ZEB-LABORATORY

Innovations at the ZEB Laboratory

Photo: Nicola Lolli

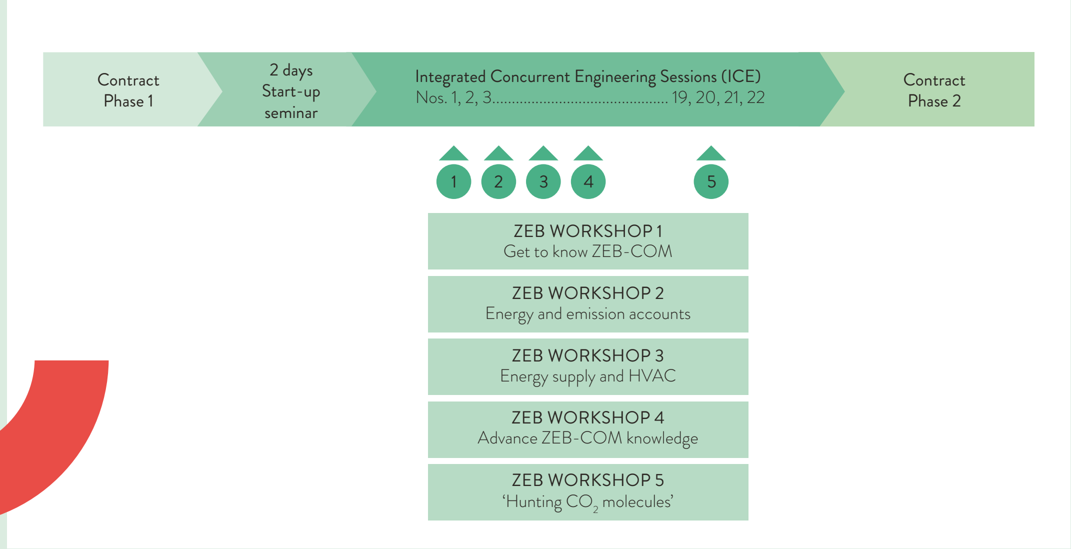


Illustration: Remy Eik, SINTEF

Photo: Tore Kvande, NTNU

1

Collaborative project delivery using ZEB methodology

REQUIREMENT

The development of buildings that make a zero contribution to greenhouse gas emissions during their construction, operation and demolition demands innovation throughout the building process. We recognise a need to develop more new concepts and solutions, and to obtain new knowledge about processes and strategies that enable the implementation of zero emissions buildings.

INNOVATION

At the ZEB Laboratory, our project delivery model gather key players together at the start of project development. We have developed and integrated the ZEB methodology as an organisational component of a project called Integrated Concurrent Engineering (ICE), which includes the co-location of the project group in a physical 'Big Room'. This project enabled the developer to meet the project team on one day a week to work through the project, drawing on input from all the technical and organisational participants involved. The participants worked in themed technical groups and in plenum, and a series of ZEB workshops were held as part of the project process. Project participants and the developer established shared objectives and resolved their problems together. They evaluated the process and reached an understanding that it was mutual and concurrent iterations over time that generated value and which helped the project to achieve its ZEB-related goals.

This is the first time that the ZEB methodology has been integrated in a collaborative effort of this type.

2

The Gløshaugen battery

REQUIREMENTS

In a zero emissions society, the built environment demands flexible energy solutions. The vision of the FME ZEN is to achieve 'sustainable neighbourhoods with zero emissions of greenhouse gases' In order to deliver this vision we have to develop tools that optimise local energy systems and their interaction with regional and national systems.

INNOVATION

Gløshaugen has access to its own local energy system with a separate heat energy supply and electricity tariff. The ZEB Laboratory generates electricity using roof- and facade-installed solar panels but is not equipped with its own battery for electricity storage. However, it is connected to the Gløshaugen electricity ring grid and utilises this as a battery.

