New Zealand Society for Sustainability and Science

The sustainable housing debate
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Here's one I prepared earlier...

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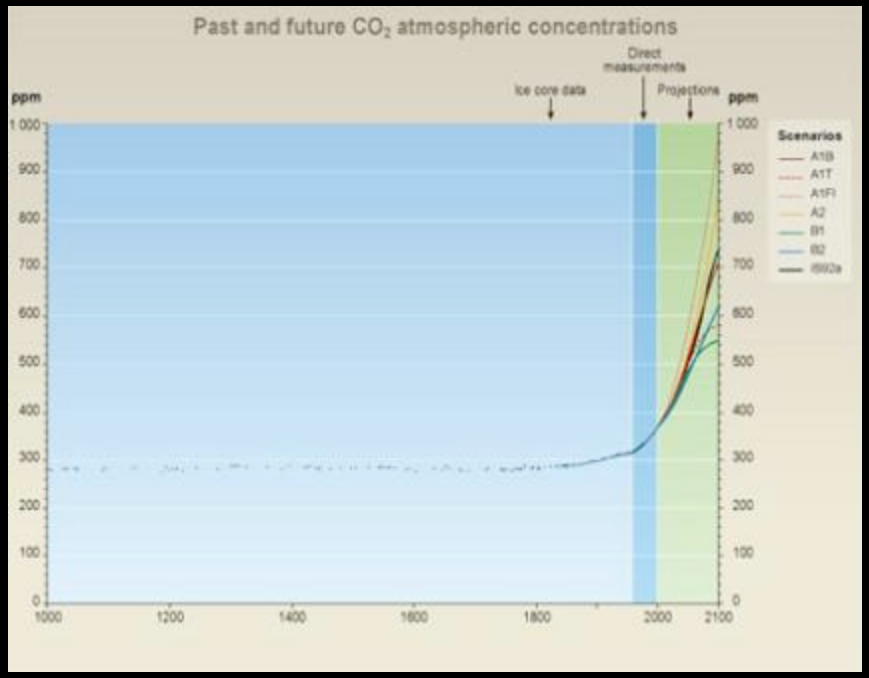
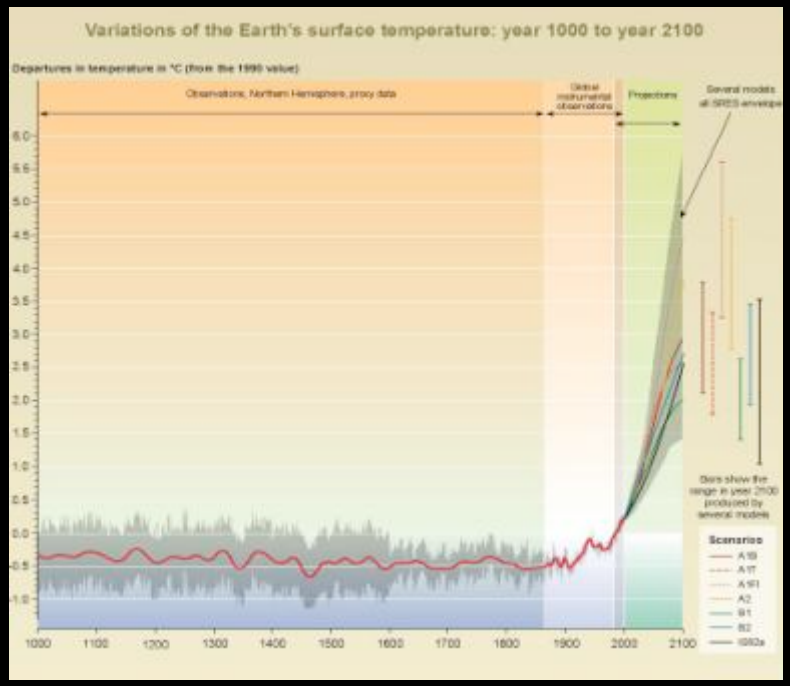
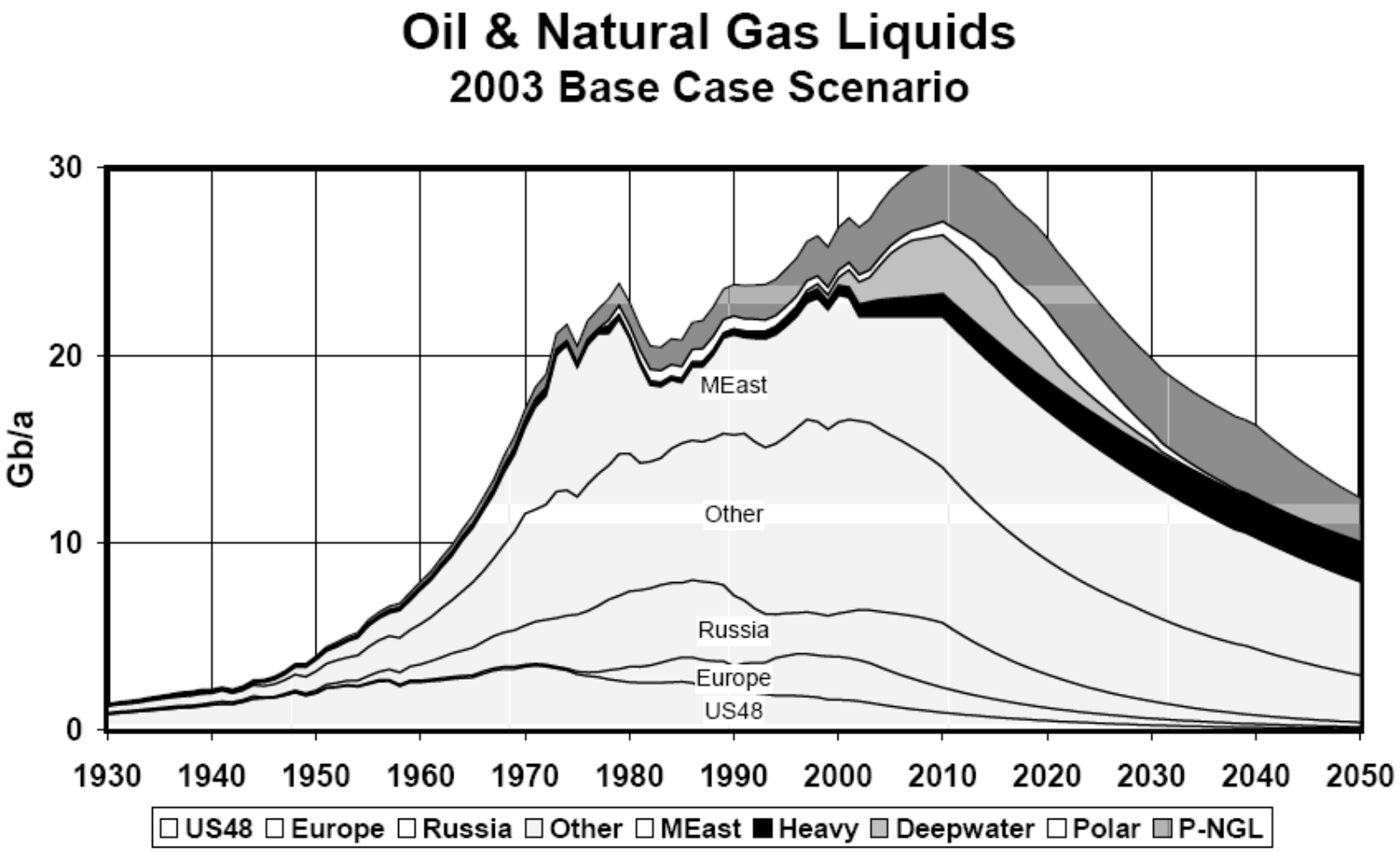




