Mulige energiforsyningsløsninger for områder som Zero Village Bergen

Presentasjon på seminaret "Bærekraftige bygninger og områder", HiB Kronstad, Bergen, 27.04.2016

Inger Andresen, professor NTNU
Igor Sartori, seniorforsker SINTEF Byggforsk

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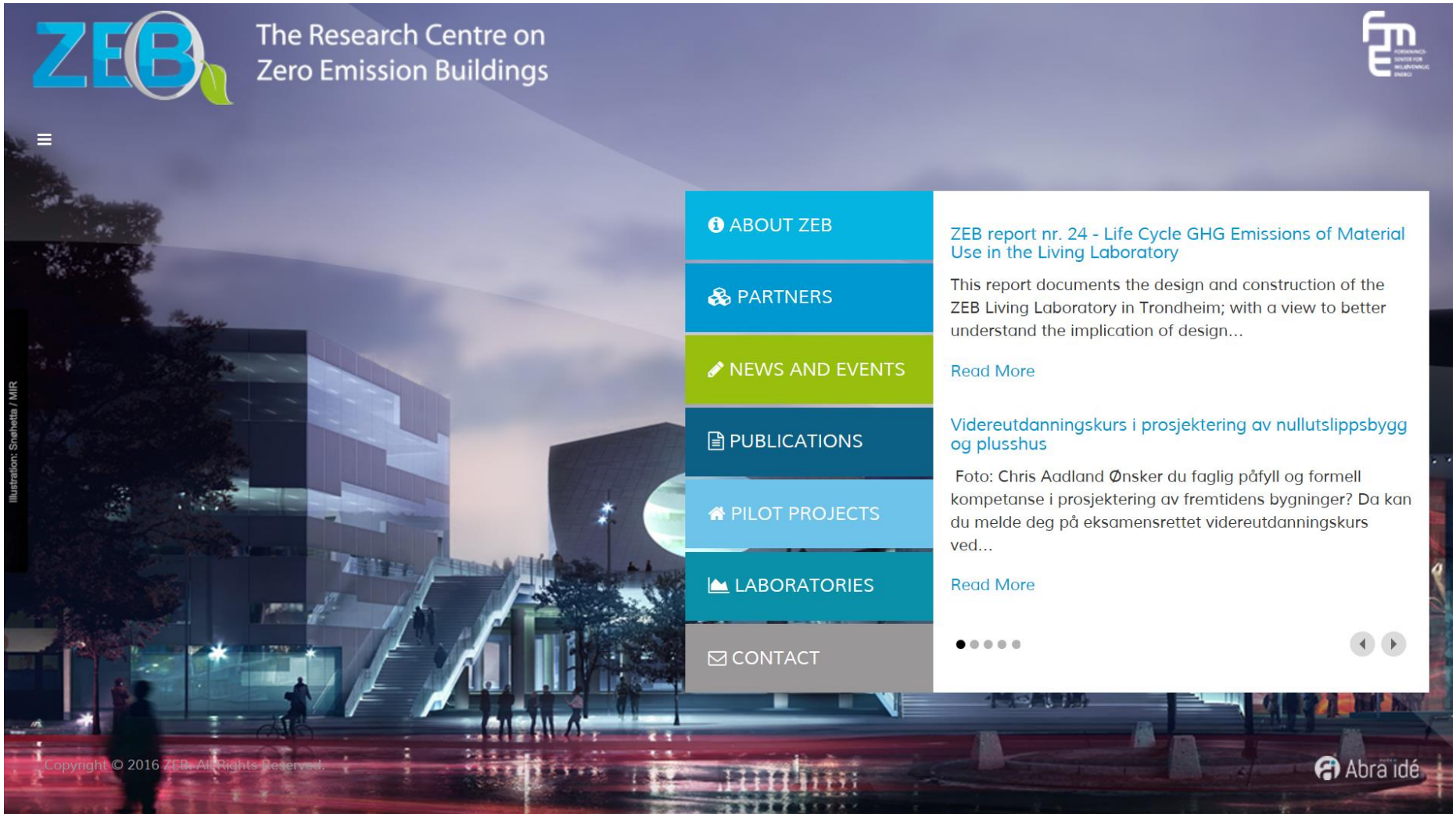
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ZEB Research Activities

WP1 Advanced materials technologies

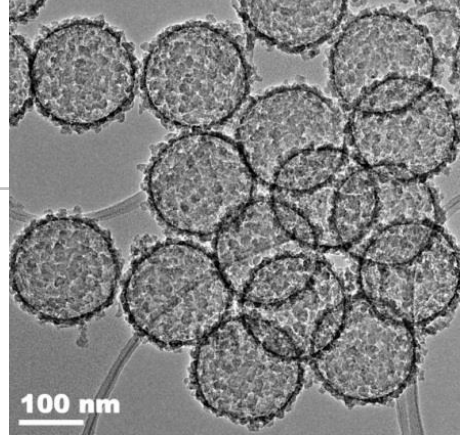
WP2 Climate-adapted low-energy envelope technologies

