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# The "Active House": Architecture, Energy and Occupants

Per Heiselberg
Division of Architectural Engineering
Department of Civil Engineering
Aalborg University

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# EU's Climate- and Energy Plan

- 20% reduction af $CO_2$ emission in 2020
- 20 % renewable energy in 2020 (In Denmark 30%)
- 20% reduction in energy use in 2020

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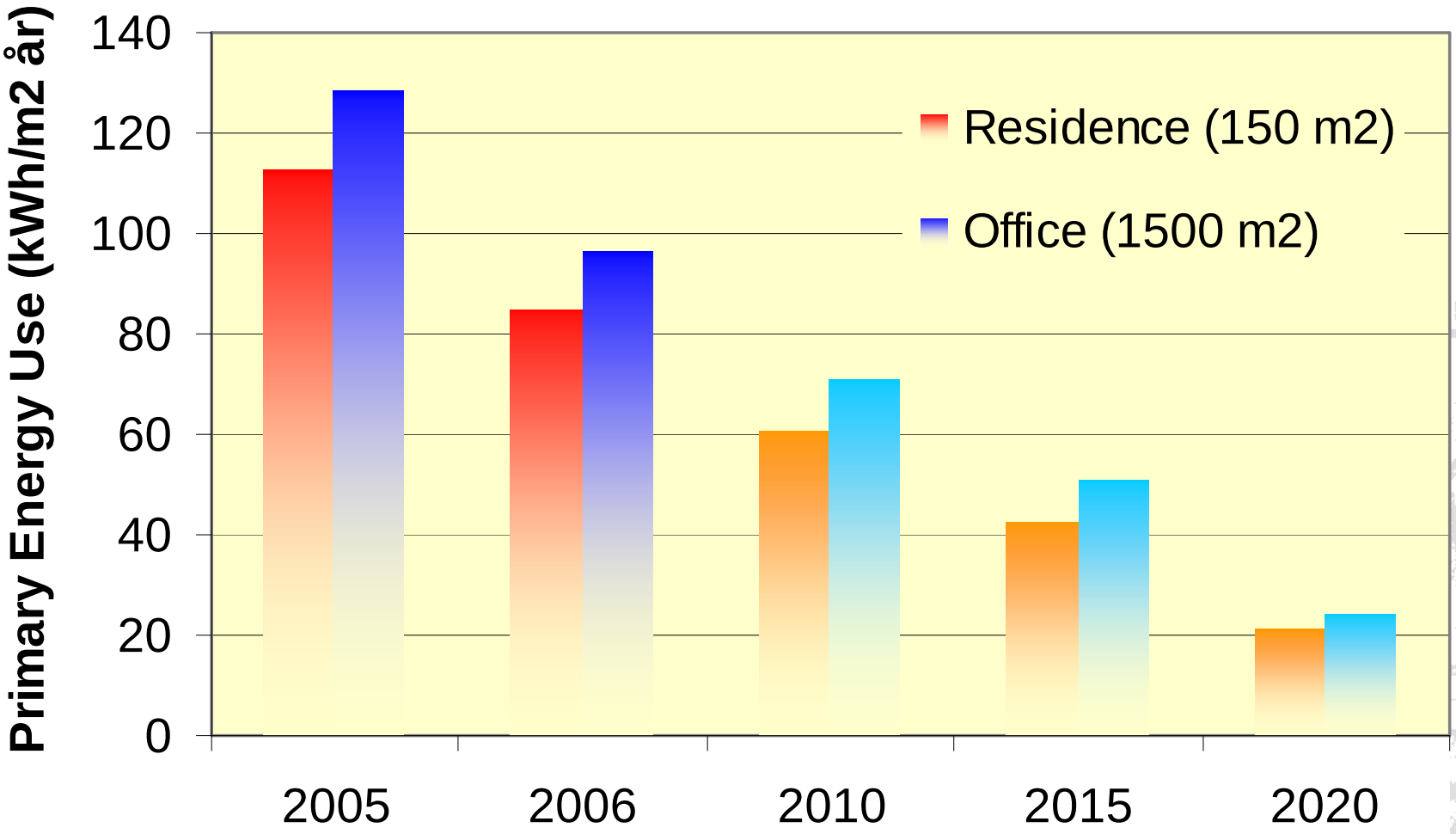
# Development Plans for Maximum Energy Use in New Buildings in Denmark