The world faces three major problems which will be upon us in the life time of the buildings which we are constructing today. The first problem is that human activity is changing the climate of the whole planet.

Source of graphs: Intergovernmental Panel on Climate Change

The General Depletion Picture



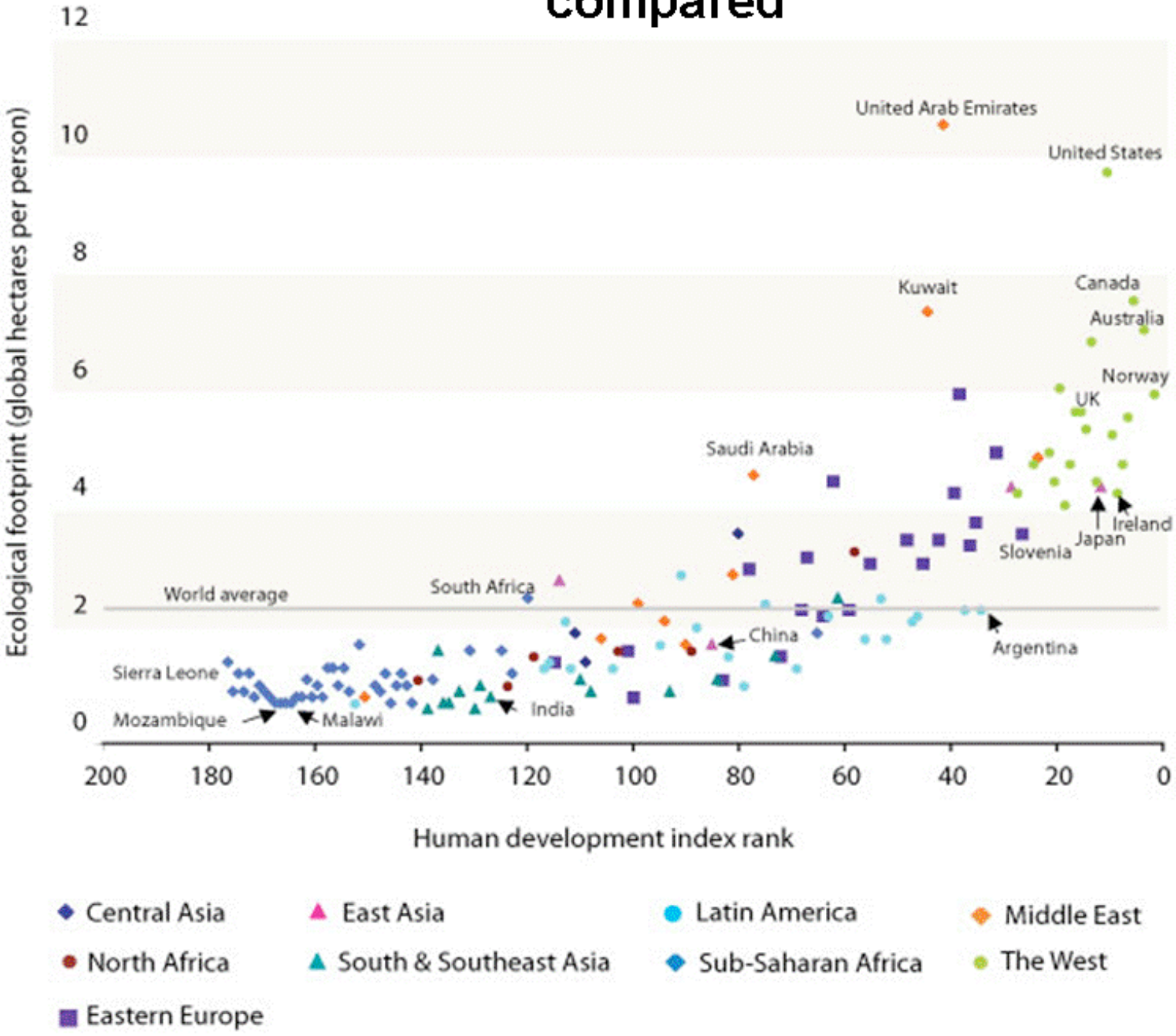
The second problem is that we are using up our resources faster than we are finding them.

ASPO (2003) *Newsletter No. 29* The Association for the Study of Peak Oil, May. p2

The third problem is that we are living beyond our means.

