



## Examples of Sustainable buildings and renovation projects from Greenland to Denmark

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## Sustainable Buildings and Renovation Projects from Denmark and Greenland

Carsten Rode  
Assoc. Prof., Head of Section for Building Physics and Services  
DTU – Department of Civil Engineering

Workshop on *Energy Self-sufficient and Sustainable Buildings*  
Brno University of Technology  
April 6, 2009

DTU Byg  
Institut for Byggeri og Anlæg

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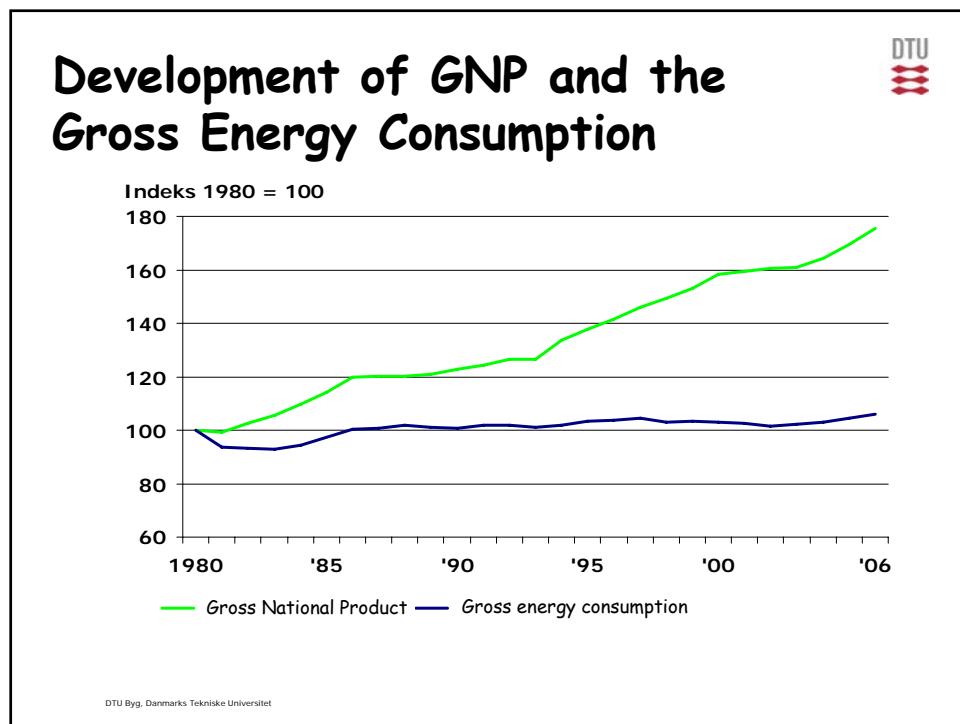
### Drivers for EU policy within energy

- Security of supply
- Sustainability
- Competitiveness

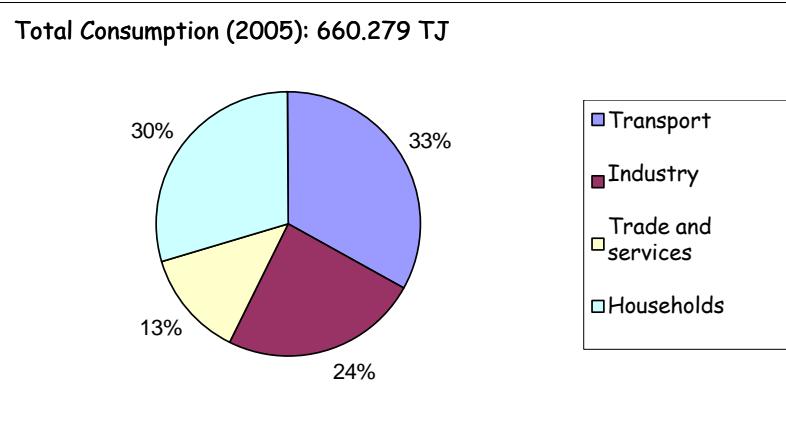
Variations of the Earth's surface temperature for...  
Departures in temperature in °C (from the 1961-1990 average)

the past 140 years (global)

