From Zero Emission Buildings (ZEBs) to Zero Emission Neighbourhoods (ZENs)

Illustration: Snøhetta

Presented by: Olav B. Fosso, Professor NTNU

Arild Gustavsen, Centre Director, Professor NTNU

**3rd UNI-SET ECE, Bucharest
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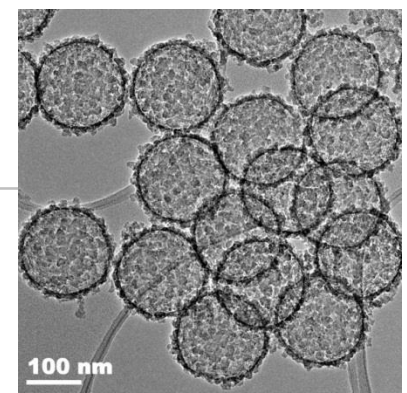# The Research Centre on Zero Emission Buildings

ZEB Research Activities

ZEB focuses its work in 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
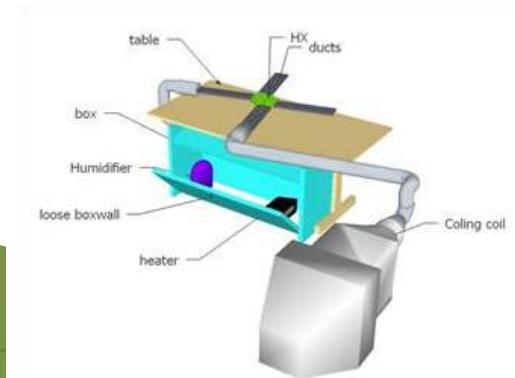- **WP5** Concepts, strategies and pilot buildings
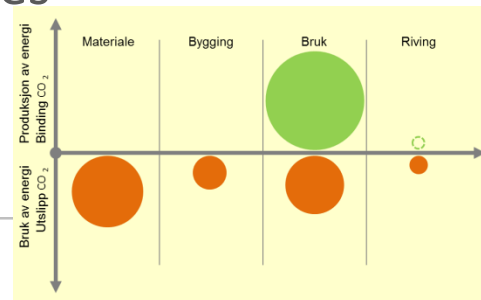- **Laboratories**

