Passive and Low-Energy Buildings - The Future

INFORSE-Europe Seminar

Sept. 30 - Oct. 4 2003, CAT, Wales, UK

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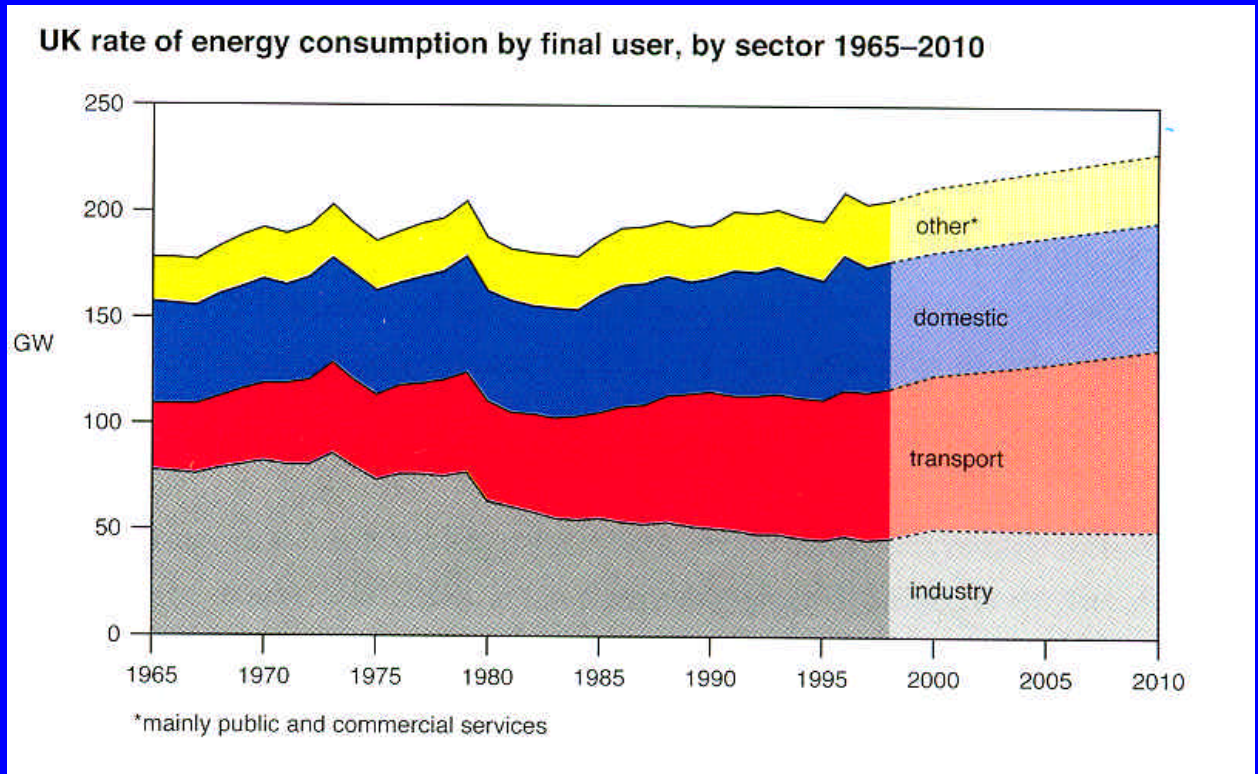
U.K. Energy Consumption



From the Royal Commission on Environmental Pollution, Summary Report

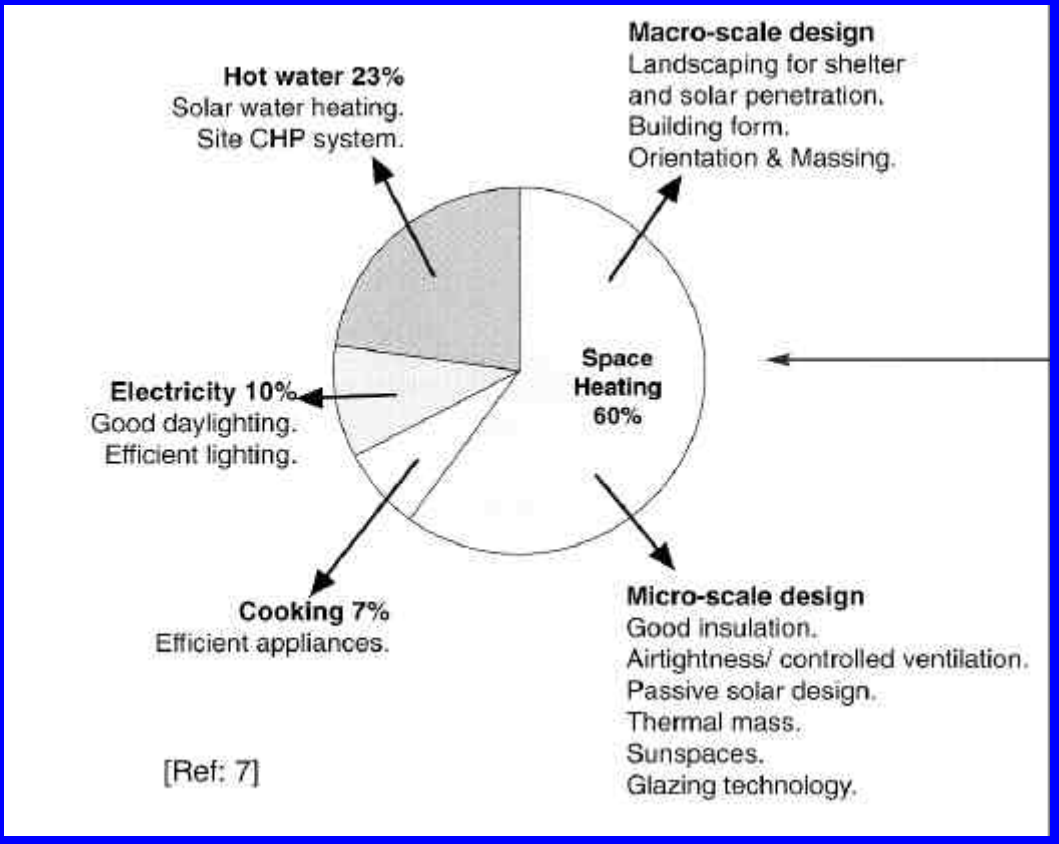
Low Energy Buildings:

- Energy Conservation - using less (Lifestyle)
- Energy efficiency - using reduced amount in such a way as to achieve maximum performance or output (Technology)
- Both necessary for reducing environmental impact

Energy Efficient Buildings Depend on..

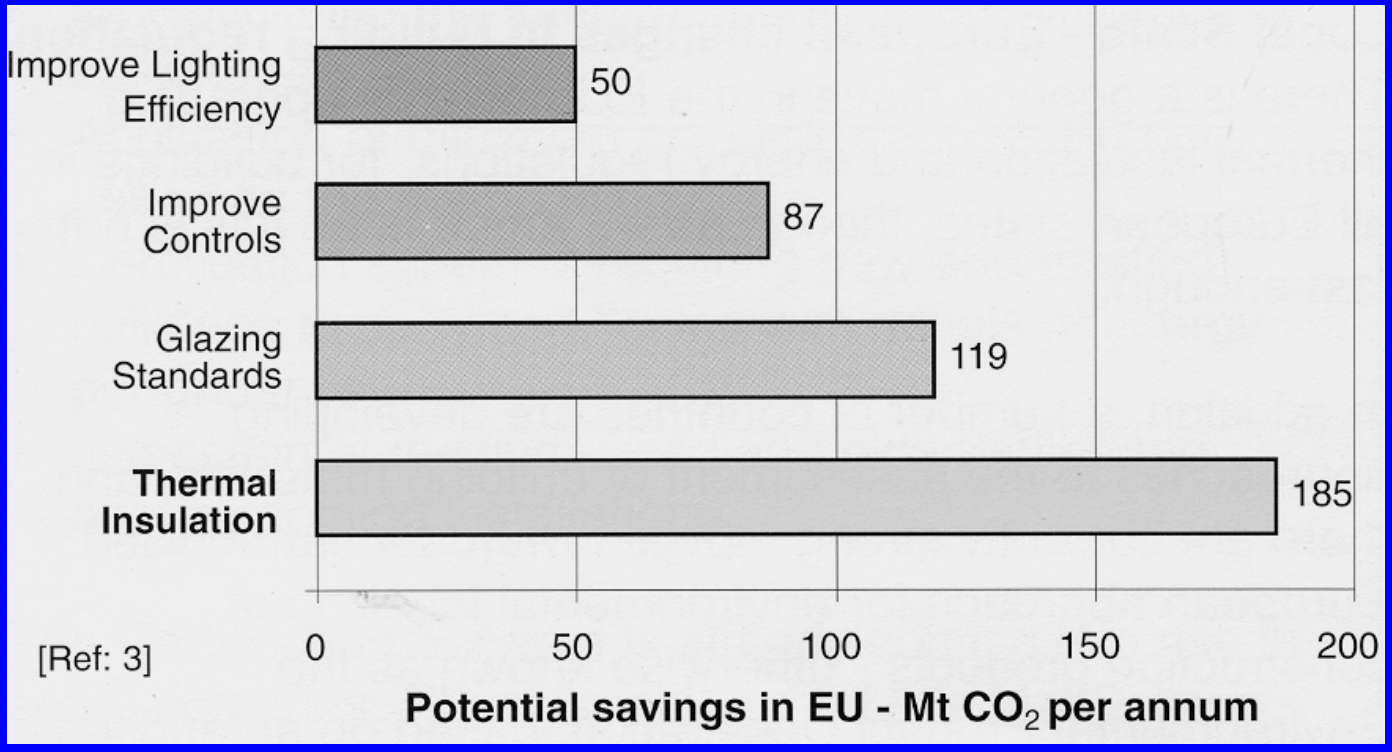
- Passive solar design
- High levels of insulation
- Good air tightness standards
- Controlled ventilation
- High performance glazing
- Protected entrances
- Efficient heating systems / appliances

Design Strategies



XCO2 Conisbee

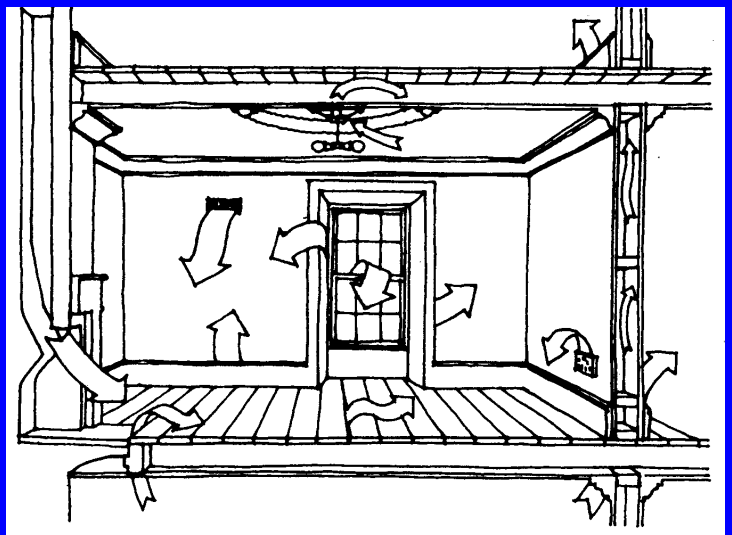
Insulation Shows Greatest Potential CO_2 Savings



XCO2 Conisbee

Air tightness

- Important to minimise (uncontrolled) infiltration
- Improves effectiveness of insulation
- Measured in air changes per hour at 50 pascals pressure difference (ach@50Pa)
- Energy efficient buildings should aim for max of 3ach@50Pa



Paths of least resistance.

Ventilation Strategy

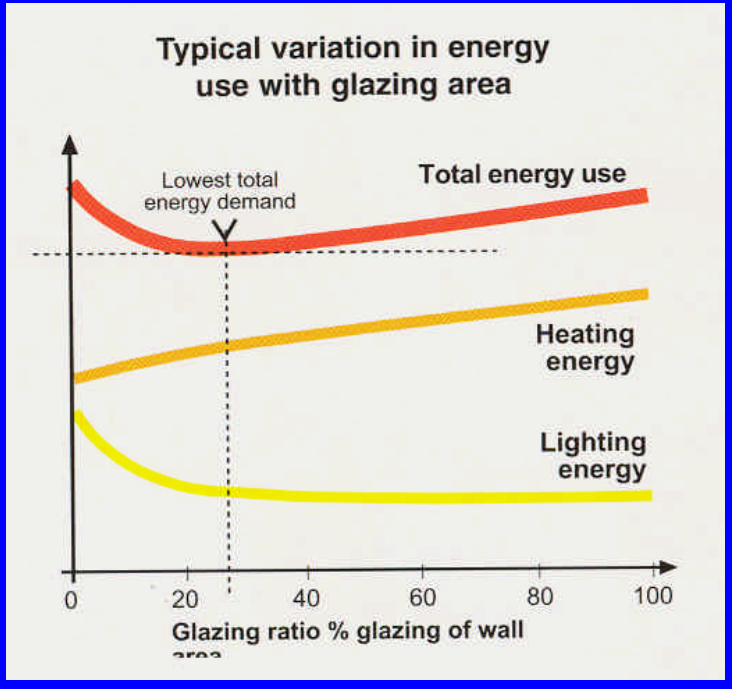
Minimise air leakage - ‘build tight’

‘Ventilate right’, by

- supply controllable background ventilation eg trickle vents
- provide controllable vents to remove moisture at source in kitchens / bathrooms - can be passive or mechanical
- whole house MVHR systems

Glazing type

- Always an area of relative heat loss, compared to wall
- Therefore, must be as efficient as possible
- Double / triple sealed units
- Low-E (emissivity) coating
- Argon filled cavity
- Innovations include vacuum units, chromic glass

