HOW BUILDING REGULATIONS IGNORE THE USE OF BUILDINGS, WHAT THAT MEANS FOR ENERGY CONSUMPTION AND WHAT TO DO ABOUT IT?

GRAM-HANSSEN, GEORG, CHRISTIANSEN AND HEISELBERG

ECEEE 2017

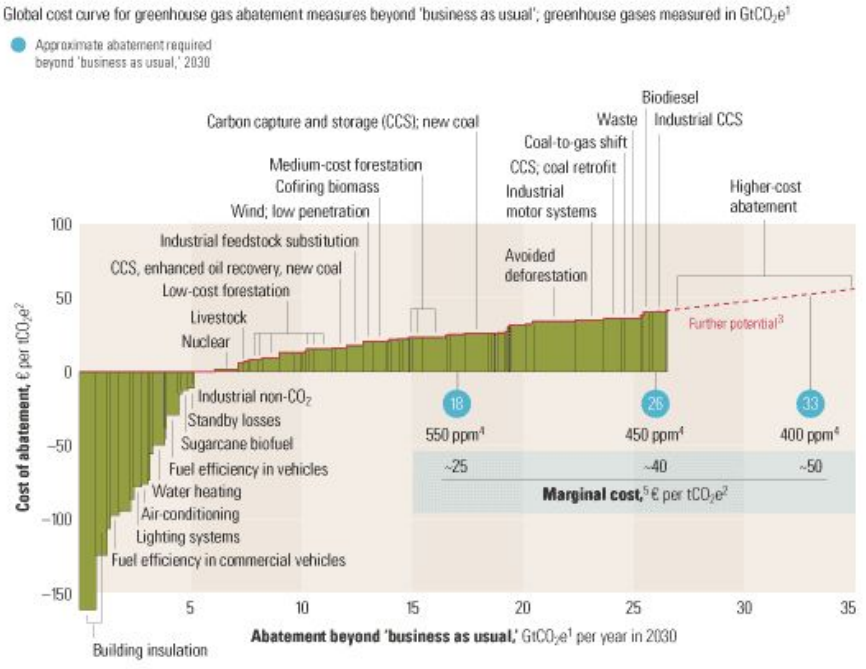
DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

What we want to say….

- Question if buildings are the most easy and cost-effective approach to reduce GHG emissions?
- Energy efficient buildings and technologies influence practices – the wrong direction
- How can this knowledge be used in building regulations?

