

Zero Emission Buildings and Architecture

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Zero emission buildings

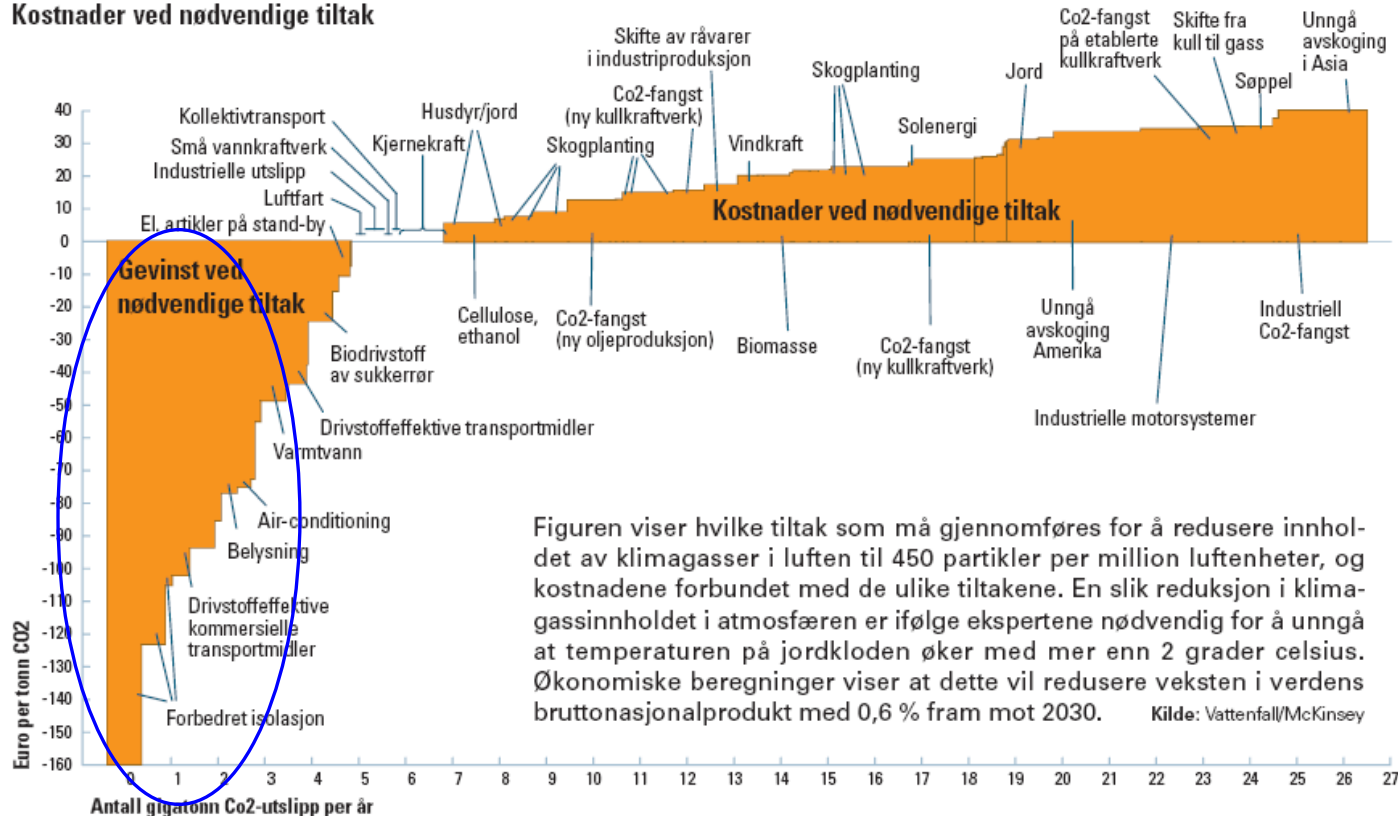
Why:

In a global and European perspective, buildings are accountable for about 40% of all GHG emissions.

IPCC reports points to measures in the building sector as being the most economical (when compared to other important sectors).

