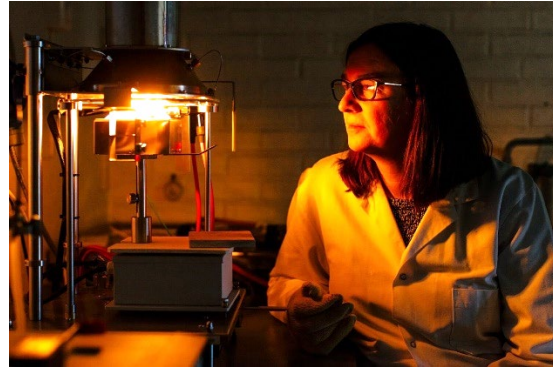
### Cone calorimeter testing

***Purpose:***

Bench-scale system to measure material flammability based on heat release rate.

***Details:***

- Sample size of 10 x 10 cm can be tested



## 5 Chemical composition of wood

### Simultaneous thermal analysis (STA)

**Purpose:**

Evaluation of chemical composition of wood.

The simultaneous thermal analyser (STA) combines Thermogravimetry (TG) and Differential Scanning Calorimetry (DSC) with the analysis of evolved gases by Fourier-Transform Infrared spectroscopy (FTIR) and Gas Chromatograph – Mass spectrometry (GC-MS).

**Details:**

- Netzsch STA 449 F1 Jupiter with SiC furnace and auto sampler
- Bruker Tensor 27 FTIR spectrometer
- Agilent Technologies GC-MS with TG coupling bundle (JAS)



### Accelerated solvent extractor (ASE)

**Purpose:**

Automated and fast solvent extraction system for solid or semisolid samples. Uses elevated temperatures and pressures to greatly increase extraction efficiencies. Also known as pressurized fluid extraction (PFE).

**Details:**

- Equipped with autosampler and solvent controller.
- Temperature range 40-200°C
- Pressure range 500 -3000 psi



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## Gas chromatography-mass spectrometry (GC-MS)

### ***Purpose:***

GC-MS is used for the identification and determination of extractives from wood and other organic materials. It also analyses greenhouse gases from soil respiration.

### **Details:**

- Agilent HP-5MS-UI Capillary column 30.0 m x 320  $\mu\text{m}$  x 0,25  $\mu\text{m}$ , used for extractives.
- Varian FactorFour™ Capillary Column VF-5ms, 30 m, 025 mm, 025  $\mu\text{m}$  for extractives.
- Chrompack CP-PoraPLOT Q-HT column 25 m x 0.32 mm, used for greenhouse gases.



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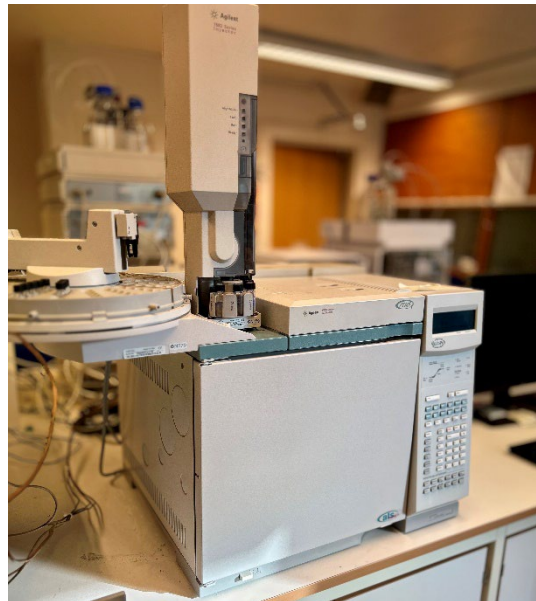
## Gas chromatography-flame ionization detection (GC-FID)

### ***Purpose:***

GC-FID is used for the determination of extractives from wood.

### **Details:**

- Agilent HP-1 Capillary column 25.0 m x 200  $\mu\text{m}$  x 0,11  $\mu\text{m}$ , used for extractives.



## High performance liquid chromatography (HPLC)

### **Purpose:**

HPLC is an analytical technique to separate and quantify components in a liquid mixture.