If we all want to live the lifestyle of Americans, Australians or New Zealanders, we will need the resources of at least three more planets like the Earth.

Human Welfare and Ecological Footprints compared



Source: Global Footprint Network (2006); United Nations Development Programme (2006).]

What can we do in our houses?-

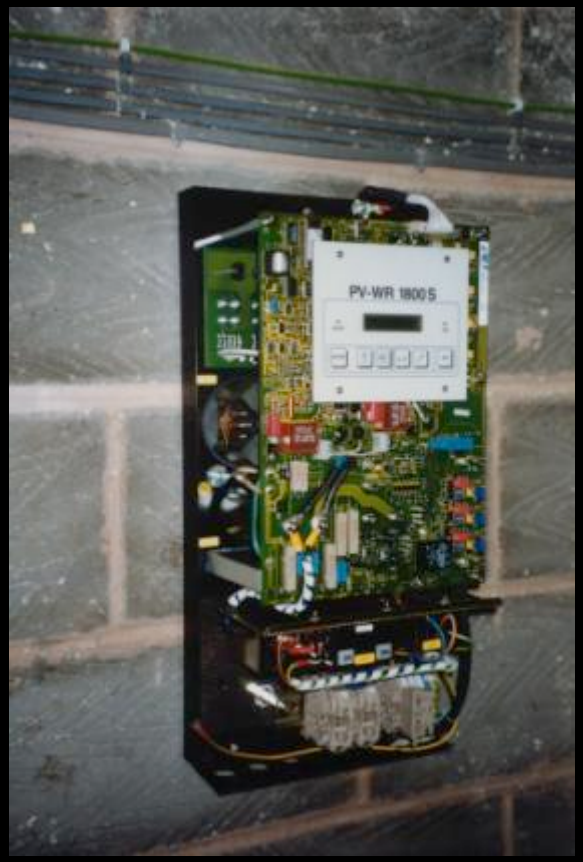
(1993) The UK's first Autonomous House. It is in a designated heritage Conservation Area in Southwell, Nottinghamshire

Superinsulated construction means space heating is hardly needed, even in the English winter. Roof insulation is 500 mm thick, wall insulation is 250 mm

Triple glazed windows (in softwood frames) have two low-emissivity coatings and krypton gas filling

The conservatory collects solar heat which is stored in the insulated massive structure. The house is designed for a life of at least 500 years

A 2.2 kW photovoltaic array makes the electricity, with the surplus exported to the National Grid

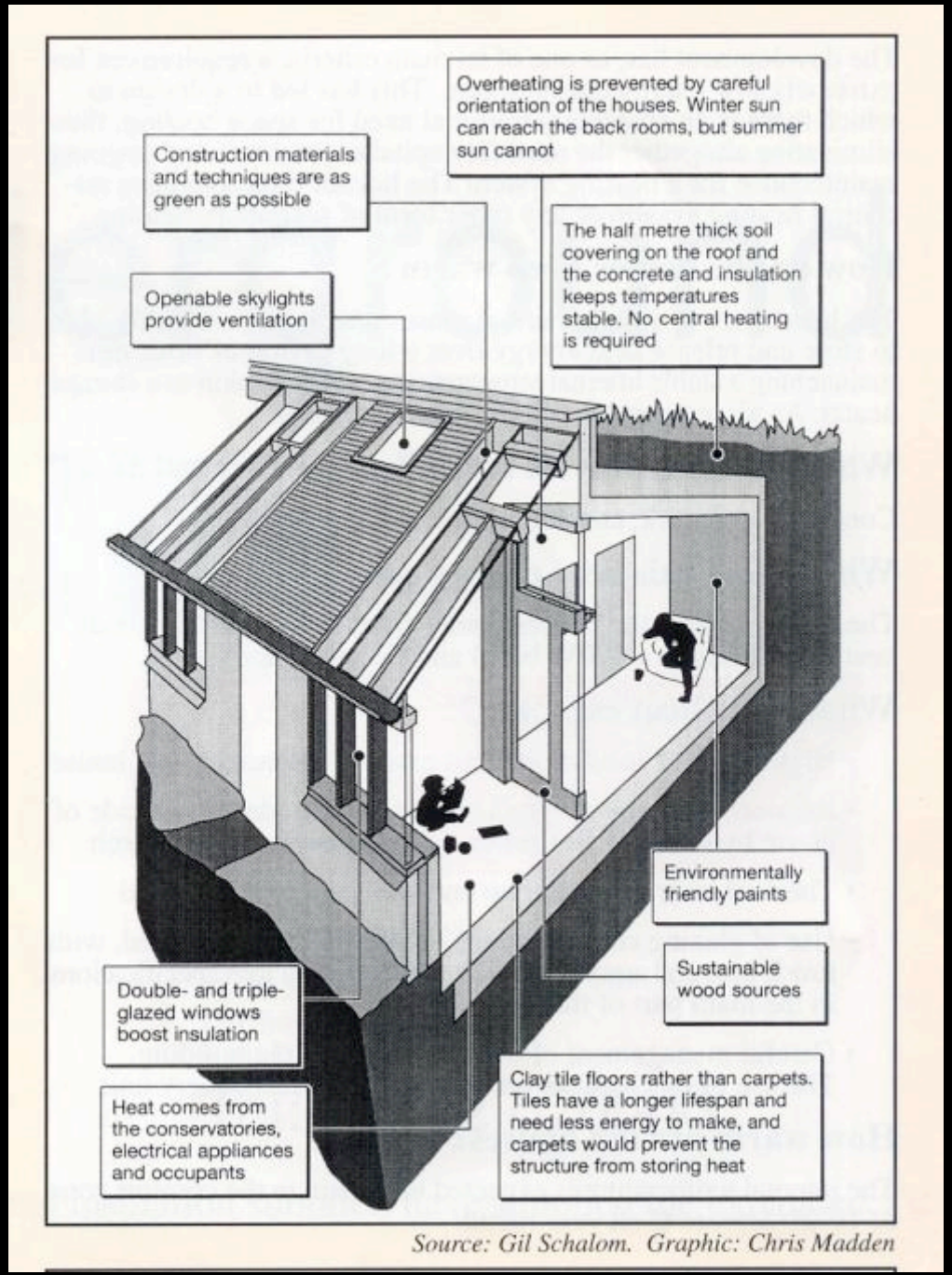


The water supply is collected off the roof, and sewage is treated in a waterless, odourless, composting toilet

