

From ZEB to ZEN

Norwegian Research on Zero Emission Buildings and Neighborhoods

CITIES Conference, Århus 31.05.2017

Inger Andresen, professor NTNU



The Research Centre on
Zero Emission Buildings



Content

ZEB - The research centre on Zero Emission Buildings

2009-2017, budget 290 mill NOK

- Some examples of results

ZEN - The research centre on Zero Emission Neighbourhoods

2017-2024, budget, budget 380 mill NOK

- Research plan



The Research Centre on
Zero Emission Buildings



ZEB's main objective

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 encompass both residential, commercial, and public buildings.

www.zeb.no

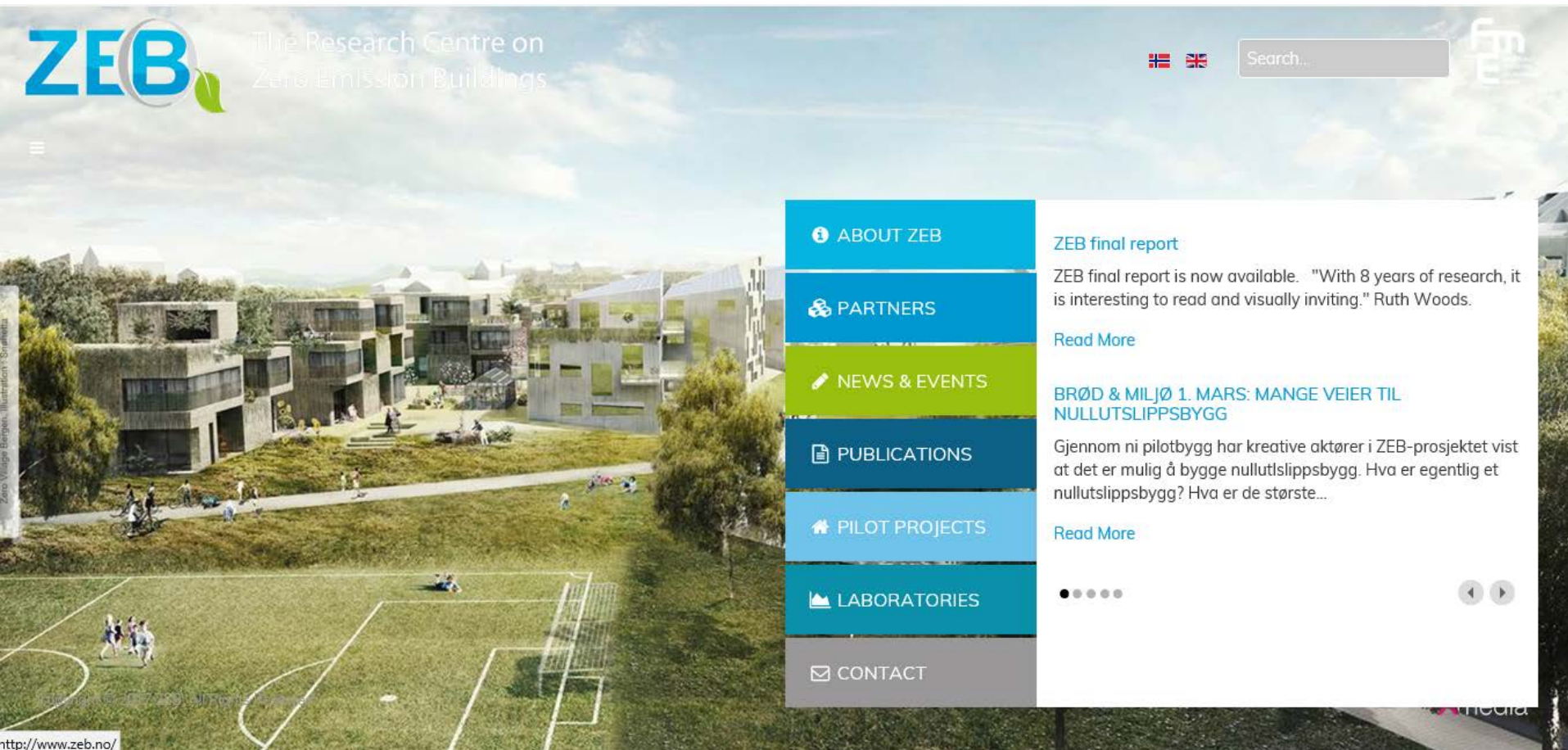


ZEB PARTNERS



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Zero Emission Buildings





ZEB Research Activities

WP1 Advanced materials technologies

WP2 Climate-adapted low-energy envelope technologies

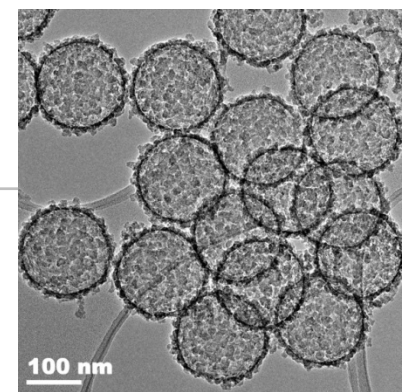
WP3 Energy supply systems and services

WP4 Use, operation, and implementation

WP5 Concepts, strategies and pilot buildings



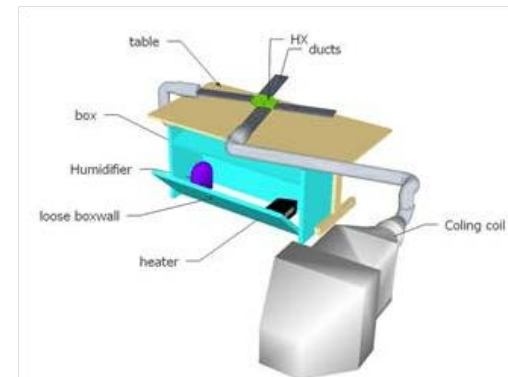
VIP Leca Isoblokk



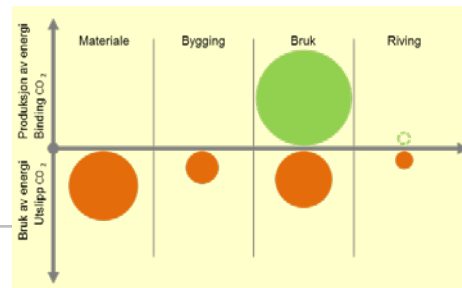
Nano insulation



User studies



Membrane heat exchanger



ZEB Definition

ZEB Pilot buildings



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What is a ZEB?