WP3 Energy supply systems and services

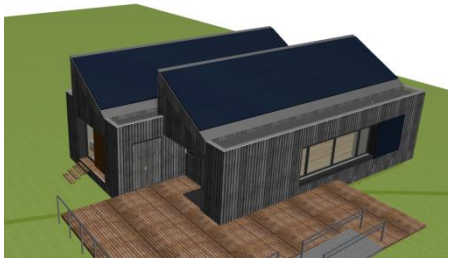
WP4 Use, operation, and implementation

WP5 Concepts and strategies and Pilot buildings

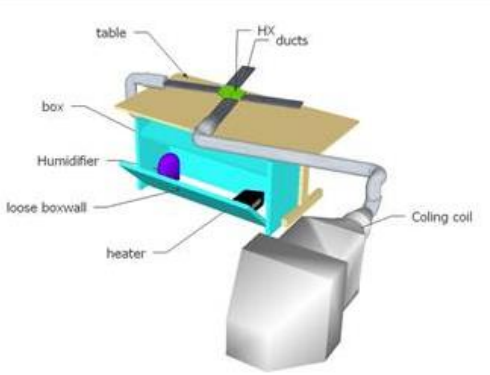
VIP Leca Isoblokk



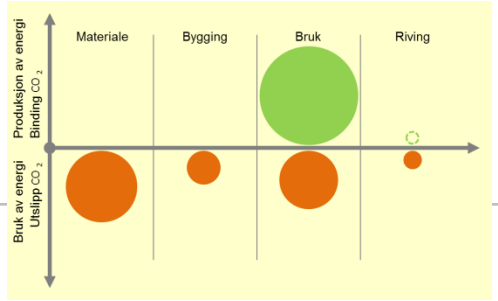
Nano insulation material



ZEB Living Lab



Membrane heat exchanger



ZEB Definition

ZEB Pilot buildings

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ZEB Pilot Buildings

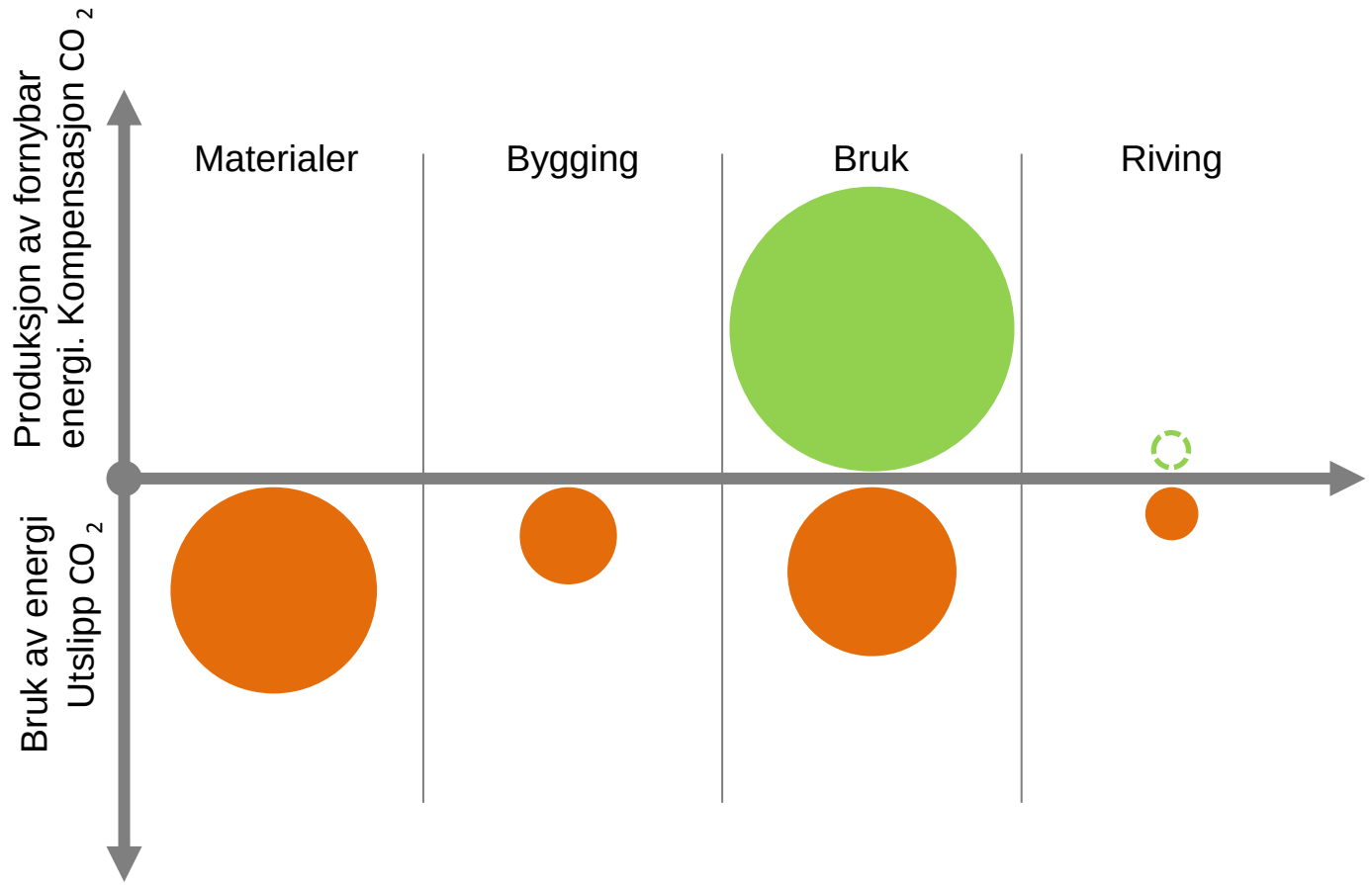




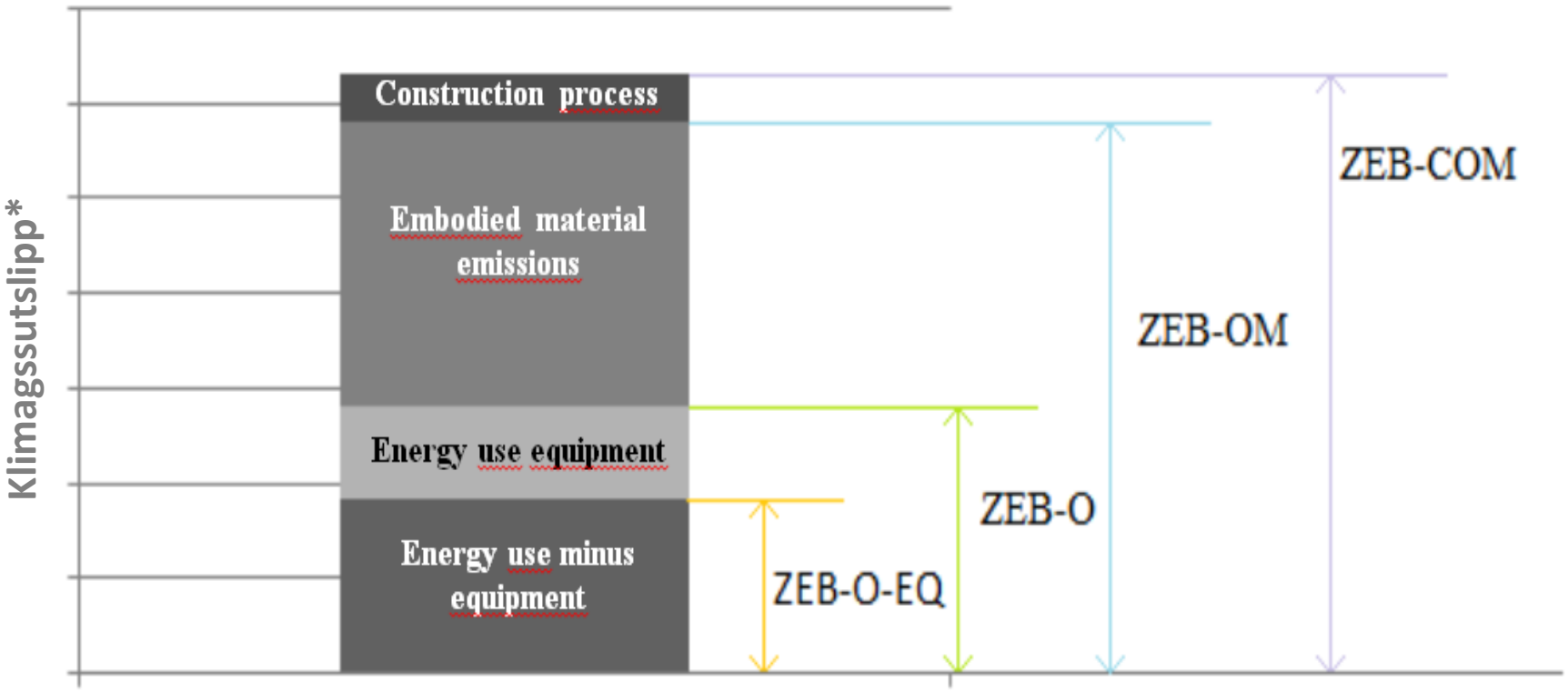




Hva er et nullutslippsbygg?



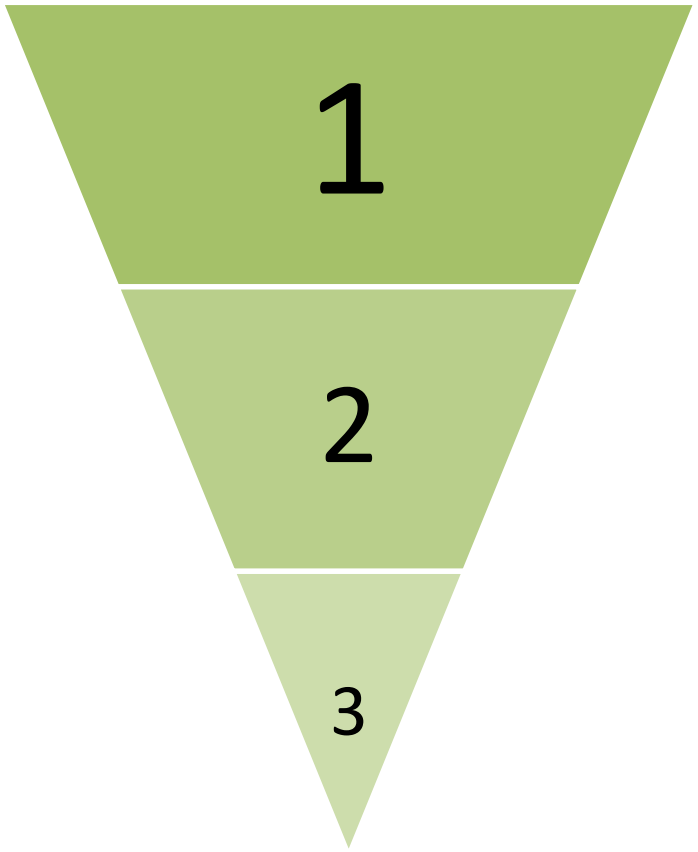
Ulike ambisjonsnivåer for ZEB



* Klimagassutslipp regnet i kg CO_2-ekv pr m^2 BRA pr år (lagt ut over 60 års levetid)

Strategi

1. Reduser energibehovet til drift av byggene
2. Reduser energibruken til fremstilling av materialer og konstruksjoner
3. Dekk det resterende behovet med produksjon av fornybar energi

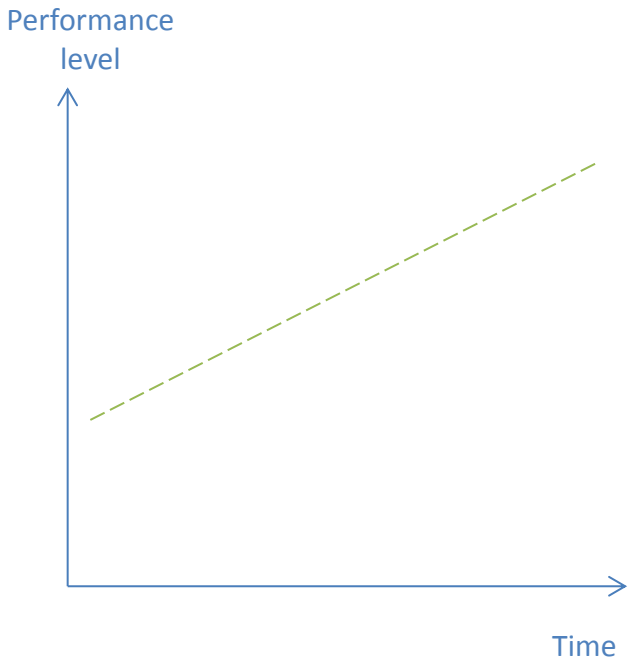


www.zerovillage.no

- Ca 800 nye boliger på Ådland utenfor Bergen
- Utvikler: ByBo AS
- Arkitekt: Snøhetta
- Energirådgivere: ZEB senteret: SINTEF, NTNU, Multiconsult, Skanska