1998 - The Hockerton Housing Project

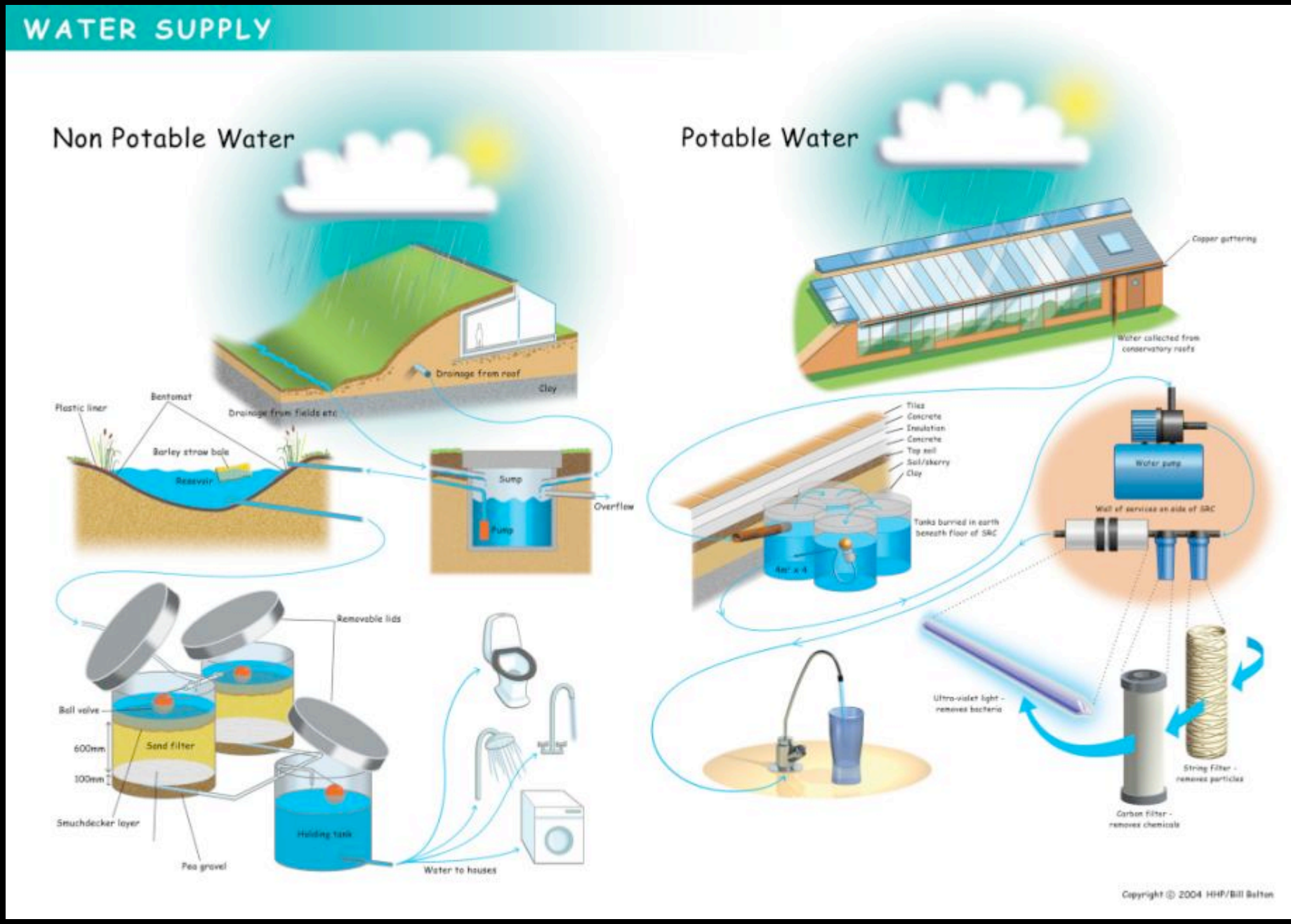
The north (non -sunny) side of the houses is buried beneath 400 mm of soil.

