Why has the level of household energy consumption stopped increasing in Norway- and how to make it decrease?

MILEN International Conference 2012

Advancing the research and policy agendas on sustainable energy and the environment

22.-23. November, Helga Engs Hus, University of Oslo

Professor Carlo Aall

Western Norway Research Institute / Aarhus University Herning

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30 researchers doing research (and no teaching!) on:

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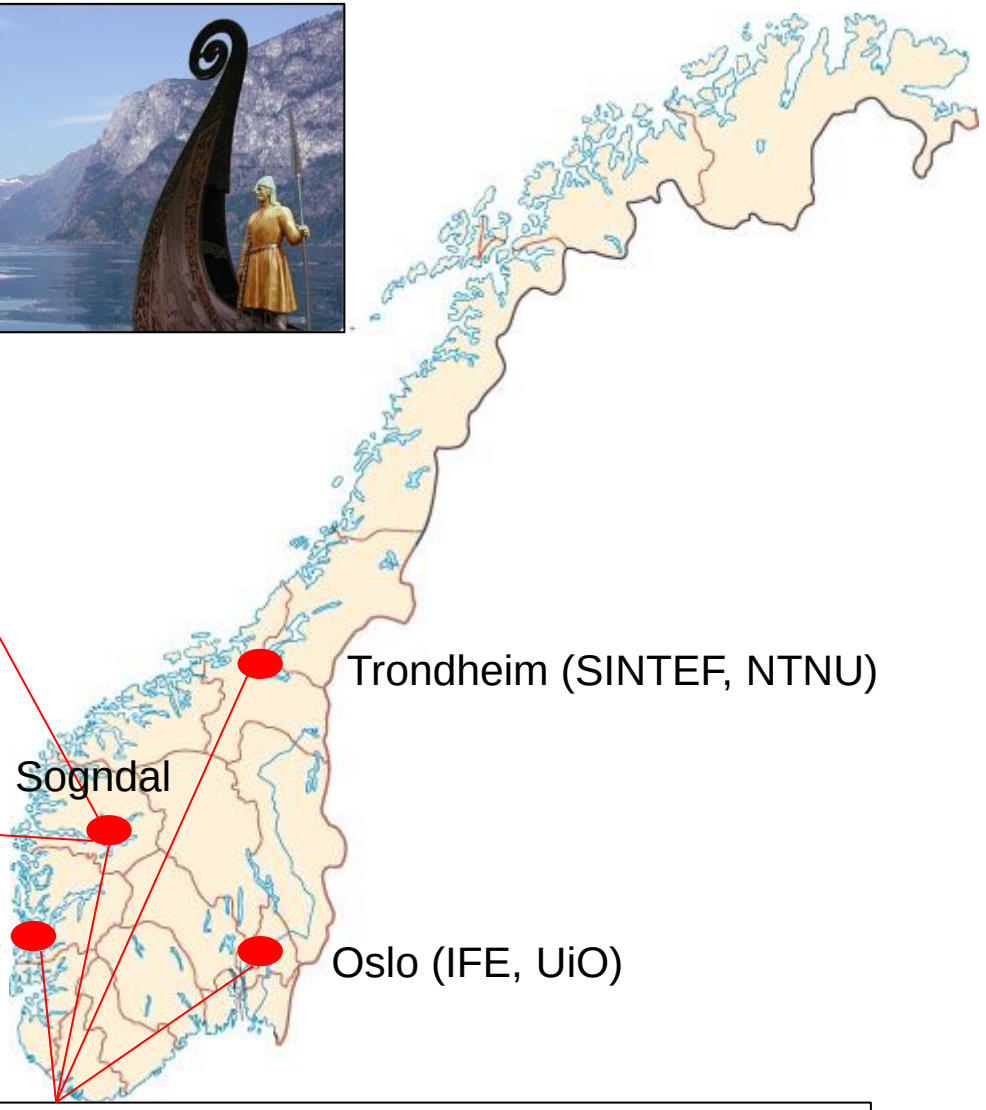
- **Sustainable Development**



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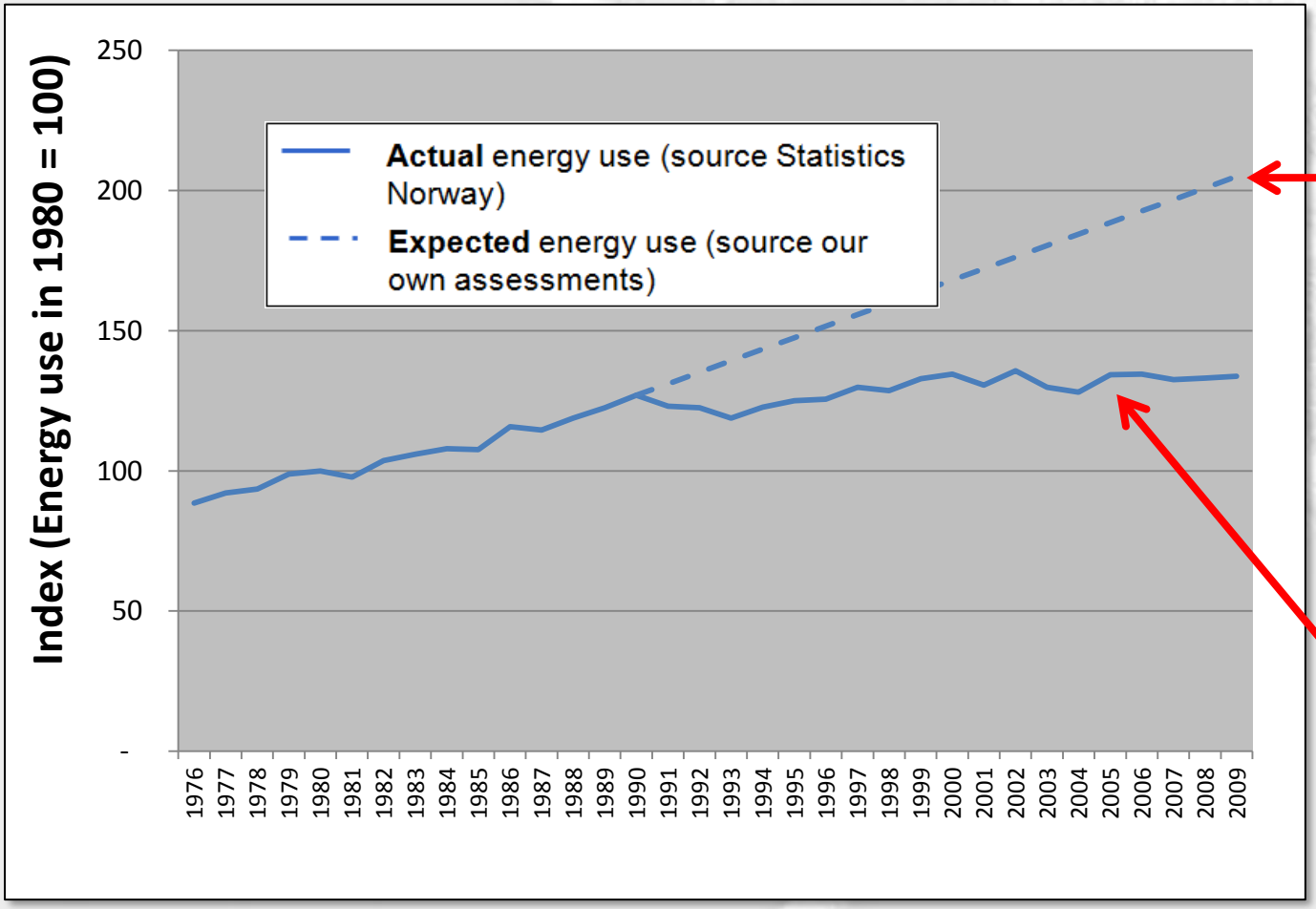
Outline

