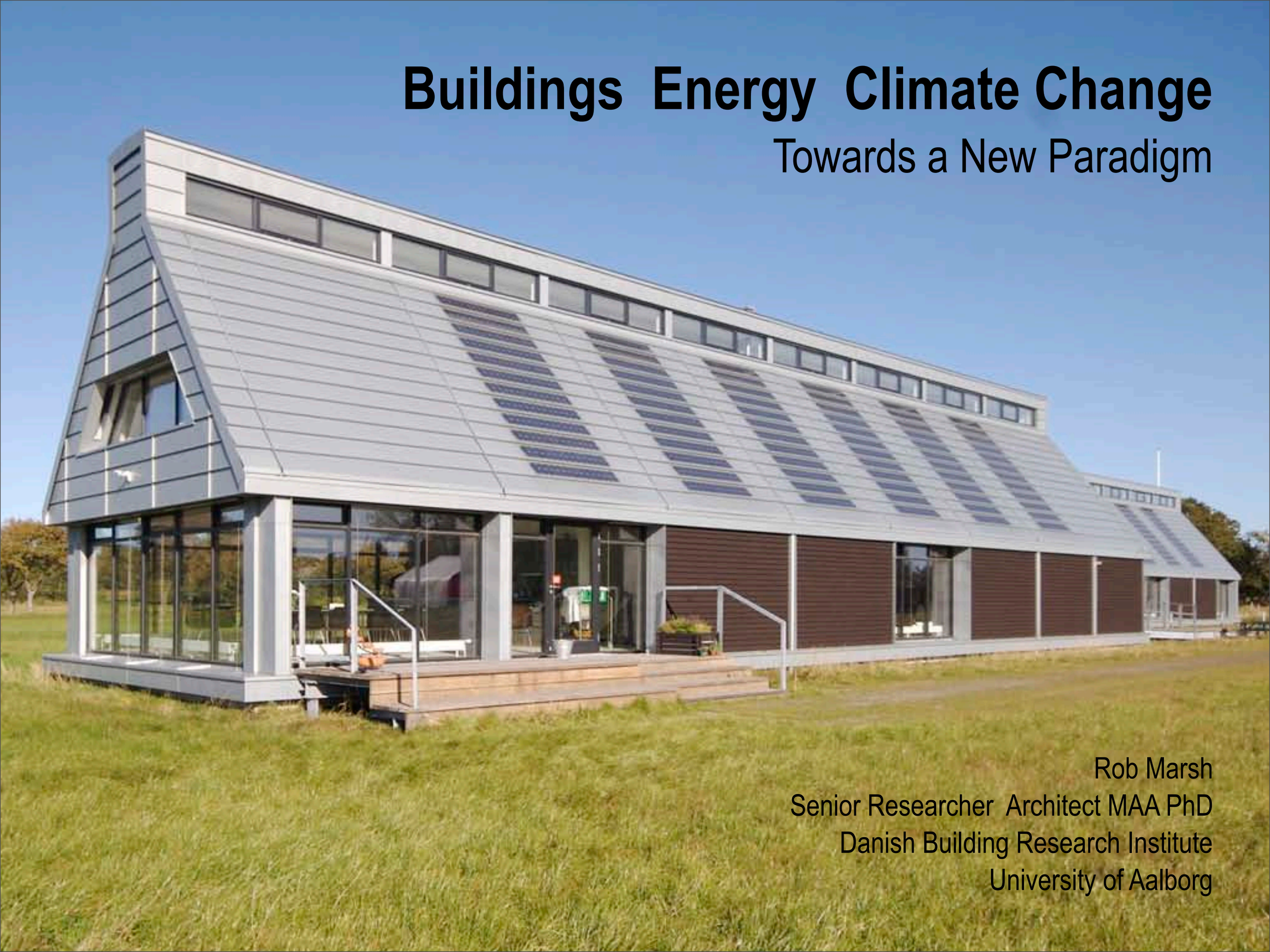
Buildings Energy Climate Change

Towards a New Paradigm



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University of Aalborg

Societys' energy and
climate related problems
develop over time

Changes in climatic conditions
and energy demands
create many challenges
for construction sector

Need to understand
these developments and
challenge the status quo

Giv indeklimaet og økonomien et friskt pust

Panasonic varmepumpe

Luk op for varmen med en Panasonic varmepumpe, og nyd de fordele, det giver for hele familien.
I får et sundt indeklima, varmebesparelser på op til 66% samt et miljøvenligt varmeanlæg, der er let at betjene. Varmepumpen kan også køle jeres bolig ned på varme sommerdage.

Panasonic

Past

Present

Future

Paradigm

Past

Past: Existing building stock

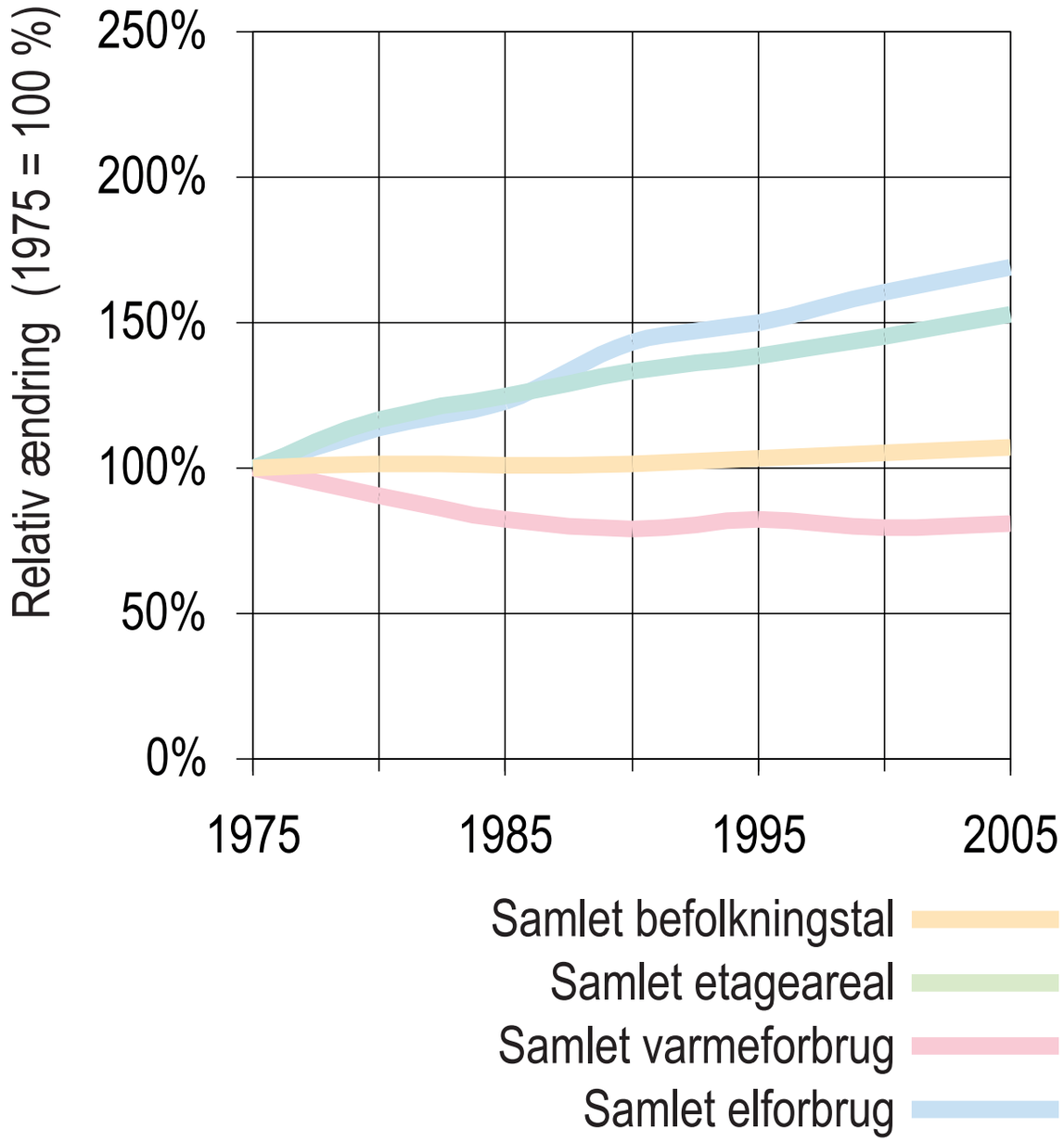
Total housing stock 1975 - 2005:

Low population growth: + 7%

Growing floor area: + 50%

Falling heat consumption: - 20%

Growing electricity use: + 70%



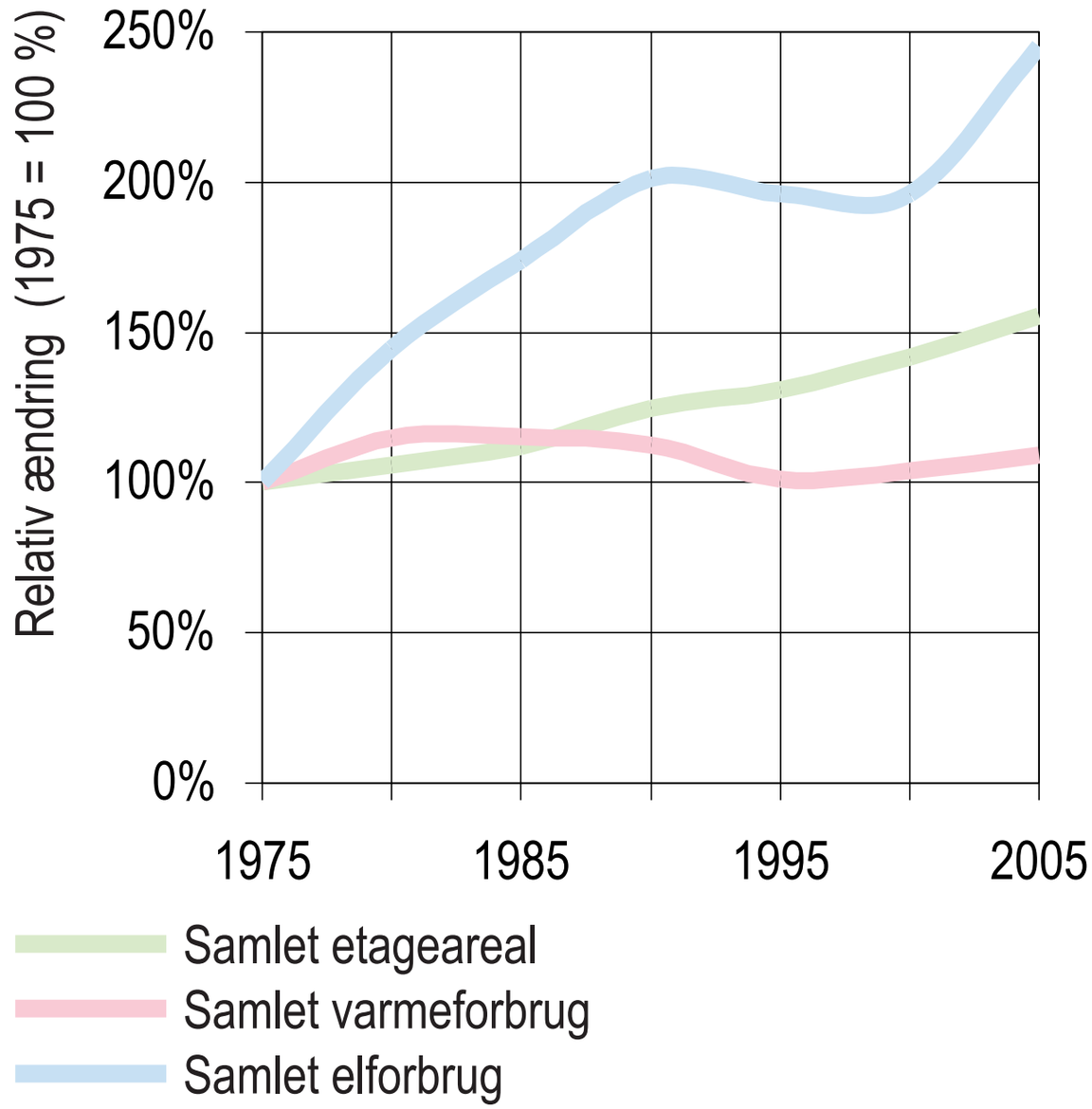
Past: Existing building stock

Total office stock 1975 - 2005:

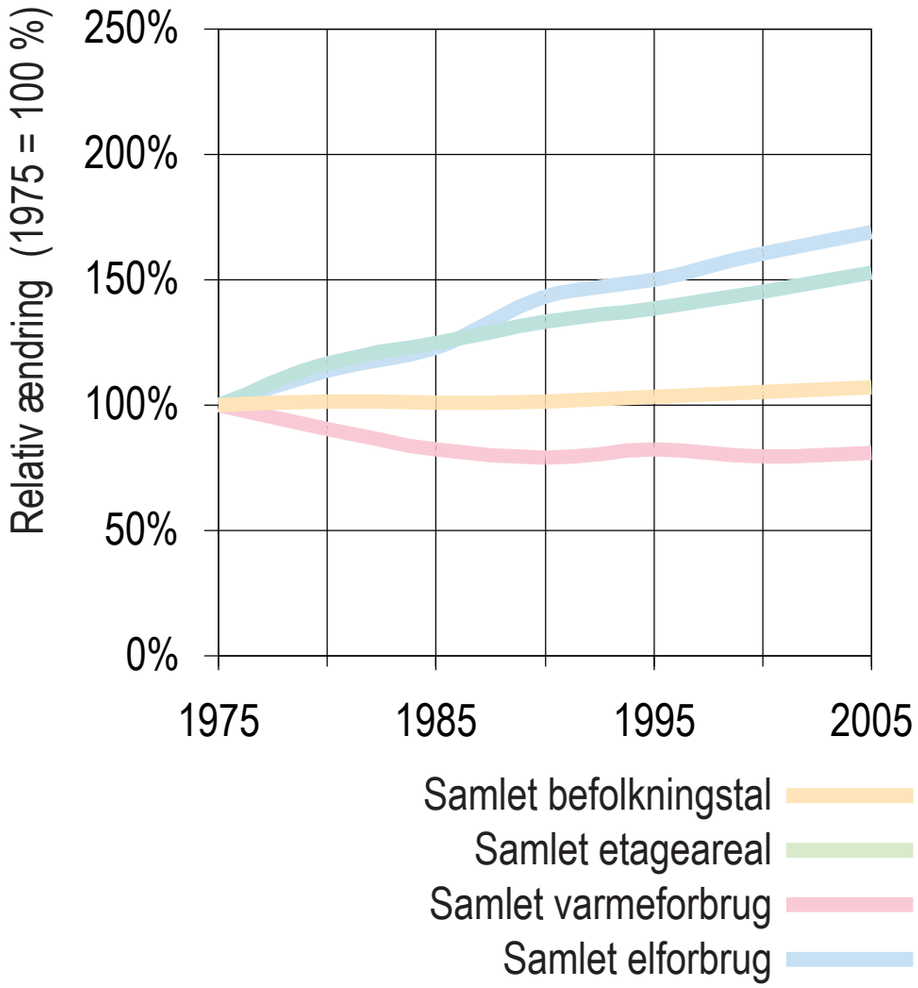
Growing floor area: + 55%

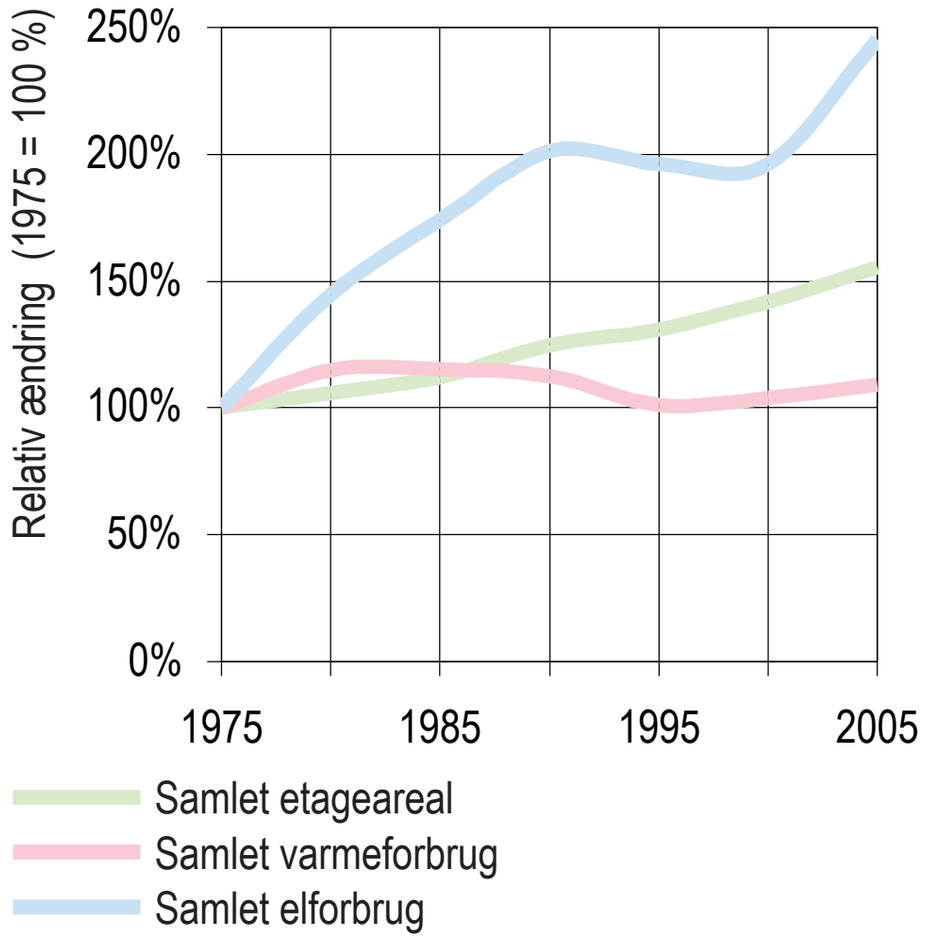
Falling heat consumption: + 10%

Growing electricity use: + 160%



Past: Existing building stock



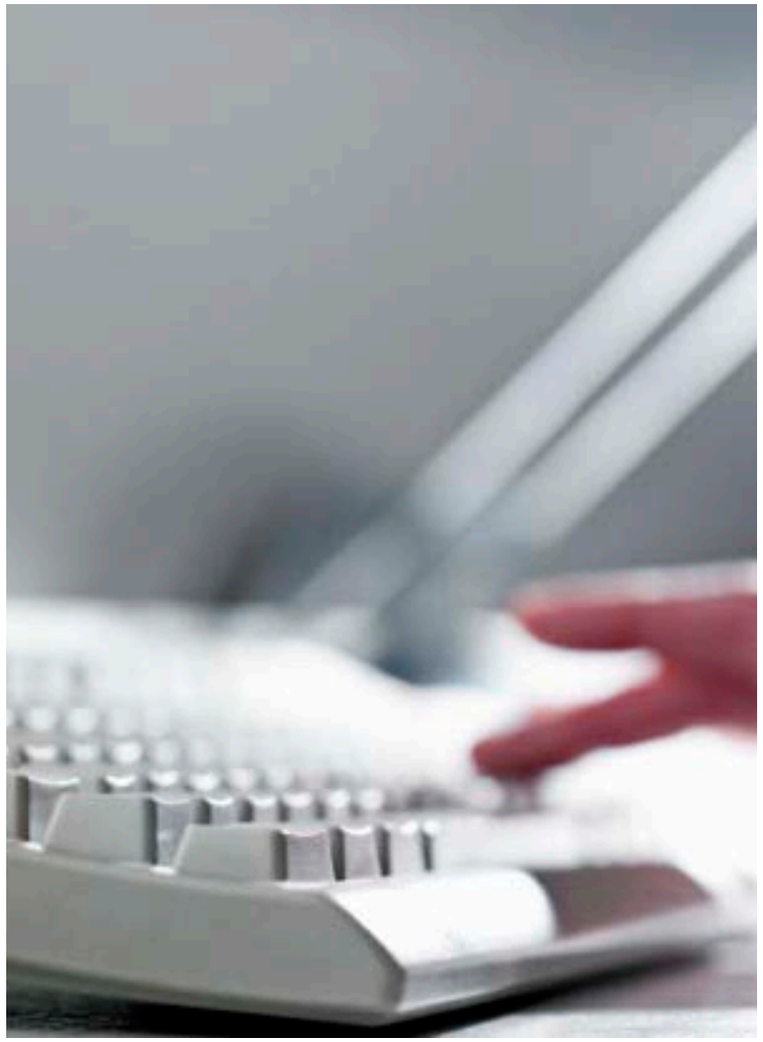


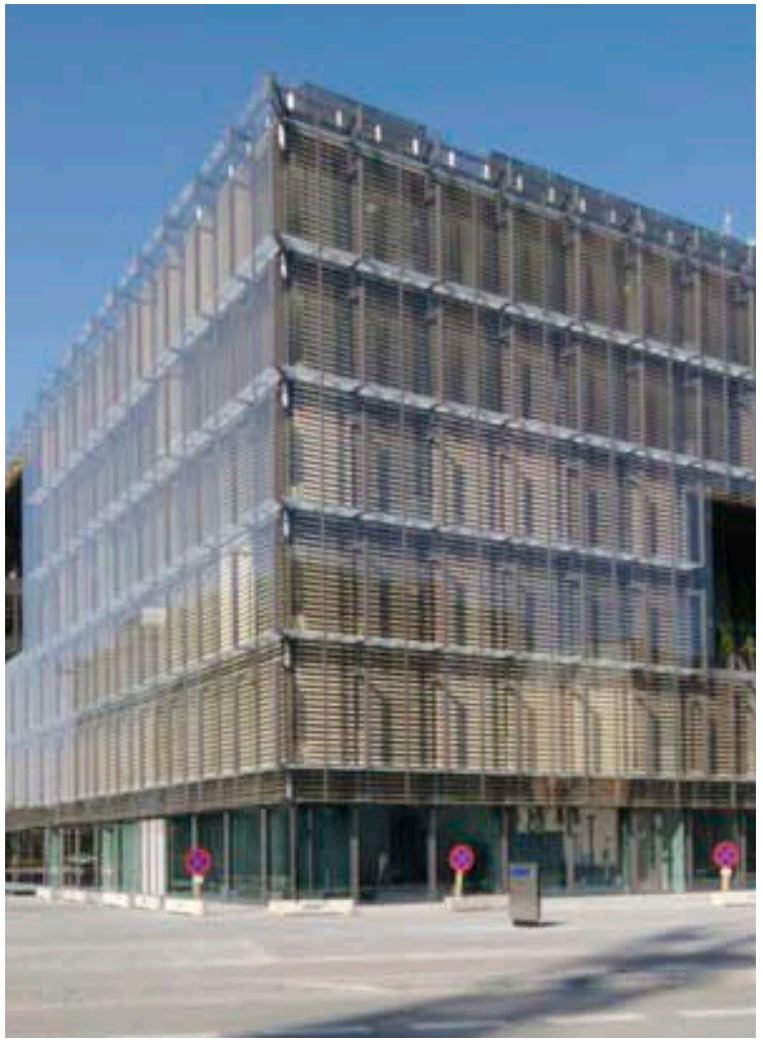
Past: Existing building stock

Falling/stable heat consumption:

- Insulation of existing building fabric; window refurbishment
- New heating system; change in heat supply
- Improved energy regulations in Building Regulations

Past: Existing building stock





Extreme growth in electricity consumption:

- Growing ownership rates for electrical appliances
- Growth in *Knowledge Society*, IT/multimedia og service sector
- New buildings with high electricity usage to lighting, ventilation, cooling

Past: Typical new buildings through time

Housing: 2 storey, 120 m^2

Office: 3 storey, 2700 m^2

For both building types:

- Heat consumption calculated from historical energy regulations
- Electricity calculated by historical data and primary energy factor of 2.5

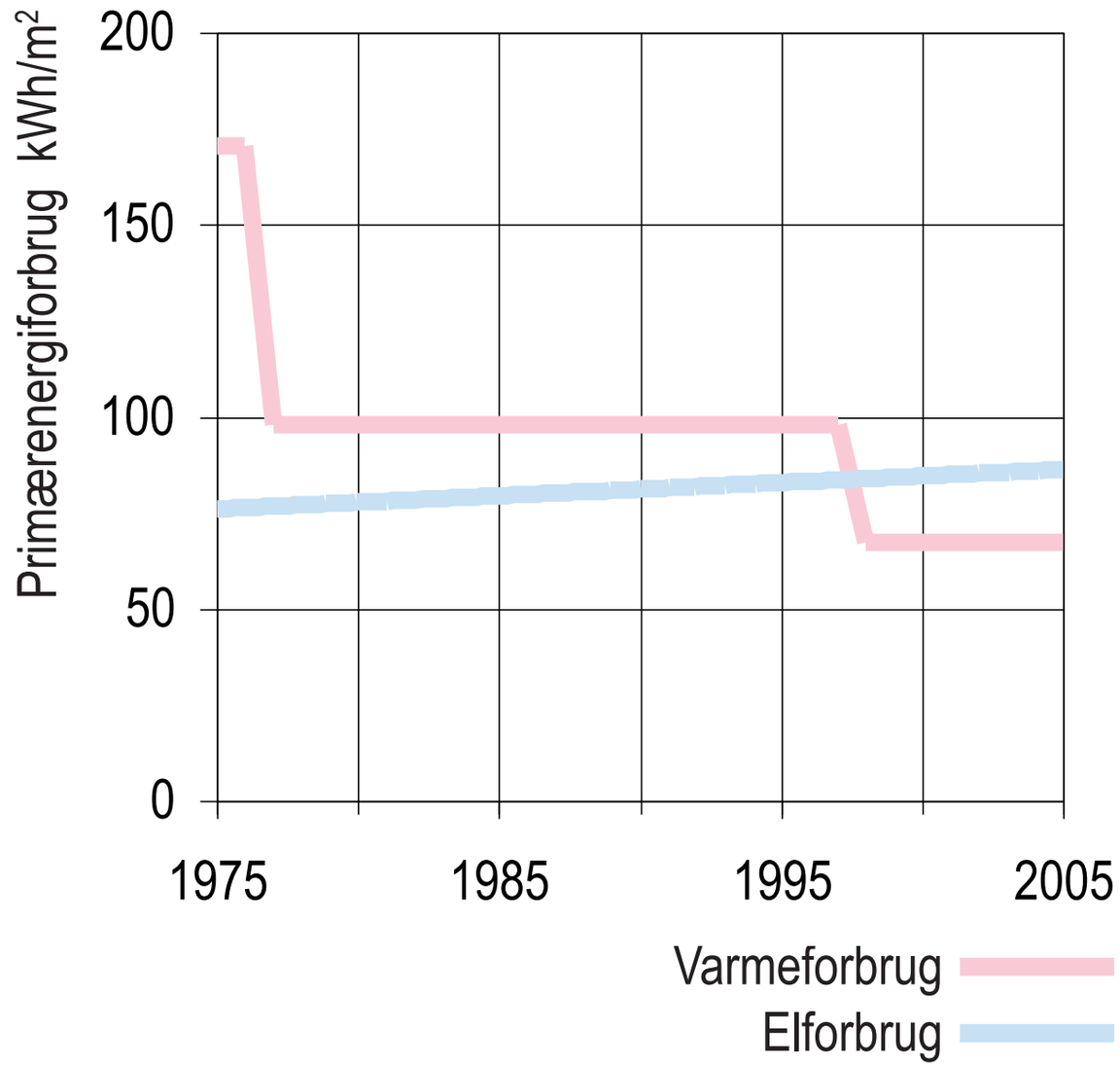
Past: Typical new buildings through time

New build housing 1975 - 2005:

Falling heat consumption: - 60%

Growing electricity use: + 10%

Electricity consumption
now larger than
heat consumption



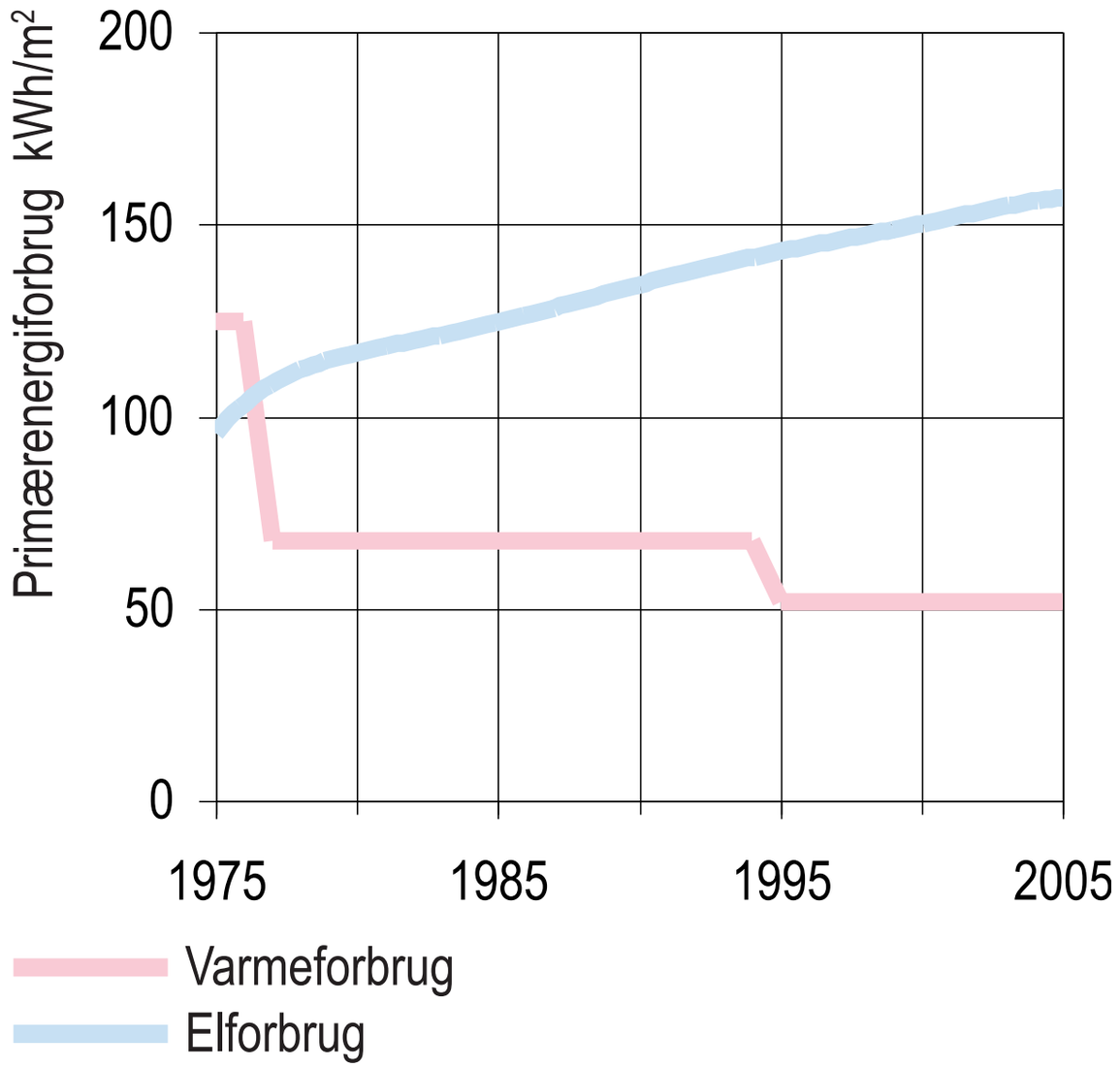
Past: Typical new buildings through time

New build offices 1975 - 2005:

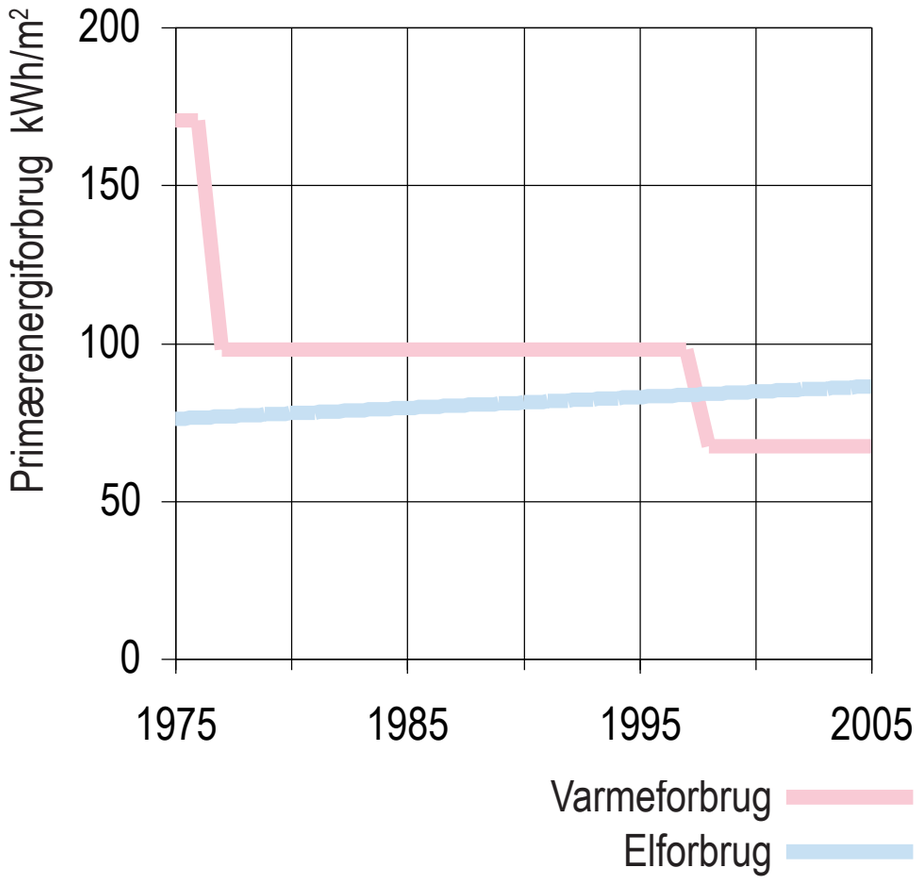
Falling heat consumption: - 60%

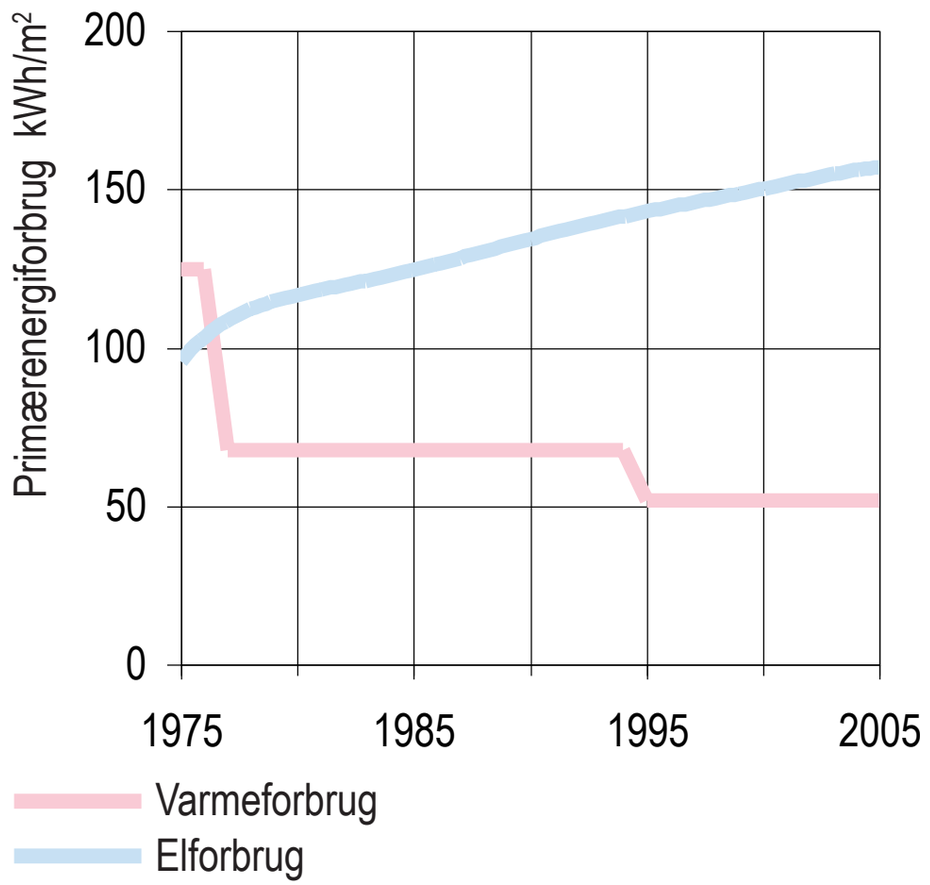
Growing electricity use: + 55%

Electricity consumption
has been larger than
heat consumption in many years



Past: Typical new buildings through time





Major transformation since 1970's oil crisis:

- Improvements in energy regulations giving large heat savings
- Growing electricity consumption has not been regulated

Present

Present: Energy regulations

Previous Danish regulations:

- Space heating demand

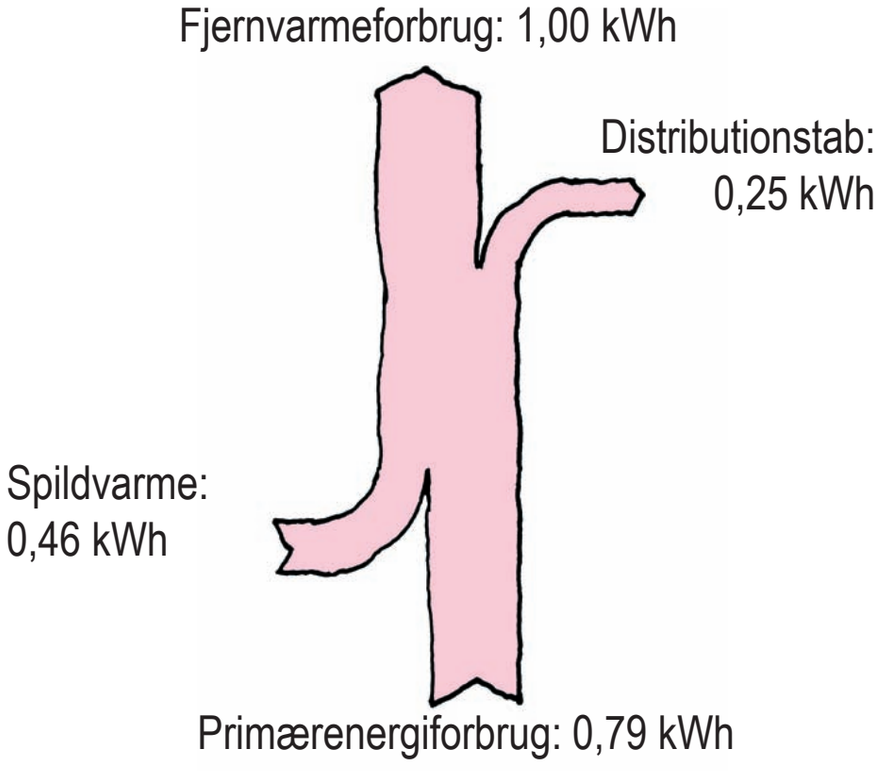
Current Danish regulations:

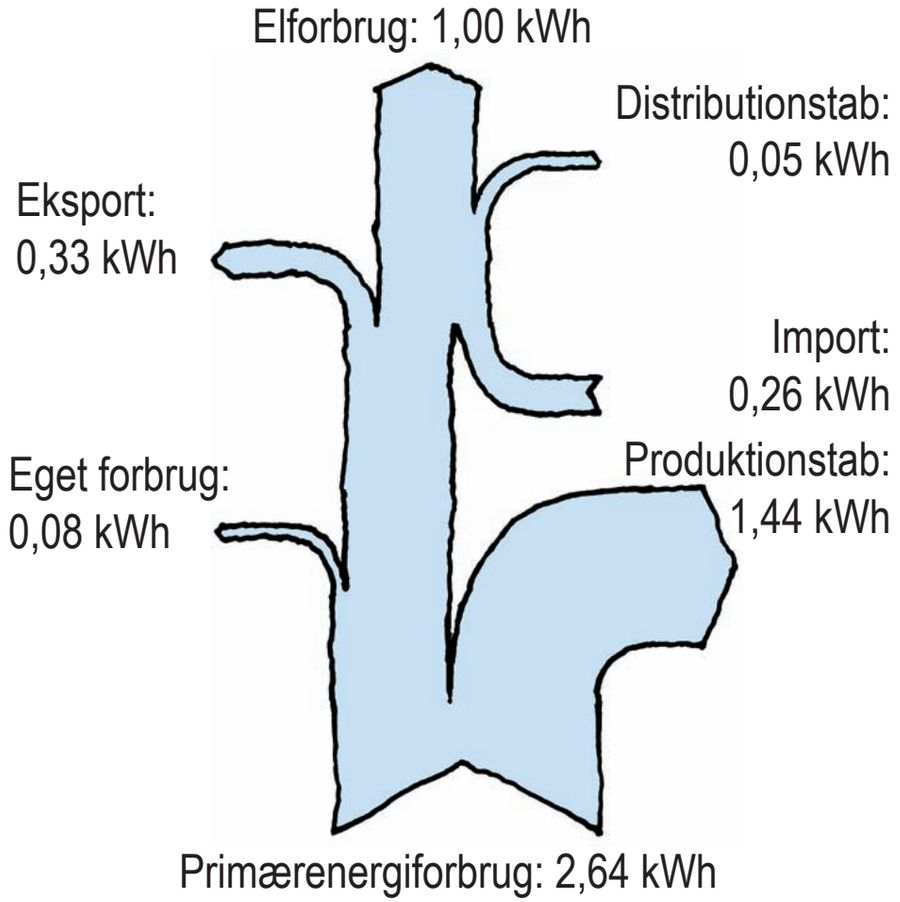
- Heating
- Hot water
- Cooling/overheating
- Building services
- Lighting (but not housing)
- Renewable energy production from solar thermal & PV
- **Weighted in relation to primary energy consumption:**

  District heat/oil/gas: 1.0

  Electricity: 2.5

Present: Primary energy factors





Energy regulations :	**1,00**
Primary energy:	**1,00**
CO_2 emissions:	**1,00**

Energy regulations:	**2,50**
Primary energy:	**3,30**
CO_2 emissions:	**4,20**

- Electricity savings 3-4 times more effective than heat savings

Present: New building total primary energy consumption

Housing: 2 storey, 120 m^2

Office: 3 storey, 2700 m^2

For both building types:

- Energy consumption calculated with present energy regulations
- Electricity calculated with current data and primary energy factor of 2.5

Present: New building total primary energy consumption

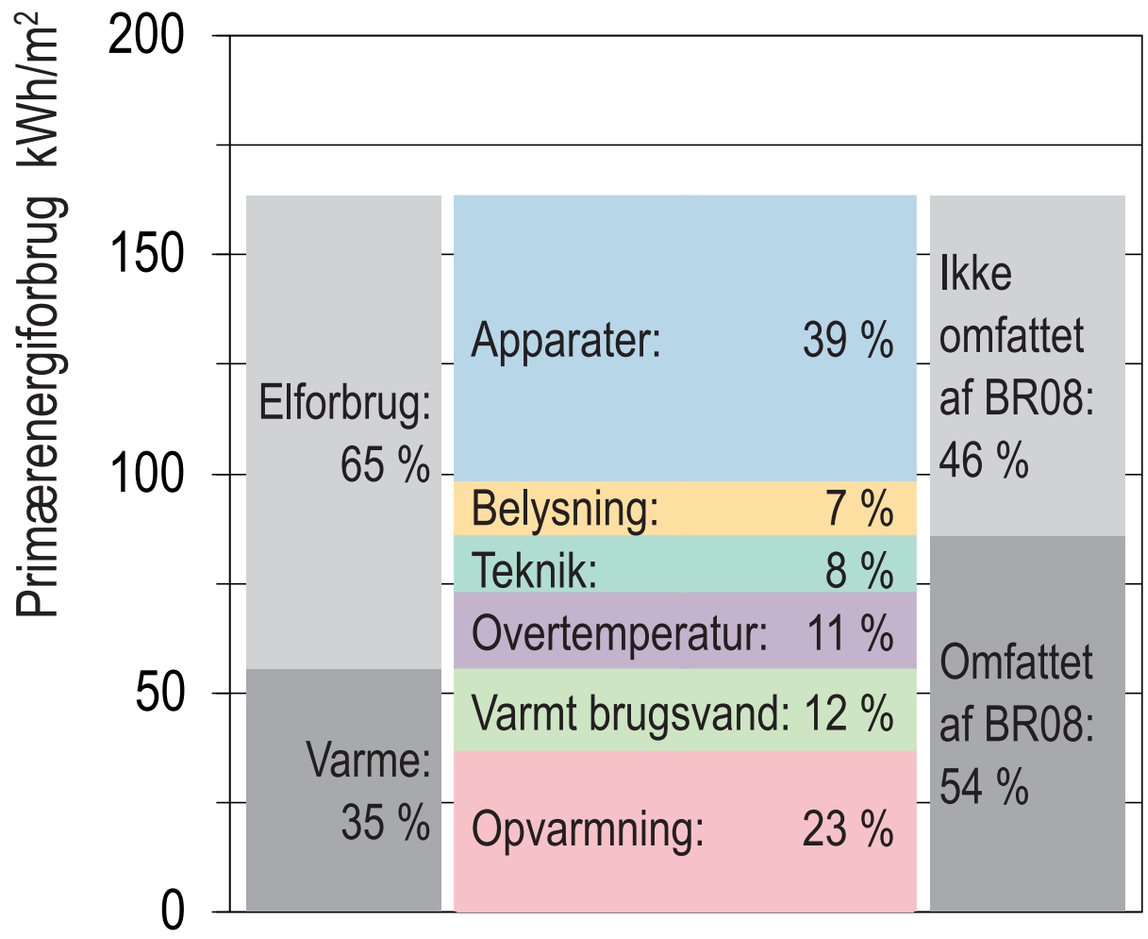
New housing:

Total primary energy consumption consists of:

- Electricity use: 65 %
- Heat consumption: 35 %

Of the total primary energy consumption:

- Not covered by energy regulations: 45 %
- Covered by energy regulations: 55 %



Present: New building total primary energy consumption

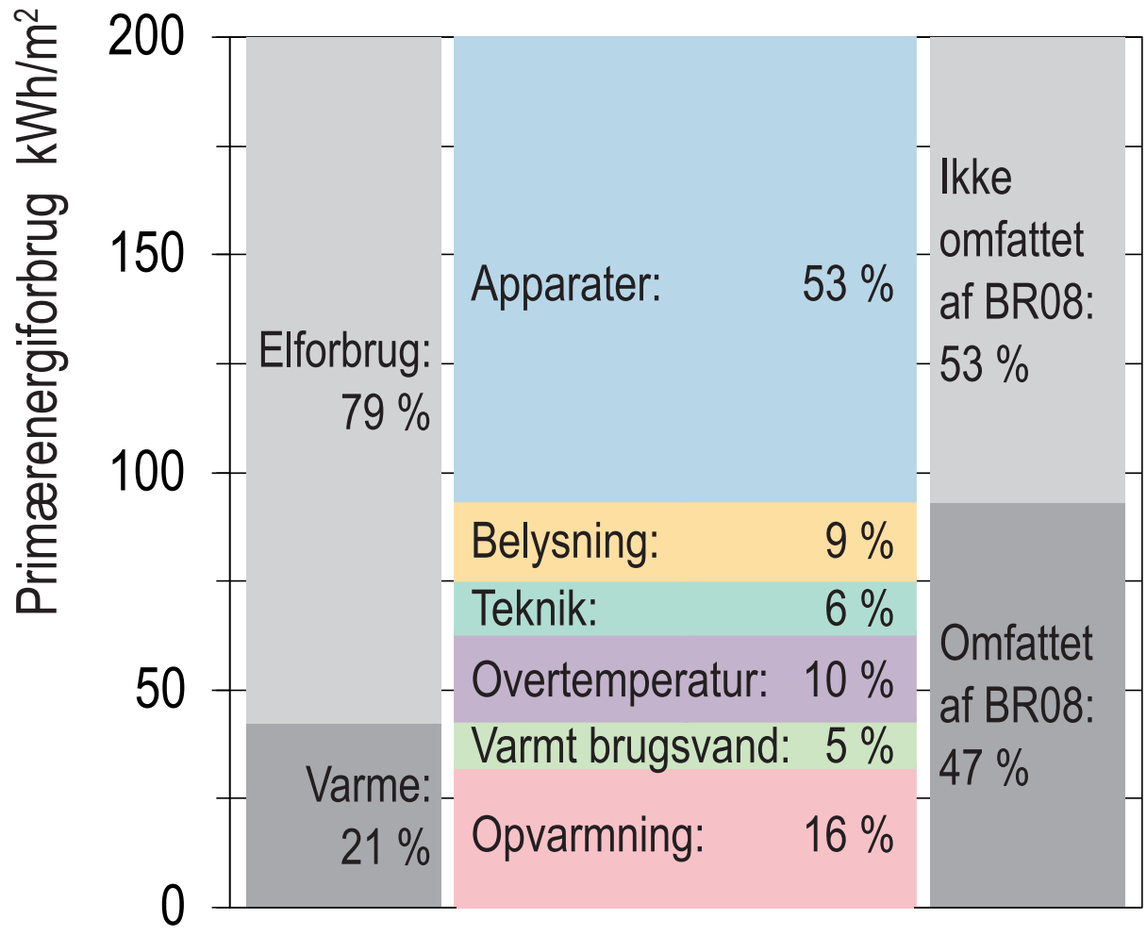
New offices:

Total primary energy consumption consists of:

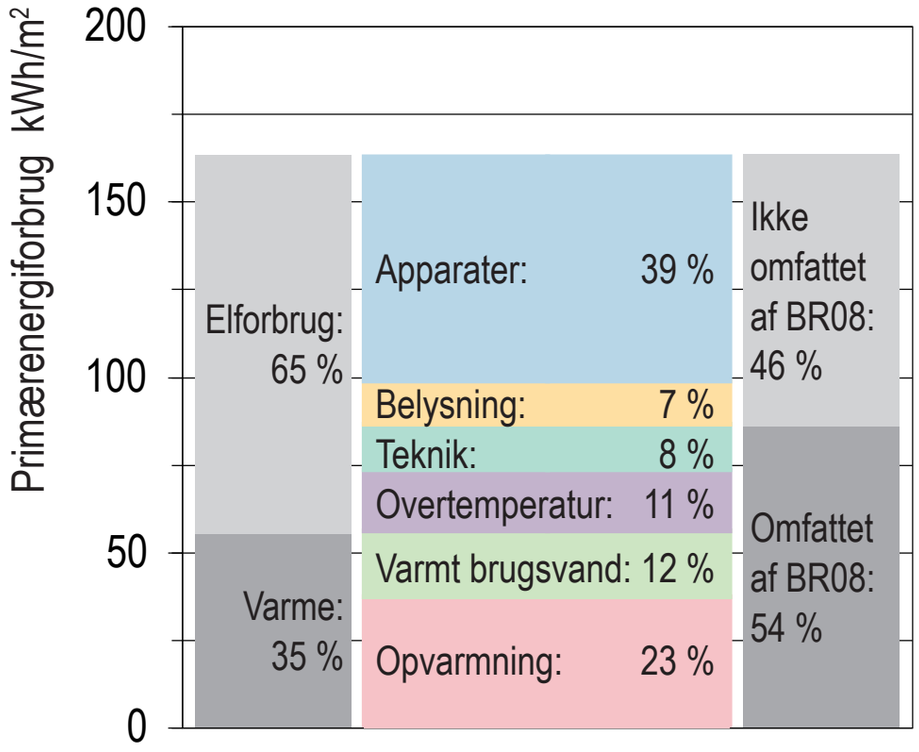
- Electricity use: 80 %
- Heat consumption: 20 %