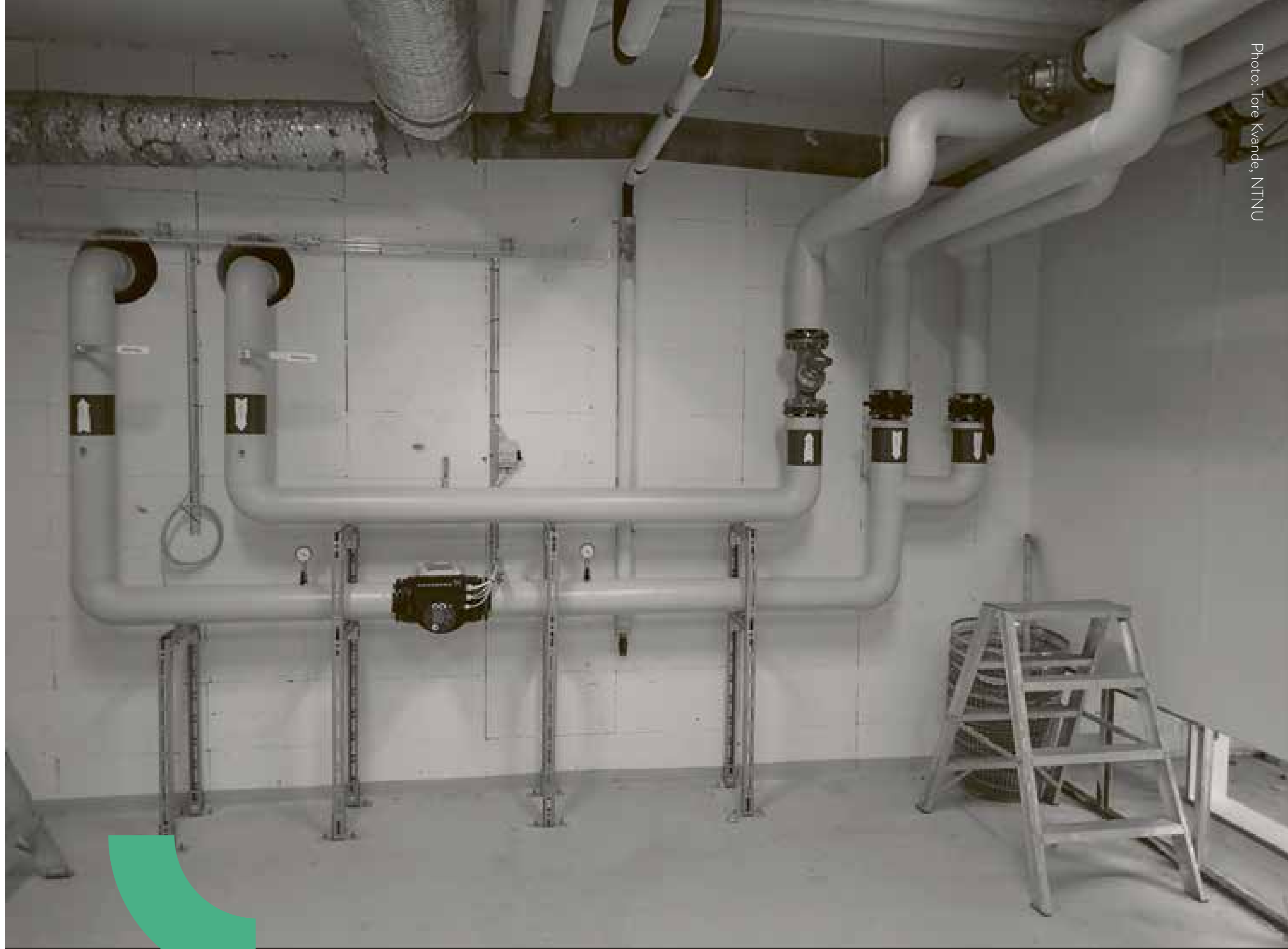


Photo: Tore Kvande, NTNU

Photo: Joachim Seehusen (*Teknisk Ukeblad*)

3

Heat storage using biowax

REQUIREMENTS

Wind and solar power both have in common that they are intermittent energy sources that cannot be turned on and off according to need. There is thus a great need for solutions that can contribute towards reducing output peaks for heating, particularly in the mornings, by storing heat generated on the previous day.

INNOVATION

At the ZEB Laboratory we have developed a heat storage unit, or thermal battery, that utilises the phase change material biowax. The wax has proved to be very well suited to this purpose. It melts at 37°C and the process takes place within the range 35 to 40°C. The laboratory is heated using radiators with a trip temperature of 40°C and return temperature of 35°C. Low temperatures have been selected in order to minimise heat losses.

The thermal battery is based on a 5 cubic metre pillow-plate heat exchanger and weighs six tonnes. Internally, it comprises five percent water, five percent steel and 90 percent wax. This makes the system compact and efficient, enabling it to respond rapidly to room heating peaks.

The battery has a capacity of 200 kWh, and is able to store heat for two to three days use during the coldest periods.

