



Modelling of heating sector in Denmark with focus on local externalities

Zvingilaite, Erika

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Zvingilaite, E. (Author). (2009). Modelling of heating sector in Denmark with focus on local externalities. Sound/Visual production (digital)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

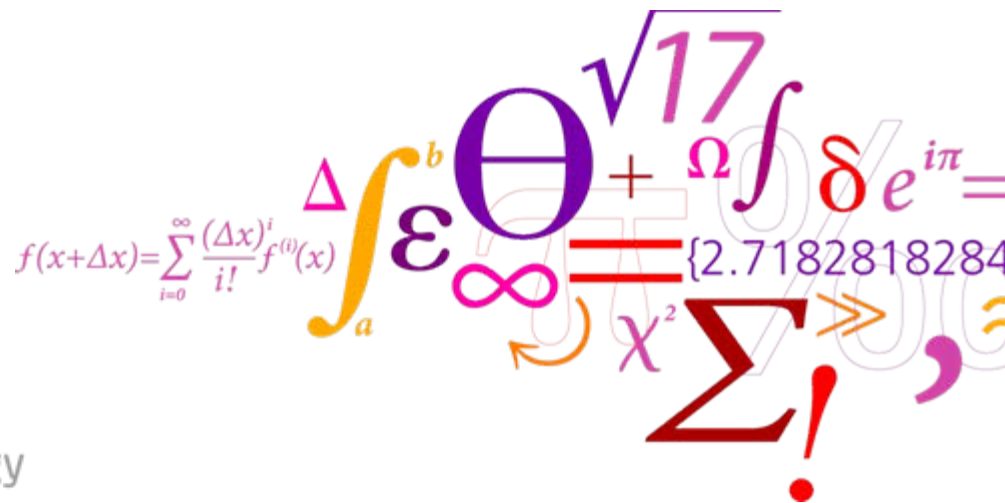
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Modelling of heating sector in Denmark with focus on local externalities

Erika Zvingilaite

PhD Student

System Analysis Division

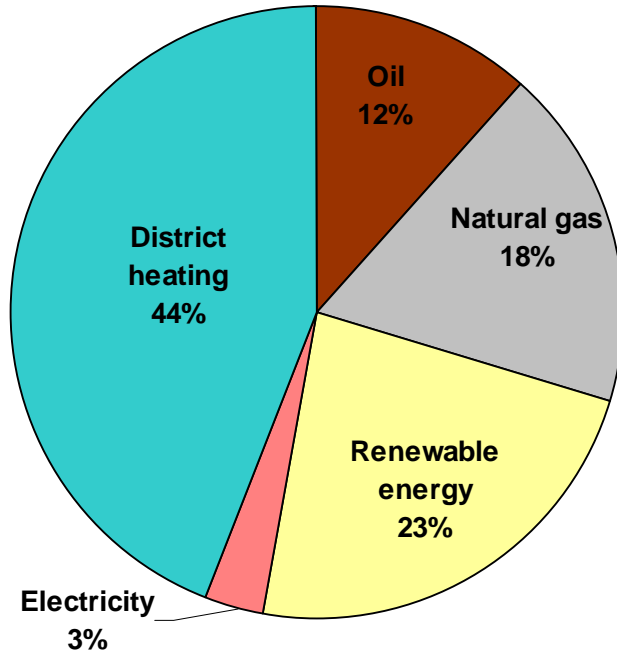


Introduction - motivation

- Reduction of energy use in general reduces pressure on environment and human health
- In heating sector demand side affects environment:
 - indirectly through district heating production (or el in case of el heating)
 - directly through individual heating technologies (DG)
- Often in energy system optimisation models focus is on technologies, that can reduce environmental impacts of the system
- Here I also included heat saving measures in buildings, which can be considered as energy technology, that only requires investments and has no operating environmental impact

