Energy Efficiency in Buildings

Potential to reality & the energy efficiency directive

Climate Strategies
Supporting European climate policy to 2030
Copenhagen - January 19, 2012

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Danish Building Research Institute SBi
Content of the presentation

• Relevant EU initiatives
  – Other existing EU directives
  – Energy Efficiency directive
  – Energy Roadmap 2050
  – Other requirements: Sustainability etc.

• Status
  – New buildings
  – Existing buildings

• Challenges in future development
EPBD - Minimum requirements

• New buildings
  – Minimum energy performance requirements
  – Local renewable sources, Cogeneration, Heat pumps, District or block heating or cooling,

• Existing buildings
  – Retrofit or replace of building element: Requirements to the building element
  – Major renovation: Requirements to building or building elements

• Cost-optimal levels of requirements
EPBD - Certification and Inspection

• Energy performance certificates
  – Energy performance and reference values
  – Recommendations for improvement
  – Display of certificates in public buildings

• Inspection of heating systems
  – Regular inspection if boilers over 20 kW
  – If boiler is over 100 kW every two years
  – For gas boilers it can extend to four years

• Inspection of air-conditioning systems
  – Regular inspection of AC over 12 kW
EPBD - Nearly zero-energy buildings

• Member States shall ensure that:
  – by 31 December 2020, all new buildings are nearly zero-energy buildings;
  – after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

• MS shall draw up national plans for increasing the number of nZEB.
Other existing EU directives

• Cogeneration
  – Promotion of cogeneration based on a useful heat demand in the internal energy market

• Renewable Energy
  – Promotion of energy from renewable sources

• Eco design
  – Requirements for energy-related products
  – E.g. Electric motors, Drives, Fans, Circulators, Ventilation, AC, Boilers, Heat pumps, Water heaters, Room heaters, Office lighting
Definition of renewable sources

- Energy from renewable non-fossil sources:
  - wind, solar
  - aerothermal, geothermal, hydrothermal
  - ocean energy, hydropower
  - biomass, landfill gas, sewage treatment plant gas and biogases

- Future scarcity of biomass!

- Heat pumps are 60 - 75 % renewable dependent on COP, but normally electrical driven!
New Energy Efficiency Directive

• EC proposal published on 22 June 2011
• Member States to achieve 1.5% annual reduction of energy consumption through energy efficiency measures
• Annual renovation of 3% of public buildings to MS minimum energy requirements
• Consumers: Individual metering for better energy management
Energy Roadmap 2050

• Published on December 15, 2011
• Focused on what is needed in the energy sector by 2050, to meet climate objectives pursuing at the same time security of supply and competitiveness goals
• Based on scenario analysis
• Energy efficiency as a “no-regrets” option
Energy Roadmap 2050: Buildings

• Higher energy efficiency in new and existing buildings is key
• Nearly zero energy buildings should become the norm
• Buildings – including homes - could produce more energy than they use
• Products and appliances will have to fulfill highest energy efficiency standards
Sustainability of buildings

CEN TC 350 Sustainability of construction works
Integradet assessment of building performance
Part 1: General framework PrEN 15643-1
Framework Task Group

Part 2
Framework for the assessment of environmental performance
PrEN 15643-2

WG1
Environmental building performance

WG3
Products
PrEN 15804

Part 3
Framework for the assessment of social performance
PrEN 15643-3

WG5
Social building performance

Part 4
Framework for the assessment of economic performance
PrEN 15643-4

WG4
Economic building performance
<table>
<thead>
<tr>
<th>Environment</th>
<th>Social</th>
<th>Economic</th>
</tr>
</thead>
</table>
| • Climate change  
• Acidification  
• Eutrophication  
• Ozone formation  
• Depletion of non-renewable  
• Use of renewable  
• Use of freshwater  
• Hazardous waste to disposal | • Thermal comfort  
• Indoor air quality  
• Ventilation  
• Acoustic comfort  
• Lighting comfort  
• Quality of drinking water  
• Outdoor conditions | • NPV of costs  
• Annualized costs  
• Maintenance costs  
• Operation costs  
• End-of-life costs  
• Total costs |
EU - Sustainability of buildings

• DG Environment
• Development of European Ecolabel and Green Public Procurement Criteria for Office Buildings
• JRC IPTS Draft Report
• June 2011
PRINCIPLES FOR NEARLY ZERO-ENERGY BUILDINGS