Energy efficiency – cheaper than new energy

Kostnader ved nødvendige tiltak

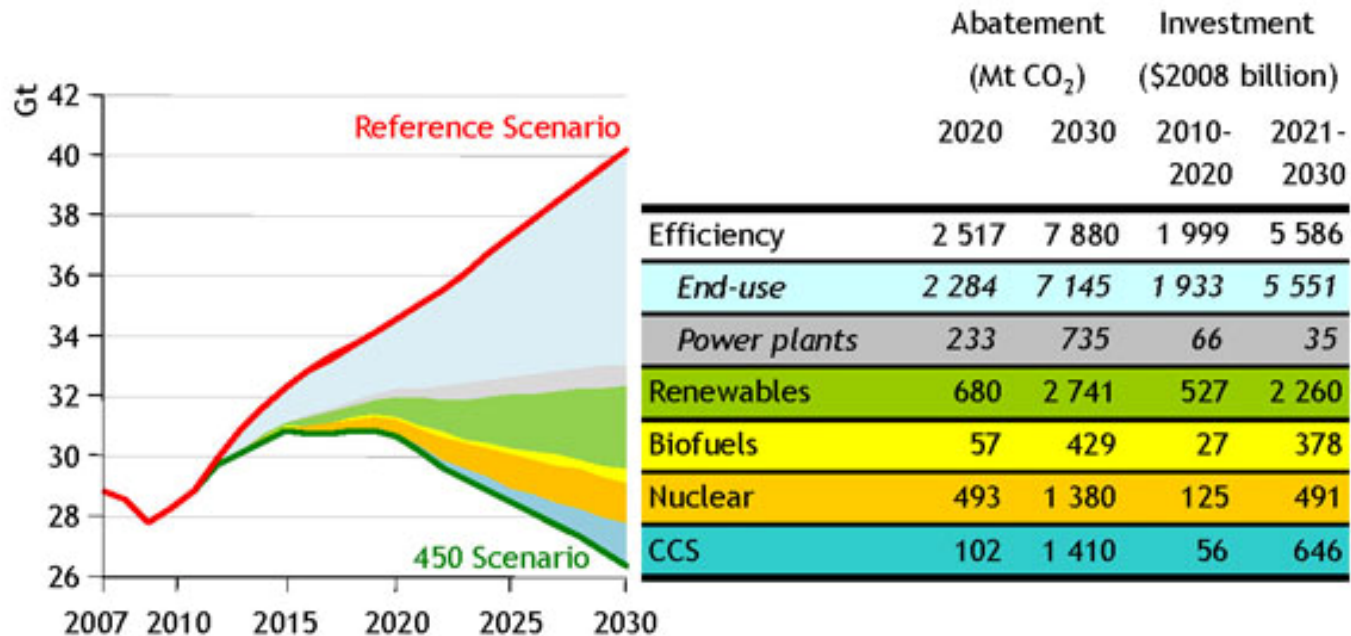


Figuren viser hvilke tiltak som må gjennomføres for å redusere innholdet av klimagasser i luften til 450 partikler per million luftenheter, og kostnadene forbundet med de ulike tiltakene. En slik reduksjon i klimagassinnholdet i atmosfæren er ifølge ekspertene nødvendig for å unngå at temperaturen på jordkloden øker med mer enn 2 grader celsius. Økonomiske beregninger viser at dette vil redusere veksten i verdens bruttonasjonalprodukt med 0,6 % fram mot 2030. Kilde: Vattenfall/McKinsey

Cost for various GHG measures in Europe, 2020. Source: McKinsey (2008)

The IEA view

World abatement of energy related CO₂ emissions in the 450 scenario:



Efficiency measures account for two-thirds of the 3.8 Gt of abatement in 2020, with renewables contributing close to one-fifth

© OECD/IEA - 2009

Zero emission buildings introduced in many national programs

1. Energy Policy and Industry Goals

USA: „The *Building Technologies Program* outlines the technology portfolio and activities that are necessary to **achieve our strategic goal of net-zero energy buildings (ZEB)** at low incremental cost **by 2025.**“
[<http://www.eere.energy.gov/buildings/about/>, 01/2007]

UK: „The objective of the proposal is to set a timetable for moving towards **zero carbon development** as a contribution to meeting the UK target to reduce carbon emissions by 60% by 2050. “
[Department for Communities and Local Government, 13th December 2006 press release]

Canada: „ The **Equilibrium House Initiative** aims the community-scale demonstration of 1,500 Net Zero Energy Houses by 2010 and all new houses to be Net Zero by 2025“
[<http://www.cmhc.ca>]

