NTNU
Norwegian University of Science and Technology

FME FORSKNINGS-SENTER FOR MILJØVENNLIG ENERGI

ZERO EMISSION NEIGHBOURHOODS IN SMART CITIES

Norwegian Energy Efficiency Policy

Historical backdrop and current status – focus on buildings

Polish –Norwegian aid for improving Energy Efficiency in Ukraine – Final conference
Kiev, 25-26 January 2018

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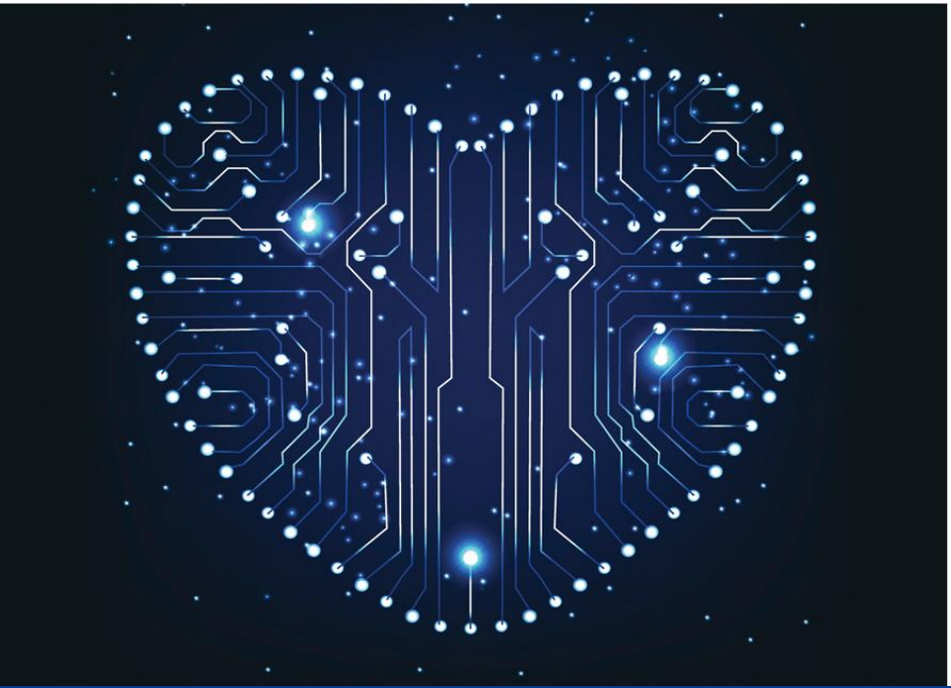


ZEB

The Research Centre on
Zero Emission Buildings

FME FORSKNINGS-SENTER FOR MILJØVENNLIG ENERGI

ZEN

ZERO EMISSION
NEIGHBOURHOODS
IN SMART CITIES

Zero Village Bergen. Illustration by Snøhetta

Agenda

- Norway energy backdrop and history of ENØK
- Energy Efficiency Policies – types, and how do they work?
- Example: Residents of a Norwegian Zero Emission Building

Energy Backdrop – Norway

- A sparsely populated, country in a cool climate with a lot of mountains and rain, and a long coast line
  - The lucky country: water, sea, oil
- Rich on energy:
  - Hydro power since late 19th century
  - Oil & gas since late 1960s
  - Today: Almost all electricity from hydro

Photo: Waterfall Kinso in Kinsarvik. From Norwegian Museum of Hydropower and Industry

A history of hydro power

Glomfjord Power Station, 1918

Source: Meld. St. 25 (2015-2016), p. 6

Streetlights and lit homes, end 1890s

Streetlights in Oslo 1892

Some of the first lit houses in Oslo, late 1890s

Photos from Teknisk museum

Energy efficiency in Norway

- Gained increased attention since the ”oil crisis” in 1973
- Norwegian response not ”saving” but energy ”economisation” (”ENØK”)
  - This means that energy efficiency was primarily understood as an economic activity – as an investment
- Assumptions about how to address the problem has nevertheless not been unified:
  - Rational people?
  - Moral weakness: ”wasteful behaviour”
  - Knowledge deficit