Direct temperatures



## Distribution of the Energy Consumption - Denmark



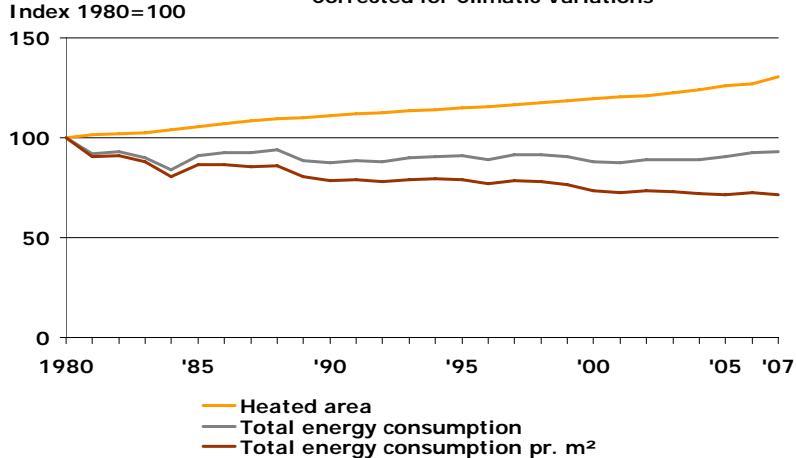
Household heating constitutes 27% of total energy consumption  
Buildings in total: Approximately 40%

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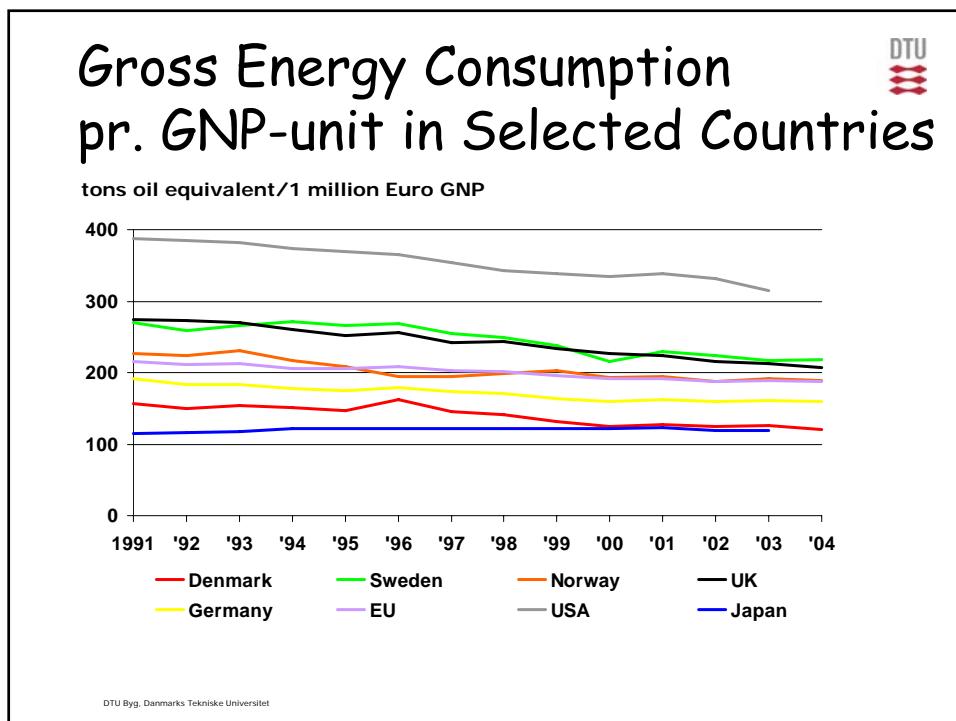
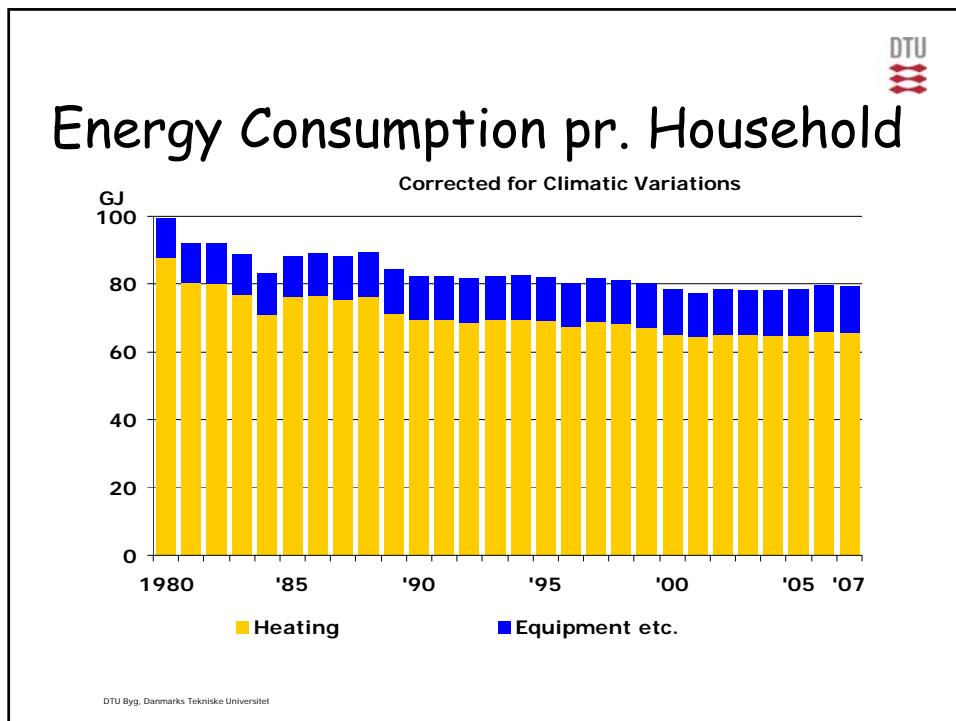