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# Komforthusene, Vejle

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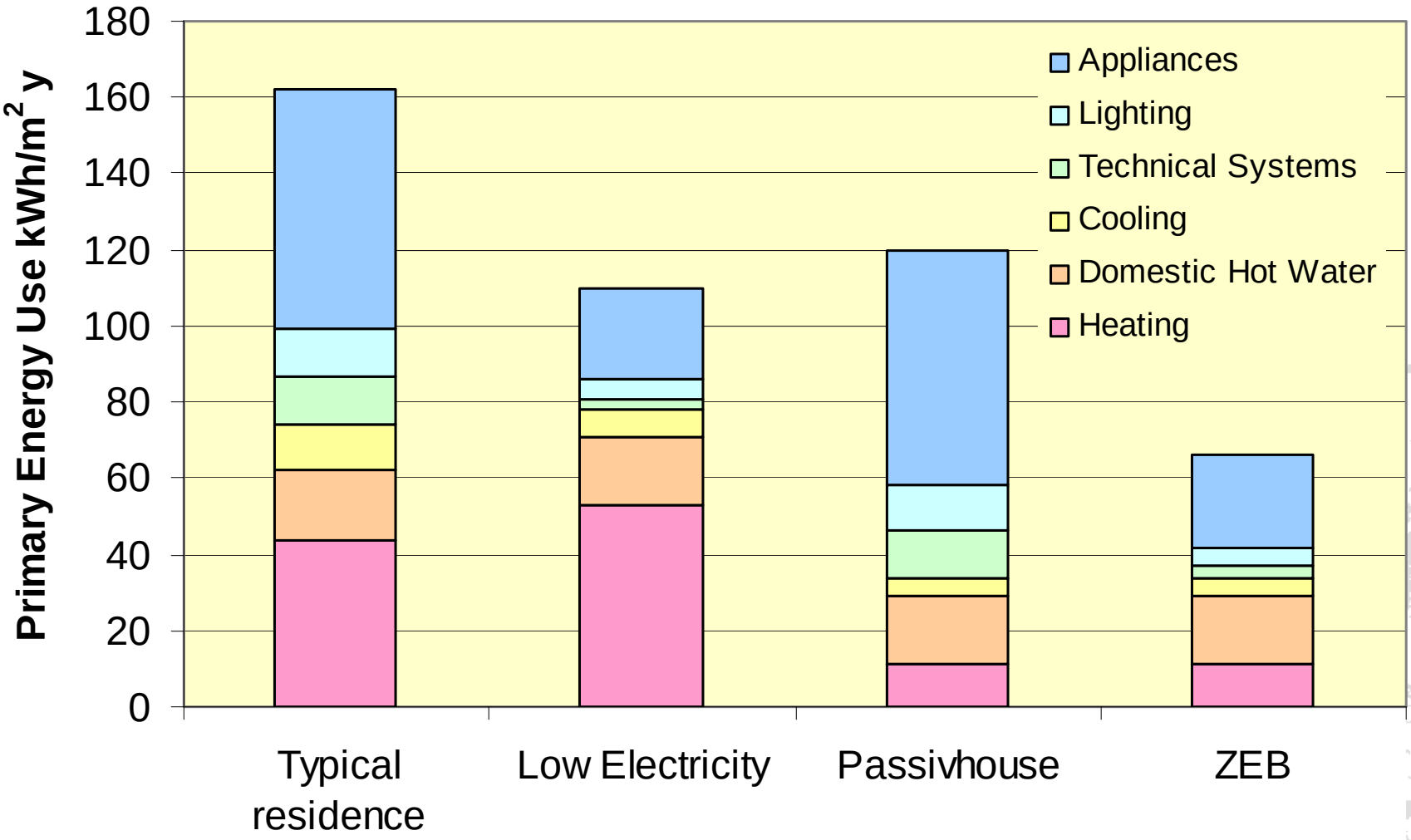
# Primary Energy Use




Source: Rob Marsh, SBi

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# What do we aim for?

- ***Net Zero Energy Buildings*** *are buildings that over a year are neutral, meaning that they deliver as much energy to the supply grids as they use from the grids.*
- ***Net Zero Energy Emission*** *are building that produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources*
- ***Zero Carbon Buildings*** *are buildings that over a year do not use energy that entails carbon dioxide emission*

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# BOLIG+ Zero Energy  Multifamily Building

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BOLIG+

# ENERGY NEUTRAL RESIDENCE

www.boligplus.org

- **BOLIG+ dogma:**
  - Energy neutral on a yearly basis,
  - Intelligent and userfriendly
  - Flexibel in use and time
  - Comfortable and healthy indoor climate
  - Adapted to the local context

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# Energy neutrality

Energy neutrality means that the energy consumption (space heating, domestic hot water, operational energy, lighting etc.) is optimized to the local context and energy bought from the utility grid is evened out by energy sold to the utility grid.

Energy delivered to the utility grid must be of at least the same quality (exergy) and usability as the energy bought from the utility grid.

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# Low energy class 1

BOLIG+ must at least comply with the requirements for low energy class 1 stated in the Danish Building Regulations, but <u>without</u> production of electricity:

$$Q < 35 + \frac{1100}{A} \quad \text{kWh / m}^2 \text{ per. year},$$

where A is the gross floor area.

Q is the gross energy for heating (and cooling), ventilation, domestic hot water, electricity for operating the building (multiplied by 2.5) plus penalty for excess heat (fictive cooling if indoor temperature exceeds 26 °C)

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# Electricity

The need for electricity for operation on the equipment, artificial light etc. is normally not part of the energy performance in Denmark. The BOLIG+ concept however do take this consumption into account for the energy neutrality.

Consumption of electricity (excl. possible consumption for domestic hot water) should not exceed 1600 kWh/year for a standard BOLIG+ family in a block of flats.

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# Flexible over time

BOLIG+ must be flexible over time:

BOLIG+ is the physical frame for possible unconventional family structures like; divided families, long distance families, net families, miniature shared living as well as traditional families.

Flexibility means that the dwelling must be able to adapt to the number of residents in the dwelling. It must be adaptable for new families, families with large kids and elder people with limited mobility. This puts large requirements for resource optimal constructions.

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# Resources

BOLIG+ must meet requirements for limited consumption of resources in case of re-construction and maintenance and thus meet the requirement for flexibility over time, covering:

*Replacement of parts of components* – Different parts of the building have different physical life time and technological life time. BOLIG+ focuses on a flexibility for replacing individual building components without harming other parts of the building.

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# Thermal envelope

*Flexible thermal envelope – in a way that the surface of the building can adapt to the daily and annual rhythm as well as different influence from sun, rain and wind.*

The thermal envelope may close, e.g. during nights or winter and open in other periods with free heating gains in an interaction between control and obtained indoor climate.

In heating periods there should be focus on utilization of passive solar energy.

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# Indoor climate

The indoor climate depends on a number of factors that are closely connected to decisions related to energy consumption, which are made during the initial phases of the design process: Daylight / artificial light, atmospheric indoor climate, temperatures, air-quality, choice of materials, acoustic and sound are all parameters that should be optimized in the design phase.

BOLIG+ must strive for a natural indoor climate. Important elements are thus optimization of daylight, control of artificial light, passive solar utilization, zoning while using sustainable and healthy building materials, all without negative influence on acoustics.

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# Indoor climate

Location in relation to sun and daylight, need for shading and neighbouring buildings influence on shadows and glare should be handled in the design of BOLIG+.

BOLIG+ must first of all have a high daylight factor via optimal orientation and disposition of functions, rooms, and light inlets must be designed to lead the daylight deep into the building. The stable light from North must be utilized and the sun from South as source for passive heating, though avoiding the risk of over heating.

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# Local context

BOLIG+ must be designed in an idiom that supplement the surroundings and is sustainable over time and expresses the period of construction.

BOLIG+ must by its proportions meet the basic human expectations to harmony and balance – while at the same time hold surprises, new ideas and challenges.

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# Local context

BOLIG+ must be able to take part in the local energy infra structure.

BOLIG+ must not set special requirements to the surroundings.

BOLIG+ must be constructed from materials that are technically suited for the local environment and that gives positive visual properties – while at the same time materials with minimal negative influence in the working environment, indoor climate and surrounding environment.