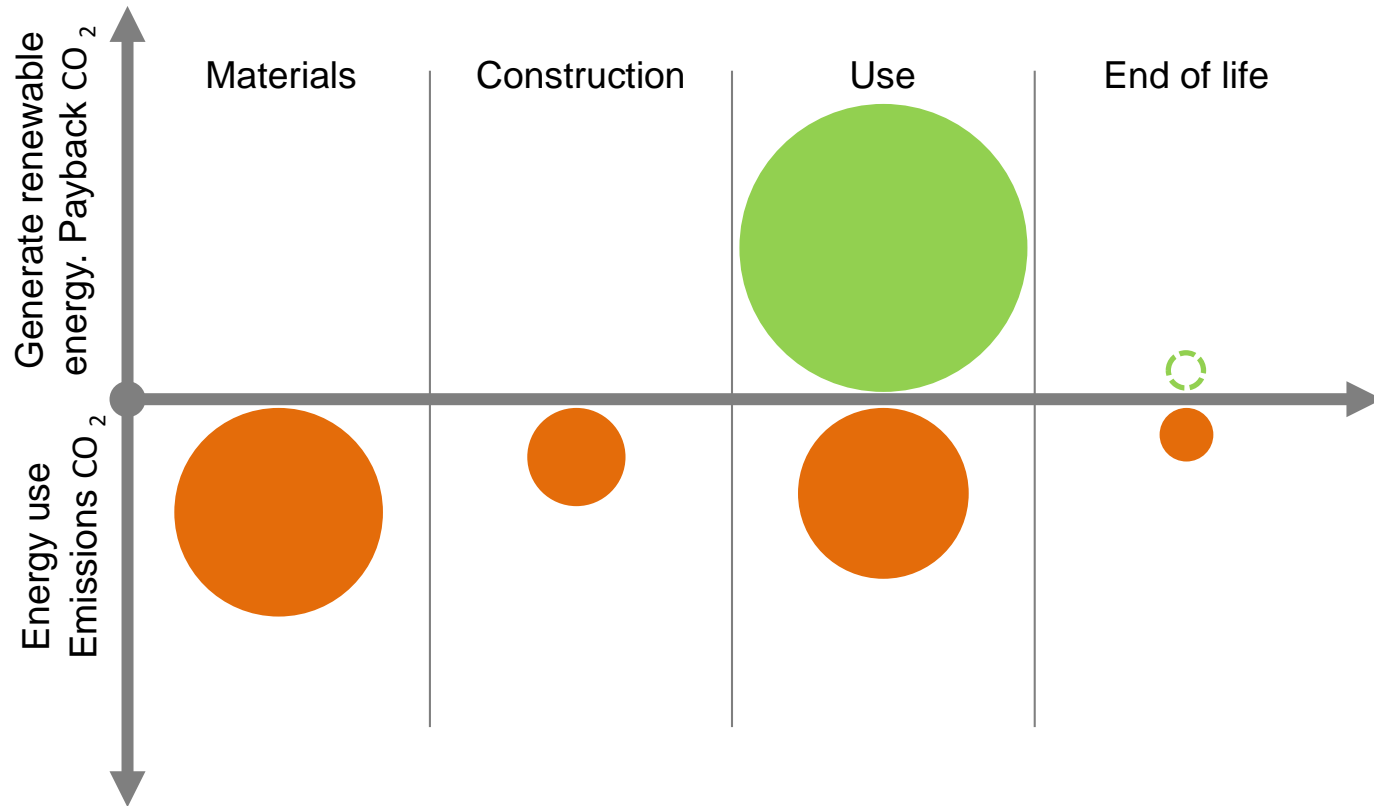
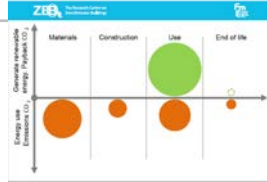
A Zero Emission Building is a building that over its life time compensates for all greenhouse gas emissions related to production, construction and operation of the building.



ZEB-hus Larvik
Eier: Brødrene Dahl
Arkitekt: Snøhetta

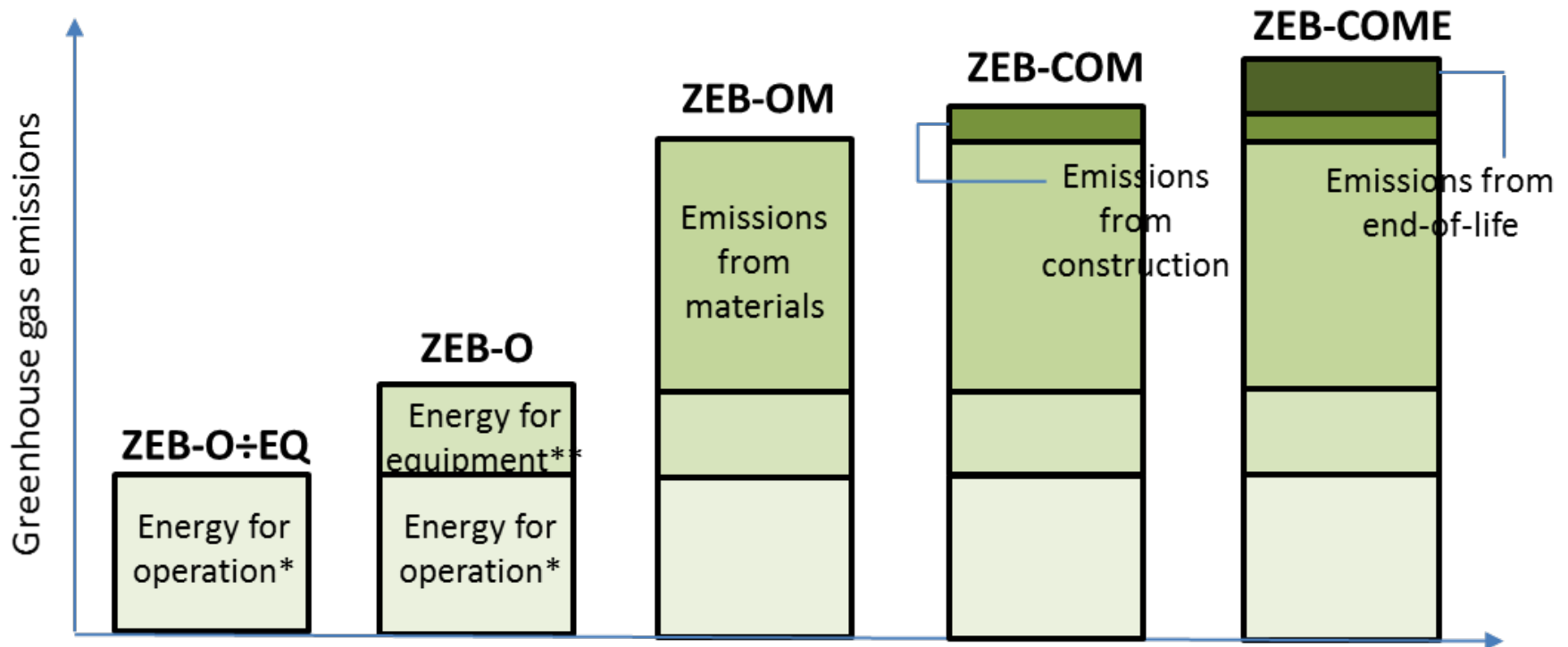
What is a ZEB?