Nano insulation material

VIP Leca Isoblokk

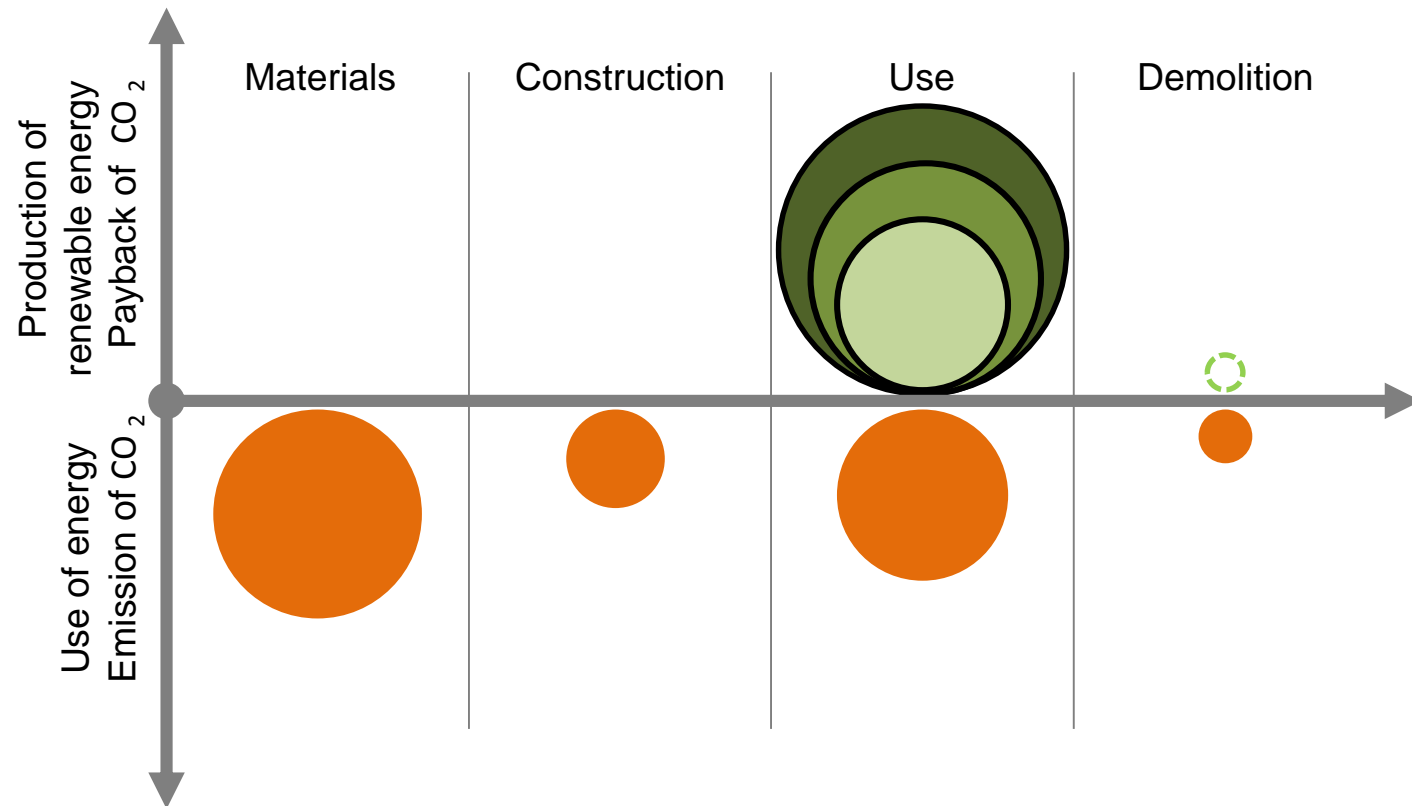Membrane heat exchanger

ZEB Living Lab

ZEB Definition

ZEB Pilot buildings

The Research Centre on Zero Emission Buildings

Zero Emission Buildings Definition

ZEB Demonstration Buildings

Pilot Building	Type of Building	Built area
1. Skarpnes, Arendal	5 new detached houses	5 x 154 m^2
2. Powerhouse Kjørbo, Sandvika	Renovation of two office buildings	5 000 m^2
3. ZEB Pilot House, Larvik	New detached demonstration house	200 m^2
4. Ådland, Bergen	720 new dwellings	80 000 m^2
5. Visund, Haakonsvern Bergen	New office building	2 000 m^2
6. Powerhouse Brattøra, Trondheim	New office building	14 000 m^2
7. ZEB Living Lab, Trondheim	New research dwelling	100 m^2
8. Heimdal VGS, Trondheim	New upper secondary school	18 000 + 8 000 m^2
9. Campus Evenstad	New office building	1 100 m^2

ZEB The Research Centre on Zero Emission Buildings

A New Research Centre

The Research Centre on Zero Emission Neighbourhoods in Smart Cities – ZEN

Illustration: Snøhetta
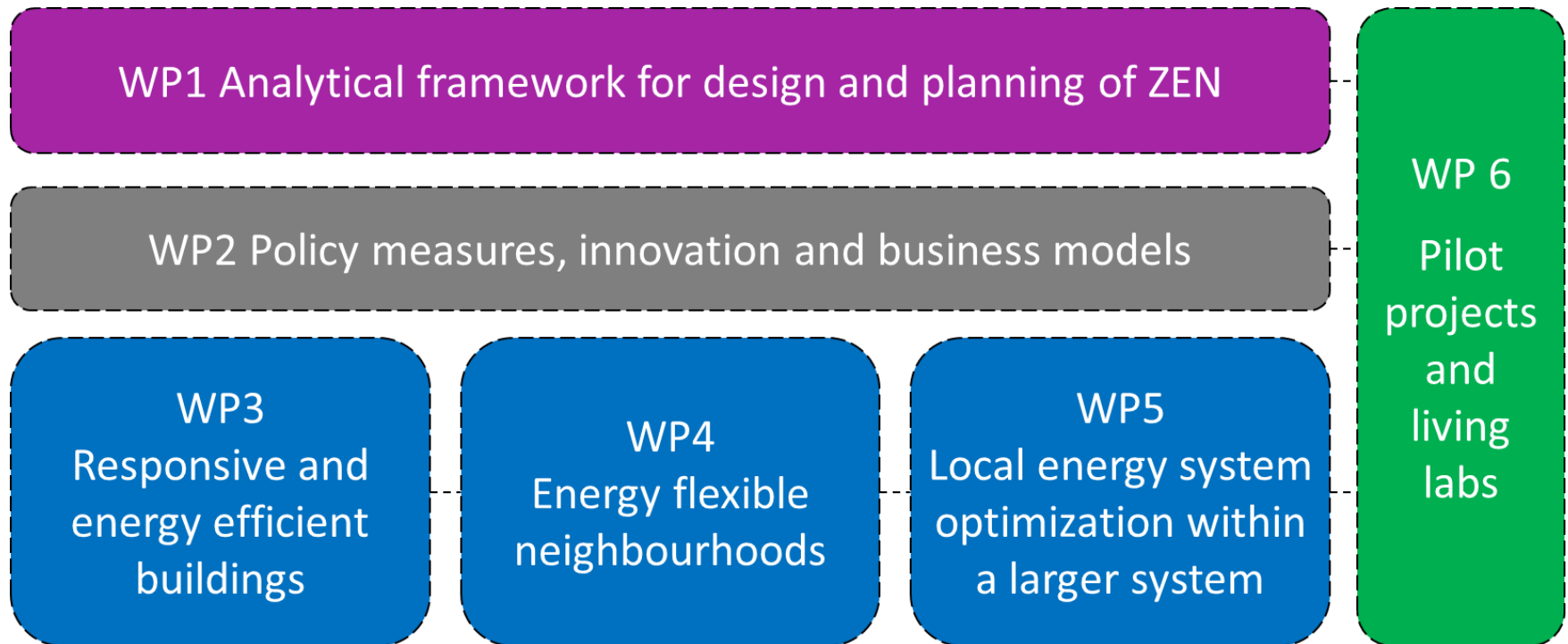Project: Zero Village Bergen by ByBo

