Strategies for Integrative Building Design

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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

Primary Energy Use (kWh/m²·y)

- Residence (150 m²)
- Office (1500 m²)

From Component to Concept Level

Energy Use

Component level

System level

Concept level

2006 2015
Design Team

Reference: Löhnert, G., IEA SHC Task 23
New Design Process

What

- integral
- creative
- achievable

Where

- realizable
- feasible
- coordinated

- univocal
- detailed
- makable

Step 1 + 2
Concept design phase
Preliminary design
- Build examples
- RBE examples

Step 3 + 4 + 5
System design phase
Final design
- Manufacturer's specifications

Step 6
Component design phase
Detailing phase
- System
- Dimensioning of components

Requirements of the client and regulations
Architecture and esthetics
Climate conditions and urban context
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
  - Optimize 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

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<th>Ventilation</th>
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<td><strong>Conservation</strong>&lt;br&gt;1. Surface to volume ratio&lt;br&gt;2. Zoning&lt;br&gt;3. Insulation&lt;br&gt;4. Infiltration</td>
<td><strong>Heat Avoidance</strong>&lt;br&gt;1. Reduction of internal heat gains&lt;br&gt;2. Reduction of external heat gains&lt;br&gt;4. Thermal mass</td>
<td><strong>Daylighting</strong>&lt;br&gt;1. Room height and shape&lt;br&gt;2. Zoning&lt;br&gt;3. Orientation</td>
<td><strong>Source Control</strong>&lt;br&gt;1. Surface material emission&lt;br&gt;2. Zoning&lt;br&gt;3. Local exhaust&lt;br&gt;4. Location of air intake</td>
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<td><strong>Step 3</strong>&lt;br&gt;INTEGRATED SYSTEM DESIGN</td>
<td><strong>Application of Responsive Building Elements</strong>&lt;br&gt;1. Intelligent facade&lt;br&gt;2. Thermal mass activation&lt;br&gt;3. Earth coupling&lt;br&gt;4. Control strategy</td>
<td><strong>Application of Responsive Building Elements</strong>&lt;br&gt;1. Intelligent facade&lt;br&gt;2. Thermal mass activation&lt;br&gt;3. Earth coupling&lt;br&gt;4. Control strategy</td>
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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.
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<sub>50</sub><0.6 h<sup>-1</sup>)
  - 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<sub>peak</sub>)
  - PV/T Solar Thermal System (DHW (60% coverage) and heat, 142kW<sub>peak</sub>)

- **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

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

Energy production solar thermal and solar cells

Electricity household

-14

Electricity technique

-8

Hot water and heating

-33

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