- Presentation of the case
- The energy and climate policy context
- Methodological approach
- Results
- Some final theoretical reflections

The case to be presented: Trying to explain the unexpected shift in Norwegian household energy-use

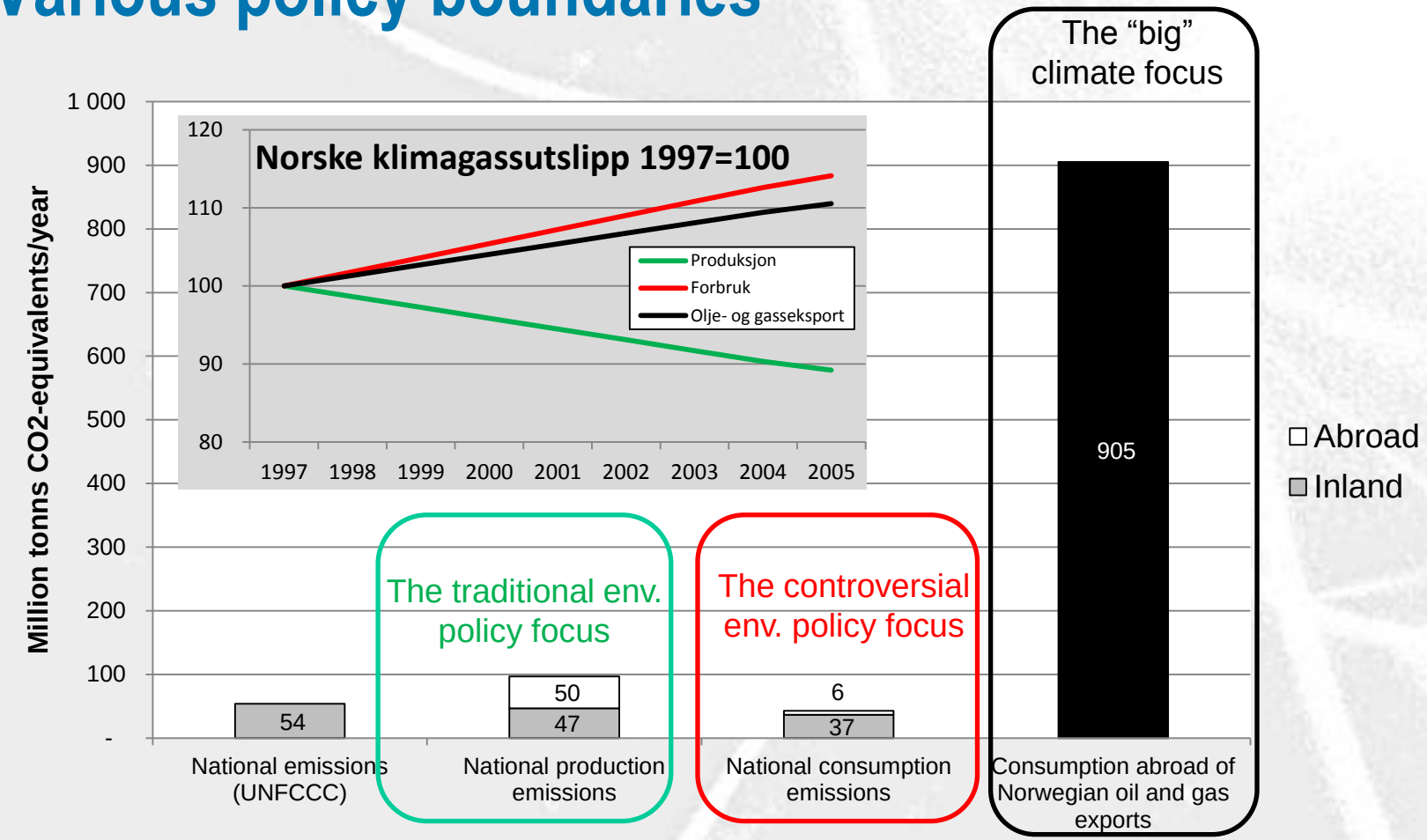


Assessments made by the Norwegian Water Resources and Energy Directorate (NVE) in **1990** (and **1998**) concluded that household energy-use would continue to increase at the same rate as from 1976 to1990

In **2011** NVE commissioned a study to explain why this had happened

The energy and climate policy context

Various policy boundaries



Hille, J., Storm, H.N., Aall, C., Sataøen, H.L. (2008): Miljøbelastningen av norsk forbruk og produksjon 1987 – 2007. En utredning for Miljøverndepartementet og Barne- og likestillingsdepartementet. VF-rapport 2/08. Sogndal: Vestlandsforsking.