### **Details:**

- Agilent HPLC 1260 Infinity 2
- The Aminex HPX-87H column and the refractive index (RI) - detector and VWD UV-detector G7114A (wavelength: 210 nm) is used for the separation and determination of carboxylic acids, monosaccharides and alcohols.
- Poroshell 120 EC-C18 4,6 x 100 mm, 2,7  $\mu\text{m}$  and VWD UV-detector G7114A (wavelength: 200 nm) is used for the separation and determination of betulin, betulinic acid and lupeol.
- ZORBAX RR Eclipse XDB-C8, 4,6 x 75 mm, 3,5  $\mu\text{m}$  3.5  $\mu\text{m}$  4.6 mm and fluorescence detector with excitation at 340 nm and emission at 445 nm is used for determination of glucosamine from chitin or chitosan.
- Poroshell 120 EC-C18 4,6 x 100 mm, 2,7  $\mu\text{m}$  and VWD UV-detector G7114A (wavelength: 220 nm) is used for determination of propiconazole.



## Inductively coupled plasma optical emission spectroscopy (ICP-OES)

### **Purpose:**

ICP-OES is used for the determination of elements in liquid or digested solid samples.

### **Details:**

- Detectable elements: Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Ga, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sc, Se, Si, Sr, Ti, V, Y, and Zn.



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## Microwave digestion system

### **Purpose:**

High pressure & temperature microwave acid digestion system for digestion of solid samples into liquid for the determination of elements

### **Details:**

- Milestone ultraWAVE
- High pressure and temperature
- Acid digestion



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## Freeze drier

### **Purpose:**

Freeze-drying is used as a sample preparation method for material with chemical components which are sensitive to heat. Sublimation during freeze drying will convert frozen water in the material to the gas phase without thawing of water.

### **Details:**

- Labconco FreZone
- 8 liter, -50°C
- 8-port manifold or heated shelf setup
- Rotary vane pump





## 6 Wood microscopy

### Wood sectioning and staining

#### **Purpose:**

Preparation of samples for microscopic analysis typically requires wood sectioning, staining the wood tissue with different agents, or embedding in resin or other media.

#### **Details:**

- Sliding microtome with disposable blades
- Different staining agents for wood tissues
- Embedding protocols of wood



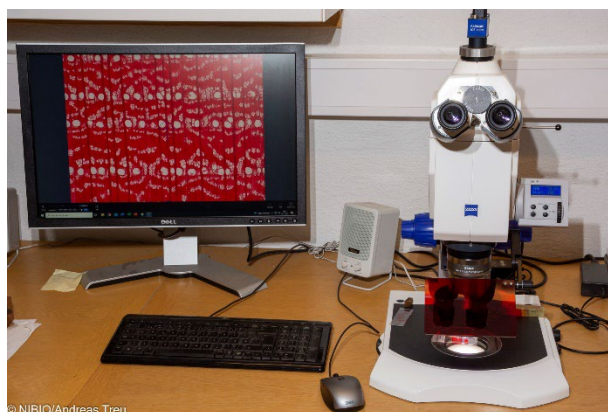
### Microscopic analysis

#### **Purpose:**

Microscopy is used for various types of analysis, i.e. the identification of wood species, fungal mycelia, surface fungi or analyses of surface coating and treatability of wood.

#### **Details:**

- Different types of microscopes are available, including reflected and transmitted-light microscopes, or fluorescence microscope
- Other microscopes (e.g. FTIR microscope) are accessible in other NIBIO departments
- We also have access to the Imaging Center at NMBU



### Xylarium – wood species library

#### **Purpose:**

The xylarium contains reference wood samples from over 600 different species. It is used to compare samples during wood identification.

#### **Details:**

- 123 different families
- 660 different species



## 7 Wood-based panel production

### Hydraulic laboratory press

**Purpose:**

The press is used to make wood-based panels, such as particleboard, laminated veneer lumber, or plywood as well as to glue solid wood.

**Details:**

- Hydraulic laboratory-press type HLP 100
- Pressing plates 60 x 60 cm
- Pressing force 10-100 t
- Max. spec. pressure 3 N/mm<sup>2</sup>
- Working height ca. 120 cm
- Maximum heating temperature 300 °C
- Glue drum, pre-press and other relevant equipment for particleboard manufacture are available



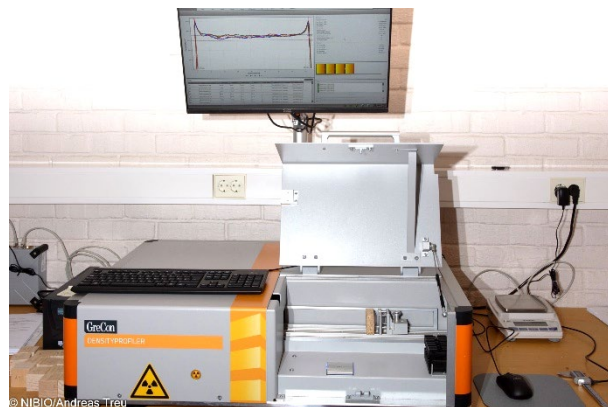
### Density profiler

**Purpose:**

Measures bulk density profiles of wood and wood-based panels using X-ray technology.