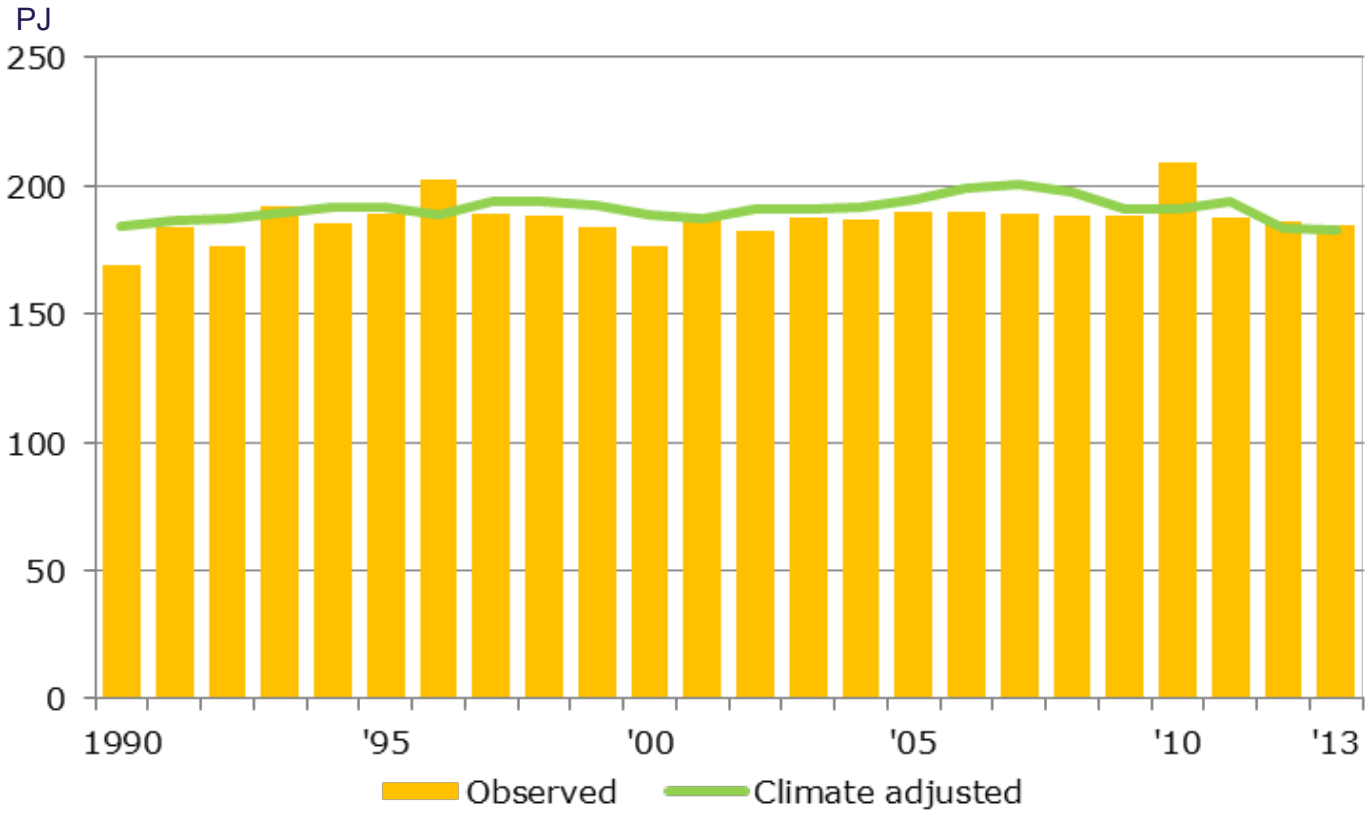
Buildings as a main target for reducing GHG emissions?

- Buildings use about 40% of global energy
- McKinsey's "global GHG abatement cost curve" says building are the most cost-effective approach to reduce GHG
- Widely adopted in EU and national policies