5 % reduction in Norwegian oil and gas production equals 100 % reduction in the official Norwegian GHG emissions

BUT:

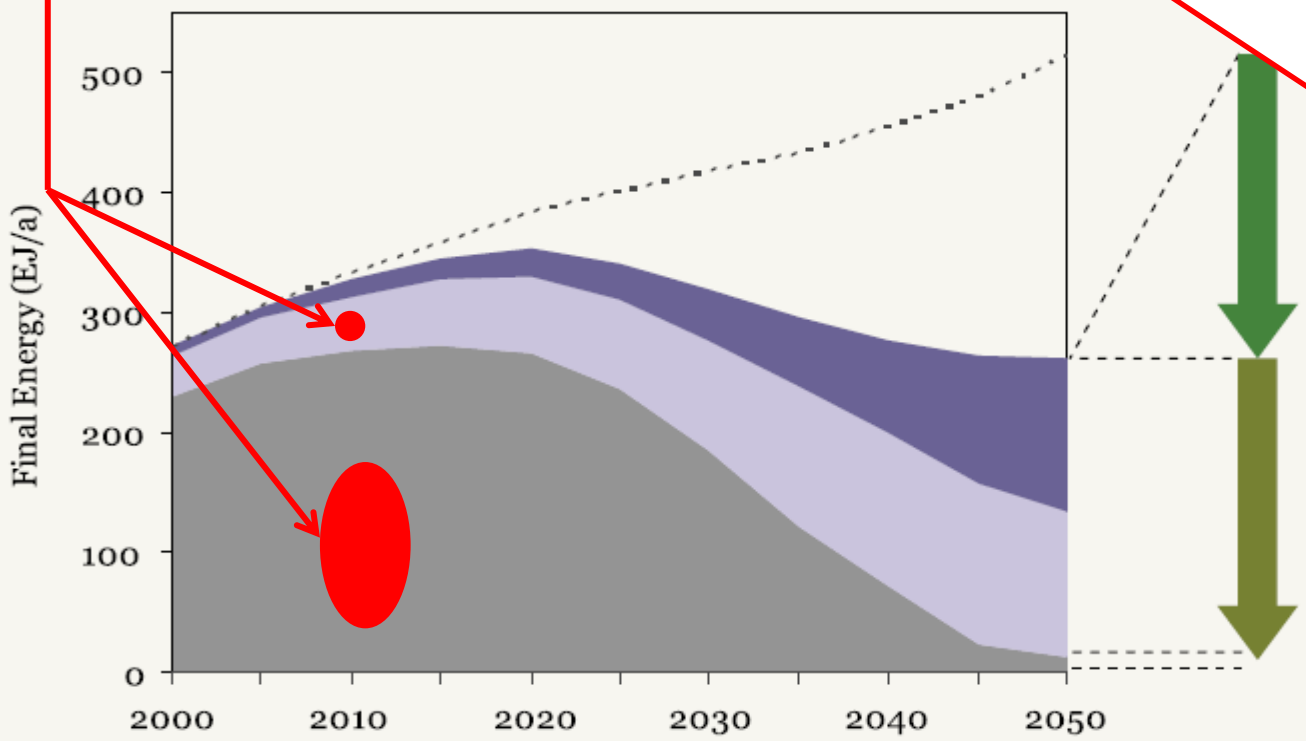
”The opening of new oilfields in Norway and the rate of Norwegian oil production in existing oilfields will **not** be governed by climate concerns”

(Statement made by the Minister of Energy, O.B. Moe to the newspaper ”Dagens Næringsliv”, 1.12.2011)

Current focus in Norway in both policymaking and research: Opening up new gas and oil fields and developing new renewable energy (mainly wind and hydro)

Debate yet to come (the degrowth debate have especially proved to be difficult to raise in Norway!")

Our study



- 50 % in energy use in relation to expected increase

5 X increase in current amount of renewable energy production

Source: The Ecofys Energy Scenario (2010).