Austria: “Vision 2050 on energy in buildings: The building stock of the year 2050 should be in total over the entire life cycle (involves the production and operation of the building) **free of any carbon emissions.**“
[http://www.e2050.at/pdf/energie_gebauede.pdf]

Netherlands: „In the Netherlands, the government and the construction sector aim at achieving **energy neutral new construction in 2020.**“
[Chiel Boonstra, Trecodome]

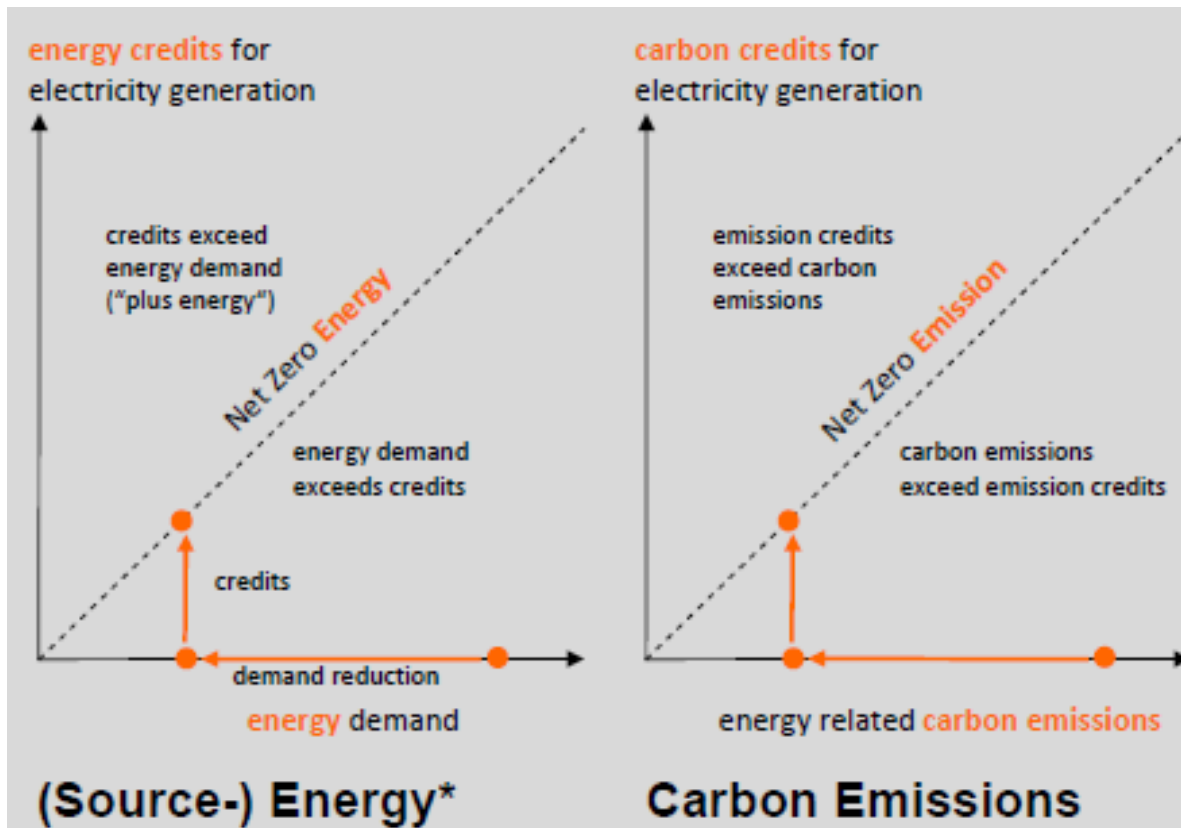
Germany: „From current point of view future capable buildings are buildings architectural demanding with high user comfort, minimal primary energy demand, optimized technology equipment, meaningful integration into larger energy supply systems as well as altogether economic energy demand cover. **Zero emission houses are the long-term objective.**“
[„Das 5. Energieforschungsprogramm der Bundesregierung“, BMWA, 07/2005]

Proposed revision of EU’s Building Directive: Demand for a roadmap for how to get from today’s standard to zero emission buildings.

Source (figure): Karsten Voss, Wuppertal University.

What is a "zero emission building"?

- No single definition
- Example of a definition ("the balance approach"):



Source: Professor Karsten Voss, Wuppertal University

Our definition:

Zero GHG emission from production, operation, and demolition.