[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

Energy consumption in households in Denmark….
…not much is happening

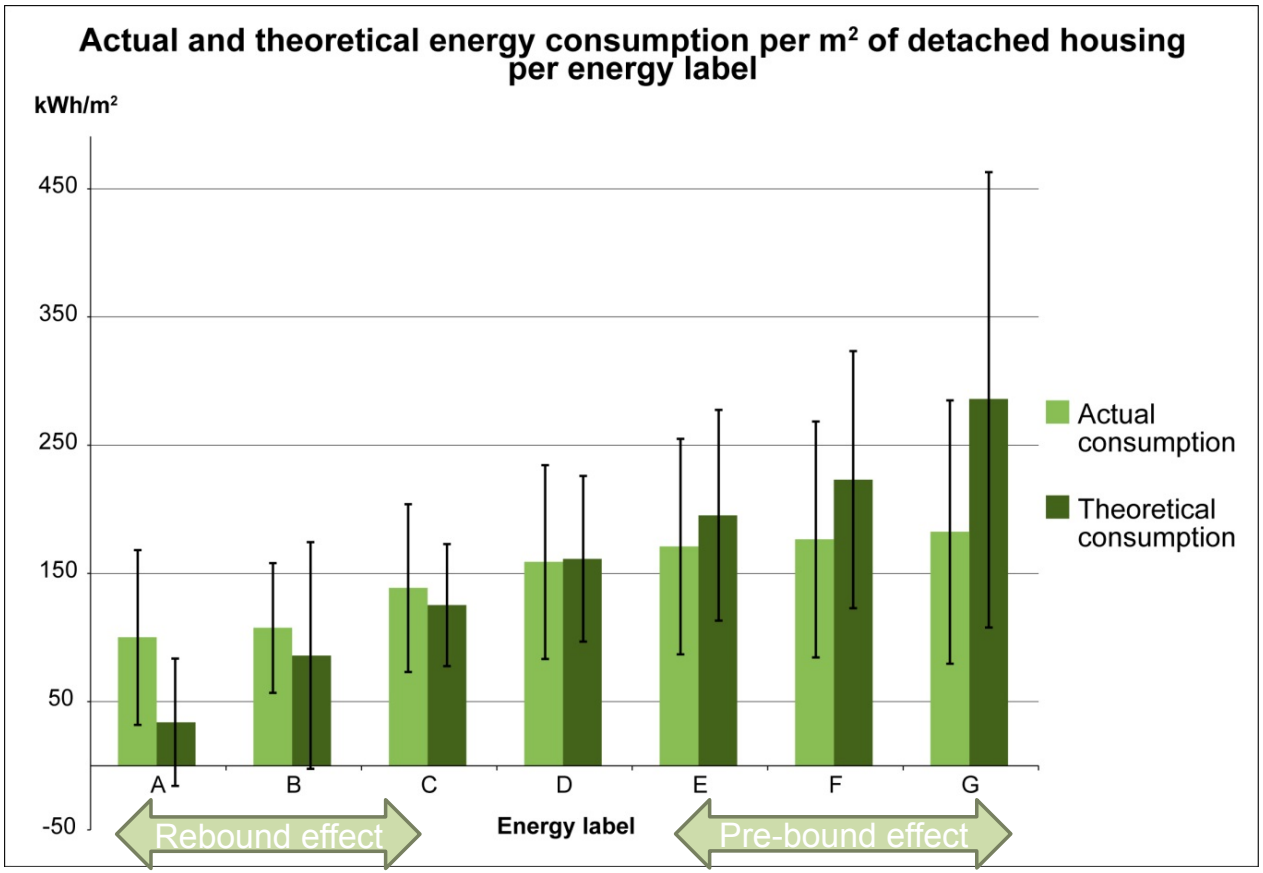


Energy statistics, Danish Energy Agency, 2013

Building regulations and energy efficiency

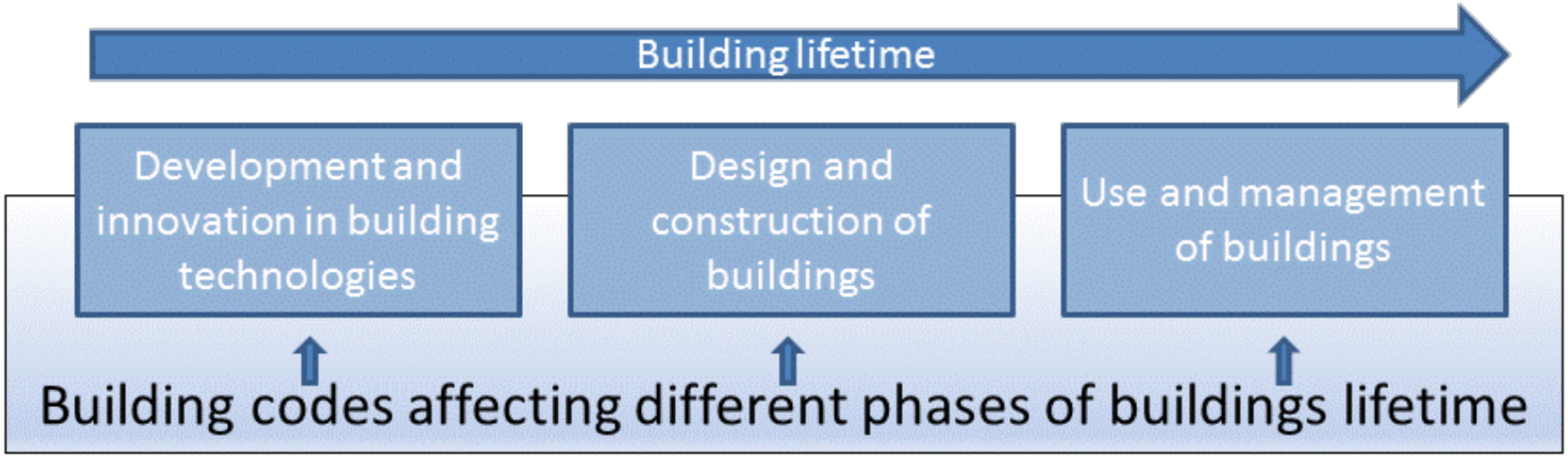
- Theoretical calculations for new build and labels
- Standard assumptions of ventilation and indoor temperature
- Evaluate buildings independent of their use
- Still tighter requirements for new build announced a head
- Market mechanisms to develop more efficient products, new build and retrofitting
- “Low-Energy” labels for new build ahead of regulations

