



# Energy performance of buildings in the EU Member States

- main challenges for the EPBD implementation now and in the future

International Sustainable Solutions  
Denmark, 23 May 2008

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## Content

- Energy Performance of Buildings Directive (EPBD)
- Energy policy
- Building stock knowledge and energy savings
- EU - Projects
  - Concerted Action CA1 and CA2
  - Buildings Platform
- Other projects
  - EuroACE - very low energy buildings
  - Bolig+ - energy neutral housing
- Main challenges for EPBD revision
- Danish implementation of the EPBD

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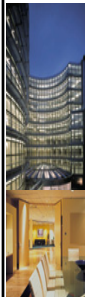
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## Background for the EPBD



**The EU needs to promote energy savings**

Three main reasons:

<b>Security of supply</b> External energy dependence 70% in 2030 if no measures taken	<b>Environment</b> Energy production and use produce 94% of CO <sub>2</sub> emissions	<b>Limited influence on supply</b> The EU can promote reduced energy use
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**Impact of action on energy use in buildings**

- Largest end-user: 40% of energy is used in the residential and tertiary sector
- Large energy-saving potential in the building sector with cost-effective measures: 22% by 2010 (estimated in 1998)

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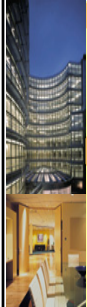
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## Objectives of the EPBD



### Objectives

- Promoting the improvement of energy performance of buildings within the EU through cost-effective measures, without jeopardising comfort or indoor air quality
- Convergence of building standards towards Member States that already have ambitious levels

### The measures

- Apply a methodology for integrated building energy performance standards based on common minimum requirements
- Application of these standards to new and existing buildings
- Certification schemes for all buildings
- Inspection & assessment of boilers/heating and cooling installations

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## Energy Policy for Europe – "3 x 20 %"



Energy Plan – European Commission - March 2007

- Reduce Greenhouse Gas Emissions by 20 % before 2020
- Reduce energy consumption by 20 % before 2020
- Incorporate 20 % renewable energy in overall energy sources in Europe before 2020

New climate plan – Commission - January 2008

- New Danish goal for renewable energy is 30 % – 17 % in 2005 till 30 % i 2020

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## New plans from the Danish government



June 2005

- For new buildings reduce energy consumption by 25% in 2010 and in 2015
- Remove the demand of affiliation to district heating and natural gas
- Remove the demand of prohibition on use of electricity for heating in low energy buildings

January 2007

- Energy efficiency and energy savings up till 2025
- Share of renewable energy supply should be increased from 15 to 30 %
- Energy savings in buildings is further increased by 1.25 % per year
- 10 % of fuel consumption in transport has to be by bio fuel
- Research in energy will be doubled to DKK1 billion (EUR 135 million)

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## Danish energy policy 2008-2011



Energy policy agreement, 21 February 2008

*Reduction of energy use in buildings:* For new buildings there shall be a cutback of at least 25% in 2010, at least 25% in 2015 and at least 25% in 2020, for a total reduction of at least 75% by 2020

- *Higher targets for energy efficiency:* The annual savings shall be increased to 1.5% of the final energy consumption in 2006, corresponding to an annual savings of 10.3 PJ
- *Knowledge Centre for energy savings in buildings:* Of the 20 million DKK earmarked for promoting energy savings, up to 10 million DKK shall be allocated annually in 2008-2011

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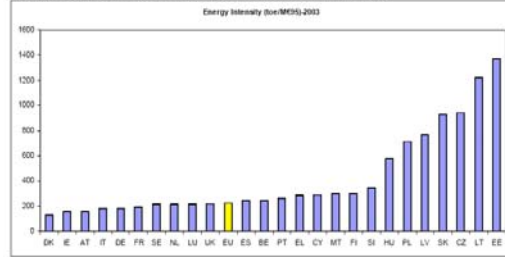
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## Energy consumption in Europe



Energy consumption per unit of GDP (Source: European Commission)