The Faculty of Architecture and Fine Art at NTNU is host for the recently established Research Centre on Zero Emission Buildings (ZEB), which is one of eight centers for Environment-friendly Energy Research (FME).

The Centre's vision is to become a national research centre that will place Norway at the forefront of research, innovation and implementation of buildings for the future – with extremely low energy requirements and a zero net climate footprint.

The primary objective is to develop solutions for existing and new buildings, both residential and commercial, in order to bring about a breakthrough for buildings with zero greenhouse gas emissions associated with their construction, operation, and demolition.



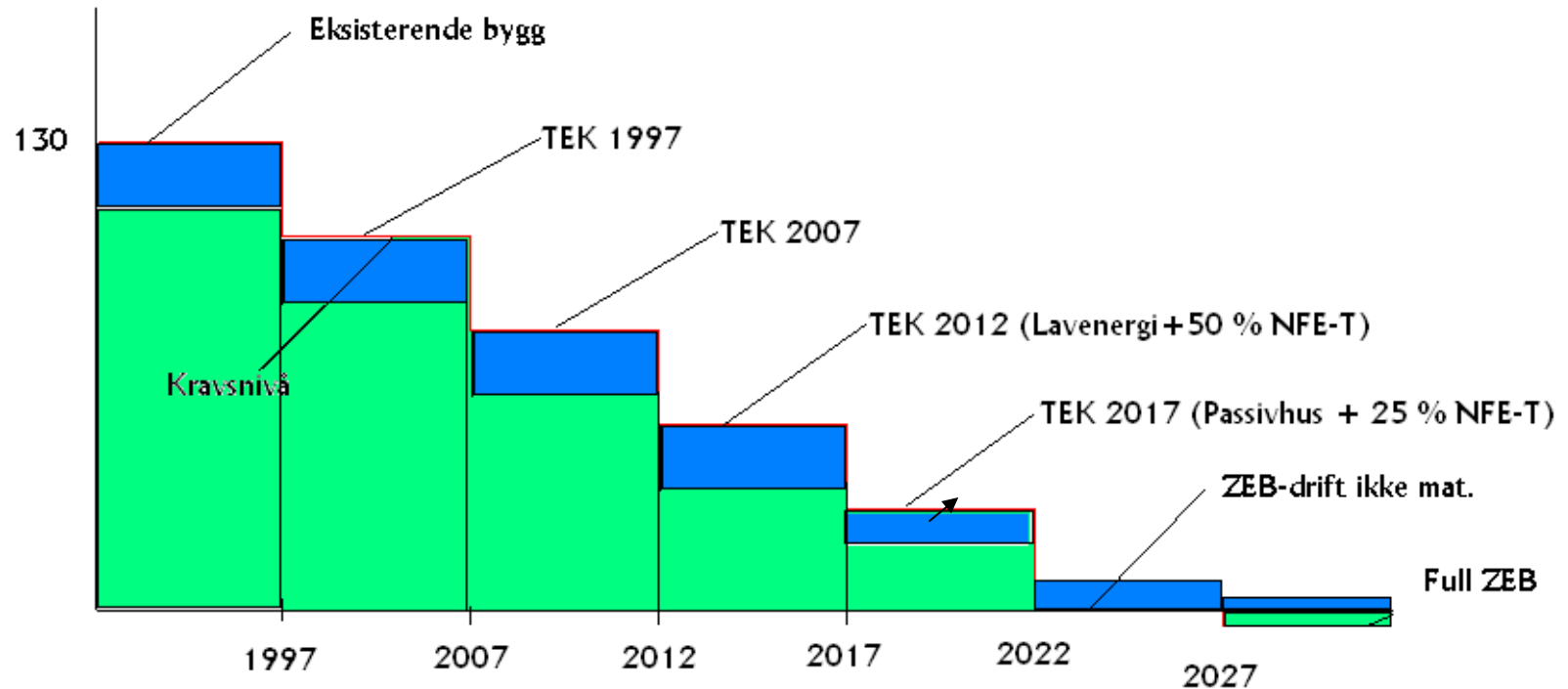
ZEB – a national team

- University and research institutions
- Producers of materials and products for the building industry
- Contractors, consultants, architects
- Trade organizations
- Public administration
- Property managers
- Users