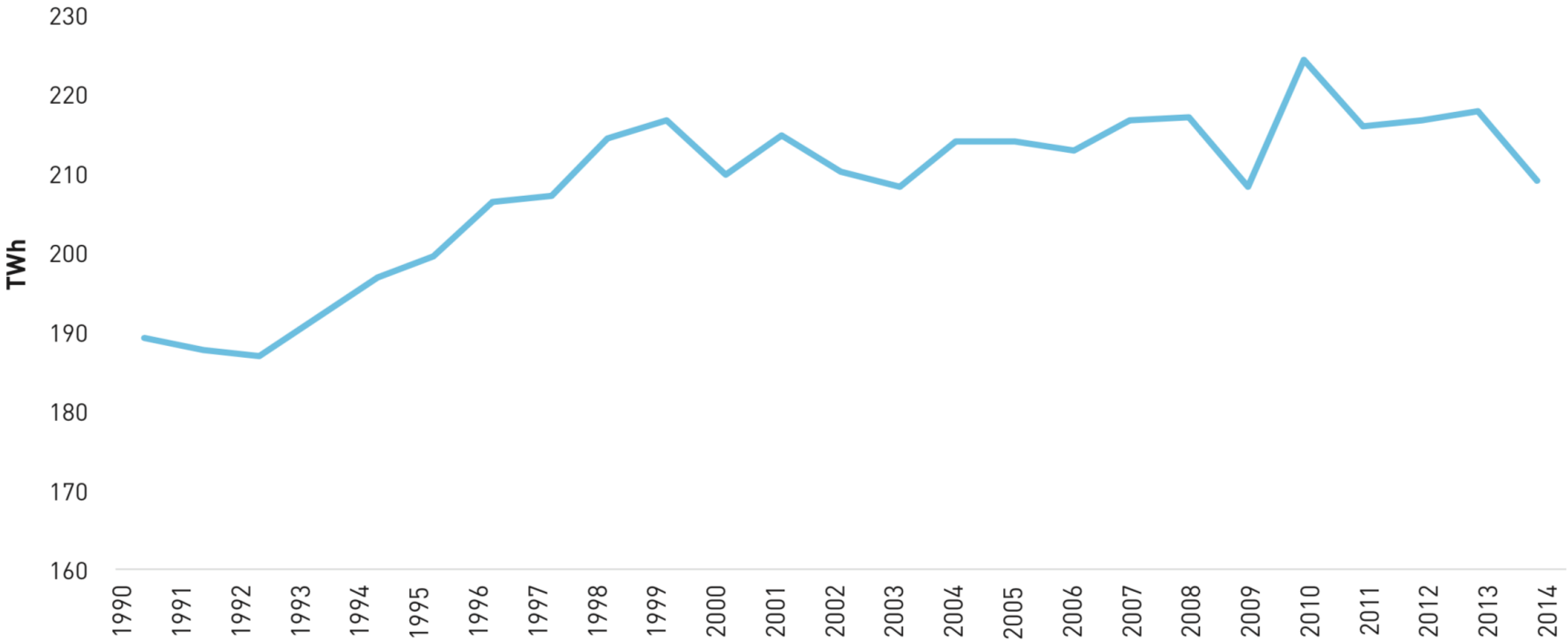
Methodolgical challenges with energy efficiency

- Difficult to measure what types of policies work, and how well they work
  - E.g. Problems with rebound effects
- Several factors influence: population change, weather changes and so on.
- Assumes a fixed understanding of needs and services: but these are never fixed (for long) and vary in time and location
- Here we divide energy efficiency potential into three
  - Technical potential
  - Economic potential
  - **Social** potential

