U.K. Energy Consumption

From the Royal Commission on Environmental Pollution, Summary Report

C. Harris @ CAT 2003  www.inforse.org/europe/seminar03

2/31
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

**Macro-scale design**
- Landscaping for shelter
- Solar penetration
- Building form
- Orientation & Massing

**Micro-scale design**
- Good insulation
- Airtightness / controlled ventilation
- Passive solar design
- Thermal mass
- Sunspaces
- Glazing technology

**Space Heating**
- 60%

**Electricity**
- 10%
- Good daylighting
- Efficient lighting

**Cooking**
- 7%
- Efficient appliances

**Hot water**
- 23%
- Solar water heating
- Site CHP system

[Ref: 7]
Insulation Shows Greatest Potential CO₂ Savings

- Improve Lighting Efficiency: 50 Mt CO₂ per annum
- Improve Controls: 87 Mt CO₂ per annum
- Glazing Standards: 119 Mt CO₂ per annum
- Thermal Insulation: 185 Mt CO₂ per annum

[Ref: 3]
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
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

Ateic Thermal Performance 26/27 Aug 01

- External
- Shop
- Earth pillar
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

- 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/m²K)
- Airtight (1.5ach@50Pa)
- Small woodburning stove, only heating
- 52% of energy consumption, met by solar
The Oxford Eco-House

- 4 kWp Photovoltaic roof
- 5m² Solar thermal
- High mass
- Airtight
- Triple glazing
- Wood burning ‘kakkleoven’
- Electric car
German ‘Passivhaus’

- No heating system
- Superinsulated (250-400mm)
- Glazing $U = 0.8 \text{W/m}^2\text{K}$
- Airtight: $0.8 \text{ach} @ 50\text{Pa}$
- MVHR system $> 80\%$ efficient
‘Houses Without Heating’
Lindas, Sweden

- 20 terraced houses, 120m² 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 750m² of solar thermal sued to preheat DHW
- 600 euros/m²; 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/m²/yr
• District Heating scheme, fuelled by 20% solar thermal, 80% GSHP
• Energy self-sufficient - 2.4MW wind turbine, grid-linked
Total Energy Consumption

- Southwell house
- