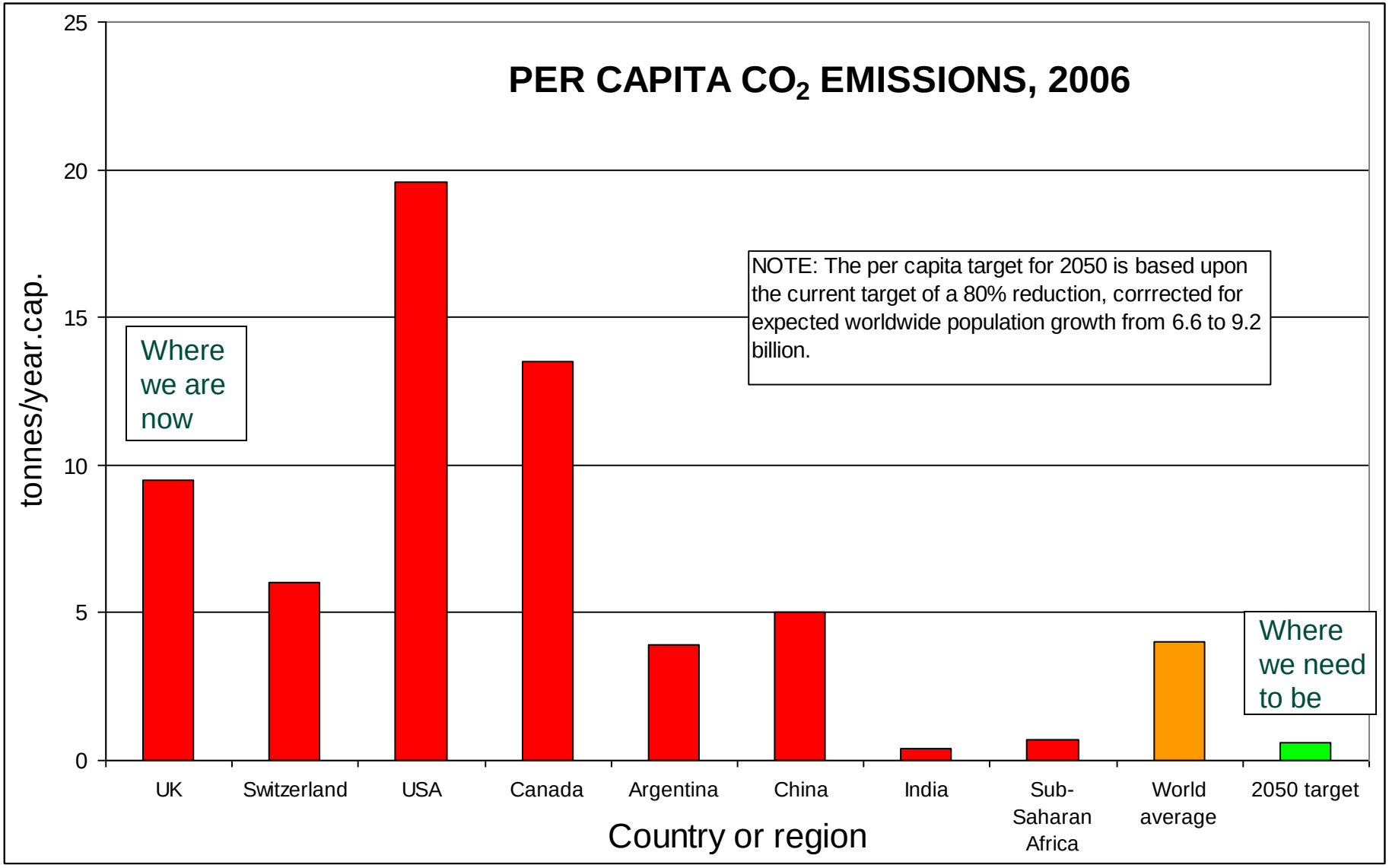
Retrofit Works: Getting the UK Priorities Right

