Climate Adapted Buildings - CAB

Adaption of buildings to a changing climate in Norway – recent and future research work

Presenter : Research manager Berit Time,
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Content

- Why research on climate change and adaption of building towards climate change ?
- Recent and ongoing research projects
- Research and development tasks meeting the challenges
- Future research – Zero Emission Buildings

Climate2000

(2000 – 2007)

Budget of 6 million Euros

Climate Adapted Buildings - CAB

(2007 – 2009)

Budget of 2 million Euros

ROBUST

(2008 – 2010)

Budget of 2 million Euros

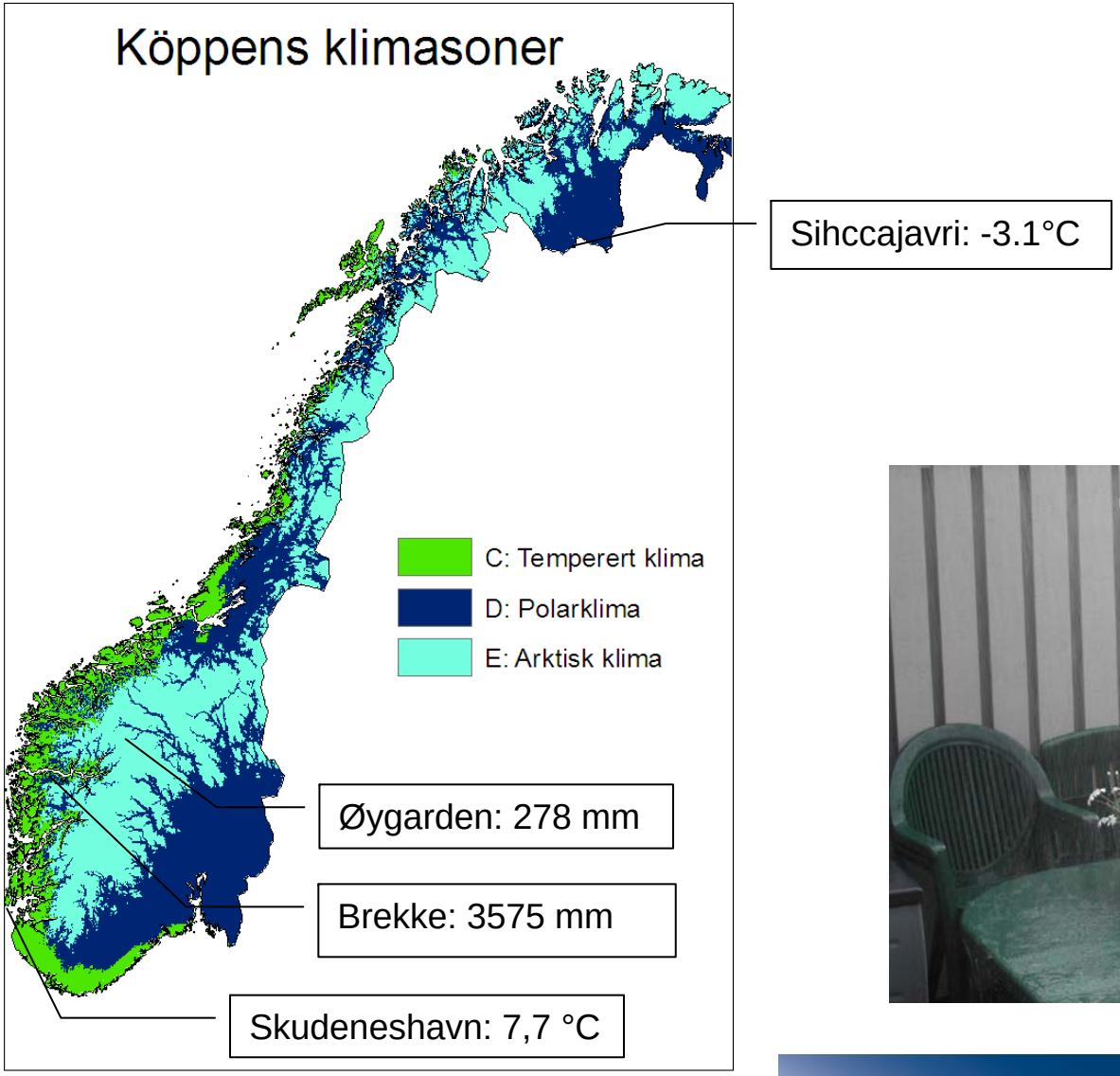
ZEB The Research Centre on Zero Emission Buildings

(2009 – 2016), Budget of 40 million Euros

Global warming and harsh climate

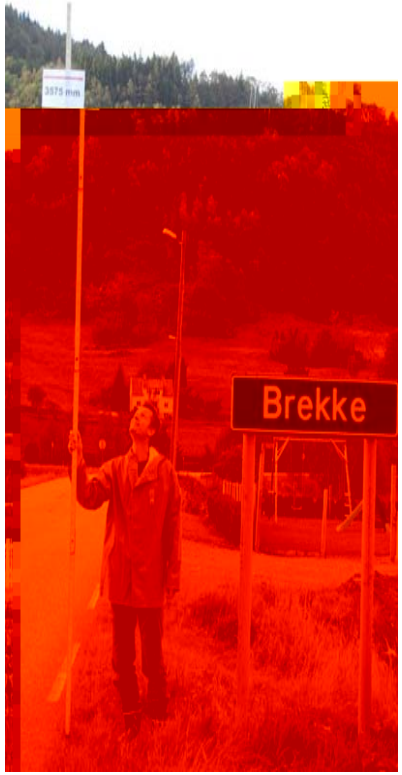
- Observations increasingly point to global warming and other changes in the climate system.
- Climate change will entail new conditions for the European construction industry
- The prospect of an even harsher climate in parts of Norway means that we must pay more attention to the design, construction and geographical localisation of buildings.
- A need to further develop knowledge, methods, tools and solutions in principal concerning the planning and design of buildings in severe climates

The climate of Norway



Norway a country with extreme climatic variations

Norway is exposed to a harsh climate and many facets of Norwegian society are, and will continue to be, affected by both climatic events and future climatic changes