10 Public partners	Oslo, Bergen, Trondheim
	Bodø, Elverum, Steinkjer
	Sør-Trøndelag fylkeskommune
	Statsbygg
	NVE – Norges vassdrag og energidirektorat
	DiBK – Direktoratet for byggkvalitet
20 Industry partners	ByBo, Elverum Tomteselskap
	TOBB
	Snøhetta, Reinertsen, Asplan Viak
	Multiconsult, SWECO, Civitas
	FutureBuilt
	Energi Norge, Norsk Fjernvarme
	NTE – Nord-Trøndelag Energiverk
	Hunton, Moelven
	Norcem
	Numascale
	Smart Grid Services Cluster
	Skanska
	GK, Caverion
Research partners	**NTNU**
	SINTEF

ZEN – The Research Centre on Zero Emission Neighbourhoods in Smart Cities

Research questions:

- **How should the sustainable neighbourhoods of the future be designed, built, transformed and managed to reduce their greenhouse gas emissions towards zero?**

- Sub-questions:
  - How can science-based knowledge on GHG emissions be integrated more effectively into practice-based neighbourhood design and planning instruments? (WP1)
  - Which policy measures, innovation and business models and forms of public private collaboration, will support long-term transitions towards ZEN? (WP2)
  - How to build new and renovate the existing building stock aiming at both high operational energy performance and low life cycle environmental impact? (WP3)
  - How to operate flexible neighbourhoods with buildings and distributed energy resources available onsite and nearby buildings as active nodes of the grid? (WP4)
  - What is the optimal trade-off and interplay between local solutions and grid reinforcement for the connection to the surrounding system? (WP5)

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Work Packages

WP1 Analytical framework for design and planning of ZEN

WP2 Policy measures, innovation and business models

WP3
Responsive and energy efficient buildings

WP4
Energy flexible neighbourhoods

WP5
Local energy system optimization within a larger system

WP 6
Pilot projects and living labs

ZEN – The Research Centre on Zero Emission Neighbourhoods in Smart Cities

Why focus on the neighbourhood dimension?

- By looking at more buildings at the same time, synergies can be realized between the energy demand profiles of individual buildings. When one building has a surplus of heat/energy, another building can use it.

- Not all buildings can be built/refurbished into zero emission buildings, e.g. protected/listed buildings or buildings on a challenging site.

- Optimizing at the neighbourhood scale can reduce the strain on the grid (synergies between buildings, PV, charging stations for electrical vehicles, etc.)

- The neighbourhood dimension is large enough to have an impact, but small enough to allow demonstration of technologies and interaction with users.
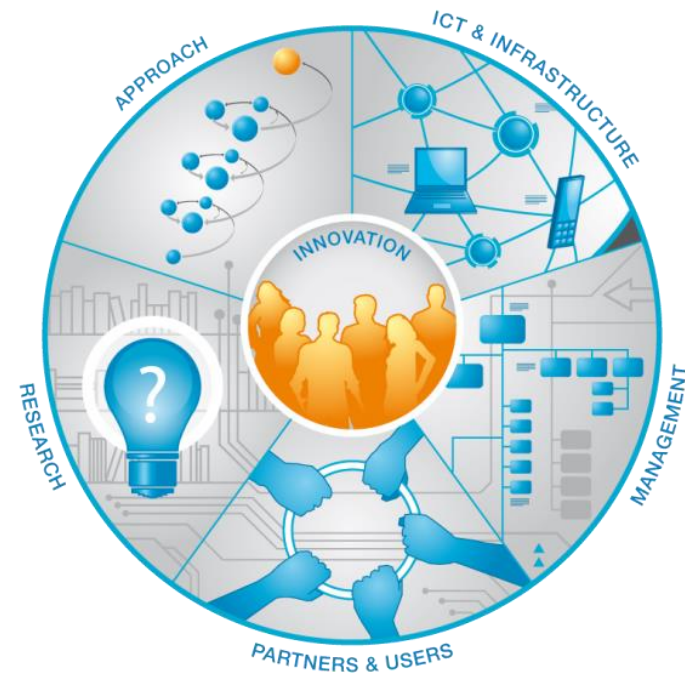
WP6 Pilot projects and living labs

To realize at least 7 pilot projects for ZEN concepts in Norway.