Eco-Build, 22 March 2012

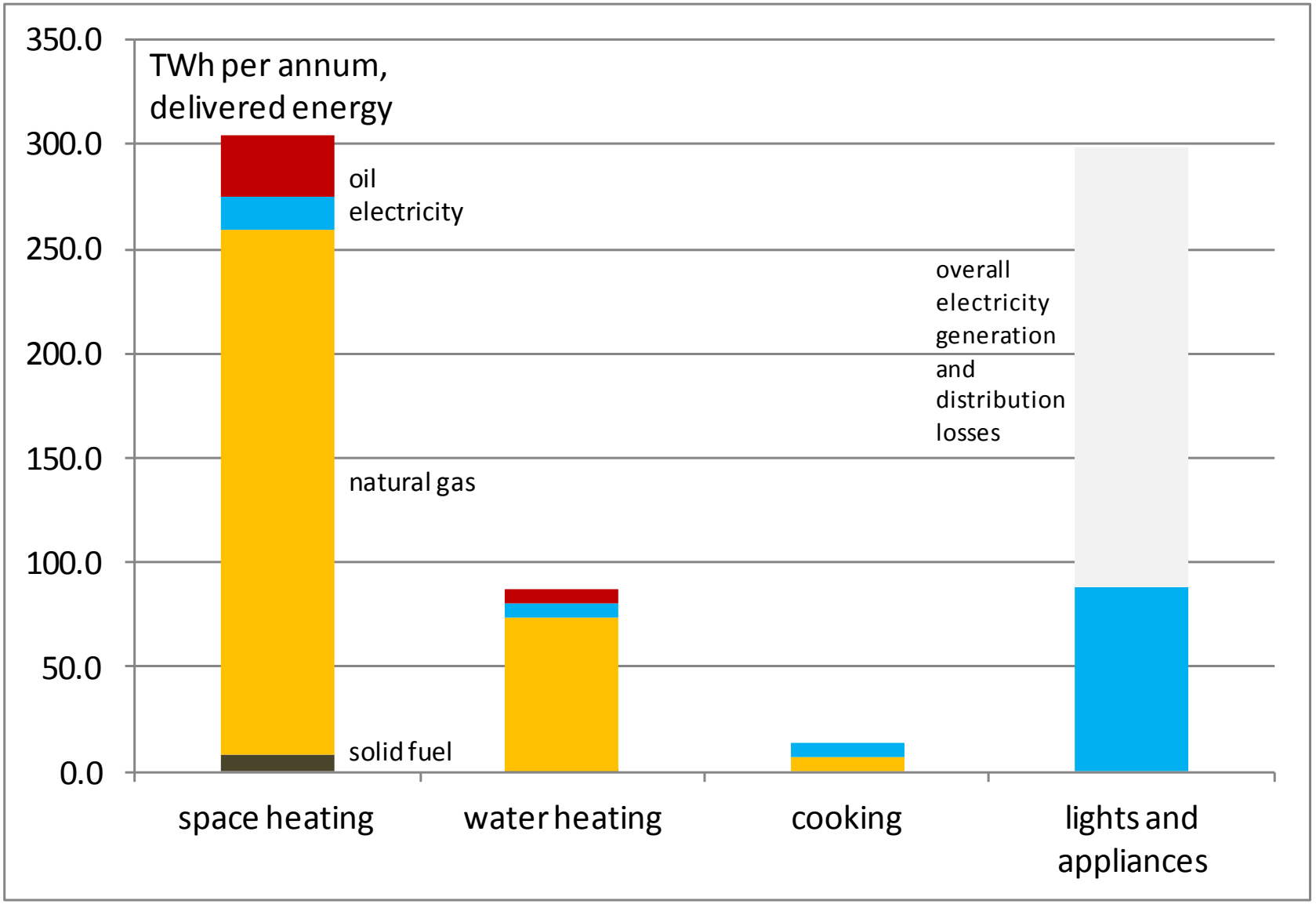
David Olivier

- International Greenhouse Gas Reduction Targets
- Greater Energy Efficiency in Heating
- Greater Energy Efficiency in the Use of Electricity
- Getting the UK Priorities Right??

International Greenhouse Gas Reduction Targets



UK Domestic Energy Use, 2009



Greater Energy Efficiency in Heating

Greater Energy Efficiency in Space and Water Heating

Reduce the quantity of heat consumed; e.g. insulate the walls, improve the windows and draughtproof a building to reduce its heat loss.

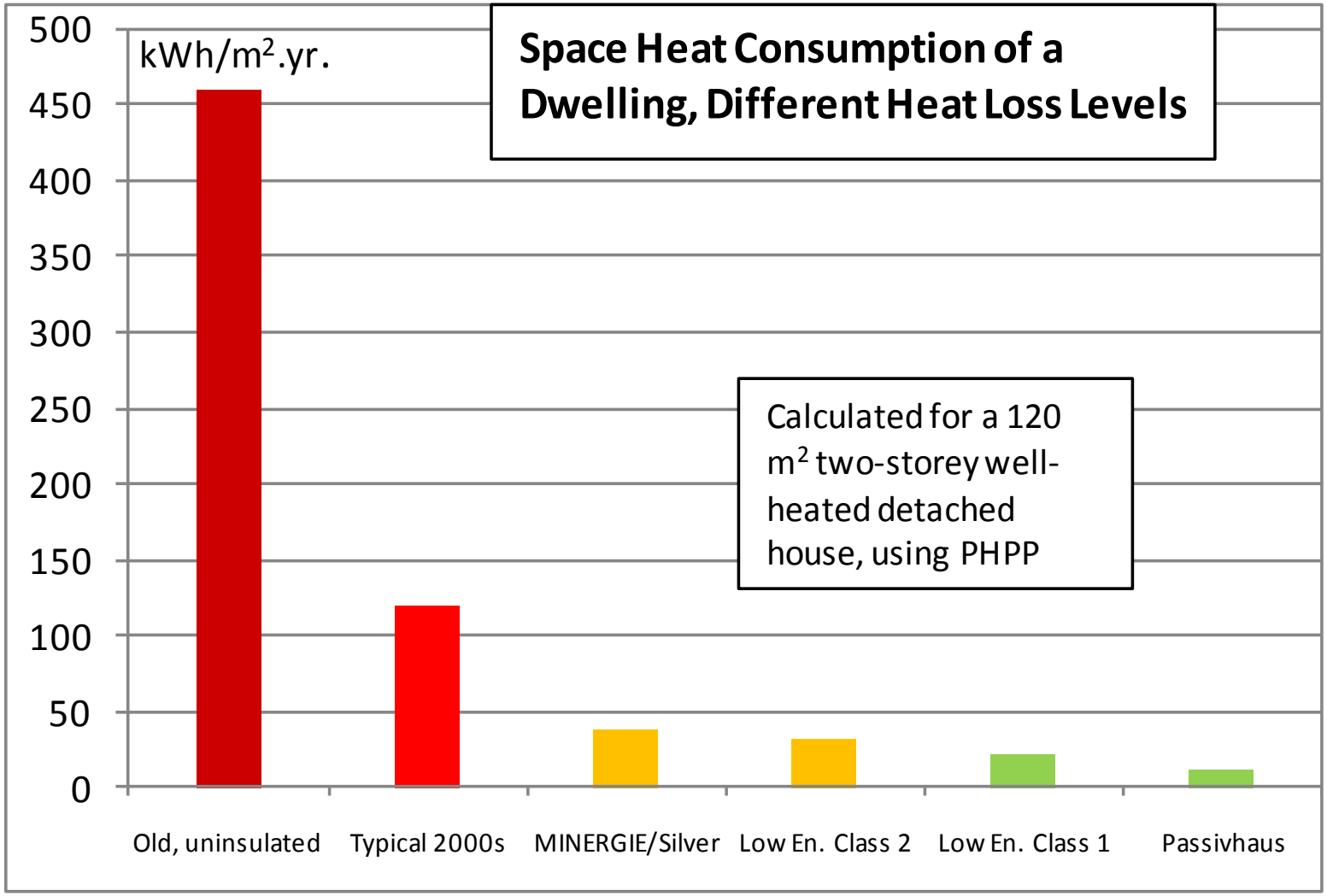
Reduce the quality of energy provided; e.g., replace a gas- or oil-fired heat-only boiler or electric heating by waste heat from gas CHP or possibly by a heat pump.

The combination. Can in theory reduce consumption of high-grade energy and CO_2 emissions by 99%. But "merely" 90-95% would be very acceptable.

Other impacts. Try to reduce other air pollution when replacing one heating system by another. Some pollutants; e.g., soot, also affect climate change.

Lower Heat Consumption

Good and best practice reduces emissions 95-97% versus "worst practice" and 70-88% vs. "2000s average practice".



Sources:

Old uninsulated and 2000s construction - author's calcs

MINERGIE - Swiss government standard.