Stamnes, Håvard; Fylla, Rasmus; Gern, Schindler, Ken; Samdal, Inger; Samdal, Inger; Samdal, Inger
A Norwegian ZEB Definition
Guideline



Calculated as CO₂-equivalents per m² heated floor area over a life time of 60 years

ZEB ambition levels



* Energy use for heating, cooling, ventilation, DHW, and lighting

** Energy use for appliances (white goods, IT-equipment, etc.)

ZEB Pilot building projects



Examples from 2 of the ZEB pilot building projects

ZEB Powerhouse Kjørbo

Upgrade of existing office building
to plus energy building

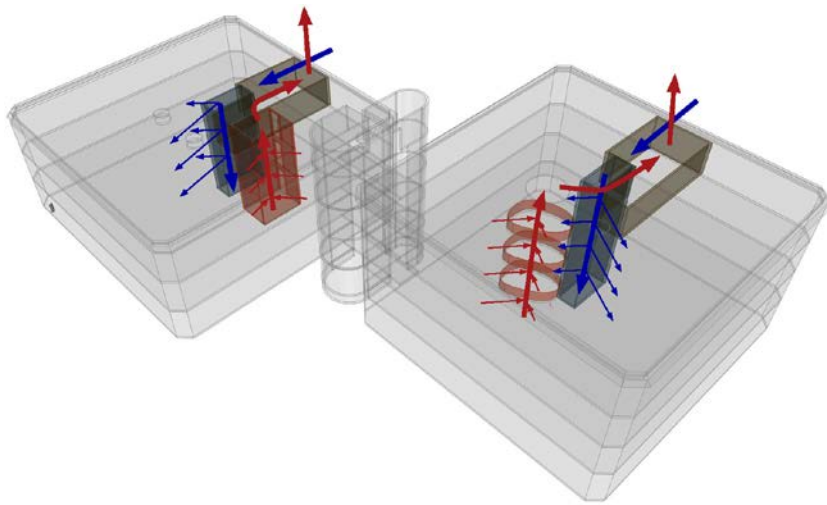


Zero Village Bergen

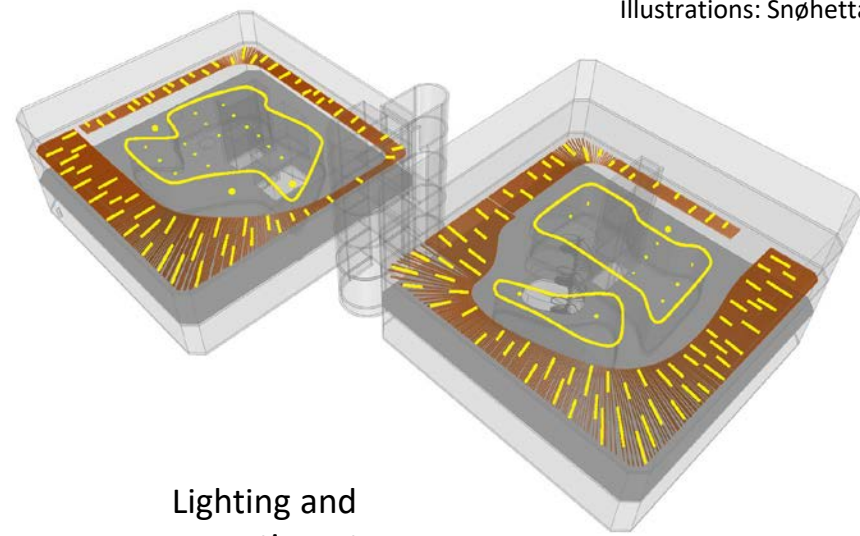
6-800 new dwellings, a kindergarten
and some commercial buildings



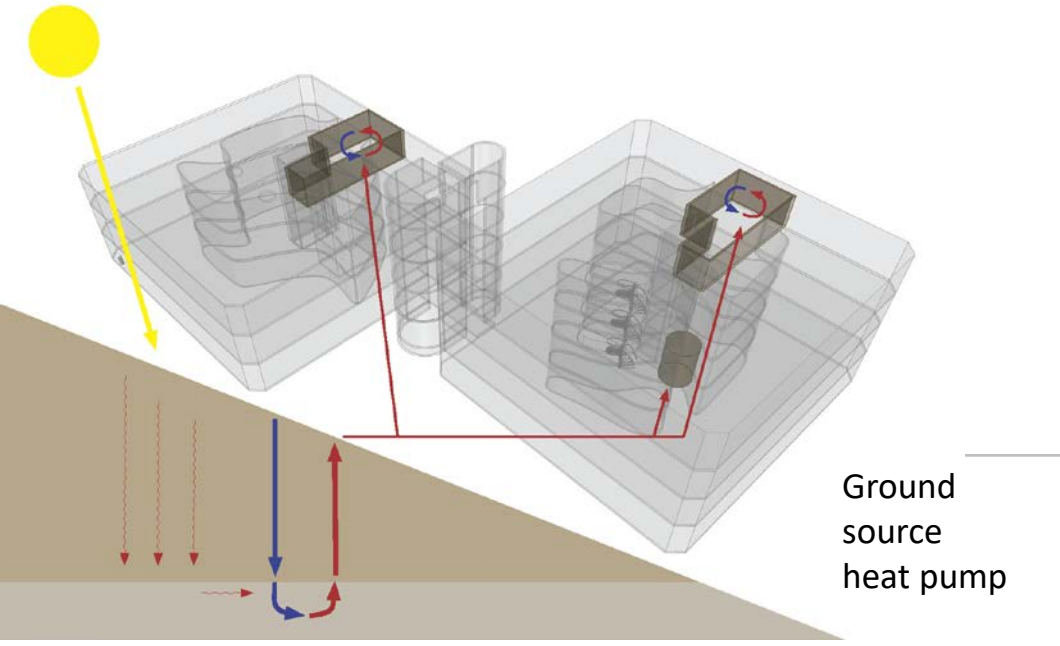




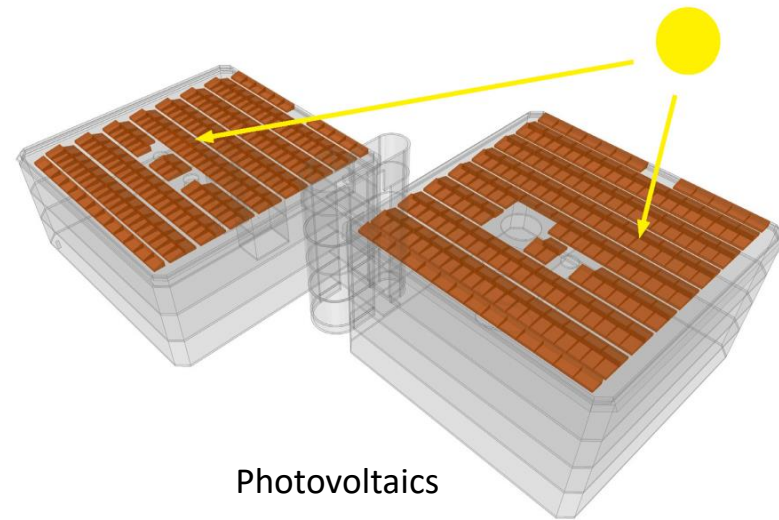
Hybrid ventilation with
exposed thermal mass