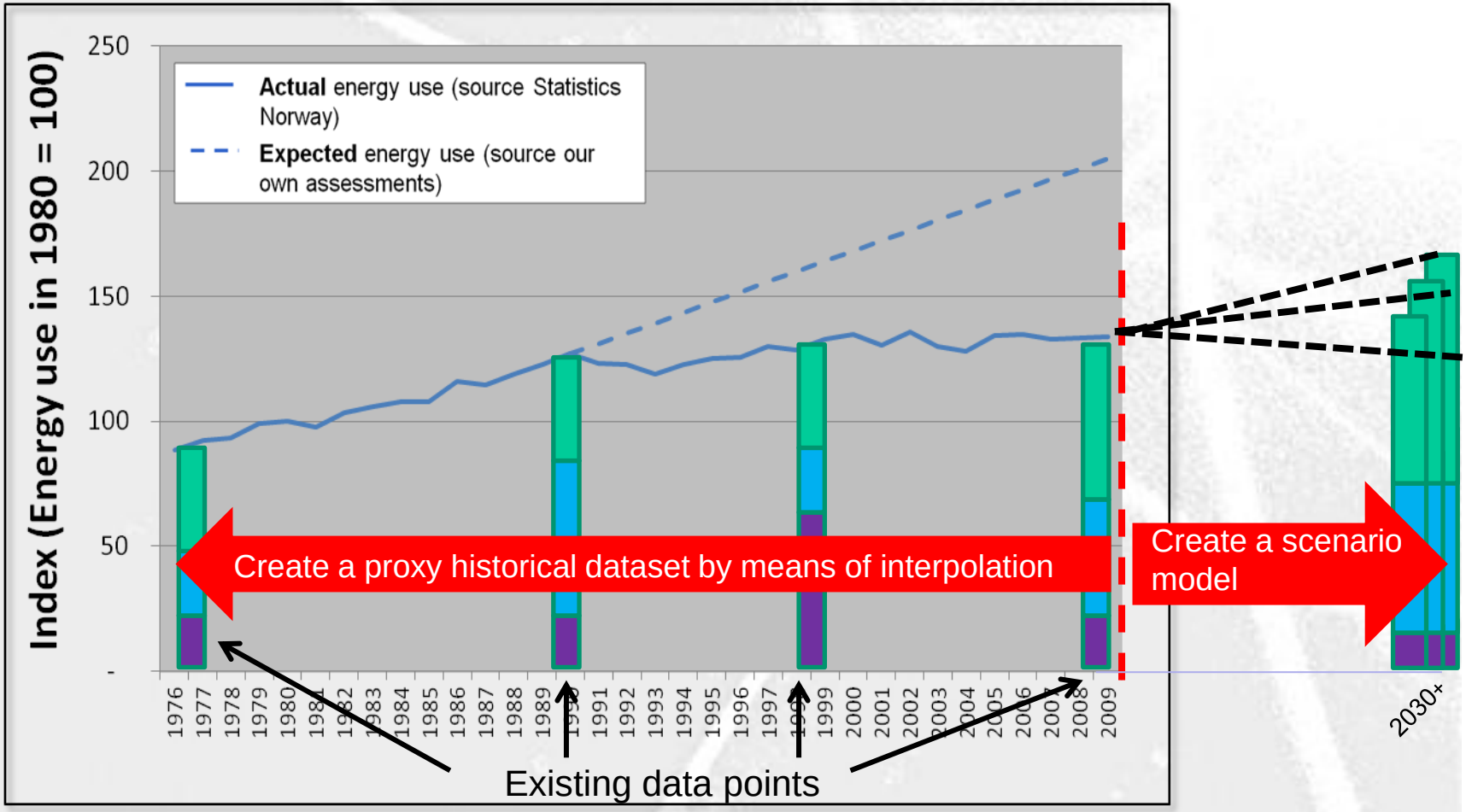
Methodological approach

Research questions

- **Q1: What are the possible causes for the leveling out of residential energy use among Norwegian households since 1990?**

- **Q2: How to achieve a reduction in residential energy use among Norwegian households the next 20 years?**

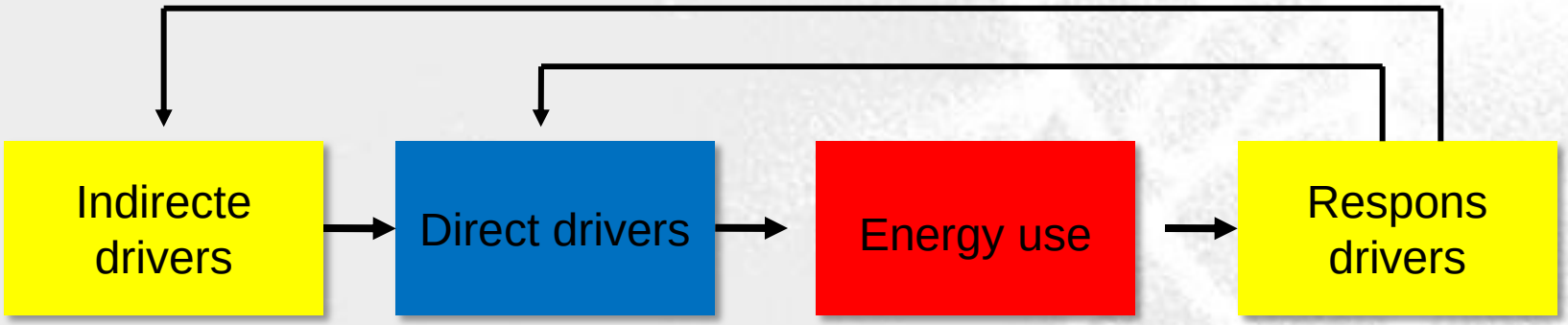
How we addressed the research questions



Methods applied

- **Literature review**
  - Going through existing Norwegian energy consumption statistics (NVE, SSB) and relevant “single” studies on energy consumption (10 studies identified)
  - Supplemented by going through relevant statistics and studies from Sweden (6 studies identified) and Denmark (5 studies identified)
- **Model development**
  - Established a casual model
  - Established a calculation model