ZEB performance goals for ZVB

- The area as a whole should reach the ZEB-O level
- The lowest performance level for single buildings should be ZEB-O÷EQ
- Within 2 years of project start, the ambition level should be raised to ZEB-OM.
- Within 4 yeas of project start, the ambition level should be raised to ZEB-COM.
- For projects with ZEB-O÷EQ level, there should be minimum requirements with regards to emissions from materials



Illustrasjon: Snøhetta

Buildings typologies and zoning: 1st sketches

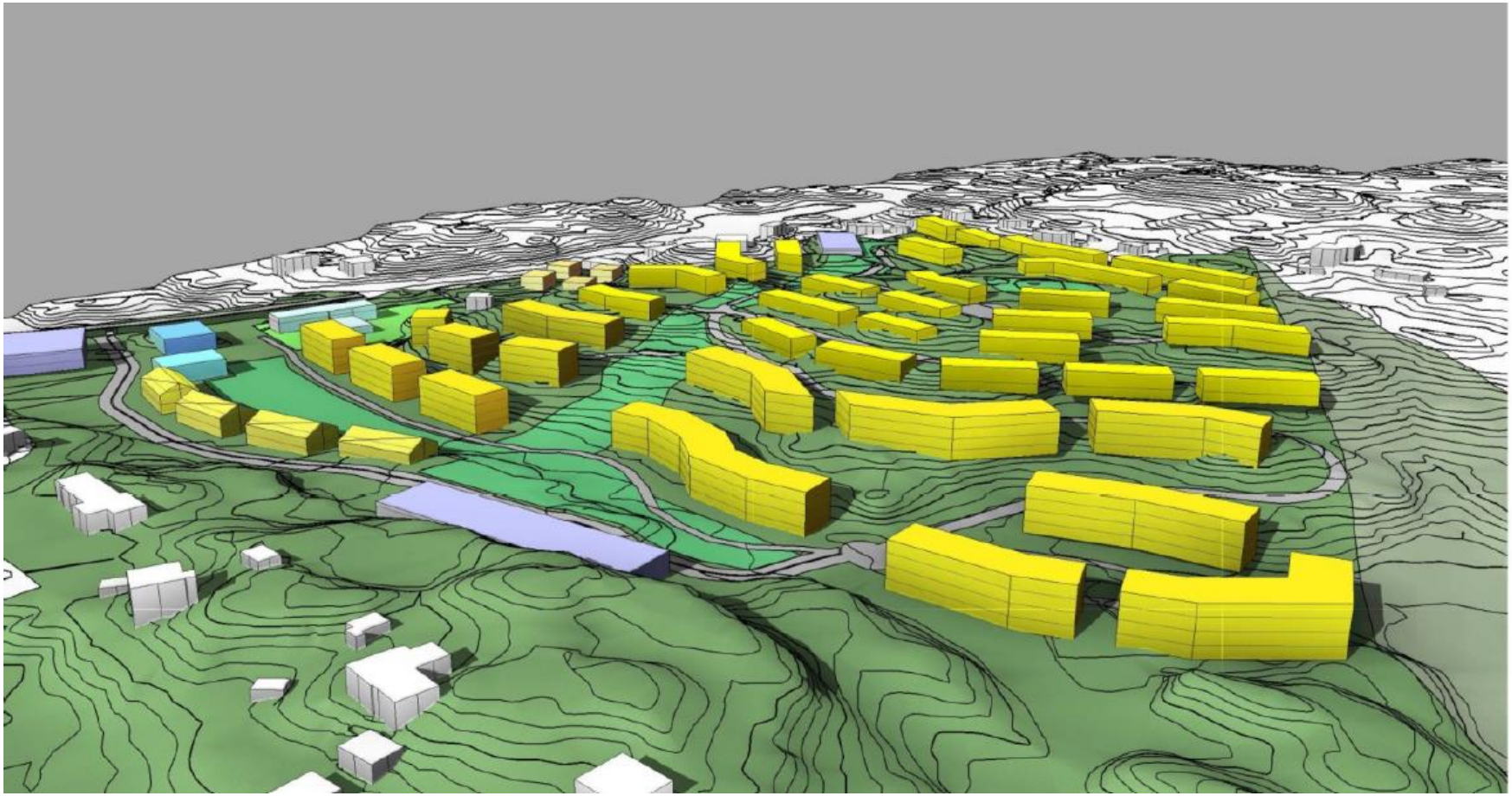
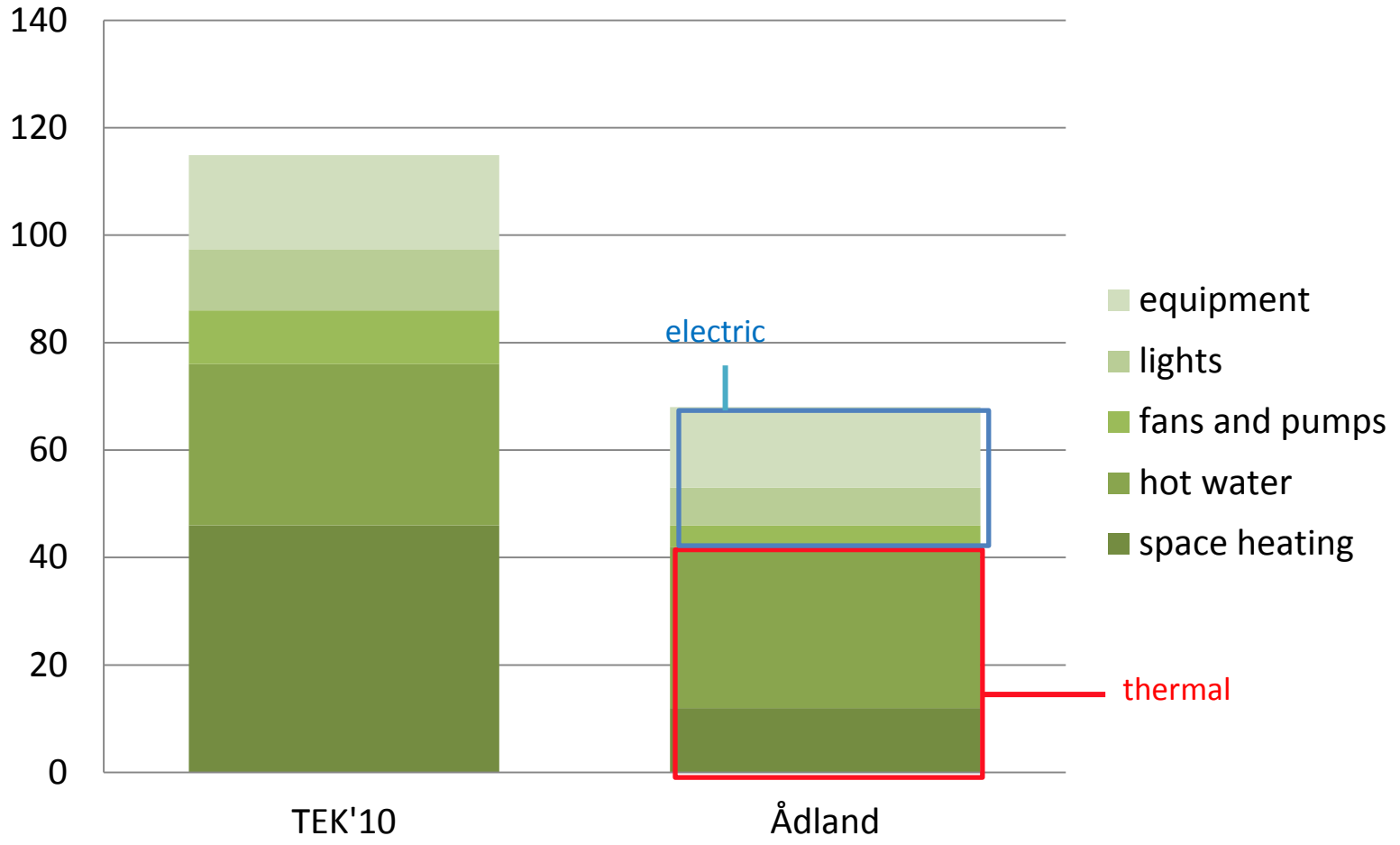


Illustration by Norconsult

Yearly net energy demand for operation [kWh/m2 HFA]



CO_2-utslipp for ulike energikilder

Table 3-3 Specific CO_2-factors employed by the ZEB Research Centre.