BOLIG+

# +BOLIGER

## 57°03´35´´N 9°54´49´´Ø

**Fremtidens energineutrale etageboliger i Aalborg**

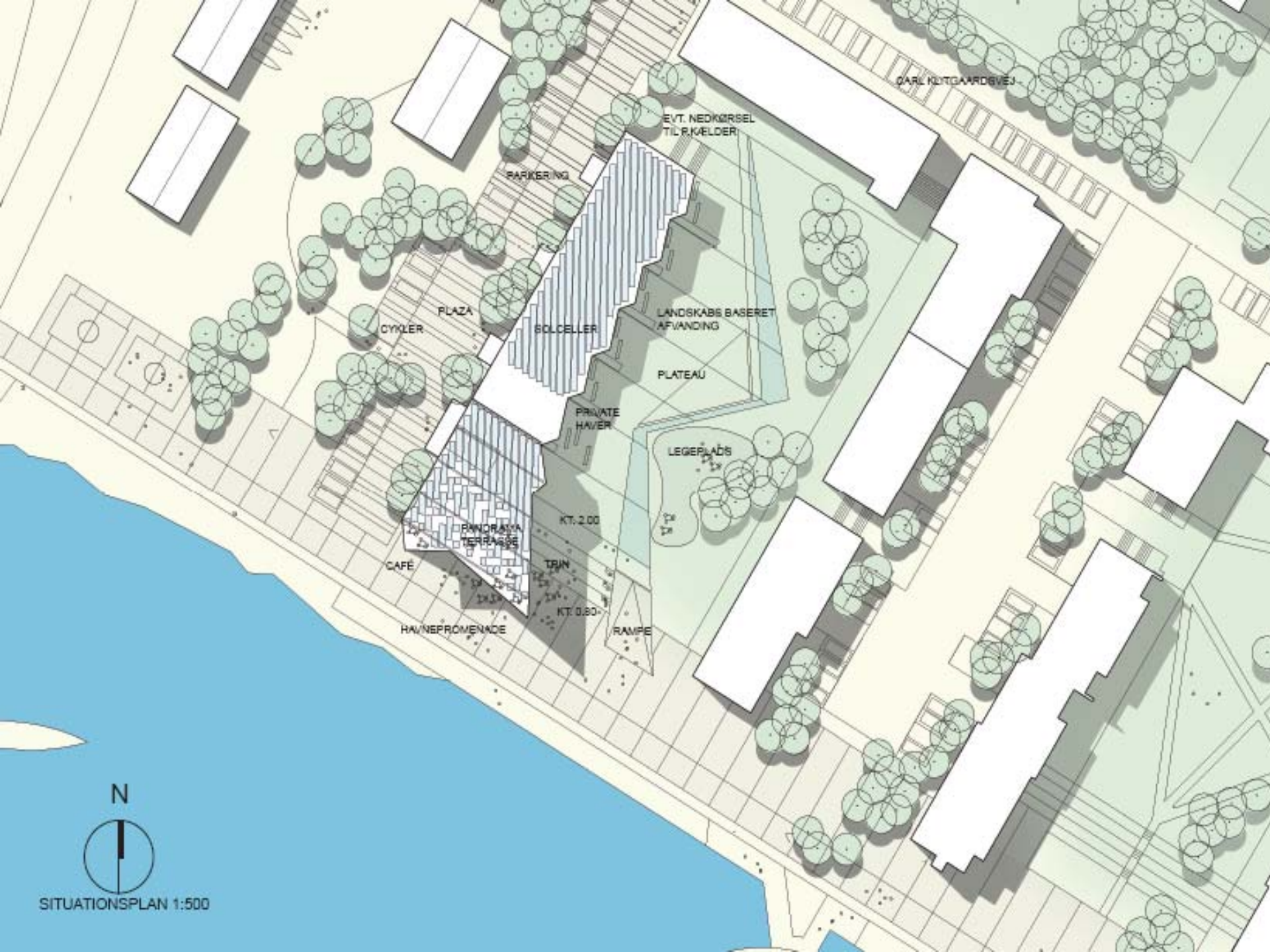
TEAM+ appointed winner 28.09.09

Architects ARKITEMA,
Leif Hansen Consulting Engineers A/S,
Esbensen Consulting Engineers A/S,
FAKTOR 3 Aps,
DONG Energy,
Thornton Thomassetti,
Housing Organisation Ringgården,
BAU-HOW Denmark.

54321

FACADE MOD SYD-ØST 1:200

FACADE MOD NORD-VEST 1:200




SITUATIONSPLAN 1:500

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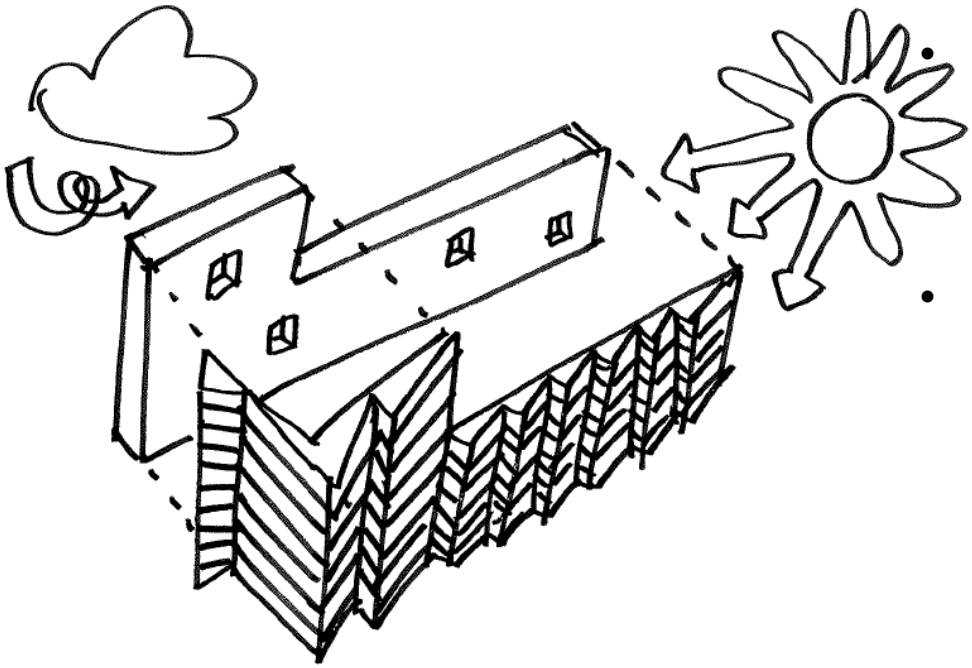
# Energy Concept