Lighting and
acoustic systems



Ground
source
heat pump



Photovoltaics

Powerhouse Kjørbo, energy performance

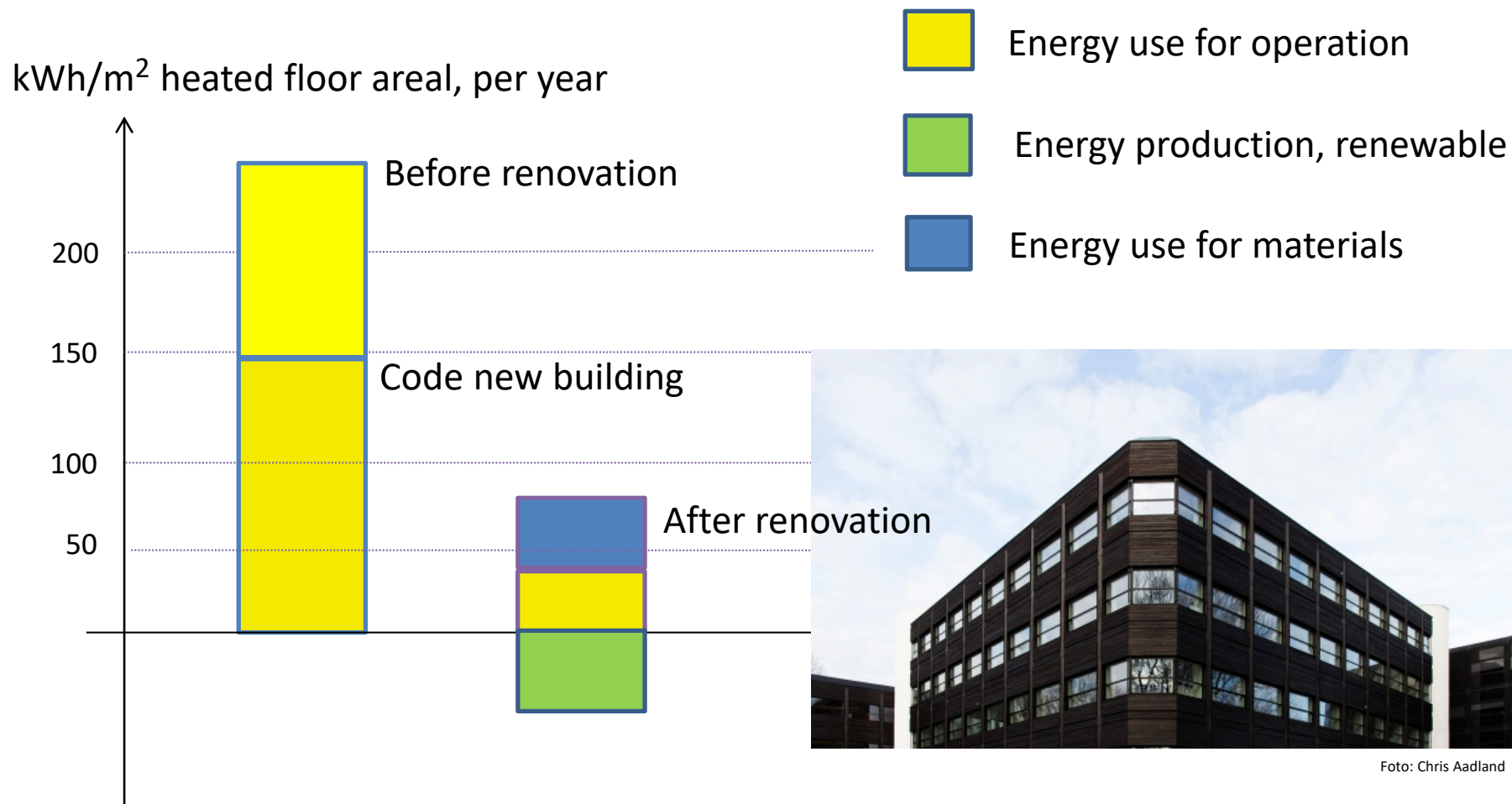
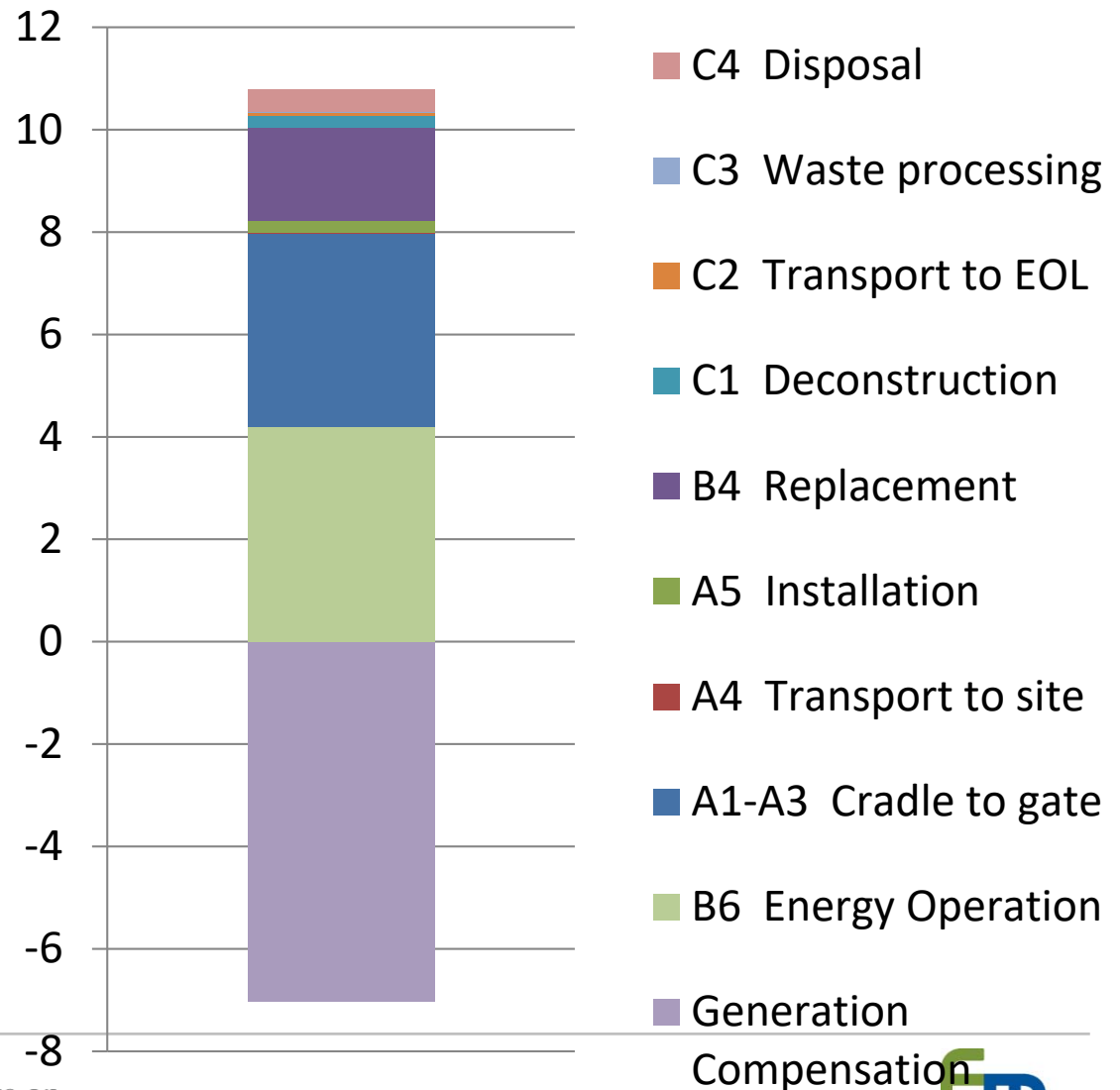