Energy carrier	$gCO_{2\,eq}$/kWh	References
Electricity from the grid	130	(Dokka 2011), (Dokka et al. 2013a), (Graabak and Feilberg 2011)
Oil (fossil)	285	(Dokka et. al 2013) (Dokka et al. 2013a)
Gas (fossil)	210	(Dokka et. al 2013) (Dokka et al. 2013a)
Wood chips	4 -15	(Dokka et al. 2013a), Lien (2013)
Pellets/briquettes	7 - 30	(Dokka et al. 2013a), Lien (2013)
Biogas from manure	25 - 30	(Dokka et al. 2013a), Lien (2013)
Bio-diesel and bio-oil	50	(Dokka et al. 2013a)
Bio-etanol	85	(Dokka et al. 2013a)
Waste incineration (heat only)	185 - 211	(Dokka et al. 2013a), (Lien 2013)

Energy concepts - 1st analysis

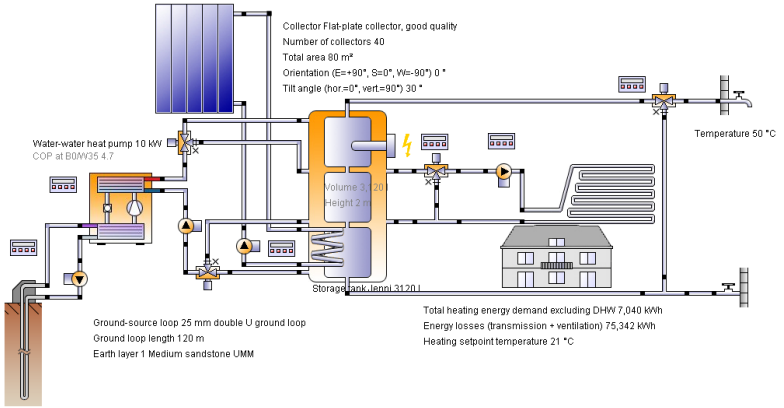
	Alternative 1	Alternative 2
Building envelope and technical installations	Passive house standard Highly efficient ventilation system with heat recovery Natural ventilation and passive cooling in summer Lighting based on LED Hot fill washing machines	Passive house standard Highly efficient ventilation system with heat recovery Natural ventilation and passive cooling in summer Lighting based on LED Hot fill washing machines
Energy supply systems	Thermal solar collectors Ground source heat pump Photovoltaics	Thermal solar collectors Biogas based CHP Photovoltaics

Alternative 1:

Solar collectors + Ground source heat pump + PV

- Local energy central
- Solar collectors, designed to cover 40 % of yearly demand. Gives 5.5 m^2 per 100 m^2 HFA.
- Heat pump covers auxilliary thermal energy.

  Seasonal COP = 2.7

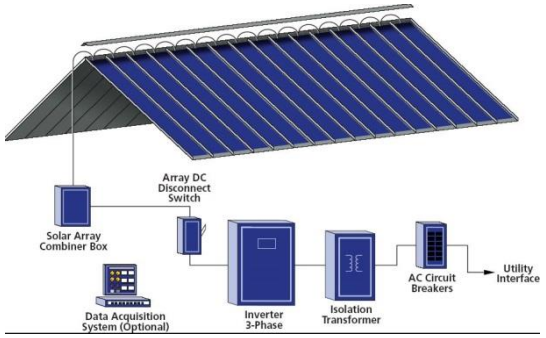


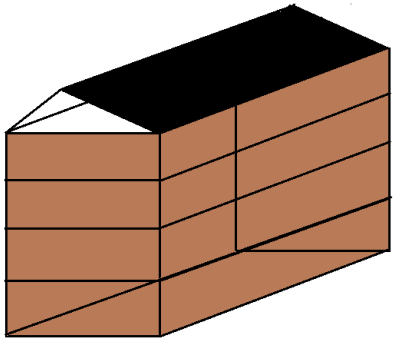
Alternative 1:

Solar collectors + Ground source heat pump + PV

In order to achieve Zero yearly balance:

- PV needs to cover 1430 MWh/yr
- Efficiency 15% and yearly solar flux of 902 kWh/m^2 gives 135 kWh per m^2 PV area.
- Need 10 560 m^2 PV, or 22 m^2 per dwelling.
- Available roof area in preliminary design: 10 630 m^2.
- Need also 2500 m^2 for thermal collectors.





Alternative 1:

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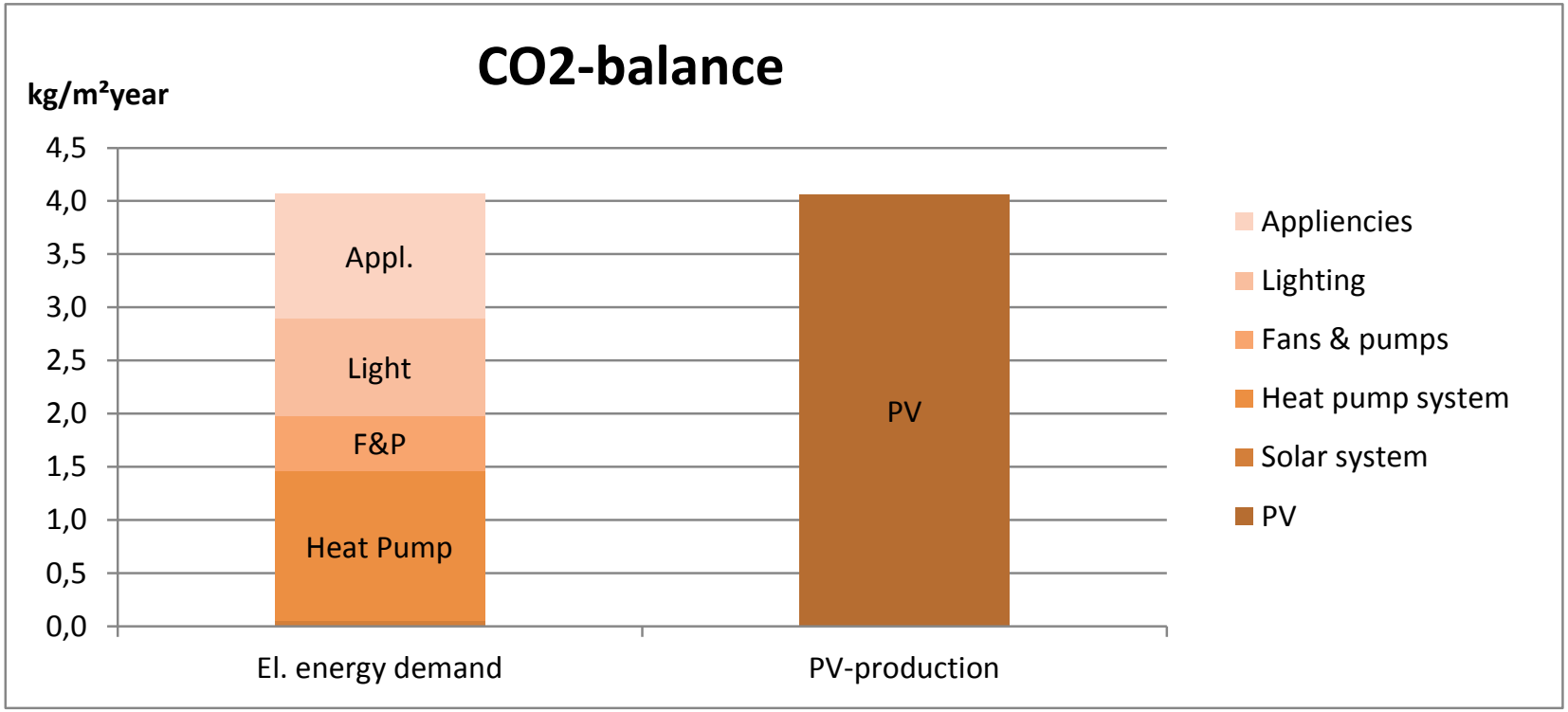
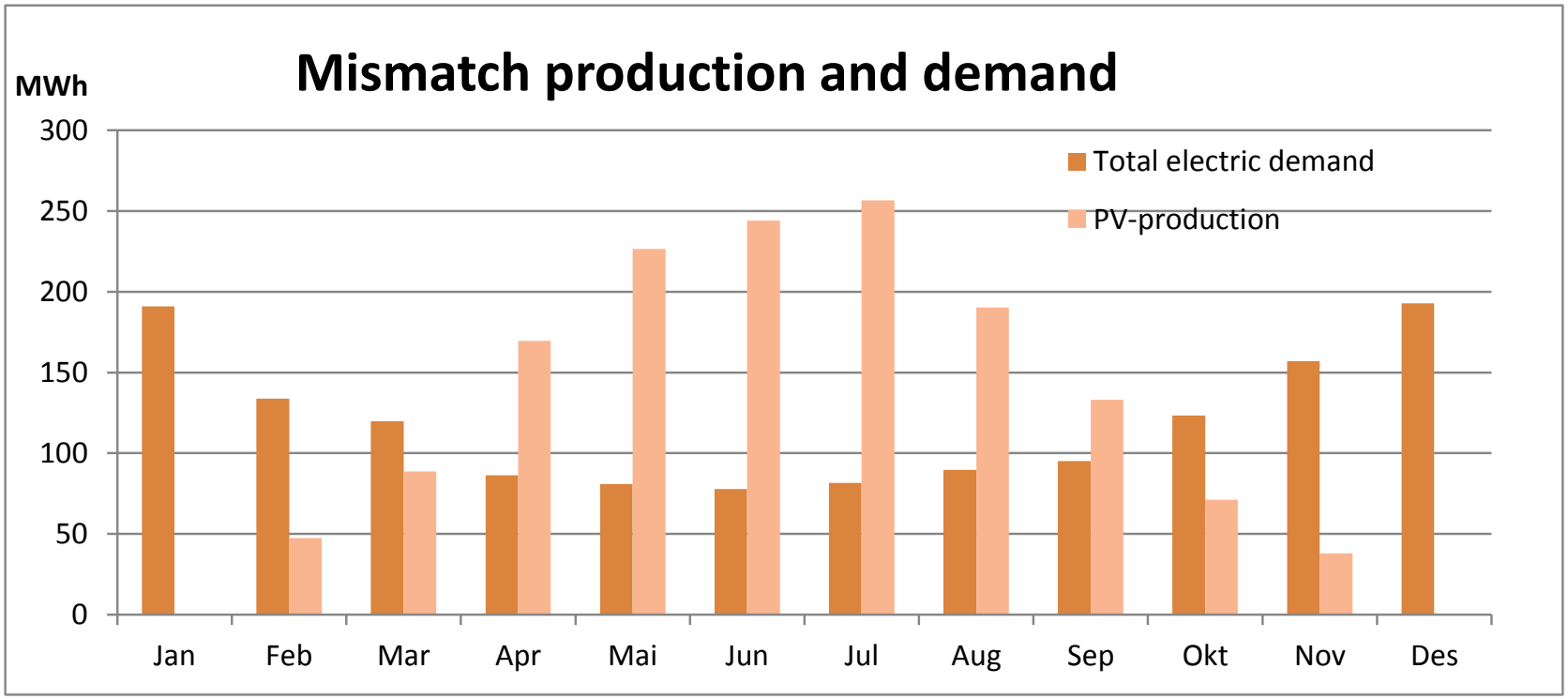