NTNU
SINTEF
SINTEF Energi
Skanska
Maxit
Isola
Glava
Protan
Hydro Aluminium
YIT
DuPont
Multiconsult
Brødrene Dahl
Snøhetta
ByBo
Forsvarsbygg
Statsbygg
Husbanken
Byggenæringens landsforening
Norsk Teknologi
Statens Byggetekniske Etat

The challenge

Klimagassutslipp(kg/m²år)



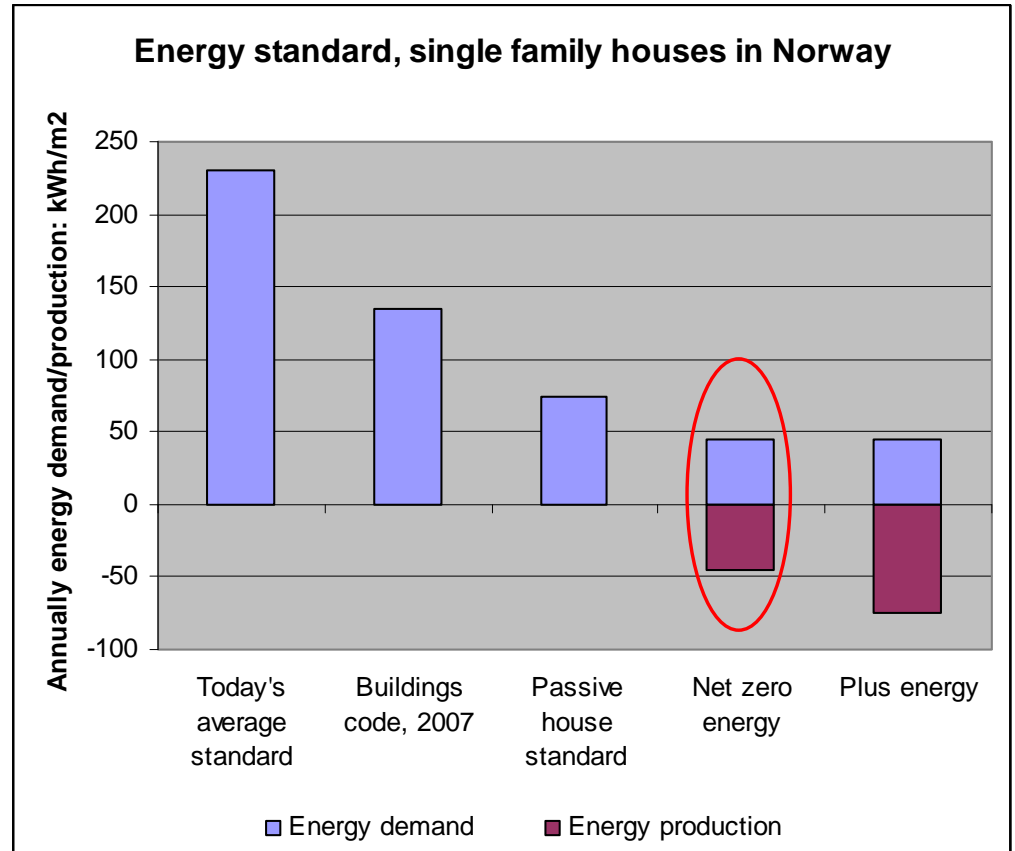
— Materialer
— Drift

NFE-T: Renewable energy for thermal needs

Source: Tor Helge Dokka, SINTEF

Our challenge:

Compensate for carbon emissions from the production of materials and construction by producing more energy than the building uses for operation.



Kilde: SINTEF Byggforsk

Reduced energy use + energy production

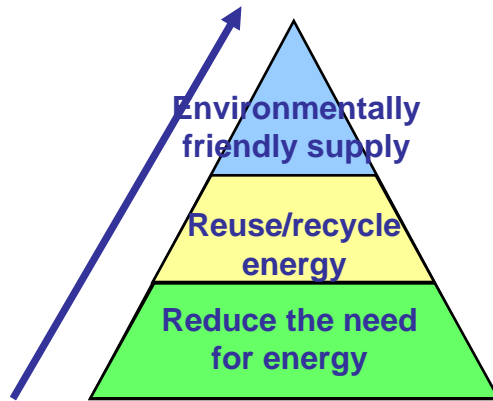
But the answer should in most cases be local production – on, or at least close to the building.