Efficient homes versus efficient practices….



Based on 230.200 detached Danish houses with an energy label. (Gram-Hansen and Hansen, 2016)

What happens when user interaction with materiality is forgotten in building regulations in different phases of buildings life?



(Gram-Hanssen, Georg, Christiansen Heiselberg, forthcoming)

Development and innovation in building technologies

What products are developed and what happens in use:

- Sun shading - but if used during winter?
- Mechanical ventilation with heat recovery – but if still opening windows?
- Low-temperature underfloor heating, but if heating to have warm feet?

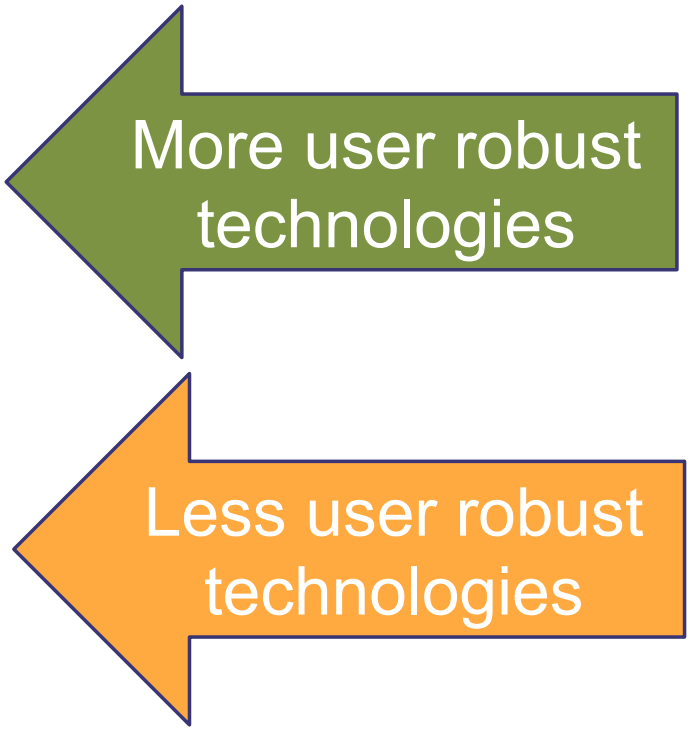
Continued development towards Near Zero Energy Buildings

Traditional technologies:

- Envelope insulation
- Building airtightness
- Ventilation with heat recovery

New technologies:

- Demand controlled ventilation
- Solar shading to control overheating and daylight
- Control of window opening



If user interaction were included other technologies might be preferred and developed

Design of buildings

The design process

- Focus on compliance with the building regulation
- Energy requirements part of the client's specifications?
- The use of the building only superficially included

Construction of buildings

- Little contact across the ‘value chain’
  - Sub-optimization within teams
  - Poor quality control and simple mistakes
  - Design specifications don’t ‘fit’

Use and management of buildings

Building regulations say:

- Measured and payed individually
- Informative bills
- Possibility of regulating rooms independent of each other

What is on the agenda

- Smart meters and feedback
- Smart homes
- Indoor climate measurement

Use and management: What should be on the agenda?