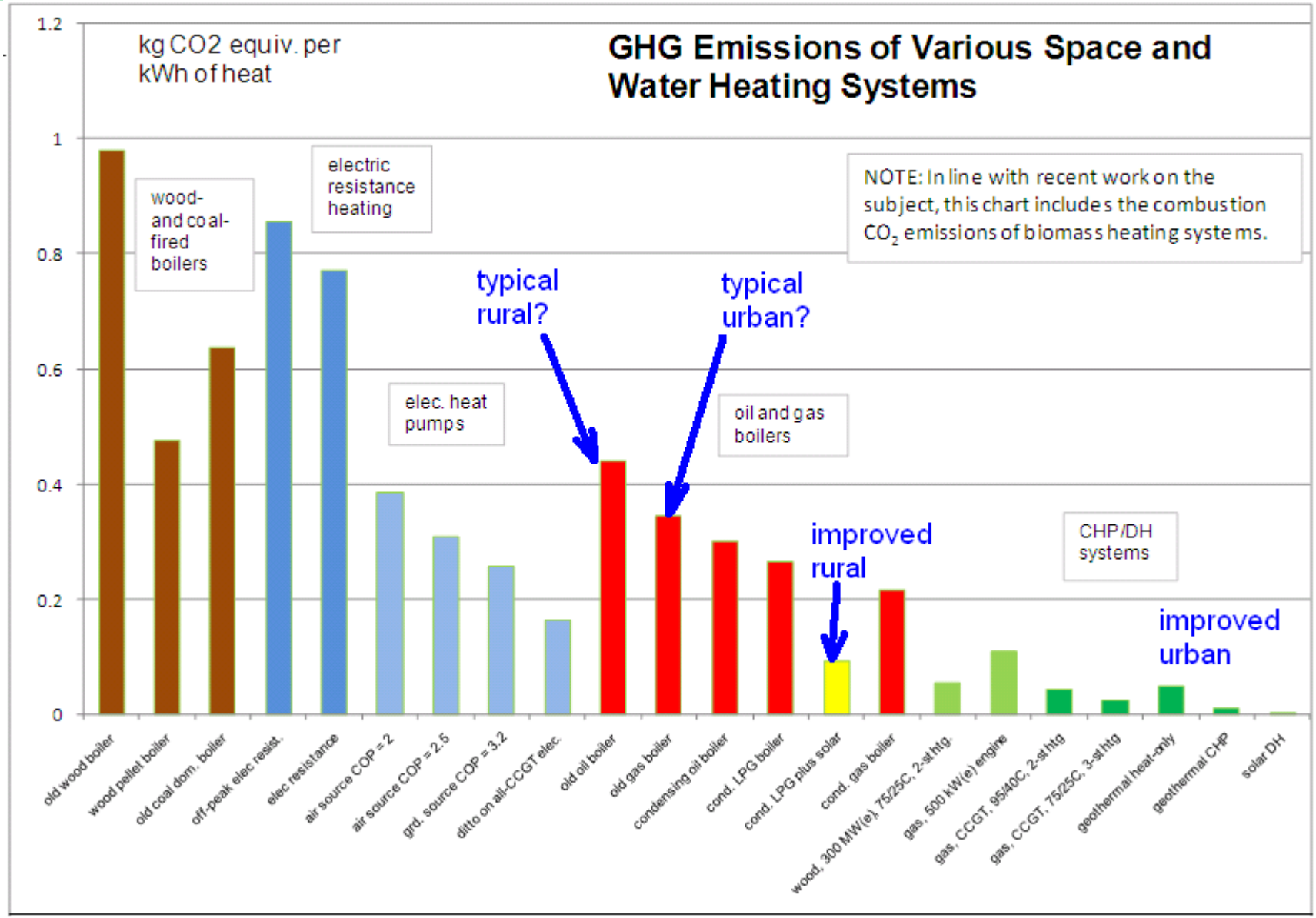
Silver - AECB, the Sustainable Bldgs Assocn.

Low Energy Class I and II - Danish government.

Passivhaus - standard - PHI, Germany

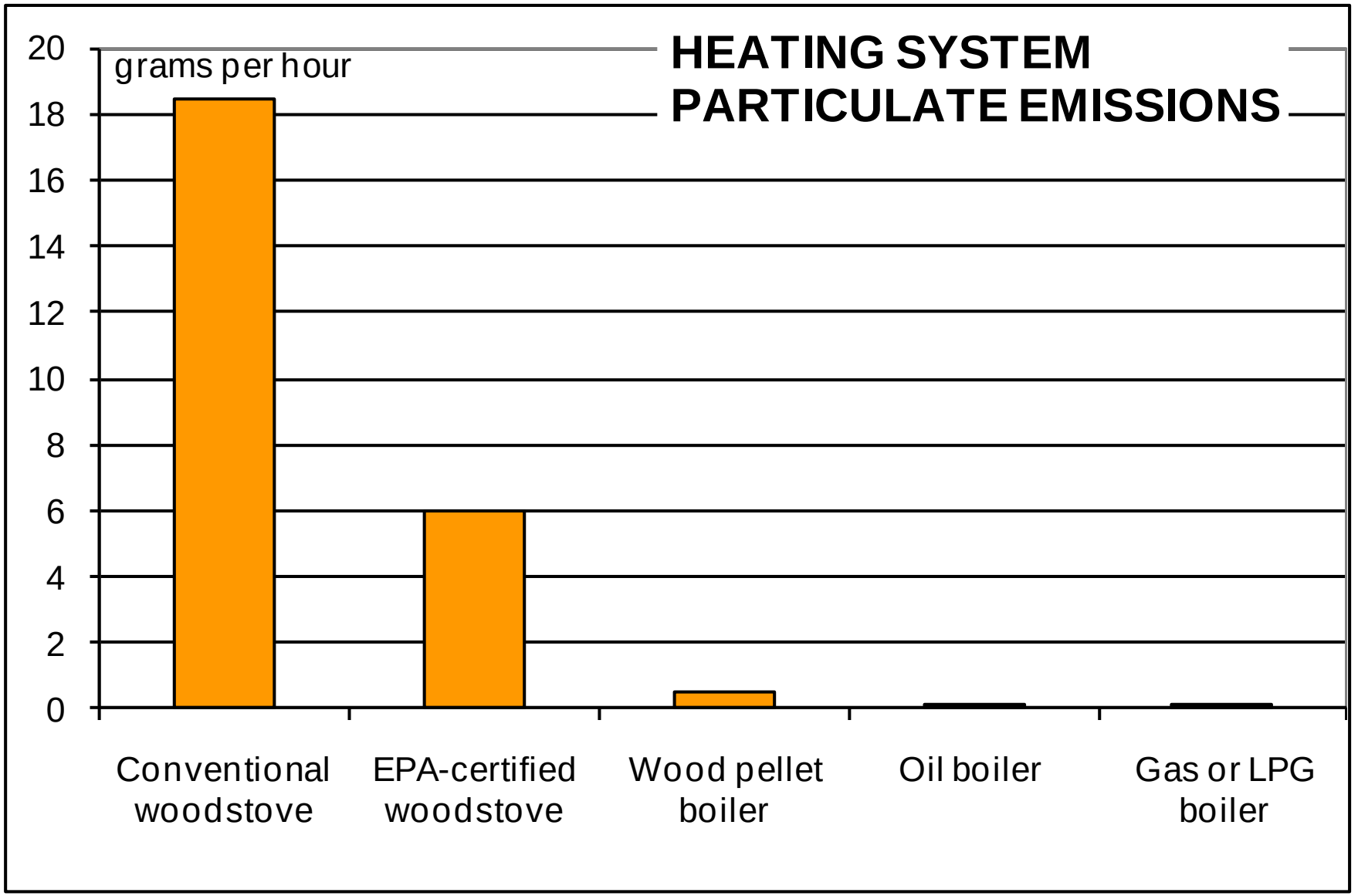
Lower-CO_2 Heat

Good practice reduces emissions 75-90%. Until power generation is non-fossil; e.g., maybe in 2040, electric heat pumps do not give dramatically lower emissions than gas- or oil-fired condensing boilers.