## Energy Consumption for Heating of Dwellings

Corrected for Climatic Variations



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## Energy use within EU

- 33%
  - of all energy in EU is used for **transport**
- 26%
  - of all energy in EU is used by **industry**
- 41%
  - of all energy in EU is used by **buildings**
  - 66% is used for heating and cooling.
  - 80% of energy consumption is used in small buildings < 1000 m<sup>2</sup>

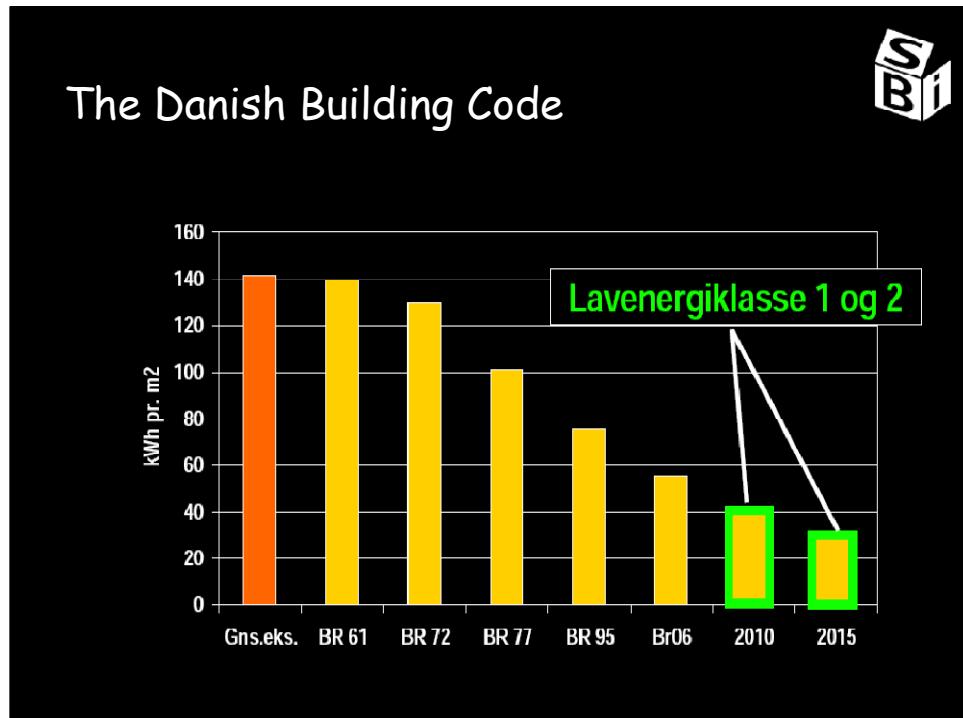
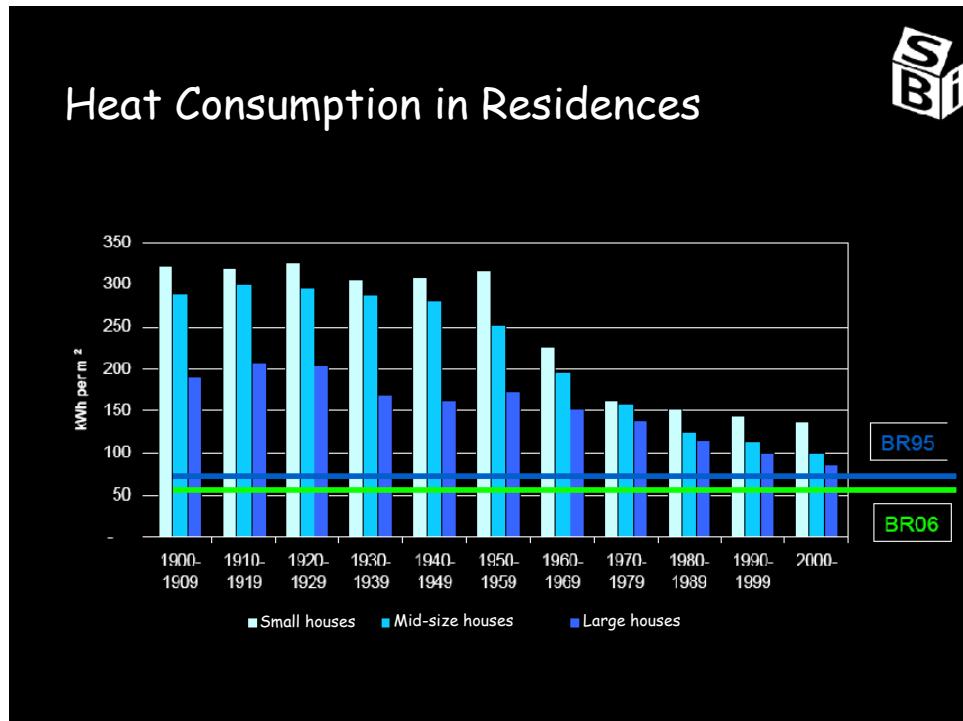
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## Energy Efficiency – First and Foremost