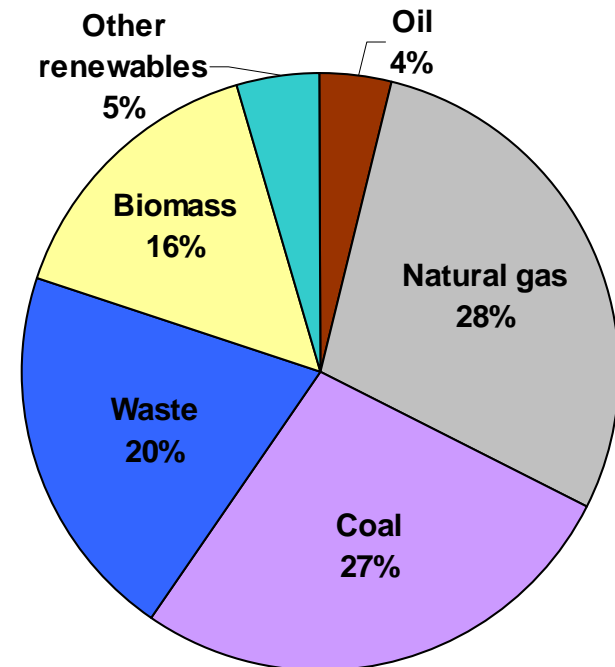
Heating sector in Denmark

Supply of space heating



Heat demand for space heating 213 PJ –
24 % of primary energy consumption

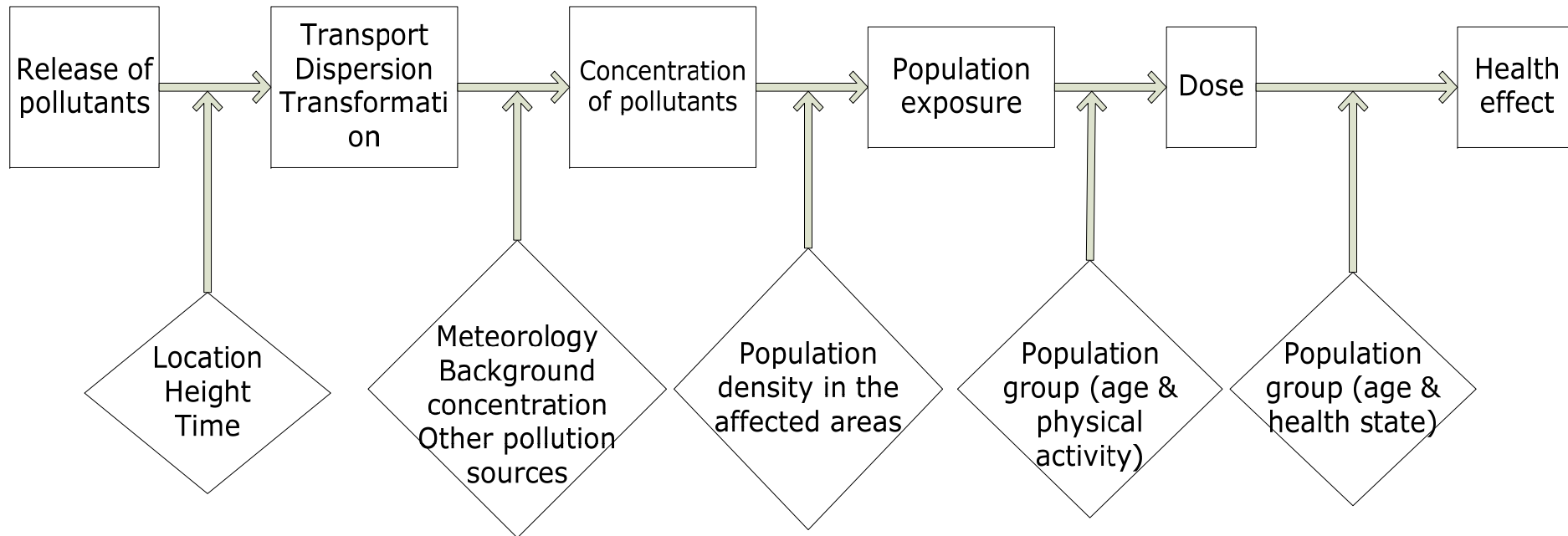
Fuel in District Heating Production



- Coal: SO₂ & NO_x
- Natural gas: NO_x
- Waste: SO₂, NO_x & particles
- Biomass: SO₂, NO_x & particles
- Oil: SO₂, NO_x

source: Danish Energy Agency, 2008

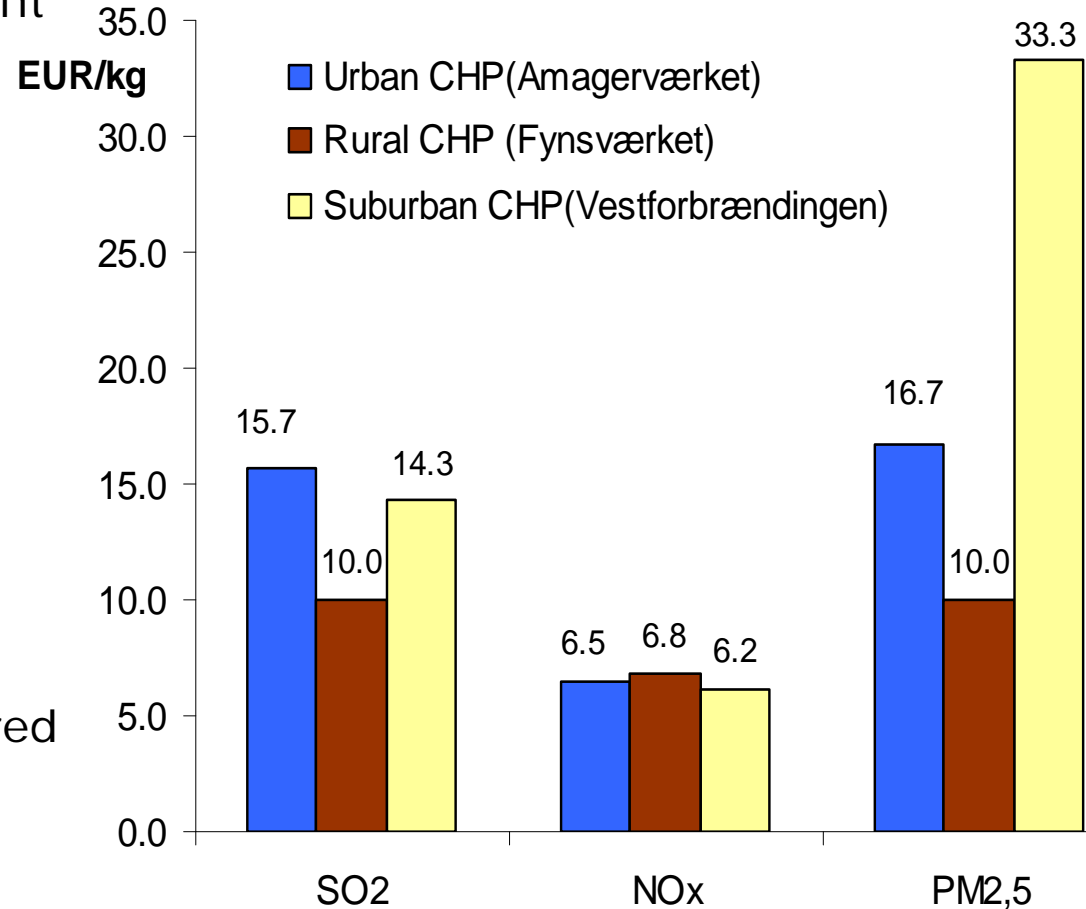
From release of local pollutants to health impacts



adopted from Hertel et al.,2001

Health related externalities and energy production

- Health related externalities of energy production are dependent on:
 - Location
 - Meteorology (wind)
 - Population
 - Height
- Externalities differ for central (DH/CHP) plants and individual technologies.
 - Health related costs of pollution by individual technologies can be compared to transport related health external costs (Gulli, 2006)

