THE AECB ENERGY PERFORMANCE STANDARDS and Best International Practice

Seminar to the Good Homes Alliance

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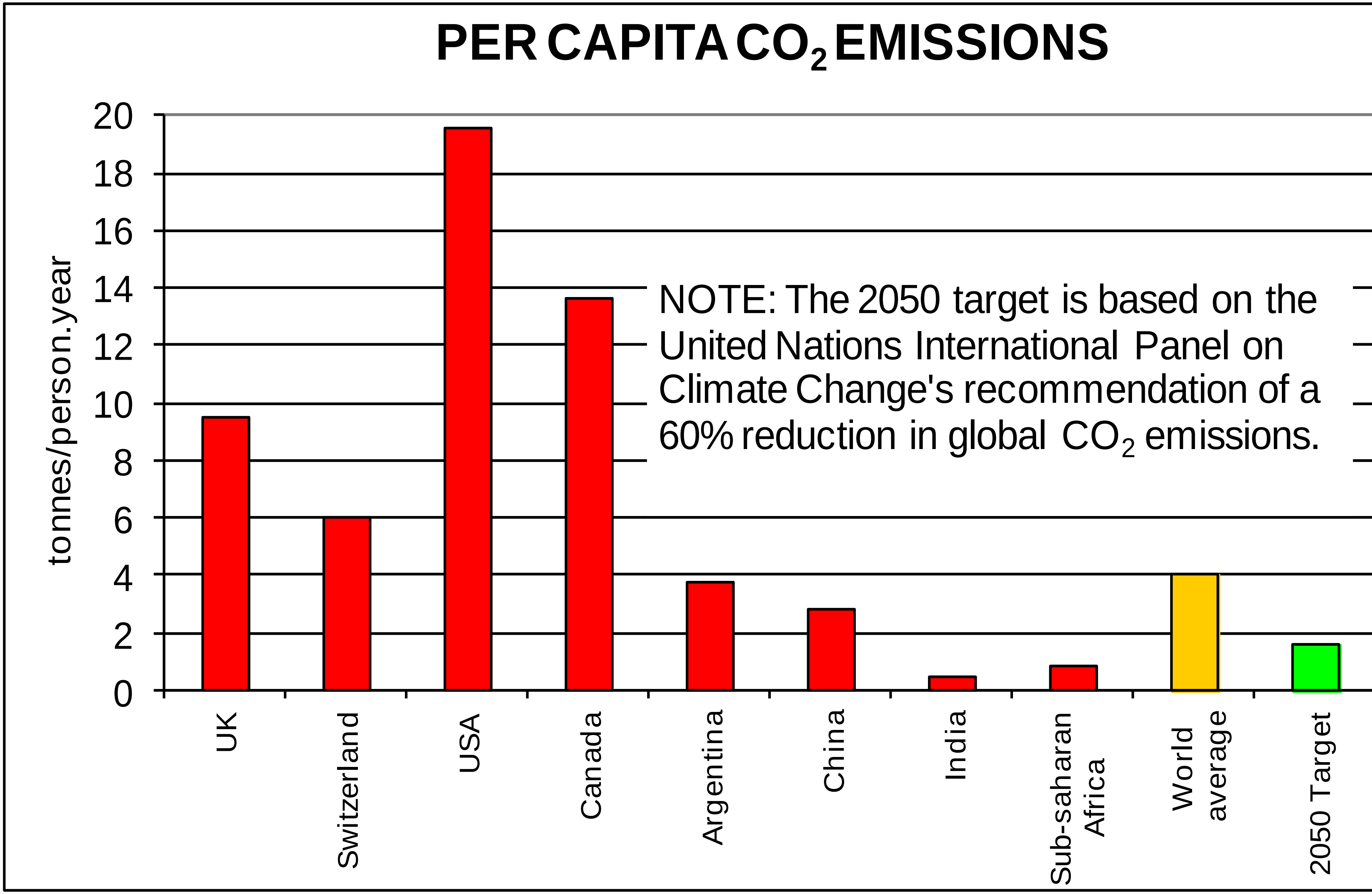
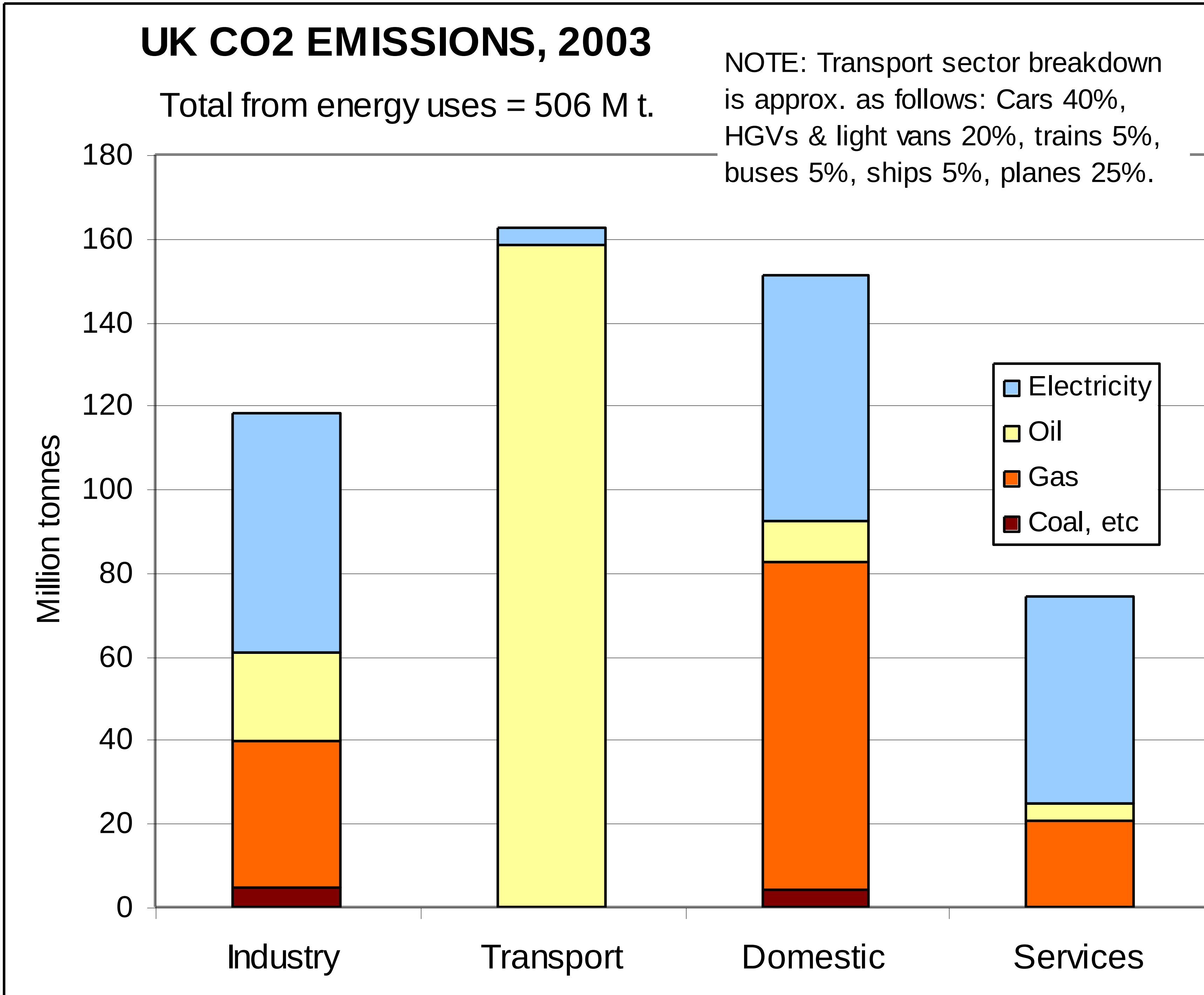
International CO_2 Reduction Targets



UK Energy Consumption and CO_2 Emissions

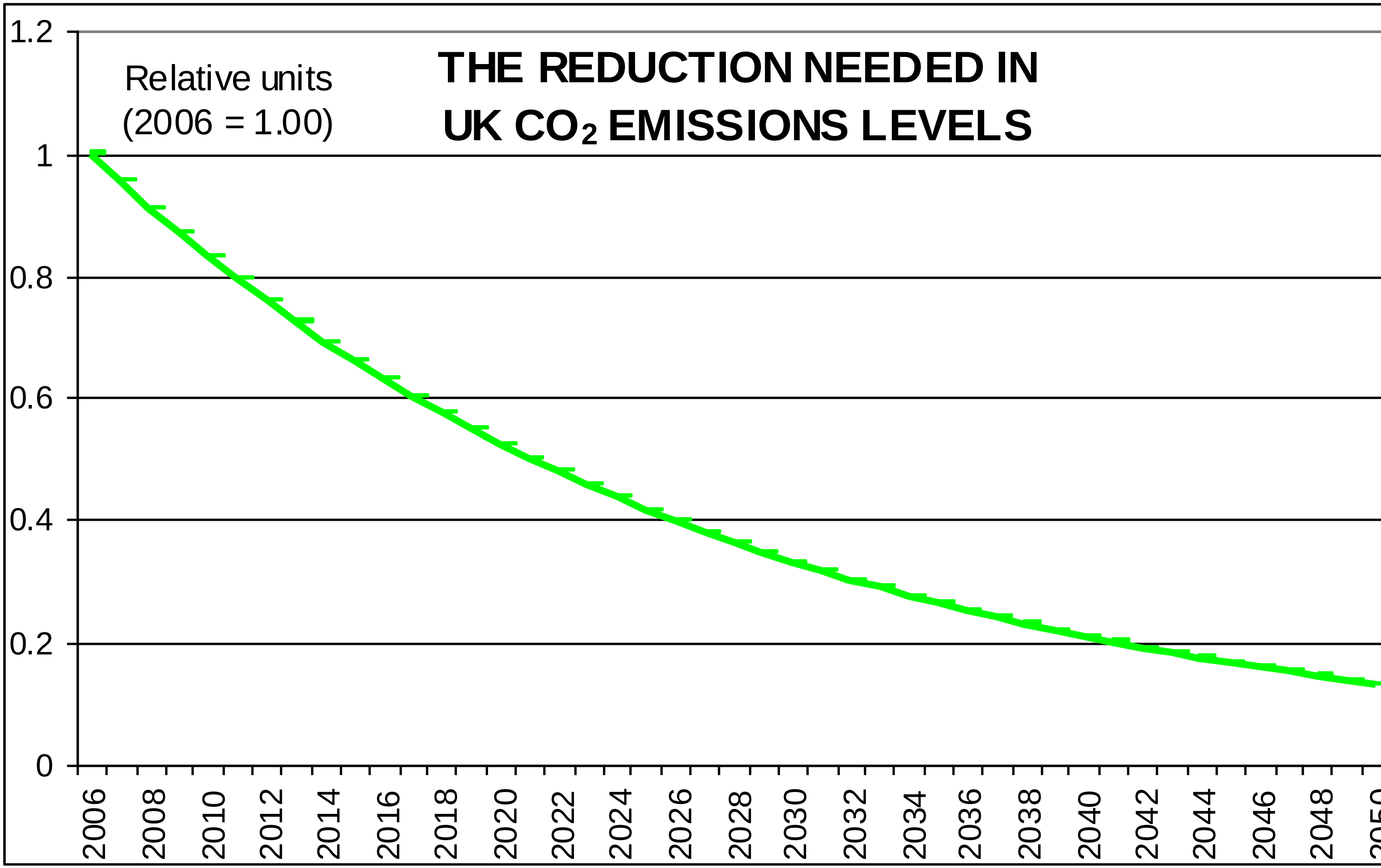
… also …

A Reality Check


UK CO2 EMISSIONS, 2003
Total from energy uses = 506 M t.
NOTE: Transport sector breakdown is approx. as follows: Cars 40%, HGVs & light vans 20%, trains 5%, buses 5%, ships 5%, planes 25%.
Million tonnes
180
160
140
120
100
80
60
40
20
0
Industry
Transport
Domestic
Services
Electricity
Oil
Gas
Coal, etc