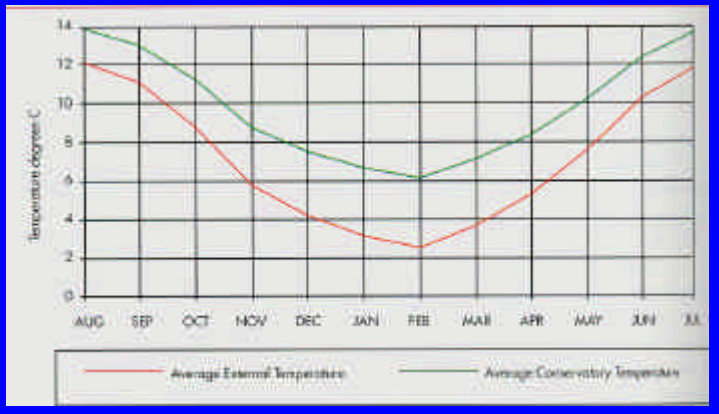


XCO2 Conisbee

Protected Entrances

Conservatories, lobbies, porches improve energy efficiency by:

- Buffer Effect, reduces heat loss
- Solar pre-heat, for incoming air
- ‘Air-lock’ effect, reduces unwanted infiltration
- Heat conduction into house, through wall/windows

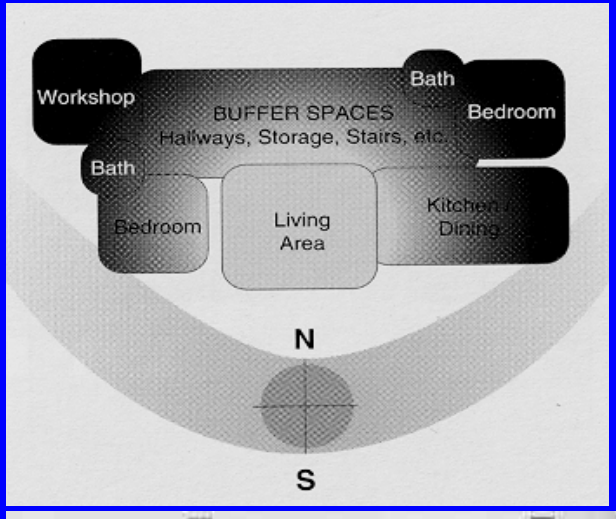


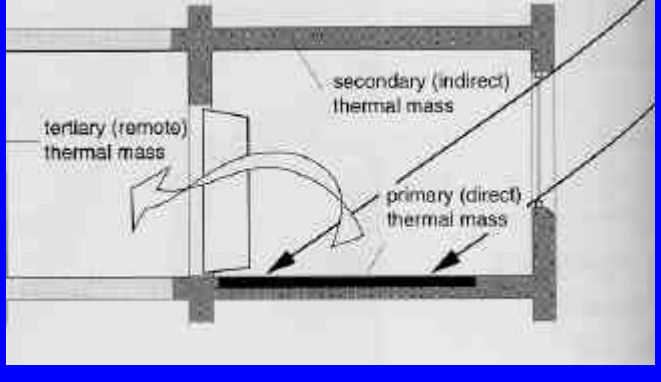
Passive Solar Design is...

- Design which seeks to maximise the admittance and storage of solar energy
- Assumes energy efficient design (insulation, air tightness etc)
- Uses building elements themselves as solar collectors
- Relies on natural not artificial or mechanical controls

Passive Solar Design relies on..

- Southerly orientation
- Appropriate glazing arrangement and internal layout
- Some degree of thermal mass
- Direct ‘coupling’ of solar radiation, mass and internal space



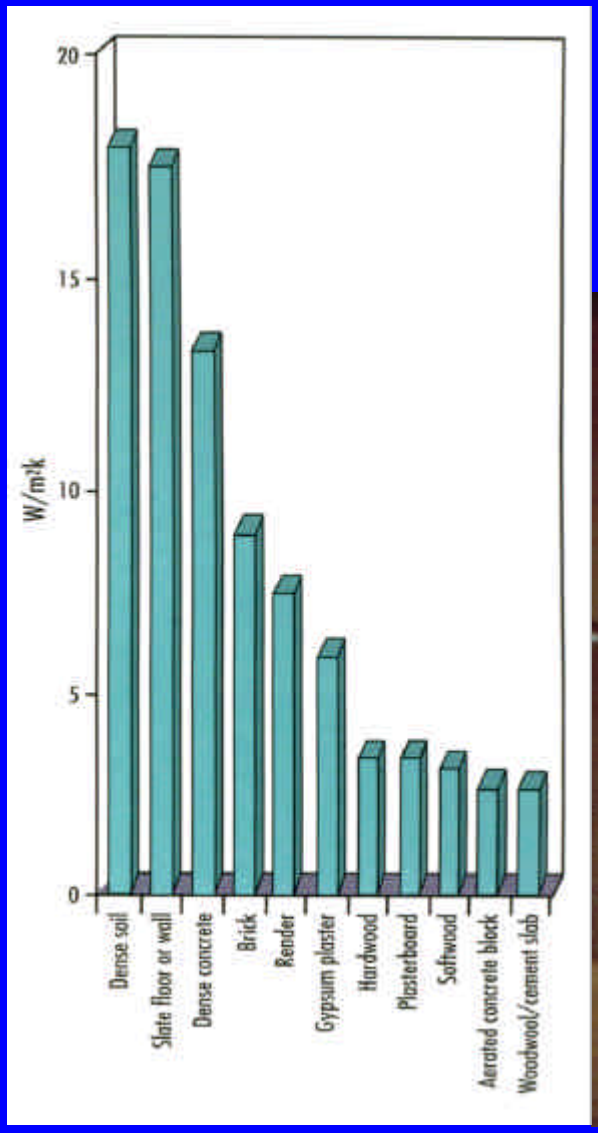


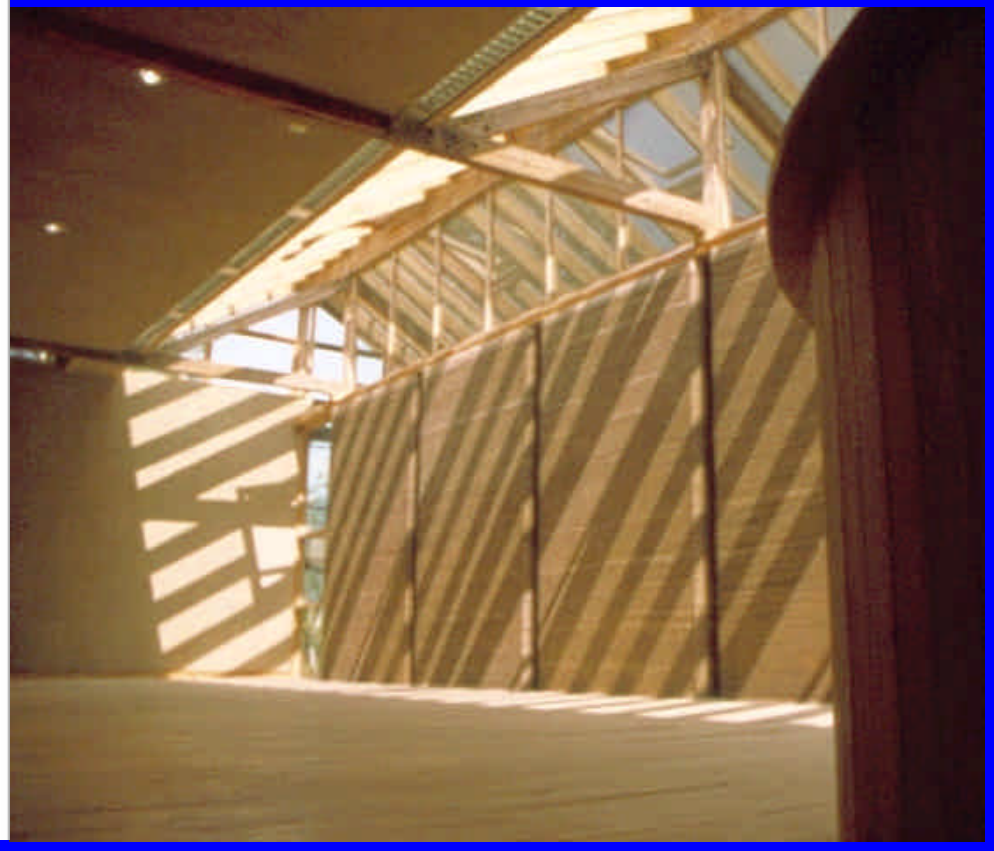
Heavyweight / Lightweight

- Slow to heat up
- Slow to cool down
- Slow response
- Ability to store heat
- Difficult to insulate
- Dense, conductive
- Non-renewable mats

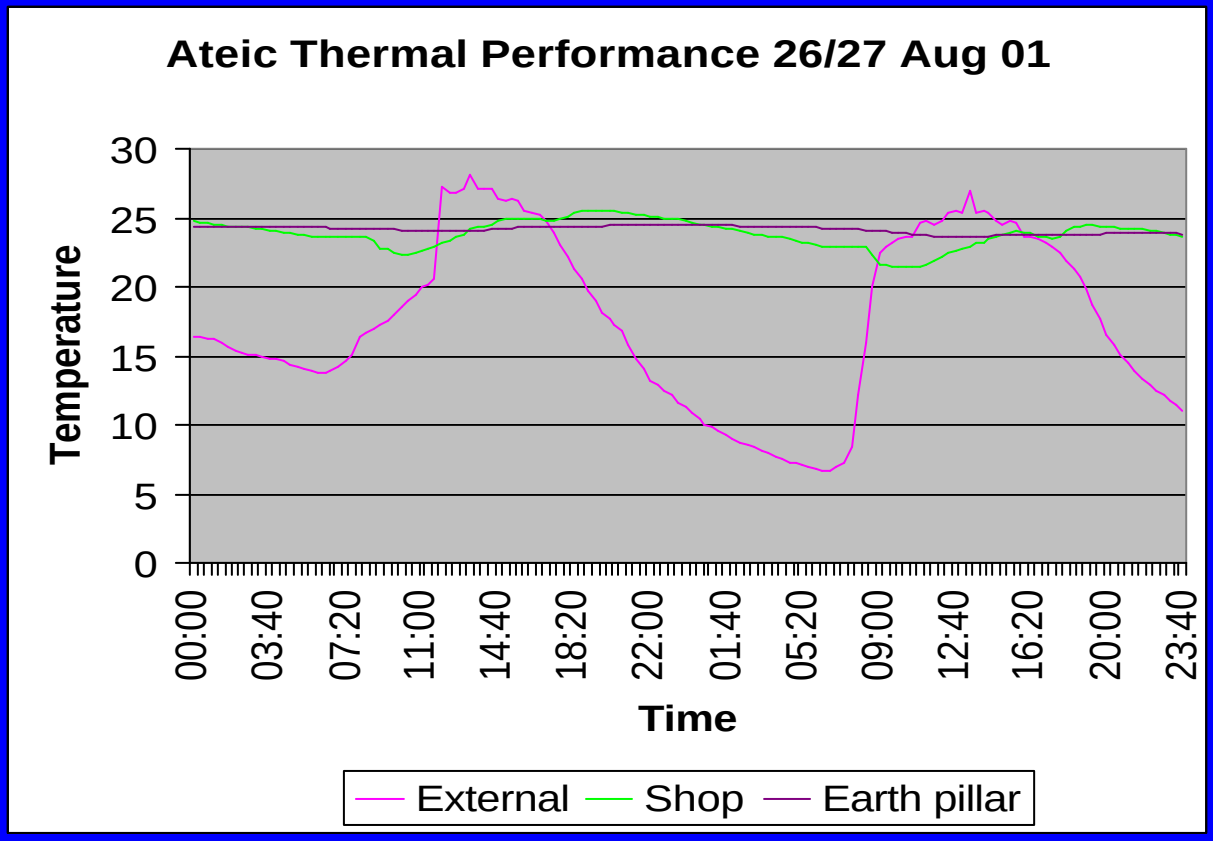
- Quick to heat up
- Quick to cool down
- Fast response
- Not a heat store
- Easy to insulate
- Less dense, insulative
- Renewable materials

Thermal Mass





Ateic Thermal Performance 26/27 August 2001



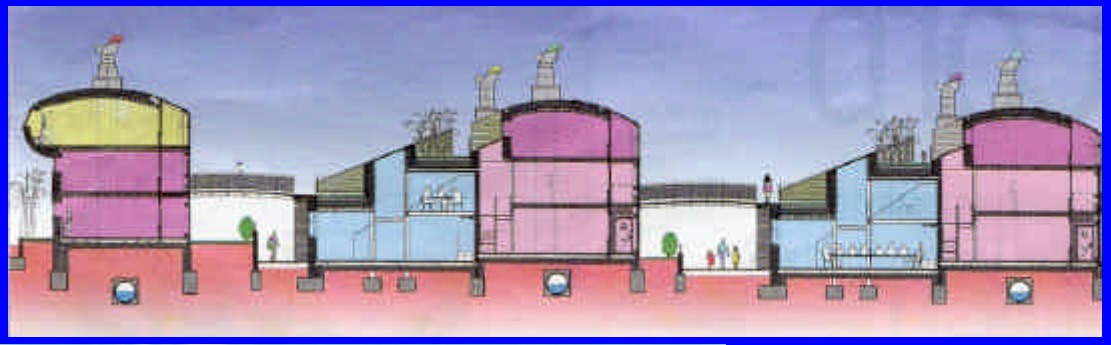
Thermal Mass

- Diurnal temperature difference necessary
- Depends on patterns of occupancy
- Needs to be ‘coupled’ to heated space
- Appropriate depth of mass
- Little difference in energy use cf lightweight well-insulated buildings

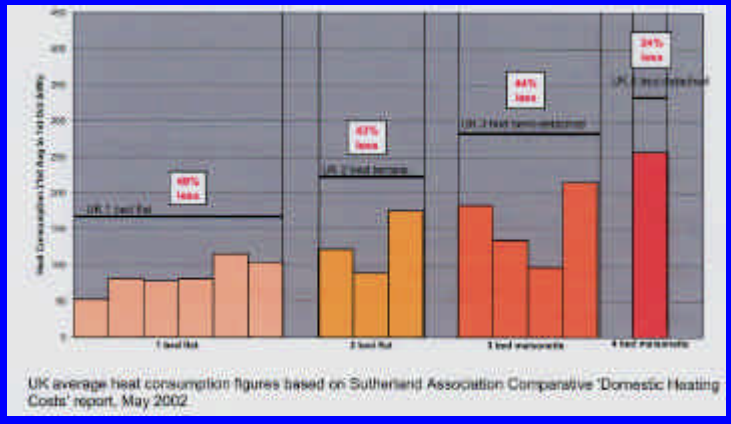
Timber Buildings at CAT

- All local, untreated
- Larch trusses & frame
- Laminated beams
- Oak frames, roof cover, cladding
- Reused Pitch Pine
- Local Ash floors & counter