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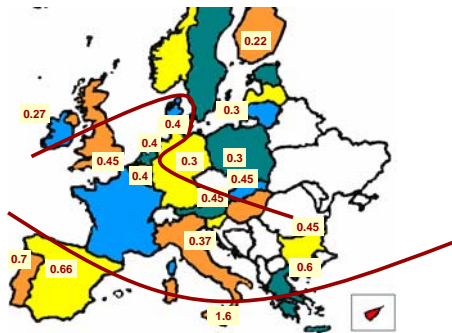
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## EU countries increased requirements



by an average of 25 % from levels prior to the EPBD

Wall U-values (indicative)  
W/m<sup>2</sup>K



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## EU project ENPER EXIST



- To conduct a survey of the level of information available in Member States regarding the existing building stock to obtain a better knowledge of the energy saving potential
- To make a proposal on how to gain improved knowledge of existing building stock by using certification schemes

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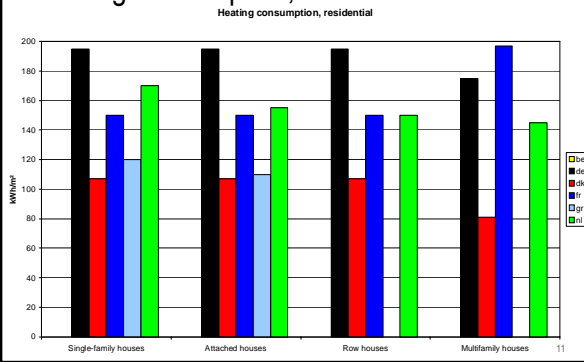
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## Heating consumption, residential



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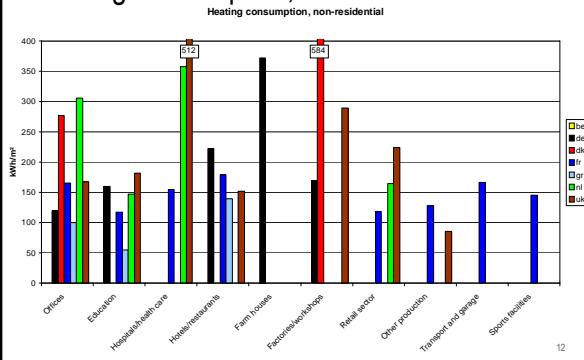
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## Heating consumption, non-residential



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## Building knowledge based on the Danish energy certification scheme



The objectives were to find the potential for saving on heating in existing Danish dwellings

- Method and calculations
  - Data from BBR register (building stock register)
  - Data from EM scheme (energy labelling scheme)
- Findings: Energy saving potential

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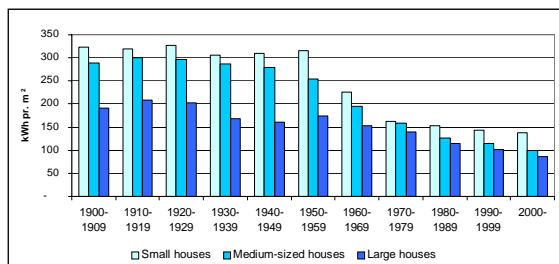
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## Heating consumption



Actual heat consumption in Danish detached houses - distributed over the decades of building (hot water included)




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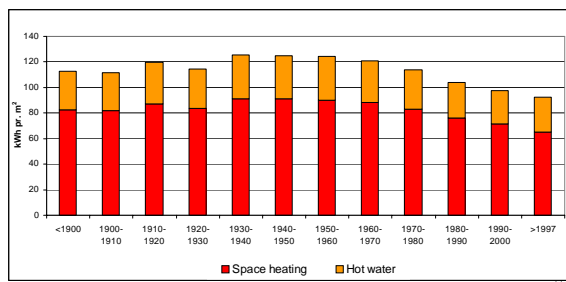
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## Heating consumption



Actual heat consumption in Danish blocks of flats - distributed over the decades of building




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## Grading into seven typical construction periods



### Period

- Until 1930
- 1931 – 1950
- 1951 – 1960
- 1961 – 1972
- 1973 – 1978
- 1979 – 1998
- 1999 – 2003

### Characteristics

- Dominated by solid brick constructions
- Cavity masonry walls
- Cavity walls insulated
- BR61
- BR72 and energy crisis 1
- BR78 and energy crisis 2
- BR95/98

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## Data sources



### BBR register

- Information about building stock, area, constructions, sizes and systems distributed on different types of buildings

### Labelling scheme (EM scheme)

- Extract from database of about 200,000 buildings in the period from 1999 to 2003
- Analyses of registered U-values distributed on different constructions and periods