The general casual model



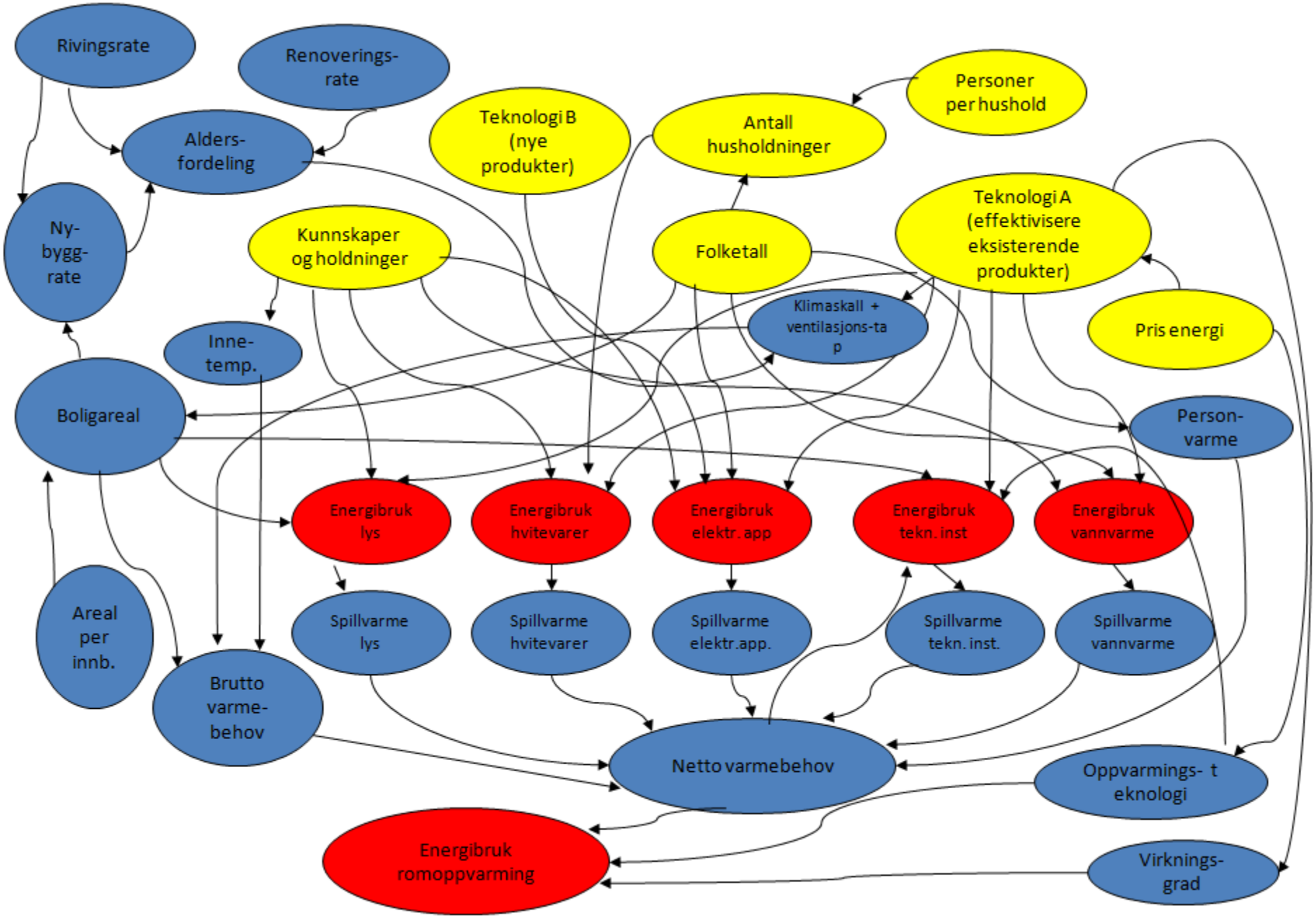
E.g. population growth

E.g. growth in living area

E.g. energy tax

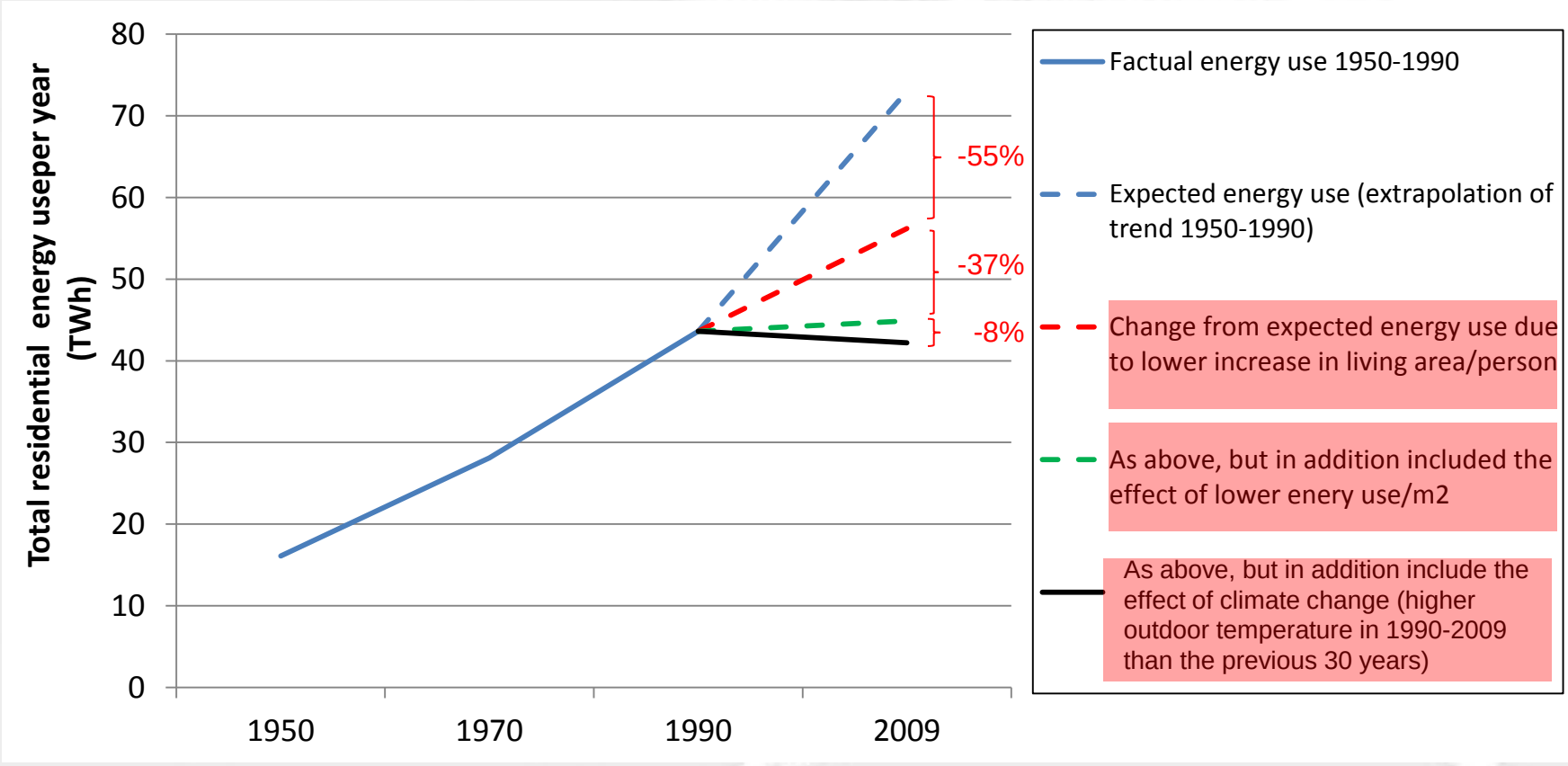
The specified casual model

Indirecte drivers	Direct drivers	Policy drivers
• Changes in environmental conditions (mainly outdoor temperature) • Demographic changes • Economic considerations • Technological development • Changes as to knowledge, attitude and preference	• Living area • The distribution of dwellings and living area according to types of building • The condition of the building envelope • Indoor temperature • Water heating specific energy consumption • Energy consumption relating to lighting and electrical equipment • Choice of heating system • Heat pumps	• Information • Taxation • Regulations • Economic support