A CO_2 Reduction Target for the UK

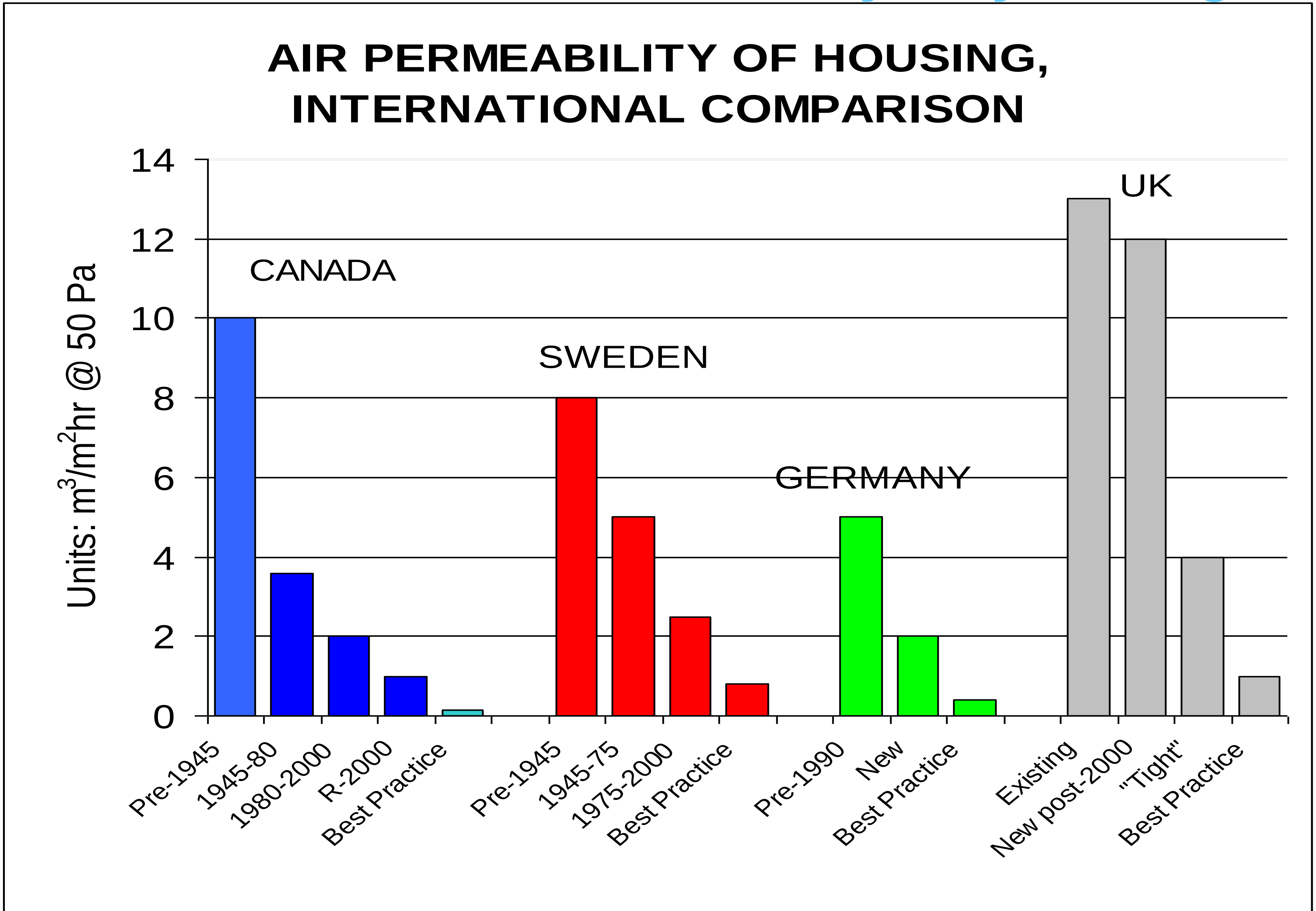
A reduction of 4.5%/year would reduce emissions by the necessary 85-90% by 2050.



Now for a Reality Check

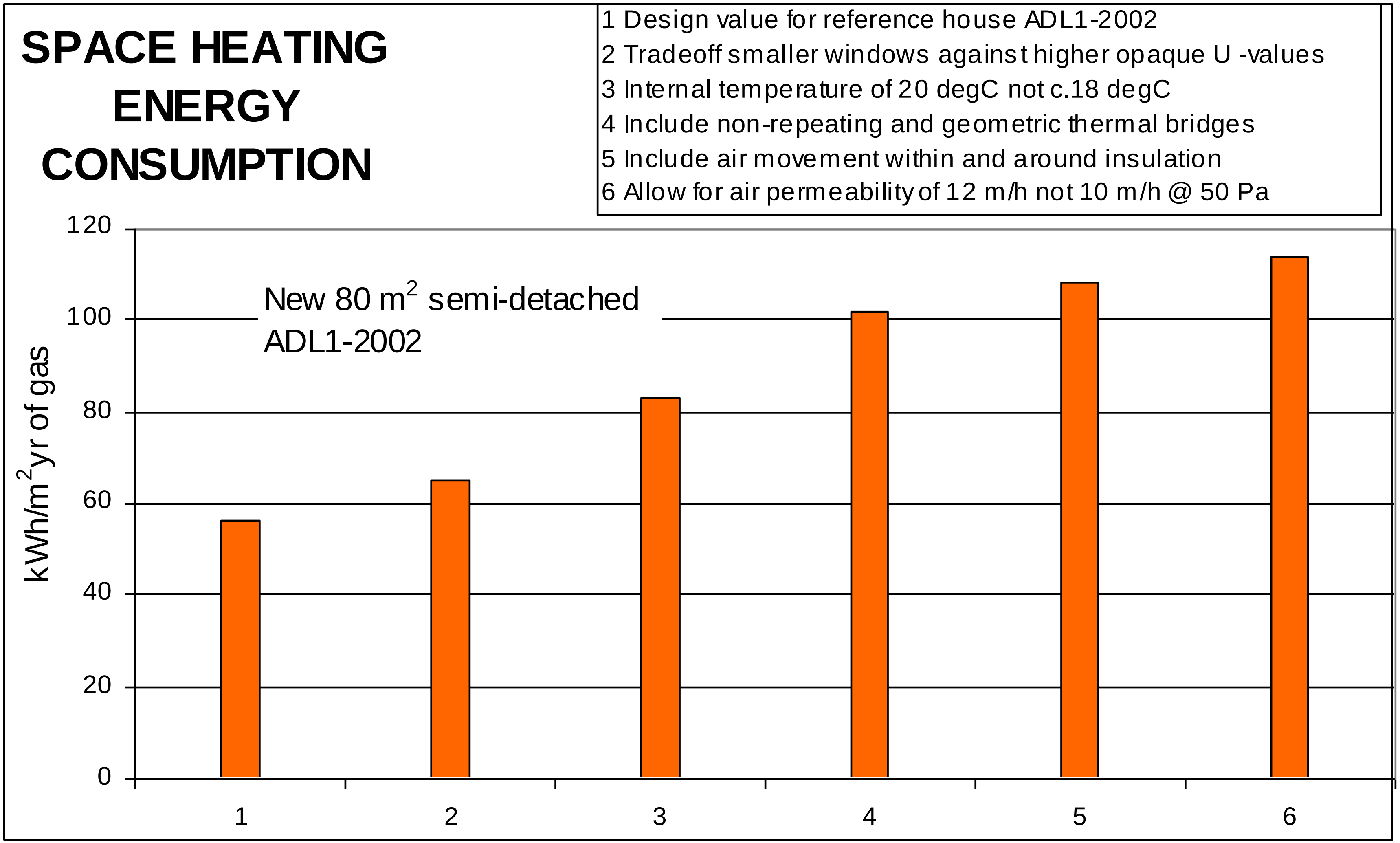
We build in ways which are not conducive to keeping the heat within a building

New UK dwellings are leakier than those built in Canada, Sweden or Germany 60 years ago.

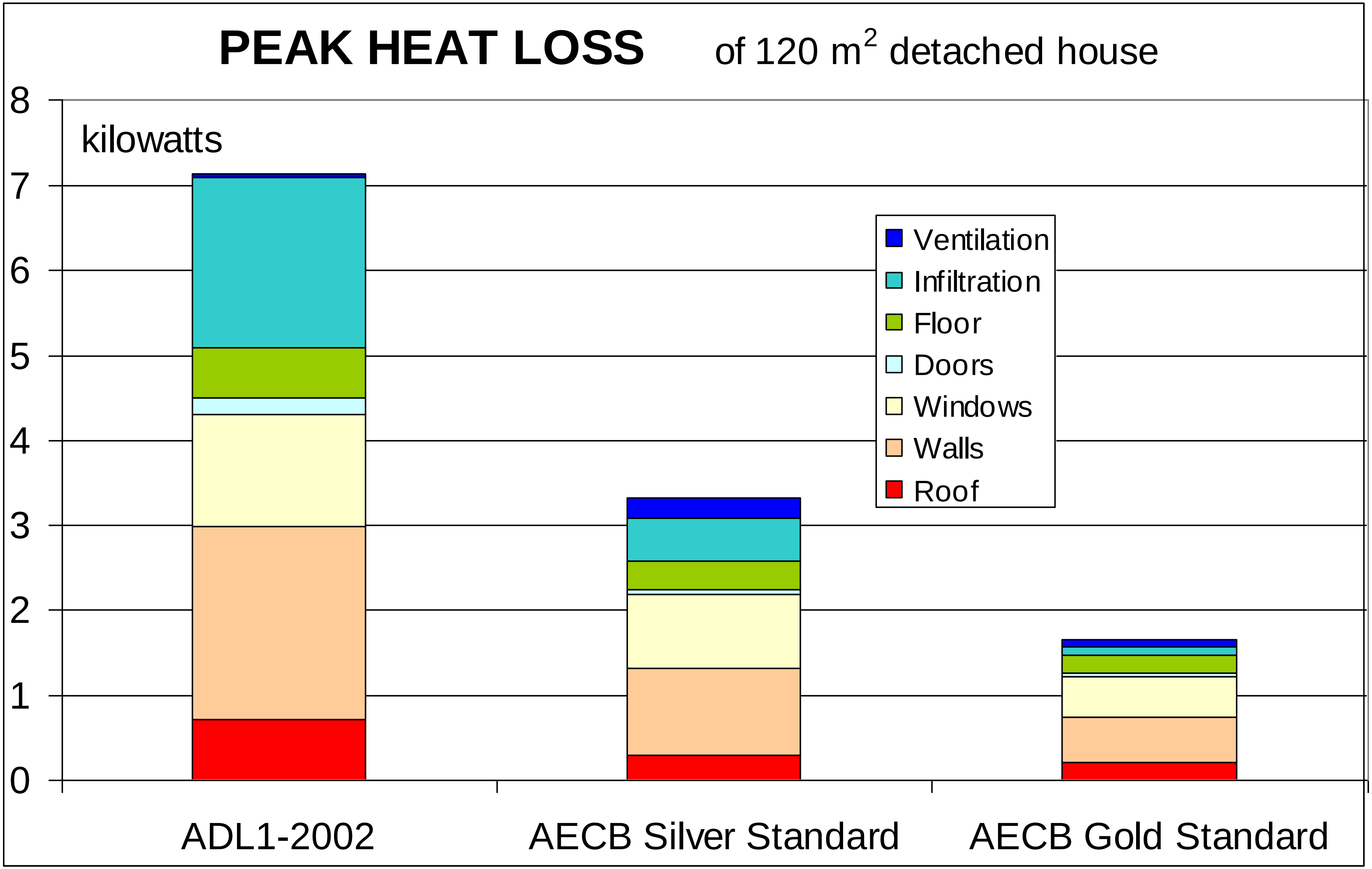


CALCULATION OF THERMAL INSULATION BENEFITS

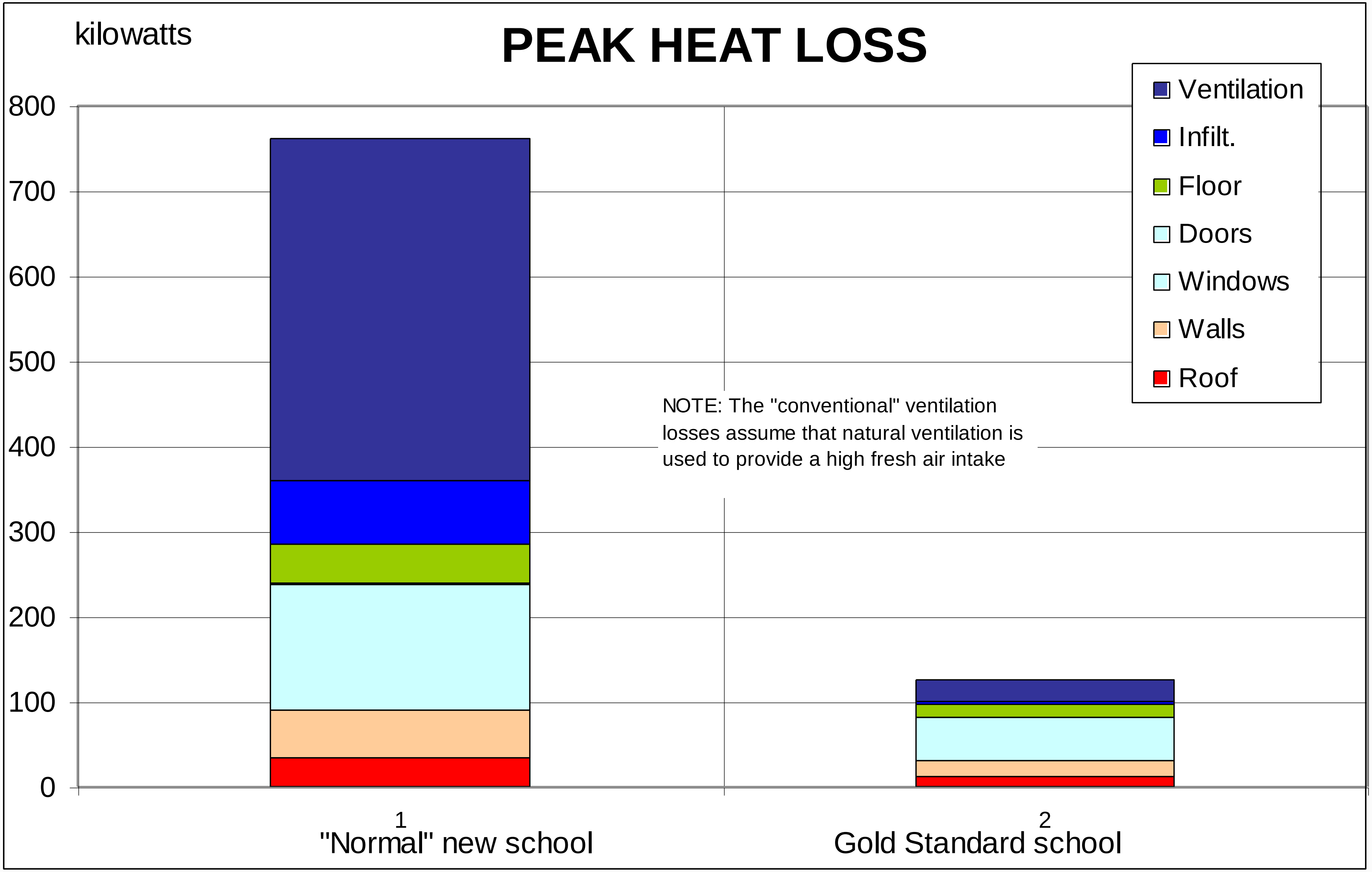
Over-optimistic procedures/methods/assumptions have been used to calculate the energy consumption of new housing.