Buildings and energy use in Norway

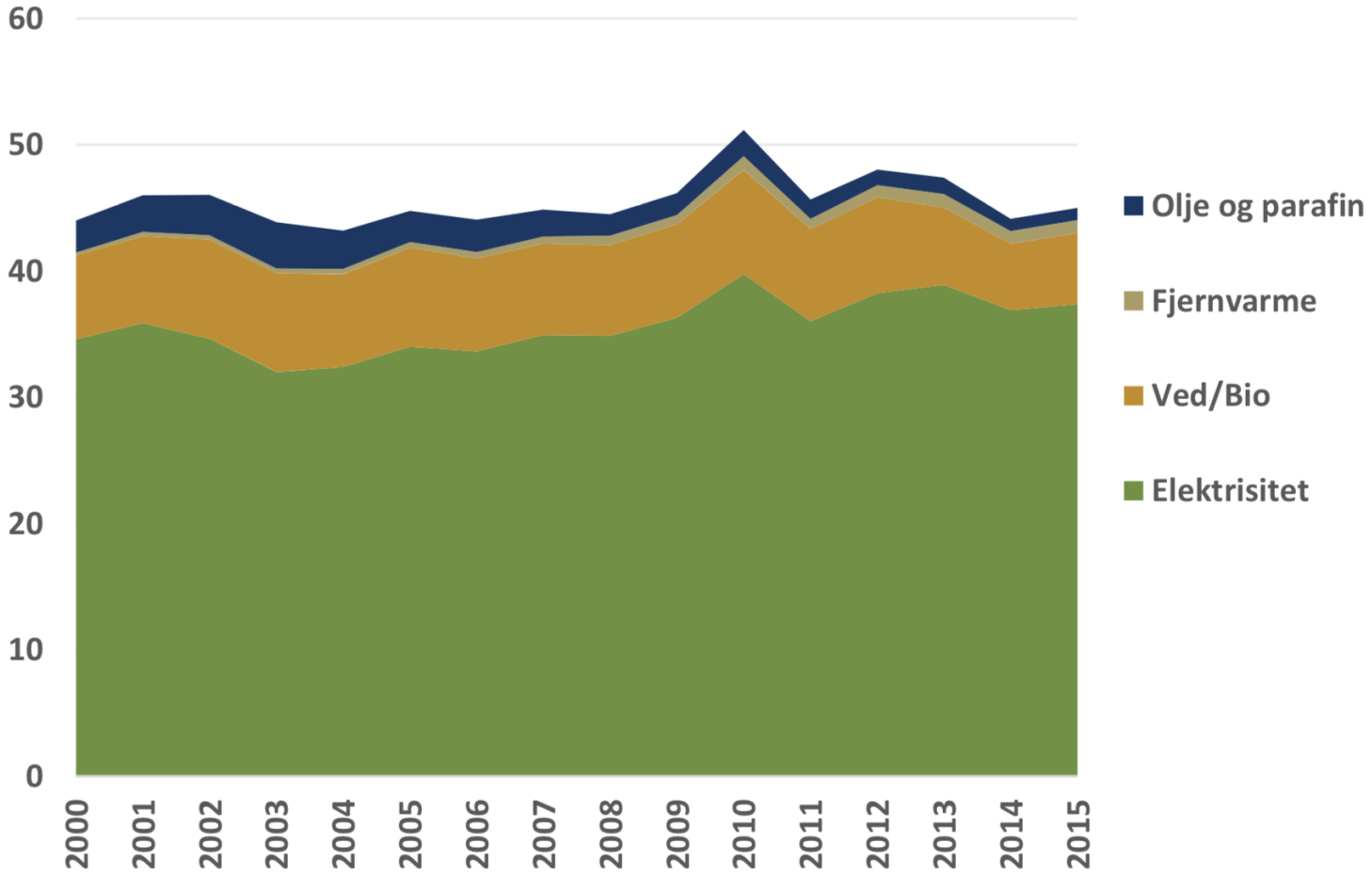
- About 40% of energy use in Norway from buildings
- Here, we focus on households – and not industry buildings
  - 21% of energy use in 2014 (St.mld. 25, 2015-16)