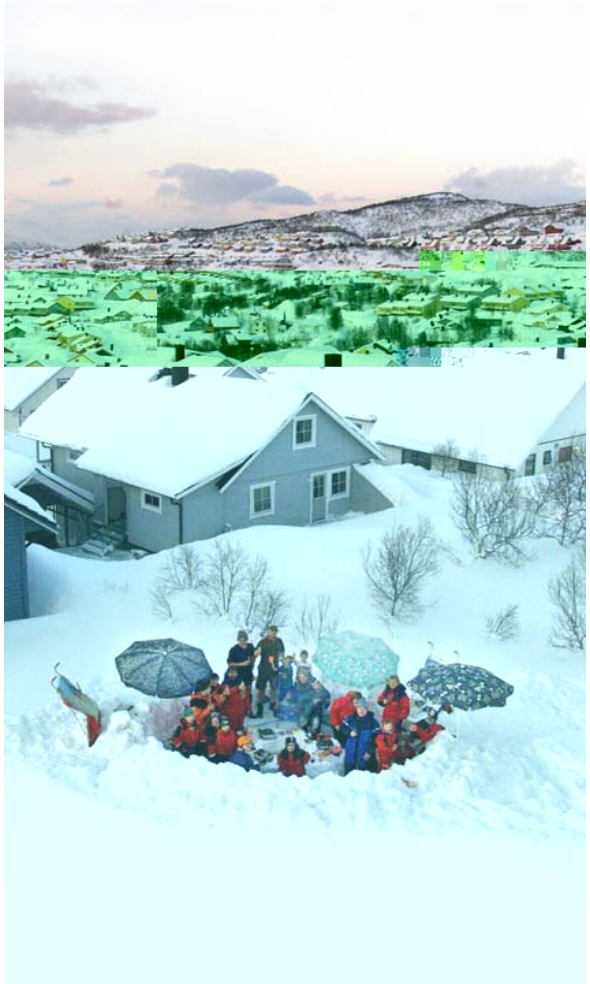
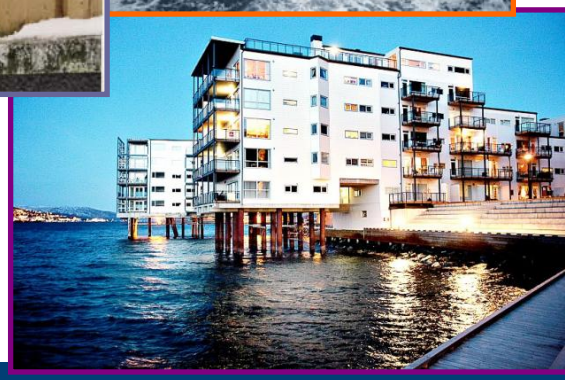


Photo: Yngve Olsen Sæbbe, Nordlys

Research tasks meeting the climate challenges

- **Analysis of building damages - sources**
- Weather protection in the construction process
- Moisture in compact roofs
- Design of weather-protective flashings
- Requirements for façade systems in relation to driving rain
- Air tightness of the building envelope
- Building envelope design for energy efficiency – Building physics challenges
- Vacuum insulation panels in structures



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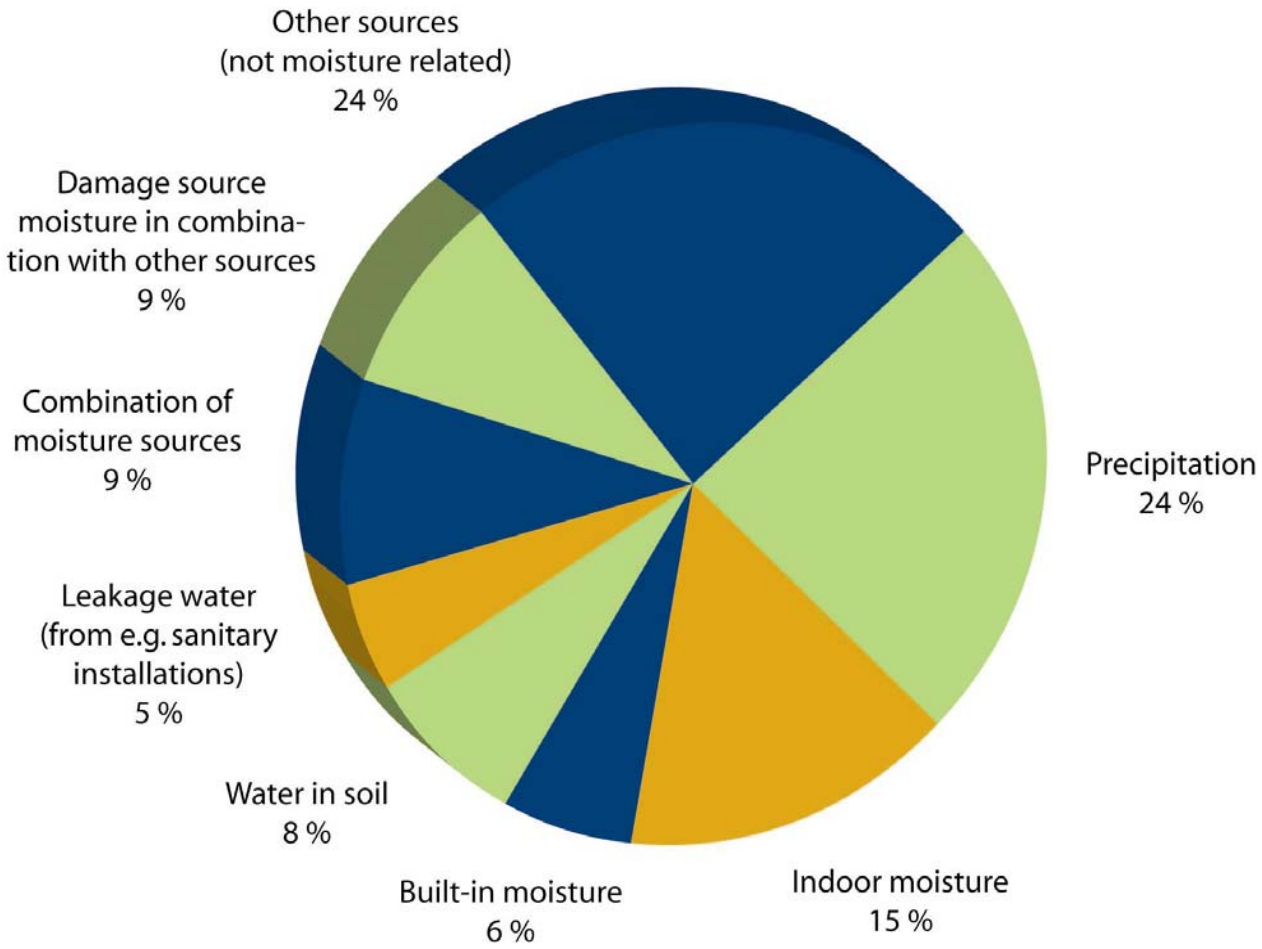

SINTEF project archive 1988-2002
(app. 3200 assignment reports,
3600 building damage cases)