- The interaction between different building technologies (e.g. thermostats and sun shading)
- The usability of technologies and interfaces
- How buildings and technologies “guide” the users
- Avoid technologies which indirectly guide users the wrong way

Example: Floor heating guides another type of comfort

- New buildings have floor heating
- Imply changing practice of heating
  - Difficult/slow to regulate
  - Regulating less
  - Equal heating in all rooms
  - Heats more rooms
  - Nice warm feet, but low-energy homes do not need all this heat

Technology guides user to have higher temperatures in new vs old houses

Based on survey questionnaire and qualitative interviews.

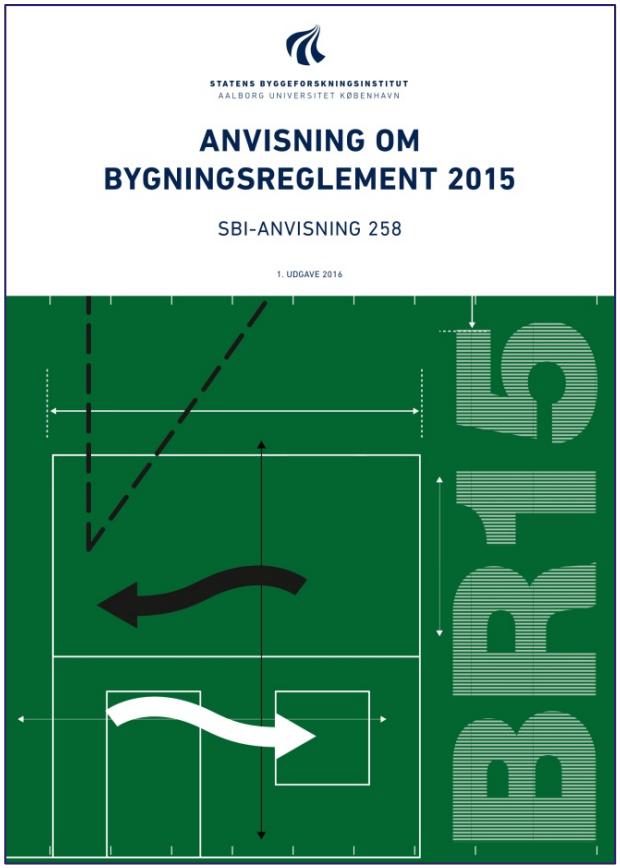
(Madsen, forthcoming)
(Hansen et al; forthcoming)

Concluding on building regulations

BR has so far delivered

- Energy efficient innovation in buildings and technologies
- Buildings which consume less
- Buildings with higher and more uniform indoor temperatures