The 300 mm thick concrete structure is surrounded by 300 mm thick insulation

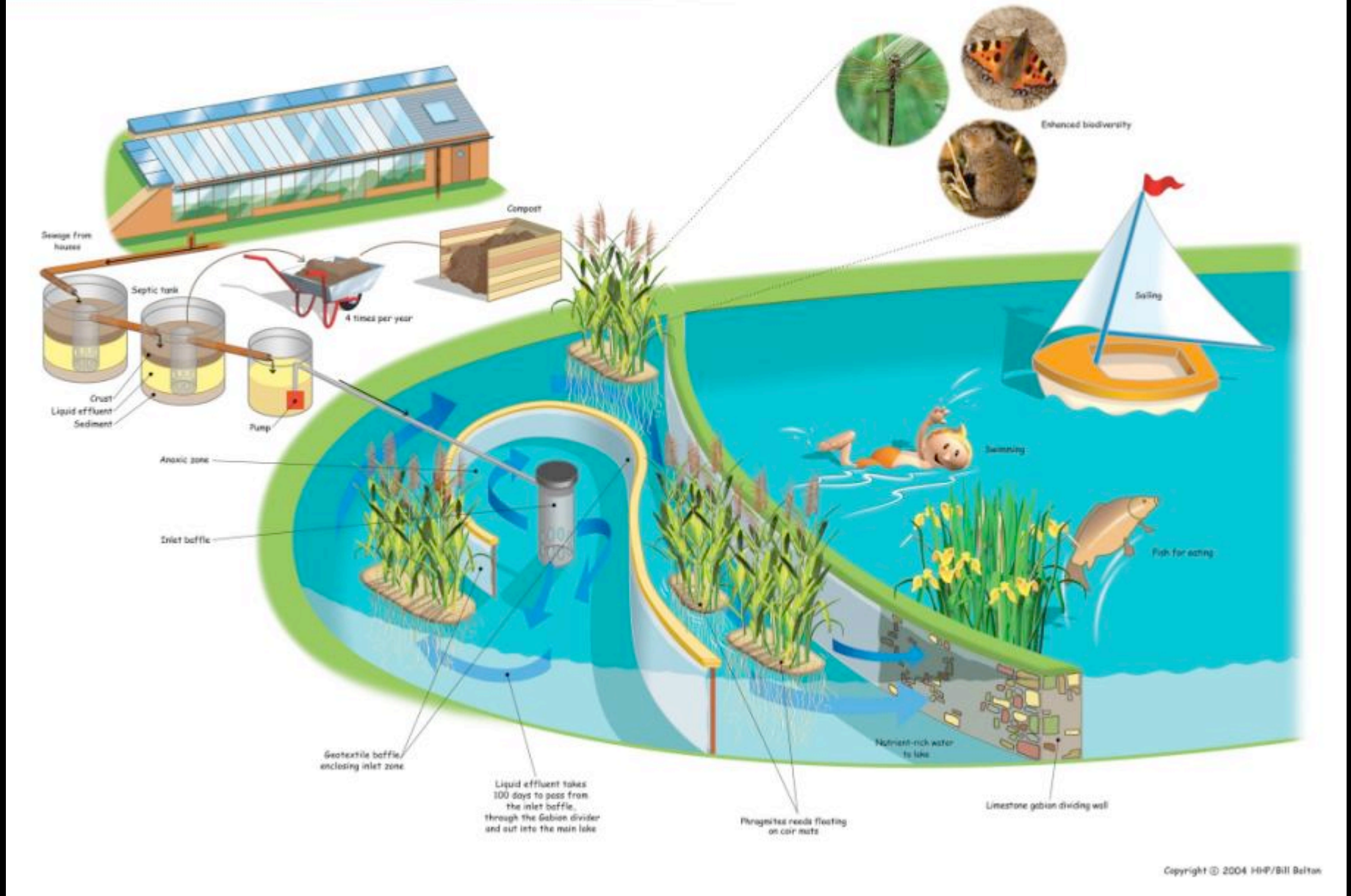


Two 6 kW wind turbines produce around 6,000 kWh each per year, and the 7.6 kW solar panels provide the same. This output of 18,000 kWh meets the energy needs of the five houses.

WATER SUPPLY



SEWAGE TREATMENT



The reeds are thriving on the sewage nutrients

This is the entire production of sewage solids from the five households from 1998 to 2006