-**innovation hubs** for *co-creation* between researchers and building professionals, property developers, municipalities, energy companies, building owners, and users;

-**living labs** to *verify, document* and *optimize* the real-life performance of the solutions developed in the ZEN Centre;

-**lighthouse projects** to *learn, inspire, and disseminate* ZEN-related knowledge.

Pilot Projects/Living Labs

Oslo: Furuset
Bergen: Zero Village Bergen
Elverum: Ydalir
Trondheim: Knowledge Axis
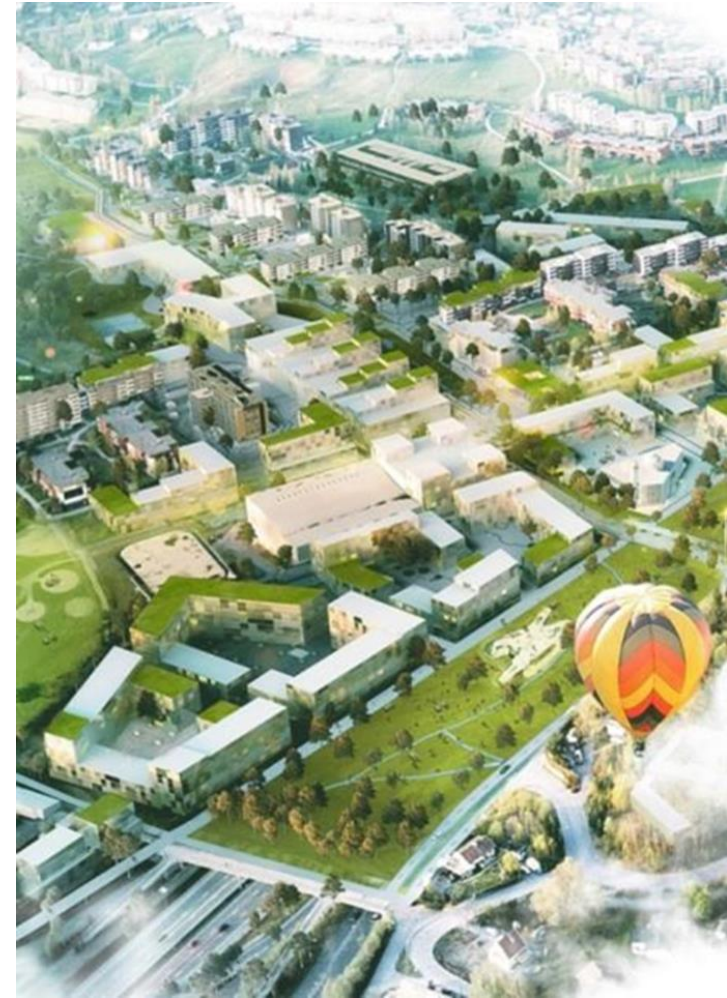**Bodø**: Airport area
Steinkjer: Residental area
Evenstad: Campus

Population of 30 000 people
Built floor area of more than 1 million m^2

ZEB Flexible Lab office building, NTNU Campus
ZEB Living Lab residential building, NTNU Campus

