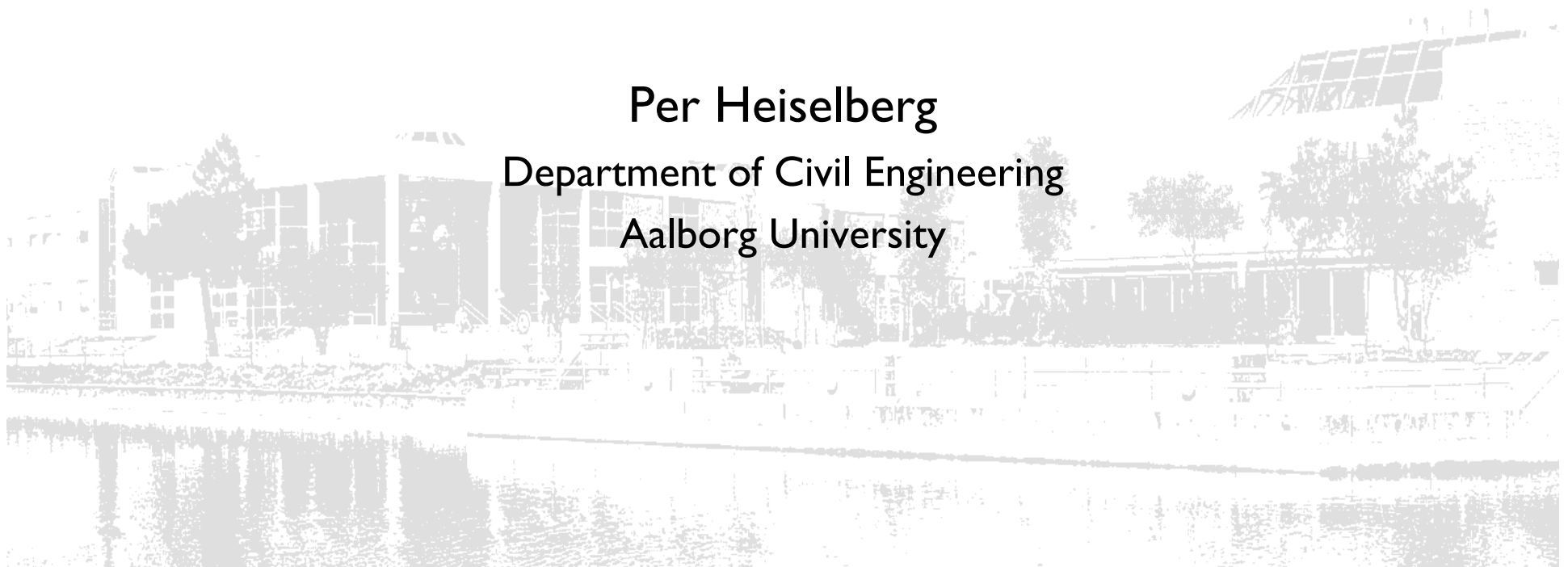


Strategies for Integrative Building Design

Per Heiselberg

Department of Civil Engineering

Aalborg University

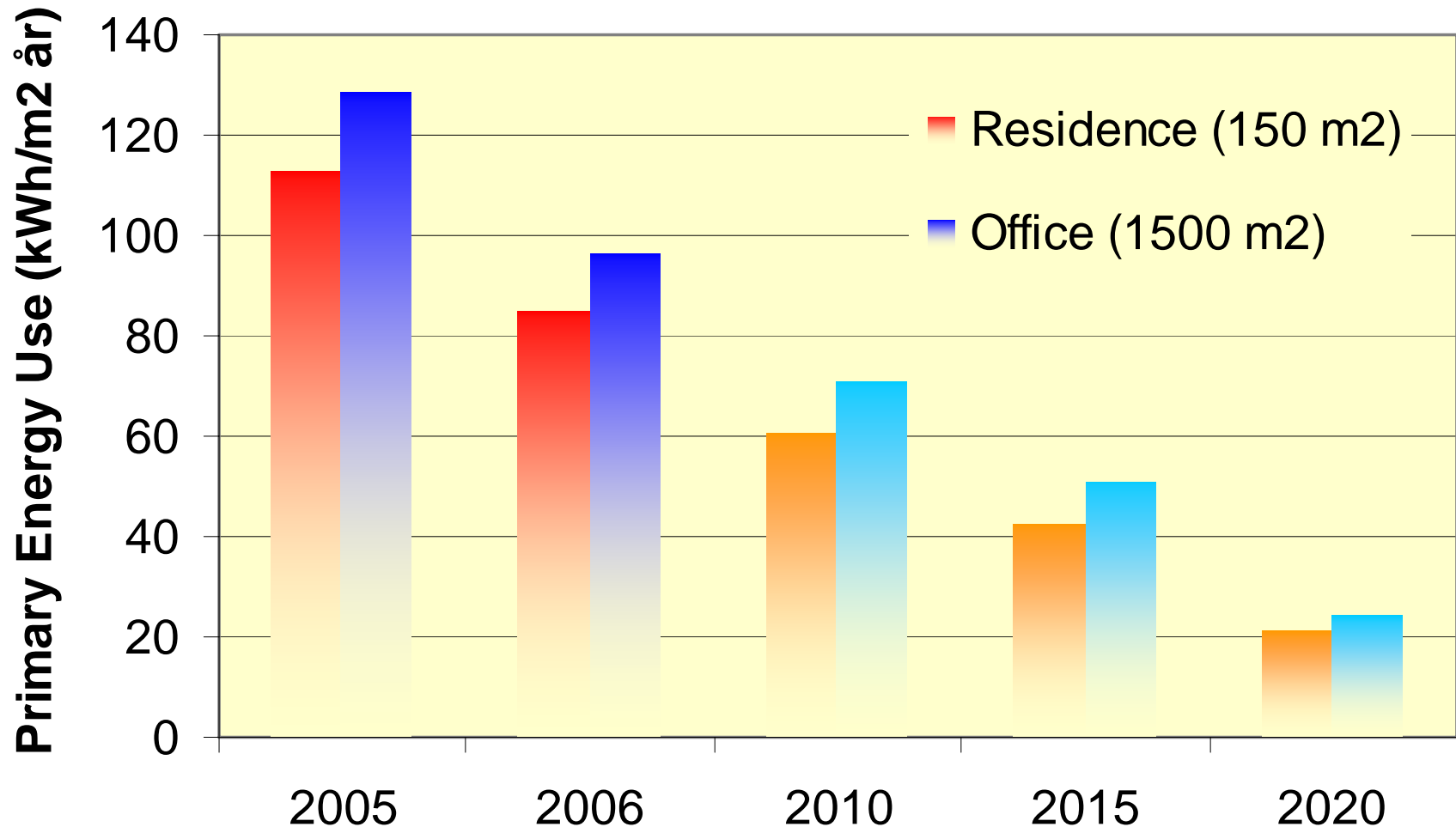


Background

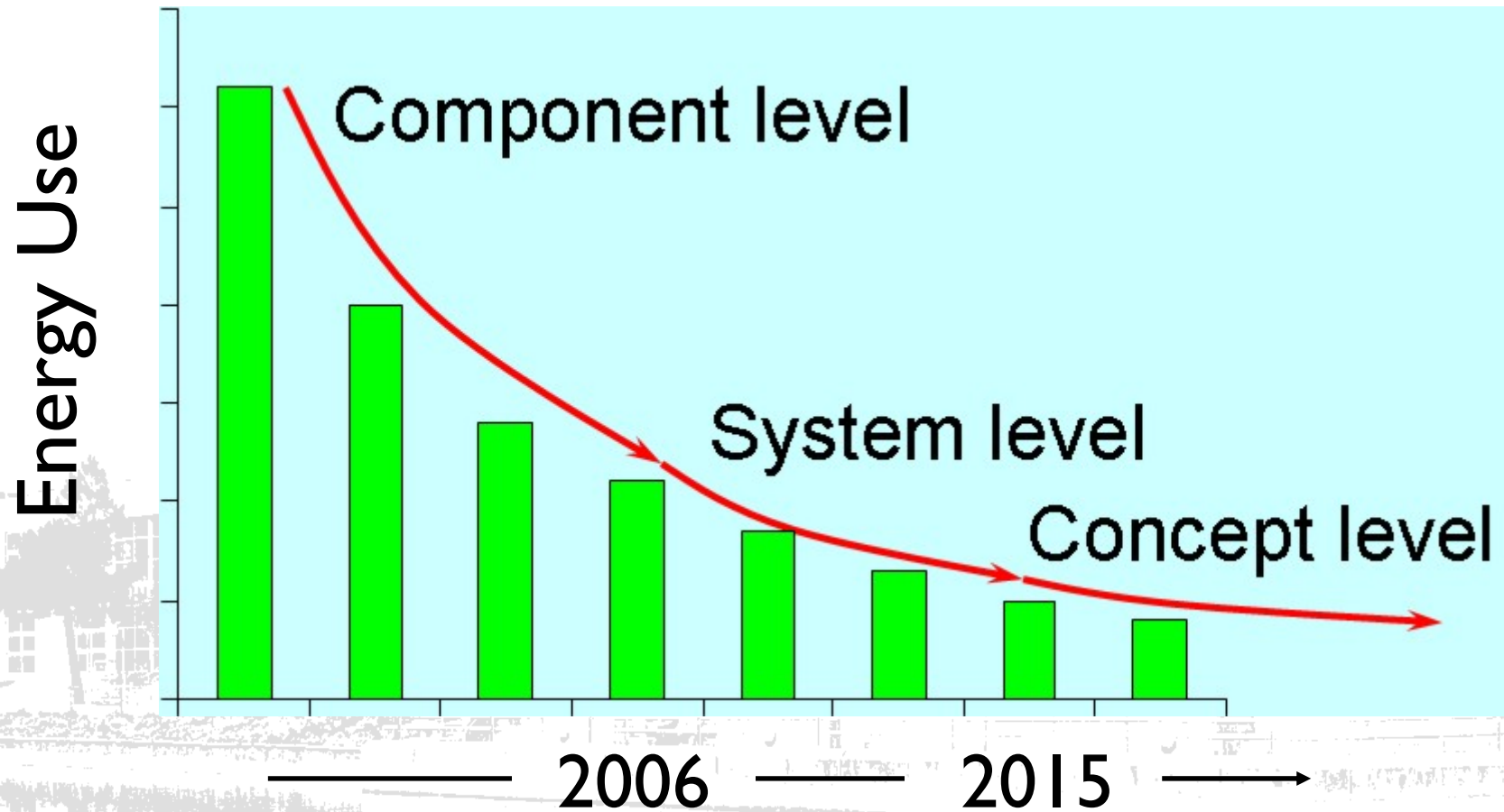


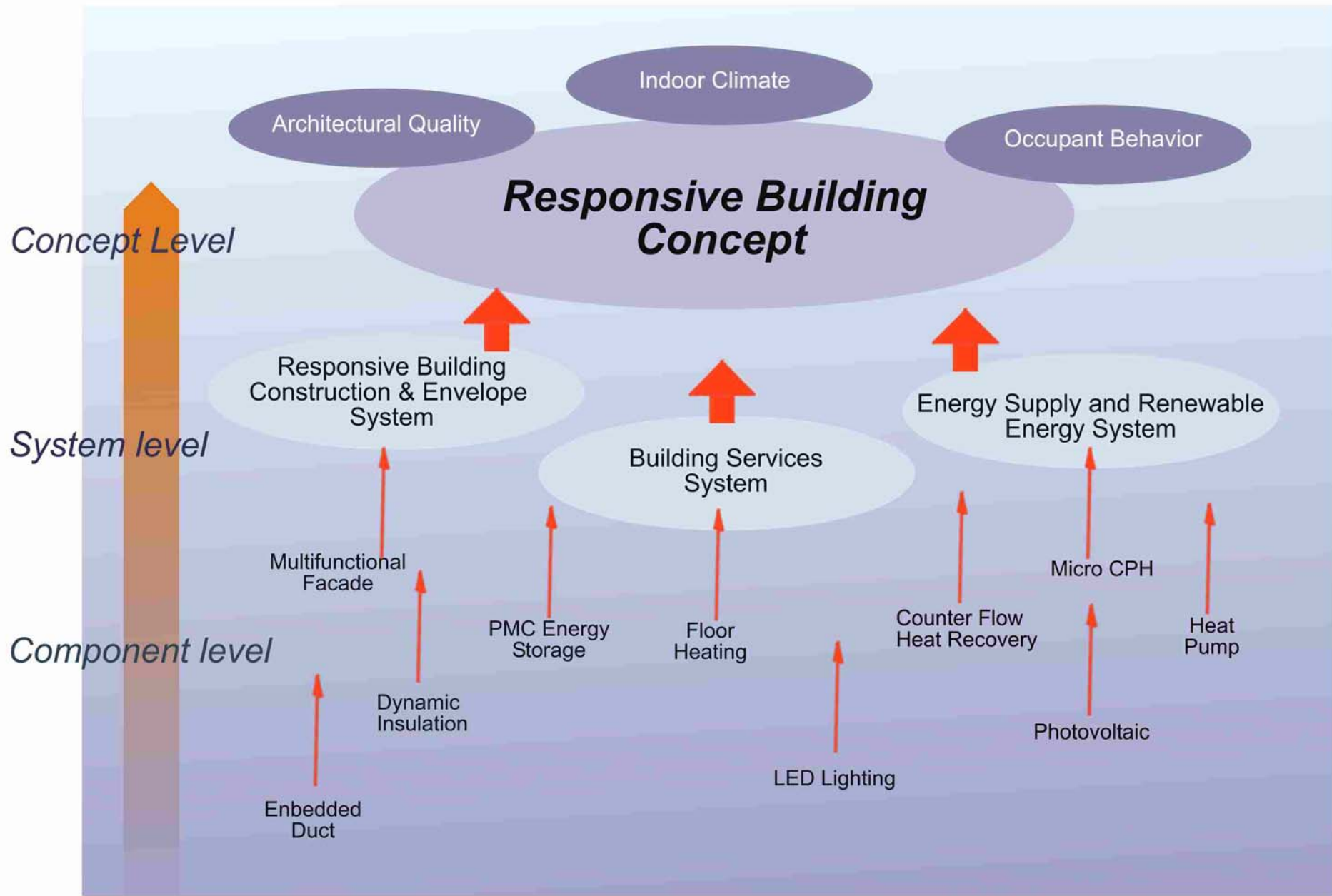
- The European Union has taken a strong leadership role in promoting energy efficiency in buildings in Europe by approving **The Directive on the Energy Performance of Buildings**
- The Directive is the most powerful instrument developed to date for the building sector in Europe
- There is a high socioeconomic potential for energy savings using existing technologies
- The main challenges in the future is to develop and optimize new competitive building solutions that integrates renewable energy to achieve the goal of **Zero energy buildings.**