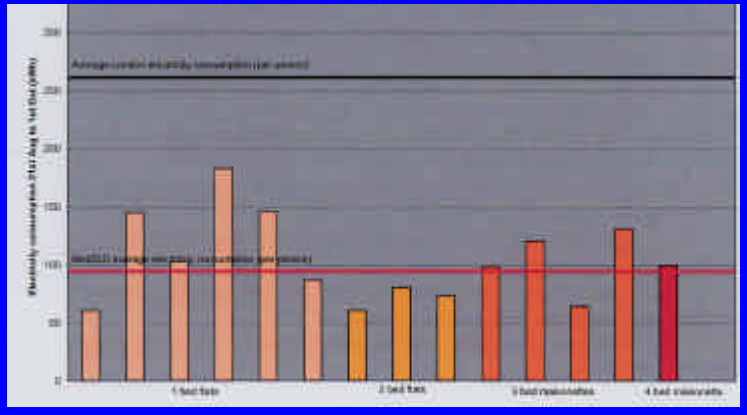
BEDZED
Urban high-density low-energy design



BedZed Energy Use



UK average heat consumption figures based on Sutherland Association Comparative 'Domestic Heating Costs' report, May 2002



- Average energy use for water heating, 43% less than average
- Electricity consumption for lighting, cooking, appliances, 60% less than average

Hockerton Housing Project:

- Community self-build
- Earth sheltered, passive solar
- 300mm EPS insulation all round
- No heating system
- PVs & wind
- Reed bed sewage system
- Shared electric car

Eco Self-Managed:

- Structural oak frame
- Superinsulated
- Lime foundations & render
- Integral sunspace
- PVs, SWH, Wood pellet boiler

The Southwell House

- Superinsulated,
- Efficient glazing (U = 0.95 W/m^{2}K)
- Airtight (1.5ach@50Pa)
- Small woodburning stove, only heating
- 52% of energy consumption, met by solar

The Oxford Eco-House

- 4 kWp Photovoltaic roof
- 5m^2 Solar thermal
- High mass
- Airtight
- Triple glazing
- Wood burning ‘kakkleoven’
- Electric car

German ‘Passivhaus’

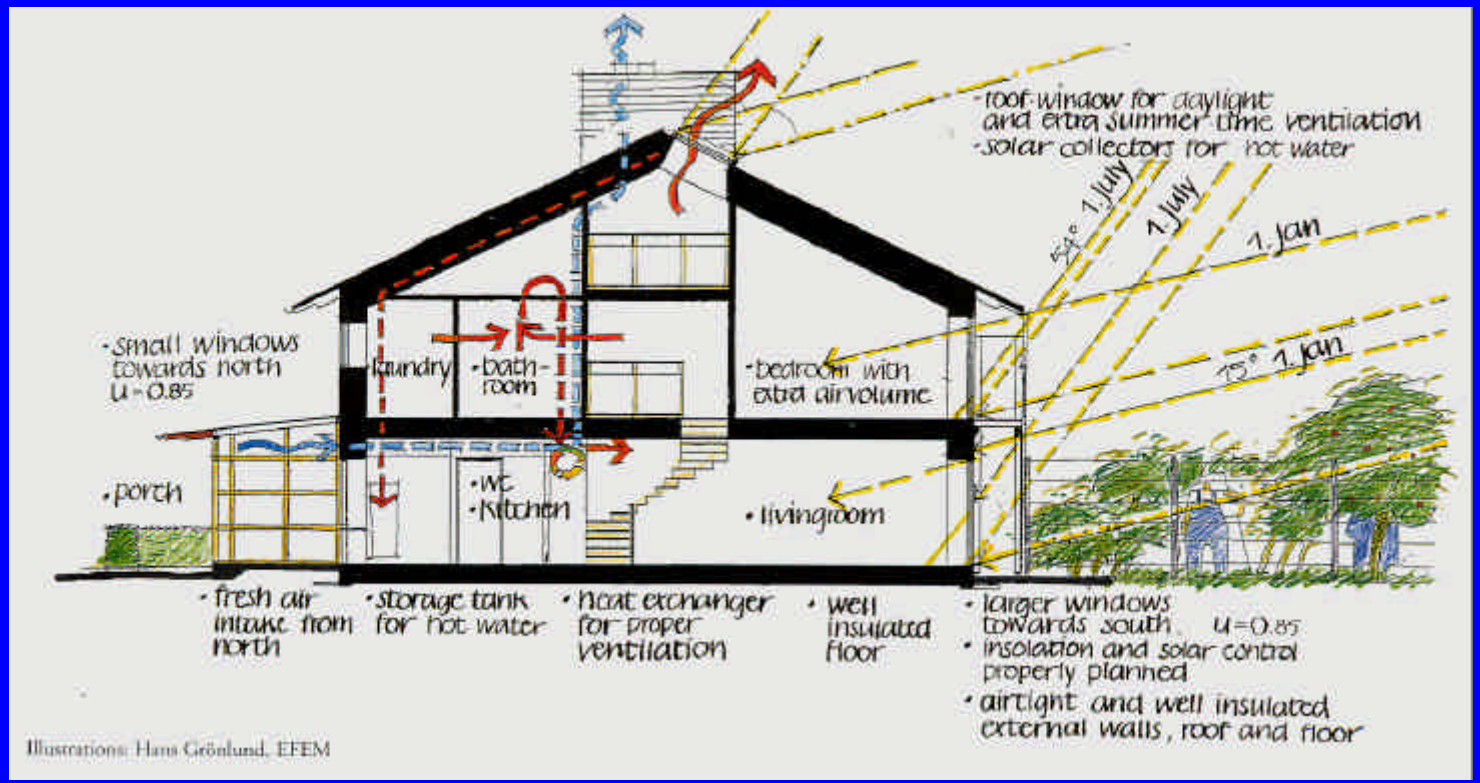
- No heating system
- Superinsulated (250-400mm)
- Glazing U=0.8W/m^{2}K
- Airtight: 0.8ach@50Pa
- MVHR system > 80% efficient