ZEB Living Lab

- 100 m² living area
- ZEB-OM (Operation and Materials)
- Building Integrated Photovoltaics: 80 m^2
- Solar panel in the facade
- Ground to water heat pump
- Heat recovery system (Flexit)
- PCM in the roof (DuPont)
- VIP in sliding doors (NorDan)
- Reflective vapor barrier (Isola)
- Mixed mode ventilation (Sapa, VELUX, and Caverion)
- LED Lights (NorDesign)
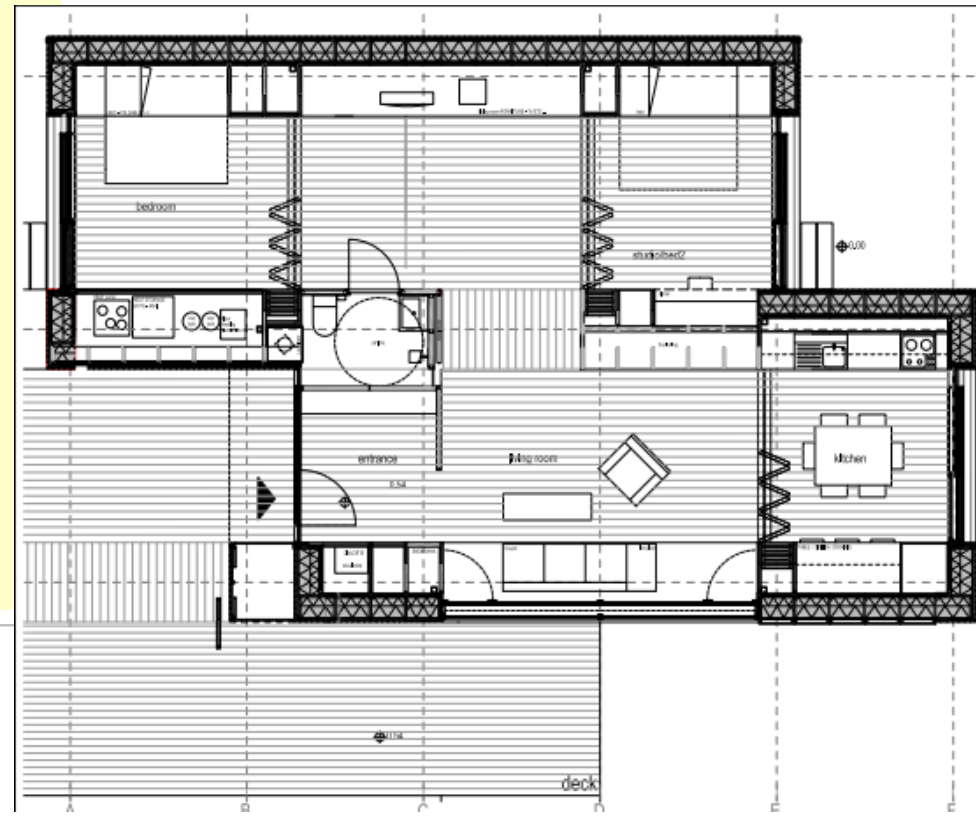
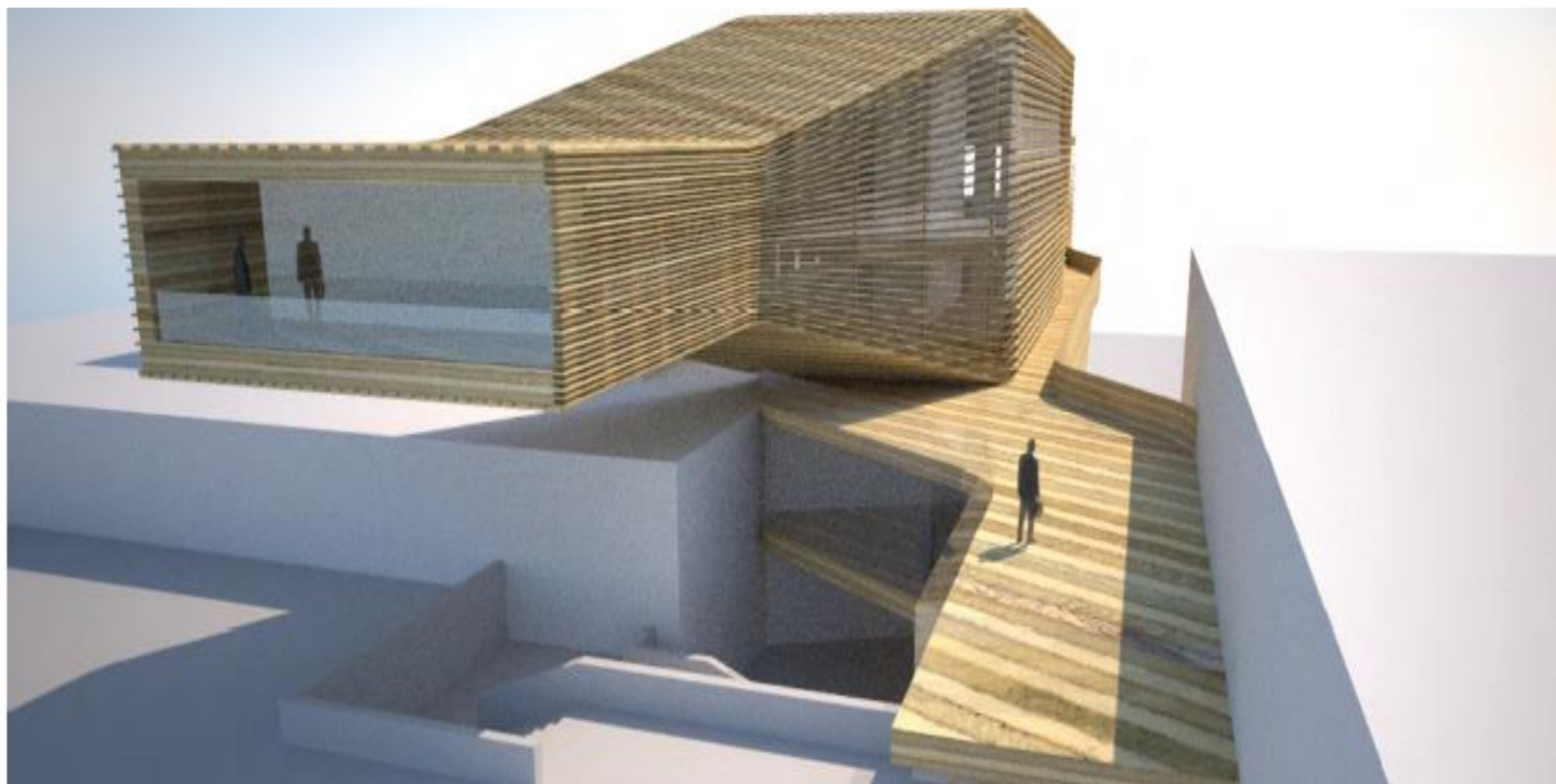