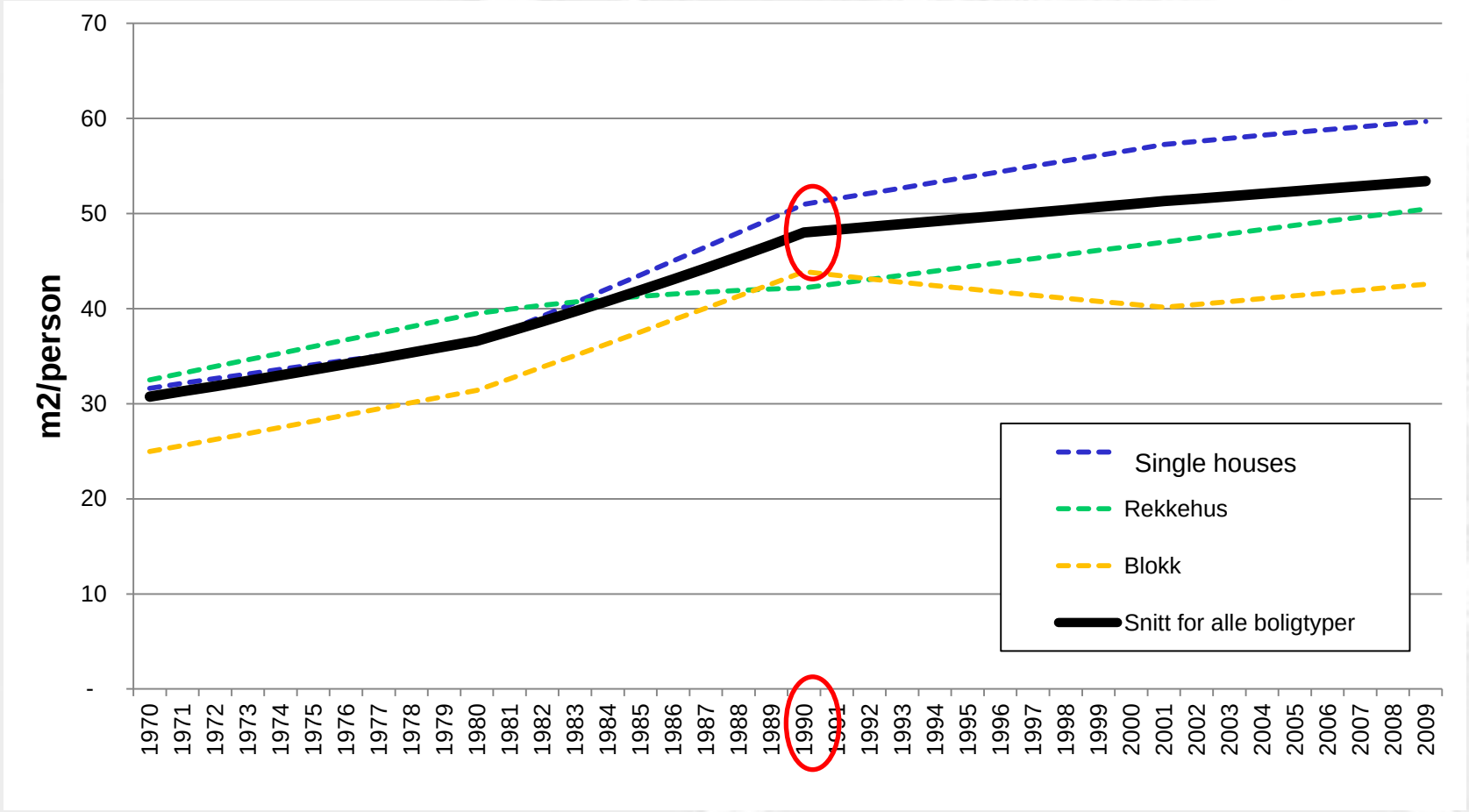

Rivingsrate
Renoverings-rate
Alders-fordeling
Ny-bygg-rate
Teknologi B (nye produkter)
Antall husholdninger
Personer per hushold
Kunnskaper og holdninger
Folketall
Teknologi A (effektivisere eksisterende produkter)
Klimaskall + ventilasjons-tap
Pris energi
Inne-temp.
Boligareal
Person-varme
Energibruk lys
Energibruk hvitevarer
Energibruk elektr. app
Energibruk tekn. inst
Energibruk vannvarme
Areal per innb.
Spillvarme lys
Spillvarme hvitevarer
Spillvarme elektr.app.
Spillvarme tekn. inst.
Spillvarme vannvarme
Brutto varme-behov
Netto varmebehov
Oppvarmings- teknologi
Energibruk romoppvarming
Virknings-grad

Results

Main categories of factors that can explain the levelling out of residential energy use