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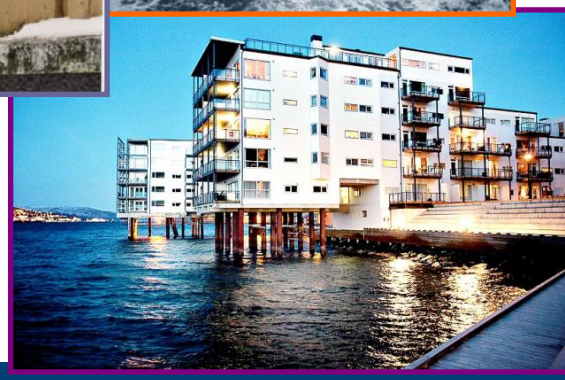

Weather protection in the construction process

- Guidelines are worked out in cooperation with the building sector showing different principles for weather protection in the construction process
- Based on field-studies and interviews
- Participated and contributed in a Nordic Network project on Wheater Protection Systems (WPS) – input to a cost/benefit analysis tool
- A study on moisture and climate issues within Norwegian legislation
- A study on climate adaptation in the Norwegian pre-fabricated housing industry

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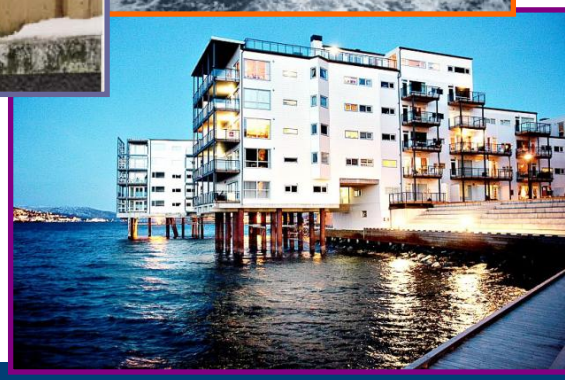

Moisture in compact roofs

- An analytical study on drying out abilities in compact roofs
- A Three-Stage Field Survey (2002, 2004, 2007)
- Test house measurements of the drying potential and risk of mould growth

A field survey - flat, compact roofs

- 12 compact roofs in different parts of the country
- 10 roofs with built in moisture
- 2 reference roofs
- Investigation 2002, 2004, 2007

- Conclusions:
  - The roofs are being dried out
  - Limited observations of microbiological growth

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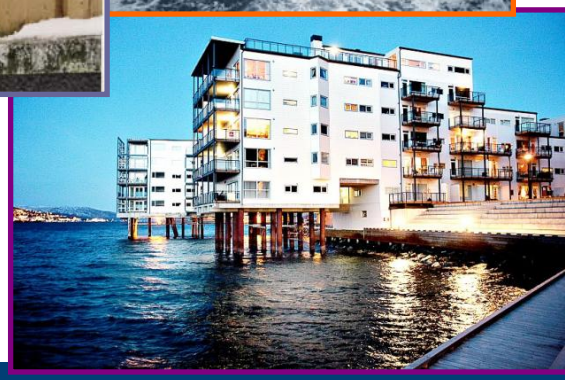
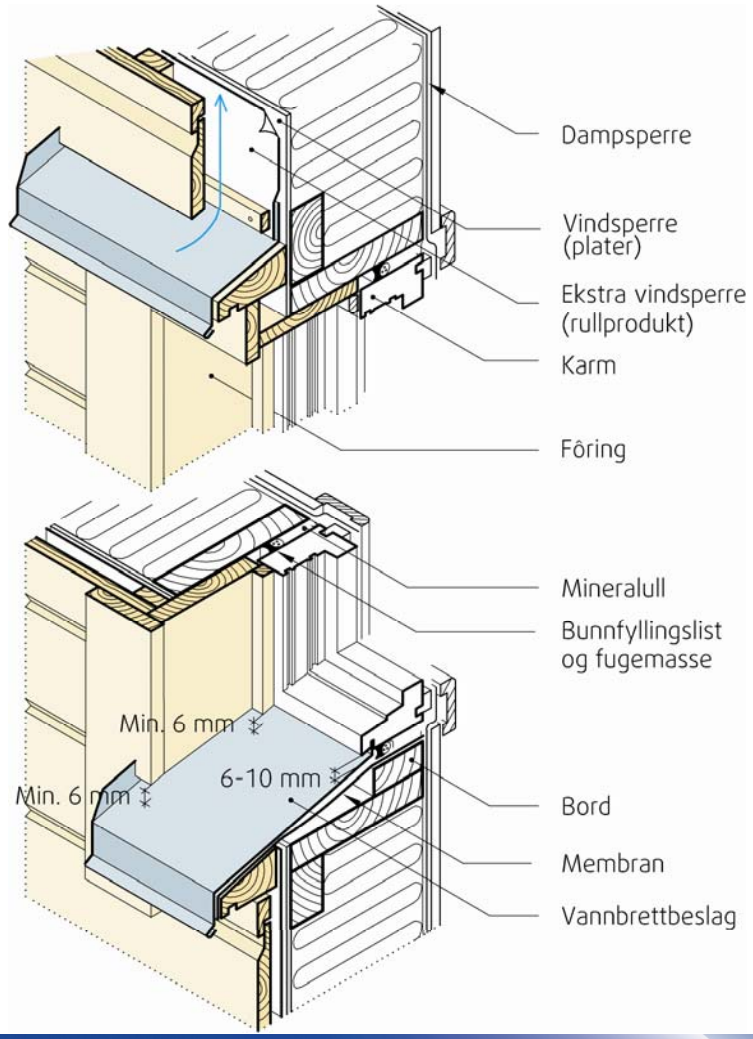