Development Plans for Maximum Energy Use in New Buildings in Denmark



From Component to Concept Level



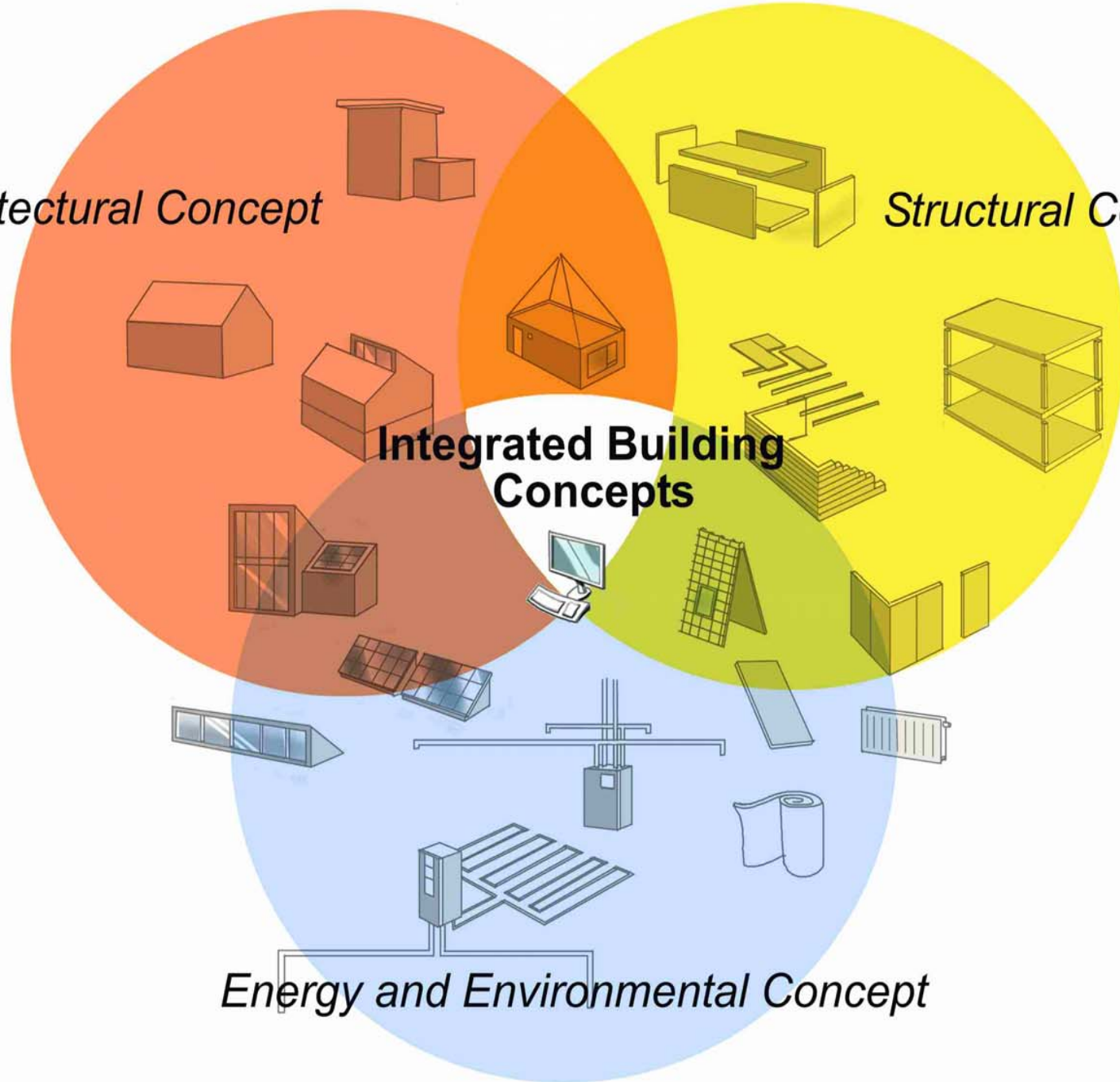


Architectural Concept

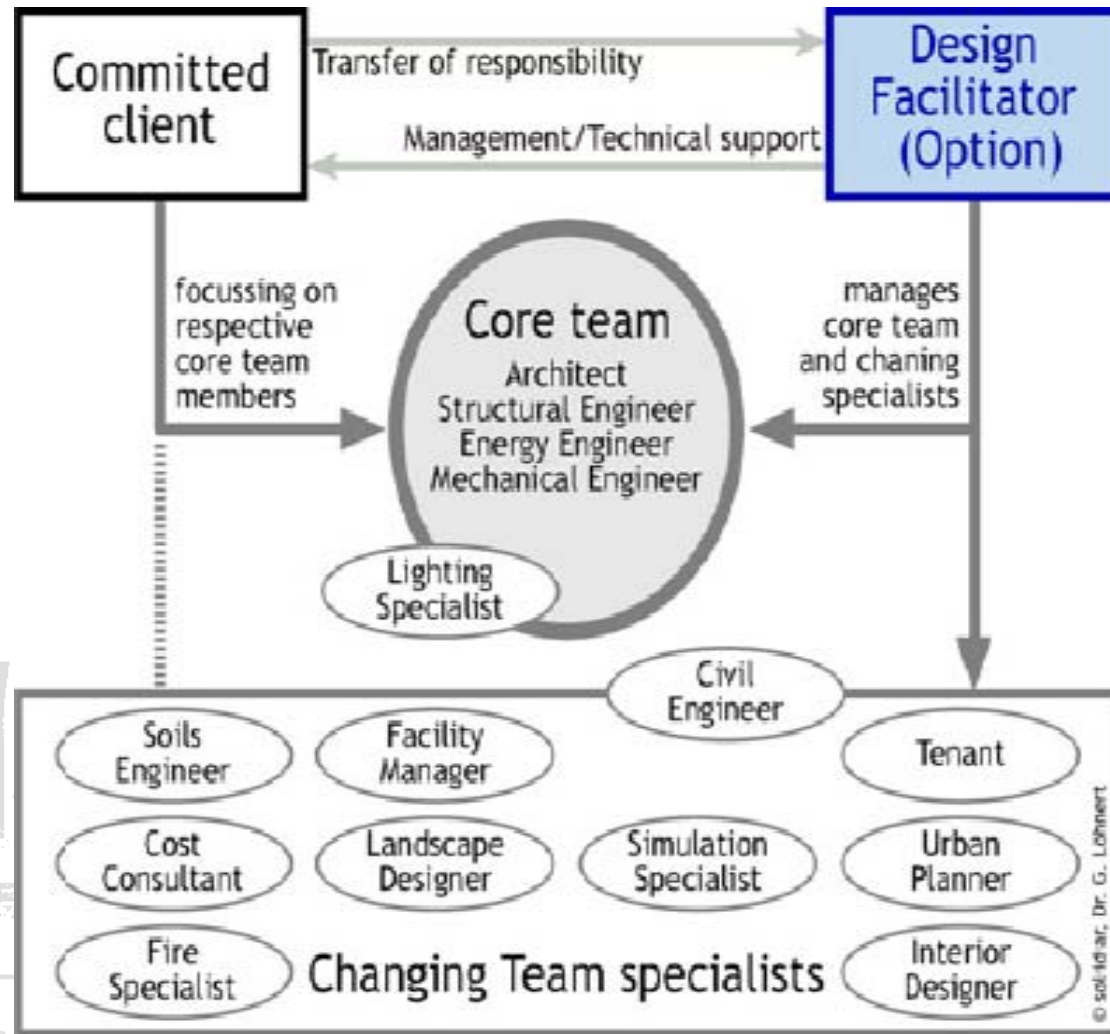
Structural Concept

Integrated Building Concepts

Energy and Environmental Concept



Design Team



What

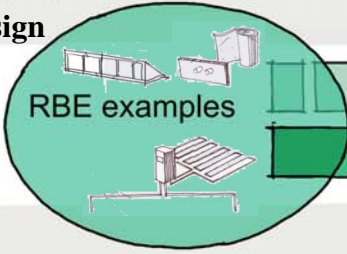
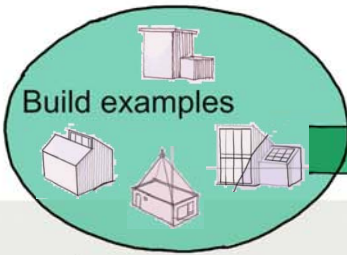
Where