- Can be implemented immediately and with economic benefit
- Less heat consumption enhances security of supply
- Less electricity consumption reduces the need for new power plants
- Low energy construction suits wind power

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## Danish Dwellings

- Old houses:  $150\text{--}600 \text{ kWh}/(\text{m}^2 \cdot \text{yr})$
- BR 2006, Energy frame:  $(70 + 2200/\text{Area}) \text{ kWh}/(\text{m}^2 \cdot \text{yr})$
- BR 2010, Class 2:  $(50 + 1600/\text{Area}) \text{ kWh}/(\text{m}^2 \cdot \text{yr})$
- BR 2015, Class 1:  $(35 + 1100/\text{Area}) \text{ kWh}/(\text{m}^2 \cdot \text{yr})$
- BR 2020, Passive house: ("No heating system")

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## Danish demands - before, now, and in future

- 1979: Demands on amount of insulation  
- 75 % of building stock is from before 1979
- 2006: Energy frame
- 2010, 2015 og 2020: Tighter demands on energy
- Future:  $\text{CO}_2$  frames?

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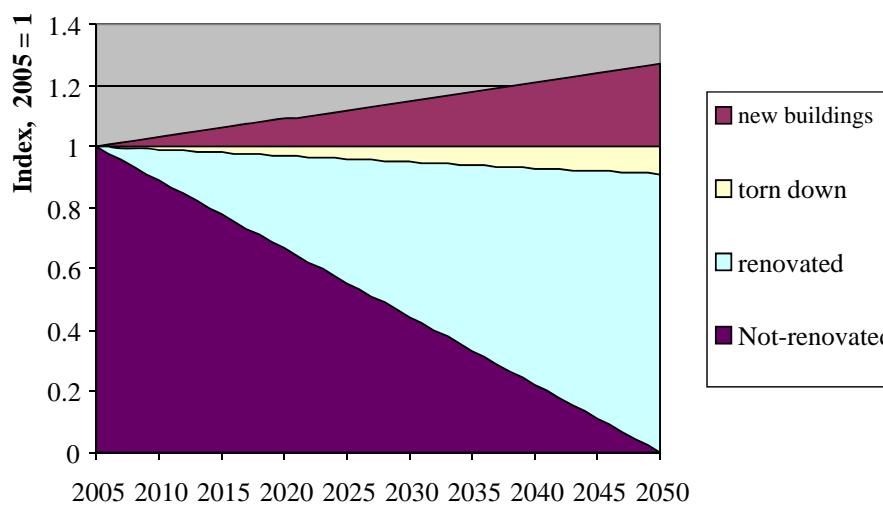


