The Research Centre on Zero Emission Buildings

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www.ntnu.no
NTNU – An international university

- Main focus: Europe, China, international mobility, international research training
- About 350 MoUs related to international cooperation for research and education
- 10 % of NTNU’s students are foreign nationals
- 30 % of NTNU’s PhD candidates are international
- 25 % of NTNU’s academic staff is international

NTNU key figures (2012)

- 49 departments in 7 faculties
- NTNU University Library
- NTNU University Museum
- 11,865 student applications with NTNU as first choice
- 22,349 registered students, 7,752 admitted in 2012
- 3,326 Bachelor and Master degrees awarded
  - 374 doctoral degrees awarded (36 % women)
- 4,972 person-years
- 3,009 employed in education and research; 629 full professors
- EUR 714 mill. budget
- 585,000 m² of owned and rented premises
The Zero Emission Building Centre’s main objective is to develop competitive products and solutions for existing and new buildings that will lead to market penetration of buildings with zero greenhouse gas emissions related to their production, operation, and demolition.

The centre will encompass both residential, commercial, and public buildings.

www.zeb.no

Zero Emission Buildings Centre Facts

- Host institution: Norwegian University of Science and Technology (NTNU)
- Research partners: SINTEF Building and Infrastructure and SINTEF Energy Research
- Industry and public partners: 22
- Researchers associated with the Centre: About 25 (some part time)
- PhD candidates: 21
  - 3-5 expected to complete during 2013
  - 13 is partly/directly funded by ZEB
- Post docs: 4
- Research on topics from nano material science to whole building performance (e.g. energy and CO$_2$), including studies on individual building technologies (e.g. building envelope and building services technologies) and user studies.
Partners in the Centre

- **Users (the reference group)**
- **Contractors**
- **Producers of materials and products for the building industry**
- **Consultants, architects**
- **Trade organizations**
- **Property managers**
- **Public administration**
- **University and research institutions**
- **The Research Council**

Other institutions cooperating with the Centre

**International partners**
- VTT (Finland)
- Chalmers (Sweden)
- Fraunhofer (Germany)
- TNO (The Netherlands)
- LBNL (USA)
- MIT (USA)
- University of Strathclyde (Scotland)
- Tsinghua University (China)

Other new
- Politecnico di Torino
- Shanghai JiaoTong University
- EMPA

**Reference group**
- Lavenergiprogrammet
- NBBL
- NVE
- Forbrukerrådet
- EcoBox
- Driftsforum
- Arkitektbedriftene
Zero energy/emission buildings (ZEBs) in international policy documents

**USA:** «... to achieve our strategic goal of net-zero energy buildings ...»

**UK:** «... The objective of the proposal is to set a timetable for moving towards zero carbon development as a contribution to meeting UK target to reduce carbon emissions ...»

**Canada:** «The Equilibrium House Initiative aims ...»

**Netherlands:** «In the Netherlands, the government and the construction sector aim at achieving energy neutral new construction in 2020.»

**Germany:** «Zero emission buildings are the long-term objective»

**Norway:** «All new buildings should be nearly zero energy buildings before 2020.»

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Why Zero Emission Buildings?


**Low Hanging Fruit:**
Energy Efficiency Pays for Itself
Zero Emission Buildings - The Challenge:

The main concept of a zero emission building is that renewable energy sources produced or transformed at the building site have to compensate for CO₂ emissions from operation of the building and for production, transport and demolition of all the building materials and components during the life cycle of the building.

The research activities

ZEB focuses its work in five areas that interact and influence each other:

– WP1 Advanced materials technologies
– WP2 Climate-adapted low-energy envelope technologies
– WP3 Energy supply systems and services
– WP4 Use, operation, and implementation
– WP5 Concepts, strategies and pilot buildings
Some Research and Development Examples

Nano insulation materials (NIM)

From theoretical concepts to development of new and innovative materials

\[
\lambda_{\text{gas}} = \frac{\lambda_{\text{gas},0}}{1 + 2\beta \text{Kn}} = \frac{\lambda_{\text{gas},0}}{1 + \frac{\sqrt{2}\beta k_B T}{\pi d^2 p \delta}}
\]

\[
\text{Kn} = \frac{\sigma_{\text{mean}}}{\delta} = \frac{k_B T}{\sqrt{2}\pi d^2 p \delta}
\]

Controlling:
- Sphere inner diameter
- Sphere wall thickness

Patent application

Without optimizing:
So far we have reached 20 mW/(mK)
Phase change material experiments

Analyses of end-use in energy efficient buildings

• Evaluation of new buildings with high energy ambitions
  – Bad interfaces
  – Lack of knowledge

• Unintended persistence of energy wasting behaviors (when refurbishing)
  – Deeply rooted values and attitudes
  – Negotiations within the household
ZEB-Definition

ZEB-DEFINITION:
1. Ambition level
2. Rules for calculation
3. System boundaries
4. CO2-factors
5. Energy quality
6. Mismatch production and demand
7. Minimum requirement energy efficiency
8. Requirement indoor climate
9. Verification in use

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Concept work – Office building
ZEB-Pilot Buildings

1. Skarpnes Arendal: 37 dwellings, ZEB-O.
3. Multikomfort Larvik: Single family house, ZEB-COM.
4. Åland: 500 dwellings, ZEB-O.
5. Powerhouse #1 – Trondheim. Large office building, Plus energy.
6. Depotbygget Haakonswenn – Bergen. Small office building, ZEB+EQ.

Establishment of laboratories and test buildings – “Living Lab” and “Test Cell”
Thank you for your attention

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