Design of weather-protective flashings



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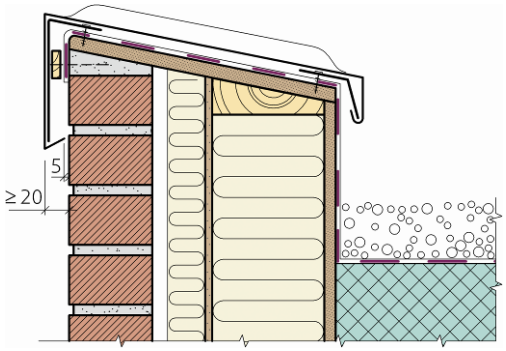		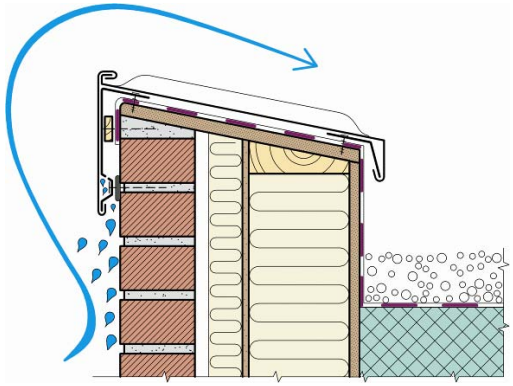
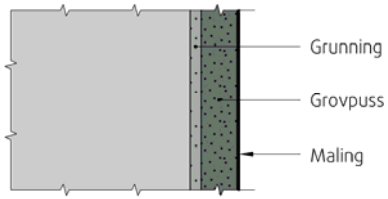		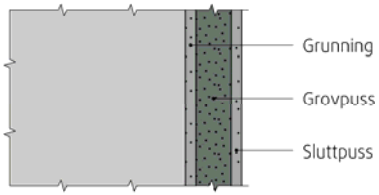
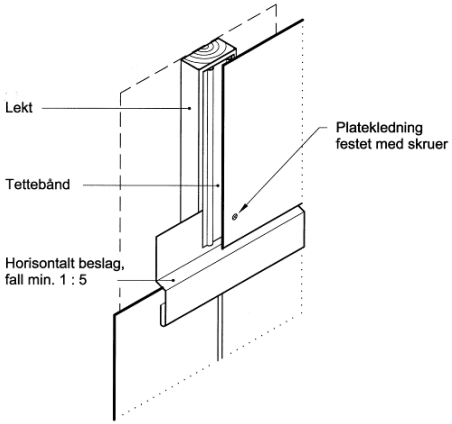		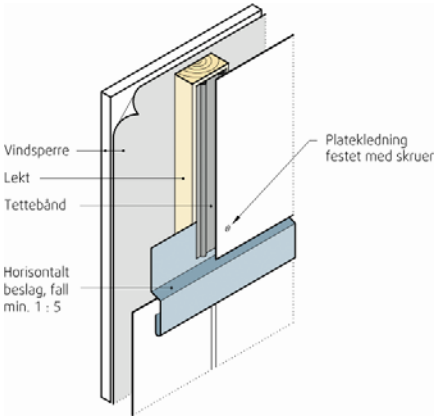

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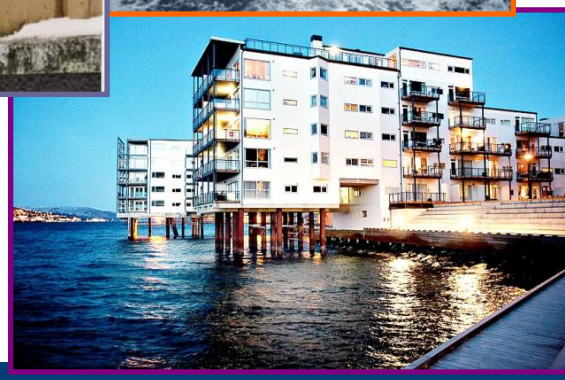
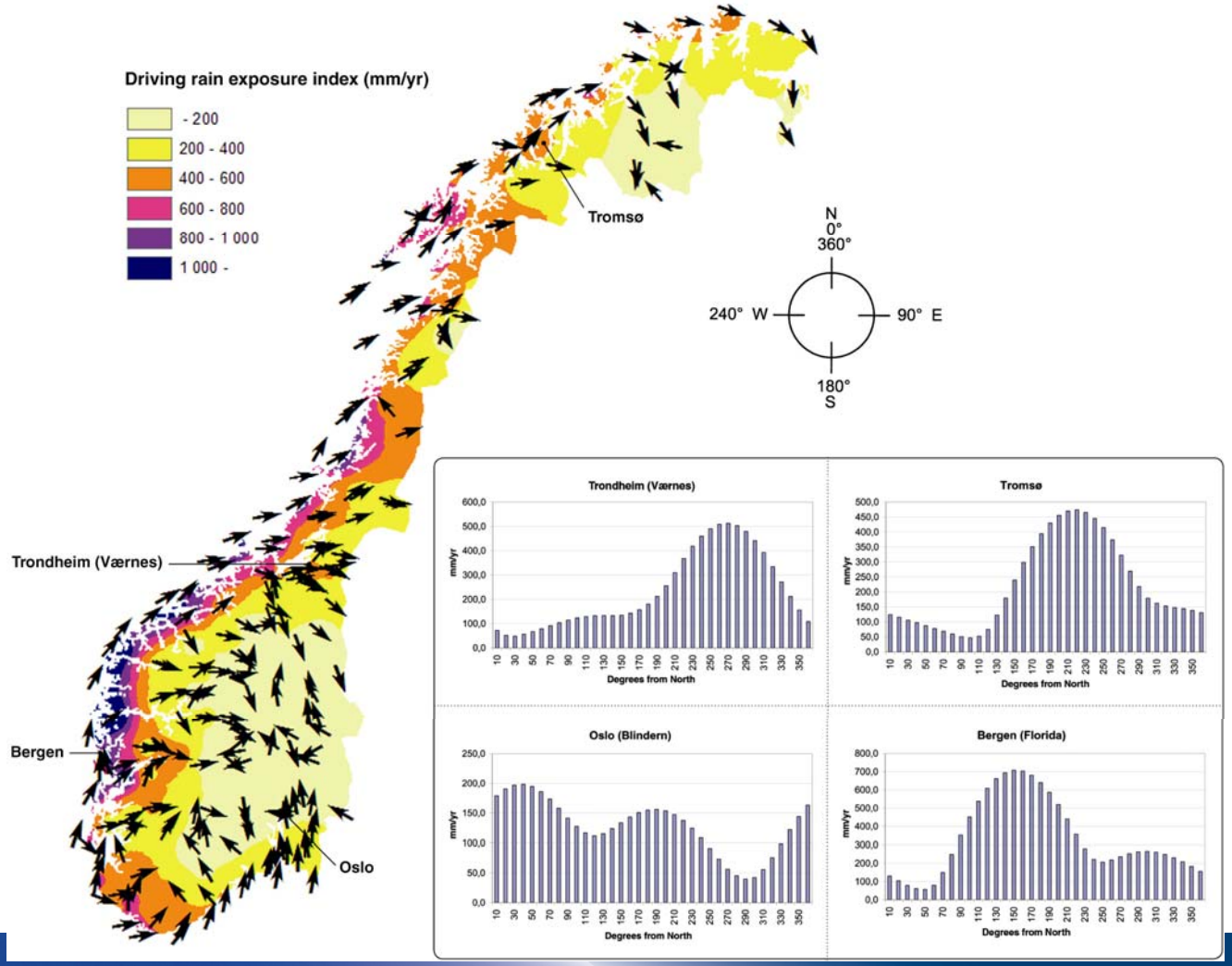


Requirements for façade systems in relation to driving rain



Rain penetration resistance of renders

Large scale experimental investigation on determination of rain penetration resistance of different rendering systems exposed to severe driving rain conditions

Conclusions:
A two-coat rendering system would not meet the basic requirements to driving rain resistance. Hence, a three-coat rendering system has to be used. The final coat can, however, be a thin layer inorganic product like silicate paint.