## Other European countries also do well...

- Ambitions are also strong in Germany, Austria, the UK ...
  - 8000 passive houses in Europe built with a good result



## Development of the Building Stock in Denmark



## Energy Renovation is More Important than Demands on New Buildings



- Building statistics shows:
  - New buildings do not replace existing buildings, but rather they come as an addition to the already built-up area



Præsentation 10.01.2008

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## Energy vs. CO<sub>2</sub>-emission



Energy form	CO <sub>2</sub> (kg/GJ)
Kul	95
Olie	74
Gas	59
District heating	Bio/co-generation/waste incineration
Electricity	District heating/ wind/nuclear

Thomas Herzog: *We are not running out of energy, we are running out of atmosphere*

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## DTU Climate Center

- Strengthen cross-going climate research at DTU
- 25 mio. kr. 2009-2011
- Lead by Risø DTU
- Contribution from 15 other DTU institutes
- DTU Byg: 1 Ph.D. and one senior researcher
  - Buildings as part of the energy system  
*houses are not islands*

**Background:**  
**COP15 - Climate Change Conference,**  
**Copenhagen Dec. 2009**

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## Huses are not Islands

- **Energy system**
  - **Low temperature district heating (now)**
    - New technologies
    - New rules
    - Coupling to process heating
    - Coupling to local renewable energy production
  - **Local storage of energy (to come)**
    - Electrical cars
    - Fuel cells
- **Transportation**
  - Location of companies
  - The traffic system



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# New DTU Guest Residences



GÆSTEBOLIGER VED DTU // LYNGBY // DANMARK

PERSPEKTIV FRA NORD-ØST

Det overordnede energistrategiske mål med projektet er, at gæsteboligerne opføres som nulenergihue i forhold til bygningsdrift og samtidig opfylder kravene til Lavenergiklasse 1 i henhold til bygningsreglementet. Husene er derfor designet med mindst muligt energiforbrug til rum-opvarmning, ventilation og varmt brugsvand samtidig med, at der er fokus på energirigtigt valg af kunstlys, elektriske apparater og udstyr, således at det samlede elforbrug ligeledes begrænses til et minimum.



## Research Needs 1

E2B JTI

- A more **efficient envelope**:
  - Improved materials
  - Bioclimatic architecture
  - Improved design, new concepts
  
- Better **equipment and systems**:
  - Efficient HVAC equipment
  - Electric appliances
  - Improved monitoring
  - Stronger systemic approach



## Research Needs 2

E2B JTI

- Stronger integration of **renewable energies**
  - SolarPV
  - Solarthermal
  - Windturbines
  - Biomass
  - Geothermal
- Change collective and individual **behavior**
  - By harmonized EU regulations
  - Promotion of EE by public sector
  - Disseminate global costing, think long-term
  - Improve individual behavior

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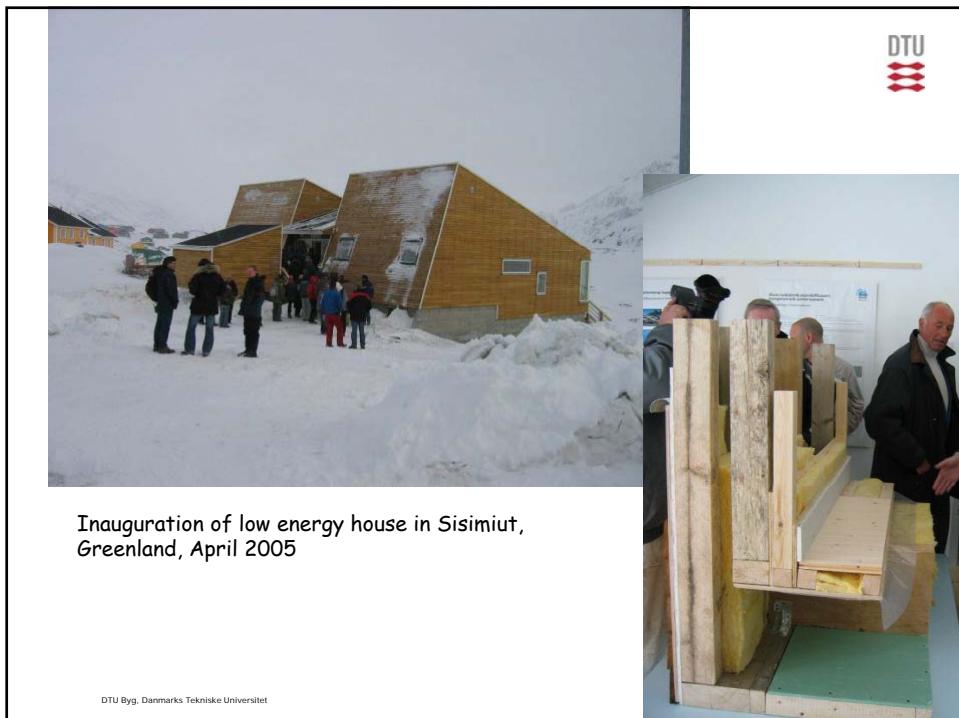
## Experimental Building 0-energy House 1973