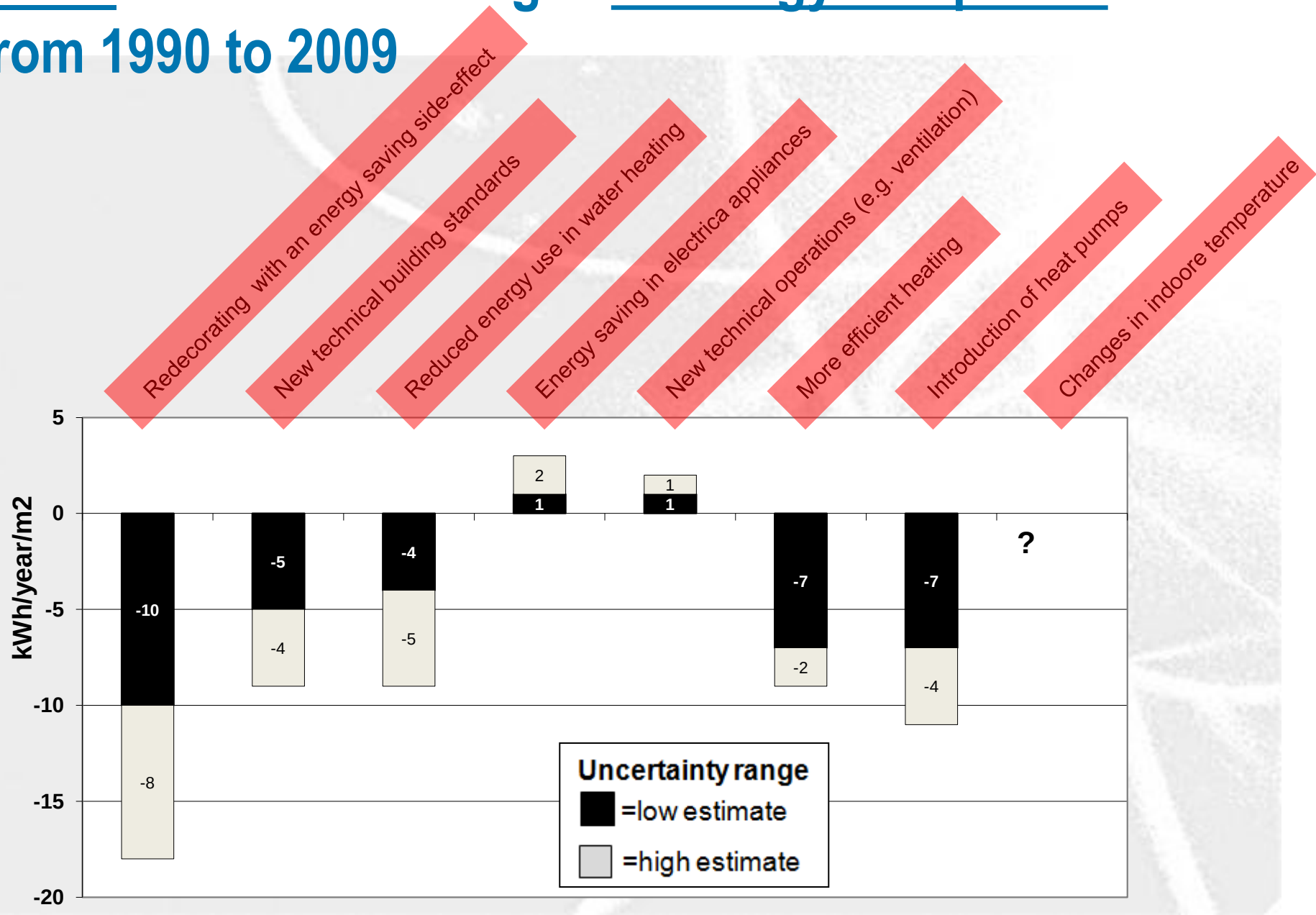
Changes in living area per capita



Reasons for a lower increase in living area per capita from 1990 to 2009

- **The growth in non-western immigration**
  - Use 1/3 less living area per capita than the rest of the population
  - Constituting 52 % of population growth from 1990-2009, and as much as 61 % from 2001-2009
- **Increase in real-estate prices and real interest rates**
  - In 2009 we inhabited an area per capita that was 2/3 larger than in 1973, but had to pay 7 times more for it (in constant currency).
- **Changes in peoples preferences?**
  - Less important to have a large home?

Direct drivers for changes in energy-use per m² from 1990 to 2009



Indirect and policy drivers of changes in energy-use per m^2

Most important

- **Individual behaviour**
  - Energy use for certain categories of electrical equipment may see differences by a factor of 20 among otherwise equal households, and there may be differences in energy use for heating by a factor of 3
- **Marked prices on energy**
  - Increased oil price → (irreversible) shift from oil to electric heating
  - Stimulation to do other energy saving physical alterations

Least important

- **Technological improvements**
  - Today: 50 % have water saving shower heads and 80 % have: refrigerators and freezers of energy efficiency class A and higher
- **Political measures aimed at reducing energy use**
  - Tax: no importance (not used much)
  - Economic support: important in promoting heat pumps (but used seldom)
  - New building requirements could explain 10-15 % of the reduction in specific energy use for all residences since 1990
  - Information: little importance

Calculation model: the scenario part

				Trinn 1	
	Formål	Verdi 2009		Til år	Årlig vekst
Areal	Areal pr person	53,8	Lineær	2 030	0,5 %
	Rivingsrate	0,1 %	Lineær	2 030	0,0 %
Boliger	Person pr hushold	2,2	Eksponen	2 030	-0,2 %
Lys	kWh pr m2	8,0			
	Teknologi A	1,00	Eksponen	2 013	-15,0 %
	Spillvarmefaktor	60,0 %	Lineær	2 030	0,0 %
Hvitevarer	kWh pr m2	13,1			
	Teknologi A	1,00	Lineær	2 030	-1,5 %
	Teknologi B	1,00	Lineær	2 030	0,5 %
	Spillvarmefaktor	50,0 %	Eksponen	2 015	-5,0 %
Elektronikk	kWh pr m2	10,9			
	Teknologi A	1,00	Lineær	2 020	-3,0 %
	Teknologi B	1,00	Lineær	2 030	2,5 %
	Spillvarmefaktor	60,0 %	Lineær	2 015	-5,0 %
Vannoppvarming	kWh pr m2	25,1			
	Teknologi A	1,00	Eksponen	2 030	-0,5 %
Beredertap	kWh pr m2	6,7			
	Teknologi A	1,00	Eksponen	2 030	-1,5 %
Teknisk drift	kWh pr m2	14,5			
	Teknologi A	1,00	Eksponen	2 030	0,0 %
Fordeling areal	Enebolig, % areal	65,8 %	Lineær	2 030	0,0 %
	Rekkehus, % areal	18,7 %	Lineær	2 030	0,0 %
	Blokker, % areal	15,5 %	Lineær	2 030	0,0 %
Fordeling boliger	Enebolig, % boliger	52,7 %	Lineær	2 030	-3,0 %
	Rekkehus, % boliger	20,6 %	Eksponen	2 030	0,0 %
	Blokker, % boliger	26,7 %	Eksponen	2 030	3,0 %