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ZEB Test Cell Lab

Laboratory for experiments and research on
- Facades
- Space heating solutions
- Ventilation systems/ strategies
- Daylighting systems
- New materials and products
- Solar collectors and panels
- Building integrated systems
- And more
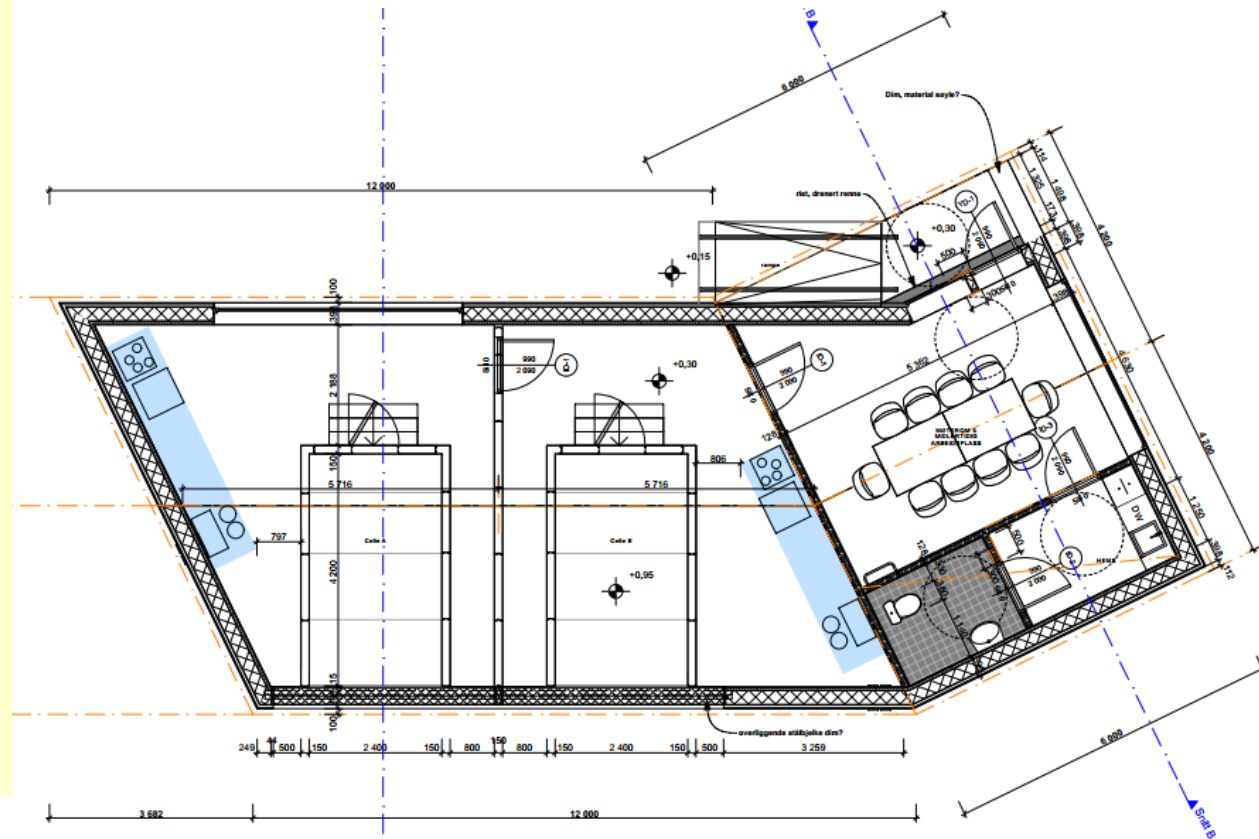
New ZEB Flexible Lab