‘Houses Without Heating’ Lindas, Sweden

- 20 terraced houses, 120m^2 each
- 200,000 Euros per house
- Extra ‘eco’ costs equal to cost of heating system

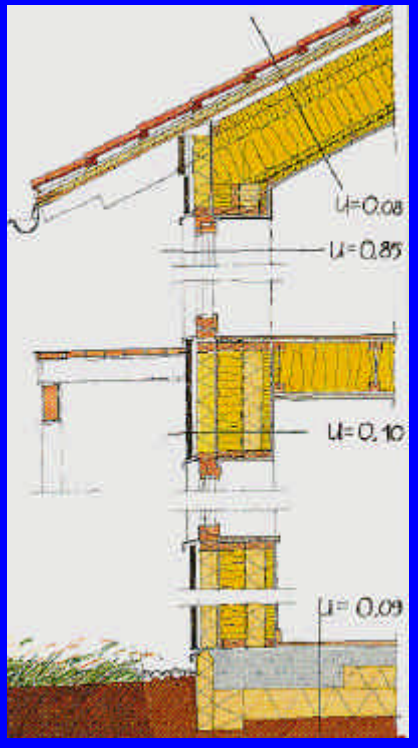
‘Houses Without Heating’ Lindas, Sweden

Architect Hans Eek



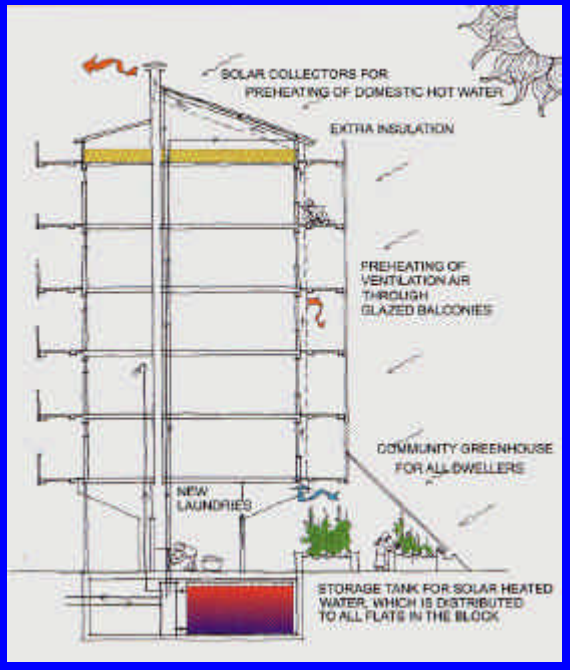
‘Houses Without Heating’ Lindas, Sweden

- Superinsulated - 480mm in roofs, 430mm in walls
- Triple glazed, low-E, krypton filled windows, U=0.85 W/m^{2}K
- Extremely airtight, 0.4 ach@50Pa
- Energy use = about 40kWh/m^2/yr



Solar Renovation, Gardsten

- 1970's apartment blocks
- Reduced energy use by 40%
- 225 apartments with 750m^2 of solar thermal sued to preheat DHW
- 600 euros/m^2; 25-30% of new build cost



Solar Renovation, Gardsten

- Experiment in one block
- Solar air heater + external insulation
- Warmed air vented to gable wall
- Further 30% reduction in energy demand

Bo01 at Malmö

- 18 different architects, one overall planner
- Brief to achieve heat+energy use <105 kWh/m^2/yr
- District Heating scheme, fuelled by 20% solar thermal, 80% GSHP
- Energy self-sufficient - 2.4MW wind turbine, grid-linked

Total Energy Consumption