Foto: Chris Aadland

GHG-emissions in different life cycle stages, Powerhouse Kjørbo

kg CO₂-eqv pr m² pr yr

distributed over a
life time of 60 years.





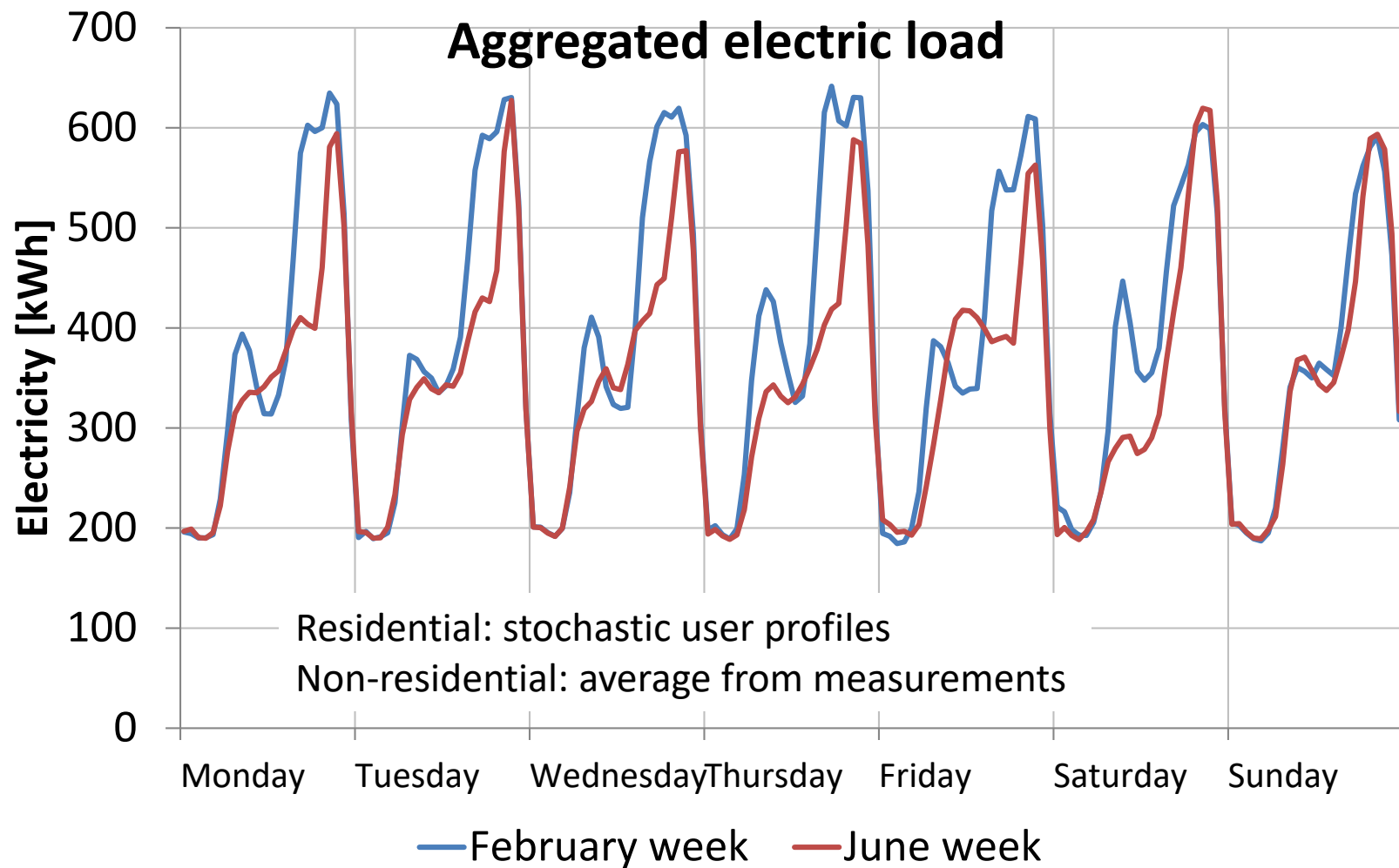
Adland

Zero Village Bergen