Net inland energy use 1990: 189 TWh, 2014: 209 TWh



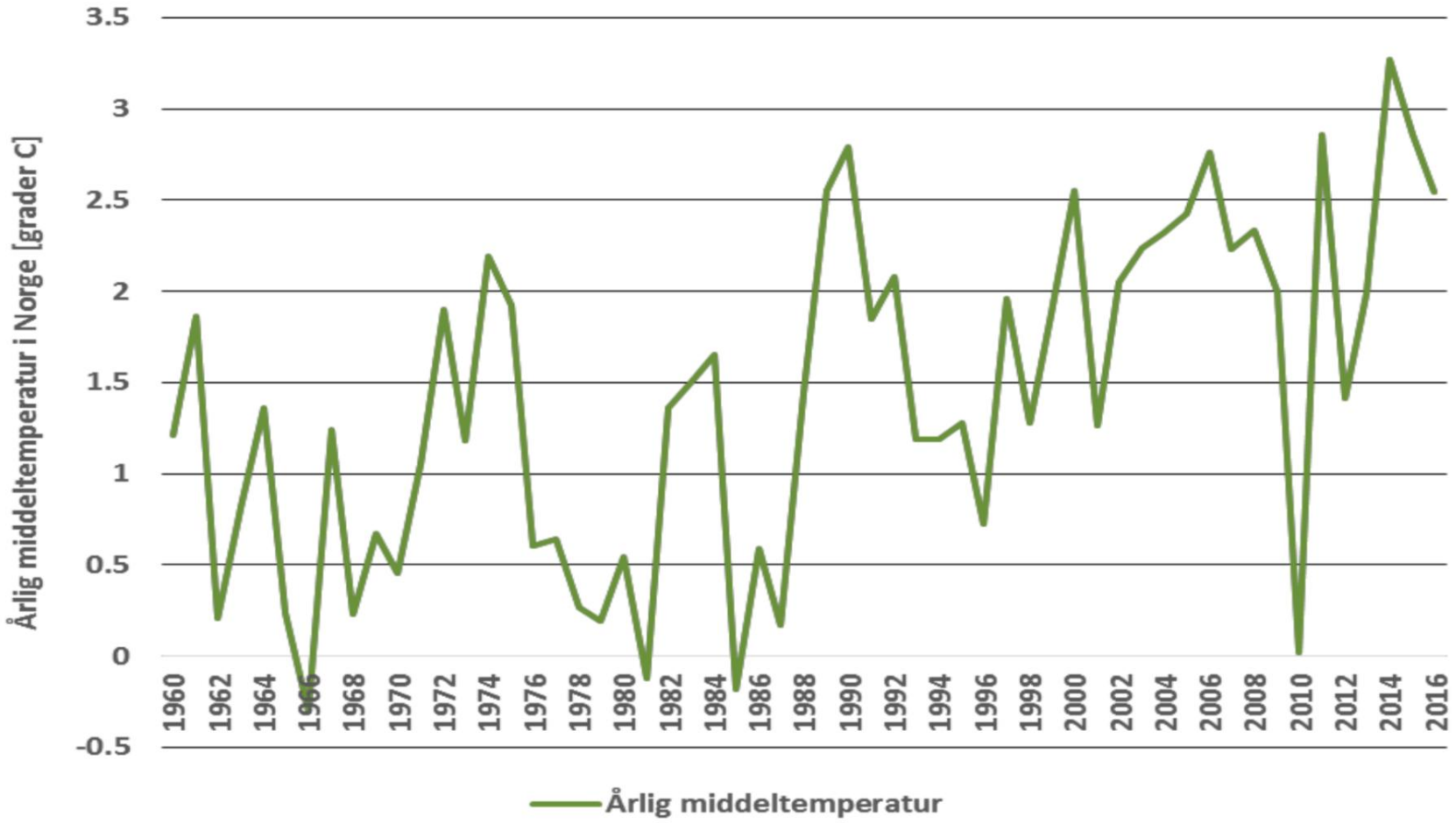
Source: Meld. St. 25 (2015-2016), p. 18

Energy Use in Households 2000-2015, measured use (about 45 TWh in 2015)



NVE Rapport Nr. 25 – 2017, p. 22

Average annual temperature since 1960



NVE Rapport Nr. 25 – 2017, p. 22

What types of energy efficiency policy have been used?

Traditional economic policy	Technology directing and competency oriented policy	Introduction of technologies instigate ”reflection”	Action and behaviour oriented policy
Energy Law and deregulation (1990)	Building regulations	Demand-side management through smart metres	Information and attitude oriented campaigns (Enova and NVE)
Taxes and other fares	Municipal laws of urban planning	Energy calculator (e.g. Through Enova)	Counceling from Enova
Support mechanisms through Enova	Demands for electronic devices (e.g. EU-regulations)		Municipal energy and climate-plans
Credits from ”Husbanken”	Ban on oil as fuel for heating		Energy ratings of buildings