Alternative 1:

Solar collectors + Ground source heat pump + PV



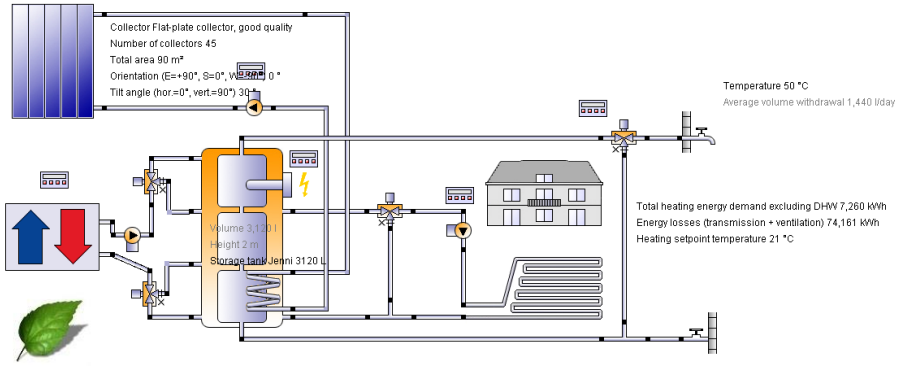
Monthly calculation: 50% electricity exported/imported from grid

Larger if hourly calculations

Alternative 2:

Solar collectors + CHP + PV

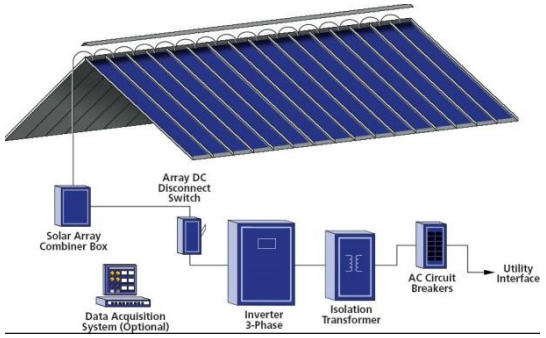
- Local energy central
- Solar collectors on roofs, designed to cover 40 % of yearly demand. Gives 5.5 m^2 per 100 m^2 HFA.
- Bio-gas CHP covers auxilliary thermal energy. Thermal efficiency 55 % and electrical efficiency 35 %.

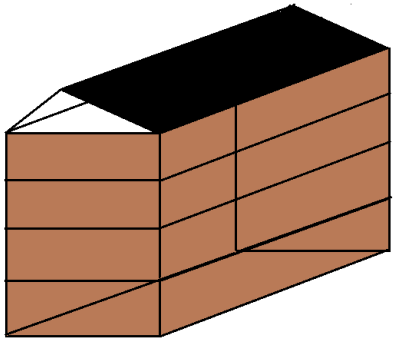


Alternative 2:
Solar collectors + CHP + PV

In order to achieve Zero yearly balance:

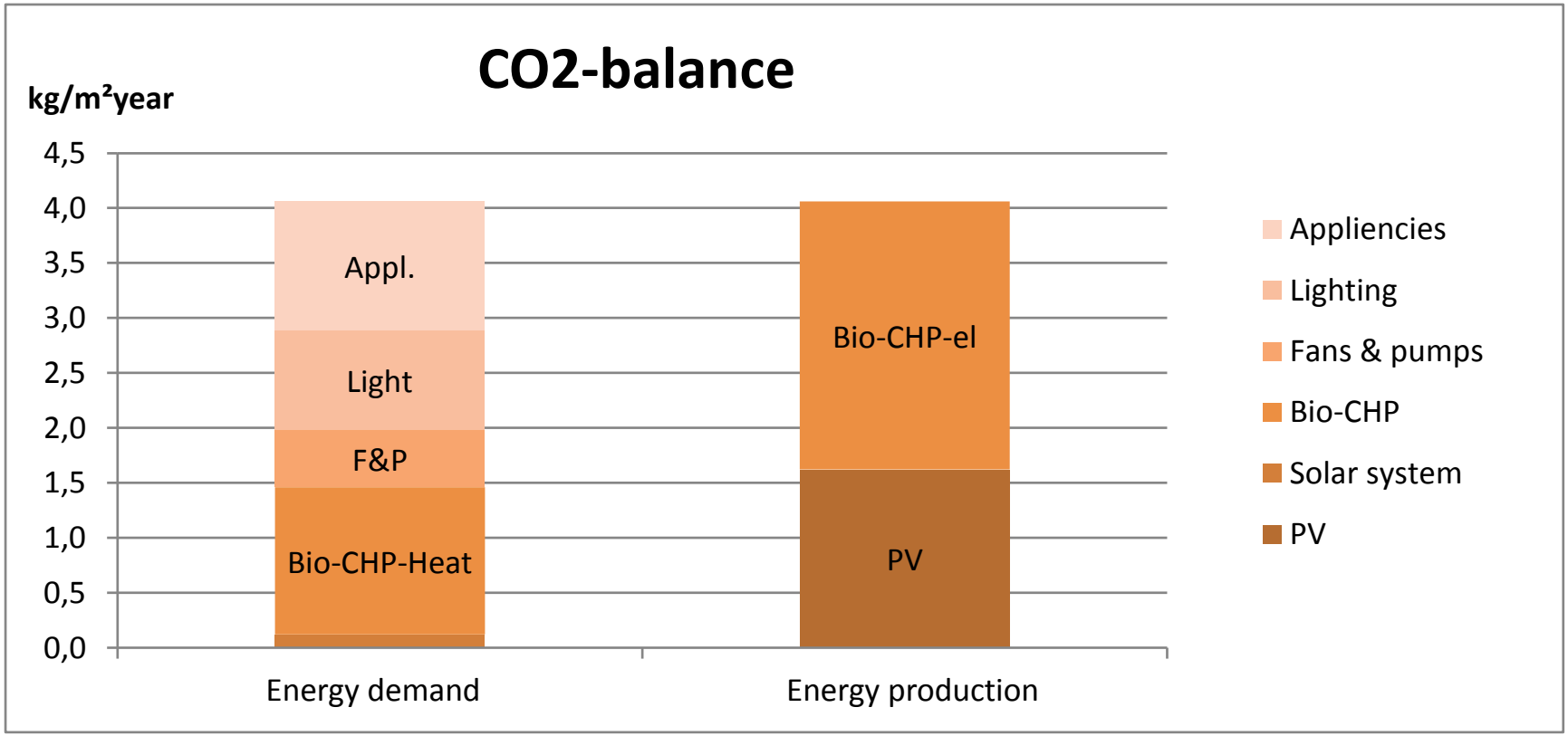
- PV needs to cover 570 MWh/yr
- Efficiency 15% and yearly solar flux of 902 kWh/m² gives 135 kWh per m² PV area.
- Need 4215 m² PV, or 9 m² per dwelling.
- Available roof area in preliminary design: 10 560 m².
- More than room for 2500 m² of thermal collectors on the roofs.