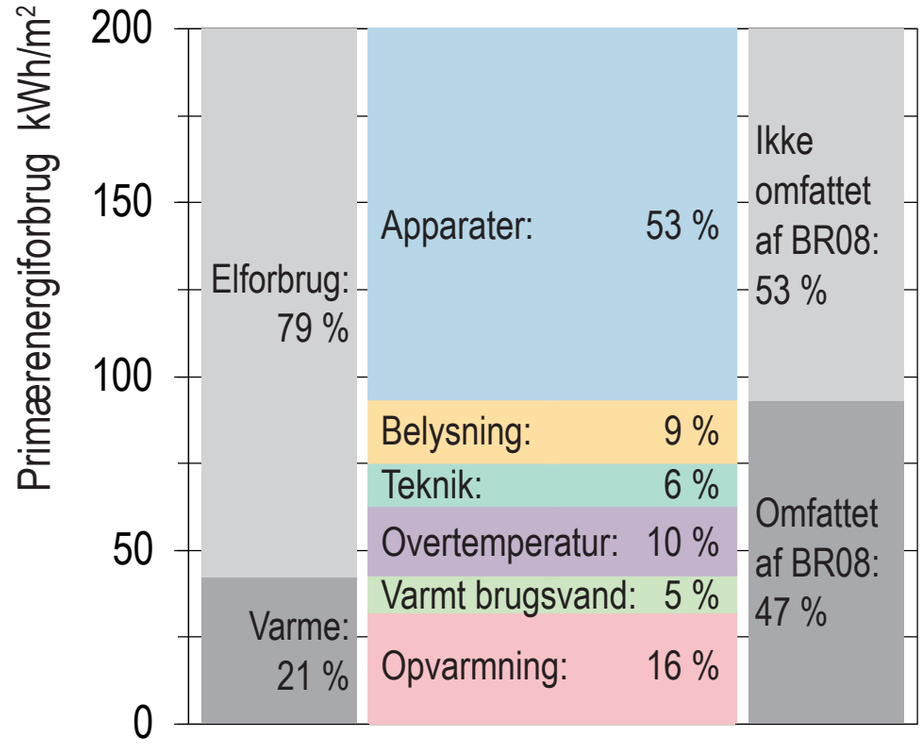
Of the total primary energy consumption:

- Not covered by energy regulations: 55 %
- Covered by energy regulations: 45 %



Present: New building total primary energy consumption





Shift in paradigm for new buildings' energy consumption:

- Implications of Knowledge Society
- Demands broad spectrum of solutions that work together
- Legal framework limits energy saving strategies

Future

Future: Climate change

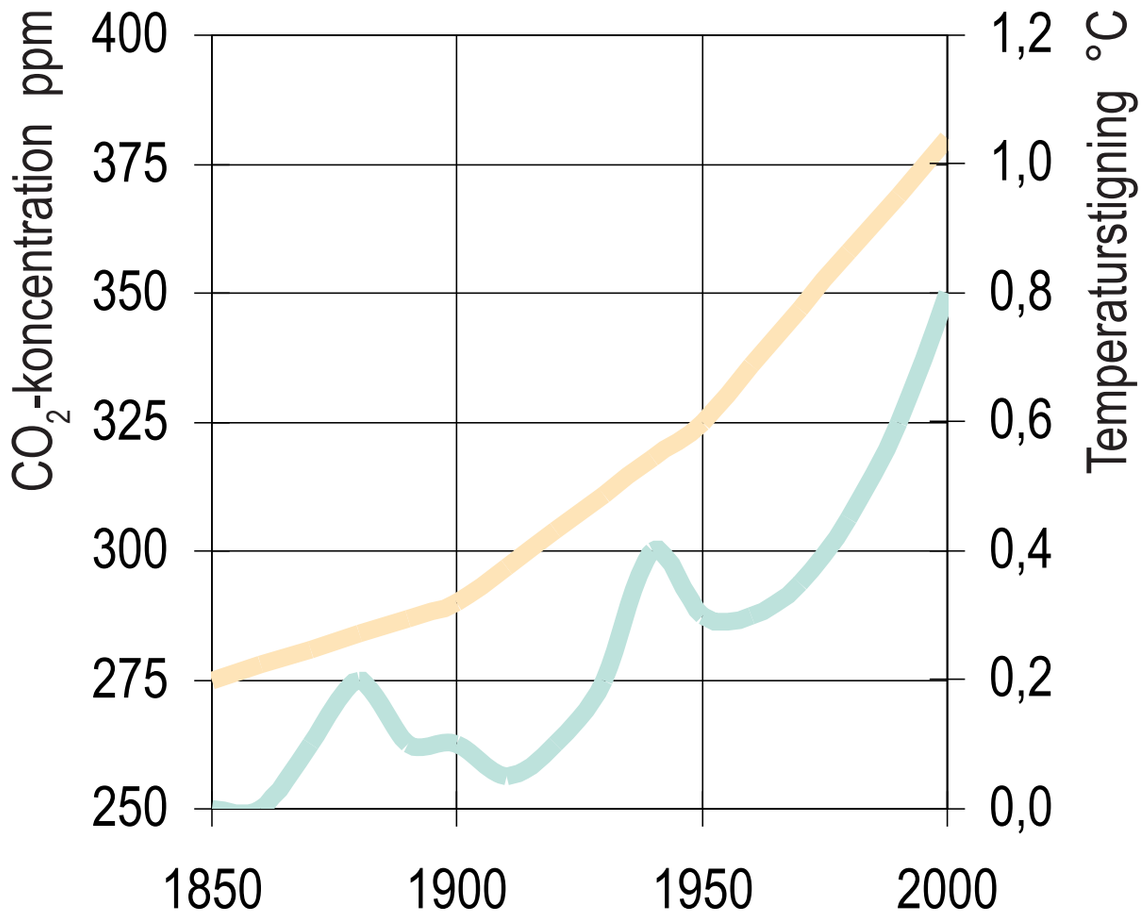
Danish energy policy:

- Supply security
- Climate change

Global rise in temperature of between 1 - 6 °C by 2100 even if CO_2-emissions are greatly reduced

Climate change means:

- Hotter summers
- More extensive heat waves
- Milder winters
- Also in North Europe



Figur 15. Atmosfærisk CO_2-koncentration og stigning i global middeltemperatur fra 1850 til 2000:
CO_2-koncentration
Temperaturstigning

Future: Climate change in Denmark

2006, 2007 & 2008:

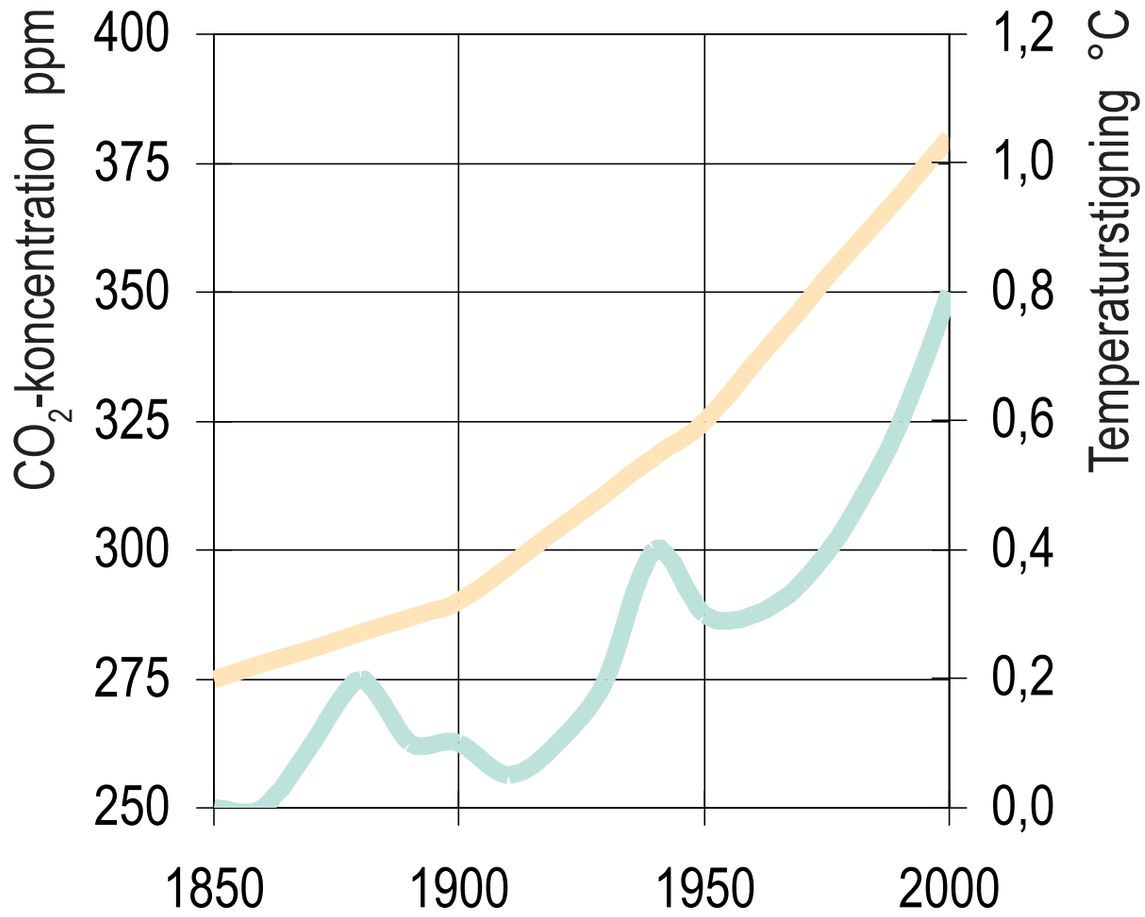
- Warmest years
  since measurements started
  in 1874

2000 to 2009:

- Warmest decade
  since measurements started
  in 1874

Danish Meteorological Institute:

- Temperature rise of 3 °C
  for winter and summer
  temperatures by 2085



Figur 15. Atmosfærisk CO_2-koncentration og stigning i global middeltemperatur fra 1850 til 2000:

CO_2-koncentration

Temperaturstigning

Future: Climate change in Denmark

Energy calculations in Denmark
use reference climate data
from 1961-90

Last 30 years vs. 1961-90:

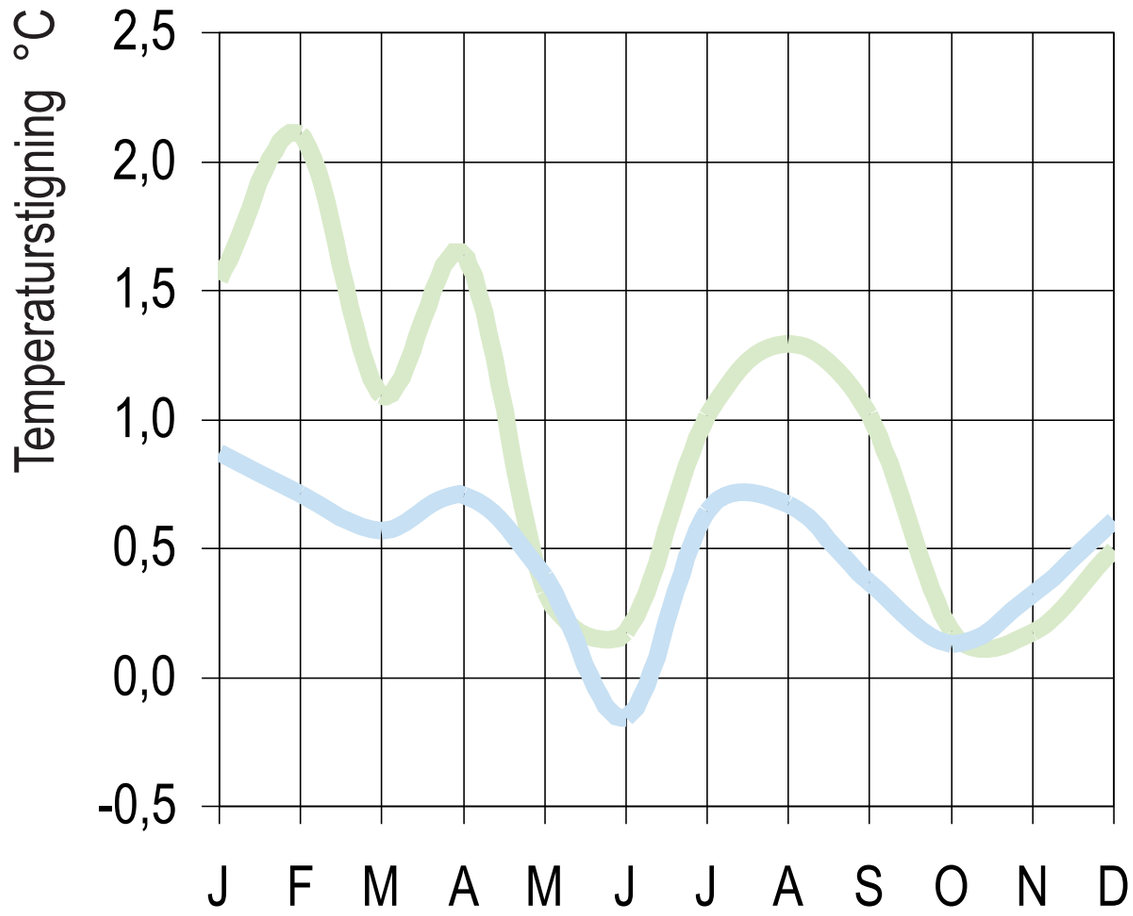
- Average 0.5 °C higher

Last 30 years vs. 1961-90:

- Average 5 % more sunshine

All new buildings designed
with outdated climate data:

- Overestimate heat demand
- Underestimate cooling demand



Figur 16. Stigning i gennemsnitlig udetemperatur i Danmark for følgende perioder:
15 år: 1993-2007 i forhold til 1975-1989
30 år: 1978-2007 i forhold til 1961-1990

Future: Climate change effect om energy consumption

Growing problems with overheating in buildings:

- Heat savings
- Growing electricity consumption
- Larges glass facades
- User demands
- Climate change

Future: Climate change effect om energy consumption

Housing: 2 storey, 120 m^2

Office: 3 storey, 2700 m^2

- Designed after current energy regulations
- Future rise in temperature based on climate change
- Mechanical cooling to eliminate overheating

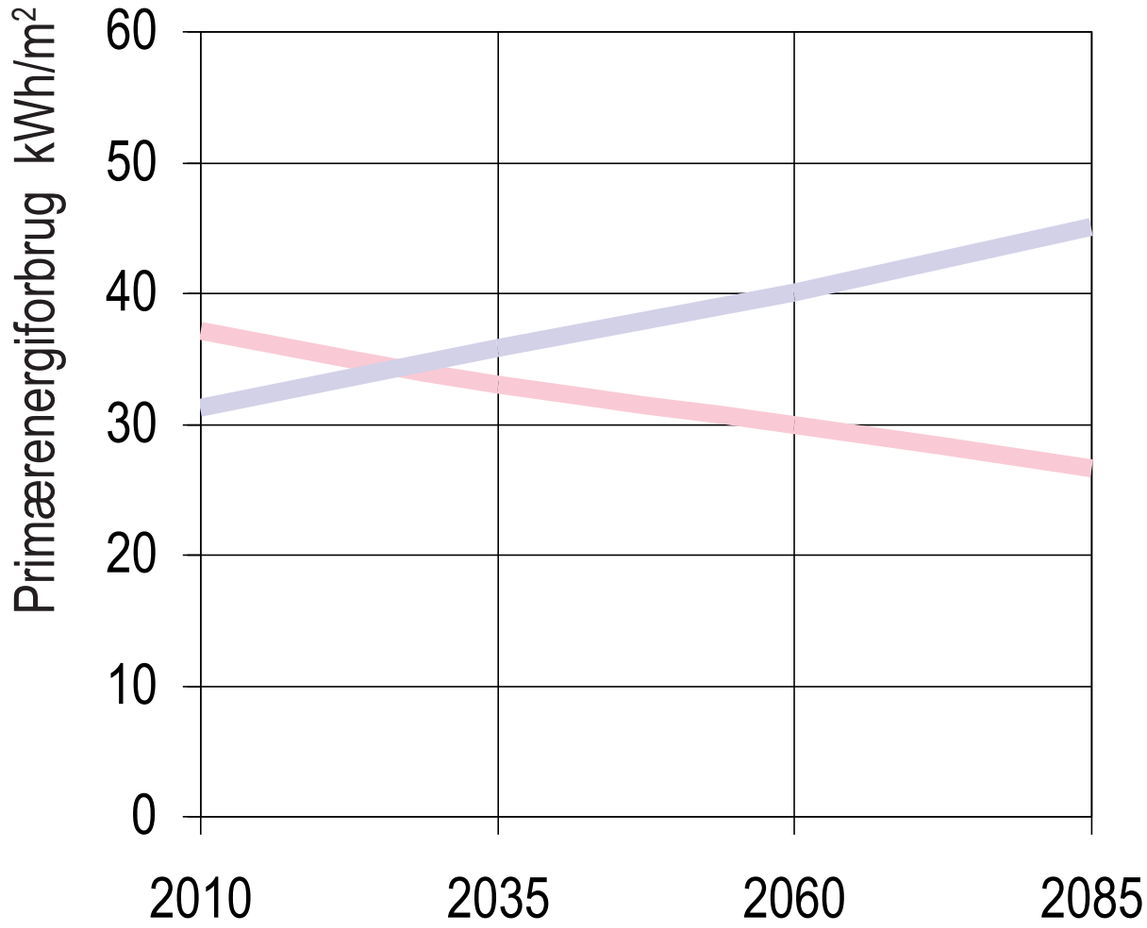
Future: Climate change effect om energy consumption

New housing 2010 - 2085:

Falling space heating: - 30 %

Rising cooling demand: + 40 %

Cooling larger than
space heating within 30 years



Figur 17. Primærenergiforbrug til opvarmning og køling for typiske boliger opført i henhold til BR08 med forventede klimaændringer fra 2010 til 2085:

Opvarmning

Køling

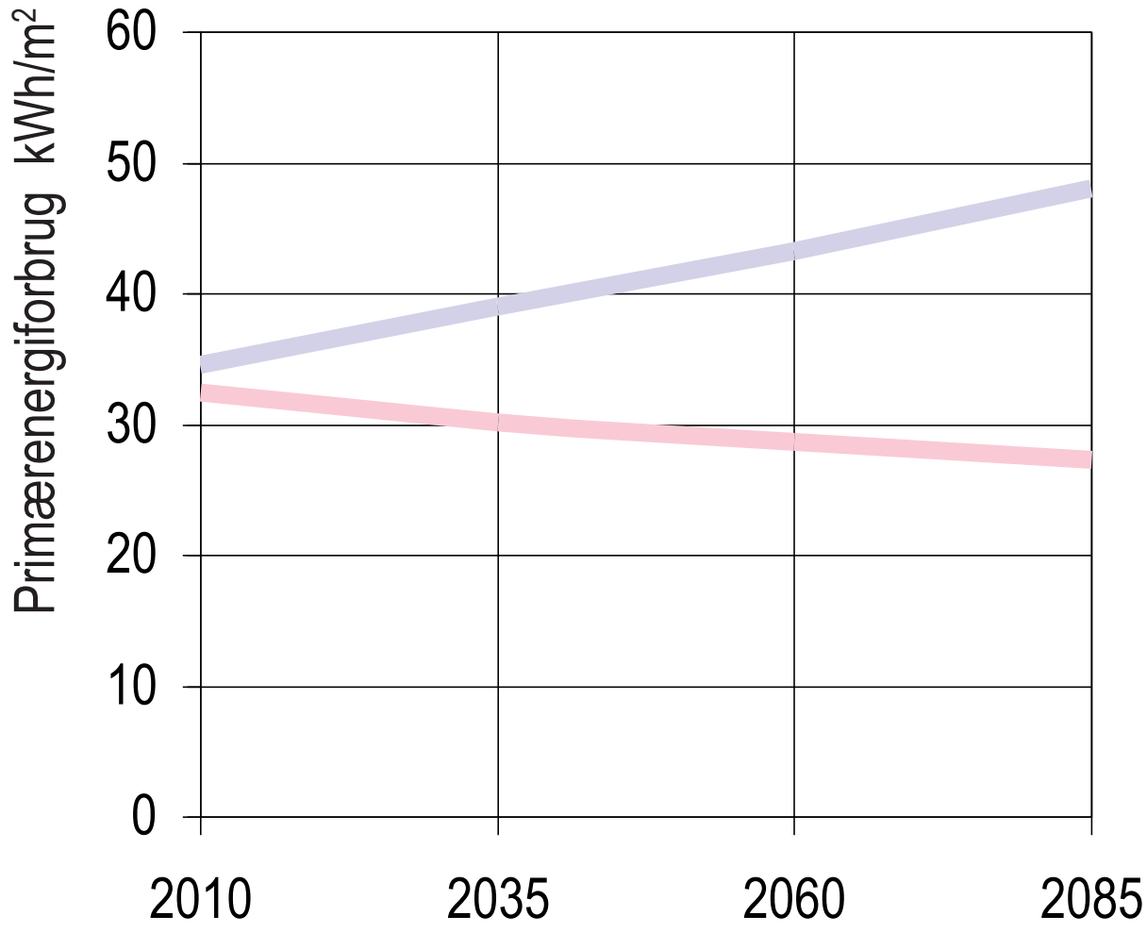
Future: Climate change effect om energy consumption

New offices 2010 - 2085:

Falling space heating: - 15 %

Rising cooling demand: + 40 %

Cooling is already
a larger problem than
space heating in offices

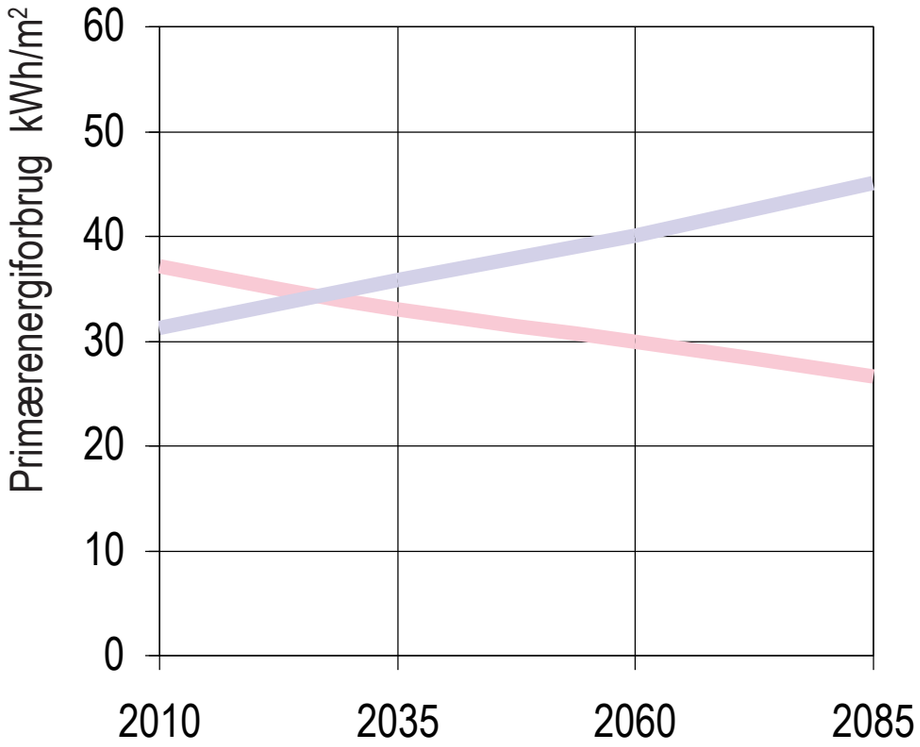


Figur 18. Primærenergiforbrug til opvarmning og køling for typiske kontorer opført i henhold til BR08 med forventede klimaændringer fra 2010 til 2085:

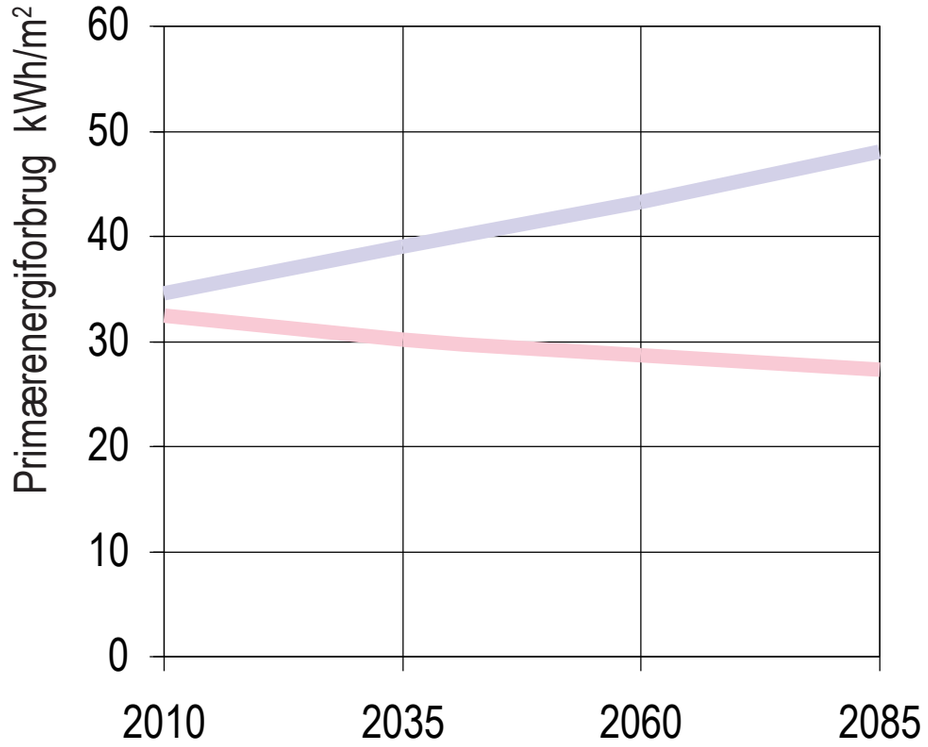
Opvarmning

Køling

Future: Climate change effect om energy consumption



Figur 17. Primærenergiforbrug til opvarmning og køling for typiske boliger opført i henhold til BR08 med forventede klimaændringer fra 2010 til 2085:
Opvarmning
Køling



Figur 18. Primærenergiforbrug til opvarmning og køling for typiske kontorer opført i henhold til BR08 med forventede klimaændringer fra 2010 til 2085:
Opvarmning
Køling

Climate change means:

- Summer conditions will dominate; not winter conditions
- Need for climate adaptation of low energy buildings

Paradigm

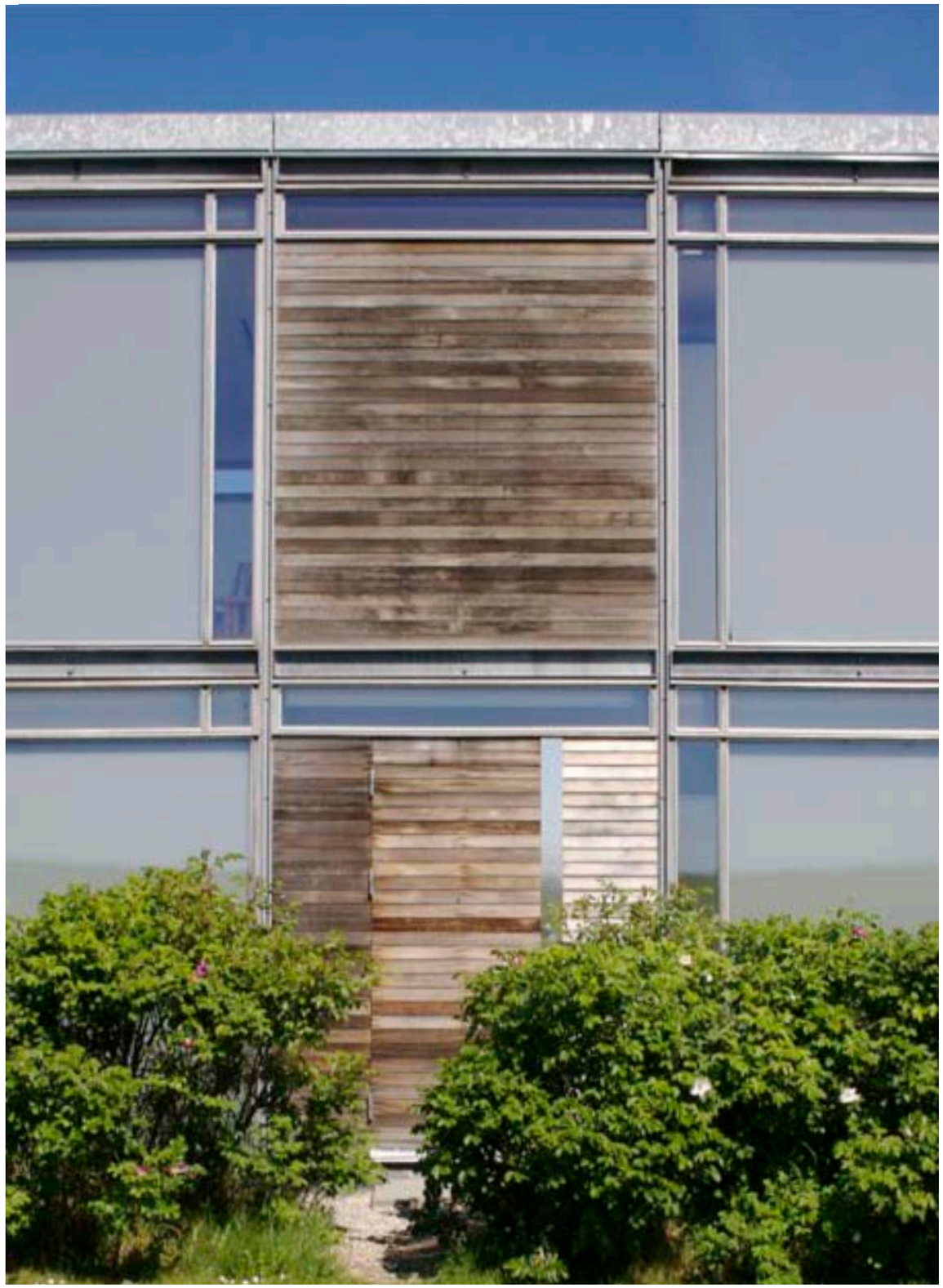
Low energy paradigms

Historical *low energy* paradigm
with narrow focus on heat savings

Say: *Energy saving*

Mean: *Heat saving*

Heat saving strategies
with negative energy and
indoor climatic consequences



Low energy paradigms: Passive solar

Concept developed i 1960-70's:

- Mountainous zones with considerable sunshine in the winter
- Large south-facing glazed areas to minimise heating

Used in Denmark from 1970's despite different climate:

- Cloudy or overcast sky for 80 % of daylight hours in the winter
- Well known projects with documented summer overheating problems

Low energy paradigms: Passive solar

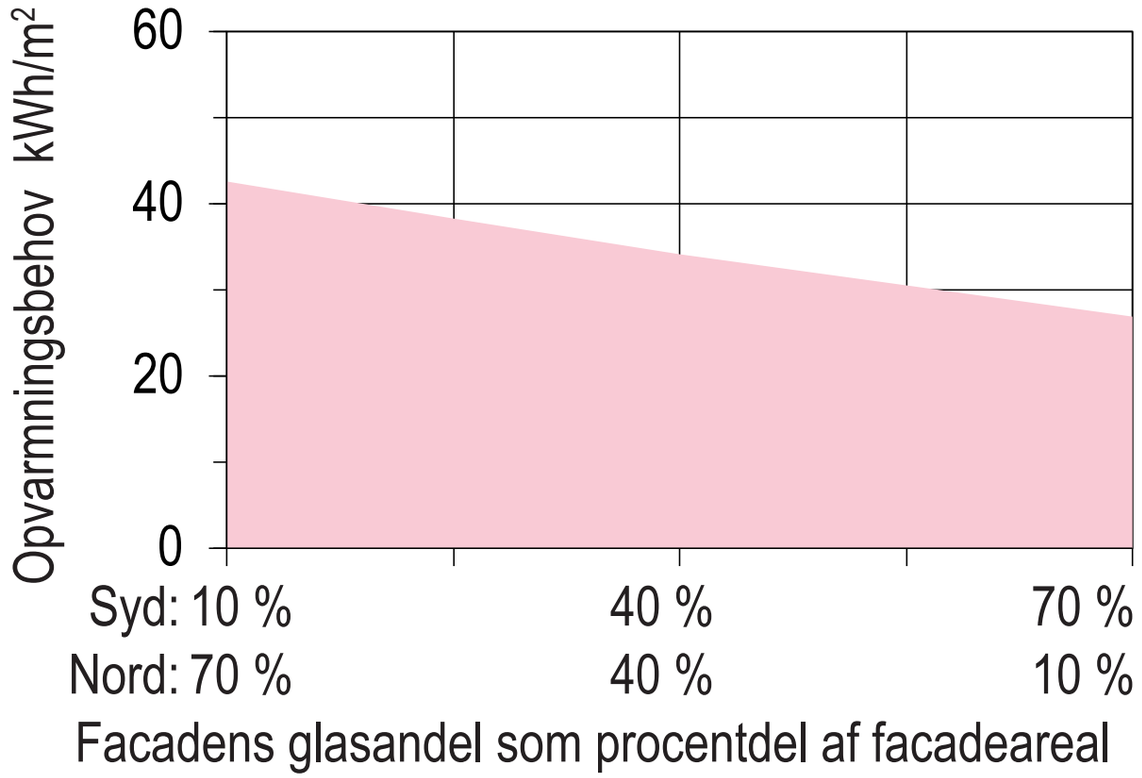
Analysis of typical house orientated north/south:

- Total glazing area fixed
- Glazing area redistributed from north-facing to south-facing facades

Low energy paradigms: Passive solar

Calculated in relation to previous energy regulations:

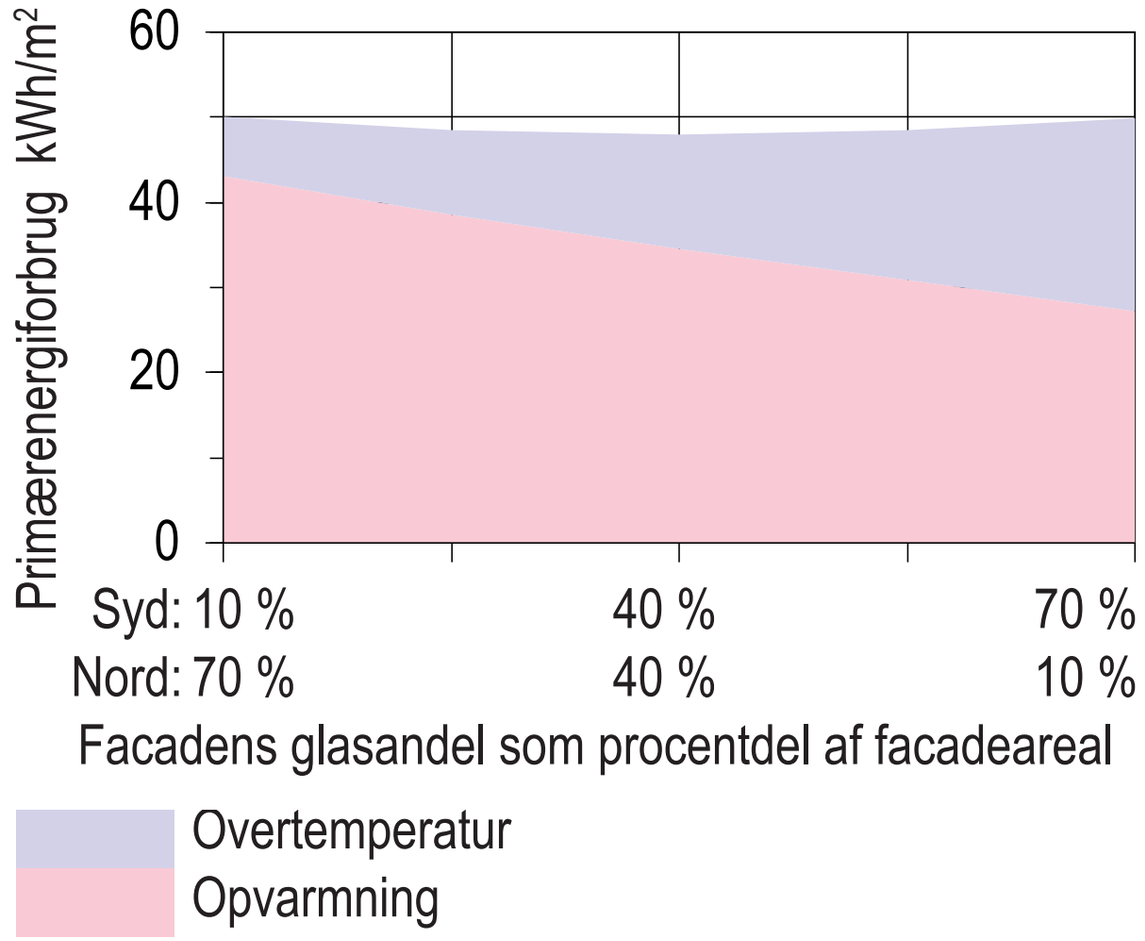
- Narrow *low energy* paradigm with focus on space heating
- Passive solar energy reduces space heating demand



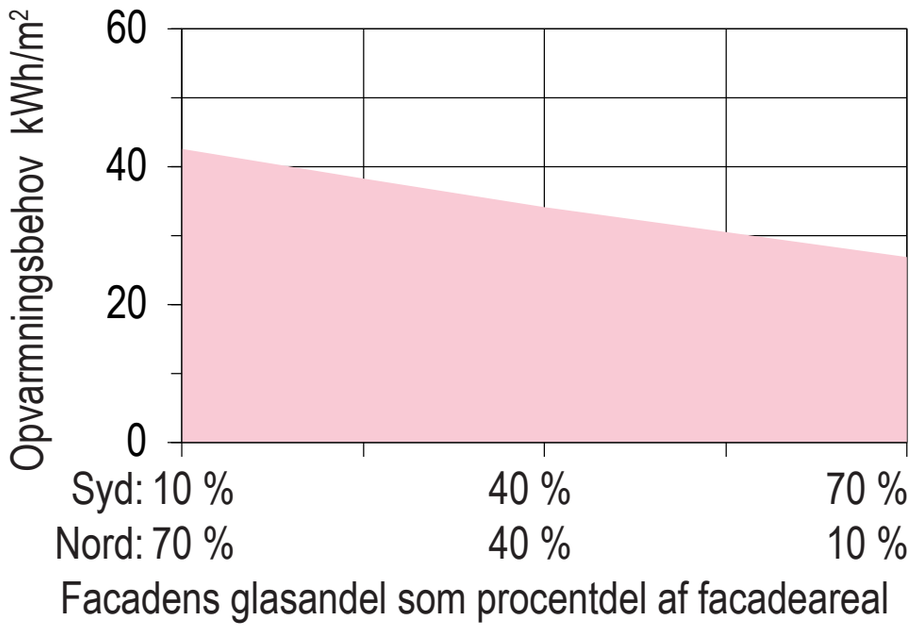
Low energy paradigms: Passive solar

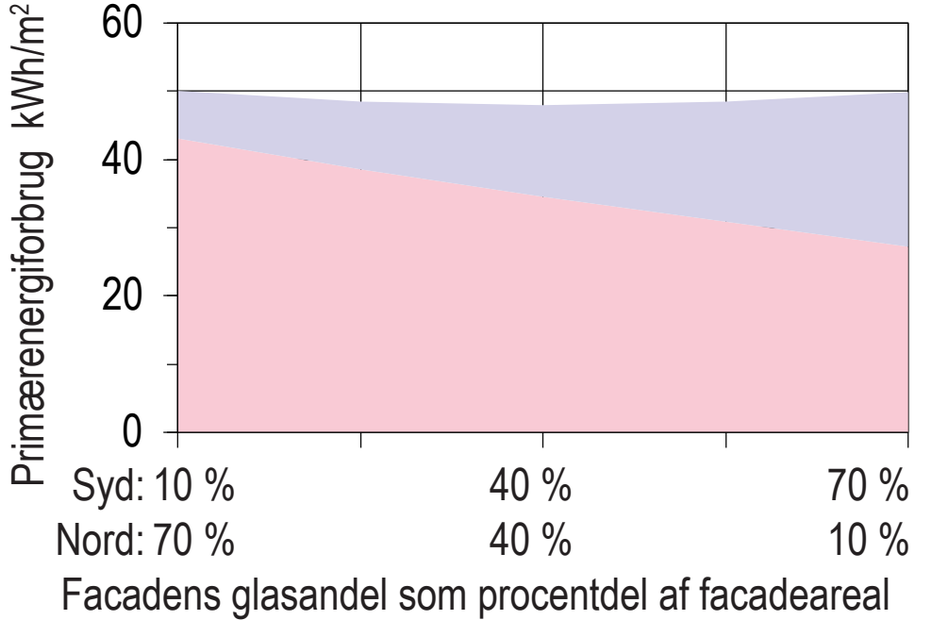
Calculated in relation to new energy regulations:

- Wider *low energy* paradigm with focus on space heating and overheating/cooling
- No advantage from passive solar energy because of overheating



Low energy paradigms: Passive solar





Same building; different *low energy* paradigms:

- Narrow *low energy* paradigm creates invisible problems
- Heat consumption replaced by electricity consumption
- Growing future problem because of climate change

Low energy paradigms: Mechanical heat recovery ventilation

Heat recovery efficiency:
65 % - 90 %

Systems have a relatively high electricity consumption:

- Deep buildings with internal rooms must be ventilated mechanically all year round
- Always advertised by high heat recovery efficiency
- Data on electricity consumption forgotten or hidden

Low energy paradigms: Mechanical heat recovery ventilation

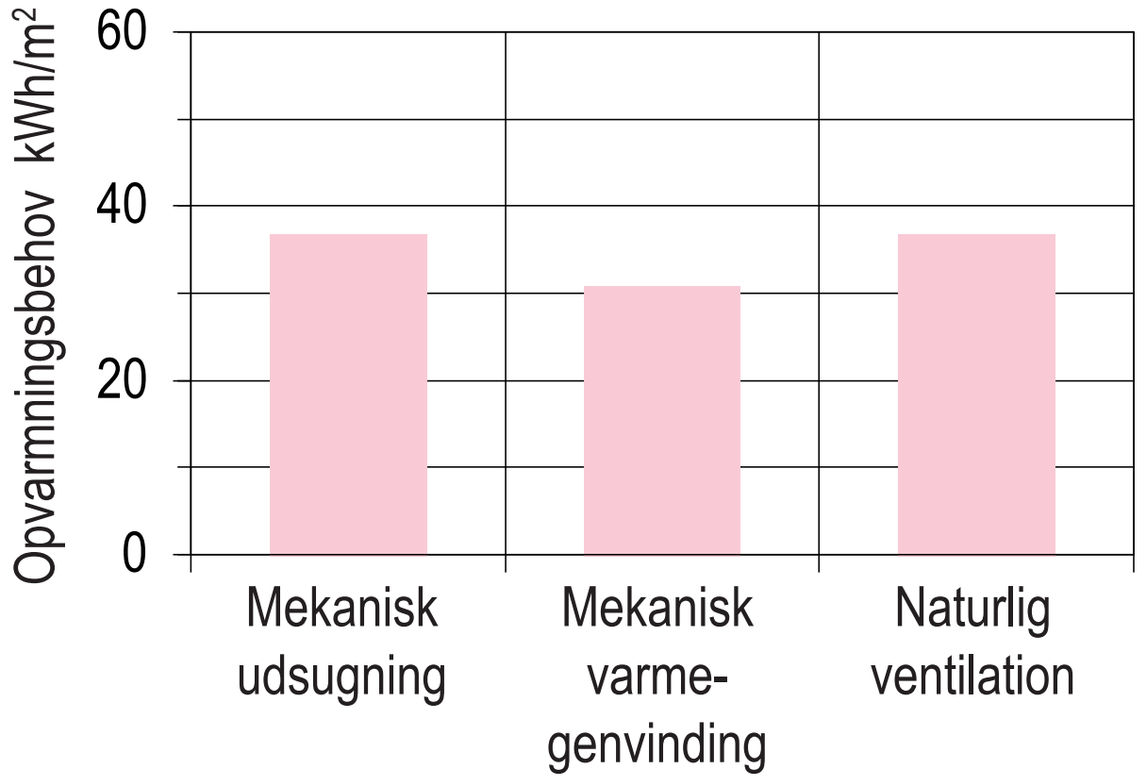
Analysis of typical house
with 3 ventilation strategies
that meet building regulations
minimum requirements:

- Mechanical extract
- Mechanical heat recovery
- Natural ventilation

Low energy paradigms: Mechanical heat recovery ventilation

Calculated in relation to previous energy regulations:

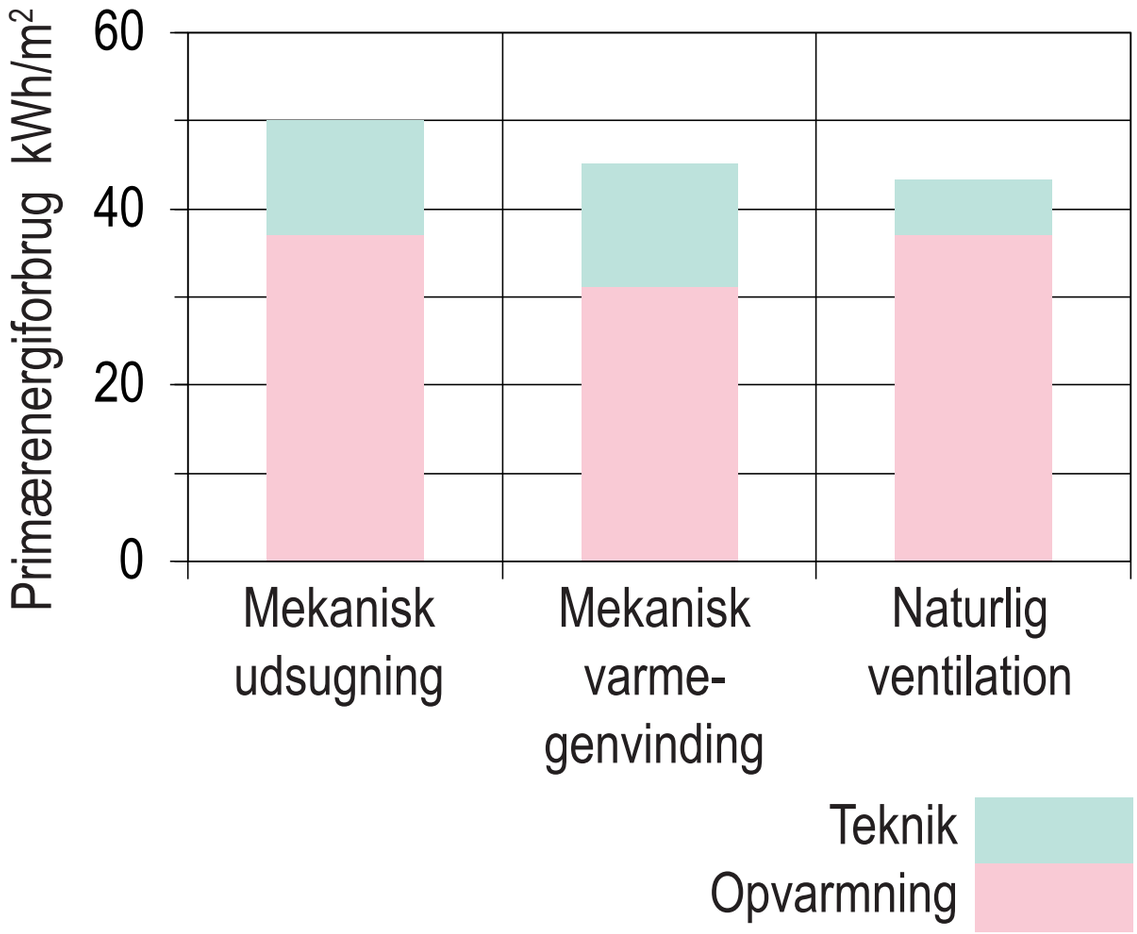
- Narrow *low energy* paradigm with focus on space heating
- Mechanical heat recovery reduces space heating demand



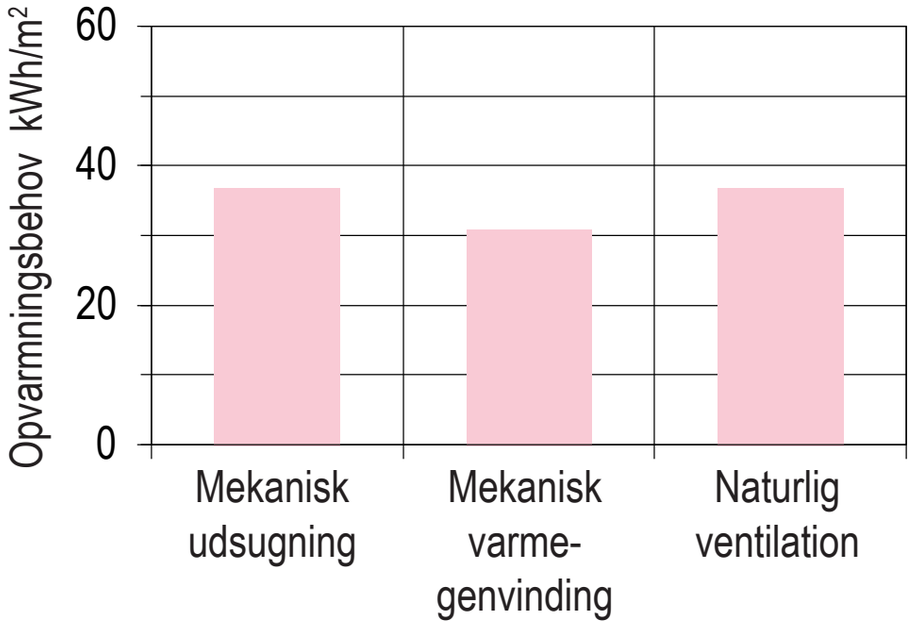
Low energy paradigms: Mechanical heat recovery ventilation

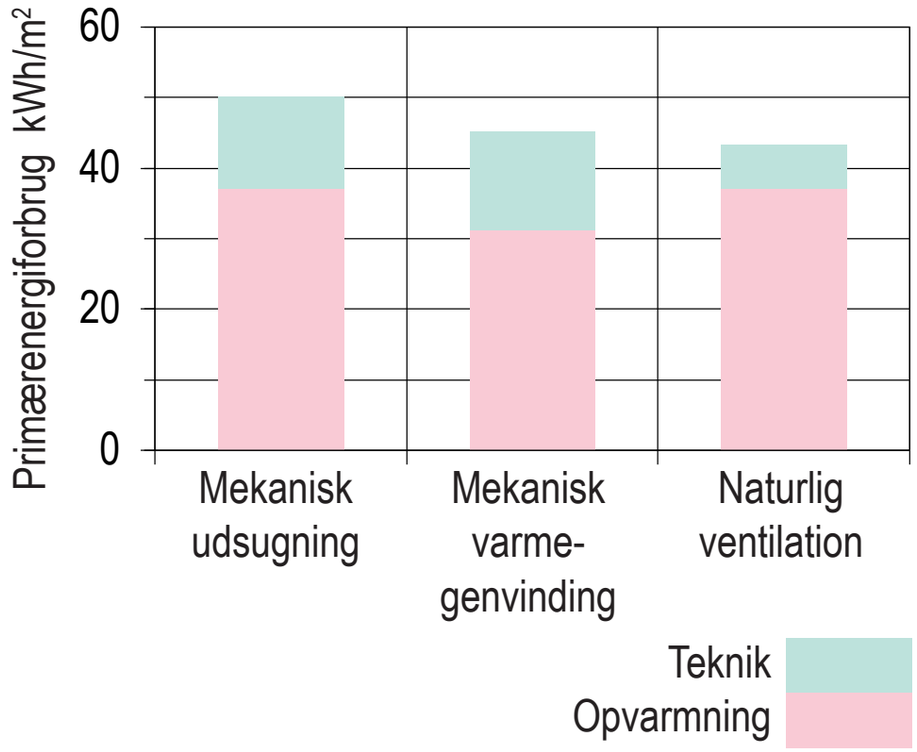
Calculated in relation to new energy regulations:

- Wider *low energy* paradigm with focus on space heating and electricity to building services
- No difference between natural ventilation and mechanical heat recovery



Low energy paradigms: Mechanical heat recovery ventilation





Same building; different *low energy* paradigms:

- Narrow *low energy* paradigm creates invisible problems
- Heat consumption replaced by electricity consumption
- No energy saving from mechanical heat recovery

Low energy paradigms

1990's energy and environmentally responsible housing:

Low energy? - No!

- Low space heating demand
- High electricity consumption
- High cooling demand
- Same primary energy consumption as ordinary housing without specific heat saving strategies

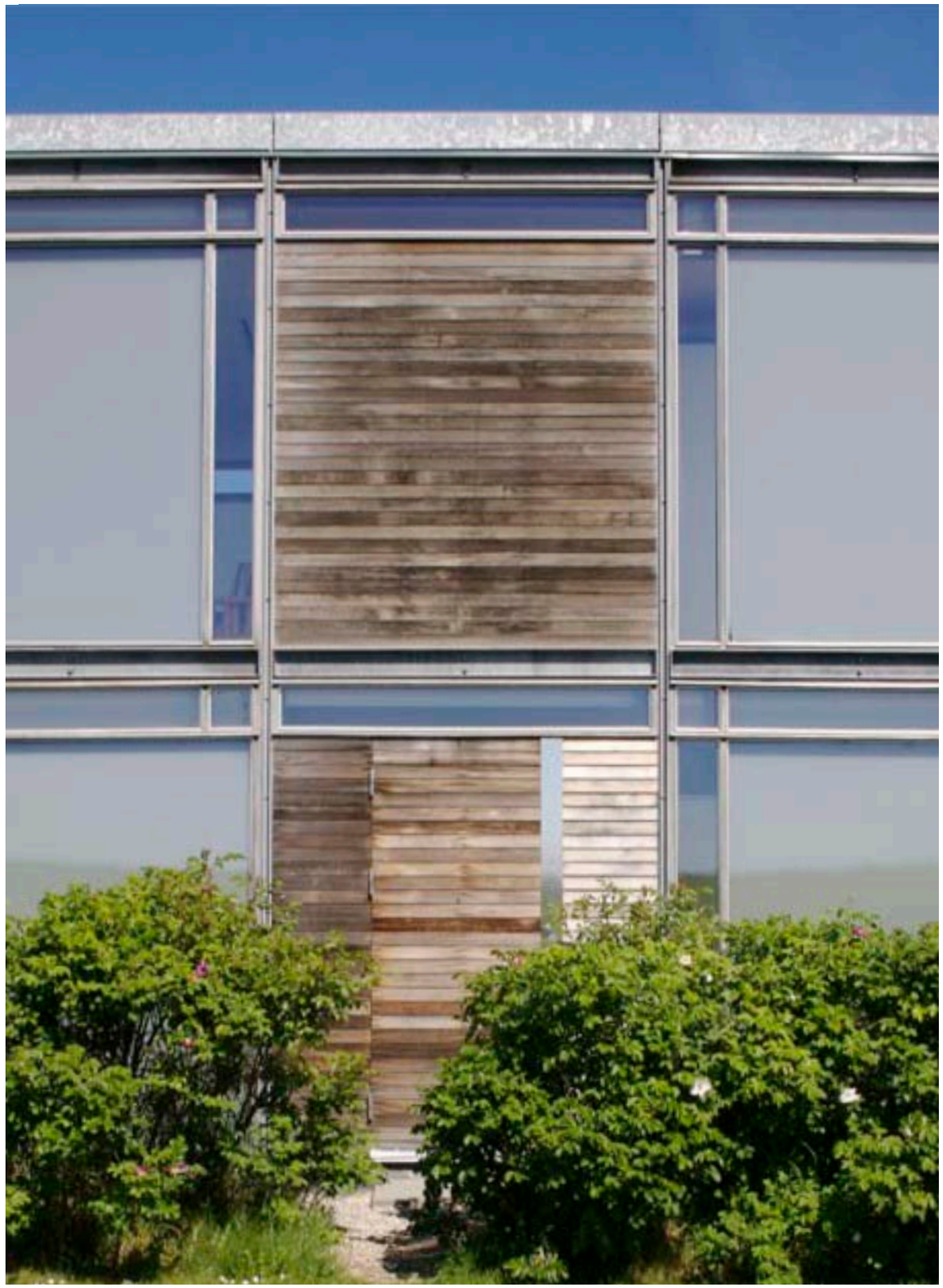
What is a Low-energy Building?

Our paradigm for 'low-energy' has been transformed:

1. Traditional heat savings

2. Building Regulations

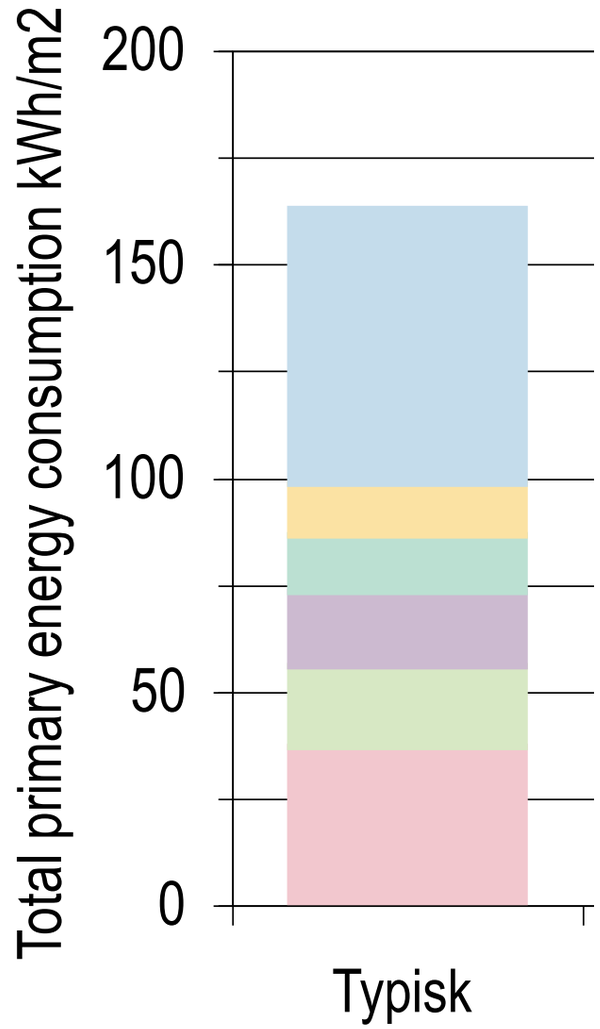
3. CO_2-neutrality



1: Traditional Heat Savings

Focus on space heating:

- only 20% af total primary energy



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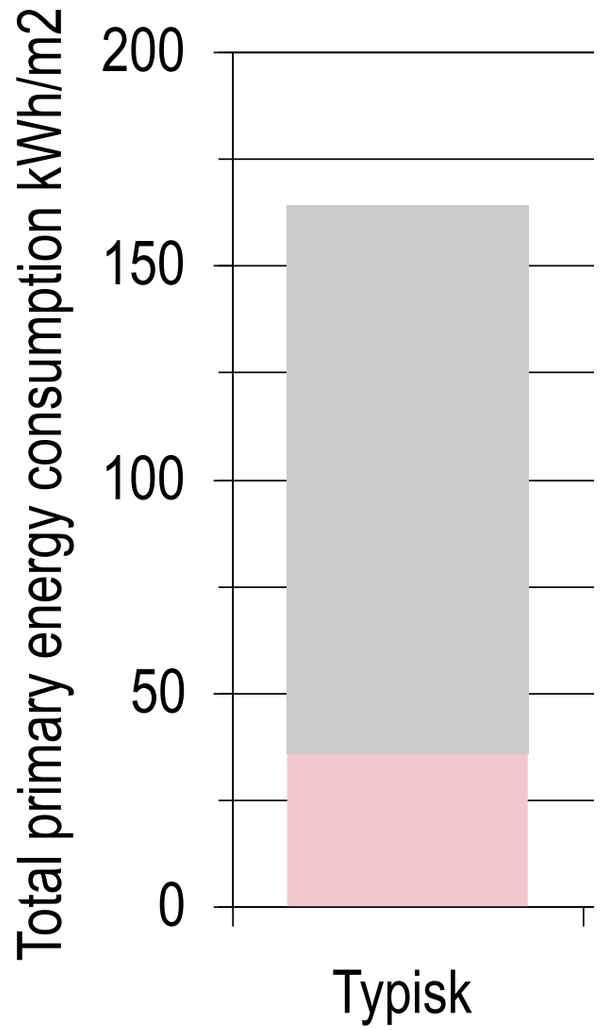
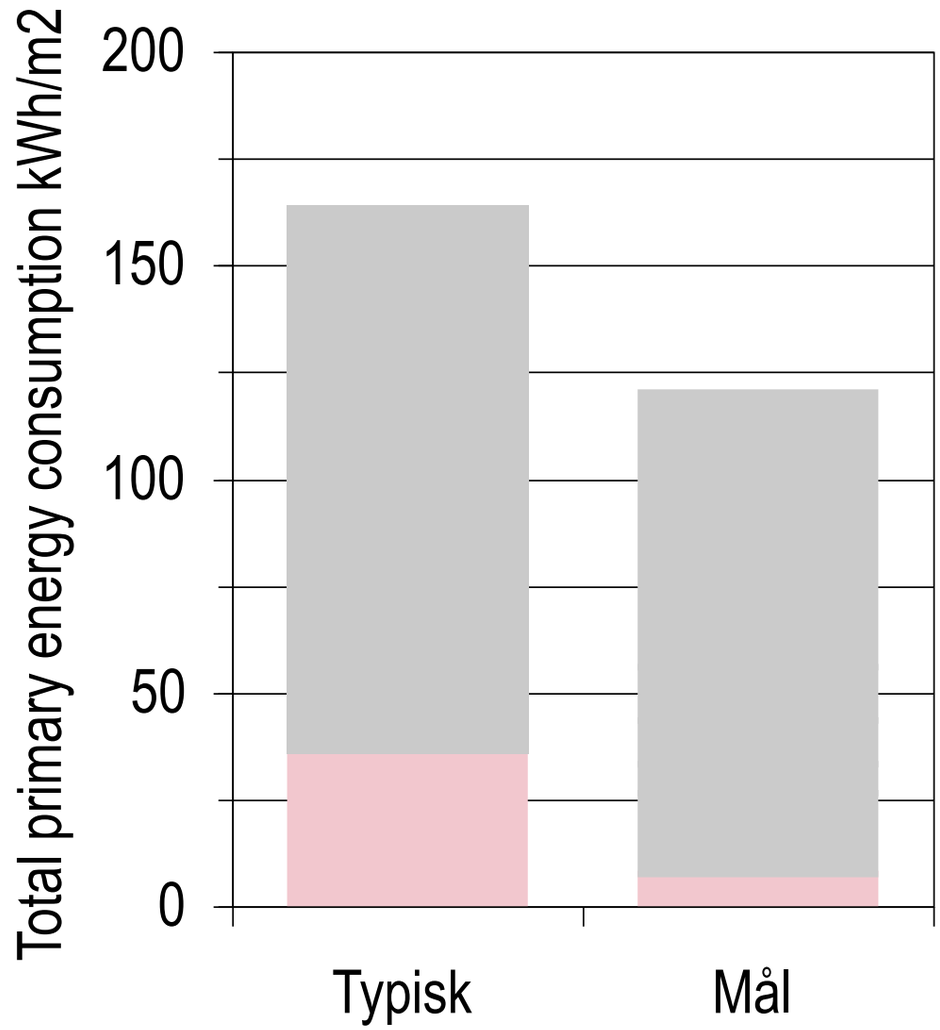


1: Traditional Heat Savings

Space heating reduced by 80 %
to under 15 kWh/m²

- Total saving only 20 %



1: Traditional Heat Savings

Space heating reduced by 80 % to under 15 kWh/m^2

- Total saving only 20 %
- Passive House Concept

2: Energy Regulations

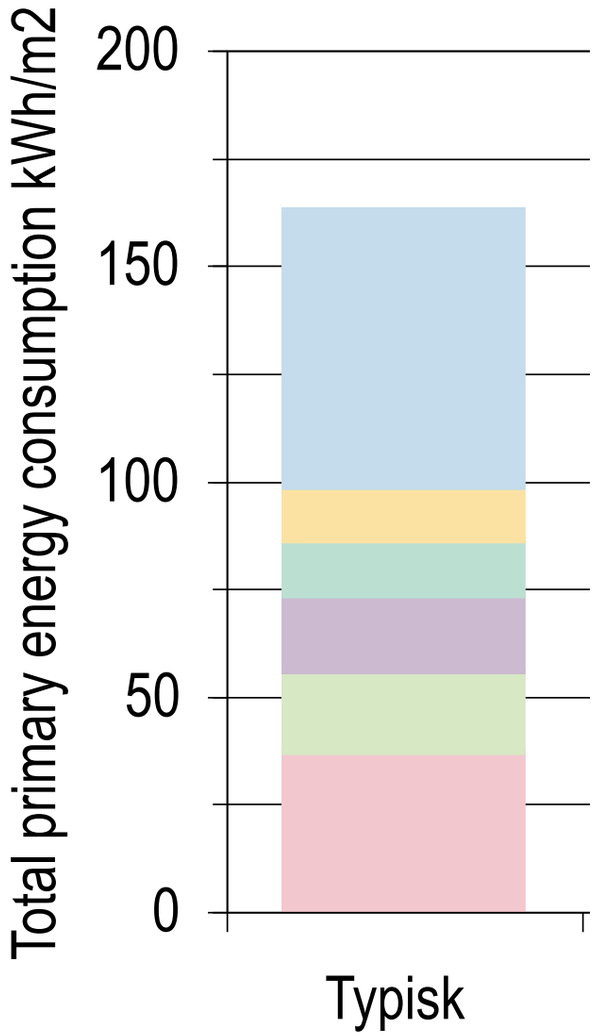
Focus on: Heating

Hot water

Cooling/overheating

Building services

- 50% af total primary energy



2: Energy Regulations

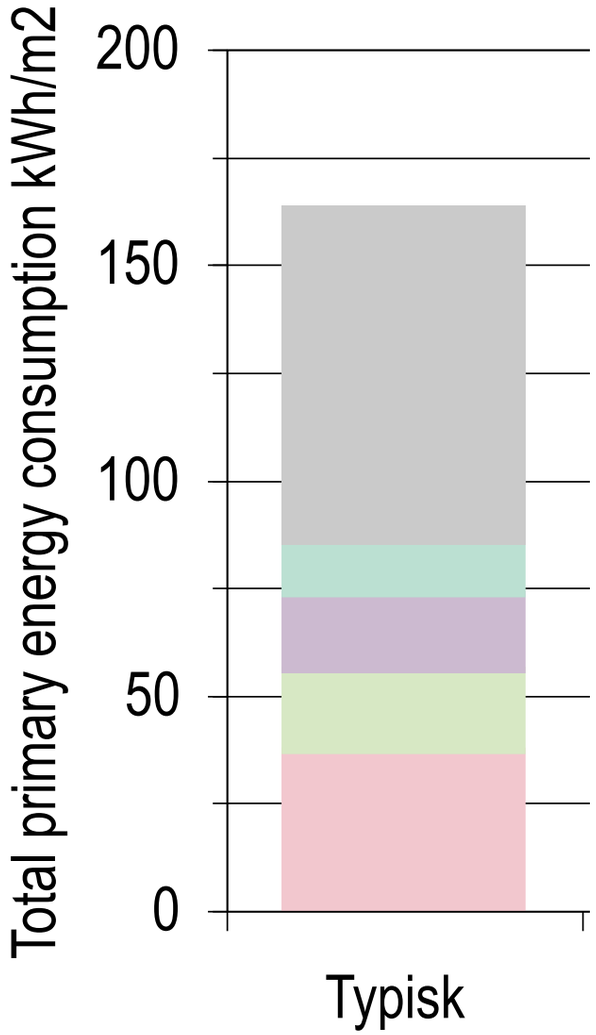
Focus on: Heating

Hot water

Cooling/overheating

Building services

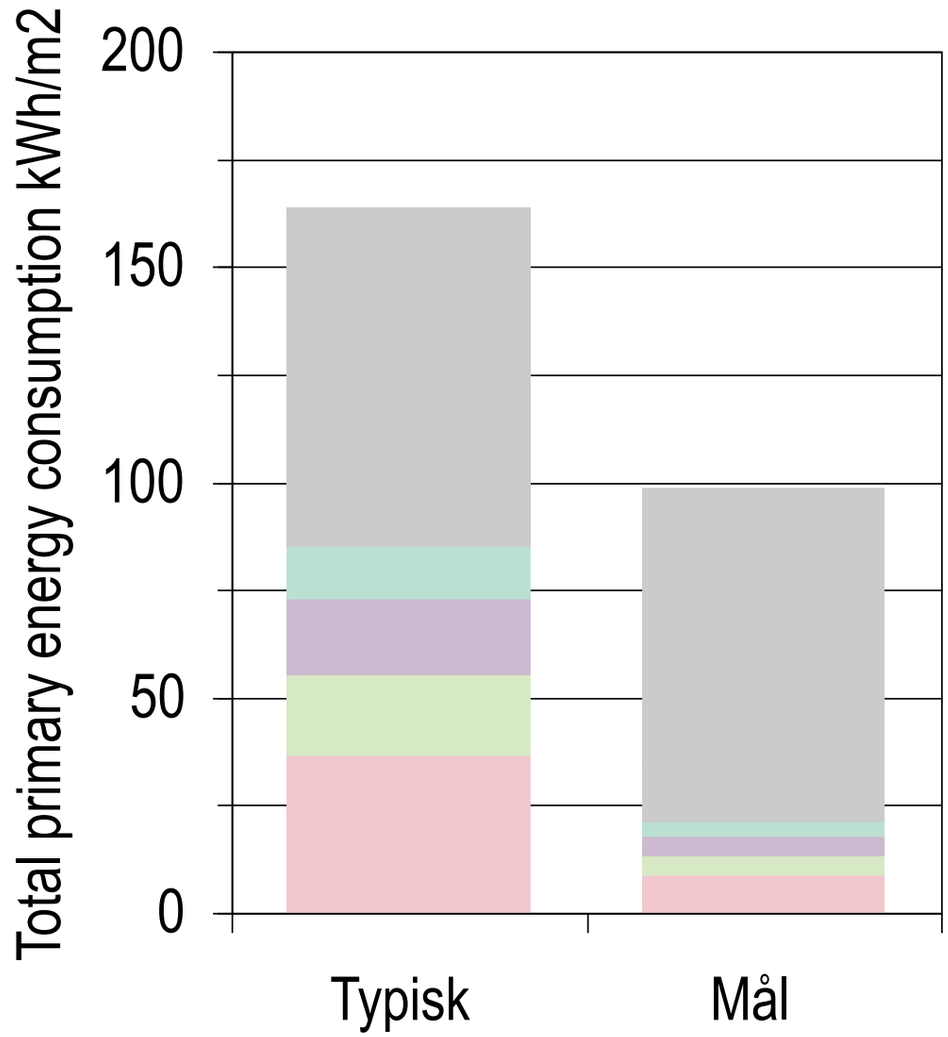
- 50% af total primary energy



2: Energy Regulations

Political aim for 75 % reduction by 2020:

- Savings for users only 40% because equipment and lighting are not covered

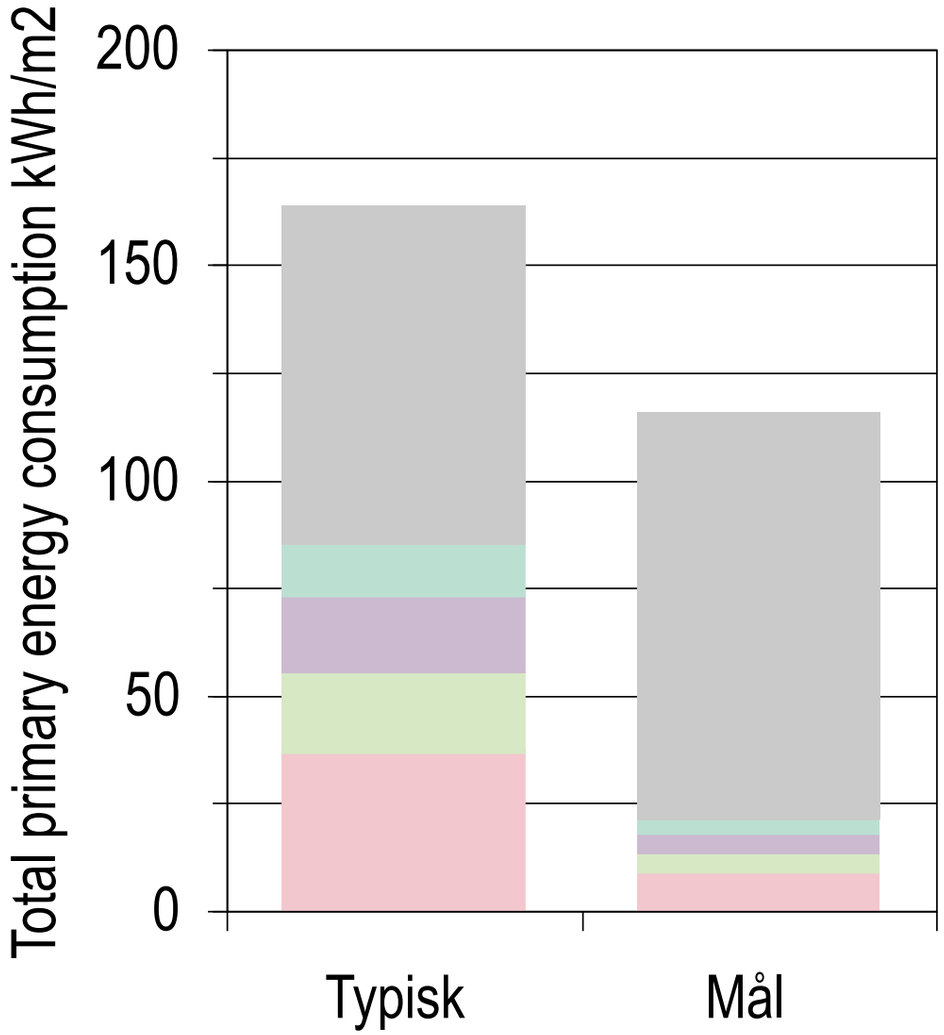


2: Energy Regulations

Non-regulated electricity consumption expected to grow 25 % by 2020:

- Electrical equipment and lighting responsible for 85 % of consumption

Building Regulations cannot be used to regulate/control electrical equipment and lighting



3: CO_2-neutrality

Focus on: Heating

Hot water

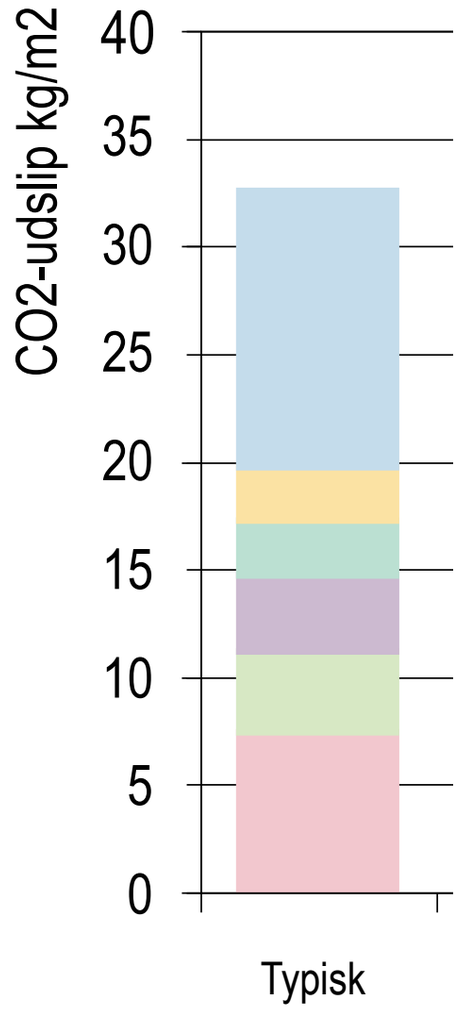
Cooling/overheating

Building services

Lighting

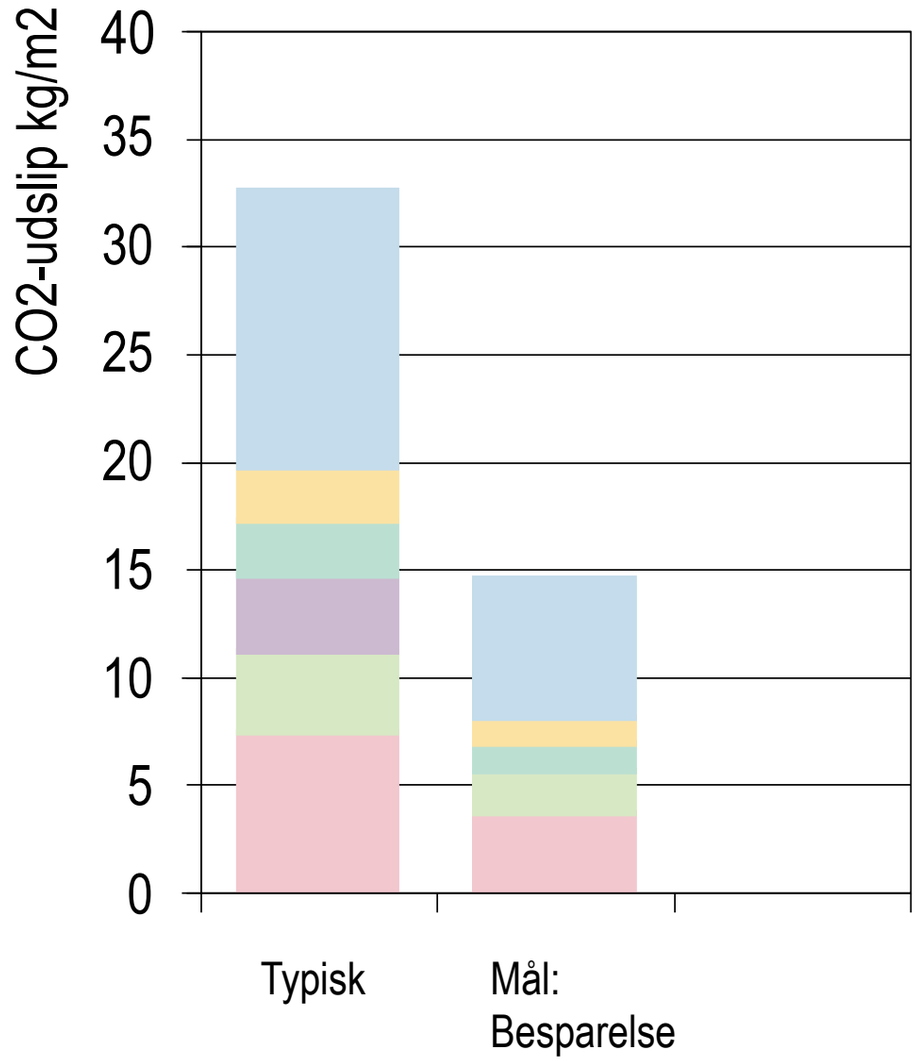
Equipment

And: Renewable energy production interacting with energy supply system



3: CO_2-neutrality

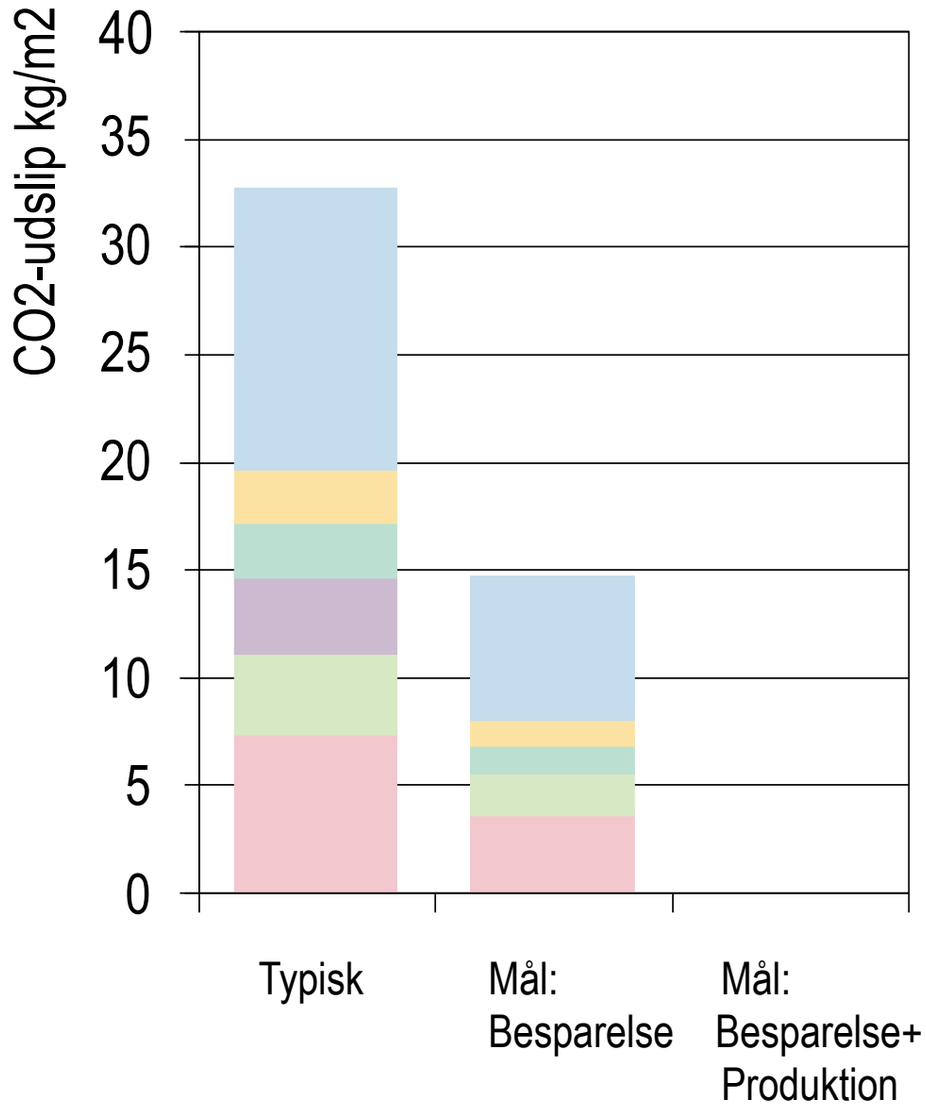
- Broad spectrum of electricity and heat savings



3: CO_2-neutrality

- Broad spectrum of electricity and heat savings

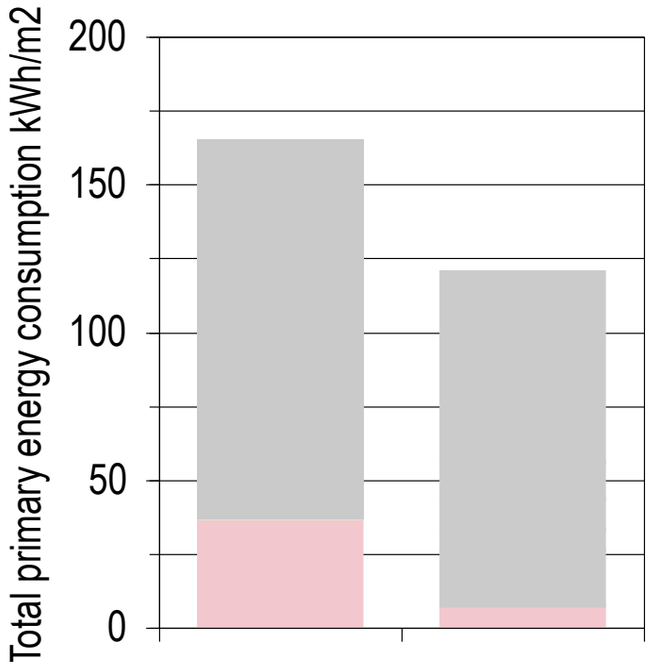
- Building integrated renewable energy production for energy neutrality on a yearly basis

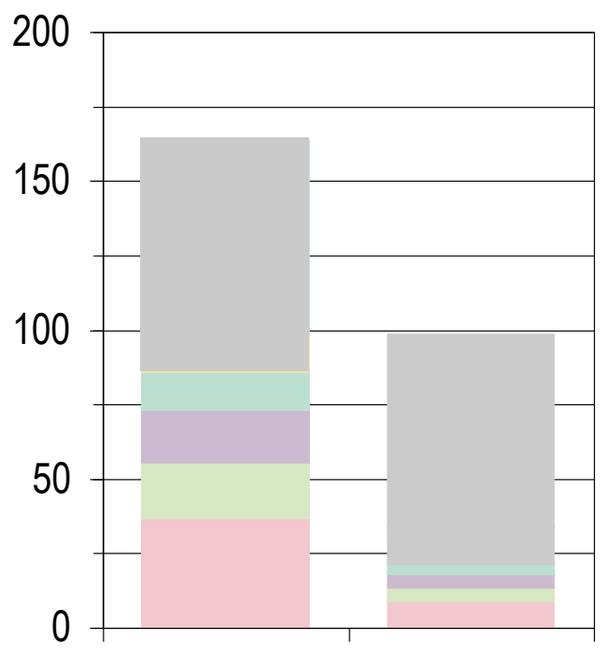


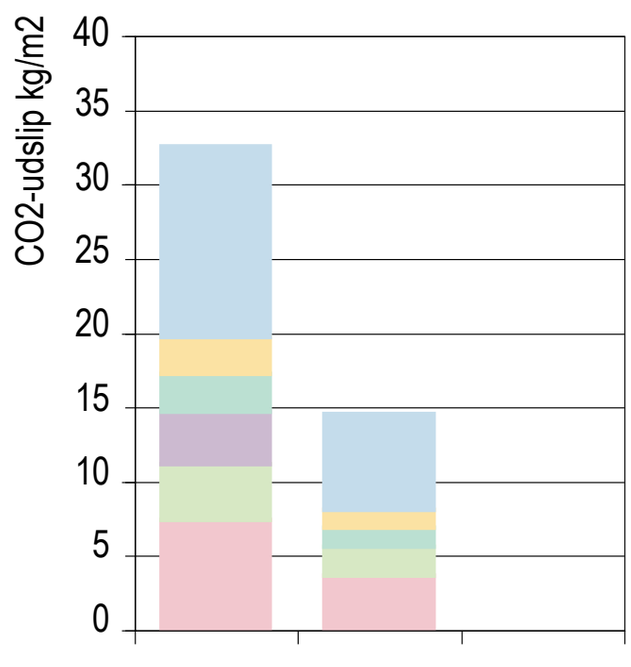
3: CO_2-neutrality

- Impossible to demand CO_2- or energy neutrality in current Energy Regulations because og electrical equipment

Low energy Paradigms







Narrow — Wide

Detailed — Holistic

Local — Global

Industry Society — Knowledge Society

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Thank you!