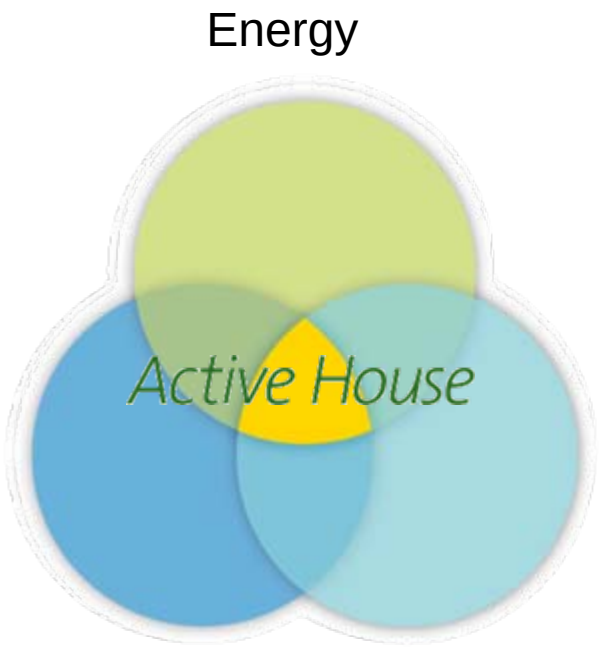
- **Reduction of energy demand**
  - High level of thermal insulation (U-value envelope 0,08 - 0,1 W/m$^2$K, windows 0,9 W/m$^2$K), avoidance of thermal bridges
  - Airtight construction ($n_{50}$<0,6h$^{-1}$)
  - Thermal mass for buffering and natural cooling (natural night ventilation)
  - Solar and heat protection glass, solar shading
  - Hot water for washing of dishes and cloth
  - Airing cupboard and cooler
- **Application of renewable energy**
  - PV-system (cover yearly electricity demand, 236kW$_{peak}$)
  - PV/T Solar Thermal System (DHW (60% coverage) and heat, 142kW$_{peak}$)
- **Efficient energy conversion**
  - Heat pump (DHW and heating, COP 3,7 - 4,0)
  - Demand controlled balanced mechanical ventilation system with high efficient heat recovery (85%, counter flow heat exchanger) and SEL 1,1 kJ/m$^3$
  - Low temperature floor heating panels
  - Optimized building lighting systems (LED)
- **Total primary energy use**
  - 13 kWh/m$^2$/yr for heating, cooling and ventilation (80% less than standard)

# Housing for life

- An Active House’

’To bring daylight, fresh air and improved environment into everyday life

# Active House




Active house concept shall move the development of houses into a new paradigm where:

- The use of energy is minimized and all energy is produced by renewable energy sources
- The indoor climate are optimized with daylight, fresh air and use of materials that has limited influence on the environment
- The local conditions plays a important role in the architecture and the design of the house

## Aesthetics

Beautiful solutions emerging from:
Energy optimization, functional and comfortable design, site character and daylight potentials