There are erroneous beliefs that Part L1 of the UK Building Regulations has "reached a limit".



It has also been said that Part L2 of the Building Regulations has “reached a limit”. This is “debatable”.



We need policies and programs which rapidly and cost-effectively deliver buildings with reduced energy consumption and lower CO_2 emissions

The Leading Countries in Energy/Building Work

1. **Canada** - Issued guidance on air barriers >45 years ago, launched the R-2000 Program 25 years ago, C-2000 Program, etc. Experience of mass builder training and making normal new homes more airtight;
2. USA - Participates in most IEA Tasks related to energy-efficient solar buildings. Superb government websites; e.g., Office of Energy Efficiency and Renewable Energy, US Dept of Energy;
3. **Germany** - Work by independent institutes and state governments. German and Swedish experts developed the Passivhaus standard in the late 1980s. Every Passive House can now obtain a 30 year fixed rate mortgage at 3.4%/yr;
4. **Austria** - Lots of grassroots action. Up to 70% of all new dwellings are self-build one-offs. Even more Passivhaus buildings per capita than Germany;
5. **Switzerland** - Federal government MINERGIE and MINERGIE-P Standards. Many good documents by the Swiss Institute of Architects and Engineers;
6. **Sweden** - Even its Building Code is close to the Passivhaus Standard;
7. **Denmark** - New buildings *in 1975* had 100 mm wall insulation. 60-65% of all buildings are now heated by CHP or by industrial waste heat;
8. Norway - State Housing Bank wrote two voluntary low-energy standards for dwellings. Main window producer makes a Passive House window.

R-2000 Standard

- Launched in Canada in 1983. “Voluntary” but message to industry was that if it did not participate, mandatory standards could be imposed;
- Directed at low-rise timber-frame buildings - 80% of new housing in Canada and 10-20% of non-residential construction is of timber;
- Energy consumption 70% less than pre-1975 housing. The space heating energy budget was 55 kWh/m^2yr even in the Prairies - the coldest inhabited climate on earth except for Siberia and north-east China;
- Some homes are being improved to the R-2000 standard during major renovation. Improving them to the Swedish air permeability standard for new construction (max. 2.88 m^3/m^2hr at 50 Pa) is regarded as straightforward.
- Between 1983 and 1993, about 70% of the registered building contractors in Canada attended government training courses on how to build an energy-efficient home.

Canada - Recent Developments

* Saskatchewan has built a Factor Nine house. It is intended to reduce energy and other resource usage to 11% of that of typical pre-1975 housing. Total delivered energy consumption will be reduced from around 300 to 33 kWh/m^{2}yr.

* Canada Mortgage and Housing Corporation EQuilibrium Program is for new housing which produces as much energy as it consumes. A competition was held and 12 grants of $50,000 were awarded for projects from the Pacific coast to the Atlantic coast. To be opened to visitors in 2008; http://www.cmhc-schl.gc.ca/en/corp/nero/nere/2007/2007-02-13-0830.cfm

* A new eco-energy initiative will provide grant aid to homeowners who are prepared to bring their dwelling up to the same standards of a new energy-efficient home.

Passivhaus Standard

* Developed in Germany 1988 onwards.

* If applied rigorously, leads to an energy consumption around 85% less than conventional buildings in the same country, housing and non-domestic alike. Often without any solar “add-ons”.

* Germany and Austria are *retrofitting* buildings to this standard at a time when they need major renovation.

See www.passiv.de, www.baudetails.info.

Summary - Passivhaus Standard

- Real U-values <0.15 W/m²K, usually <0.10 W/m²K.
- "Thermal bridge-free" construction.
- Glazing U-value <0.8 W/m²K.
- Air leakage <0.6 air changes/hour @ 50 Pa
- Peak space heating load <10 W per m² floor area
- **Space heating energy <15 kWh/m²yr.**
- Consequently no separate heating system, only water-air heat exchanger(s); i.e., plumbing coil(s), in vent. ductwork.
- Vent. system specific fanpower <1.44 W per l./s.
- Vent. system equiv. heat recovery >75% as seasonal average, excl. fan heat gains and the benefit of the earth tube heat exchanger if used.
- Highly energy-efficient lighting systems, electrical appliances & office equipment.
- **Primary energy consumption <120 kWh/m²yr.**
- See www.passiv.de

German Progress to Date

- 6,000 houses or flats met the Passivhaus Standard by spring 2006; c.1% of new housing meets the standard;
- Many private and government offices have been built to the PH Standard, starting in 1997-98;
- Ten new schools or new school buildings and three new sports halls have been built to the PH Standard, starting in 2000-03;
- About 20 more PH schools are at the design or construction stage;
- Two schools dating from the 1950s or 1960s have been *retrofitted* to the PH Standard, plus hundreds of dwellings - even listed medieval timber-frame homes;
- Frankfurt city council decided in 2005 that *all* new public buildings must meet the PH Standard.