The ZEB Laboratory is the first in the world to implement this type of heat storage. Phase change materials have been utilised previously, but this is the first time that biowax has been used in an active thermal battery.

A new concept for stormwater management

REQUIREMENTS

Climate change is resulting in increased levels of precipitation, often in the form of torrential rain. In urban areas this will increase the stress on existing stormwater drainage systems. The reasons for developing a stormwater management system close to the ZEB Laboratory are the limited capacity of the existing drainage system, combined with the poor infiltration capacity of surrounding soils. This means that it is important to detain, or slow down, stormwater on site for as long as possible before releasing it in a controlled manner into the main drainage network.

INNOVATION 1

The ZEB Laboratory is equipped with a combination of different detention systems. The run-off from these is collected in a large reservoir from which release into the main drainage network can be controlled.

Roof run-off is collected and led to the detention reservoir in a separate conduit system. A permeable covering, two rain beds and green areas around the lab facilitate local detention of the water, each with their own run-off properties. The water from each of these systems is directed to the main detention reservoir in separate conduit systems.

We are planning to install instruments that will enable us to measure run-off volumes from all the systems. We will then be able to compare them and in time tailor the use of different combinations of systems with different run-off profiles in order to adapt to local circumstances and requirements.

INNOVATION 2

The stormwater detention reservoir 'Alma Smart Tank', combining both a detained volume and a serviceable volume, has recently been developed by the Skjæveland Group. The reservoir outlet is constructed such that some of the stormwater can be contained and used as a serviceable resource for anything from watering the green areas during dry weather to the washing of bicycles. It may also be possible to combine this with a water purification system in order to achieve desired water qualities for a variety of purposes.