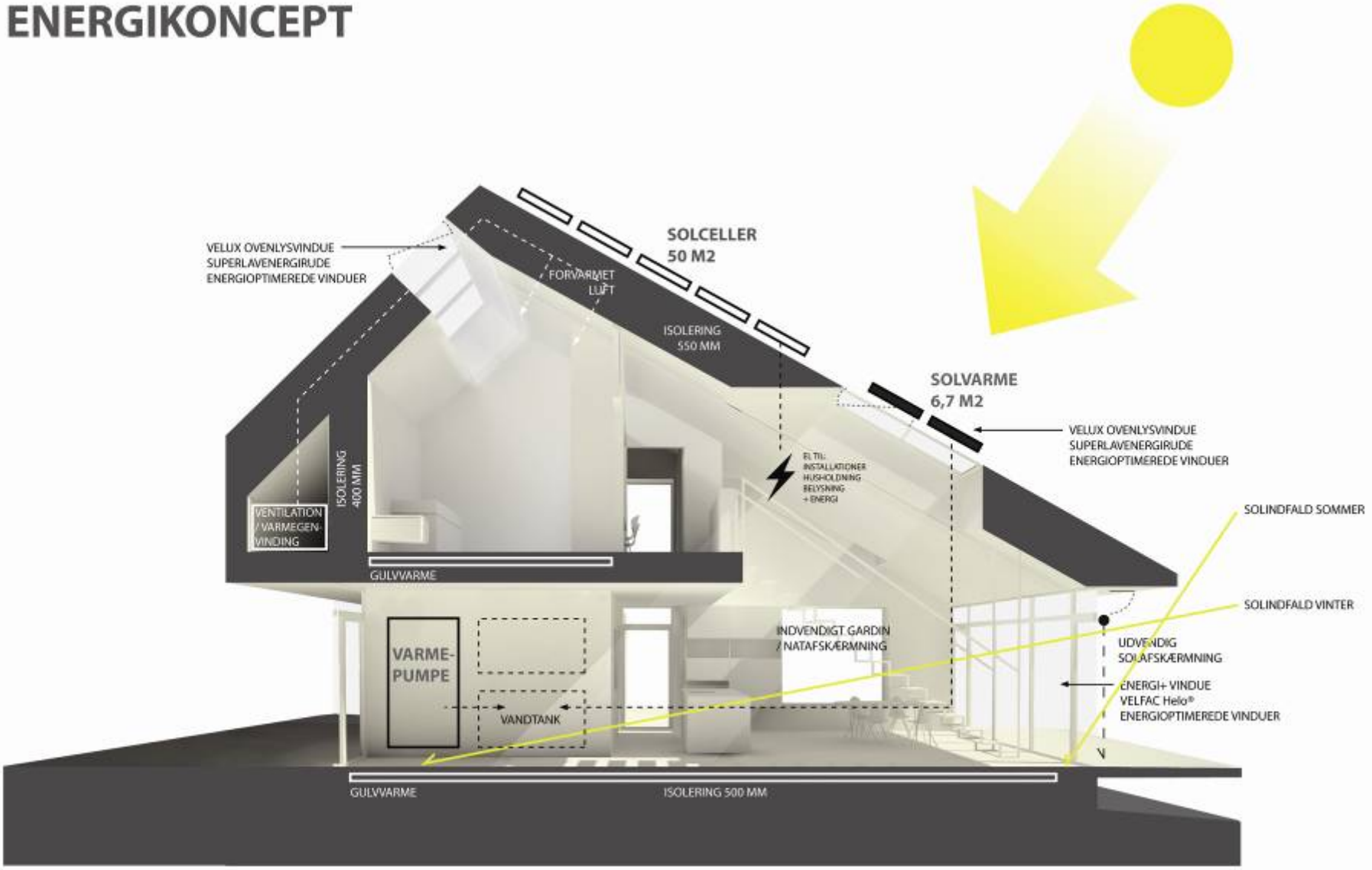
# Comfort

Functional and flexible arrangement
Pleasent and healthy indoor environment
Close contact to nature and its ressources