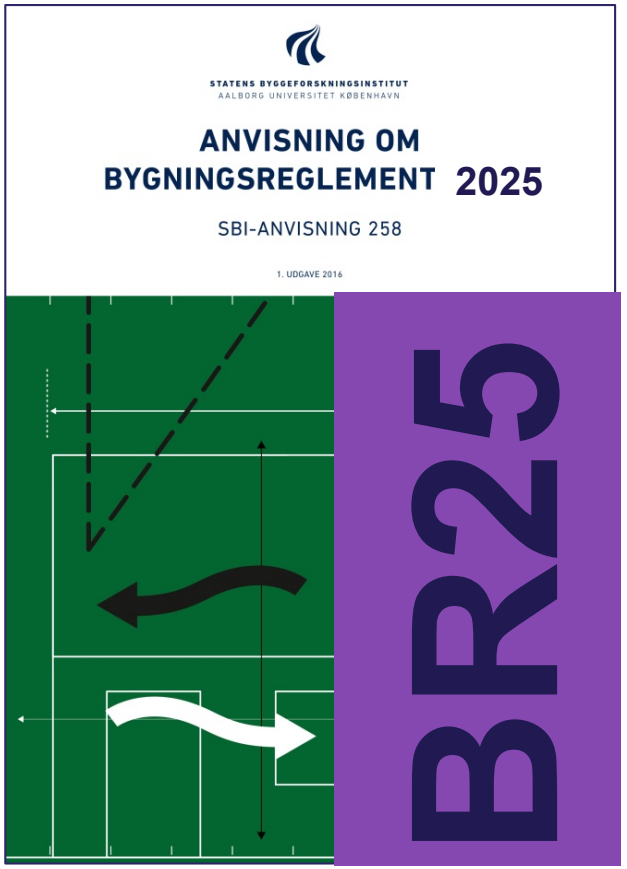
Continuous tightening along the same line might force a development which do not deliver further reductions and is expansive



Advising for future building regulations

- Energy modeling which include user behavior (e.g. rebound estimates) might be relevant for some purposes

- Supplement pre-construction theoretical calculations by post-occupancy measurements and commissioning plans



Concluding…

- Is it realistic to say that buildings are the most cost effective approach to reduce GHG emissions?
- Better understandings of “rebound effects” and deal with them rather than ignoring or accepting them