Cleaner Heat

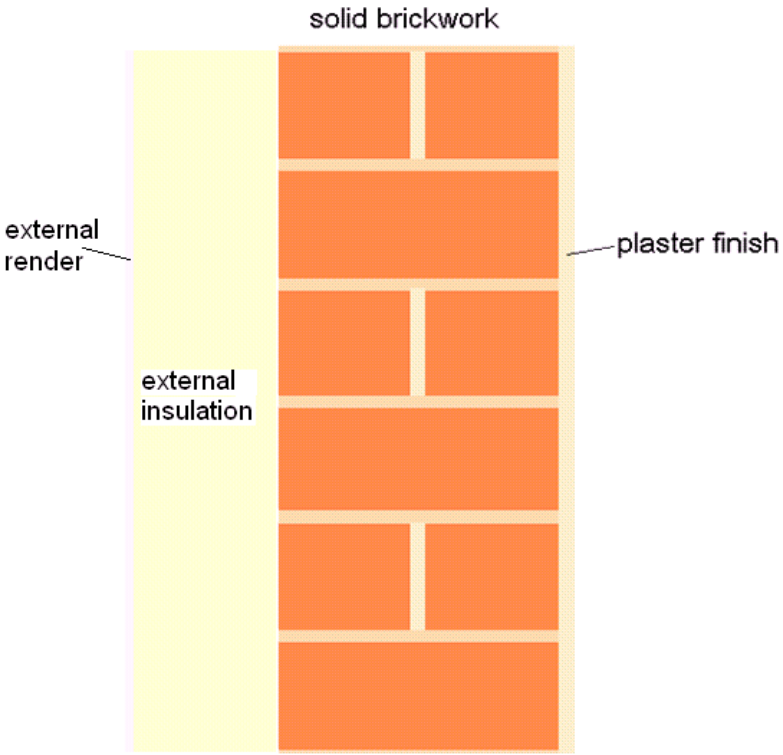
UK air quality breaches EU law. It is undesirable to make matters worse.



Insulating Existing Construction?

Solid Brick Walls

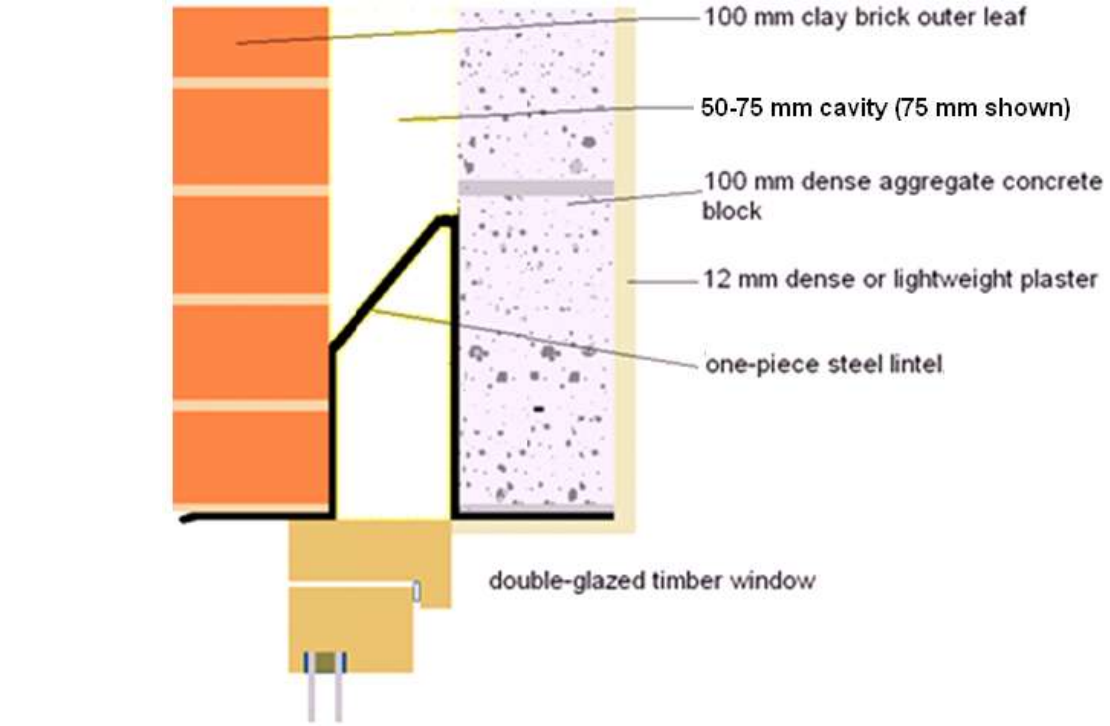
Externally, a moderate (6x) to very large (20x) improvement is possible. Internal insulation is possible but needs great care.

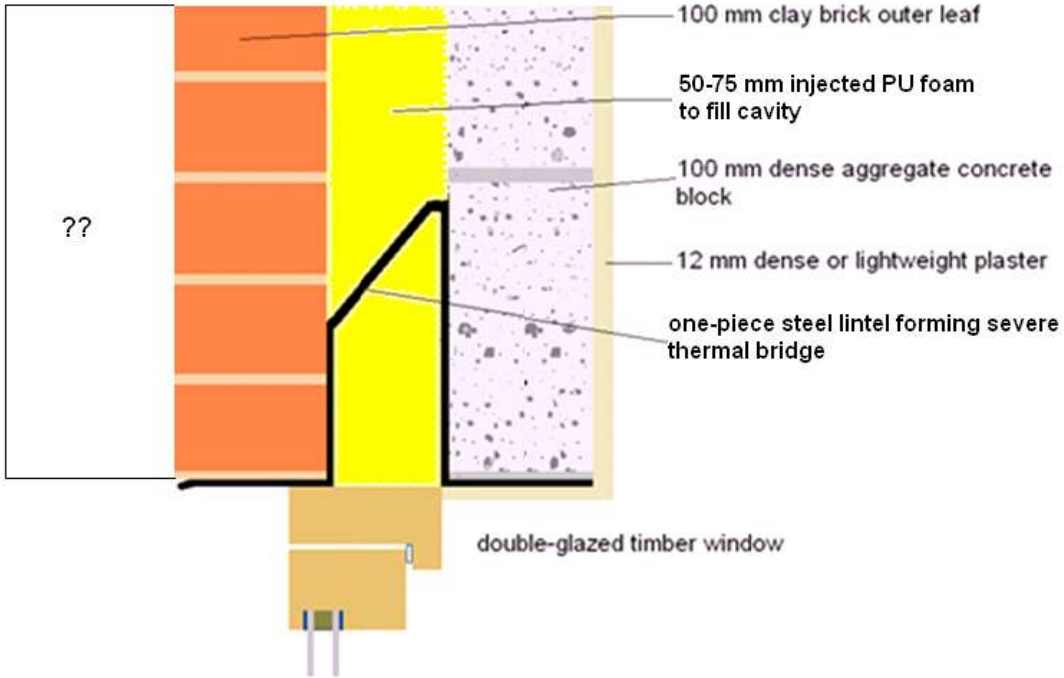


Insulating Existing Construction?