Climate exposure of wooden facades – experimental investigation

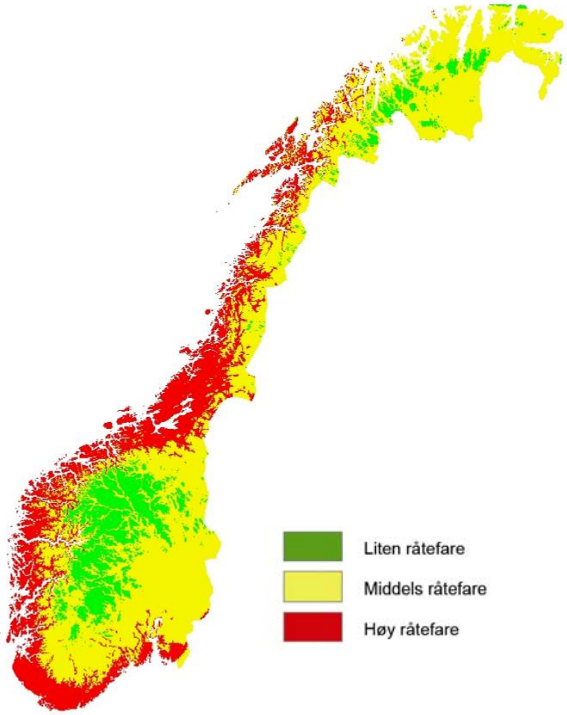
Parameters investigated:

Geographical orientation of the facade,Ventilation of the cladding, Surface treatment, Growth rate of wood

Wooden claddings

Conclusions regarding the *code-of practise* clearly show:

- **Air gap openings in the top and bottom part** of the cladding limits the moisture content in wooden claddings exposed to driving rain.
- An air gap opening in the top and bottom part of the cladding equivalent to a **4 mm continous air gap** is sufficient to limit the moisture content of wooden claddings exposed to driving rain.
- For climates, orientations or geometries where only small amounts of driving rain hits the wall the wooden cladding might even perform better with no planned air gap openings at all.



The map of Norway shows the risk of rot for wooden constructions calculated estimated climate files for the period 2021-2050. (Liten=low, middels=medium, høy=high)

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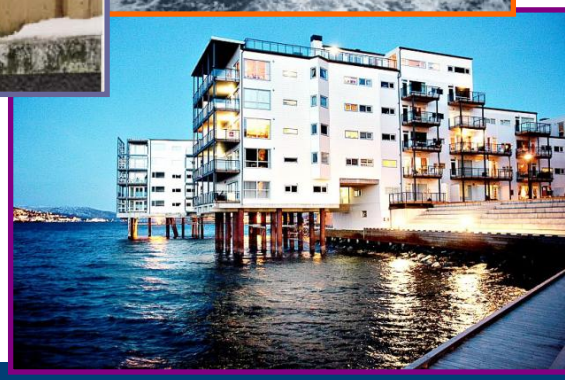
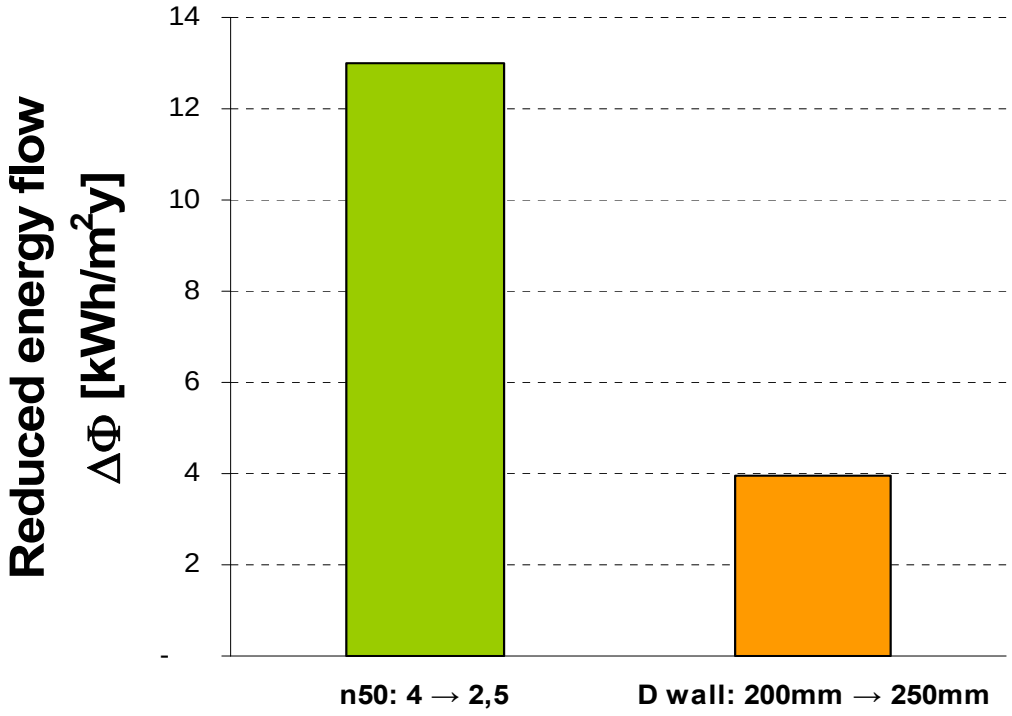
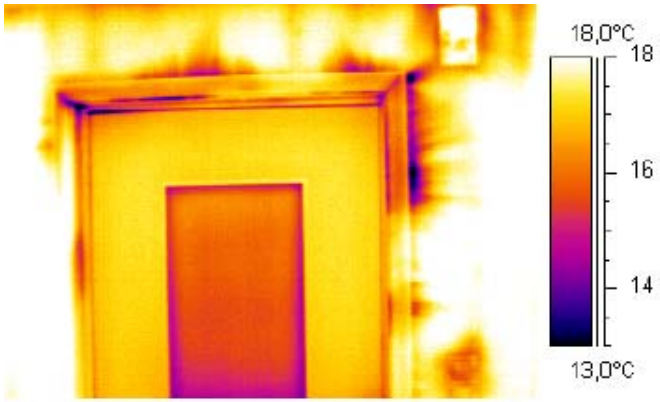


Air-tightness of the building envelope

- Effect on energy consumption
- Effect on moisture performance

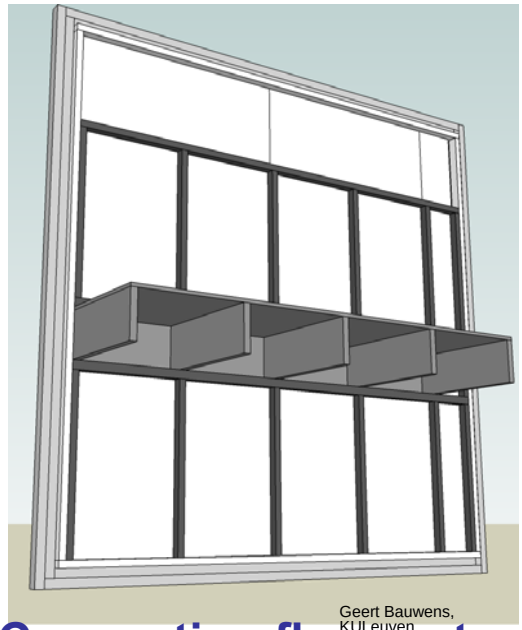




*) BRA = 120 m², moderat skjerming, mer enn én utsatt fasade, θ_u = 5,6°C, bal. ventil.