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## Demonstration Buildings: Low Energy Houses class 1 or Better

6 low energy houses built in 1979 in Lyngby with energy consumption for heating and hot water of 5000 kWh



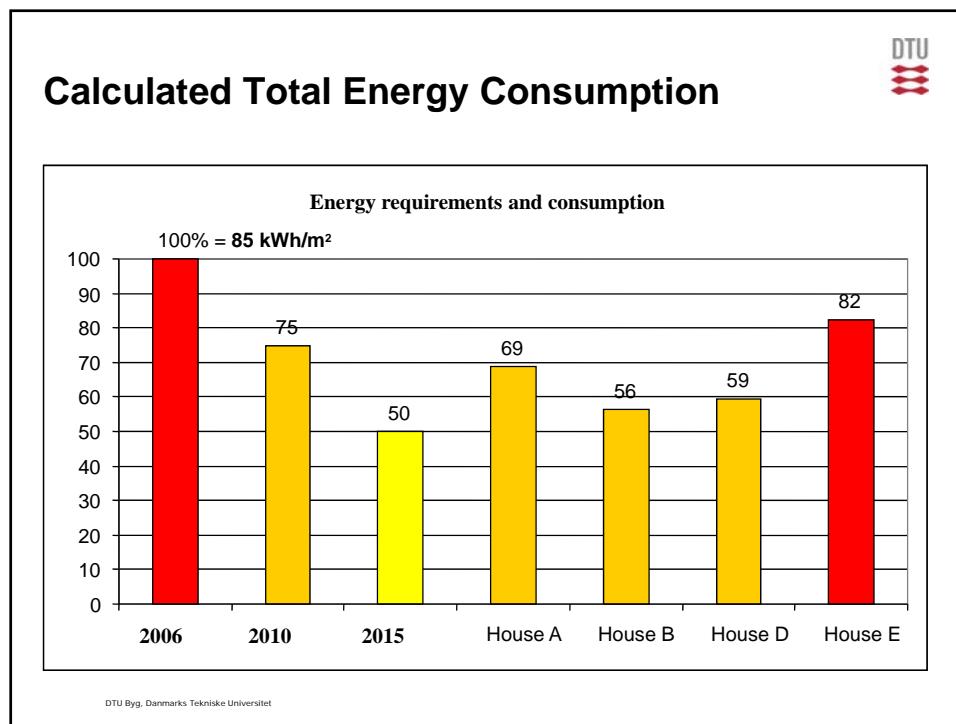
Inauguration of low energy house in Sisimiut,  
Greenland, April 2005

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### Type Houses Developed, Built and Measured

House	Location	Gross floor area [m <sup>2</sup> ]	House type
A	Snekkersten	135	Detached, 1-storey
B	Lemvig	145	Detached, 1-storey
C	Hillerød	153	Detached, 1½-storey
D	Thyholm	88	Row house, 1-storey
E	Brøndby	133	Detached, 1-storey

## Examples: Renovation of Lundebjerg in Ballerup



- Brick buildings from the 60's with cold bridges in the outer wall
- Mould
- External renovation with new facade insulation system, new windows. In addition: A new ventilation system with heat recovery



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**Energy  
renovation**

**New windows:**



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**Examples:  
Renovation of Lundebjerg in Ballerup**