New Design Process

Requirements of the client and regulations

Climate conditions and urban context

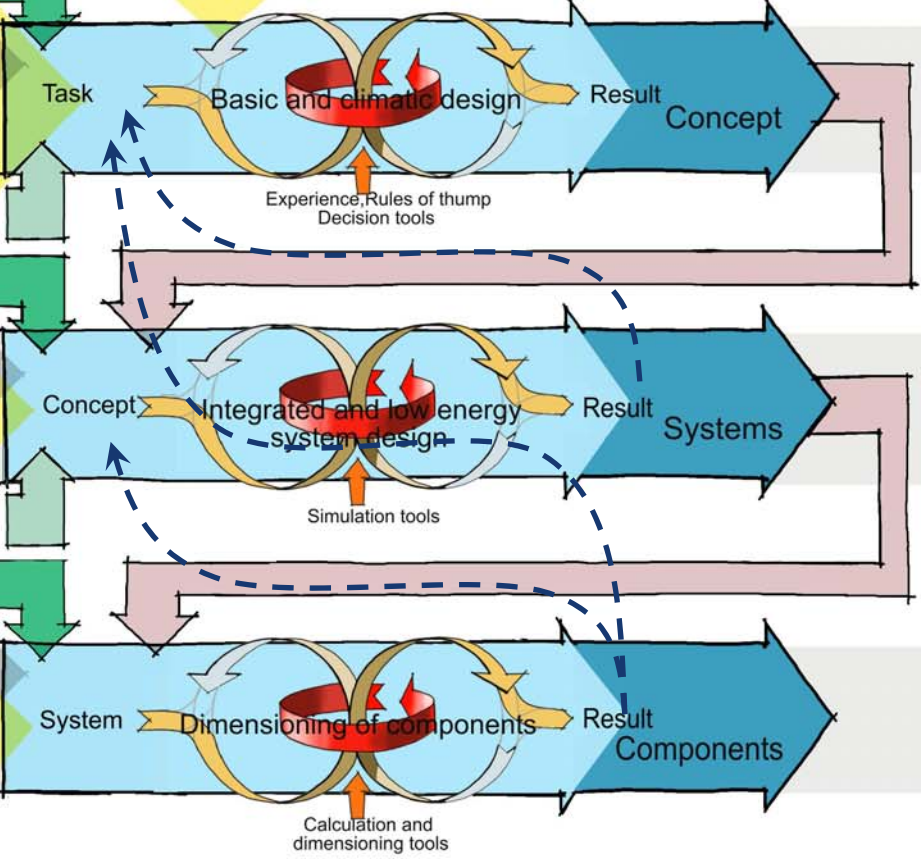
Architecture and esthetics



Step 1 + 2
Concept design phase
Preliminary design

Step 3 + 4 + 5
System design phase
Final design

Step 6
Component design phase
Detailing phase



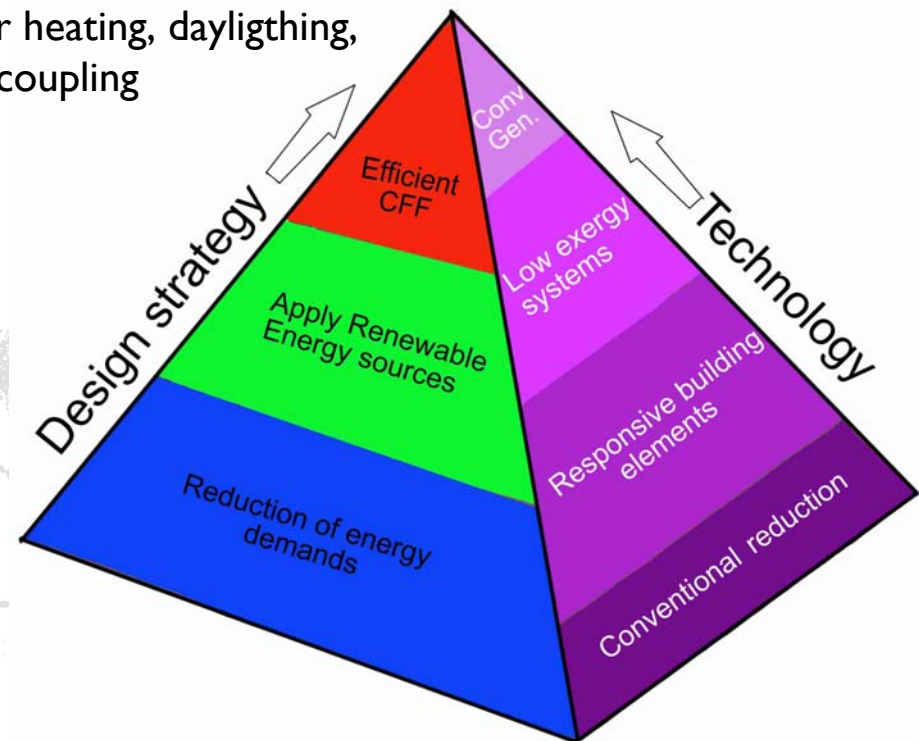
- integral
- creative
- achievable

- realizable
- feasible
- coordinated

- univocal
- detailed
- makable

Design Strategy and Technical Solutions

- *Reduce Demand*
 - Optimize form and zoning, insulation, air tightness, heat recovery, efficient electric lighting and equipment, low pressure drops, etc
 - Apply Responsive Building Elements
- *Utilize renewable energy sources*
 - Provide optimal use of passive RES: solar heating, daylighting, natural ventilation, night cooling, earth coupling
 - Apply active renewable energy sources
 - Optimise the use by application of low exergy systems.
- *Efficient use of fossil fuels*
 - Use least polluting fossil fuels in an efficient way,
 - Provide intelligent demand control of systems



Design steps

	Heating	Cooling	Lighting	Ventilation
Step 1 Basic Design	<i>Conservation</i> 1. Surface to volume ratio 2. Zoning 3. Insulation 4. Infiltration	<i>Heat Avoidance</i> 1. Reduction of internal heat gains 2. Reduction of external heat gains 4. Thermal mass	<i>Daylighting</i> 1. Room height and shape 2. Zoning 3. Orientation	<i>Source Control</i> 1. Surface material emission 2. Zoning 3. Local exhaust 4. Location of air intake