Photo: Tore Kvande, NTNU


Photo: Tore Kvande, NTNU

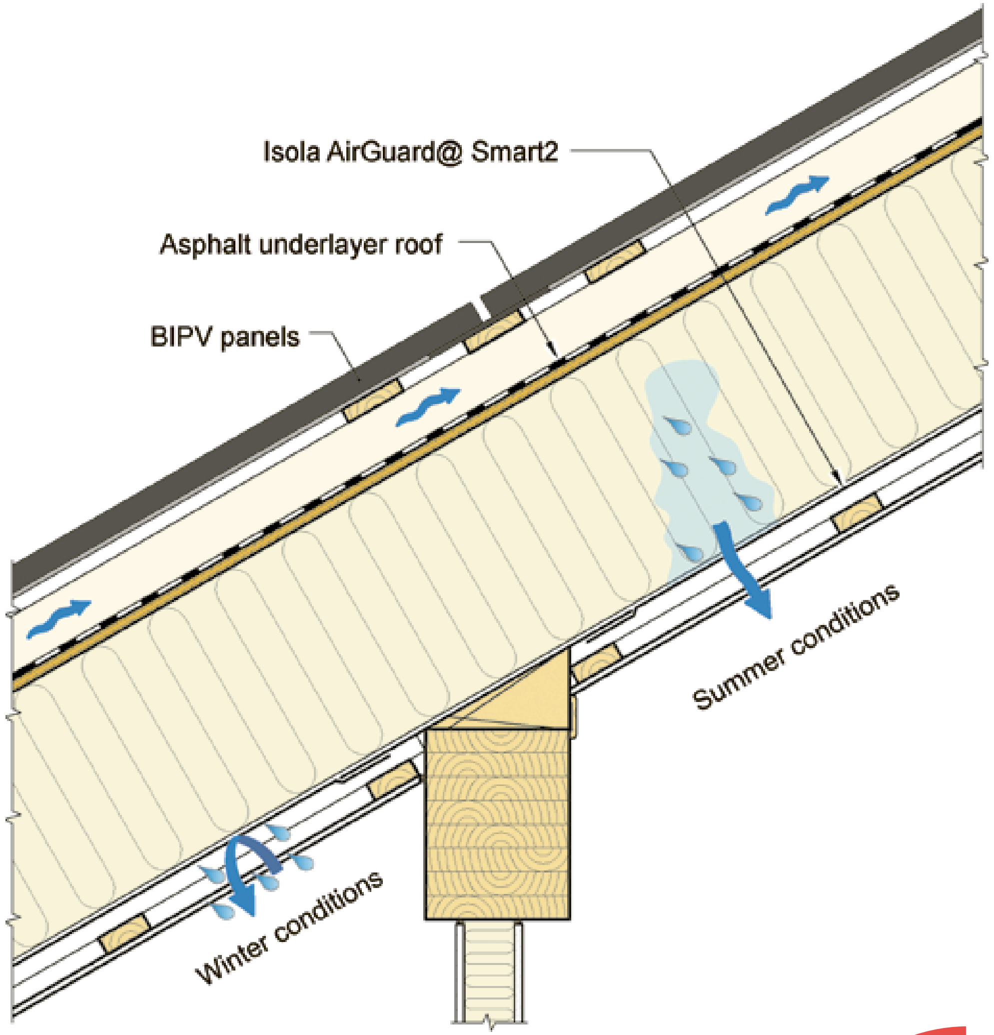


Illustration: Remy Eik, SINTEF

5

Smart vapour barriers in compact timber roofs

REQUIREMENTS

A focus on reducing greenhouse gas emissions often means that it is beneficial to expand the use of materials such as timber for building construction, and not least as constructional support in large buildings. Efficient and cost-optimal approaches to timber construction are thus in great demand.

INNOVATION

At the ZEB Laboratory we have developed an innovative and compact timber-supported roof construction incorporating smart vapour barriers.

We have been warned against the construction of non-ventilated roofs due to the risk of damaging moisture accumulation. We have identified a roof construction technique that we believe greatly reduces the risk of moisture. Measurements will give us the answer.

This innovative approach results in lower building heights, reduced materials use, an efficient construction process and economic benefits. If buildings are properly designed and constructed, it may also result in robust moisture proofing. There is very great interest in the market for constructions of this type.

Construction techniques for integrated solar panel roofs (BIPV)

REQUIREMENTS

The ZEB Laboratory serves as not only a tool for demonstrating how greenhouse gas emissions linked to buildings can be reduced, but also how we can adapt future buildings to climate change.

The generation of renewable energy using buildings commonly focuses on the use of solar panels. In order to reduce materials use it is important that the panels also serve as roof cladding/tiling. The building sector is currently looking for principles and guidelines for optimal BIPV construction techniques in order to adapt new buildings to climate change.

INNOVATION

The ZEB Laboratory faces due south. It is constructed with an approximately 20 metre-long, BIPV installed, eaveless roof sloping at 32 degrees. Traditional roof cladding is replaced by highly efficient, rainproof and ventilated solar panels resulting in a sealed and very smooth surface. Under torrential rain, the roof will receive large volumes of water that will flow at high speed down to the foot of the roof.

In order to maximise the roof area installed with solar panels and preserve the building's architectural expression, we have developed an interior guttering system. This is an experimental approach that takes future climate change during testing of the system into account.