Measured biodiversity has increased following the construction of the houses

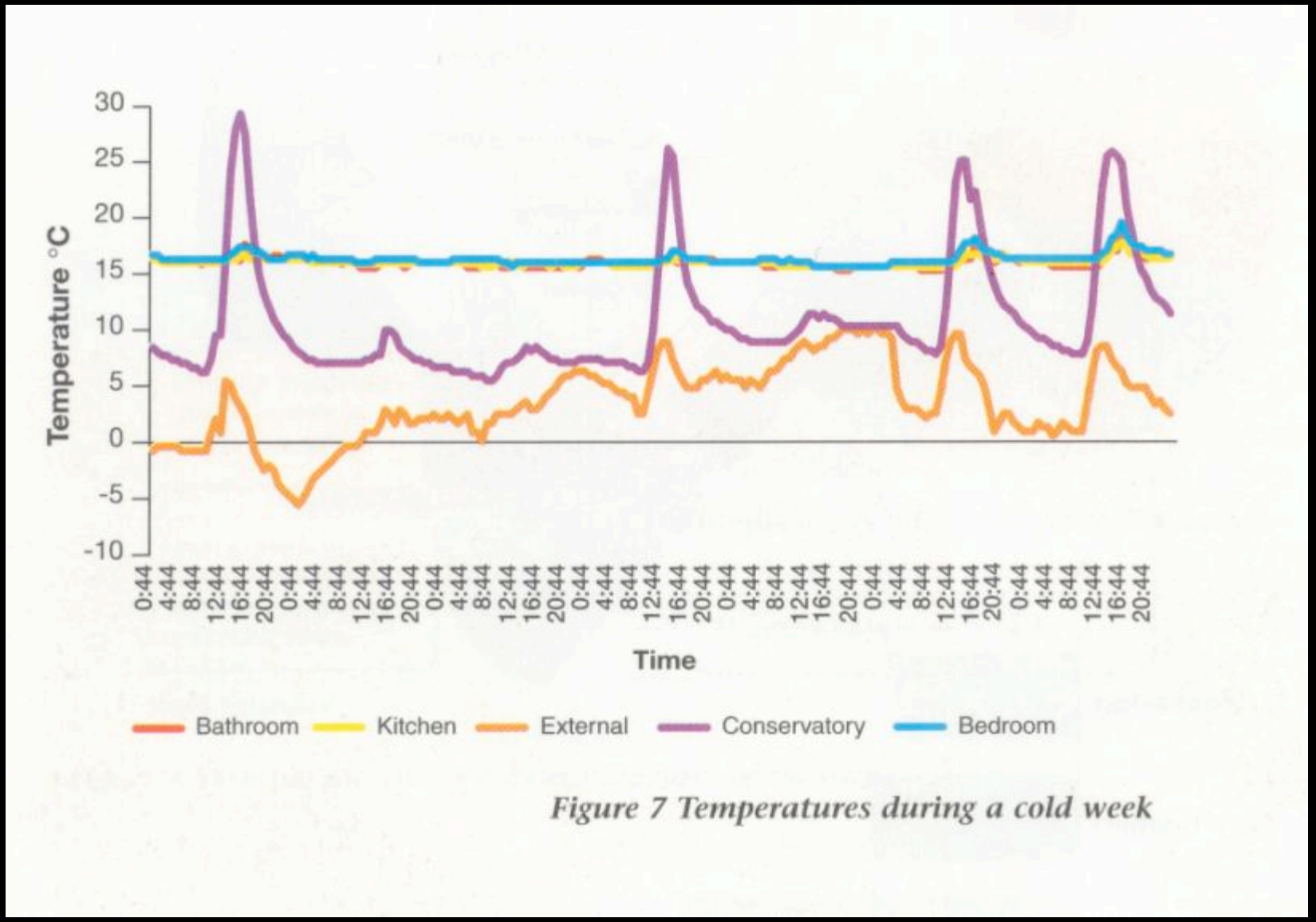


Figure 7 Temperatures during a cold week

These houses have no heating, but they stay at 17^{o} when it is -6^{o} outside

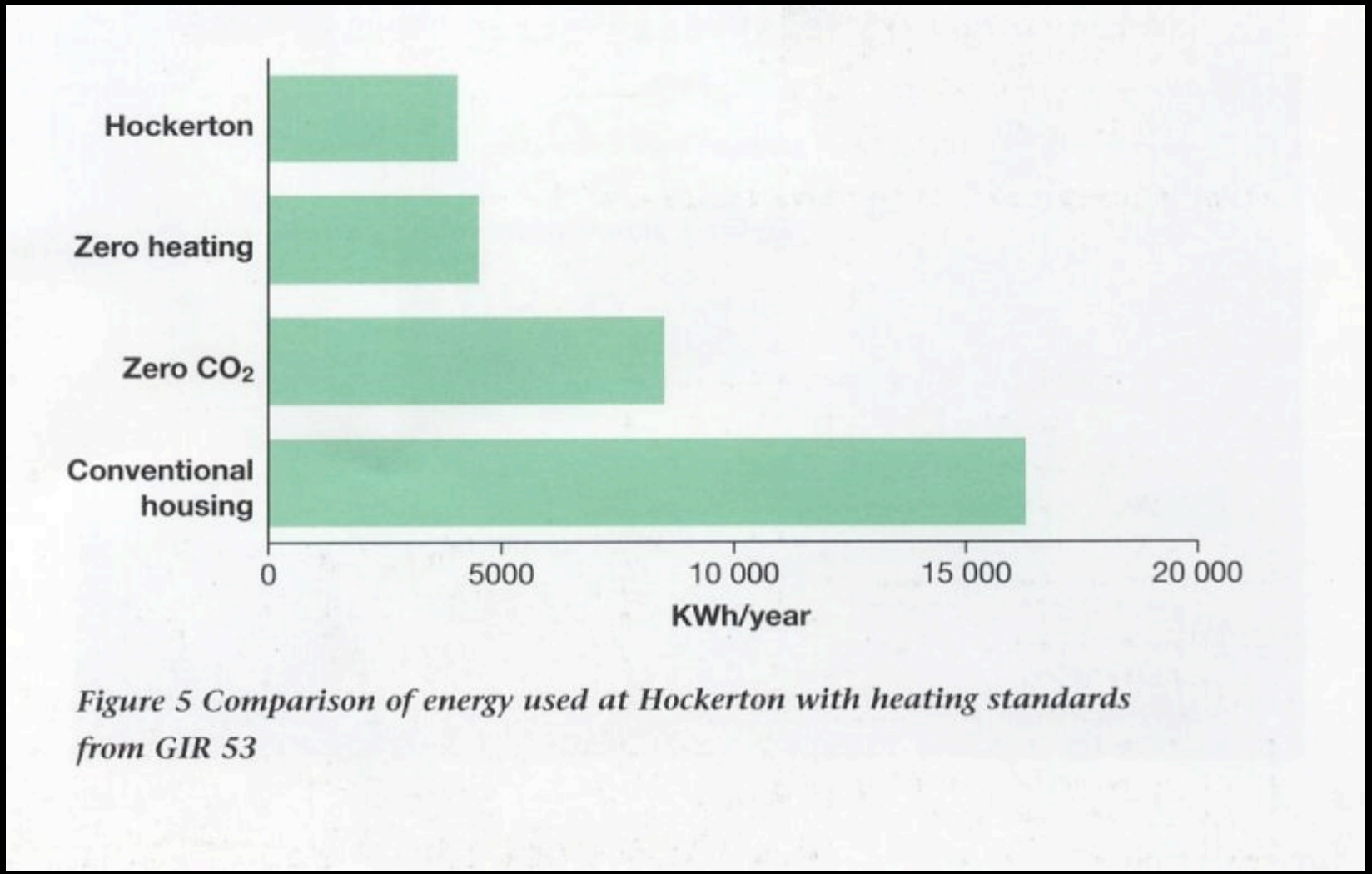


Figure 5 Comparison of energy used at Hockerton with heating standards from GIR 53