Alternative 2:

Solar collectors + CHP + PV



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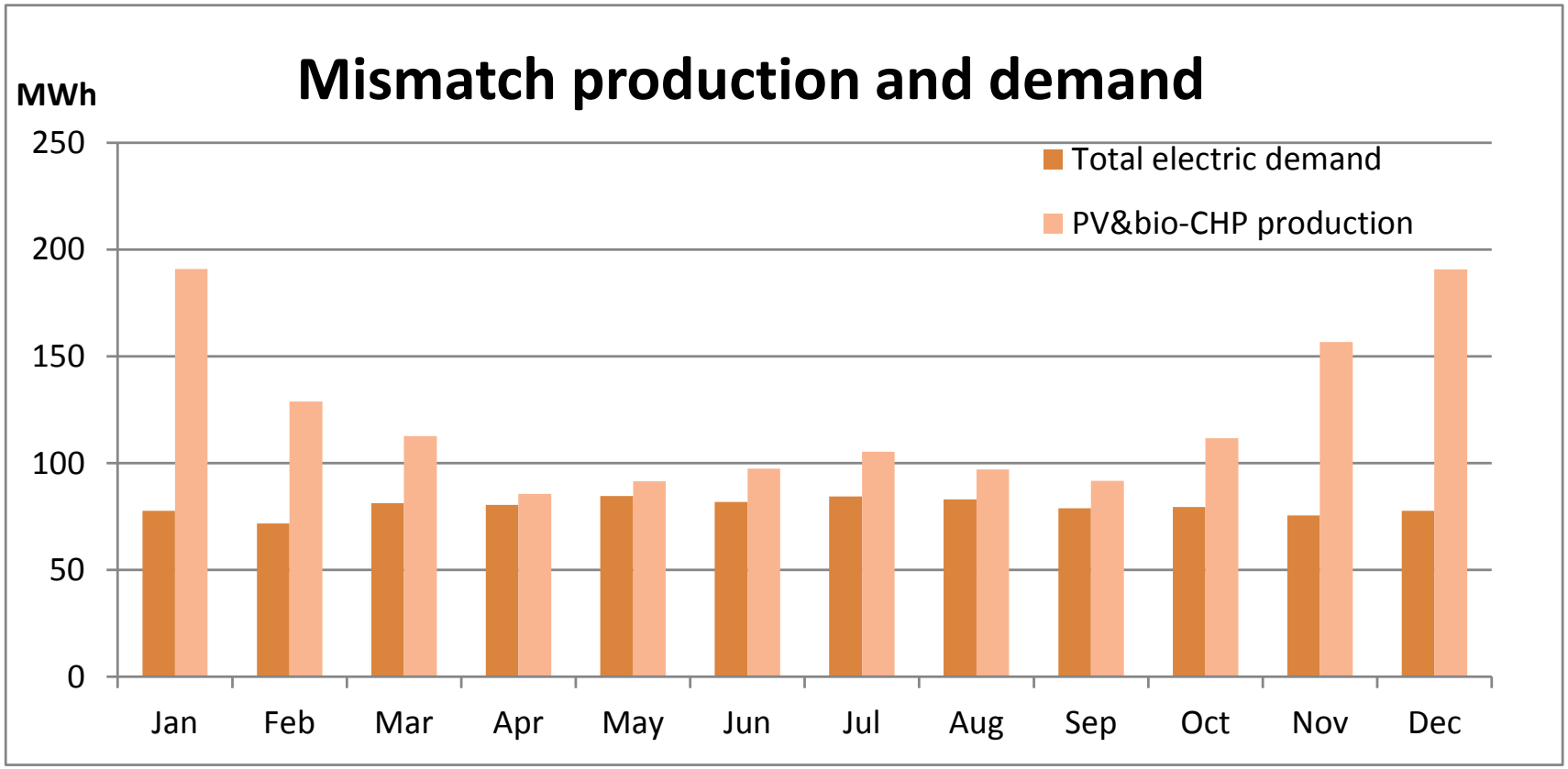
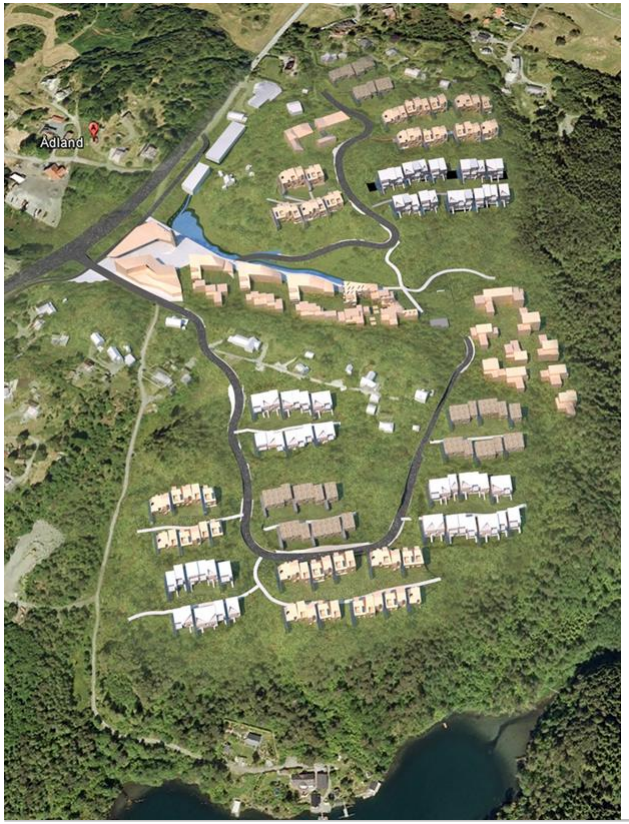
Solar collectors + CHP + PV