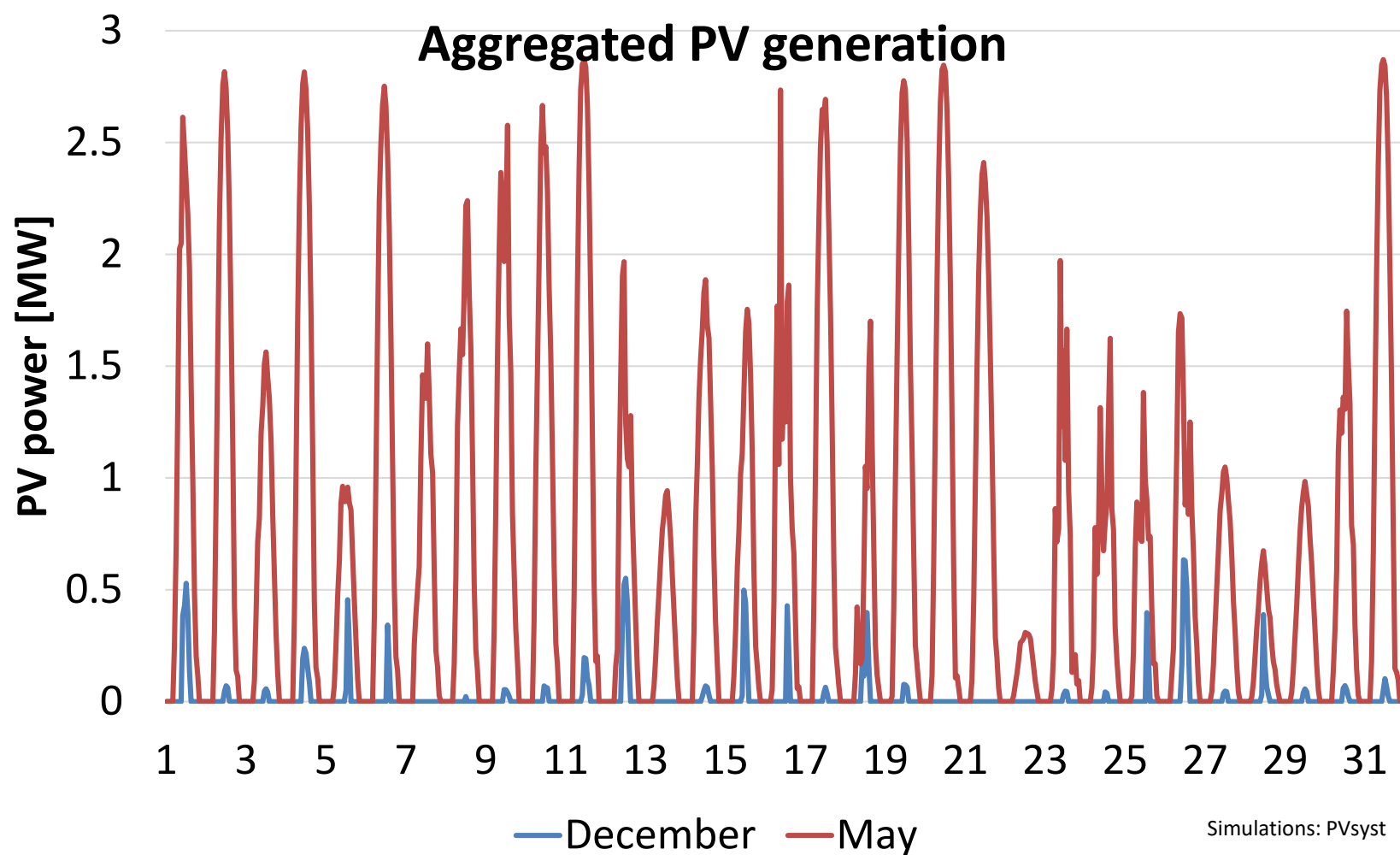
6-800 new dwellings
A kindergarten
Commercial buildings

Illustrasjon: Snøhetta

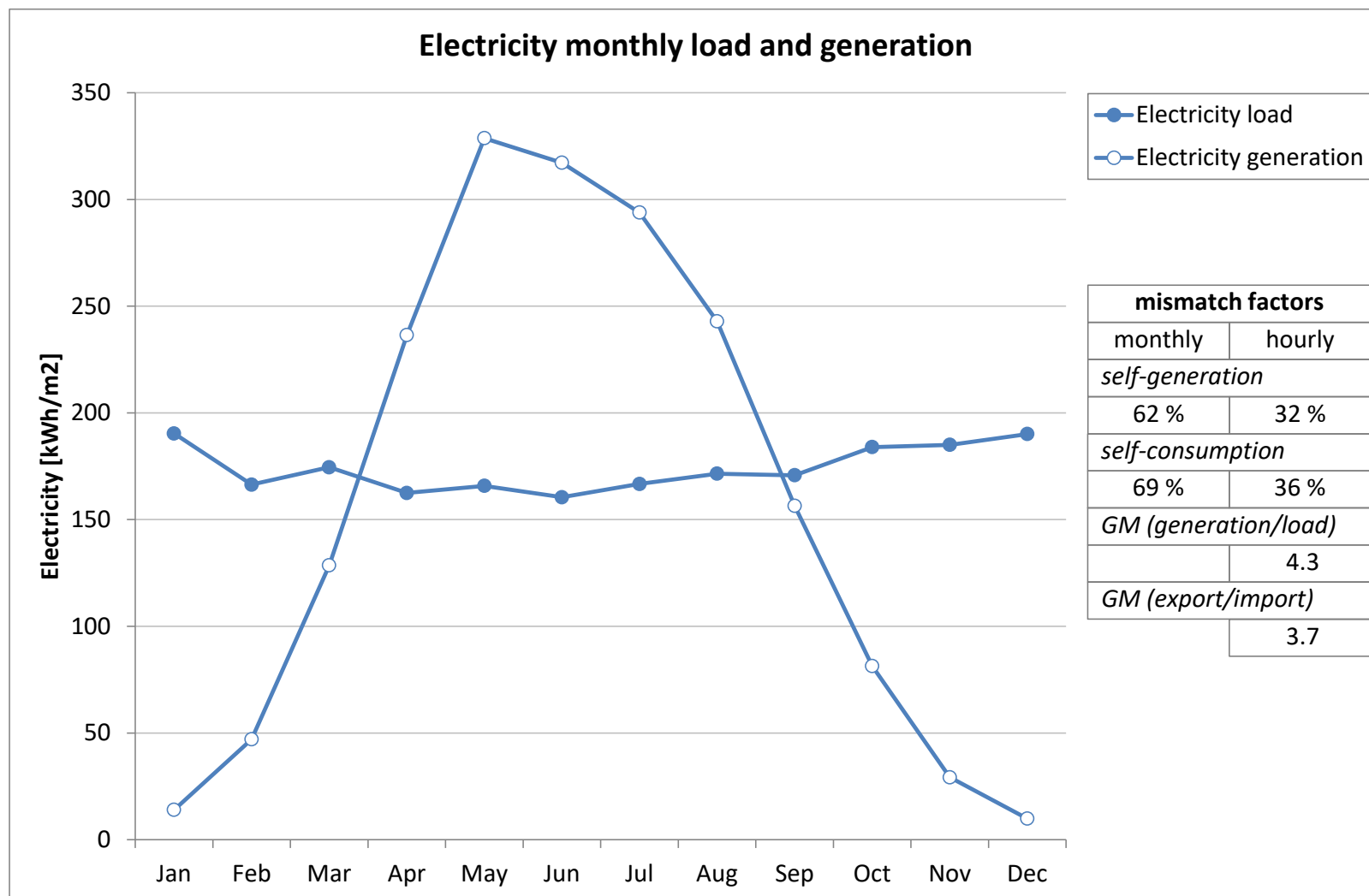
Typical weekly profiles for the electric load