**Details:**

- GreCon DAX07 Density profiler
- Density range 75-1500 kg/m<sup>3</sup>
- Repeat accuracy: approx. ± 2 kg/m<sup>3</sup>
- Resolution: 0.01 kg/m<sup>3</sup> / 10 µm step size
- Specimen thickness: 1-350 mm



## Sieve shaker

### **Purpose:**

Determines the particle size distribution of wood-based material such as chips, sawdust, shavings, or fibres come from wood processing and can be used for wood-based panels. This is an important property which affects the strength properties and the amount of glue in wood panels.

### **Details:**

- Endecotts Model EFL2 mk3
- Different sieve sizes can be combined.



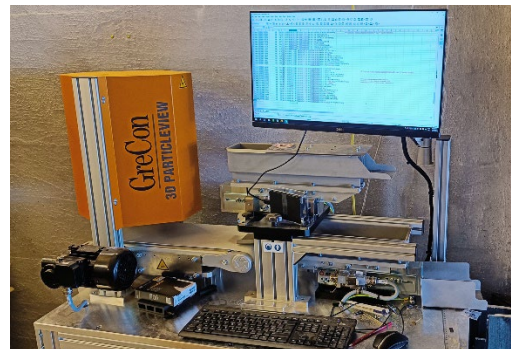
## Laser-based particle analysis

### **Purpose:**

Measures the entire particle geometry (length, width, and thickness) using laser technology. Vibratory conveyors separate and transport the particles into the measuring area where their geometry is measured by a line laser including a camera unit.

### **Details:**

- GreCon 3D PARTICLEVIEW
- Software processes recorded data into different outputs (distribution functions, ratio sizes, etc.)
- Applicable to wood chips, particles and granulates.
- Inspection width: 130 mm
- Resolution: 20  $\mu\text{m}$  in thickness, 100  $\mu\text{m}$  in width and height



## 8 Wood sample production

### Carpenter's workshop

***Purpose:***

All types of samples for our research can be produced in the workshop by our skilled carpenter.

***Technological details:***

- Various saw types (Circular-, band saw)
- Belt sander
- Planer ö



## 9 Staff members

Our skilled staff is ...



Gry Alfredsen



Monica Fongen



Erik Larnøy



Lone Ross



Michael Altgen



Eva Grodås



Andreas Treu



Eirik Nordhagen



Kristina B. Gedde



Stephen  
Amiandamhen



Katrin Zimmer



Sigrun Kolstad



Simen Gjølshj



Thor Erik V Alstad



Knut M. Sandland

# 10 Location

The department of wood technology is located in Høgskoleveien 8, 1433 Ås, Norway



# Contact

For further questions please contact

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Norsk institutt for bioøkonomi (NIBIO) ble opprettet 1. juli 2015 som en fusjon av Bioforsk, Norsk institutt for landbruksøkonomisk forskning (NILF) og Norsk institutt for skog og landskap.

Bioøkonomi baserer seg på utnyttelse og forvaltning av biologiske ressurser fra jord og hav, fremfor en fossil økonomi som er basert på kull, olje og gass. NIBIO skal være nasjonalt ledende for utvikling av kunnskap om bioøkonomi.

Gjennom forskning og kunnskapsproduksjon skal instituttet bidra til matsikkerhet, bærekraftig ressursforvaltning, innovasjon og verdiskaping innenfor verdikjedene for mat, skog og andre biobaserte næringer. Instituttet skal levere forskning, forvaltningsstøtte og kunnskap til anvendelse i nasjonal beredskap, forvaltning, næringsliv og samfunnet for øvrig.

NIBIO er eid av Landbruks- og matdepartementet som et forvaltningsorgan med særskilte fullmakter og eget styre. Hovedkontoret er på Ås. Instituttet har flere regionale enheter og et avdelingskontor i Oslo.