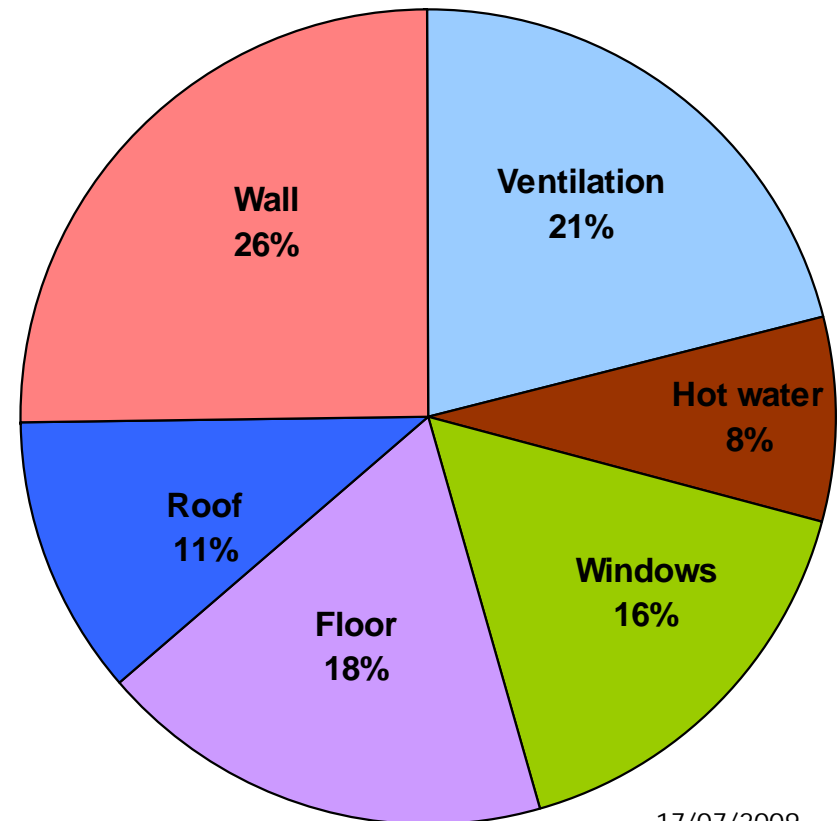


based on Andersen et al., 2008

Heat saving potentials in buildings

- Profitable heat saving potential:
 - 80 % (over 45 years) in dwellings
 - 75 % in public buildings
- 75 % of residential and public buildings are built before 1979, when the first important tightening of building standards was introduced
- Heat saving measures:

Heat consumption in dwellings



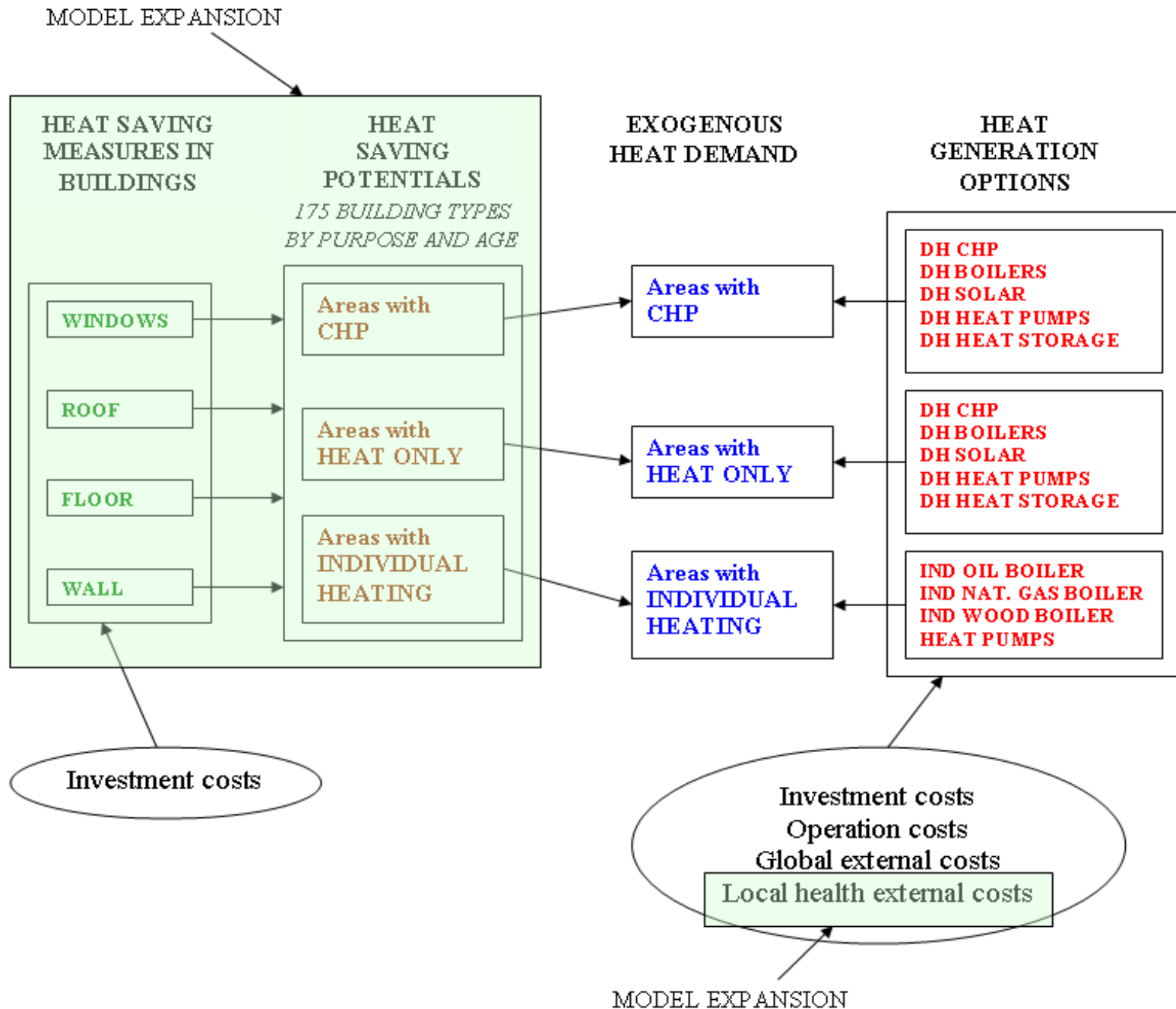
source: Frandsen, F. B., Dansk Byggeri

The model



- Model used: Balmorel (www.balmorel.com) – a linear optimisation model of heat and power sectors in the Baltic Sea Region
 - only the Danish heat and power sector is included in this analysis
- Sectors included in the analysis:
 - Electricity
 - District heating: CHP and a few HEAT ONLY
 - Oil and natural gas based individual heating (53 % of total individual heating)
- Division into areas – according to technology and geographical location:
 - 21 areas with district heating supply from CHP plants and a few HEAT-ONLY areas
 - 2 individual heating areas
 - in different areas – different health costs