Modern Cavity Walls

Using high-performance cavity fill, likely U-value = 0.4 W/m^{2}K. Existing UK support programs need to be modified immediately as they use inferior insulants.





Costs of Thermal Retrofits

A reality check

- In experience in northern England costs were £75k per property. This approaches or even exceeds the construction cost of a new 75-80 m^2 dwelling.

- The figure could possibly be cut to £50k after the industry gains greater familiarity with the techniques needed.

- Synchronisation of retrofits with maintenance; e.g. re-pointing, re-rendering, replacing windows and external doors, re-roofing and new heating systems could possibly reduce the marginal cost to below £50k; e.g. £30k. But it would extend the timescale.

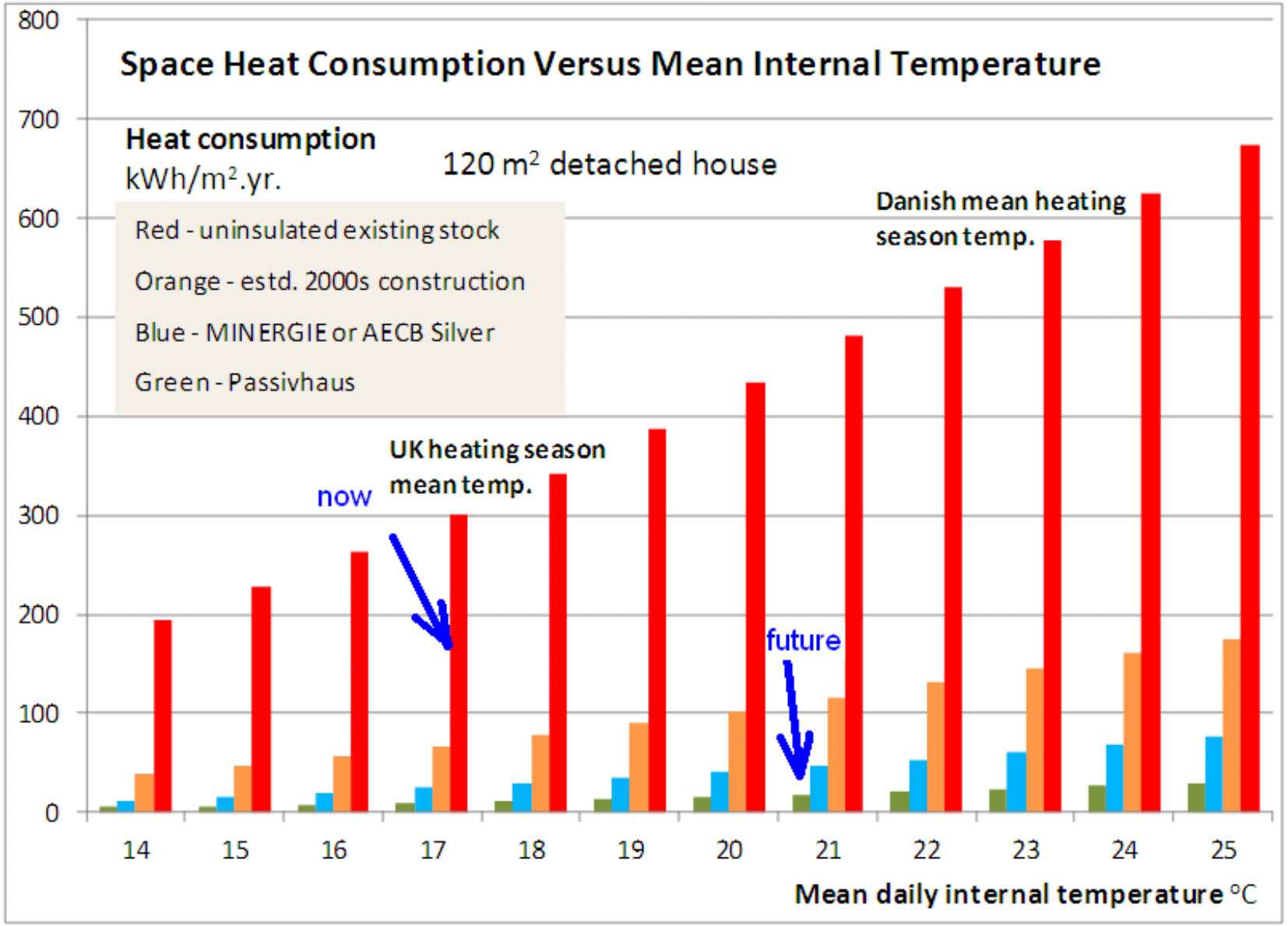
- Over a 35 year period, Canada has achieved very low "superinsulated retrofit" costs. But their practice would typify rural or suburban regions with "no planning or spatial constraints".

Saving from Thermal Retrofits

Another reality check

- Measured savings may be lower than those calculated under present assumptions.
- UK buildings are the least well-insulated or -draughtproofed of any major central or northern European country.
- Existing internal temperatures are very much a compromise between running costs and thermal comfort.
- There are 25,000 excess deaths in a typical UK winter. Some if not many of them are caused by living in cold conditions.
- Occupants of many homes are more concerned by the lack of comfort than by the running costs or environmental issues.
- Retrofit programs need to address energy, CO_2 and social policy.

Then the outcome could be CO_2 savings, warmer buildings *and* a reduction in "fuel poverty"



Limits to Thermal Retrofits

- The UK has a high proportion of legally-protected buildings; e.g., Grade I, II* and II listed or Scheduled Ancient Monuments.
- Many are in designated areas; e.g., National Parks, Areas of Outstanding National Beauty, Conservation Areas and Green Belt.
- These give rise to practical restrictions on reducing buildings' heat loss.

NOTE: Terms may vary between England, Wales, Scotland and Northern Ireland

CHP and/or District Heating

Top right - typical PEX twin pipe for low-density areas

Bottom left - street in the city of Aarhus, Denmark

Bottom right - typical Danish connection to piped heat for detached houses.