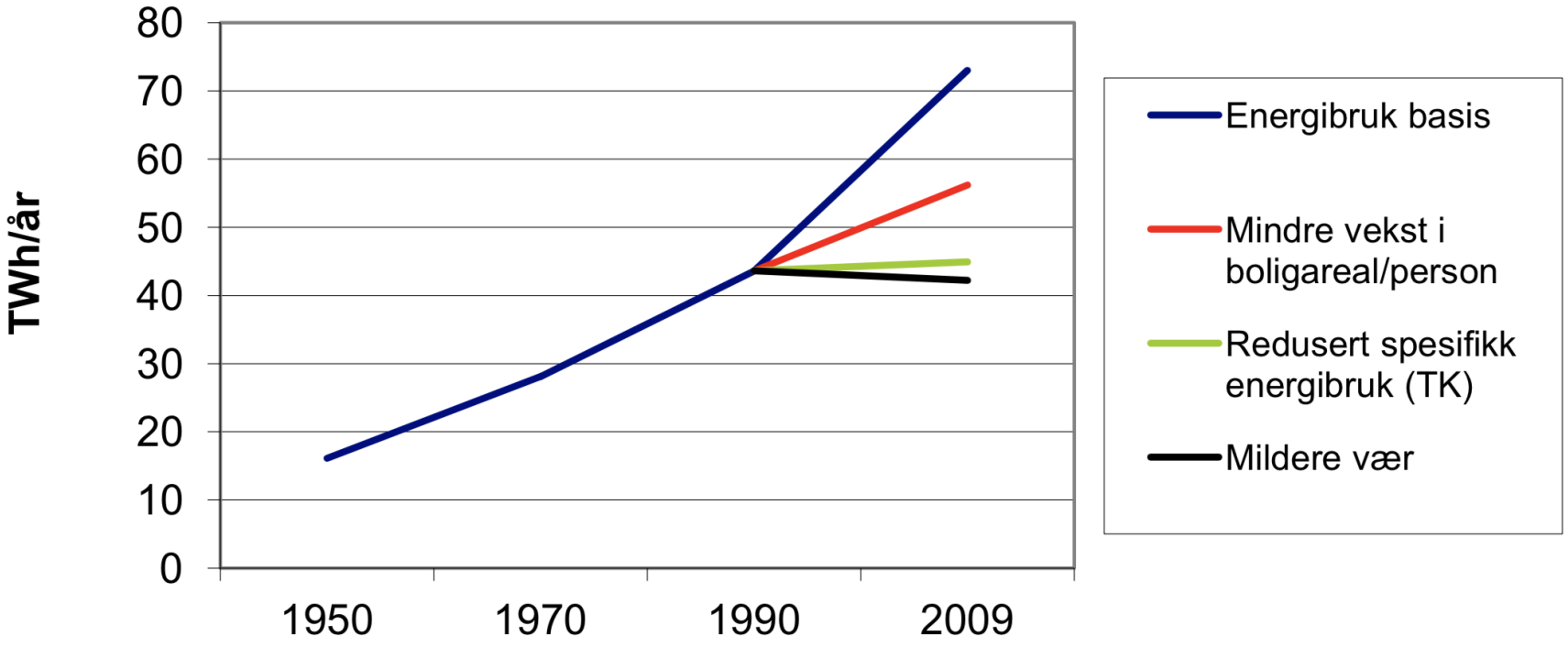
Briefly about Enova

- A government institution established in 2001 and offers councelling, services and subsidies for private and industry
- Marked a transition from only economy focus to other types of policy as well
- Prioritised different types of technologies (e.g. Heat pumps) and incentives for companies.

Which policies have been effective?

- Based on four different nation wide reports:
  - Hille, Simonsen & Aall (2011), ”Trender og drivere for energibruk i norske husholdninger. Rapport til NVE”
  - Riksrevisjonen (2015): ”Riksrevisjonens undersøkelse av myndighetenes arbeid med energieffektivitet i bygg”
  - SSB (2016): Rapporter 2016/16: Evaluering av virkemidler for å fremme energieffektivisering
  - Sørensen (2017): Sørensen, K. H. Virker de? Virkemidler for energieffektivisering med vekt på bygninger. CenSES rapport 2/2017
- Agreement that:
  - Overall energy efficiency efforts have had limited impact
  - Building regulations have had the largest impact on energy use
  - Information campaigns have limited effects
  - Economic incentives have not been effectful
  - Rebound effects are unknown but potentially large
- Reasons / explanations diverge somewhat

The flattening of energy use in households



Source: Hille, Simonsen & Aall (2011), ”Trender og drivere for energibruk i norske husholdninger. Rapport til NVE”

A brief look at some policies

- Information and motivational campagins
  - Low impact
  - Strong focus on economic benefits
  - Does not take into account that people have different relations to energy
- The liberalisation of electricity market
  - People have become users rather than market oriented consumers of cheapest electricity (they dont change provider every day)
- Taxes: the taxes that are politically feasible are too low
- Energy classifications of buildings: unknown / dubious effects
- Subsidies through Enova: probably have effect, but encertaintuy about the extent

Effects of heat pumps

There are about 736 000 heat pumps in Norway in 2014 used 6 TWh electricity to produce 15 TWh heat (Meld. St. 25).

- Hille, Simonsen and Aall (2011):
- Heat pumps contributed about 9% reduction – about the same as the effects of milder climate
- SSB (2016): considerable rebound effects:
- ”households that own heatpumps use approximately the same amount of electricity as other households, because they use less other forms of energy (e.g **wood heating**) and have a **higher average indoor tempterature**”

Effects of smart meters and load shifting

- Analysis indicates the possibility of energy efficiency if load shifting is enabled (SSB 2016)
- Studies show that load shifting is challenging for several reasons (e.g. Throndsen 2016)
  - 1: Load shifting imples that strongly routinised activities must be shifted
  - 2: Preference for ”resource men” and not the average home dweller