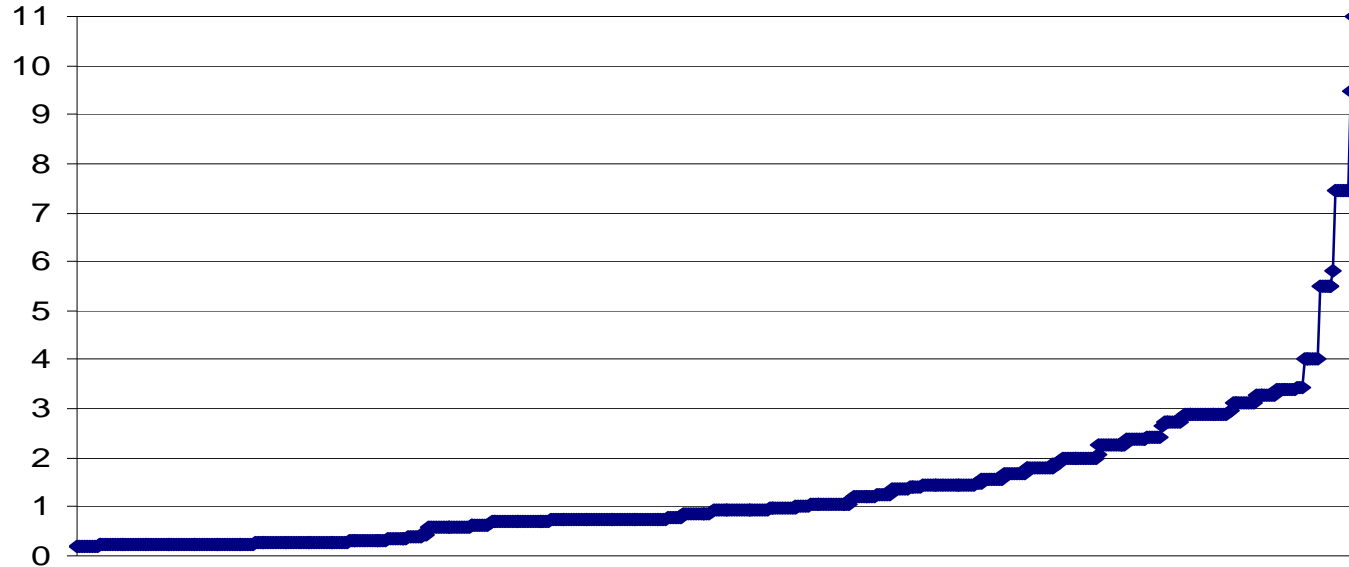
Heat sector fragment of the model



Heat saving measures

Investment cost of heat saving measures in different types of buildings

EUR/kWh/year

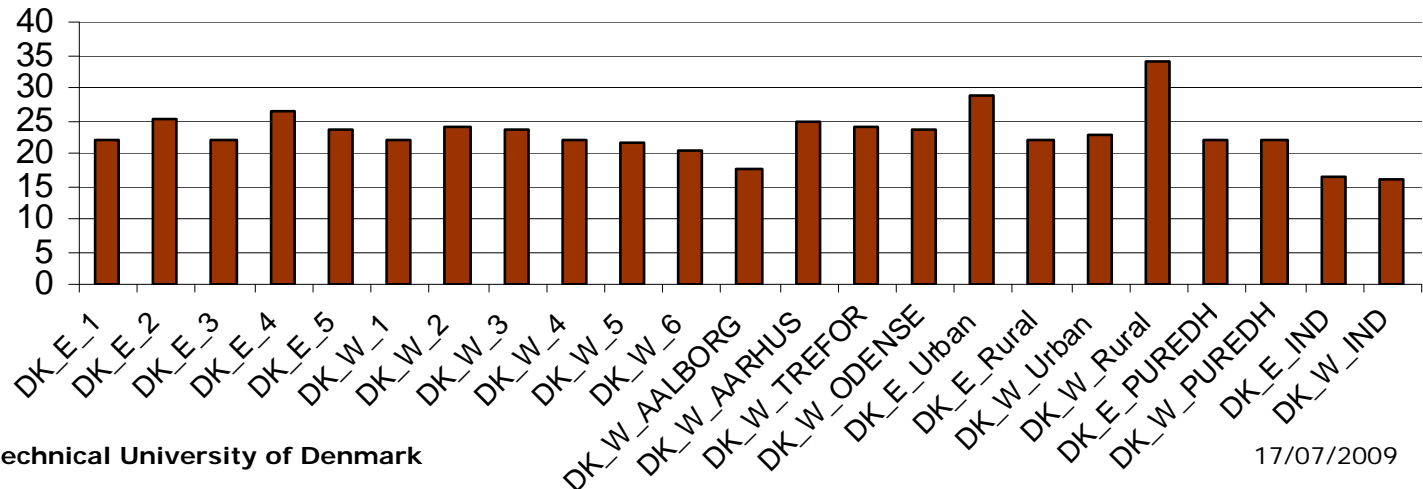


SAVING MEASURES

- insulation of walls
- insulation of roof
- insulation of floor
- replacement of window glazing