Air leakage paths

- Entrepreneurs, planners and producers of materials are concerned about risks for air leakage paths.
- Air leakage paths have been identified and quantified in experimental investigations in the laboratory.

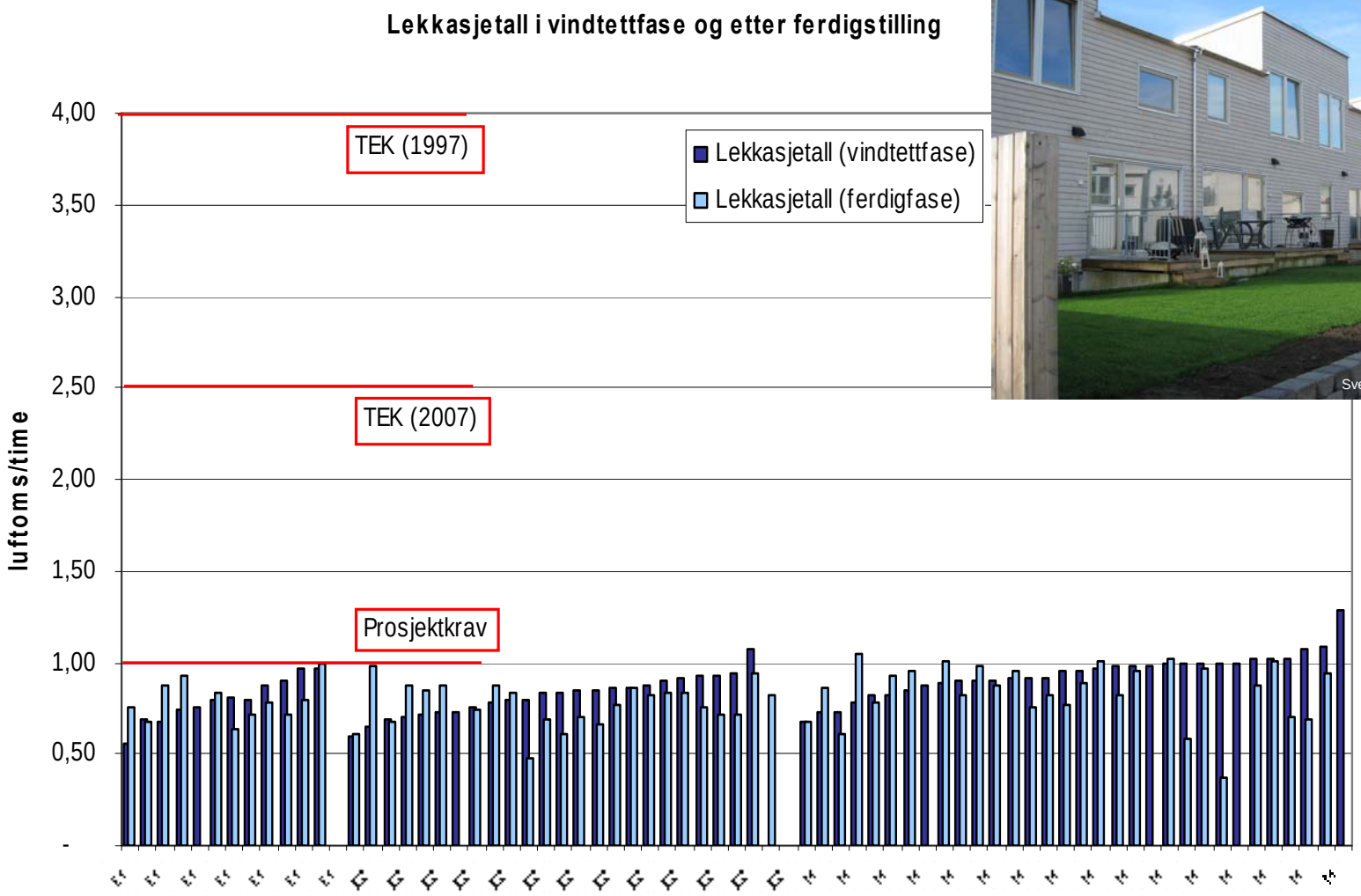


Connection floor outerwall

Chimney through a roof

Window in a wall

Air-tightness of a project of 73 houses



Sverre Holøs, SINTEF Byggforsk

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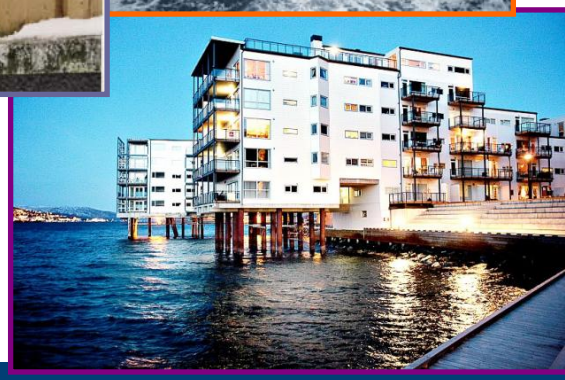