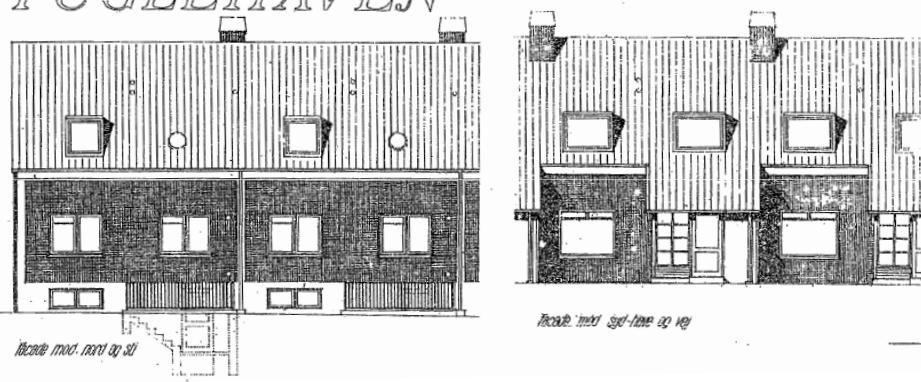
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Energy situation	Heat consumption, kWh/m <sup>2</sup>
Initial	<b>80</b>
Energy renovated	<b>46</b>
Energy renovated with heat recovery on ventilation air	<b>19</b>



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**FUGLEHAVEN**



- How to energy renovate best possibly and cheapest?
  - Insulation
  - Heat supply
  - Comfort, indoor climate
  - Architectural considerations
  - Rules and regulations
  - Common solutions vs. individually owned

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**Landskrona, Sweden**

**Passive houses med heating consumption 15 kWh/m<sup>2</sup>**

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Byggår 2004

Byggherre:  
Landskronahem

Entreprenör:  
Skanska

Projektledning:  
Prime Project AB

Arkitekt: Mernsten  
Arkitektkontor AB

35 lägenheter

Hyresrätter; hyra ca 930 kr/m<sup>2</sup>år



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**Landskrona**

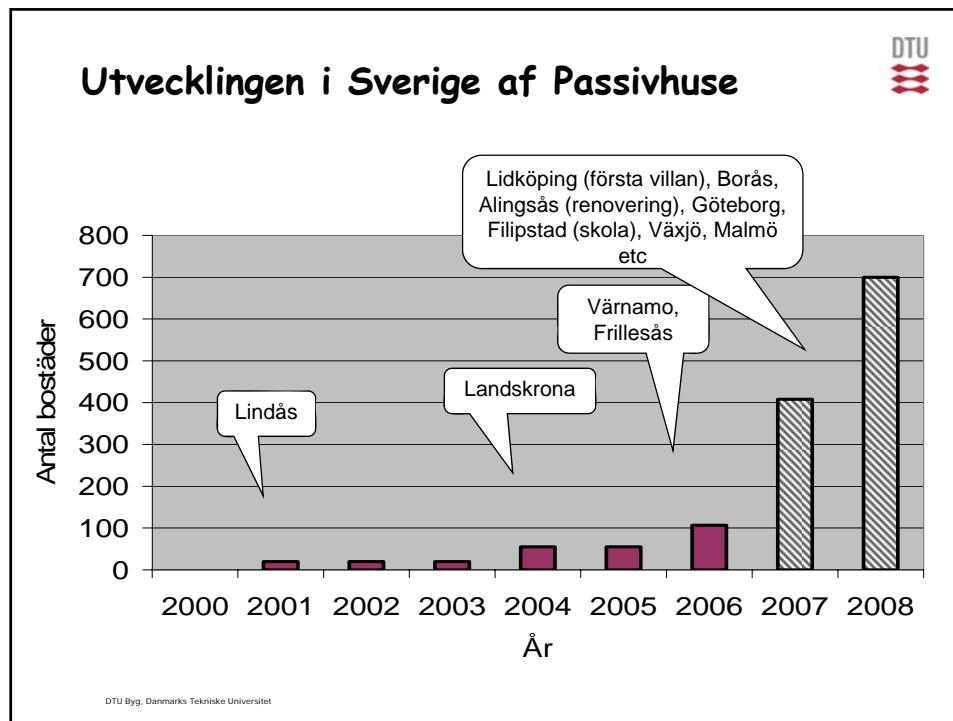
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Energieffektiva bostäder  
Välisolerat klimatskal  
Lufttät konstruktion  
Mekanisk FTX > 80% återvinning  
Luftvärme (el) 900 W/lgh  
Varmvatten eluppvärmt  
- Ekonomi i fokus!