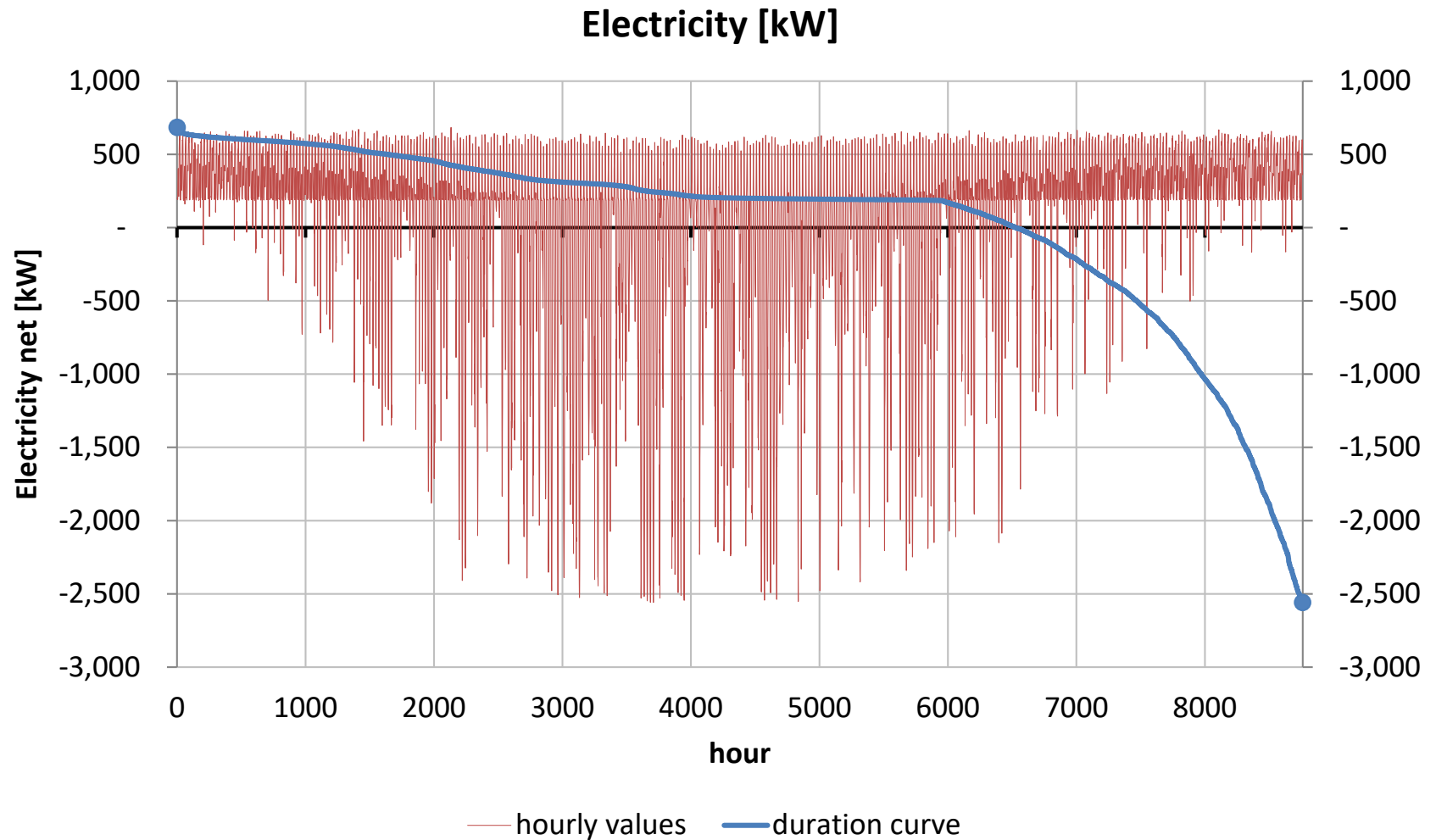
PV generation highest/lowest months

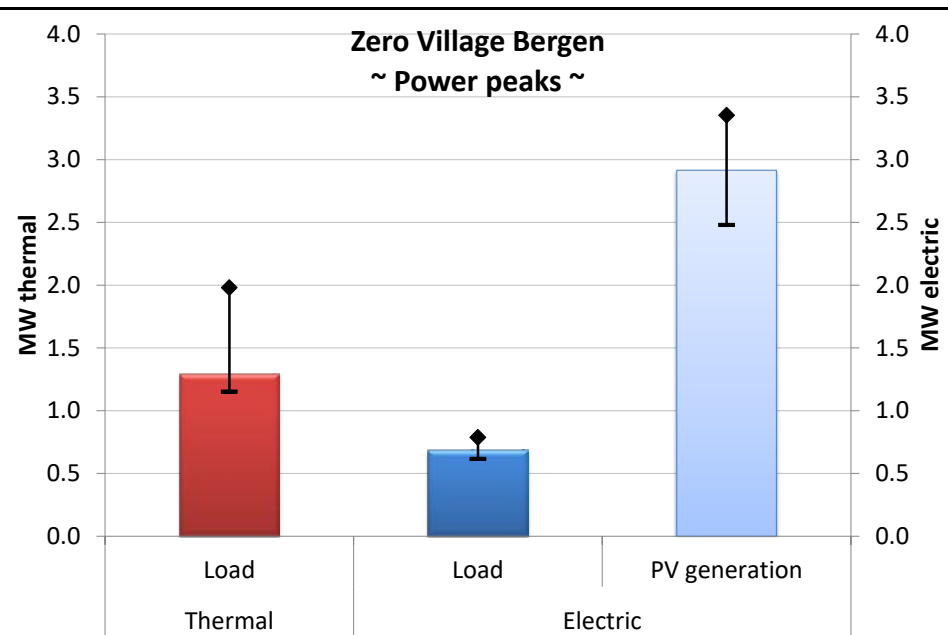
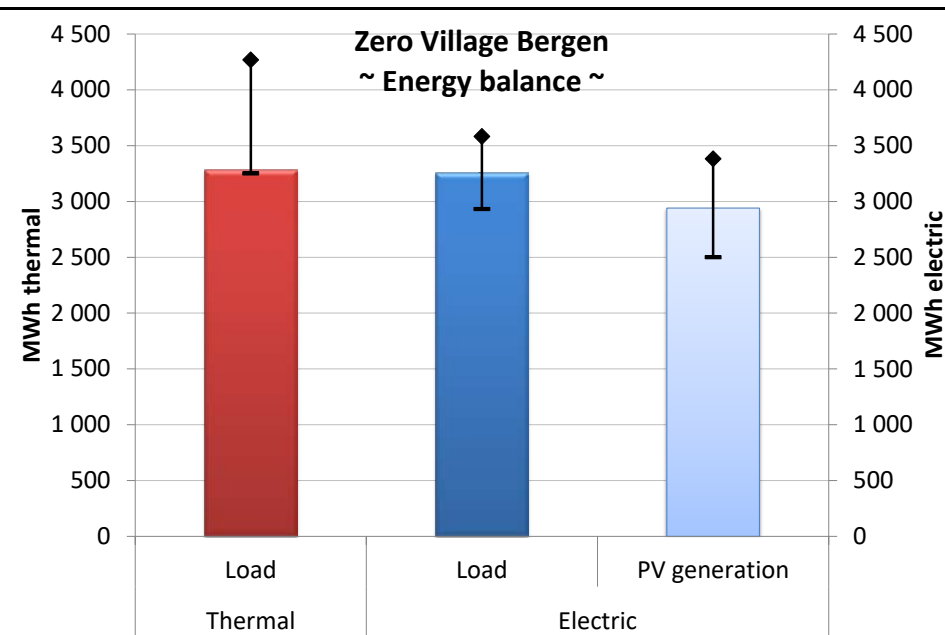