Heat saving potentials in different areas in 2025

% of heat demand



Scenarios - 2025

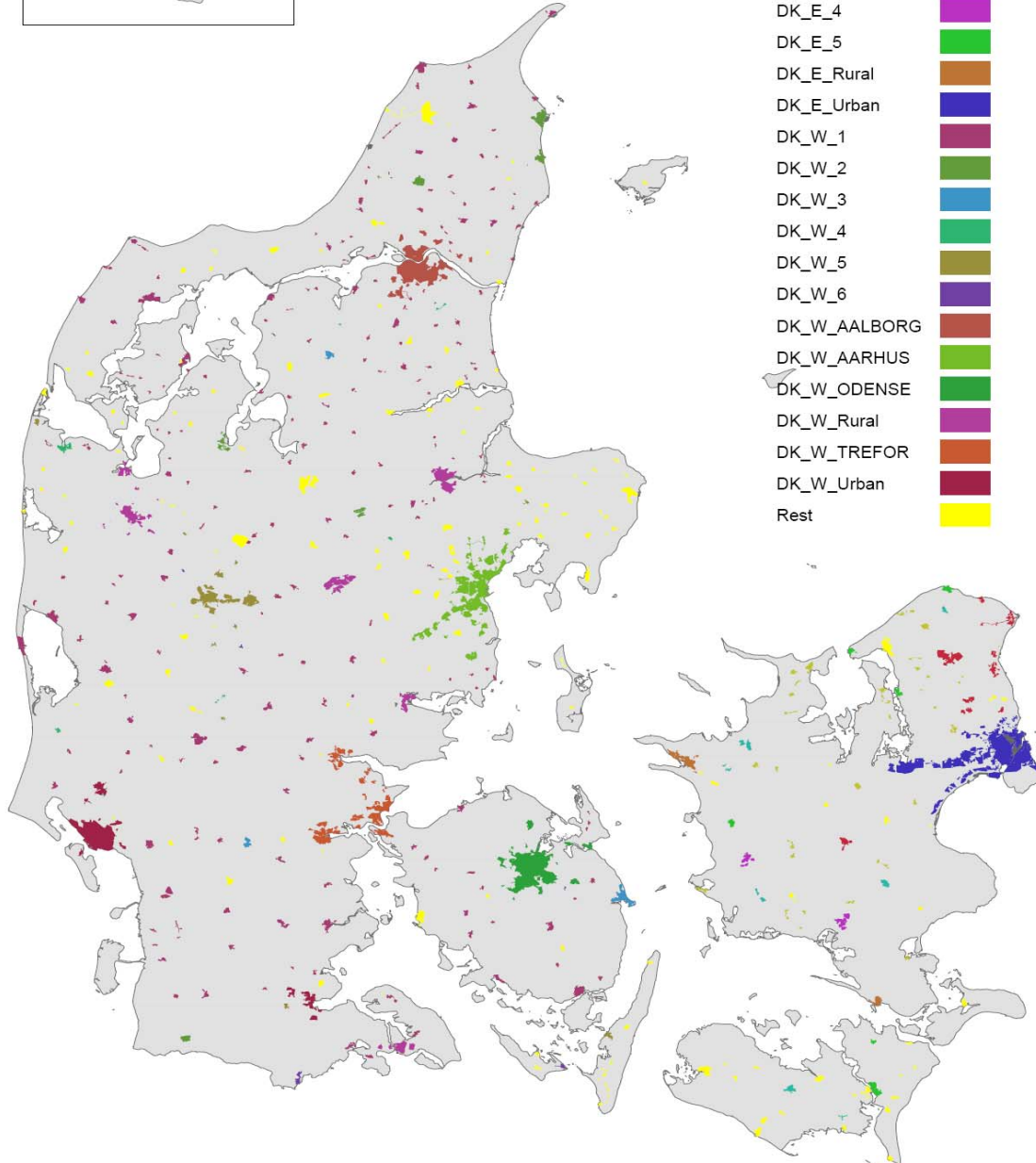
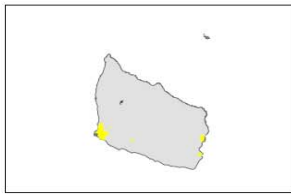


Scenario	Description
A	<u>No health externalities</u> included and <u>no heat saving investment possibilities</u>
B	<u>Health externalities</u> included, but <u>no heat saving investment possibilities</u>
D	<u>Health externalities</u> included, possibility to invest into <u>heat savings in buildings</u>
D1	Health externalities included, possibility to invest into heat savings in buildings and no possibility to invest neither into solar DH nor heat pumps

Health related external costs included in the model

Area	SO2 Cost, EUR/t	NOx cost, EUR/t	PM2,5 Cost EUR/t
Average cost	9100	5870	10900
High cost	13542	10483	18533
Low cost	5962	2533	7595
Individual heating cost	32550	9222	29200