Vindturbin Heinseter, kilde: www.vardar.no



Strategy: Trias Energetica



Source: Lechner, Lysen, and others

The most environmentally friendly kWh is the one that is not used!

**ny
fornybar
energi**
(sol, varmepumpe, bioenergi)

behovsstyring
visualisering av energibruken

energieffektivt lys og utstyr

høyeffektiv varmegjenvinning

klimaskjerm uten luftlekkasjer

superisolerte vinduer

godt isolert bygning uten kuldebroer

optimal orientering og design av vinduer og glassflater

enkel og kompakt bygningsform

redusert arealbruk og arealeffektivitet

optimal plassering og orientering i forhold til klima og sol

start passiv energidesign

Source: Ecobox v/Stein Stoknes
Passiv energidesign
- Stein Stoknes NAL | ECOBOX
Basert på "Kyoto-pyramiden", Rødsjø og Dokka

The first step – reduced need

I.e. at least low energy and “passive” houses

Photo: Stein Stoknes



Passive houses - Løvåshagen

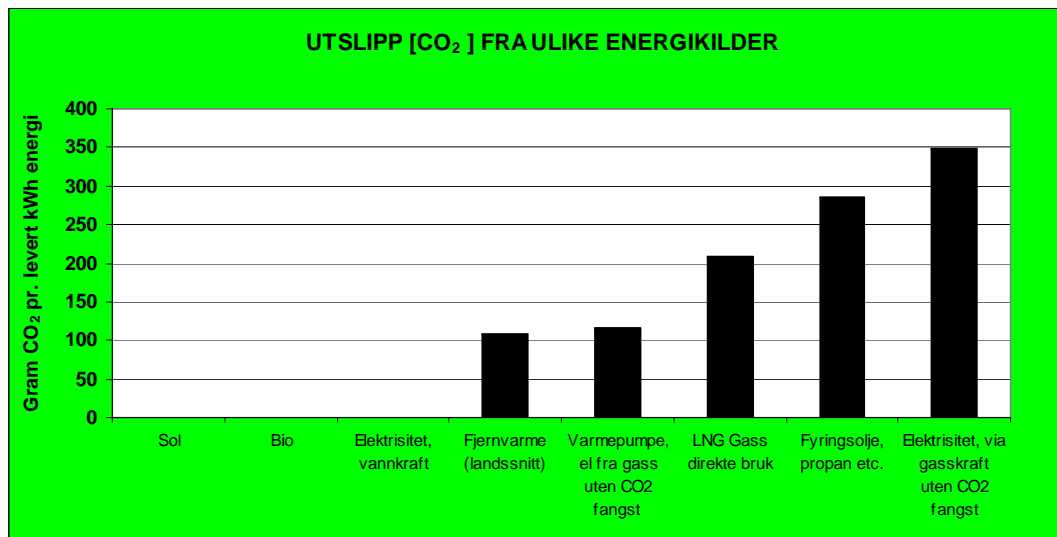
“The project has demonstrated that it is possible to build buildings for the future to about the same price as the price of standard buildings today – if the correct measures are used.”

Quote from the architect (Jan Haaland)



The next step – energy production (renewable energy)

Environmental loading using different energy sources:



Source: Tore Wigenstad, SINTEF



Zero emission: Architectural consequences

"Zero Energy Buildings are designed to perform well, be comfortable, require only standard maintenance, and look no different than ordinary buildings".

Quote: NREL/U.S.DOE

Nonsense!

Zero emission buildings can have many different architectural expressions and provide many architectural possibilities!

Architect: Coop Himmelblau
Source: Klaudia Farkas, NTNU



Architectural consequences

What looks “green” is not always the most “green”.