Requirements that can be changed by the user

- Future population growth rate (as defined by Statistics Norway)
- Rate of change for the factors below (linear, exponential and by leaps)
- Housing (area, residents, and numbers – overall, and distributed among types of residence)
- Electrical appliances (specific energy use, waste heat and technological development)
- Ambient heat (distribution between type of residence and technological development)
- Choice of energy carrier for heating
- Gross heat demand (distribution between type of residence and technological development)

Conclusions as for possible development of residential energy use in Norway (1)

- **Main question**
  - We have experienced 19 % reduction in relation to expected total energy use from 1990 to 2009. Can we achieve a similar change the next 20 years with an accompanying expected population growth of + 27%?
- **Main result**
  - Growth rate for living area is decisive!

Annual changes in living area per capita	Total energy use by 2030
+ 0,5 % (same as for the period 1990-2009)	+ 20 %
+ 0 %	- 30%

Equals the effect that all new buildings after 2009 will be built with passive energy standard (68 kWh/m²)

Conclusions as for possible development of residential energy use in Norway (2)

- **Changes of probably little importance**
  - Transition from oil and firewood to electric heating: neglectable effect
  - Ongoing transition to energy saving light bulbs: -2 % of total energy use
  - Transition to more energy efficient electrical equipment: - 3 % of total energy use
- **Changes of greater (potential) importance (other than stabilizing the growth rate of living area per capita)**
  - Continued transition to heat pumps (in the remaining 50% of residential homes): - 25 % of total energy use
  - A continued upgrading of building envelopes: -15 % of total energy use
  - Energy saving relating to water heating: - 10 % of total energy use
- **Behavioral changes potentially of even large importance?**
  - Choice of indoor temperature and the use of energy consuming indoor appliances: - **?? %**

Some final theoretical reflections

When is “change” change?

- **Change eco-efficiency in consumption**
  - E.g. change to a car with less fuel consumption per km
- **Change patterns of consumption**
  - E.g. change from private car to public transportation
- **Change volume of consumption**
  - E.g. reduce your total transport work (person kilometres)
- **How does these categories apply to the case of energy-use in Norwegian households?**

Categorisation of observed changes

Observed changes	Category of changes in consumption	Contribution to total reduction
Reduced increase in living area		
due to non-western immigration	Reduced volume	-41 %
due to increase in real-estate prices	Reduced volume	-14 %
due to changes in peoples preferences	Reduced volume	?
Lower energy-use/m2		
Redecorating	Changed patterns	-13 %
New technical building standards	Increased eco- efficiency	-6 %
Reduced energy use in water heating	Increased eco- efficiency	-6 %
Energy saving in electrical appliances	Increased eco- efficiency	+2 %
Increased energy use for technical operations	Increased eco- efficiency	+1 %
More efficient heating	Changed patterns	-6 %
Introduction of heat pumps	Changed patterns	-8 %
Changes in indoor temperature	Reduced volume	?
Changes in outdoor temperature	Climate change	-9 %

Decoupling and ecological modernization – or "overflow" effect?

- **Q1: What are the possible causes for the leveling out of residential energy use among Norwegian households since 1990?**
  - Reduced increase in per capita living area (relating to 55% reduction in the expected level of energy use)
  - Reduced energy use per m² (relating to 37 % of the reduction)
  - A milder climate (relating to 8 % of the reduction)
- **Is this an example of decoupling and ecological modernization?**
  - Decoupling: The ability of an economy to grow without corresponding increases in environmental pressure
  - Ecological modernization: Decoupling can be achieved by means of increasing environmental productivity
- **I would say the answer is "no"**
  - Decoupling and ecological modernization presupposes that environmental policies have been in action
  - Most of the reduction in the expected level of energy use is due to unexpected effects of non-environmental motivated policies – thus reductions could be viewed as an overflow effect of an abundance of energy

What are the best strategies to achieve the desired changes?

- **Q2: How to achieve a reduction in residential energy use among Norwegian households the next 20 years?**
  - Develop policies specifically aimed at reducing energy use
  - Best option policies: Prevent increase in per capita living area (and possible reduce it)
  - Second best policies: Promote further reductions in energy saving (water heating, transition to heat pumps, and upgrading of building envelopes)
  - Gain a better understanding of how to change peoples attitudes toward choice of indoor temperature and the use of energy consuming indoor appliances
- **What change modes have proven to be most effective so far - and thus might be the best to choose also in the future?**

Strategy	Observed change (1990-2009)	Potential change (2009-2030)
Increase environmental efficiency	+ (10%)	+
Change patterns of consumption	++ (30%)	+++
Reduce volume of consumption	+++ (60%)	++++

Knowledge gap!

Relevant litterature (1)

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Relevant litterature (2)

Høyer, K.G. (2010): "Seven theses on CO_2-reductionism and its interdisclipinary counteraction", in Bhaskar, R., Frank, C., Høyer, K.G., Næss, P., Parker, J. (2010): *Interdisclininarity and Climate Change. Transforming knowledge and practice for our global future*. London: Routledge. 35-54

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Thank you for your attention!

Carlo Aall
Western Norway Research Institute
www.vestforsk.no
caa@vestforsk.no
+ 47 991 27 222