Throndsen, W. (2016) ”Response and Responsibility. Smart meters, end use, and the possibility of a green material public” PhD Thesis, NTNU

Challenge 1: The Norwegian ”Comfort society”

- Energy use of households is shaped by diverging views on
  - Comfort
  - Cleanliness
  - Environment and climate challenges
- Non-economic concerns weigh heavily: The home is for comfort, not to make money!
- But positive: energy efficiency is ”unintended” consequence of renovations

Challenge 2: The ”Bermuda” triangle

- Low demand for energy efficient buildings – dominated by actors who want to build as cheap as possible
- Passive public regulations, i.e. strong belief in information and behaviour campaigns
- Conservative construction industry. No incentives to apply new methods

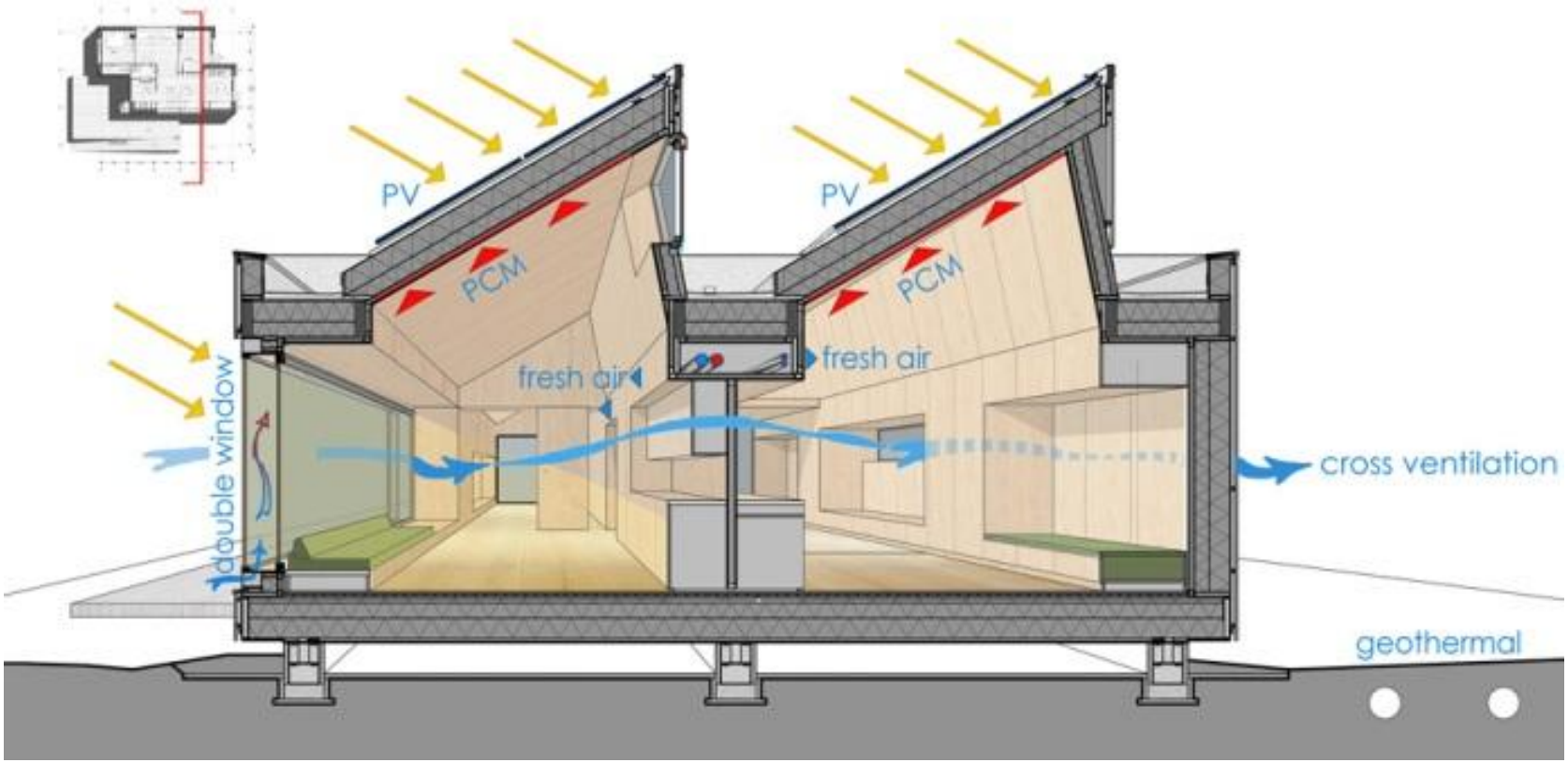
Ryghaug, M., & Sørensen, K. H. (2009). How energy efficiency fails in the building industry. Energy Policy, 37(3), 984-991.