The global CO₂ cost of 15 EUR/t is included in all scenarios



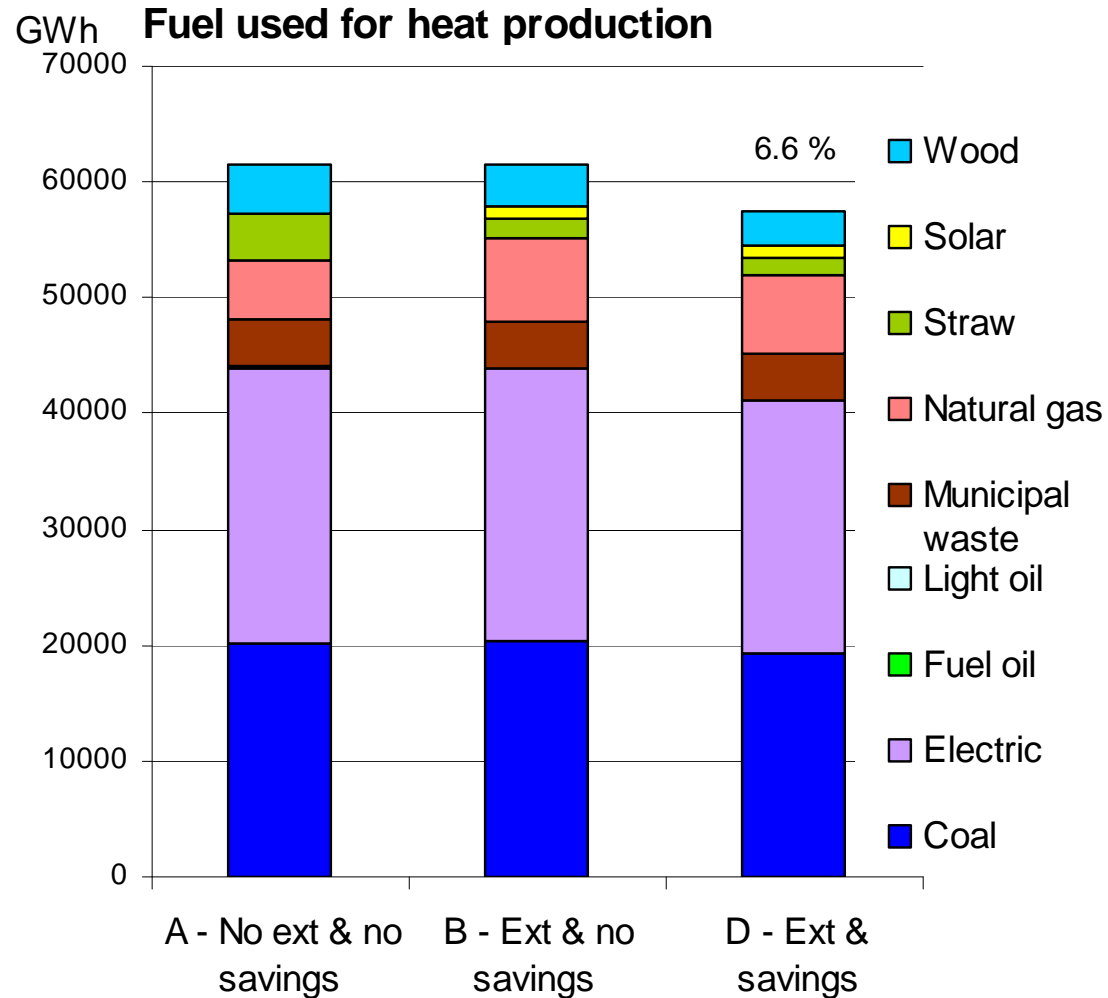
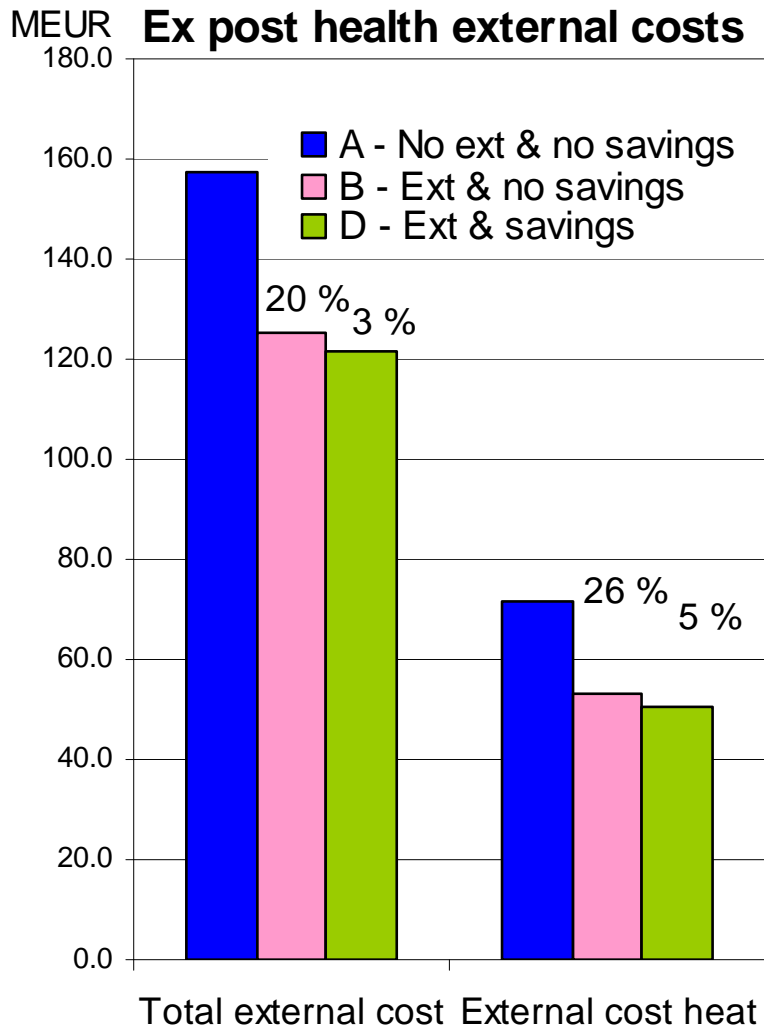
Fjernvarmenet

- Ikke med i Balmorel
- DK_E_1
- DK_E_2
- DK_E_3
- DK_E_4
- DK_E_5
- DK_E_Rural
- DK_E_Urban
- DK_W_1
- DK_W_2
- DK_W_3
- DK_W_4
- DK_W_5
- DK_W_6
- DK_W_AALBORG
- DK_W_AARHUS
- DK_W_ODENSE
- DK_W_Rural
- DK_W_TREFOR
- DK_W_Urban
- Rest