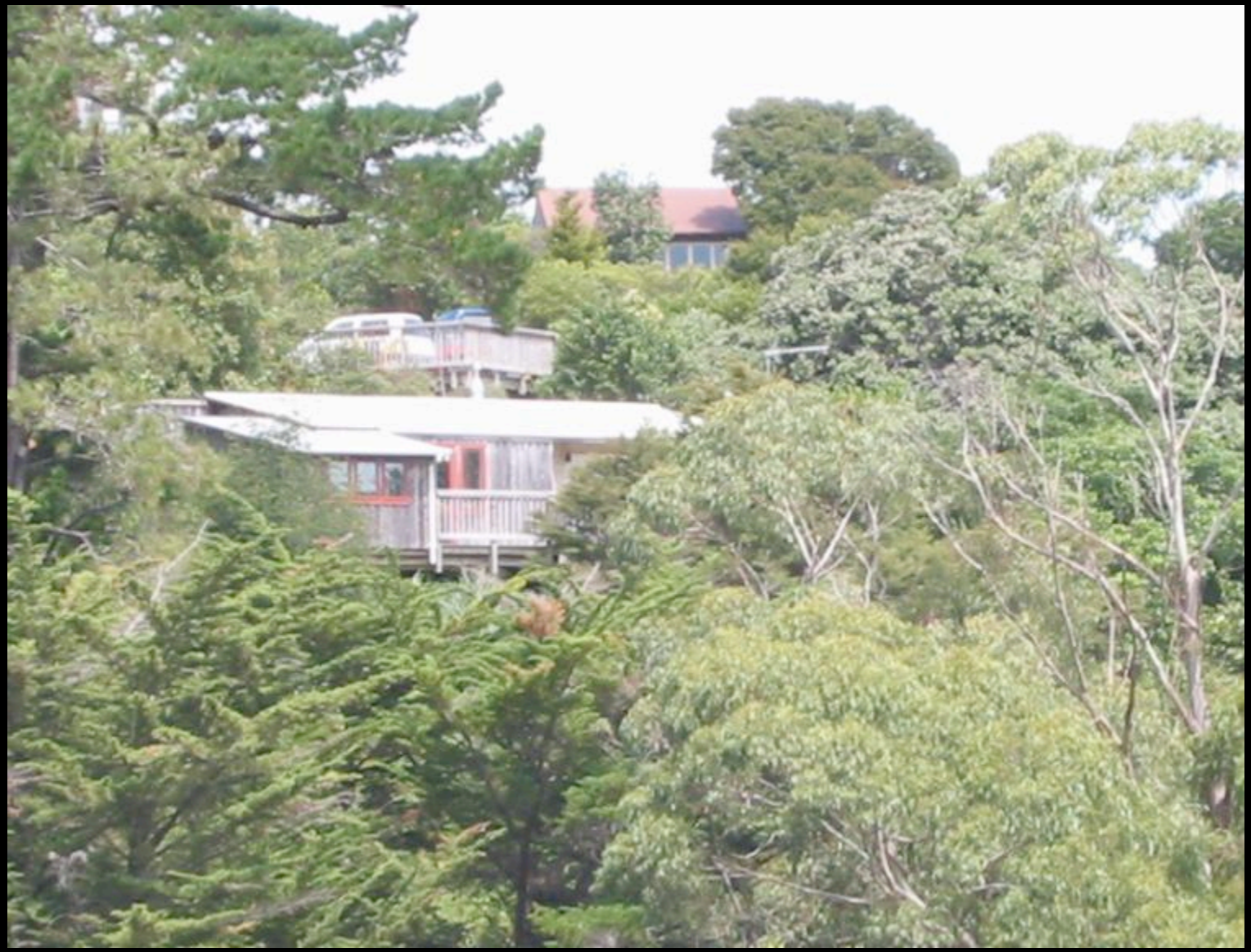
Energy consumption is much lower than normal houses and is all supplied by on-site renewable energy generation

There are two key issues for passive solar design

MASS

INSULATION

You have to have both...



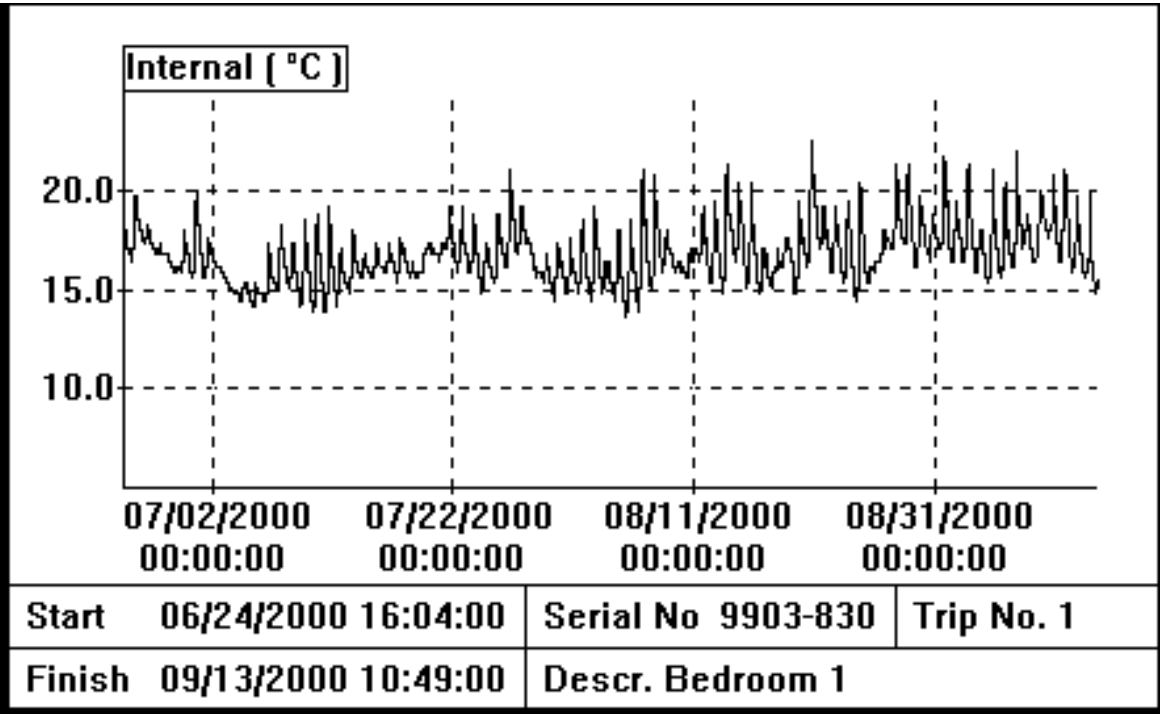
1998 - This house at 22 Hauraki Road, Waiheke Island uses low mass superinsulated construction