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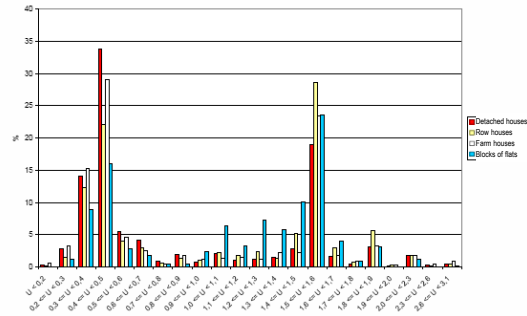
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## EM: Outer walls, before 1930



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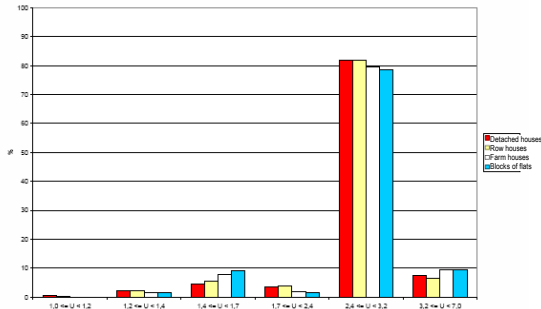
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## EM: Windows 1961-1972



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## Building models



- Model for average buildings
- Estimation of heat losses through the thermal envelope by using the P-factor method
  - The P-factor expresses the heat loss through the building construction in  $W/m^2K$ .
- Data from the labelling is used to provide an overview over the P-factors

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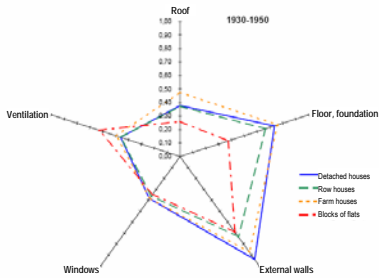
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## 1931 - 1950



P-factor for dwellings 1931-50. External walls cause the largest heat loss per  $m^2$  heated floor.

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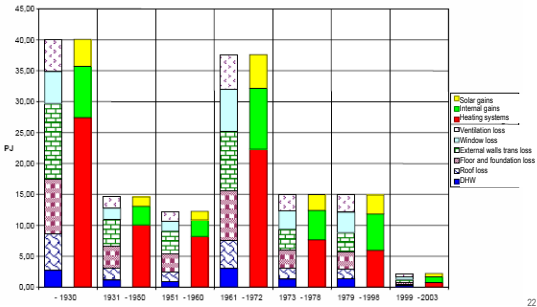
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## Energy balance for single family houses



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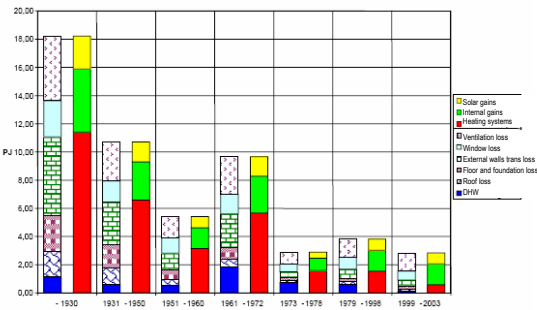
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## Energy balance for blocks of flats



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## Assumptions



- 50 % of all external walls and floors with U-values of 1.0 W/m<sup>2</sup>K and above can be improved to a U-value of 0.45 W/m<sup>2</sup>K
- 50 % of all roofs with U-values of 1.0 W/m<sup>2</sup>K can be improved to a U-value of 0.35 W/m<sup>2</sup>K
- All windows can be replaced with windows of today's standard corresponding to an average U-value of 1.6 W/m<sup>2</sup>K
- All U-values of the improved U-values is the average U-value taking into account thermal bridges

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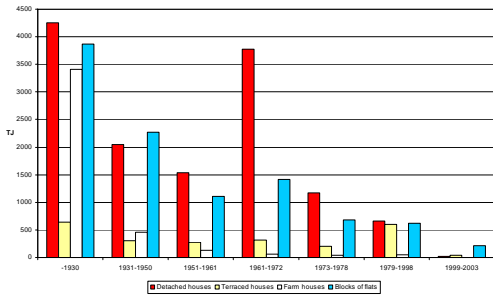
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## Energy saving potential in TJ



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## Energy saving potentials



- One third of heating consumption in dwellings can be saved
- More than 30 PJ ( $30 \cdot 10^{15}$  Joule) per year can be saved in DK corresponding to 830 million litres of oil
- It is a conservative estimate, but on the safe side!

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## Minimum set of information to be recorded



### Building

- Built-up area and heated floor area, number of floors
- Construction year and year of major renovations
- Location of the building (climate zone)
- Recorded energy and water consumption (for comparison with calculations)

### Thermal envelope

- Type, area and U-value for each opaque construction type
- Area, U-value and solar energy transmission factors for each transparent element incl. any shading objects
- Thermal bridges (length/size, transmission coefficient)
- Thermal storage capacity of the building

### Systems

- Primary and secondary heating system (incl. efficiencies and location)
- Ventilation system including an estimate of the natural or mechanical ventilation rate
- Cooling system (incl. efficiencies and location)
- Heating and cooling distribution systems (pipe length, insulation level, location)
- Domestic hot water production (incl. location and distribution)

### Default values

- Internal loads (persons, equipment, lighting, etc)
- Domestic hot water consumption (based on persons and/or floor area)

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There are many variations on the form of the certificates....



But, despite the differences, we can all "read" the same type of message in any of the certificates...

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Labelling scale for none-residential  
kWh/m<sup>2</sup> year, A is the heated floor area



- $A < 70 + 1600/A$
- $B < 95 + 2200/A$
- $C < 135 + 3200/A$
- $D < 175 + 4200/A$
- $E < 215 + 5200/A$
- $F < 265 + 6500/A$
- $G > 265 + 6500/A$

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Inspections of boilers  
and air-conditioning systems



- Many MS have organised an inspection system following one of the two main approaches based on available experience:
  - Like proof of regular maintenance and random on-site check
  - Like regular inspection performed by, e.g. chimney-sweeps, normally in charge of safety checks
- Other MS have implemented or intend to organise information, promotion and information campaigns to accelerate the replacement of old boilers or to improve servicing
- There are yet no consensual methods to assess the equivalence of the effects of inspections and information campaigns



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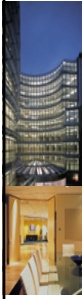
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## Concerted Action - objectives



- To enhance and structure the sharing of information and experience from national implementation
- To promote good practice concepts in activities required of Member States for implementation of the EPBD
- To create favourable conditions for an accelerated degree of convergence of national procedures
- To complement the work of the Energy Demand Committee (Article 14 of the EPBD) and its ad-hoc group on CEN standards and Certification

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## Concerted Action 2 - objectives



Work focuses on a series of specific, objective issues arranged in 5 core themes:

- Certification procedures
- Inspection of boilers and air-conditioning systems
- Specifications and training requirements for experts and inspectors
- Methods for procedural aspects for energy performance
- Information campaigns

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## Recommendations



- Need for MS to introduce national or regional definition of very low energy buildings in their building regulation
- MS to develop a national strategy towards this level of energy performance to become the standard
- Need for MS also to develop a strategy for existing buildings
- Important that the European Commission initiate actions to follow the ambition in the EU Action plan – to develop an EU strategy towards very low-energy houses
- Current recast of the EPBD is a “golden opportunity” to introduce requirements to MS to define very low energy buildings and national strategies towards this level of energy performance

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[www.BoligPlus.org](http://www.BoligPlus.org)



BOLIG+ is about energy neutral housing units of high architectural standard with a significant reduction of CO<sub>2</sub> emissions

BOLIG+ concept was initiated at the Danish Energy Camp 2005, where some representatives from the building sector got 36 hours to solve the job:

*How can we develop energy efficient houses to the growing population in the world?*

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## BOLIG+ concept



1. Energy neutral on a yearly basis, including electricity for domestic low energy appliances and operation
2. An intelligent and user-friendly house
3. Flexible in daily use and over time
4. A house with a good and healthy quality indoor climate
5. Of high architectural quality and adapted to the local context

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### Goals for amending the EPBD in 2009

- Mandatory targets for minimum energy efficiency requirements in all MS
- Advancing towards what today is "passive housing" (or A, A+) standard (i.e. at least 50% better than today's minimum requirements)
- Lowering the threshold of applicability of energy requirements in major renovations below 1000 m<sup>2</sup>
- Imposing mandatory monitoring of results at MS level and common reporting formats to the European Commission
- Financial support schemes clearly desirable
- Information and awareness campaigns are essential