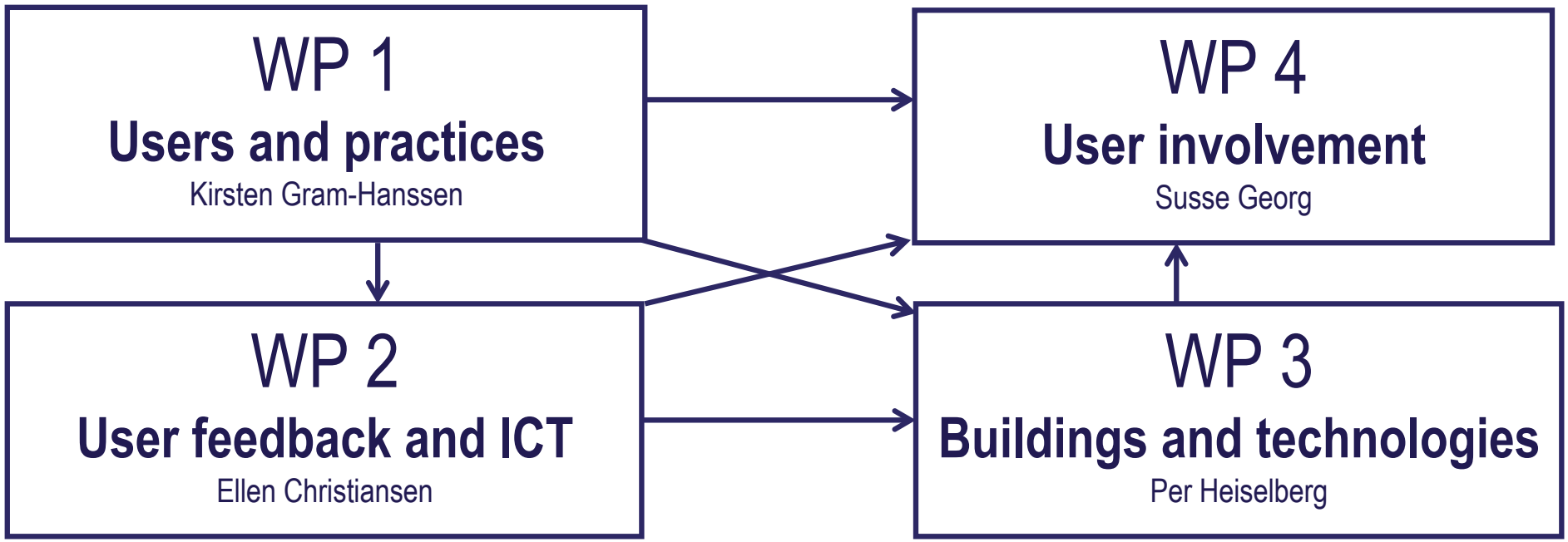
THANKS ☺

DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

UserTEC – User practices, technologies and residential energy consumption

2 DK and 4 international Universities + 12 Danish and International companies

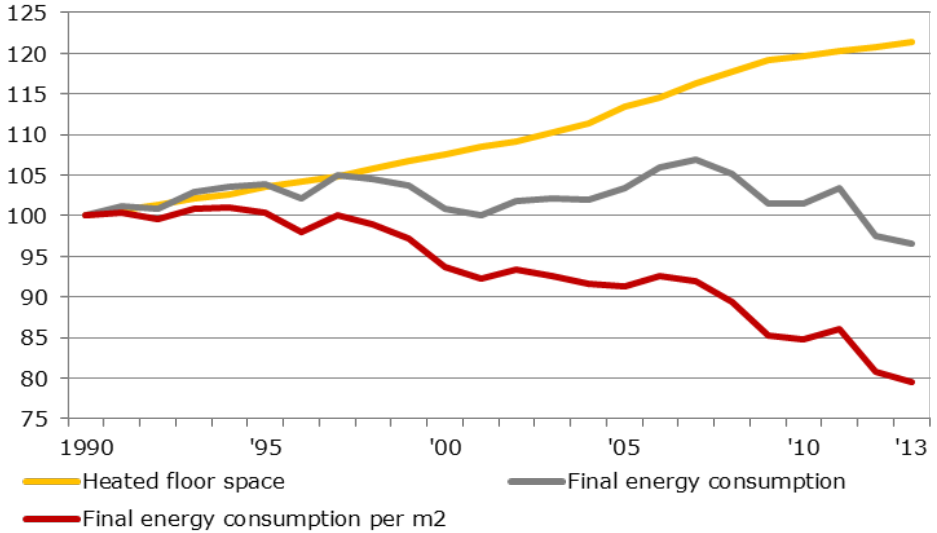
Supported by Innovation Fond Denmark with 2,3 mill euro



DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

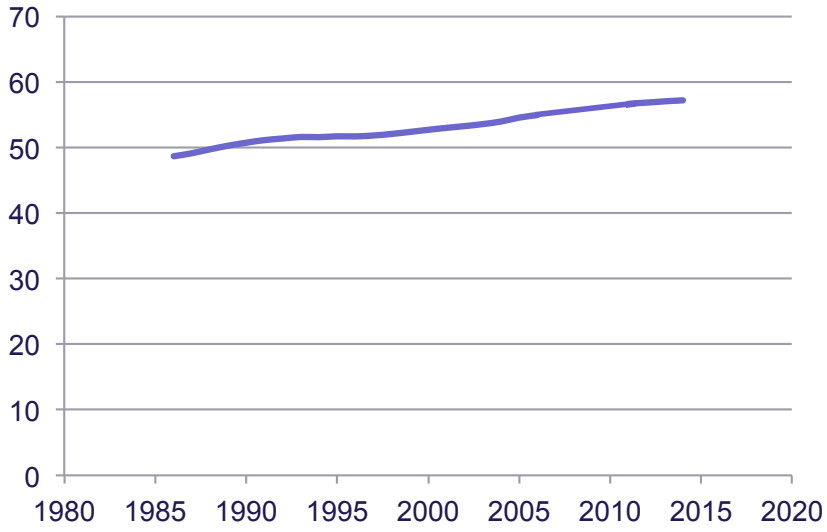
Energy efficiency and number of heated square meters

Index 1990=100



Energy statistics, Danish Energy Agency, 2013

Squaremeter per person



Statistics Denmark, 2013