Paving the way for effective implementation of policy requirements

Executive Summary
# Planned initiatives towards nZEB

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>66.5 kWh/m²/year (final energy)</td>
<td>-15 %</td>
<td></td>
<td></td>
<td>Passive house</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>119-138 kWh/m²/year (primary energy)</td>
<td>-25 %</td>
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</tr>
<tr>
<td>Denmark</td>
<td>2010: 52.5-60 kWh/m²/year (primary energy)</td>
<td>-25 %</td>
<td>-50 %</td>
<td></td>
<td>-75 %</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>65 kWh/m²/year (heating demand)</td>
<td>-15-30 %</td>
<td>-20 %</td>
<td></td>
<td>Passive house for public</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>Until 2012: Fossil fuels: 80-130 kWh/m²/year, Electricity 130-250 kWh/m²/year (primary energy)</td>
<td></td>
<td></td>
<td></td>
<td>Positive E+</td>
<td></td>
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<tr>
<td>Germany</td>
<td>2009: 70 kWh/m²/year (primary energy)</td>
<td></td>
<td>-30%</td>
<td></td>
<td></td>
<td>NFFB</td>
</tr>
<tr>
<td>Ireland</td>
<td>2011: 64 kWh/m²/year (primary energy)</td>
<td>-60 %</td>
<td></td>
<td></td>
<td>CO₂ neutral</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>Regulated through EPC factor 2008: -100-130 kWh/m²/year (primary energy)</td>
<td>-25 %</td>
<td>Climate neutral public building</td>
<td>- 50 %</td>
<td></td>
<td>ENB</td>
</tr>
<tr>
<td>Norway</td>
<td>2010: 150 kWh/m²/year (net heating demand)</td>
<td></td>
<td></td>
<td></td>
<td>Passive House</td>
<td>ZEB</td>
</tr>
<tr>
<td>Sweden</td>
<td>2009: 110-150 kWh/m²/year (delivered energy)</td>
<td>-20 %</td>
<td></td>
<td>25 % of all new is ZEB</td>
<td></td>
<td>ZEB</td>
</tr>
<tr>
<td>Switzerland</td>
<td>2011: 60 kWh/m²/year (primary energy)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>United Kingdom</td>
<td>Regulated through CO₂ demands 2010: ~100 kWh/m²/year (primary energy)</td>
<td>-25 %</td>
<td>-44 %</td>
<td></td>
<td></td>
<td>Zero Carbon</td>
</tr>
</tbody>
</table>
# The three nZEB Principles

<table>
<thead>
<tr>
<th>First nZEB Principle: Energy demand</th>
<th>Second nZEB Principle: Renewable energy share</th>
<th>Third nZEB Principle: Primary energy and CO₂ emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>There should be a clearly defined boundary in the energy flow related to the operation of the building that defines the energy quality of the energy demand with clear guidance on how to assess corresponding values.</td>
<td>There should be a clearly defined boundary in the energy flow related to the operation of the building where the share of renewable energy is calculated or measured with clear guidance on how to assess this share.</td>
<td>There should be a clearly defined boundary in the energy flow related to the operation of the building where the overarching primary energy demand and CO₂ emissions are calculated with clear guidance on how to assess these values.</td>
</tr>
</tbody>
</table>
Costs

- The specific capital costs related to the actual local building standards range for all examined variants from savings of 3 €/(m²a) to additional costs of 20 €/(m²a) (= savings of 5 % to additional 30 % referring to total costs)
- Southern Europe: The more PV is added the more financially attractive the nZEB solutions become

*The average investment costs for using different heating technologies vary largely according to the local market circumstances, contract negotiations, sales volumes etc. and might differ substantially from one case to another.
Existing building stock
**Tabula WebTool**

The Tabula WebTool is a platform developed by the Danish Building Research Institute Energy and Environment. It is designed to provide detailed information on building types, construction periods, and additional classification criteria. The tool allows users to select and display calculation charts based on various building details such as country, construction year class, and building type.

### Tabula WebTool Features
- **Country**: National, (Germany, Austria, Czech Republic)
- **Construction Year Class**: ...1919, 1919...1944, 1945...1960, 1961...1980, 1981...2000
- **Additional Classification**: Generic (Standard / agglomeration typisch)
- **Building Types**
  - SFH Single Family House
  - TH Terraced House
  - MFH Multi Family House
  - AB Apartment Block

### Building Selection
- **Building Size Class**: n/a
- **Construction Period**: n/a
- **Reference Floor Area**: n/a
- **Heat Supply System**: No selection

### Display Options
- **Display chart**: Energy need for heating
- **Select a Building to display the Calculation Charts**
- **Automatic selection**: Exemplary existing building

The platform provides a comprehensive view of building characteristics, enabling researchers and professionals to make informed decisions regarding energy efficiency and environmental impact.
Age profile

- Variations in the age profile between the 3 regions are relatively small. Nonetheless, older buildings (before 1960) have the biggest share in the North & West region.

- A large boom in construction between 1961 and 1990 (with a few exceptions, the housing stock more than doubled in this period).

- Countries with the biggest share of recently constructed buildings (1990-2010) appear to be Ireland, Spain and Poland.

- Countries with the biggest share of residential stock dating from 1961 to 1990 seem to be Estonia, Hungary, Latvia and Finland.

Age profile of residential floor space

- EE: Data only from 1951 onwards.
- IT: Data excludes heritage buildings before 1950.
- LT: Data only from 1941 onwards.
- ES: Data excludes secondary houses.
- SE: Data only from 1921.
## Defining Renovation Depths and Associated Costs

<table>
<thead>
<tr>
<th>DESCRIPTION (renovation type)</th>
<th>ENERGY SAVING (% reduction)</th>
<th>INDICATIVE SAVING (for modelling purposes)</th>
<th>AVERAGE COST (€/M2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>0-30%</td>
<td>15%</td>
<td>60</td>
</tr>
<tr>
<td>Moderate</td>
<td>30-60%</td>
<td>45%</td>
<td>140</td>
</tr>
<tr>
<td>Deep</td>
<td>60-90%</td>
<td>75%</td>
<td>330</td>
</tr>
<tr>
<td>NZEB</td>
<td>90%+</td>
<td>95%</td>
<td>580</td>
</tr>
</tbody>
</table>
Cost Reductions for Different Levels of Renovation over Time
Challenges in future development

• Further development of cost efficient and robust solutions to new nZEB buildings
• Cost efficient, robust and aesthetic solutions to renovate existing buildings
• Preservation of existing buildings culture
• Balancing of energy efficiency in buildings and supply system
• Inclusion of on site renewable energy production especially PV (photo voltage)
• Dynamics in consumption and supply
Process in development

• Looping!

• Energy performance of buildings
• Energy performance of supply systems

• "Competition" between building and supply (where we needs both)

• Further development of building and supply system efficiency