Summary

- Several traditional policies have been rather ineffective
  - Information and behaviour focus has limited effects
  - Economic incentives are also limitied since energy cannot be separated from our everyday lives
- Somewhat unexpected reasons for reductions in energy use:
  - Warmer climate
  - Change in space demand per person
  - Renovation of old buildings

CASE: The ZEB Living Lab

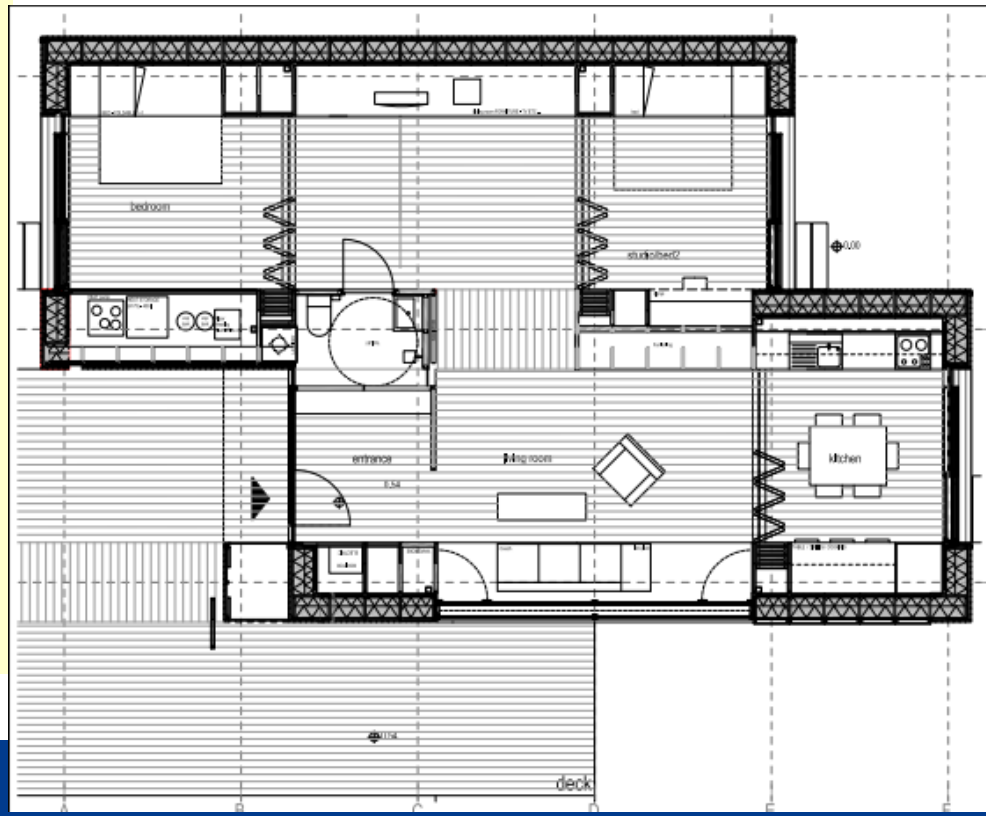
Cross-cut of the Trondheim Living Lab



Source: Luca Finocchiaro, NTNU

ZEB Living Lab, Trondheim

- 100 m² living area
- ZEB-OM (Operation and Materials)
- Building integrated photovoltaics: 80 m²
- Solar panel in the facade
- Ground to water heat pump
- Heat recovery system (Flexit)
- PCM in the roof (DuPont)
- VIP in sliding doors (NorDan)
- Reflective vapor barrier (Isola)
- Mixed mode ventilation (Sapa, VELUX, and Caverion)
- LED Lights (NorDesign)



Data material

- Two groups of students, families and elderly lived in the lab for 25 days each, in 2015-2016
- This example concentrates on heating the building

ELSEVIER

Energy Research & Social Science

journal homepage: www.elsevier.com

SCIENCE

Original research article

Domestication, acceptance and zero emission ambitions: Insights from a mixed method, experimental research design in a Norwegian Living Lab

Marius Korsnes[a, *], Thomas Berker[a], Ruth Woods[b]