Pictures: www.pipesystems.com Google earth.
www.danskfjernvarme.dk

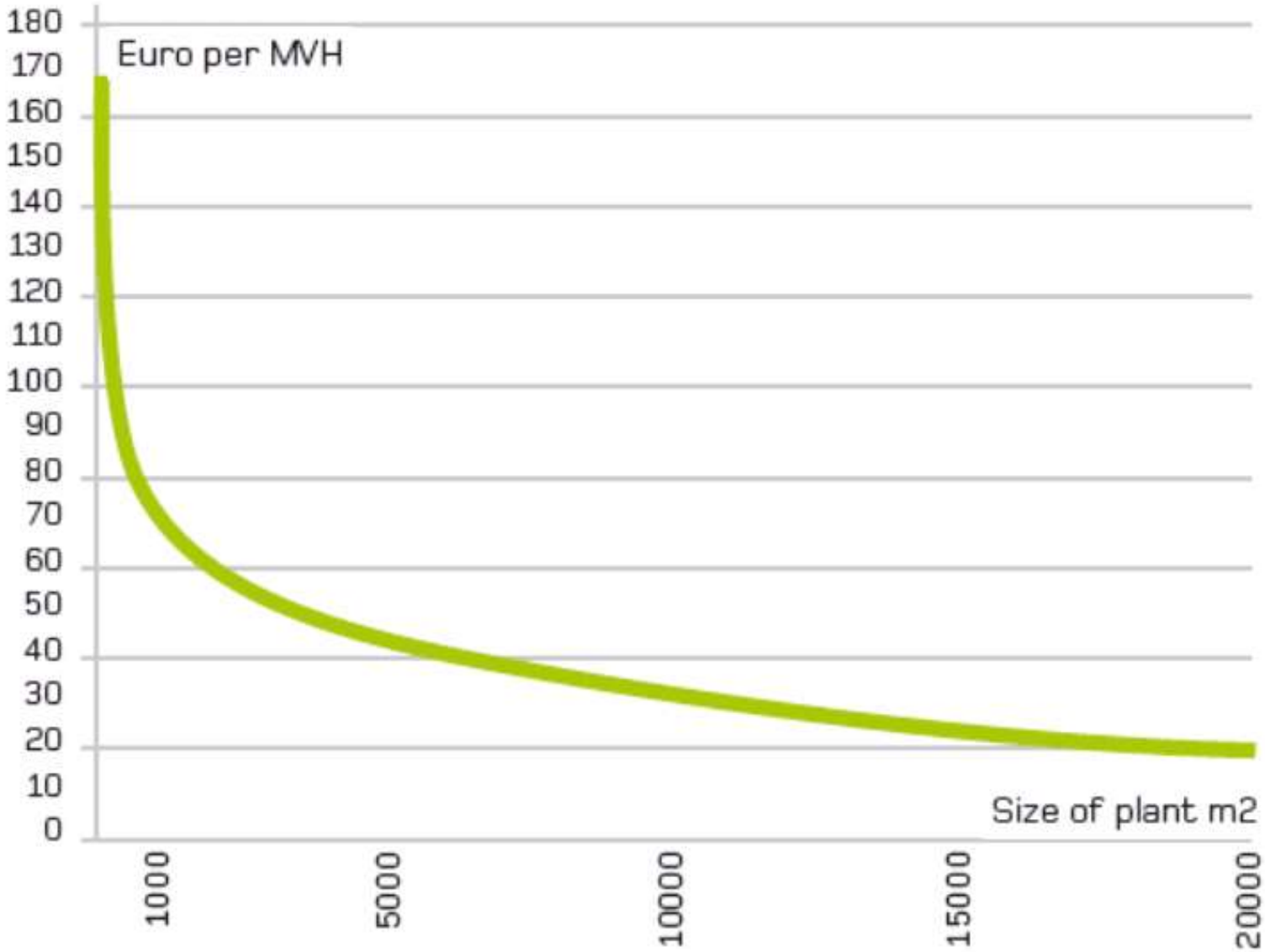
Large-Scale Solar

- Marstal, Denmark.
- 4,600 people, 2,100 homes.
- Will soon have 33,000 m^2 of solar collectors connected to the heat network.
- Where sheep may safely graze.

Pictures from Marstal Fjernwärme AMBA.

Cost of Solar Heat Versus System Size

http://dbdh.dk/images/uploads/pdfbladet/EU%20aim%20at%20great%20expansion%20of%20large-scale%20solar%20thermal%20plants.pdf



Heat production cost falls from **17 to 1.6 pence per kWh** as system size rises from 50 to 20,000 m^2.

Biomethane CHP, Germany

The picture shows a gas production and storage system, not the CHP plant. Germany's target is an average biomethane output of 11.5 GW by 2030.

Picture courtesy of:

http://www.farmworldonline.com/general/meggiegermanyblog.asp

Electric Heat Pumps

Ground source heat pump, rural Wales, evaporator coil being laid in ground.

Picture: from John Cantor Heat Pumps Ltd.

More Efficient Use of Electricity

More Efficient Use of Electricity

• Reduce the *quantity* of electricity consumed for lighting; e.g., by *good-quality* LEDs, T5 tubes, reflector luminaires, better controls, more use of daylighting.

• Reduce the *quantity* of electricity consumed for domestic and office electrical equipment, by replacing existing stock by A++ models, etc.

• Use energy-efficient motors, pumps, fans and controls in HVAC systems to reduce the quantity of electricity consumed.

• Savings quite often as high as 75-90%.

• Much higher returns on capital than most retrofit insulation. Cheaper to save electricity than even to operate most offshore wind farms.