Net delivered electricity – monthly



Net delivered electricity – hourly





Further analyses – Zero Village Bergen

- Connection to district heating
- CHP based on biofuels
- Ground source heat pump
- Local storage – ground, dhw, electric batteries (cars)

- Scenarios for energy/fuel prices, framework conditions, technology development

In cooperation with Bybo, BKK, CMR and ProxLL



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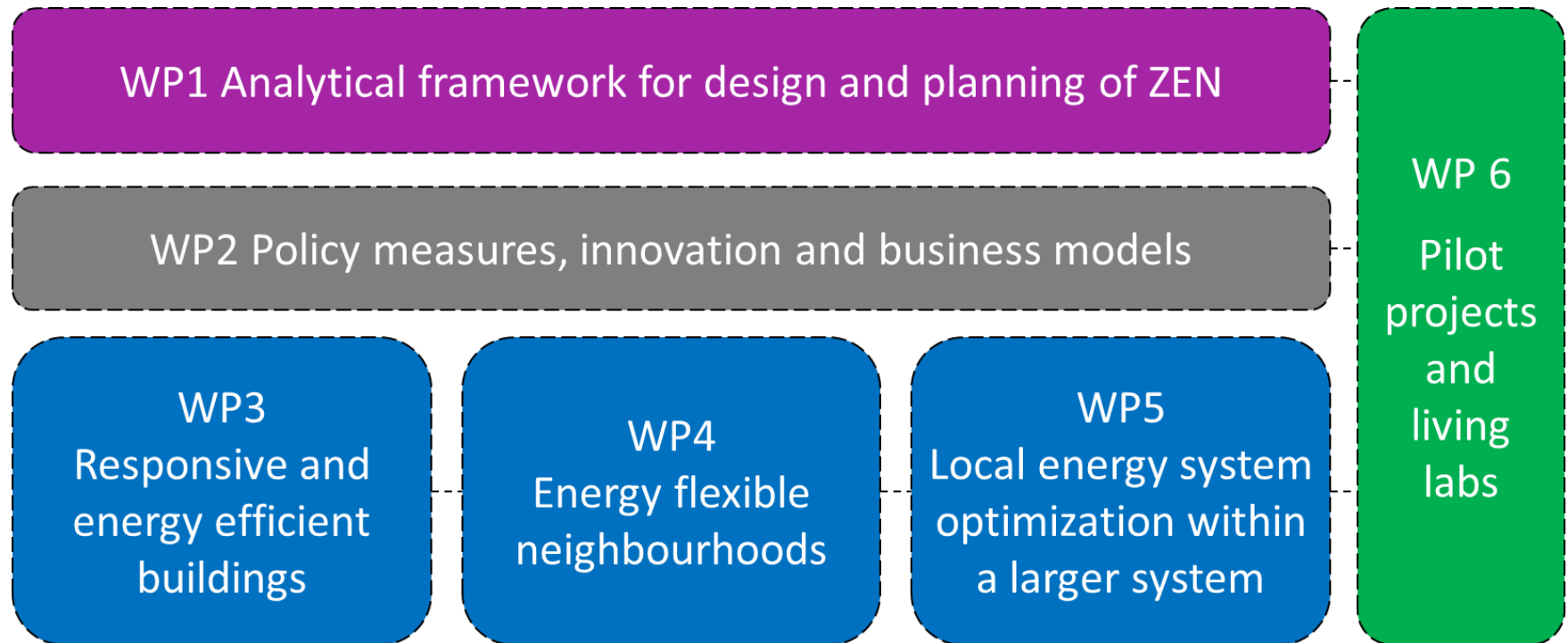




2017-2024:
THE RESEARCH CENTRE ON
**Zero Emission
Neighbourhoods
in Smart Cities**

BUILDINGS – USERS – ENERGY SYSTEMS – PILOT PROJECTS

Work Packages



PARTNERS

10 PUBLIC PARTNERS

Oslo
Bergen
Trondheim
Bodø
Elverum
Steinkjer
Sør-Trøndelag fylkeskommune
NVE
DiBK

2 RESEARCH PARTNERS

NTNU Sintef

20 INDUSTRY PARTNERS

ByBo	Norsk Fjernvarme
Elverum	NTE – Nord-Trøndelag
Tomteselskap	Energiverk
TOBB	Hunton
Snøhetta	Moelven
Reinertsen	Norcem
Asplan Viak	Numascale
Multiconsult	Smart Grid
SWECO	Services Cluster
Civit	Skanska
FutureBuilt	GK
Energi Norge	Caverion

PhDs and Post Docs, announced 2017

Post Doc: Information management of big data to achieve ZEN

PhD student: LCA methods for zero emission neighborhood concepts

PhD student: 3D Visualisation to improve stakeholder participation (start in 2018)

PhD student: Tools for transition pathways in ZEN

PhD student: Dialog based public procurement as a driver of creating effective public-private collaboration and business models for ZEN development

Post Doc: Innovation systems for zero emissions neighbourhoods

PhD student: IEQ flexibility, control strategies and resulting energy efficiency

PhD student: Optimal integrated building designs for resilient zero emission neighbourhoods

PhD student: Building energy performance assessment through in-situ measurement

PhD student: Thermal comfort enabling thermal flexibility of buildings

PhD student: Modelling and control of the aggregated energy flexibility of buildings

Post Doc: Interaction between zero emission neighbourhoods and district heating systems

PhD student: The value of buildings' energy flexibility in the power market

PhD student: Investment planning models for local energy systems

Post doc: ZEN Living Labs

PhD student: CO2 emission and correlation to building form and spatial morphology at neighbourhood scale



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ZEN

Pilot Projects/Living Labs

Oslo:	Furuset
Bergen:	Zero Village Bergen
Elverum:	Ydalir
Trondheim:	NTNU Campus
Bodø:	Airport area
Steinkjer:	Residential area
Evenstad:	Campus

Population of 30 000 people

Built floor area of more than 1 million m²

ZEB Flexible Lab office building, NTNU Campus

ZEB Living Lab residential building, NTNU Campus



A photograph of a modern building with dark wood cladding and stone walls, featuring a large window and a wooden deck. The image is overlaid with a semi-transparent dark blue rectangle containing text.

THANK YOU!

inger.andresen@ntnu.no

Z
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