Important Findings

- PH buildings have better internal air quality than those with “window ventilation”. Particularly significant in densely-occupied non-domestic buildings and flats;
- They provide higher thermal comfort standards than conventional structures – also noted in USA 20 years ago;
- Past mechanical ventilation rates of 30+ m^3/hr were too high, leading to uncomfortably dry indoor air from November to March. 20 m^3/hr = 5-6 litres/sec.cap. suffices;
- Building occupants prefer winter air temperatures of 21.5^{o}C to the 20^{o}C hitherto assumed in Germany for design purposes or the c.18^{o}C assumed in UK SAP calculations;
- In summer, the temperature in offices or classrooms can be kept <24^{o}C c.99% of the time using earth tubes and/or night ventilation. German summers are more “severe” than summers in “London and the SE”.

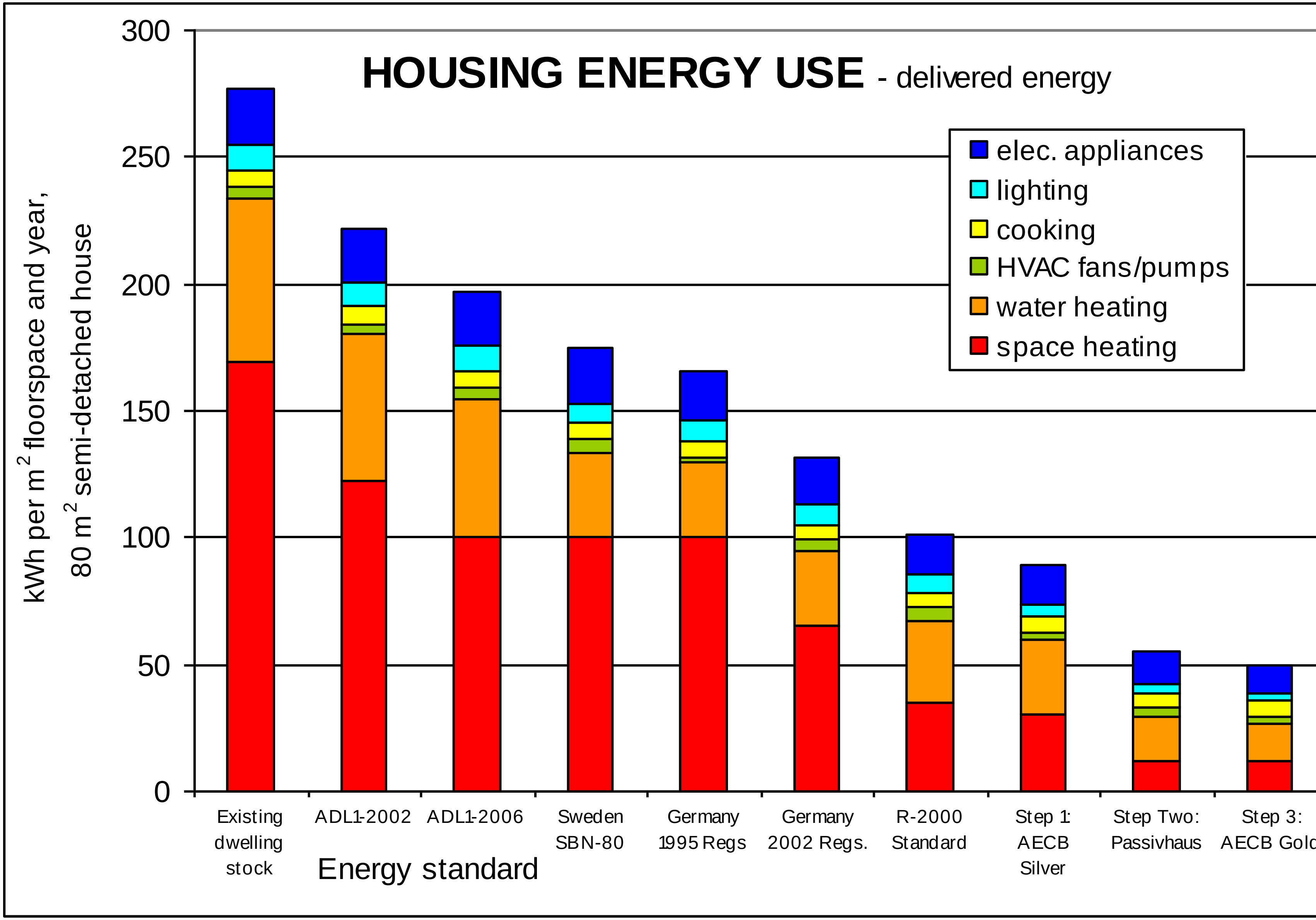
AECB Silver and Gold Standards

* Developed in UK 2003 onwards for application by all 1,400 members in their own projects;
* Lead to energy consumption respectively 75% and 85% lower than the UK building stock;
* Lead to CO_2 emissions respectively 70% and 95% lower than the building stock. See www.aecb.net.