Energy-Efficient ‘Cold’ Appliances

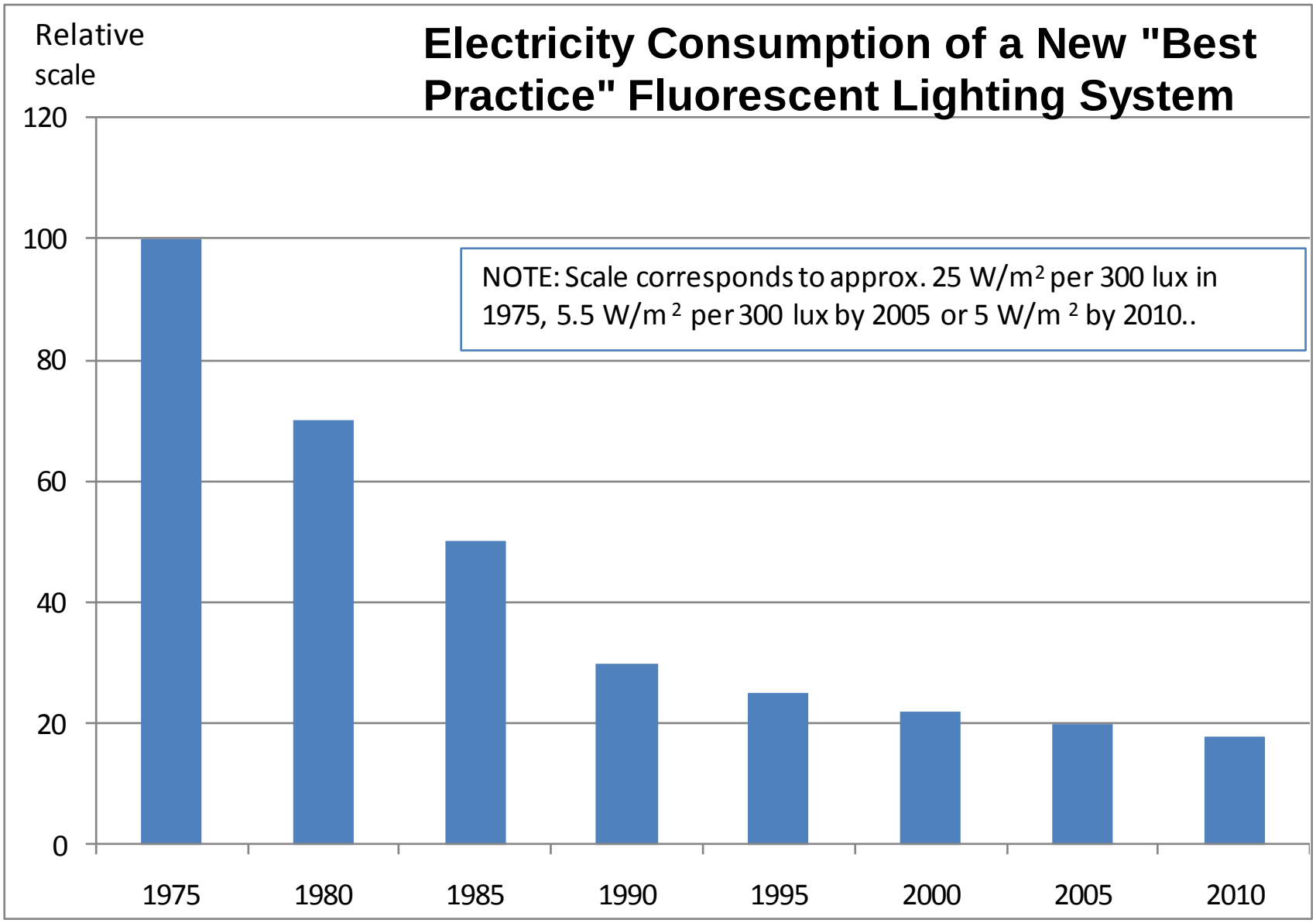
Below left - energy-efficient 259 litre larder refrigerator, USA, 76 kWh/yr. Plus optional external condenser. Old UK models about 500 kWh/yr Saves 85%.

Below right - A++ 195 litre chest freezer, Europe, 113 kWh/yr. Old UK models about 700 kWh/yr. Saves 84%.

Results of US test at 32°C and 21°C are interpolated linearly to calculate consumption in a CEN test at 25°C.

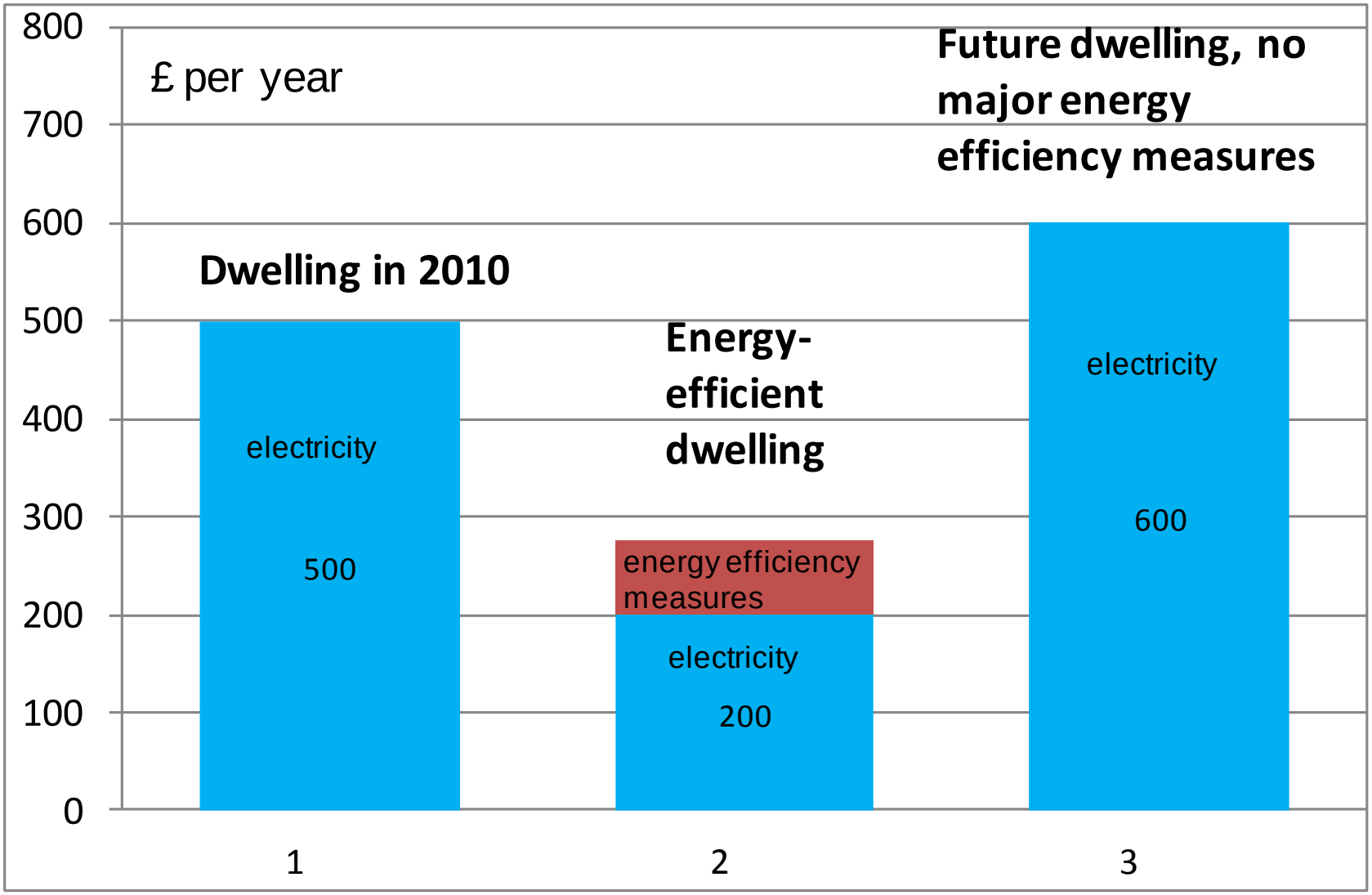
Pictures from www.liebherr.com and www.sunfrost.com