- **be a basis for international competitive industrial development**
- **be a basis for knowledge development at an international level**
- **be a research arena for developing zero emission buildings**
- **be an arena for risk reduction when implementing zero emission building technologies**

University: Research - Education

- Post. Docs 5
- PhD-students 22
  - Mobility plan:
    - 3 months at industry partner
    - 6 months with international research unit
- MSc-students - Project and MSc-thesis work
- A number of relevant BSc, MSc, Phd-programmes and courses offered – Architecture, Innovation and business development, Humanities, ICT, Engineering
- EIT - Experts in Team (Multi-disciplinary course)
- Summer schools in Sustainable energy
- Dissemination activities on energy saving issues

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Thank you for your attention

Contact: Arild.Gustavsen@ntnu.no

Illustration: Snøhetta/MIR
Project: Powerhouse Brattørkaia

# WP1 Analytical Framework for Design and Planning of ZEN

Goal: Develop definitions, targets and benchmarking for ZEN, based on customised indicators and data (quantitative + qualitative); Develop life cycle analysis methodology for energy and emissions at neighbourhood scale; Develop a citizen-centred architectural and urban toolbox for design and planning of ZEN, incl visualisation and decision support
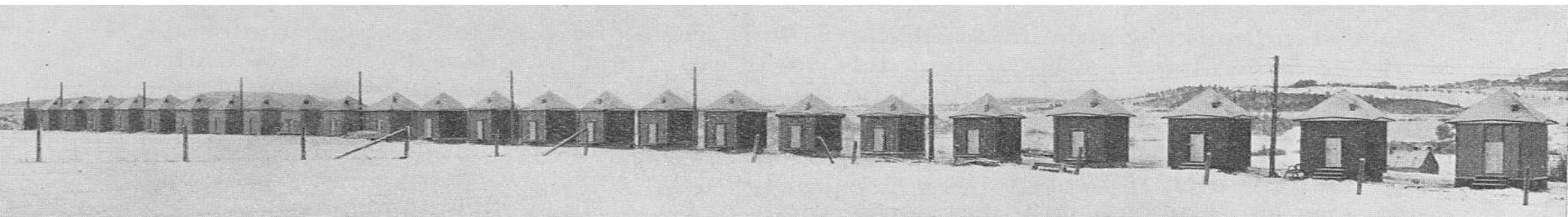
WP2 Policy measures, innovation and business models

Goal:

WP2 will evaluate possible transition pathways towards ZEN consisting of integrated studies of policy measures, different forms of public private collaboration, different financial and business models and instruments as well as improved innovation processes.
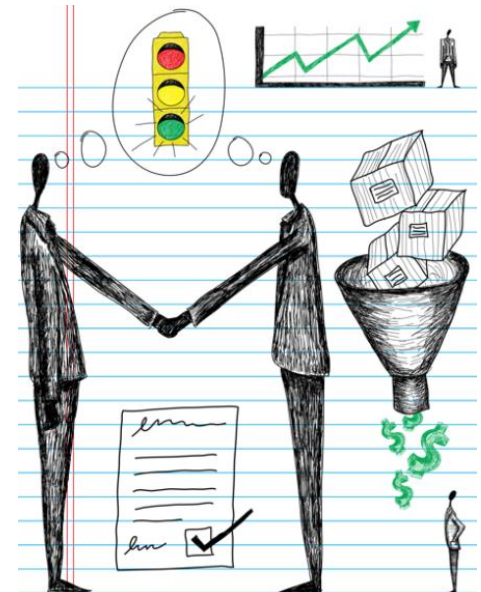
WP3 Responsive and energy efficient buildings

Goal:

WP3 will create cost effective, responsive, resource and energy efficient buildings by developing low carbon technologies and construction systems based on lifecycle design strategies
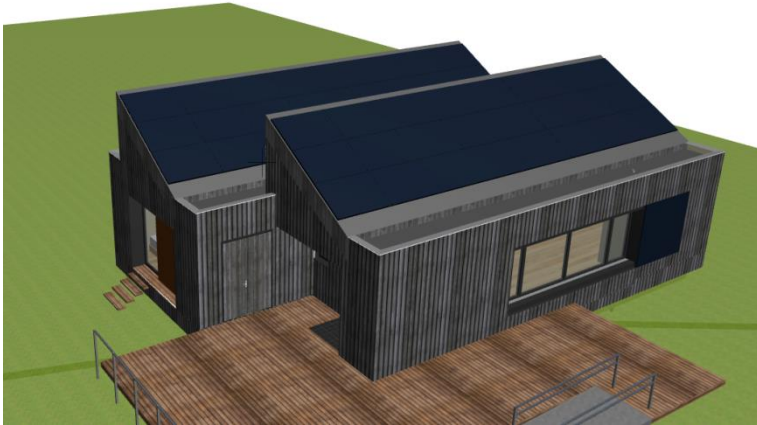