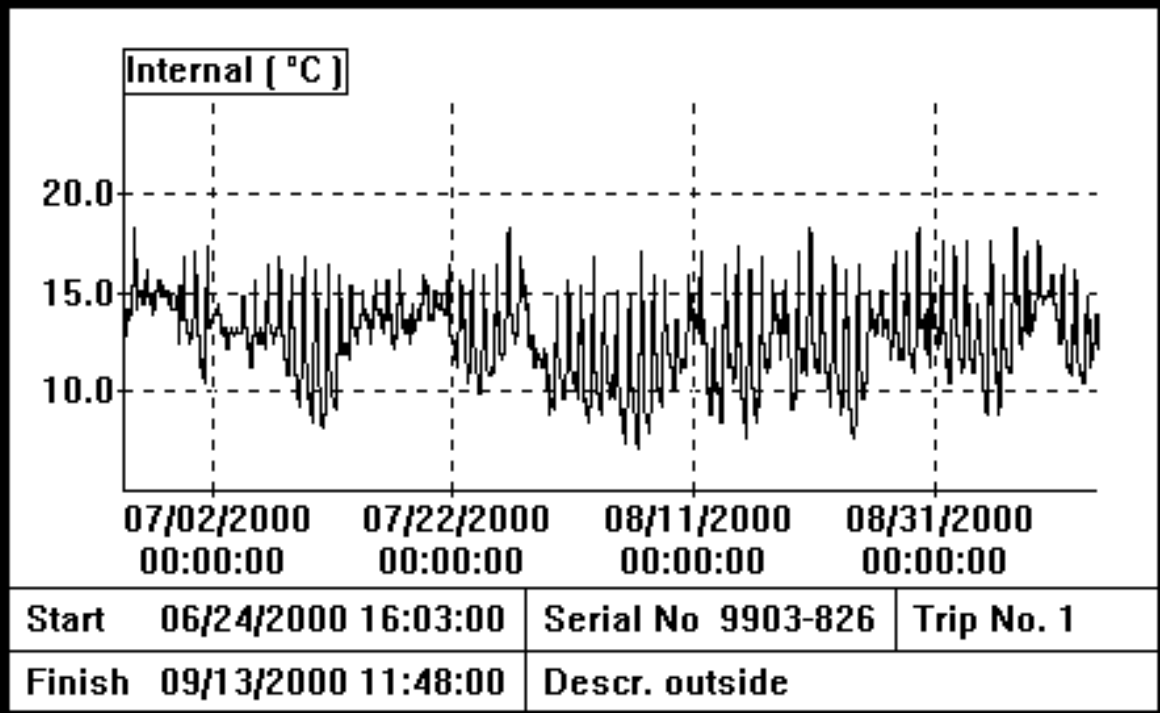
The house is “superinsulated” with 150 mm thick insulation in walls and floor, and 200 mm in the roof.

Windows are double -glazed with low -emissivity glass. This means that they work as well as triple glazing. They were made by a local supplier on Waiheke Island

Temperature recordings from the **unheated** bedroom for the winter of 2000 (24 June to 13 September) - the range is between 14°C and 23°C

This is the external temperature over the monitoring period. It goes down to about 7°C, and up as high as 18°C, but is mostly in the 10°C - 15°C band





Small, well-shaded windows are advisable in low-mass/ high insulation construction, to avoid solar overheating

This house at 20 Karaka Road, Waiheke island, shows what can be done with a “typical” NZ house. It has been fitted with a 4.4 kW grid-connected solar power system to meet all energy needs, at a cost of $81,000. The house already had a rain tank to meet all water supply

2000

The photovoltaic panels are connected to the electricity grid through a pair of German SMA ‘Sunny Boy’ inverters, each rated at 2.2 kW. A data logger records the performance of the system in operation. The inverters are installed on the wall of the garage beneath the house

The modular solar array is quite unobtrusive

The solar panels cost about
the same as buying a large four-wheel-drive vehicle

2 Hauraki Road

built 1984 196 m^2

In mid-2003 we bought this house on Waiheke Island, and we have converted it to be more sustainable.

The existing large single glazed windows on the north elevation have been replaced with double low-emissivity glazing in thermally-broken frames.

Hot water is provided by solar panels on the conservatory roof, connected to a 315 litre hot water storage cylinder under the house. The water can get very hot, but an anti-scald mixing valve controls the temperature of the water that reaches the taps.

The European A-rated refrigerator/freezer has half the energy consumption (347 kWh per year) of a typical refrigerator/freezer available in New Zealand.

All lights have been replaced with compact fluorescent lamps which use only 20% as much electricity for the same light output as an incandescent lamp. Total installed lighting has been reduced from 3.8 kW to 760 Watts.

The roof and floor insulation have been increased to R 5, more than double the current requirement of the Building Code. Wall insulation could not be upgraded because there is no space available within the thickness of the wall structure.

These simple measures have reduced total annual energy consumption of the all-electric house to around 3,300 kWh.

An average NZ house uses around 10,000 kWh per year.

We have recently installed two photovoltaic systems to help to reduce the annual energy demand. One system is 800 Watts and the other is 1,000 Watts. Together these systems mean that the house now needs only 1,000 kWh a year from the grid.

800 Watt array

1000 Watt array

Results - it is essential to know the outcomes

Name	date	area	demand	NON-RENEWABLE
UK (new build)				
Autonomous House	1993	176 m^2	4,500 kWh	1,500 kWh
Hockerton	1998	145 m^2	3,600 kWh	zero kWh
NZ (conversions)				
Karaka Road	2001	91 m^2	5,000 kWh	zero kWh
Hauraki Road	2006	196 m^2	3,300 kWh	1,000 kWh

All the houses have zero mains water demand and autonomous sewage treatment

Conclusion

These four projects show that it is already practicable to build new “no bills” houses, and to convert existing houses, using off-the-shelf technology.

However, we should not allow ourselves to get too focused on the house…

Table 1: NZ household carbon emissions from different aspects of life in tonnes per year (current)

House construction and maintenance	0.2 tonnes
House operation (power, light, heating, hot water)	2.0 tonnes
TOTAL for house	2.2 tonnes
Waste	1.0 tonnes
Driving the family car	4.0 tonnes
Food (for four people)	16.0 tonnes
TOTAL for behaviour	21.0 tonnes

Some behaviours are a disaster in carbon terms…

Return flight for the family to Europe	16.0 tonnes

Table 2: NZ household carbon emissions from different aspects of life in tonnes per year (trying to be more carbon neutral)

House construction and maintenance	0.3 tonnes
House operation	0.0 tonnes
House saving	1.9 tonnes
Waste	0.0 tonnes
Driving the family car	1.0 tonnes
Food (for four people)	4.0 tonnes
Air travel	0.0 tonnes
Behaviour saving	16.0 tonnes

The differences that we can make by changing our houses are trivial – we have to change our behaviour