Fluorescent Lighting Efficiency



Domestic Electricity Bills

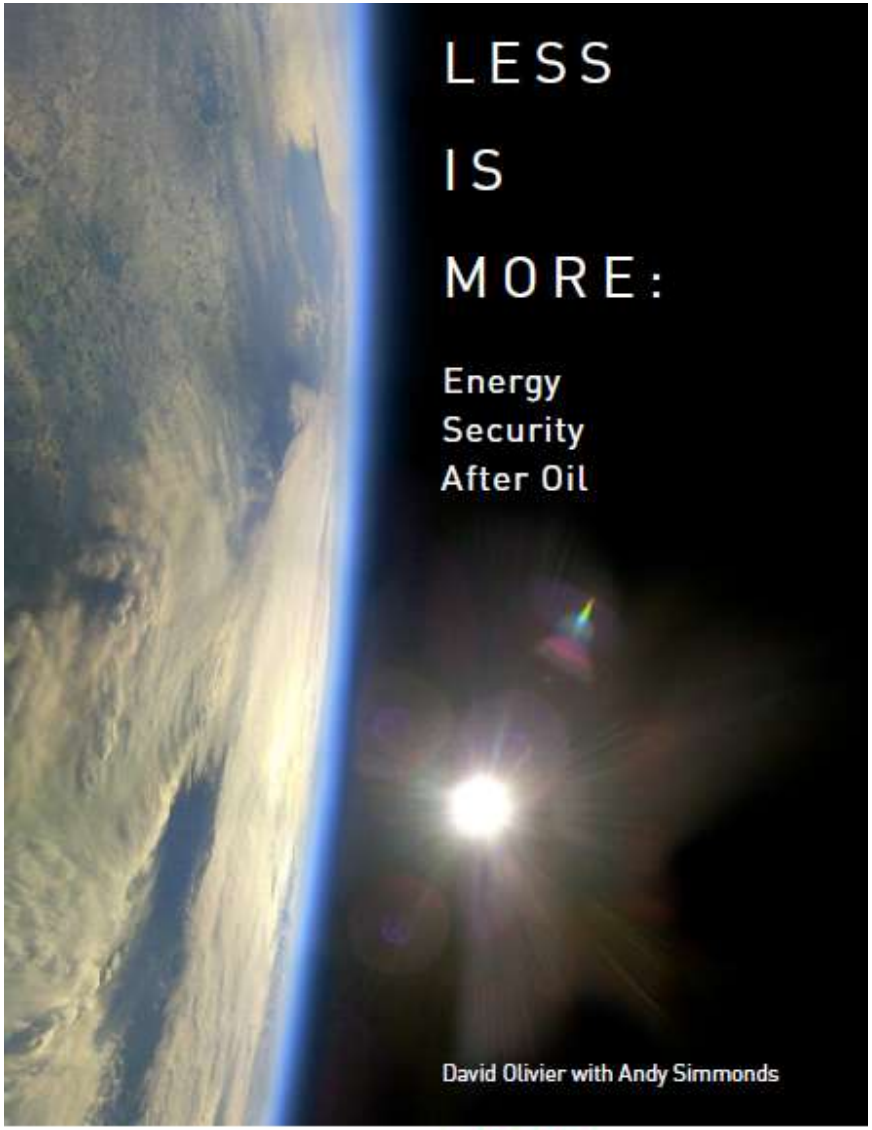
With and without major energy efficiency investment



Getting the UK Priorities Right?

LESS IS MORE: *Energy Security After Oil*

- The report puts forward the ingredients of a more secure and affordable energy future after oil. The technologies needed work and do not depend on speculative breakthroughs.
- Consistent with reducing atmospheric CO_2 to 350 ppm, not just reducing CO_2 emissions by 80%.
- Lower-cost than present policy of high investment in energy supply, especially in electricity.
- Especially fitting for the UK, the first industrial country, to take such an initiative.



http://aecb.net/news/wp-content/uploads/2012/02/LessIsMore-03.02.12-V1.0.pdf

An Integrated Strategy

Reduce the Quantity of heat consumed; e.g. insulate our walls, roofs, ground floors, upgrade windows and draughtproof buildings to reduce their heat loss.

Match the Quality of energy supplied to the demand; e.g., in urban areas, replace gas-fired heat-only boilers or electric resistance heating by waste heat from power stations.

Reduce Electricity Consumption for Lights, Appliances, Pumps and Fans. Re-regulate UK electricity suppliers, force them to invest in "least-cost planning" *and* allow them to make a fair return out of energy efficiency.

Security. Give preference to options which increase energy and/or network security and stability. Only support packages of technologies which are compatible in an energy economics and engineering sense.

The Proposed Green Deal

Needs major amendments

- Key technologies are excluded.
- Maximum support levels are too low.
- The “Golden Rule” is wrongly-defined”.
- The loan is to be repaid on the electricity account, but 93% of UK space heating comes from gas, LPG, oil or solid fuel.
- The interest rate envisaged exceeds energy company borrowing costs or mortgage interest rates. Repayments would be excessive, discouraging energy users from action.
- The organisations charged with delivering it are mostly retailers and know less about domestic energy use.

Redesign Financial Incentives

Transfer support to sound, proven measures

Energy efficiency

- Retrofit insulation and draughtproofing *beyond Part L*.
- Modify heating controls and insulate DHW tanks and pipes.
- Fossil and bio-methane CHP/DH, low supply temperatures; e.g., 75^{o}C flow and 25^{o}C return. Equiv. to electric heat pump with COP of 12-13.
- Mechanical exhaust ventilation (MEV). Easier and cheaper to retrofit.
- Balanced mechanical ventilation & heat recovery (MVHR) just occasionally.
- Energy-efficient heating pumps, fans, controls, lighting, domestic appliances and office equipment.

Redesign Financial Incentives

Transfer support to sound, proven measures

Lower-cost renewables

• Passive solar heat.

• Daylighting. Solar light = 5-10x more valuable than solar used as heat.

• Large-scale solar thermal. Crane into place. 1.6 p, not 20 p/kWh, meet renewable heat target(s) more affordably. Needs a heat network.

• Geothermal. Southampton is in part heated by a 1981 well, but many more areas could be used. One has been drilled in Newcastle-upon-Tyne. Also needs a heat network.

• Anaerobic digestion. Large digesters are more cost-effective than small ones.

For further information, contact:

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