Photo: Tore Kvande, NTNU

Photo: Tore Kvande, NTNU

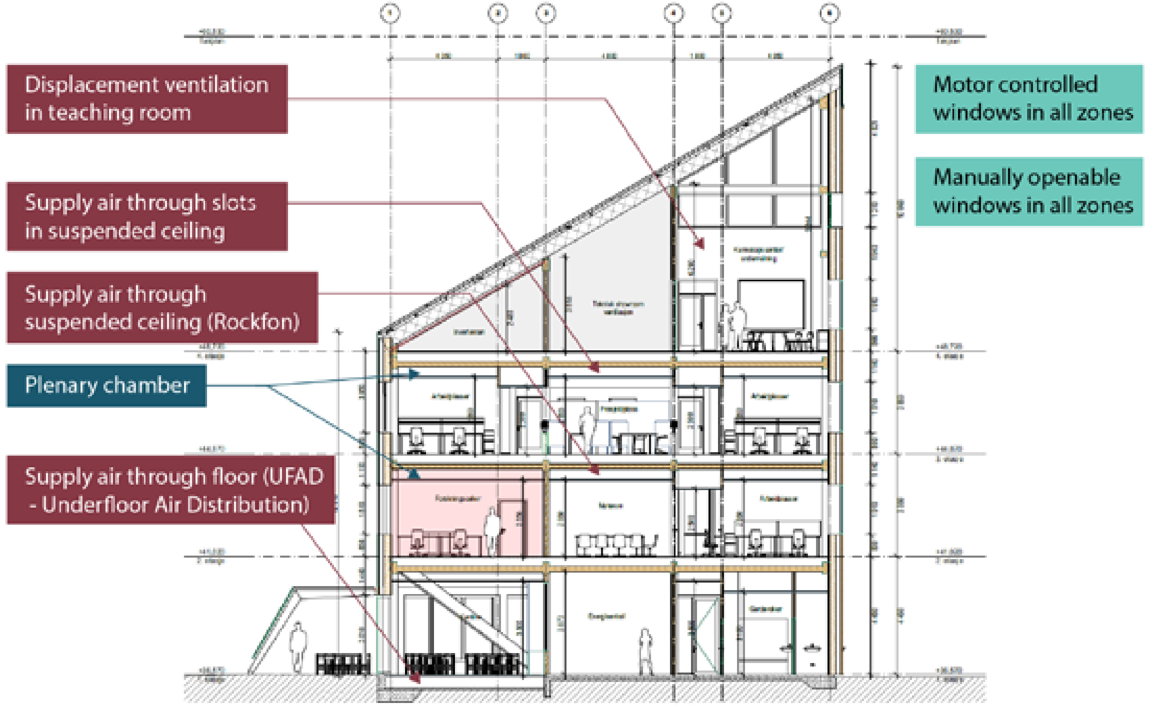


Illustration: Remy Eik, SINTEF

7

Three new ventilation solutions – natural, mechanical and a hybrid

REQUIREMENTS

Energy efficient climatising is important in both existing and future buildings, and we recognise a need for ventilation systems that are energy efficient and with a small environmental footprint in terms of materials use. They must be flexible enough to adapt to a variety of uses and must meet the needs of their users. In order to achieve a healthy interior climate, a ventilation system must function in harmony with the building's heating and cooling systems.

INNOVATION

In response to a need to conduct research into a variety of ventilation systems, the ZEB Laboratory has developed a system that enables a building to be climatised using natural forces (natural ventilation), mechanical devices (balanced ventilation) or a combination of the two (hybrid ventilation). We have a number of different methods of supplying air to areas within the building in such a way that each floor will have its own dedicated ventilation system. Ground floor air will be supplied by means of underfloor air distribution (UFAD), and first floor air via permeable panels fitted into the ceiling. Second floor air will be supplied via openings in the ceiling panels, while the third floor will be ventilated using more traditional methods.

Acoustic timber floor insulation without concrete topping

REQUIREMENTS

In order to reduce greenhouse gas emissions from buildings it is often beneficial to use timber for constructional support. However, there is a need for improved design strategies, better solutions and greater accessibility to knowledge regarding sound transmission in timber constructions. This is vital to the competitiveness of the timber construction sector when benchmarking against other, heavy construction approaches.

INNOVATION

At the ZEB Laboratory we have developed an acoustic timber floor without the use of concrete topping. The floor has been constructed using low compression mineral wool, two layers of particle board and a floor covering overlain by massive timber elements.

Photo: Tore Kvande, NTNU

8

R&D opportunities at the ZEB Laboratory

Photo: m.c.herzog / visualis-images

WHY DO WE NEED A ZERO EMISSION BUILDING SERVING AS A LABORATORY?

In order to mitigate the effects of climate change, it is vital that we reduce greenhouse gas emissions by means of the sustainable development of buildings and neigborhoods.

We must make buildings energy efficient and release the saved energy for other uses.

We must adapt our buildings and infrastructure to climate change.
We must also develop good built environments for our communities with robust buildings and healthy interior climates.


Photo: Lindbak


Photo: Lindbak

THE ZEB LABORATORY SHALL

- promote the development of a globally competitive industry
- generate knowledge to high international standards
- be a research centre for the development of climate adapted zero emission buildings
- be an arena for risk mitigation linked to the implementation of climate adapted zero emission buildings
- be a national resource for all research organisations in the field

Vision

DID YOU KNOW THAT BUILDINGS:

- account for one third of all greenhouse gas emissions
- account for 55% of electricity consumption in Europe
- Norway can release about 30 TWh of electricity by energy efficiency measures in buildings.

Photo: m.c.herzog / visualis-images

WHAT RESEARCH DO WE CARRY OUT AT THE ZEB LABORATORY?