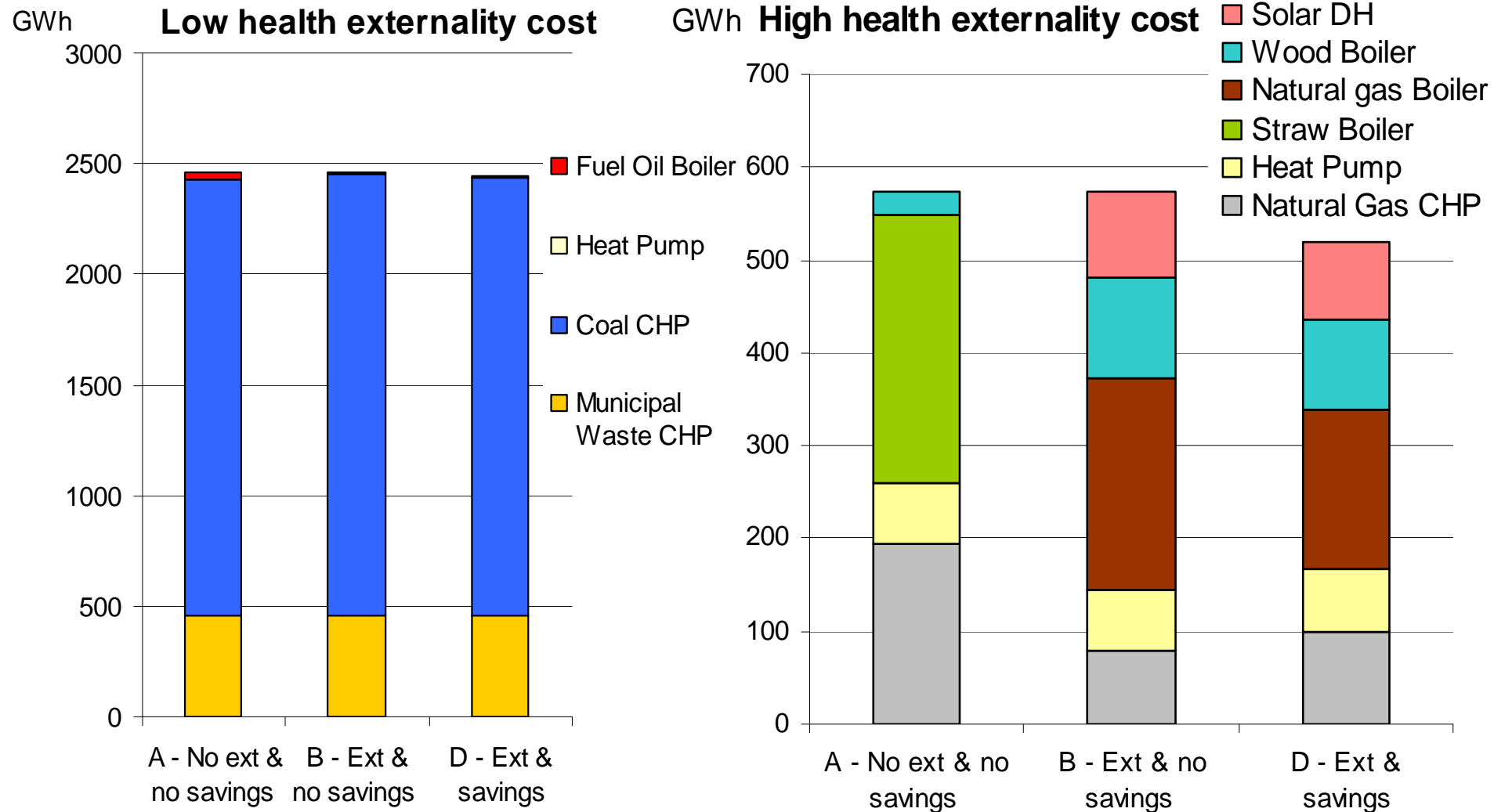


by Bernd Möller,
Aalborg University 2008

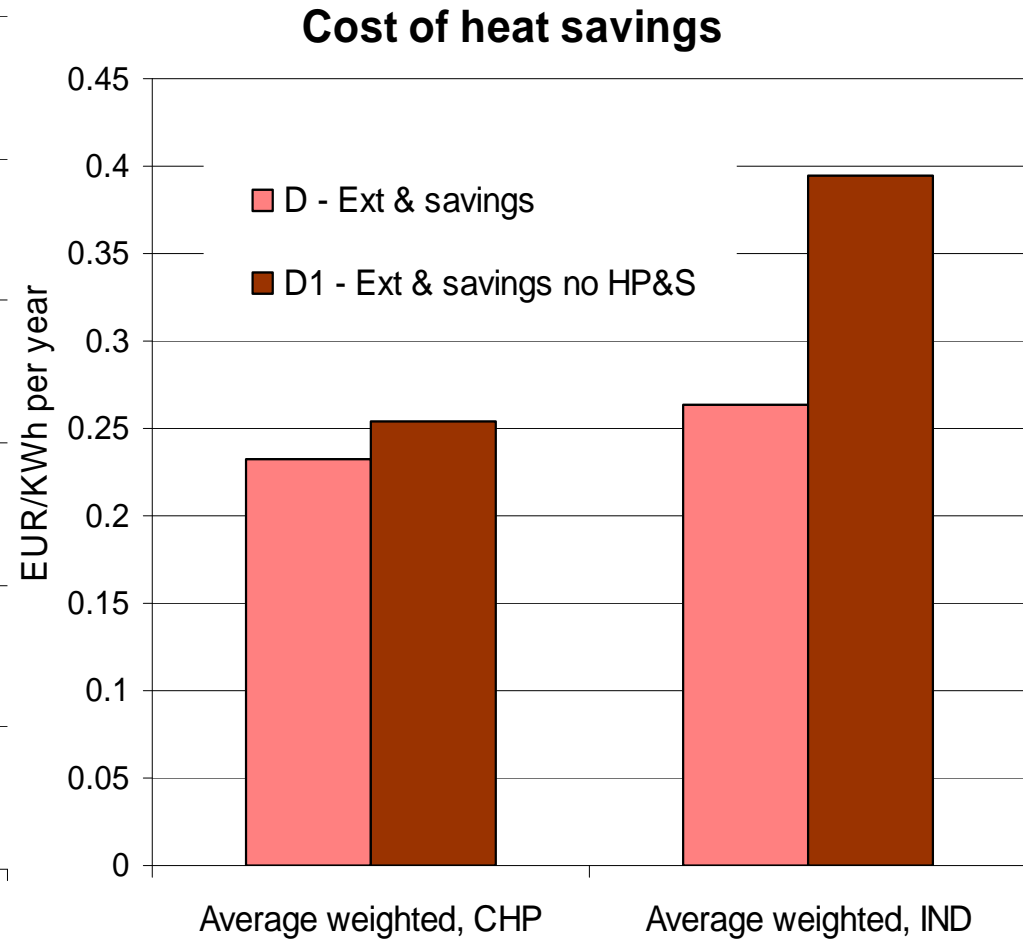
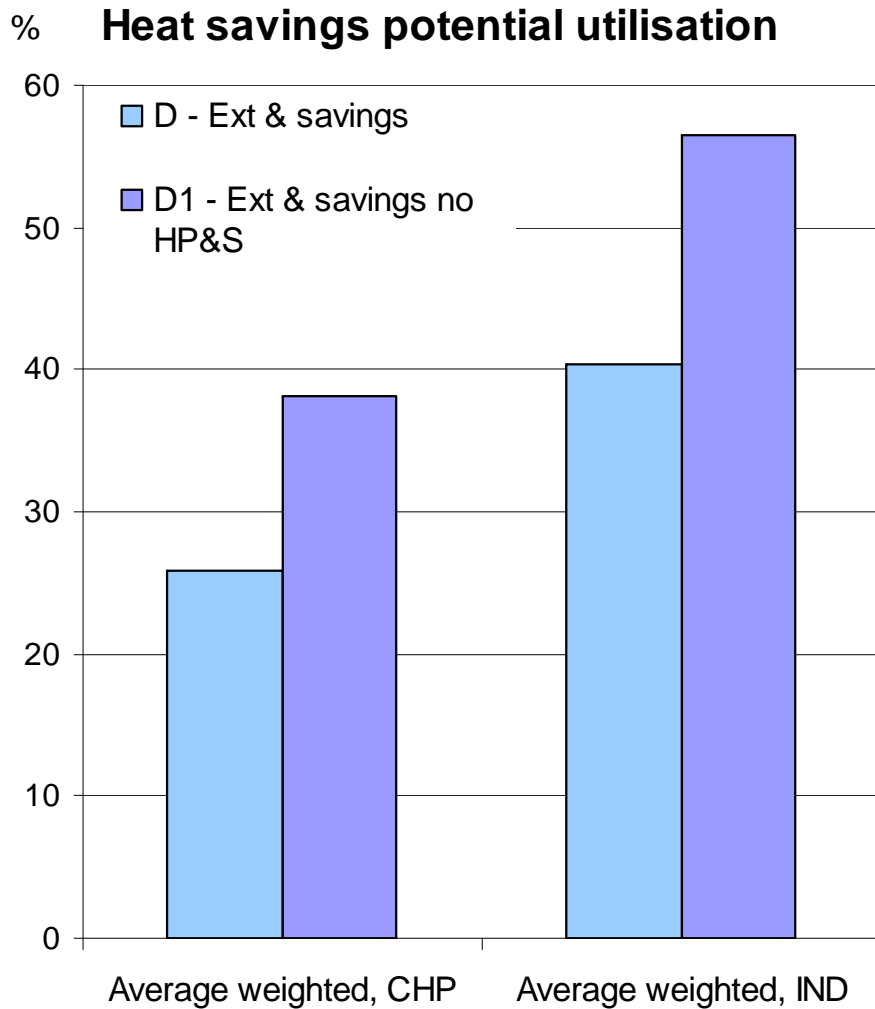
Results I