Canadian “Green Home”:

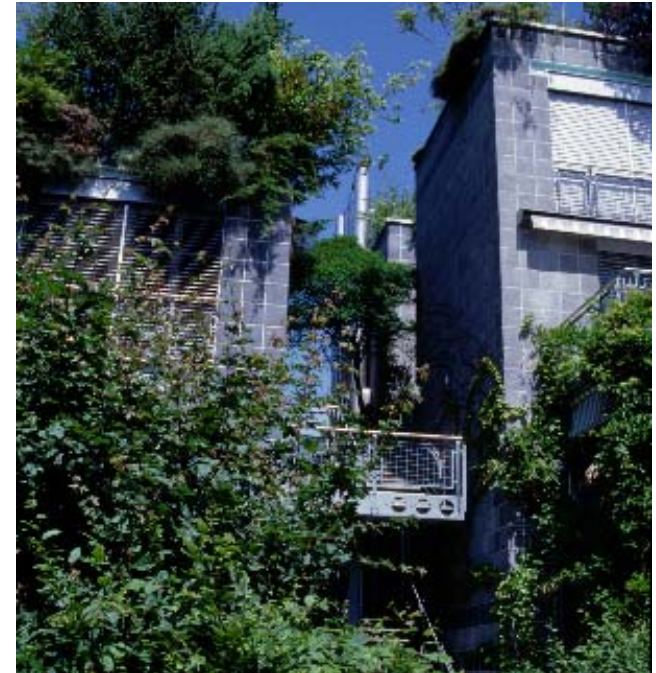
65% reduction in energy use for operation

33% reduction in embodied energy

73% reduction in purchased water

99% reduction in use of chemicals that influence the ozone layer

98% reduction in waste



Architectural consequences

Focus on energy use alone may have a negative effect on diffusion among architects and clients.
Ref. the history (last century!):

- *"Engineering Christmas Trees"*
- *"for those with a particular interest"*
- *"for those that are not "real" architects"*

(Quote from a prominent Norwegian architect to first year architecture students)

Delayed the development of good solutions.



Architectural consequences

Today's situation is very different!



Source: Ecobox

~~“Passive house
= container”~~

But simpler
shapes make
easier to reach
the passive
house goals.

Source: Inger Andresen, NTNU

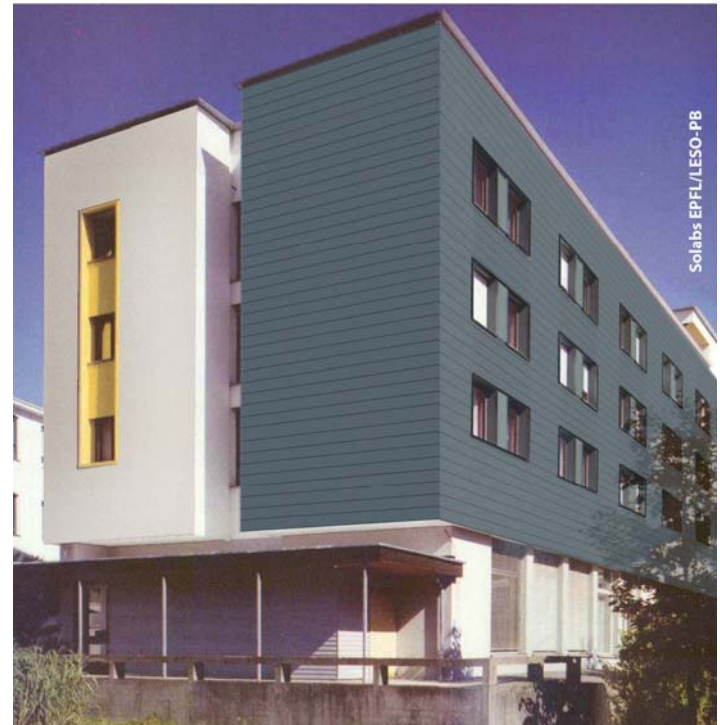


Architectural consequences

Today's situation is very different!

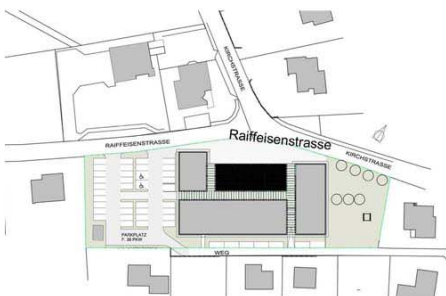
But taller buildings may have problems getting sufficient roof surface for energy producing elements (solar thermal collectors and solar cells).

Using the facades may be the solution – especially at our latitudes.



Architectural consequences

An alternative to facades may be coverings over atria, terraces, parking lots, ...



Gemeindeforum Ludes,
Austria
Architect: Herman Kaufmann



Source: Klaudia Farkas, NTNU

Zero emission – office- and factory bldg.