Step 2 Climatic Design	<i>Passive Heating</i> 1. Direct solar heat gain 2. Thermal storage wall 3. Sunspace	<i>Passive Cooling</i> 1. Free cooling 2. Night cooling 3. Earth cooling	<i>Daylight Optimization</i> 1. Windows (type and location) 2. Glazing 3. Skylights 4. Light shelves	<i>Natural Ventilation</i> 1. Windows and openings 2. Atria, stacks 3. Air distribution 4. Ventilation control
Step 3 Integrated System Design	<i>Application of Responsive Building Elements</i> 1. Intelligent facade 2. Thermal mass activation 3. Earth coupling 4. Control strategy	<i>Application of Responsive Building Elements</i> 1. Intelligent facade 2. Thermal mass activation 3. Earth coupling 4. Control strategy	<i>Daylight Responsive Lighting Systems</i> 1. Intelligent facade 2. Interior finishes 3. Daylight control strategy 4. ...	<i>Hybrid Ventilation</i> 1. Building integrated ducts 2. Overflow between rooms 3. Control strategy 4. ...
Step 4 Design of Low Exergy Mechanical Systems	<i>Low Temperature Heating System</i> 1. Application of renewable energy 2. Floor/wall heating 3. ...	<i>High Temperature Cooling System</i> 1. Application of renewable energy 2. Floor/wall cooling 3. ...	<i>High Efficiency Artificial Light</i> 1. LED 2. ...	<i>Low Pressure Mechanical Ventilation</i> 1. Efficient air distribution 2. Low pressure ductwork, filtration and heat recovery 3. Low pressure fan 4. ...
Step 5 Design of Conventional Mechanical Systems	<i>Heating System</i> 1. Radiators 2. Radiant panels 3. Warm air system	<i>Cooling System</i> 1. Cooled ceiling 2. Cold air system	<i>Artificial Lighting</i> 1. Lamps 2. Fixtures 3. Lighting control	<i>Mechanical Ventilation</i> 1. Efficient air distribution 2. Mech. exhaust 3. Mech. ventilation