Heating in the ZEB Living Lab

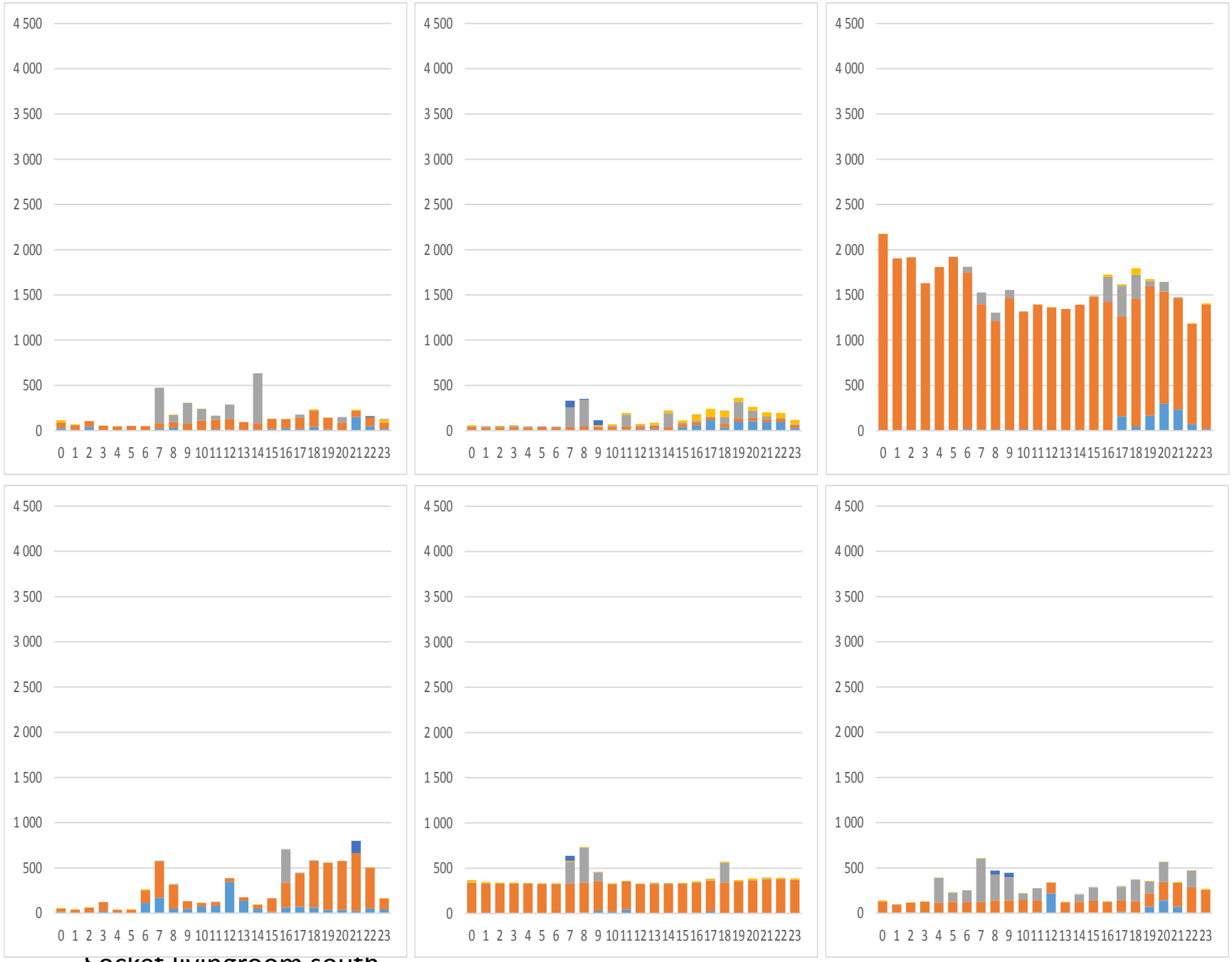
- For the students:
  - Stable temperatures of Living Lab were not noticed until after moving home
- For family:
  - No large changes, but faulty heating system made them bring their own device
- For elderly:
  - Were used to heating with firewood
  - The heating in Living Lab was slower and less cozy
  - Decided to keep temperatures higher, and then cool quickly if needed
  - An important hobby was lacking: collecting and stacking firewood

Conclusions: Heating and electricity

- Electricity:
  - No large changes observed
- Heating:
  - Large changes for elderly who did not like becoming more passive
  - New ways of temperature control can be unfamiliar to occupants
    - E.g. speed of temp increase/responsive system
  - Should be kept flexible to reach broad spectre of people
- What does this mean for energy use?
  - Not clear, but…

Sockets selected weeks|

Energibruk time for time [Wh/uke]



Socket livingroom south and entrance

Livingroom north

Kitchen

Bedrooms

Bathroom

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Thank you for your attention!

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