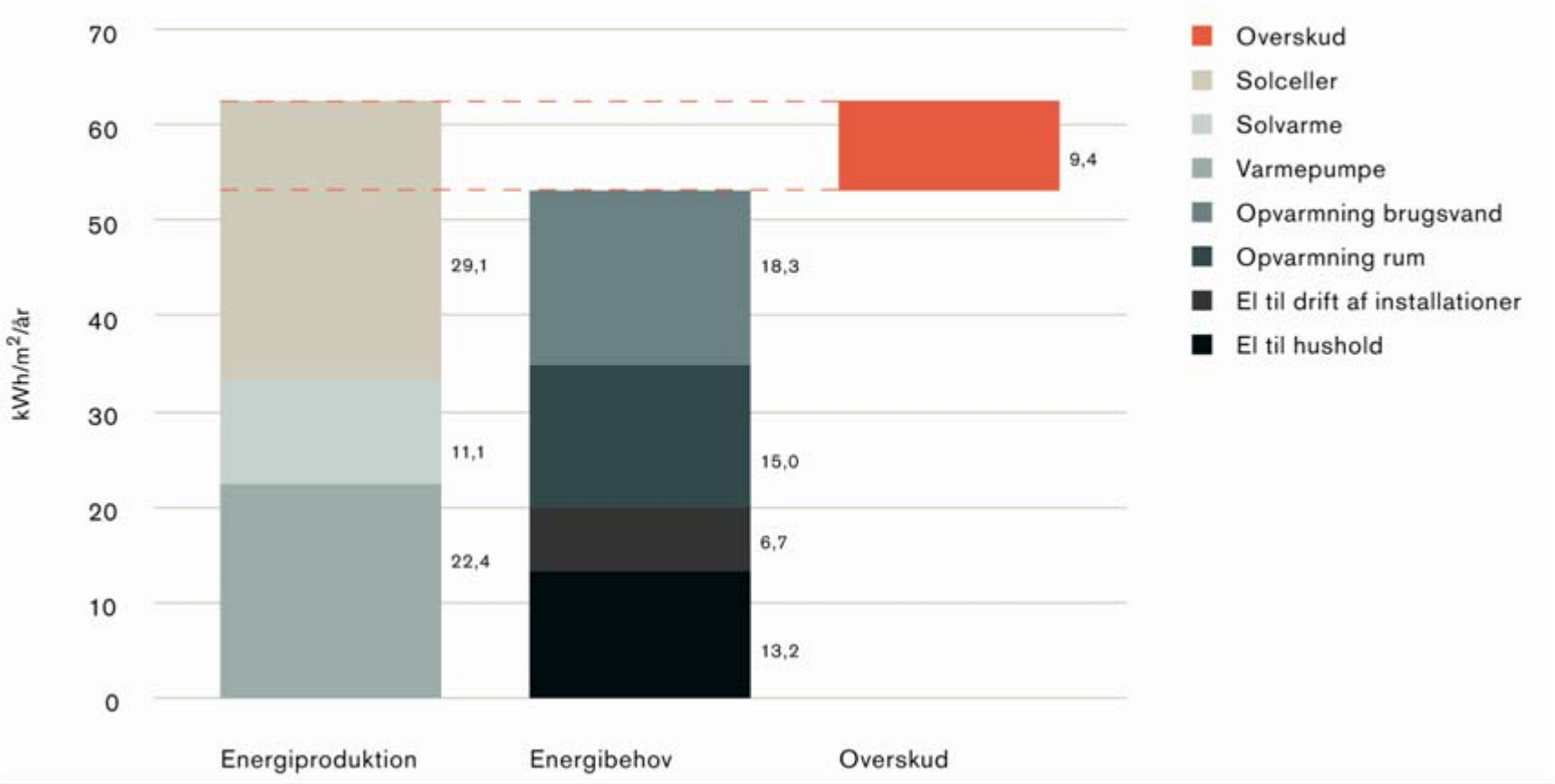
## Udviklingsmodel

| Program | Energi | Æstetik | Komfort |
|---|---|---|---|
| Mål | I Bolig for livet produceres mere energi end der forbruges. Energioverskud tilbagebetaler materialers energiindhold over ca. 40 år. Energiforbruget dækkes af vedvarende energikilder, vurderes i et helhedsperspektiv og søges minimeret gennem optimering af bygningsdesignet. | I Bolig for livet er der i spændingsfeltet mellem energioptimering og høj komfort smukke løsninger der appellerer til vores sanseoplevelser og skaber indtryk af nærværd, indlevelse og betydning.<br>Oplevelserne skabes via rumligheder der understreger energioptimerede løsninger, integration af vedvarende energi, stedets særlige karakter og dagslystes potentialer. | I Bolig for livet skal funktionelle rammer og et godt indeklima sikre et komfortabelt og sundt liv i boligen.<br>Komfort og indeklima optimeres gennem bygningsdesign med fokus på gode dagslysforhold, adgang til frisk luft, god kontakt mellem inde og ude, fleksible plandispositioner, samt i forhold til valg af materialer og vedligehold. |
| Virkemidler | | | |
| Liv | Energiforbrug og – produktion er en naturlig og integreret del af livet i og omkring boligen. | Livet i boligen og samspillet med naturen afspejles i udtrykket i de 5 aktive facader og den rumlige komposition. | I funktioner og relationer mellem de fleksible rum er livet i boligen et gennemgående tema. |
| Lys | Optimering og aktiv regulering af dagslyset for at reducere brugen af elektrisk lys. | Samspil mellem lys, materialer og rum. Aktive facader dimensioneres og orienteres for optimeret udnyttelse af lysets æstetiske potentialer. | Lysindtaget formes omkring lysfortællinger om det liv der leves i og omkring huset |
| Luft | Optimering af facade og bygningsvolumen for naturlig ventilation som suppleres med behovstyret mekanisk ventilation med varmegenvinding. | Bygningens form afspejler naturligt luftflow, passiv opvarmning og integration af udvendige vedvarende energikilder mod syd. | Høje termiske komfortkrav.<br>Rigeligt med frisk luft, ingen træk. |
| Vinduer | | | |
| Profiler | Nyt energioptimeret vindue med slanke profiler af nyt varmeisolerende materiale. De slanke profiler sikrer stort varme- og lysindfald. | Slanke profiler, der giver et let og elegant udtryk. Lette sammen- og indbygninger, hvor profiler ikke ses indefra. Facadebeklædning og inddækninger harmonerer med rammeprofilers materialitet. | De slanke profiler giver god rumlig sammenhæng mellem inde og ude samt ingen vedligeholdelse. |
| Lysninger | Lysningspaneler forbedrer linietab og formidler dagslyset langt ind i rummet. | Lysningspaneler formidler dagslyset samt skaber god rumlig overgang mellem inde og ude. | Lysninger udgør rum i rummet, samt møbler som siddeniche. |
| Afskærmninger | Udvendig automatisk solafskærmning optimerer lys- og varmeindtag. Indvendig afskærmning fungerer som natisolering. | Afskærmningen udtrykker den aktive facade via forskellige udtryk afhængigt af behov og klima. Afskærmningen tillader optimalt dagslysindtag i forhold til afskærmning for varme. | Afskræmningen understøtter det liv der udspilles i husets fleksible og aktive rumligheder. |
| Ruder | Energioptimerede ruder, 3-lags glas med argon. | Naturligt dagslys. | Ingen kulde ved ruder. |
| Styring | Intelligent trådløs og integreret styring til optimering af energiforbrug via passiv opvarmning og afskærmning af facader, styring af lys, ventilation og varmeanlæg. | Skjult. | Styring foregår automatisk med mulighed for manuel betjening via udbygget brugerinterface. Styringen samkøres med andre funktioner for at optimere komfort og brugervenlighed. |