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## Main gaps of the EPBD



- Promotion of passive solutions is seen as lacking in the EPBD. *Building regulations promoting better summer design and prevention of overheating may have a more important potential for producing energy savings than inspections of small air-conditioners of doubtful cost-effectiveness*
- New requirements set up by MS, especially for major renovations, often cause significant difficulties to building owners. *Financial support schemes clearly desirable*
- *Information and awareness campaigns are essential and they should be addressed in a more systematic way*

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## Monitoring impact of the EPBD



- MS agree that monitoring the EPBD creates a lot of valuable information about the energy quality of national building stocks. This information is most valuable for governments and for commercial parties as well
- It is fundamental to determine the energy savings resulting from the EPBD
- “The added value of the certificate” must be clear to the building users
- MS must make use of the information in the certificate to stimulate energy savings in buildings

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## Danish status on EPBD implementation



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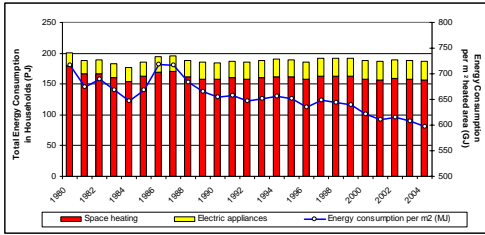
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## Energy Consumption



Total energy consumption in households and consumption per m<sup>2</sup> heated space in Denmark  
Climate adjusted



Based on Energy Statistics 2003 (Danish Energy Authority, 2004)

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## New energy requirements for new buildings



- New energy requirements for new buildings in relation to EPBD (Article 5) in Addenda to existing Danish Building Regulations
- New energy requirements issued 16 June 2005
- Requirements came into force 1 January 2006 with a transposition period of 3 months until 1 April 2006 when the new requirements must be complied with to obtain a building permit

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## Energy savings for new buildings



- The new energy requirements are not only an implementation of EPBD
- The new energy requirements also impose stricter energy performance in buildings according to current Danish action plans to save 25 % energy in new buildings (compared with new buildings, meeting requirements existing before 1 January 2006)

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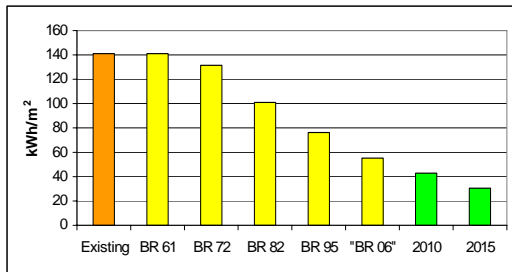
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## Net heating consumption in relation to Danish Building Regulations



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## Requirements for new buildings



- For buildings heated to at least 15 °C there is an energy frame requirement based on the energy supply needed for operating the building
- There is one frame for housing (not including lighting) and another for non-domestic buildings (including lighting)
  - In non-domestic buildings with high ventilation requirements, high lighting requirements, long hours of operation or large hot water demand, an addition is given to the basic energy frame

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## New buildings



- Energy frame for supplied energy
- Heating + 2.5 x Electricity + Excess temperature
- Requirement to the heat loss by transmission
- Minimum requirements to building parts and linear losses (foundations etc.)

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## The energy frame for dwellings, hotels, etc:



The limit for the amount of energy estimated to cover heating, hot water heating, ventilation and cooling is:

$$70 + 2200/A \quad \text{kWh/m}^2 \text{ pr. year,}$$

where A is the total heated area.

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## Low energy buildings



- Low energy buildings Class 2 have an energy demand of 75 % compared with the minimum requirement
- Low energy buildings Class 1 have an energy demand of 50 % compared with the minimum requirement
- The low energy building classes are also used to obtain exemption from obligatory connection to public natural gas or district heating networks

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## Supplementary requirements



The energy frame is supplemented with requirements for:

- U-values
- minimum boiler efficiency
- pipe insulation
- heat recovery
- fan power efficiency
- automatic control
- low temperature heating

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## Proof of compliance



- Compliance with the energy requirements must be verified after completion of the building to obtain a use permit
- Controlling compliance with regulations is the responsibility of local authorities
- In practice, compliance is controlled by the energy consultant who also issues the energy certificate

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## New requirements for existing buildings