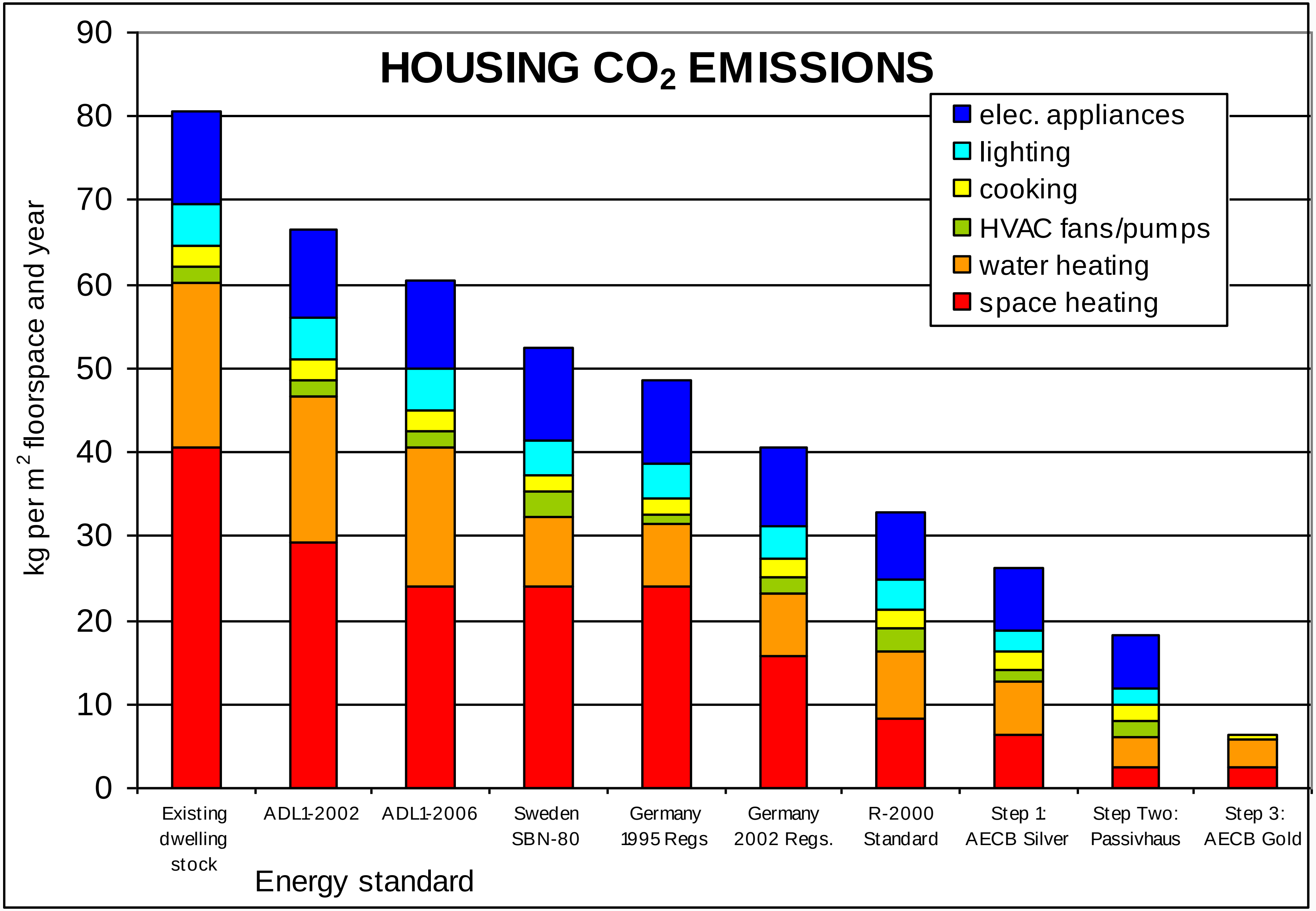
Summary - AECB Gold Standard

- Opaque real U-values <0.15 W/m^2K, usually <0.10 W/m^2K
- Minimal thermal bridging
- Glazing U-values <0.8 W/m^2K
- Air permeability <0.75 m^3/m^2hr @ 50 Pa
- Peak space heating load <10 W per m^2 floor area
- Space heating useful energy <15 kWh/m^2yr.
- Vent. system specific fanpower <0.8 W per l./s
- Vent. system equiv. heat recovery >85% as seasonal average excluding fan heat gains, including benefit of earth preheating tube(s) if used
- The most energy-efficient lighting systems, domestic appliances & office electrical equipment on the market
- Elec. generated from on-site or dedicated renewables; e.g., PV, micro-hydro or community wind turbine helps to offset CO_2 emissions from the elec. consumption for lights & appliances.

Impact of Effective Energy Performance Standards on Energy Consumption.



Impact of Effective Energy Performance Standards on CO_2 Emissions.



What Have These Programs Delivered?

Case Studies

Headquarters of the Rocky Mountain Institute in Old Snowmass, Colorado, USA (built in 1983, photovoltaics added in 1992).

The Saskatchewan Factor Nine Home (2007).

A Detached House to the Passiv Haus Standard in Hohen Neudorf, Brandenburg, Germany (2004).

The First School to the Passivhaus Standard in Waldshut, Germany (2003).

See also www.passiv.de

Some early UK projects were informed by practice elsewhere in Europe and North America …

The Elizabeth Fry Building.

UEA, Norwich (1994).

3,500 m^2 of floorspace on four floors. Heated by two 24 kW(t) domestic wall-hung condensing boilers. No cooling provided or needed, only automated summer night ventilation using hollow-core concrete floors. High score in PROBE user survey. Large lecture theatres in basement, seminar rooms and offices on other floors. Gas usage 25-30 kWh/m^2yr since 1997.

A Detached House to the AECB Silver Standard

Charlbury, Oxfordshire (1993).

Lower Watts House

Measured Energy Use from 1993-2005:
Gas 50 kWh/m^2yr.
Electricity 12 kWh/m^2yr.
Total 62 kWh/m^2yr.

Recent UK projects *still are* informed by “best international practice” …

The Pines Gardens Calyx

St. Margaret's Bay, east Kent.

A small non-domestic building aiming at the AECB Gold Standard.

The Pines Gardens Calyx. August 2005.

A Detached Cottage to the AECB Gold Standard

Rural site in north-west Herefordshire (photos taken 2006).

The project will produce all its energy from solar energy, mainly passive gains, an experimental solar water heating system and roof-integrated photovoltaics.

Emerging Issues

For “Low-” or “Zero-CO_2” Buildings

Solid Biomass Heating

- May need a separate boiler house or larger plant room;
- No appliances can efficiently provide a heat load of 50-300 kWh/month; e.g., homes built to international best practice;
- The capital cost is higher than that of boilers fuelled by liquid or gaseous fuels (including liquid/gaseous biofuels);
- The exhaust emissions of the best equipment are level with a poor-quality oil boiler; the worst are 100 times higher;
- Older wood combustion technologies emit enough CH_4 to be worse for climate change than an oil boiler. See; e.g., http://www.eia.doe.gov/oiaf/1605/gg02rpt/methane.html

Emerging Issues (cont.)

Heat Pumps using "Renewable" Electricity

Beware of the "Green Electricity Illusion"

See www.aecb.net/energyinbuildings/php#background

- All consumers in a region receive the same supply mix from the national grid (79% fossil fuel, 17% nuclear, 4% "renewable");
- "Green tariffs" are a misnomer. Too little is being produced even to meet suppliers' minimum legal obligations.
- Incremental changes in demand, such as that due to a growth in electric heating, are met by raising the output of coal- or gas-fired plant (marginal CO_2 emissions are c.0.9 kg per delivered kWh versus mains gas 0.195 kg per kWh, LPG 0.235 kg per kWh);
- If we wish to reduce CO_2 emissions, we should (a) utilise other methods of space and water heating, (b) use electricity more efficiently in its essential applications and (c) continue to install renewable electricity systems.

Clean, large-scale, CO_2-free space and water heating - on the other side of the North Sea.