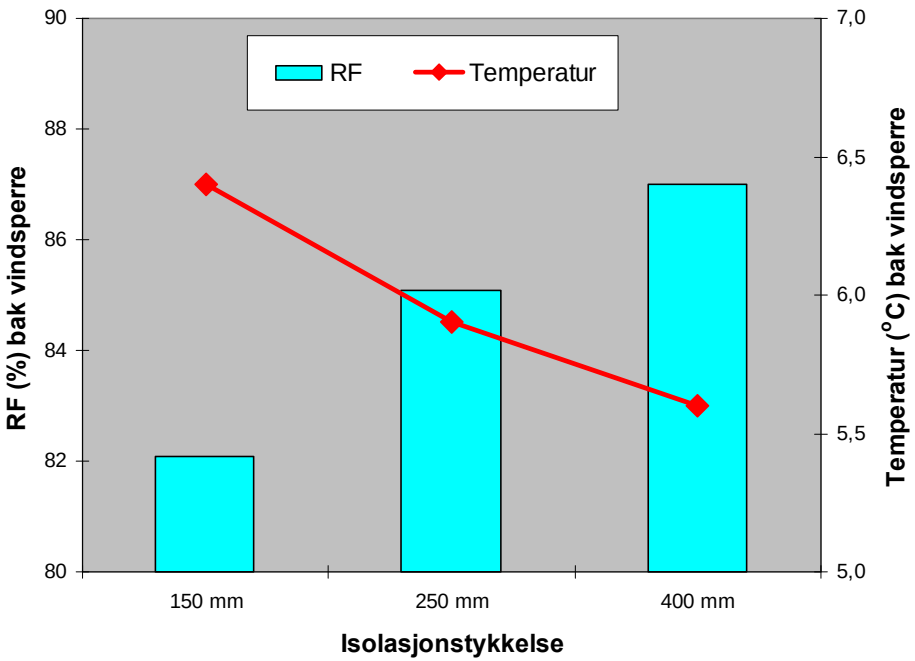
Building envelope design for energy efficiency
Building physics challenges

- Heavily insulated roofs, walls and floors – optimal performance and moisture conditions
- Air-tightness in constructions
- Windows and window design -
- Building technology, materials and material use
- Climate adaption and long term performance
- Intergration of active elements in the building envelope

ByBo – Løvåshagen Bergen, a passivhouse

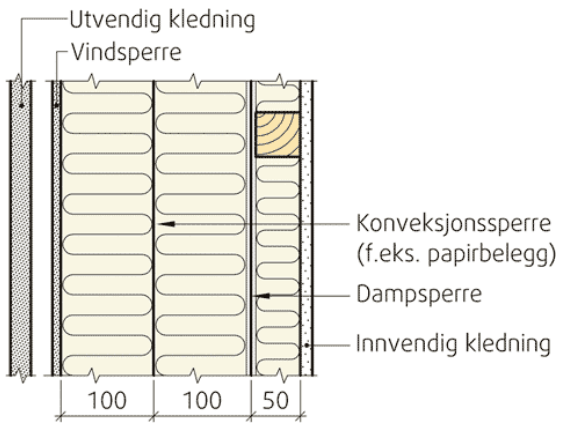
More heavily insulated envelopes – moisture challenges

- The outer parts of a heavily insulated wall and roof will become colder and the RH in this areas will increase.
- Thicker walls and roofs mean higher vapour resistance, more wooden materials in the envelope and more built in moisture that has to dry out.
- An increase in thickness of insulation gives an increase in internal air- and moisture movement in the insulation layer.



Advices – how to minimize the risk of moisture problems

- **In the planning process;**
  - Choose a very vapour open wind barrier
  - Prefabrication of building elements
  - Design a “convection-barrier” in the insulation layer



- **In the building process;**
  - Protect the construction and building materials against moisture
  - If wetted dry out before mounting the vapour barrier/-retarder
  - Fix the vapour barrier/-retarder immediately after the insulation layer has been mounted
  - Keep the temperature on a moderate level after closing the envelope

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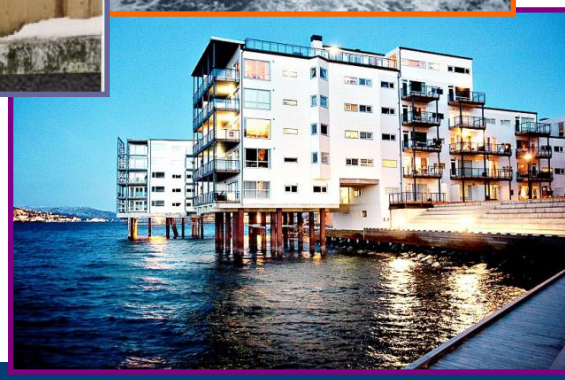
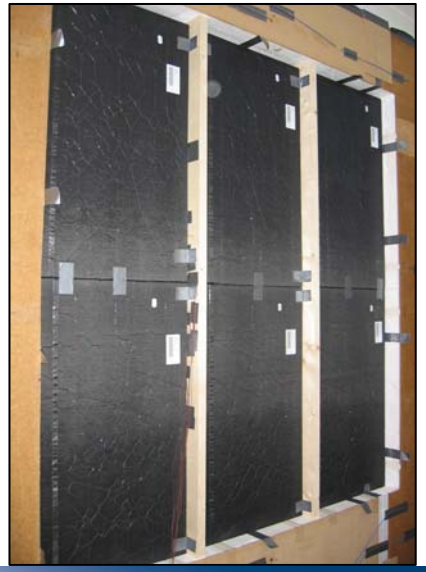


Vacuum insulation panels (VIPs) in structures

VIP first phase large scale hot box measurements:

- Investigate the effect of different VIP arrangements
- Single and double layer configurations versus panel thicknesses
- Edge effects including air gaps between the VIPs
- Staggering of VIPs, i.e. overlapping panels
- Taped VIP joints

Vacuum insulation panels in terrasse



Test setups in Hot-box

Towards Zero Emission Buildings

1. Energy Policy and Industry Goals

USA: „The *Building Technologies Program* outlines the technology portfolio and activities that are necessary to **achieve our strategic goal of net-zero energy buildings** (ZEB) at low incremental cost **by 2025**."
[http://www.eere.energy.gov/buildings/about/, 01/2007]

UK: „The objective of the proposal is to set a timetable for moving towards **zero carbon development** as a contribution to meeting the UK target to reduce carbon emissions by 60% by 2050. "
[Department for Communities and Local Government, 13th December 2006 press release]

Canada: „ The **Equilibrium House Initiative** aims the community-scale demonstration of 1,500 Net Zero Energy Houses by 2010 and all new houses to be Net Zero by 2025"
[http://www.cmhc.ca]

Austria: "Vision 2050 on energy in buildings: The building stock of the year 2050 should be in total over the entire life cycle (involves the production and operation of the building) **free of any carbon emissions**.
[http://www.e2050.at/pdf/energie_gebauede.pdf]

Netherlands: „In the Netherlands, the government and the construction sector aim at achieving **energy neutral new construction in 2020**.
[Chiel Boonstra, Trecodome]

Germany: „From current point of view future capable buildings are buildings architectural demanding with high user comfort, minimal primary energy demand, optimized technology equipment, meaningful integration into larger energy supply systems as well as altogether economic energy demand cover. **Zero emission houses are the long-term objective**."
[„Das 5. Energieforschungsprogramm der Bundesregierung", BMWA, 07/2005]