- New requirements for renovation of existing buildings (Article 6) in Addenda to Danish Building Regulations
- In multi-family houses and non-domestic buildings, the 25 % rule (Preamble 13) in the EPBD is implemented in all buildings independent of floor area
- To comply with the requirements, all cost efficient energy saving measures must be taken

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## Concept of cost effectiveness



Cost effectiveness >1.33 :

$$\frac{\text{Value of annual saving} * \text{Lifetime}}{\text{Investment}}$$

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## Requirements to components



Cost efficient energy saving measures are required in all buildings for specific components in the case of:

- renovation of roof
- renovation of climate shield on external walls
- renovation or change of windows
- installation of a new boiler
- change of heat supply

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## Requirements to existing building in the Building Regulations



- If people do not implement cost effective energy saving measures by themselves, the new energy requirements in the Building Regulations will "help" them
- But no "Building permit" needed and no public control

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## Why do it - if no public control ??

(Beside the good sense of doing it)



- In many relations professionals need to follow the rules to avoid situations where they have to pay compensation - if sued afterwards
- In the case of rented dwellings, the tenant will probably keep the owner focused (because they have to pay the energy bill)

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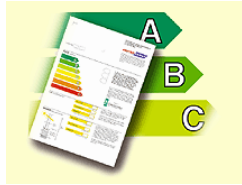
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## New Energy Certification in Denmark



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## Energy Certification from 2006

Based on use - not size of buildings

- Single family houses
  - at sale or renting
- Buildings with flats
  - combination of building and flats
  - large, regularly every 5 year – small, at sale or renting
- Public buildings – trade and services
  - regularly, every 5 year



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## Danish experience of certification

- Very difficult to estimate savings if based on metered values
  - Two consultants might get very different results +/- 70 %
  - Consultants might hesitate to propose savings
  - What is gained by metered consumption might be lost on adjustment and on advising
- Need for detailed and accurate handbooks for consultants
  - Inspection must be specified
  - Standard values for input
  - Typical or common used values must be given
  - Clear rules for inspection, but also for advising

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## Danish experience - 2



- Use standard calculation principles to ensure that reports are reproducible
- Very complex methods do not necessarily raise quality
- Effective software and database solutions are very important – preferably Internet on-line solutions

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## Energy certification scale



- There are 7 classes on the certification scale ranging from A to G, where A is the best
- New buildings must at least be certified as Class B to get a use permit.

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**Block of flats**

**Identification of building Date**

**Measured consumption**

**Energy label based on calculation**

**Energy label after improvements**

**Most important recommendations including possible savings, investments, prices in DKK and payback period**

Measure	Investment (DKK)	Annual Savings (DKK)	Payback Period (years)
1. Heating 3: Insulation of external walls	8.000	1.000	12.00
2. Heating 3: Insulation of roof	4.000	1.000	16.00
3. Heating 3: Insulation of external walls	9.000	2.000	18.00

Contd.

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# Handbook for energy consultants



Daily guide for energy consultants

- Base for quality assessment
- Guide for assessment of building etc.
- Guide for calculation
- Guide for advising on savings
- Guide for filling in energy labels
- Guide for reporting / procedures etc.




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Bilag 9 - U-værdier for vinduer inkl. karm og kulfæstningstype

U-værdi (W/m²K)	4-lags glas	2-lags glas	Termovis	3-lags termovis	2-lags termovis	2-lags termovis	2-lags termovis
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2

U-værdi (W/m²K)	4-lags glas	2-lags glas	Termovis	3-lags termovis	2-lags termovis	2-lags termovis	2-lags termovis
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2

Typical windows

U-værdi (W/m²K)	4-lags glas	2-lags glas	Termovis	3-lags termovis	2-lags termovis	2-lags termovis	2-lags termovis
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2
U-værdi	1,0	1,2	1,4	1,6	1,8	2,0	2,2

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# Energy saving measures



The energy consultant must identify two types of energy saving measures:

- Energy saving measures that can be executed immediately
- Energy saving measures that are only feasible if carried out as a supplement to a renovation procedure

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## Future energy saving in buildings



- Danish government has had ongoing plans for energy savings for many years
- According to plans further energy saving must be achieved in new building by 2010, 2015 and 2020. The target is additional 25 %, 50 % and 75 % savings
- The aim is to achieve further savings in existing buildings

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