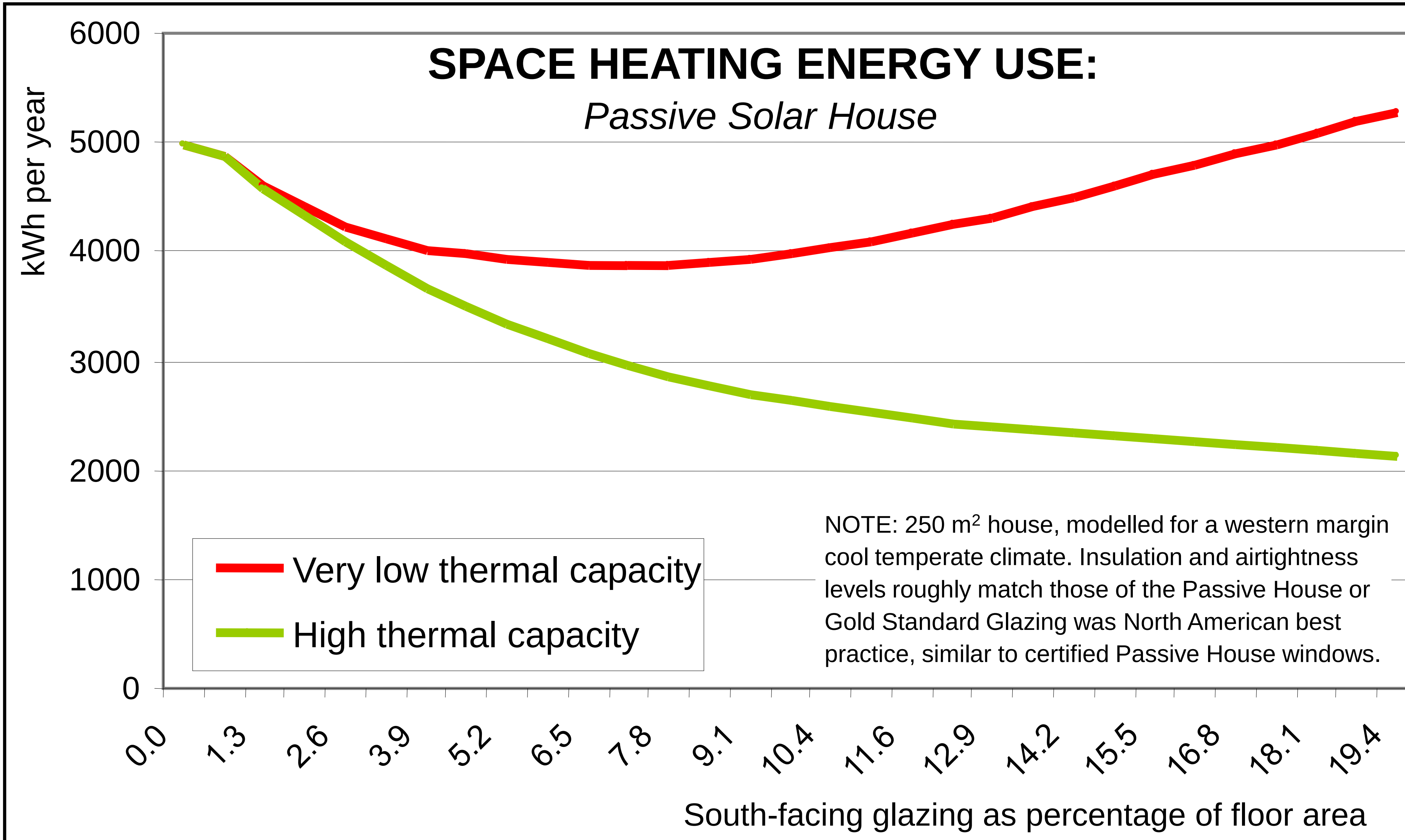
1996 - 10,000 m^2 of ground-mounted solar collectors and a long-term heat store help to heat the small coastal town of Marstal, Denmark.

Large collectors produce heat at *one-sixth* the cost of small, single-house collectors.

2002 - To increase the solar fraction for the town's district heating system, the solar collector area is raised to 18,000 m^2.

Another Emerging Issue

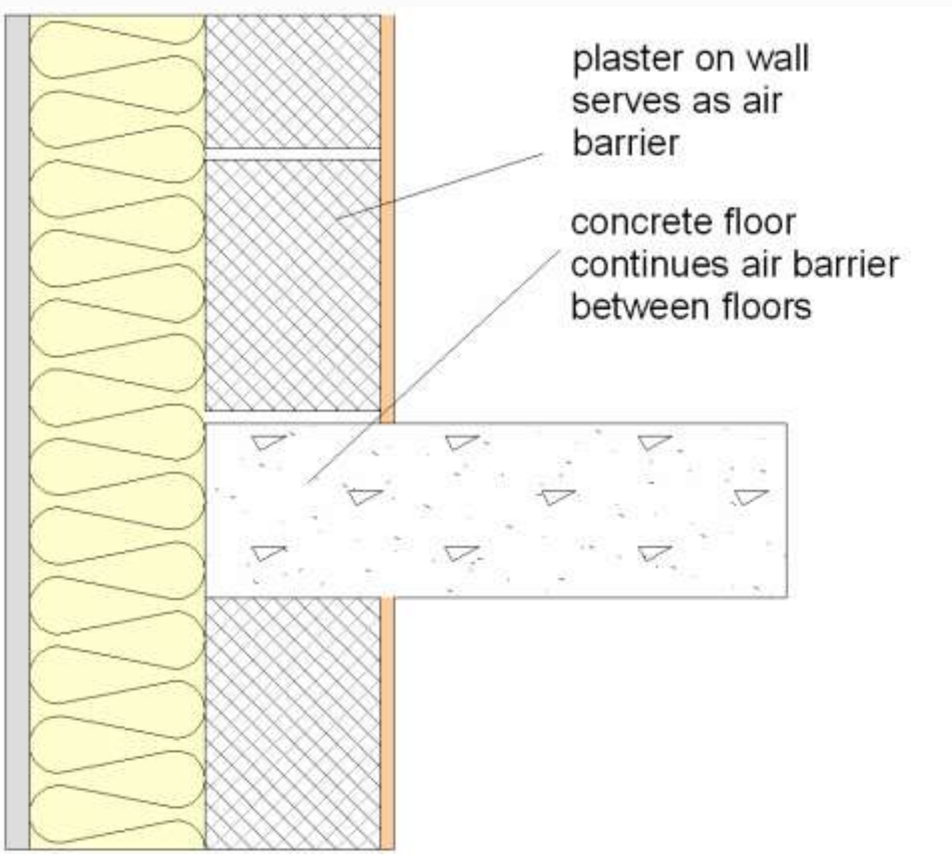
On the western edge of Europe, there is ample scope for new dwellings to utilise more passive solar energy - given high thermal capacity construction.



Better design guidance and builder training is clearly needed.

Examples of sound thermal envelope design.

SOLID MASONRY,
EXTERNAL INSULATION



TIMBER-FRAME