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**Danish/Nordic Passive Houses**

- [Click...](#)
- What about Arctic...?

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# LavEByg



## Hvad er LavEByg:

- "Højtekn. netværk: Integrerede lavenergiløsninger på bygningsområdet"
- Støttes økonomisk af Forsknings- og Innovationsstyrelsen under MVTU

## Hvem er LavEByg:

- BYG-DTU, DTU-MEK (ICIEE), AAU, SBi-AAU og TI
- Byggevareproducenter, rådgivende ingeniører, arkitekter, udførende, brancheorganisationer, andre faglige netværk, offentlige myndigheder

## Hvad er LavEByg's formål:

- Skabe varige samarbejdsrelationer mellem virksomheder og institutioner
- Udvikle konkrete fælles samarbejdsprojekter ml. virksomheder og instit.
- Øge anvendelsen af forskningsbaseret viden i byggeriet
- Erstatte en erfarings- og anvisningsbaseret byggebranche med en forsknings- og videnbaseret byggebranche
- ..og derved bidrage til at det store potentiale for energibesparelser ved nybyggeri og renovering realiseres

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# LavEByg



- LavEByg's overordnede aktiviteter:
  - Strategiudvikling
  - Matchmaking
  - Virksomhedsrettede ydelser
  - Formidling
- Fokus i 2008-09 er på Energirenovering af eksisterende bygninger (til lavenerginiveau)

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# LavEByg



- Netværket er åbent for nye deltagere, der ønsker at deltage aktivt i udviklingen af integrerede lavenergiløsninger - og særligt i relation til renovering !
- Yderligere information:
  - Svend Svendsen / Henrik Tommerup, BYG.DTU
  - LavE-BYG-netværkets hjemmeside:  
[www.lavebyg.dk](http://www.lavebyg.dk)

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**Report shows:**  
There are considerable energy savings to achieve in public sector buildings.

Energy savings can be realized economically by stating more strict requirements in rules and regulations.

Based on analyses it is estimated that the energy savings potential is 15,9 PJ/yr (of which electricity: 3,7 PJ/yr) corresponding to 74 % savings compared to 2006.

Investment needs to make this before 2020 are 0,35 billion €/yr. The savings in energy consumption are 0.45 billion €/yr.

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**BYG•DTU**

Henrik Tommerup  
Energirenovering af typisk parcelhus  
opført i perioden 1960-1980  
Def 2: Målinger



DANMARKS TEKNIKSE UNIVERSITET

**Energy renovation of typical residence from 1960-1980**

Rapport BYG•DTU R-166  
2007  
DSTU-A004-2007  
2007-01-17/1777848

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**Measurements of energy consumption and indoor climate in a typical detached dwelling from the 1960/70's, which has been thoroughly energy renovated, shows that big energy savings can be achieved, and at the same time the indoor climate improved.**

This is accomplished without compromising the architectural qualities.

For the specific house, an energy saving of 65 % was reached.

The potential for larger energy savings in Danish detached houses is considerable, since 45 % or appr. 500.000 of all 1,1 mio. Danish houses are from the 1960/70's.

Presentation

Energirenovering af murermesterhus

Henrik Tommerup



Department of Civil Engineering  
DTU-Bypgård 118  
2800 Kgs. Lyngby  
<http://www.bypg.dtu.dk>

2004

**The energy saving measures are :**

- Insulation of cavity walls (blowing in of appr. 80 mm insulation).
- Insulation of walls below windows/behind radiators (75 mm).
- New extra window panes with energy (low-emission) glazing.
- Insulation of small attic (250 mm).
- Insulation of sloped wall (75 mm).
- Insulation of big attic (300 mm).
- Partially new radiators and thermostatic valves.

**The renovation does not change the appearance of the house**

**Calculations:**  
The proposed renovations will reduce the design heat loss from 93 W/m<sup>2</sup> to 44 W/m<sup>2</sup>, corresponding to 53 % reduction.

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Also other expertises should be involved ...

- Solar heating
- Building physics
- Building materials
- Building design and Architectural Engineering

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Contact:  
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BYG • DTU  
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