01
Construction process delivery models

02
Construction techniques, solutions and performance

03
Building operation and control

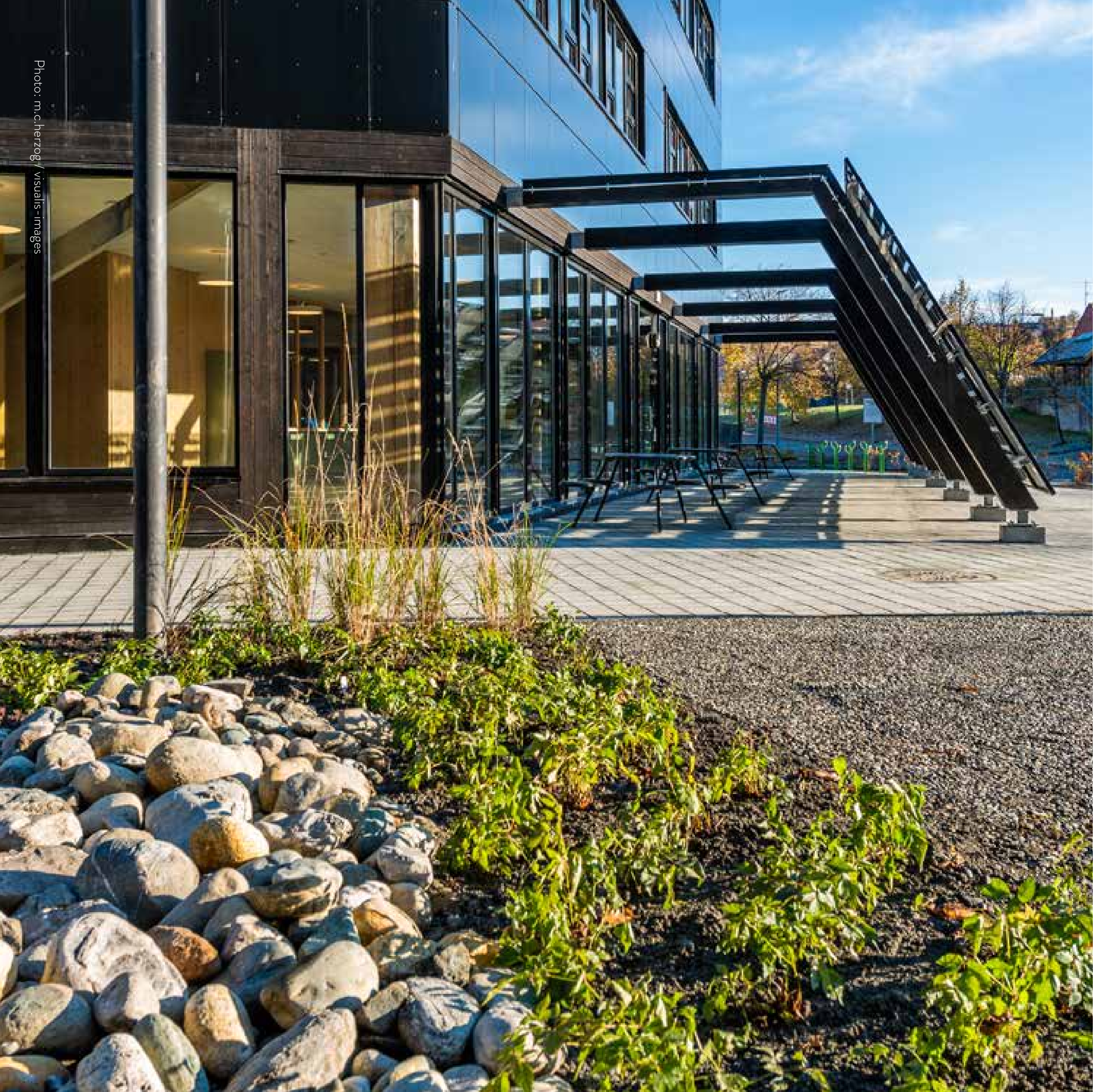
04
Energy consumption and interaction with local energy systems.

05
People in buildings – buildings as workplaces

06
Interior climate, ventilation and energy distribution (heating and cooling systems)

07
Building-integrated and local energy harvesting

08
Stormwater management



THE ZEB LABORATORY

- is equipped with 1,500 sensors, 150 controlled objects and generates 17,000 data points.
- offers two twin rooms, each with up to 11 workstations equipped with upgraded instrumentation and control functions.
- is equipped with temperature and humidity sensors located at various sites in the roof and building facade.
- can be set to 'Research Mode' (i.e. it is possible to override the main building control system using separate algorithms).

FUNDING:

SINTEF

NTNU

ENOVA

The Research Council of Norway

Photo: Nicola Lolli

Photo: m.c.herzog / visualis-images Design: Marianne Eidal, Rim design

ZEB-LABORATORY

Address Høgskoleringen 13
NO-7034 Trondheim, Norway
www.zeblab.no