ZEB Pilot buildings - overview

Klimax Breakfast Meeting
October 12, DIGS Trondheim

Inger Andresen, Professor NTNU
ZEB Research Activities

**WP1** Advanced materials technologies

**WP2** Climate-adapted low-energy envelope technologies

**WP3** Energy supply systems and services

**WP4** Use, operation, and implementation

**WP5** Concepts and strategies and Pilot buildings

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ZEB Living Lab

VIP Leca Isoblokk

Nano insulation material

Membrane heat exchanger

ZEB Pilot buildings

ZEB Definition
How to make a Zero Emission Building?

• What kind of cake
• Recipe
• Cooks
• Ingredients
ZEB ambition levels (what kind of cake)
From standard building to ZEB

kWh or GHG emissions per m² and year

- Existing average
- TEK'10
- TEK'16 passivhus
- TEK'20 nearly zero energy/emission
- TEK'25 Zero emission

Energy use for operation
Generation of renewable energy
Energy use for materials
ZEB Ambition levels (what kind of cake)

**ZEB-O**

![Graph showing ZEB ambition levels with categories: Materials, Construction, Use, Demolition, and axes for Production of renewable energy, Payback of CO₂, Use of energy, and Emission of CO₂.](image-url)
ZEB Ambition levels (what kind of cake)

ZEB-OM
ZEB Ambition levels (what kind of cake)

ZEB-COM

- Materials
- Construction
- Use
- Demolition

Production of renewable energy
Payback of CO₂

Use of energy
Emission of CO₂
ZEB definition (recipe)

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Selamawit Mamo Fufa, Reidun Dehl Schienbusch, Kari Sørnes,
Marianne Inman and Inger Andresen

A Norwegian ZEB Definition Guideline
What kind of ingredients?
ZEB Pilot buildings - examples of ingredients
Net energy demand (netto energibehov) for operation kWh/(m^2år)
Insulation of exterior walls, $W/(m^2K)$

*design values*
Air leakage numbers, $n_{50}$

*green are design values, blue are measured values
Window area (% of heated floor area)
# HVAC systems

<table>
<thead>
<tr>
<th>Project</th>
<th>System type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powerhouse Kjørbo</td>
<td>Displacement ventilation. Centrally located shafts and radiators. Large thermal mass.</td>
</tr>
<tr>
<td>Powerhouse Brattørkaia</td>
<td>Displacement ventilation. Underfloor air supply. Large thermal mass.</td>
</tr>
<tr>
<td>FLO Haakonsvern</td>
<td>Mixing ventilation with active diffusers. Radiators in offices. Ventilation cooling.</td>
</tr>
<tr>
<td>Campus Evenstad</td>
<td>Hybrid ventilation, displacement. No cooling system.</td>
</tr>
<tr>
<td>Heimdal VGS</td>
<td>Displacement/mixing. Decentralised ventilation units.</td>
</tr>
<tr>
<td>ZEB House Larvik</td>
<td>Mixing ventilation. One radiator per floor.</td>
</tr>
<tr>
<td>Skarpnes</td>
<td>Mixing ventilation. One radiator per floor.</td>
</tr>
<tr>
<td>Zero Village Bergen</td>
<td>Mixing ventilation.</td>
</tr>
</tbody>
</table>
Ventilation heat recovery, %

*design values, average during operation
Renewable thermal supply

<table>
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<tr>
<th>Project</th>
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</thead>
<tbody>
<tr>
<td>Powerhouse Kjørbo</td>
<td>Ground source <strong>heat pump</strong> + heat from servers</td>
</tr>
<tr>
<td>Powerhouse Brattørkaia</td>
<td>Sea water <strong>heat pump</strong> + district heat</td>
</tr>
<tr>
<td>FLO Haakonsvern</td>
<td>Sea water <strong>heat pump</strong> (from local central)</td>
</tr>
<tr>
<td>Campus Evenstad</td>
<td>CHP system based on gasification of wood chips</td>
</tr>
<tr>
<td>Heimdal VGS</td>
<td>CHP system with biogas, ground source <strong>heat pump</strong></td>
</tr>
<tr>
<td>ZEB House Larvik</td>
<td>Ground source <strong>heat pump</strong>, greywater heat recovery, solar collectors, exhaust air heat pump</td>
</tr>
<tr>
<td>Skarpnes</td>
<td>Ground source <strong>heat pump</strong></td>
</tr>
<tr>
<td>Zero Village Bergen</td>
<td>? Ground source <strong>heat pump</strong> or CHP</td>
</tr>
</tbody>
</table>

**ZEB** The Research Centre on Zero Emission Buildings
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<tr>
<td>Powerhouse Kjørbo</td>
<td>Photovoltaics</td>
</tr>
<tr>
<td>Powerhouse Brattørkaia</td>
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</tr>
<tr>
<td>FLO Haakonsvern</td>
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<td>Heimdal VGS</td>
<td>Photovoltaics + CHP</td>
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<td>ZEB House Larvik</td>
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<td>Skarpnes</td>
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<td>Zero Village Bergen</td>
<td>Photovoltaics (+CHP?)</td>
</tr>
</tbody>
</table>
Yearly output per m$^2$ PV area, kWh/m$^2$
Yearly output per m² floor area, kWh/m²

- PH Kjørbo
- PH Brattværkaia
- FLO Haakonsvern
- Heimdal VGS
- ZEB house Larvik
- Skarpnes
- Zero Village Bergen
- Living Lab
Embodied emissions in materials

**kg CO$_2$-ekv/(m$^2$yr)**

- **PH Kjørbo**
- **ZEB house Larvik**
- **Heimdal VGS**

*design values*

- 69 Other renewable
- 49 PV system
- 43 Low voltage supply
- 36 Ventilation
- 28 Stairs
- 26 Outer roof
- 25 Structural deck
- 24 Inner walls
- 23 Outer walls
- 22 Superstructure
- 21 Groundwork and foundations
Short summary:
There are several paths to ZEB!
Open for registration now:

Nullutslippsbygg – Vi får det til!

TORSDAG 19. JANUAR 2017
SCANDIC NIDELVEN TRONDHEIM