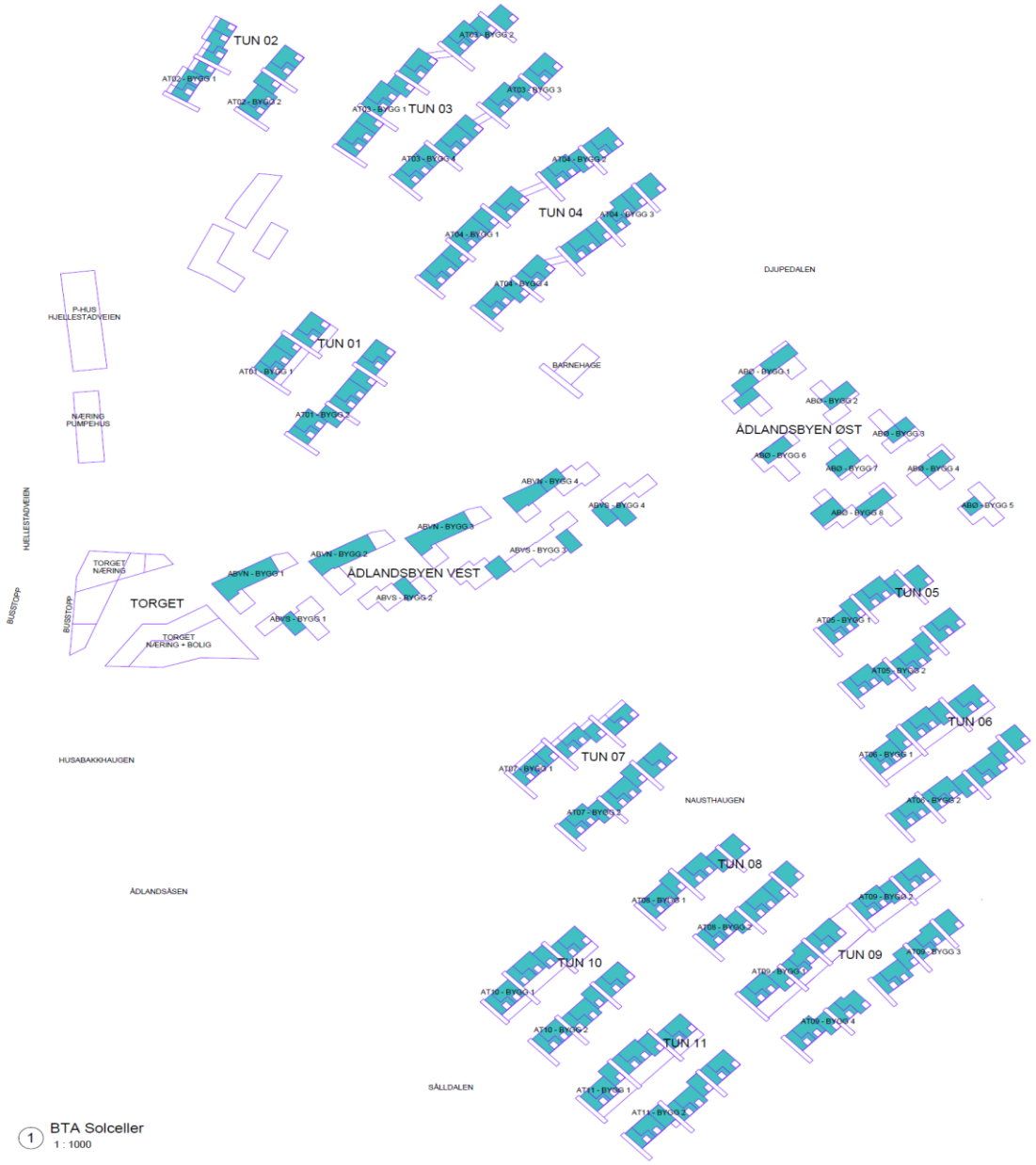


Monthly calculation: 35% electricity exported/imported from grid

Larger if hourly calculations

Phase 2:
detailed simulations of loads and production





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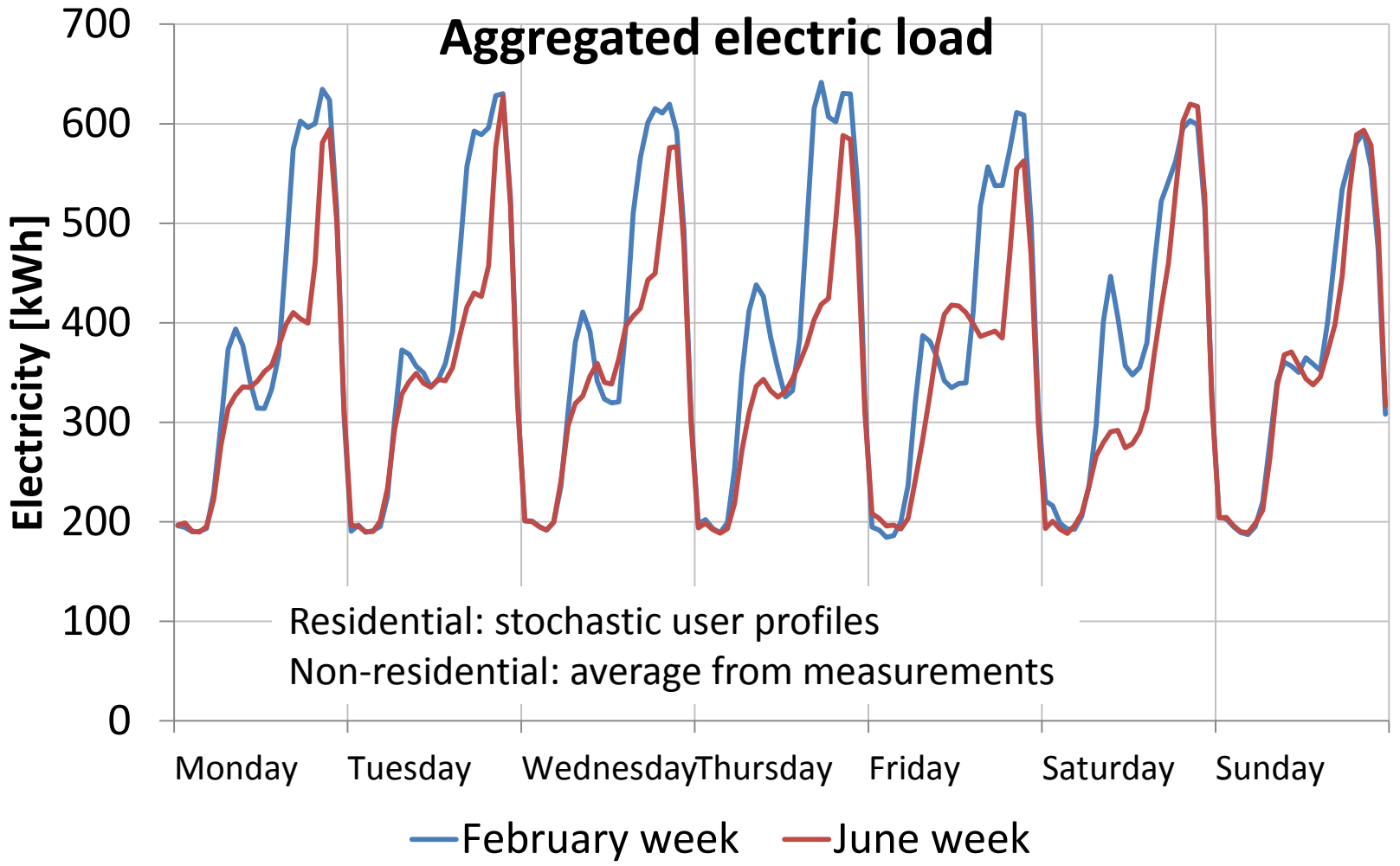
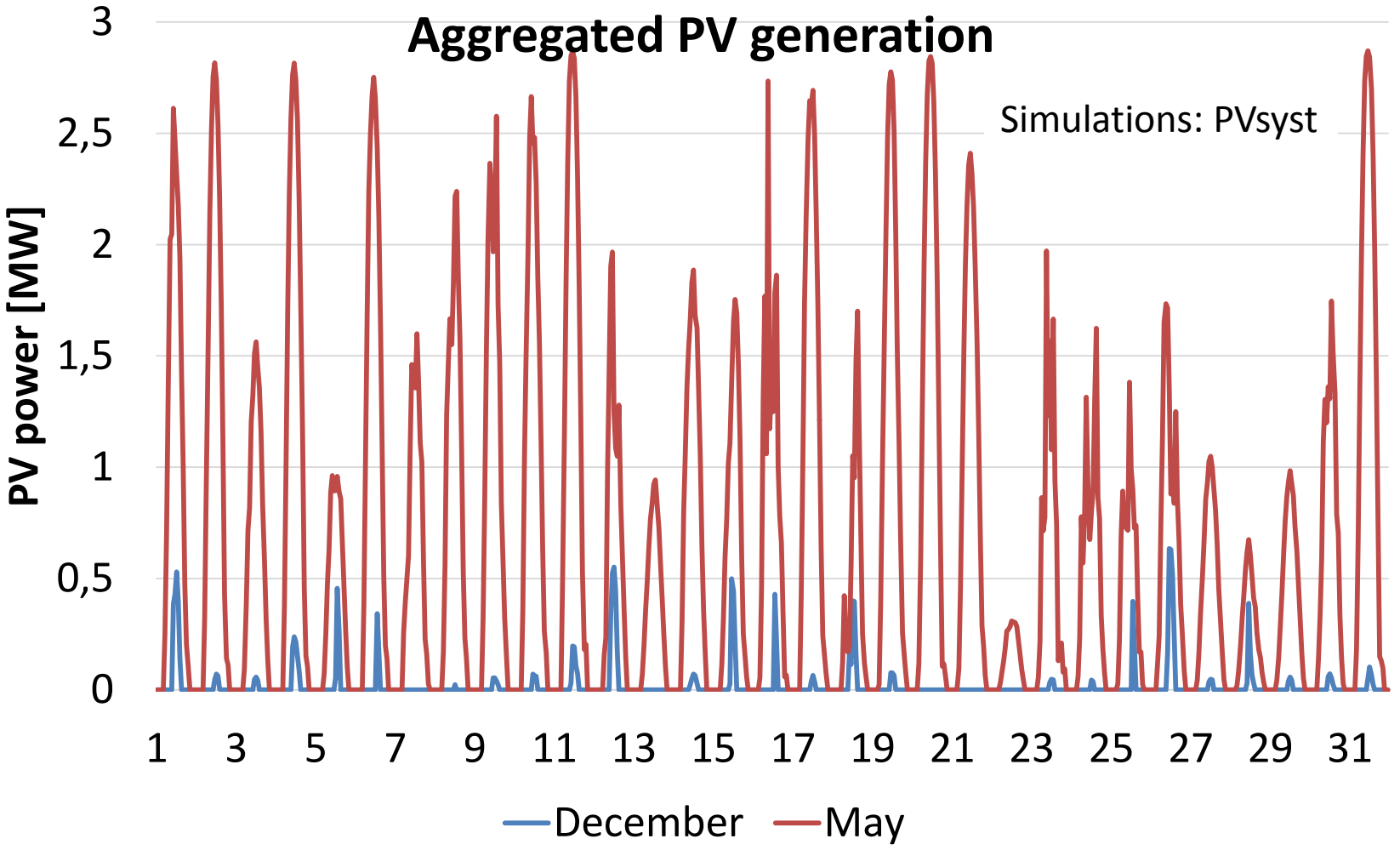
Typical weekly profiles for the electric load