# ENERGIKONCEPT

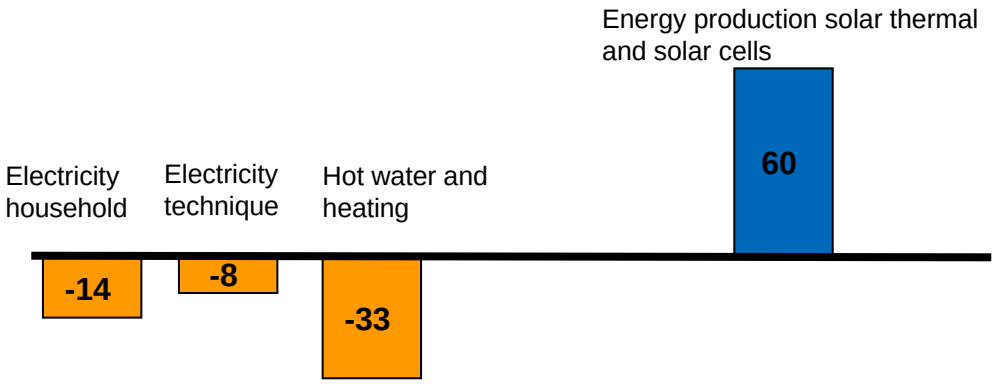


## Solar Energy production results in a yearly surplus



# The first Active House – Housing for life

**Energy need and production from solar** [kwh/m$^2$/year]



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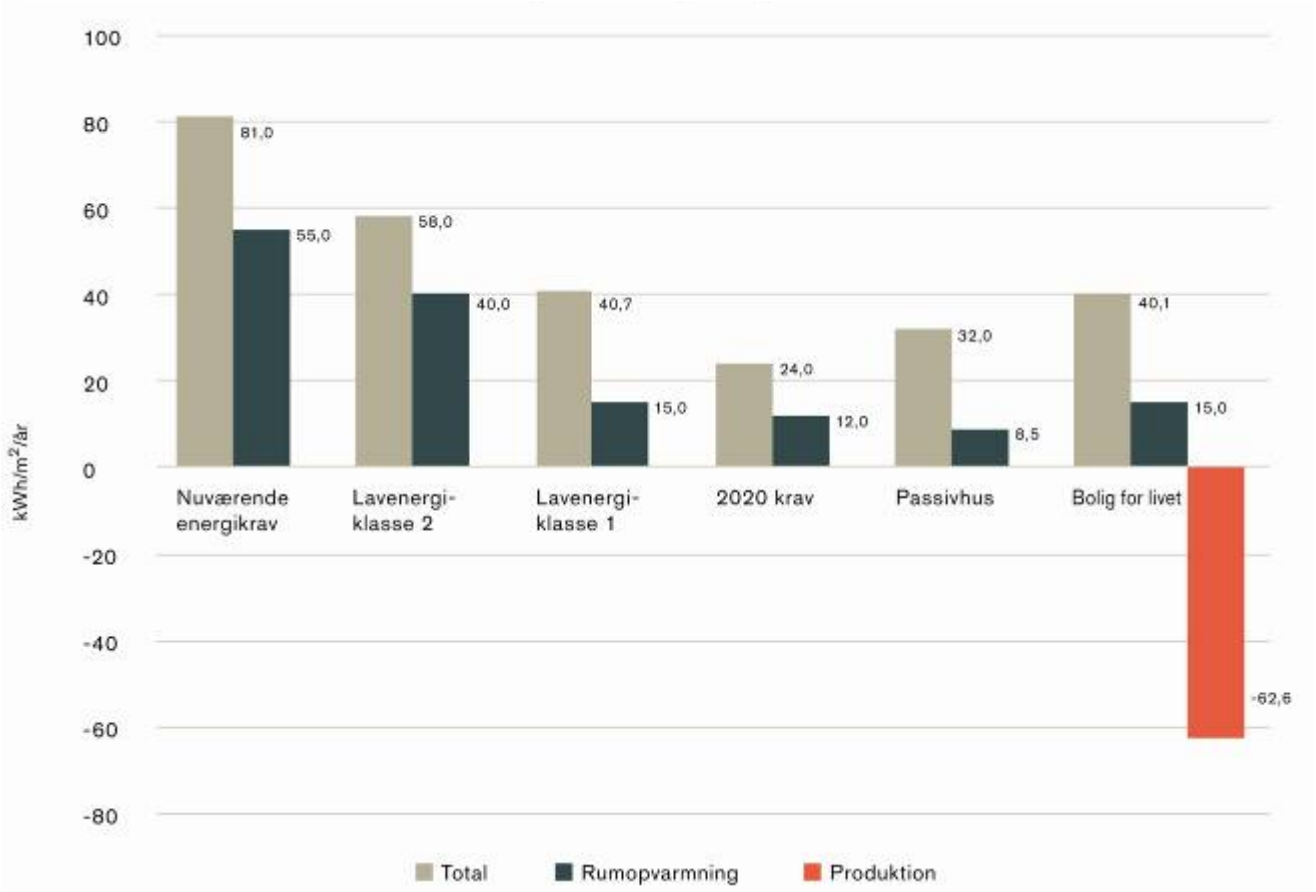
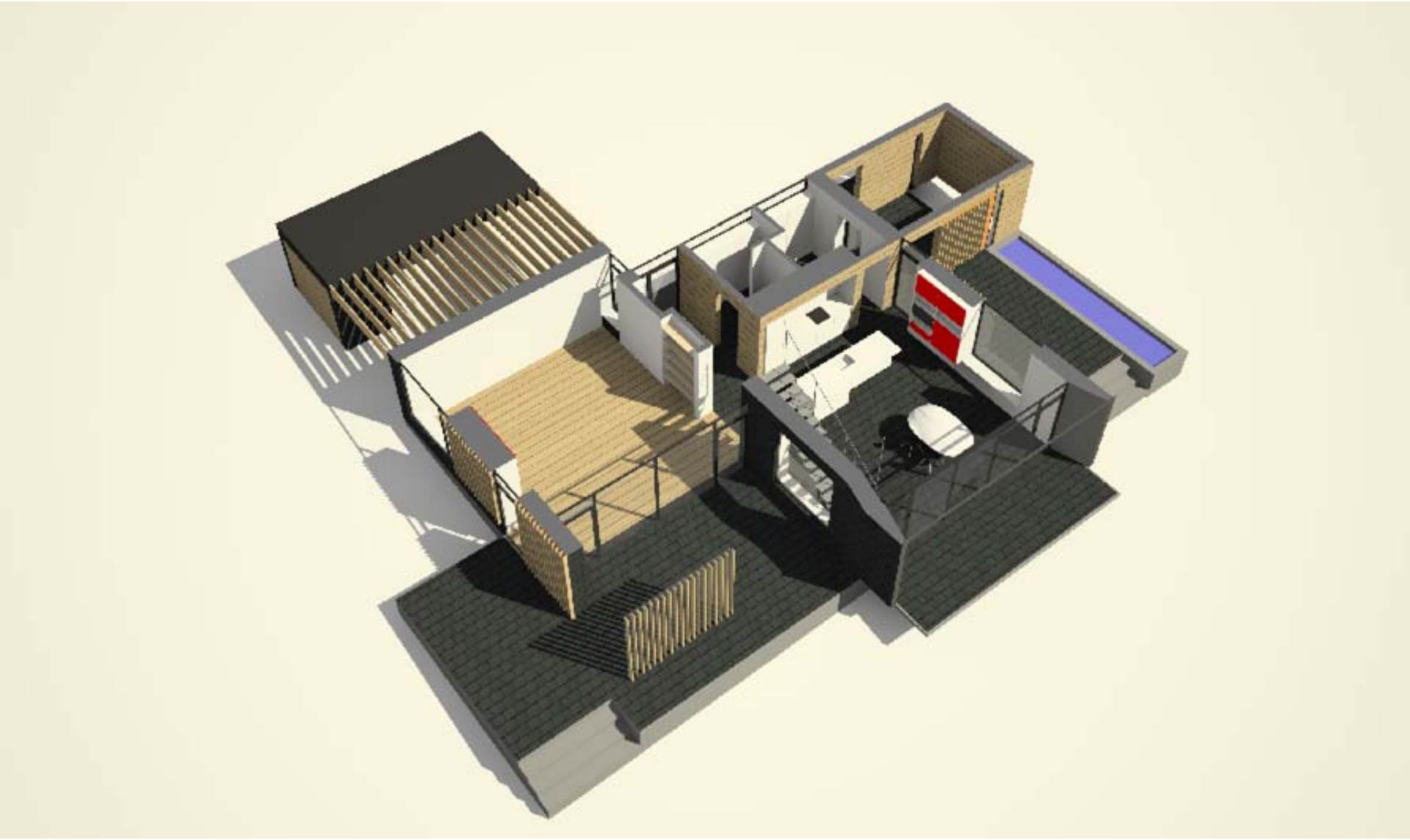