+BOLIGER

57°03'35''N 9°54'49''Ø

Fremtidens energineutrale etageboliger i Aalborg

TEAM+ appointed winner

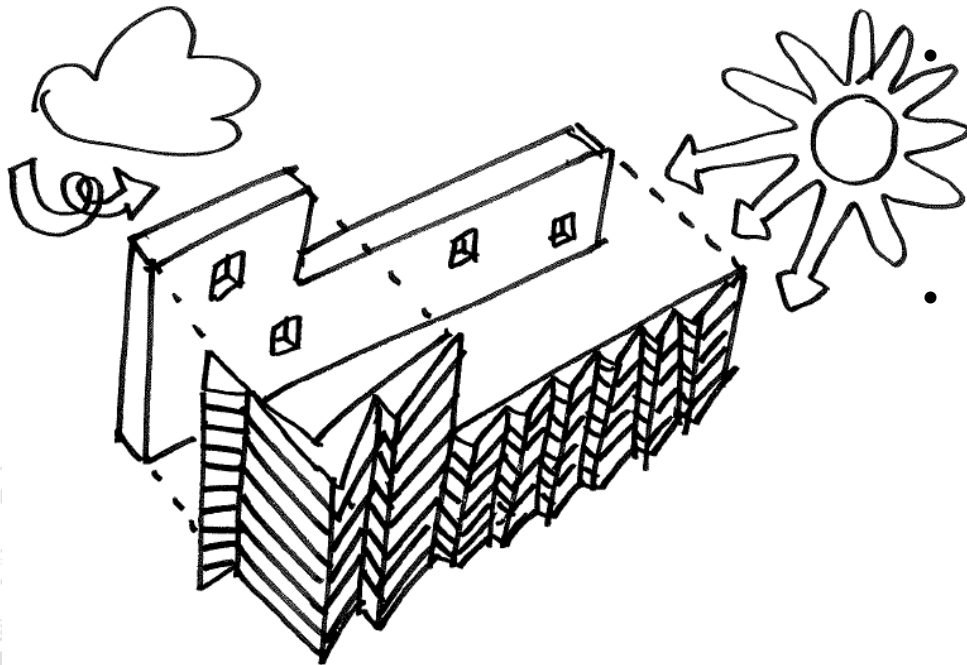
28.09.09

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



54321

Energy Concept



- **Reduction of energy demand**
 - High level of thermal insulation (U-value envelope 0,08 - 0,1 W/m²K, windows 0,9 W/m²K), 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/m³
 - Low temperature floor heating panels
 - Optimized building lighting systems (LED)
- **Total primary energy use**
 - 13 kWh/m²/yr for heating, cooling and ventilation (80% less than standard)

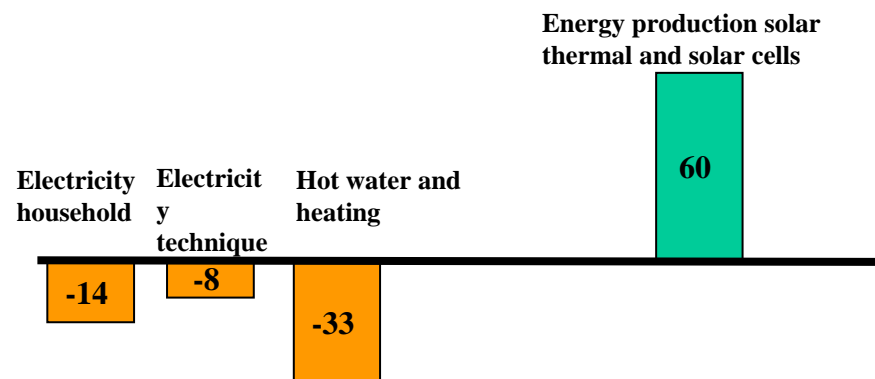
The first Active House – Home for life



VKR Holding
 VELFAC, VELUX
 WindowMaster
 Sonnenkraft
 AART arkitekter
 Esbensen Rådg.
 Ingeniører
 KFS-Boligbyg



Energy need and production from solar [kwh/m²/year]





Thanks for your attention