Kilde figur: University Wuppertal, School of Architecture, Building Physics and Technical Building Services. Prof. Karsten Voss

Partners:

NTNU
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Hydro Aluminium
YIT
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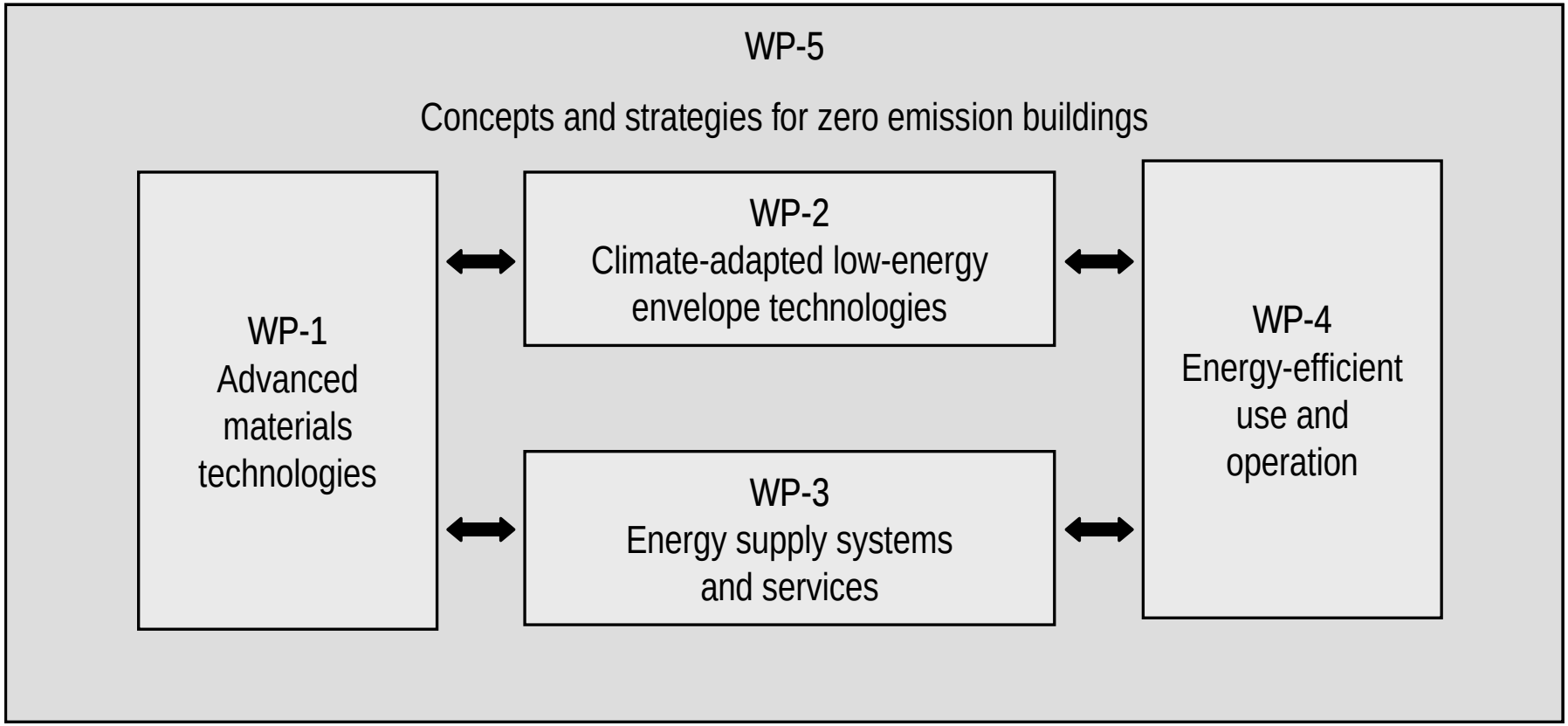
Bybo
Forsvarsbygg
Statsbygg
Husbanken
Byggenæringens landsforbund
Norsk Teknologi
Statens Byggetekniske Etat

ZEB

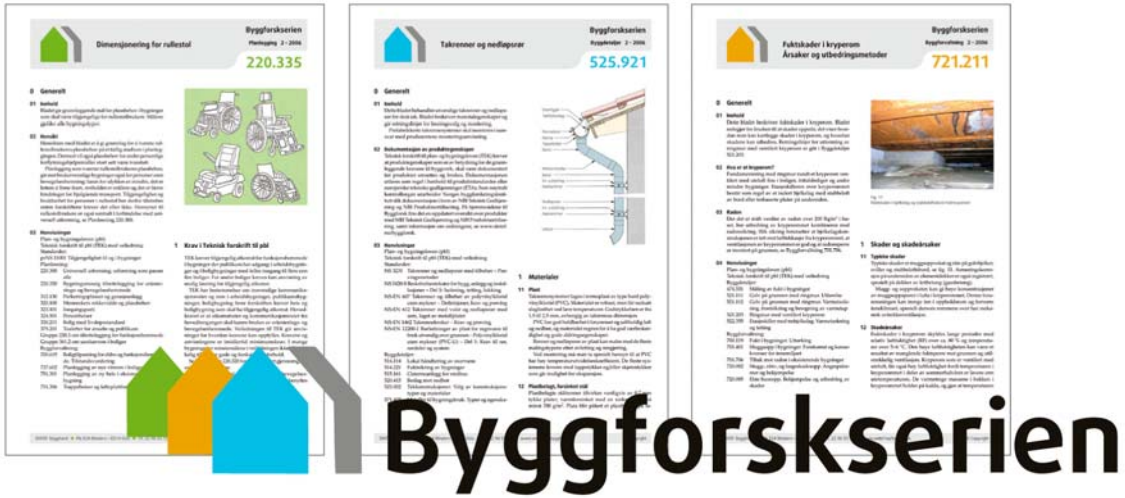
The Research Centre on Zero Emission Buildings (2009 – 2016)

Budget ~ 40 mill. Euros

ZEB - Work Packages



Knowledge Systems



- The web-based knowledge system consists of about 800 design guidelines, the first guidelines being published first time in 1958. It is the most used planning and design tool amongst Norwegian architects and engineers and is found on nearly all construction sites

- It complies with the performance-based requirements in the building code, and it is an important reference to pre-accepted solutions

- The principal objective of the Building Research Design Sheets is to adapt experience and results from research in such a way that they can be of practical benefit for the construction industry

www.sintef.no/byggforsk

Sharing knowledge

- We have a strong focus on being Norway's leading provider of research-based knowledge to the construction industry

- Through our research and development activities, we have established a unique platform for disseminating knowledge throughout a large part of the Norwegian construction industry

www.sintef.no/byggforsk