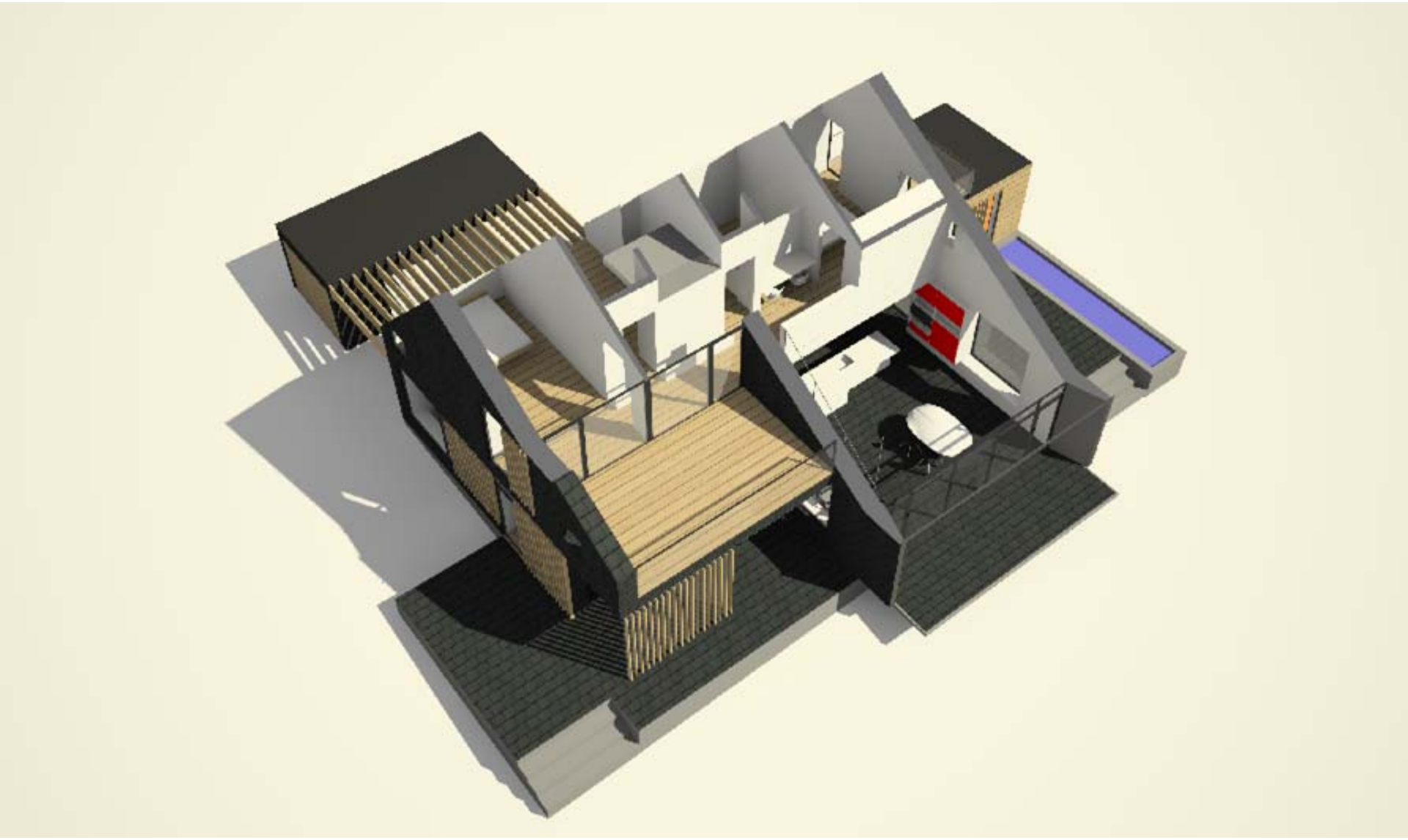

Statements:

Bolig for livet lever op til de forventede 2015 krav med fjernvarme som forsyning *uden* egenproduktion

Bolig for livet er beregningsmæssigt 100% energi- og CO2 neutral på årsbasis

Bolig for livet er forberedt til miljørigtig transport, med et stik til opladning af en elbil i garagen.





**Innovation** is created by putting together existing knowledge in new ways

**Working group VKR Holding:**

VELFAC og VELUX

WindowMaster, Sonnenkraft

**Consultants:**

AART archietchts

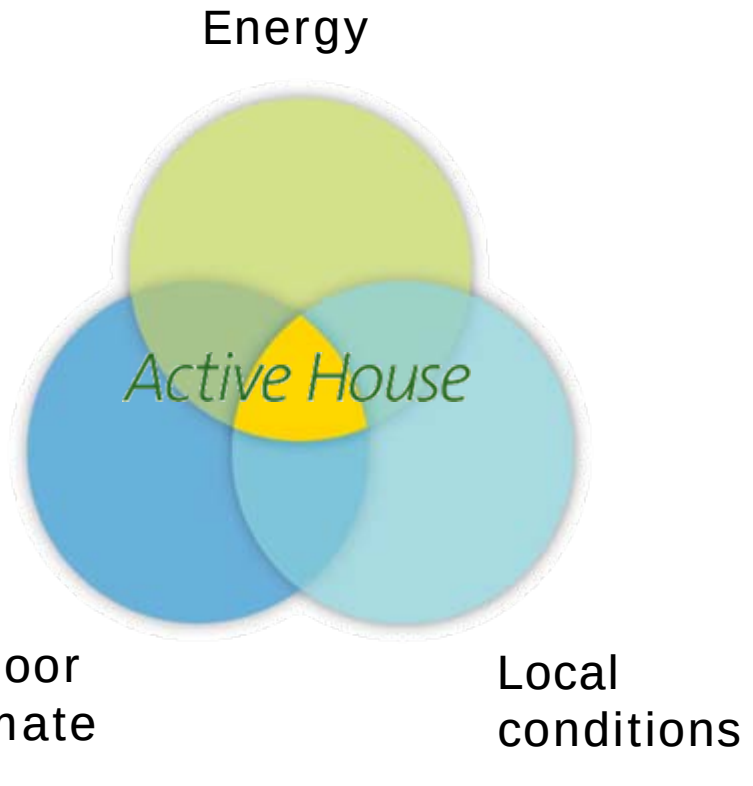
Esbensen Consulting engineers A/S

KFS-Boligbyg

**Expert knowledge:**

University college, Århus

Alexandra Institute

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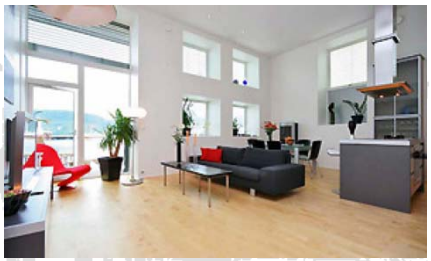
# Summary



- The Bolig + competition were very challenging for the teams participating.
- It showed that close integration of the architectural and energy/komfort concept is essential – as well as close cooperation based on respect.
- In the optimal case synergies will be exploited for a further development and optimization – if not compromise will be the dominating characteristic

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# BOLIG+

## etageboliger i Aalborg

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# Forslag til energikoncept