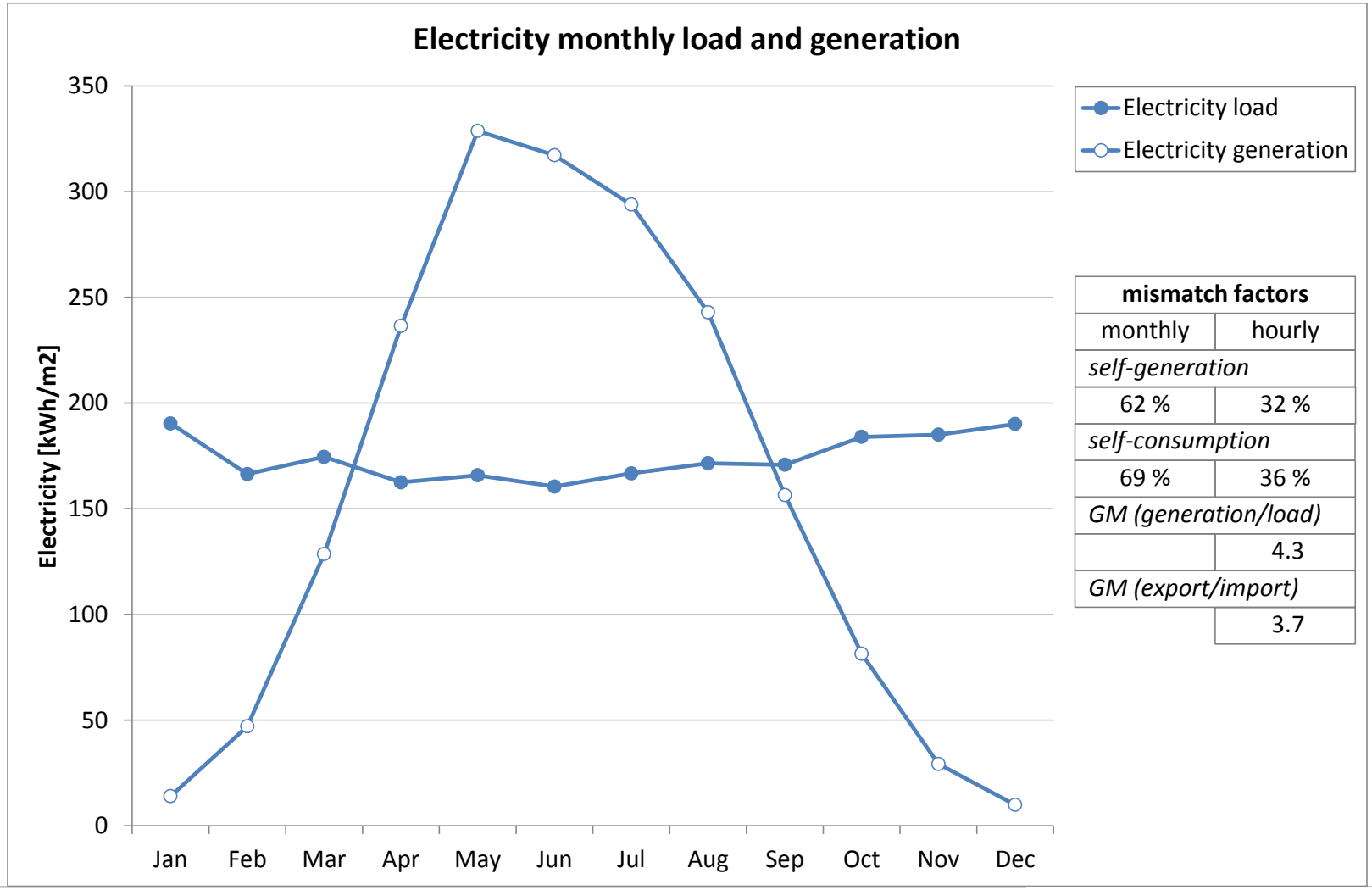
Source: ZEB report (2016)

PV generation highest/lowest months



Source: ZEB report (2016)

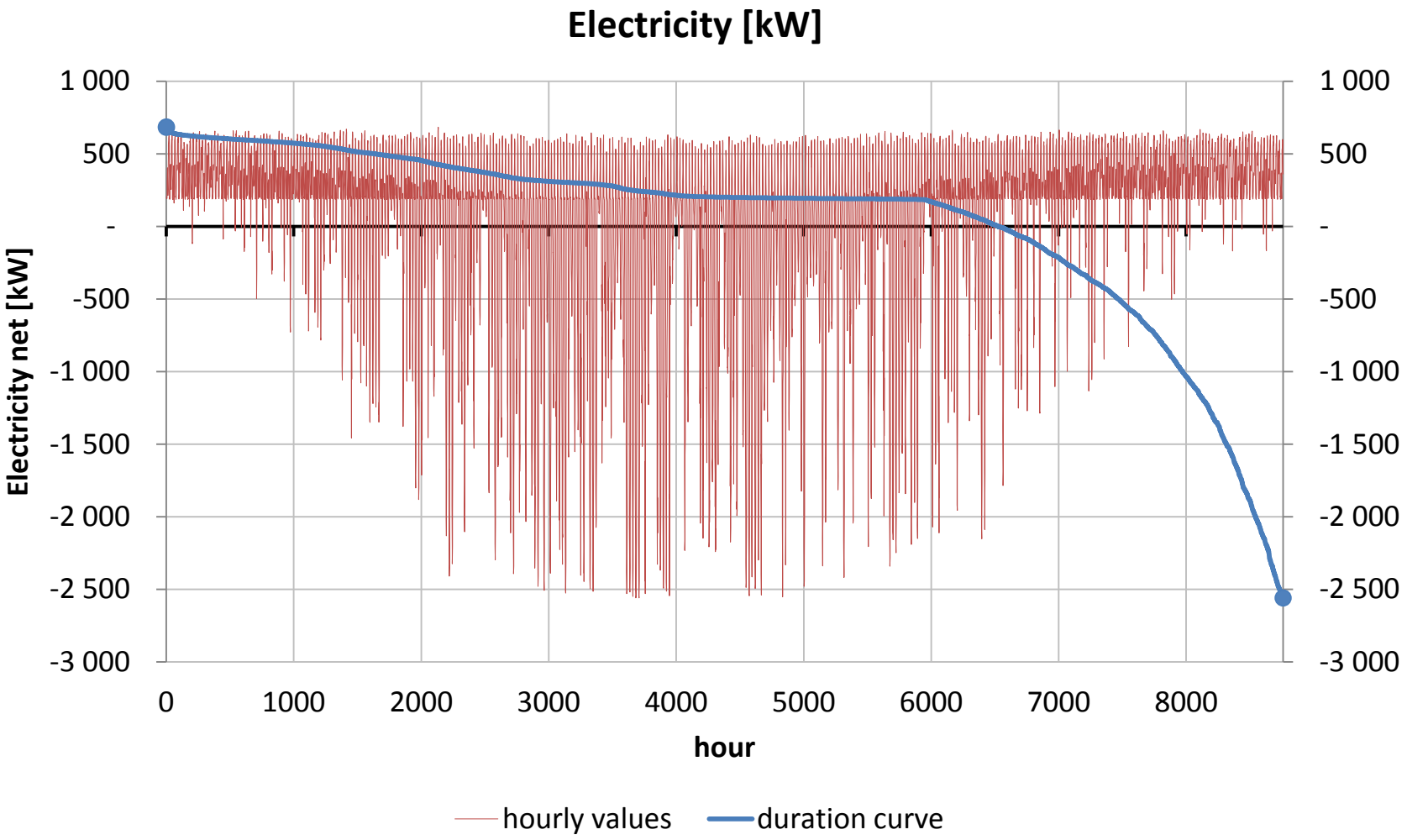
Net delivered electricity – monthly



mismatch factors	
monthly	hourly
self-generation	
62 %	32 %
self-consumption	
69 %	36 %
GM (generation/load)	
	4.3
GM (export/import)	
	3.7

Source: ZEB report (2016)

Net delivered electricity – hourly



Source: ZEB report (2016)

Further analyses

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

- Scenarios for energi/fuel prices, framework conditions, technology developement

In cooperation with Bybo, BKK, CMR and ProxLL

View of Zero Village Bergen, Illustration: Snøhetta