”Solarfabrik”,
Freiburg (2001)

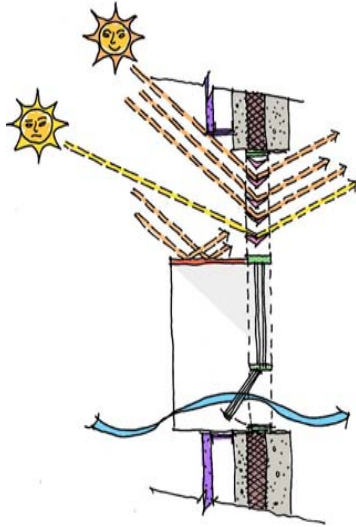
- Natural ventilation
- CHP with canola oil
- Solar cells



Source: Karsten Voss,
Wuppertal University

Zero emission – office building

National Renewable Energy Lab
Research Support Facilities (RSF)



Source: RNL Design/ Shanti Pless, NREL



Zero emission – dwellings

Solar Settlement Freiburg, Germany



Architectt: Rolf Disch
Source: Karsten Voss

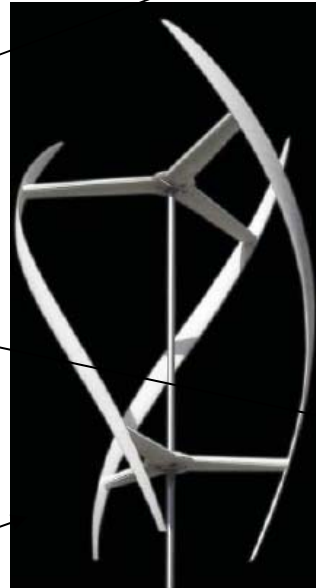
What do we have to do:

Reduce energy needs to a minimum (passive houses etc.).

Use clean, renewable energy to cover the remaining need for thermal energy (for heating and cooling).

Use renewable energy to cover the need for electricity.

Consider embodied energy as well.



Source: Tor Helge Dokka

What do we have to do:

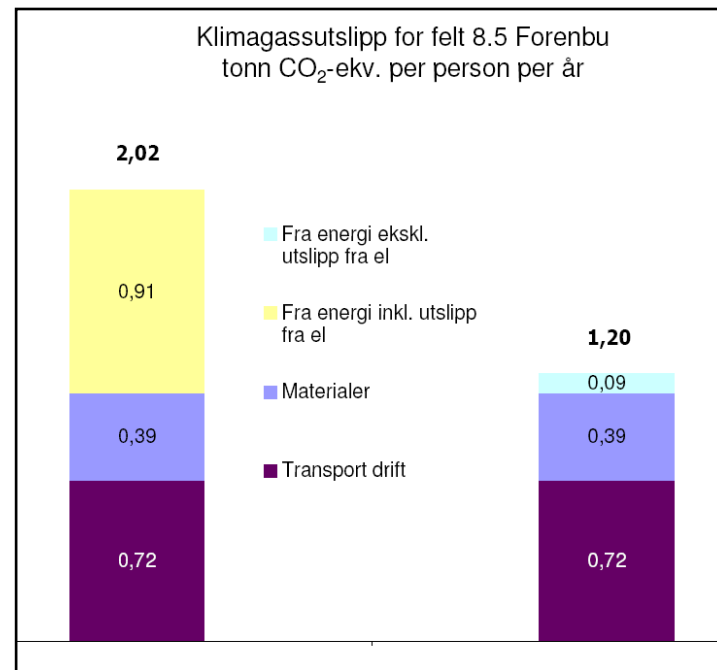
We must also consider the energy use for buildings and for transportation together.



Foto: MARCUS ENGSTRÖM



How about the car as both energy use and energy producer?



Source: Statsbygg

Zero emissions and architecture – what is needed?

We cannot afford to say "we are in it for the beauty"!

- High demands on:**
- environmental issues
 - usability (function, comfort, ...)
 - identity, cultural heritage, culture
 - architectural expression
 -

- Therefore:**
- **Use a holistic approach**
(“top down” rather than “bottom up”)
 - **Cooperate**
(“integrated design processes”)
 - **Start with needs and well defined goals**
(rather than with potential solutions or interesting technologies)

”Architecture can be a good means to reach a desired development and a useful tool in dealing with the climate challenge”.

Quote Stein Stoknes, Ecobox

Good luck!