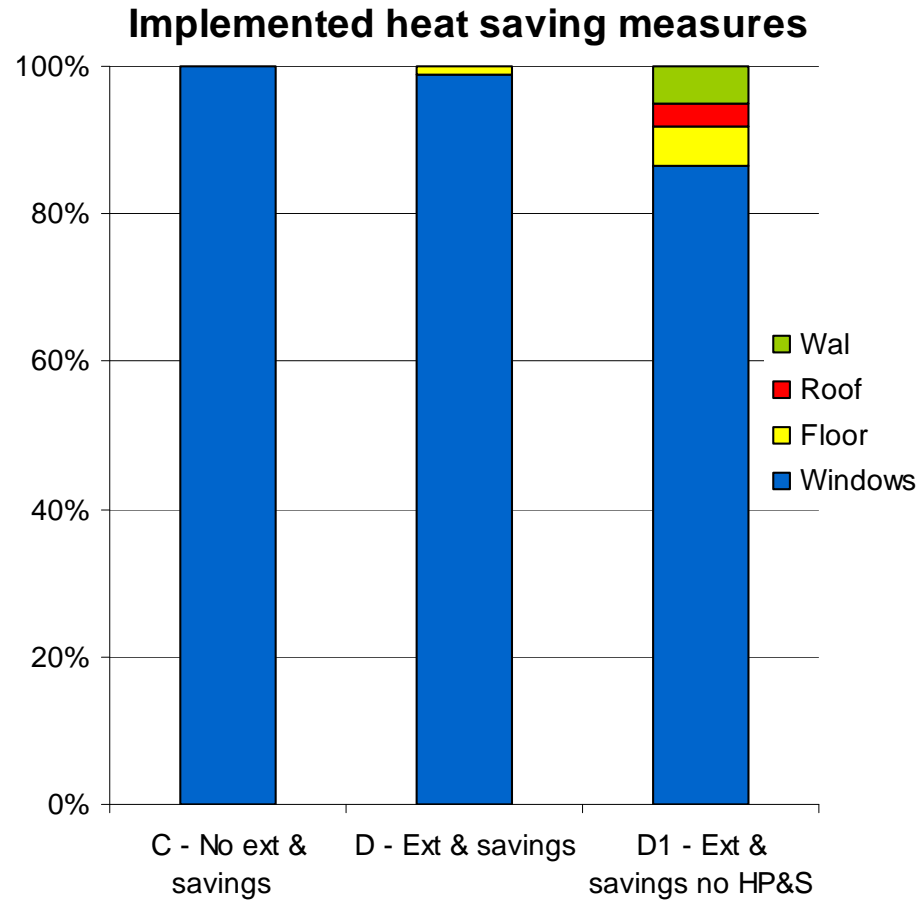
Results II – examples of different District Heating areas



Results III



Results IV – implemented heat saving measures



Conclusions



- When health externalities are included, ex post total health external costs from heat and power sector are reduced by 20 %
- When health externalities are included, ex post total health external costs from heat production are reduced by 26 %. Heat savings in buildings contribute to further 5 % reduction in ex post health related external costs from heat sector.
- Biomass based heat production (one of the means to reduce CO₂ emissions) becomes less attractive when health externalities are included due to relatively high release of local pollutants – no renewable targets and relatively low CO₂ price
- The most cost-effective heat saving measure in buildings in DK seems to be replacement of window glazing
- Heat saving measures are more beneficial in the buildings with individual heat production than in buildings, connected to District Heating

Thank you for attention!

The presented study is a part of the research of the Centre for Energy, Environment and Health, financed by The Danish Strategic Research Program on Sustainable Energy under contract no 2104-06-0027.

For more information visit www.ceeh.dk