*ZEB Living Lab
Photo: Ole Tolstad/NTNU*

ZERO EMISSION NEIGHBOURHOODS IN SMART CITIES

WP4 Energy flexible neighbourhoods

Goal

The aim of WP4 is to develop knowledge, technologies and solutions for design and operation of energy flexible neighbourhoods.
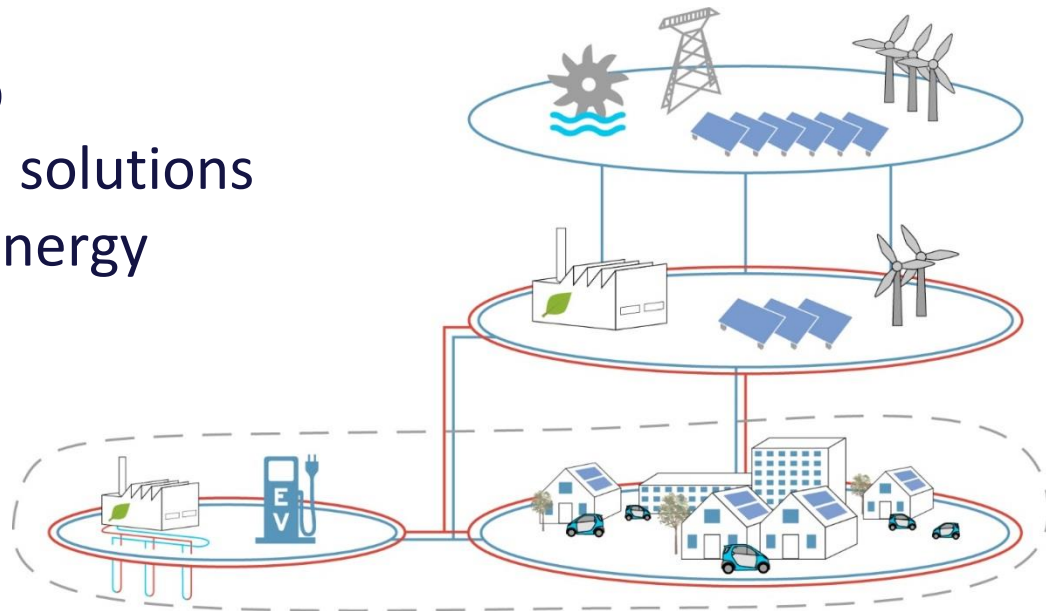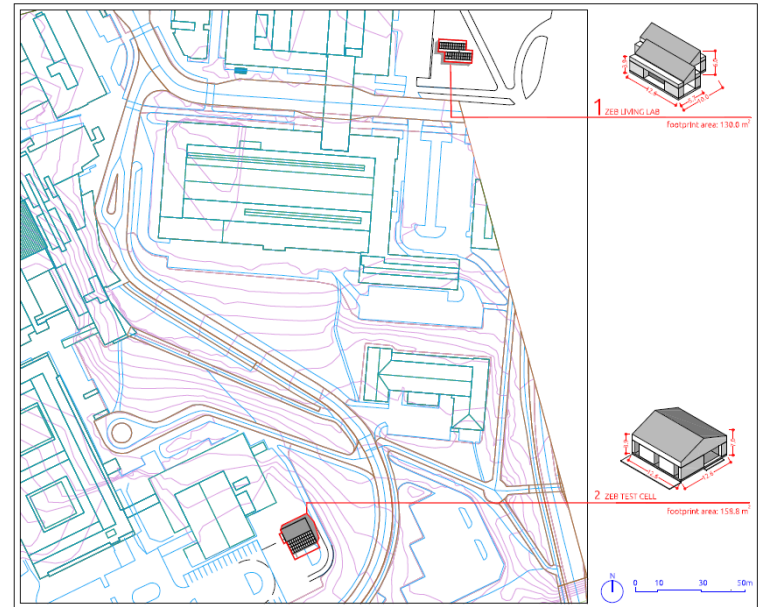
Establishment of research buildings at NTNU – ZEB Living Lab and ZEB Test Cell Lab

ZEB Living Lab – A dwelling for user-technology interaction studies

ZEB Test Cell Lab for research and development of ZEB technologies

ZEN Centre Facts

- Host: Norwegian University of Science and Technology - NTNU
- Research partners: SINTEF Building and Infrastructure and SINTEF Energy Research

- Start date: Fall/winter 2016, when contract with Research Council of Norway has been signed

- Total budget: ca. 380 MNOK (2016 – 2024)
- Approximately 20 PhD candidates and 5 post docs will be hired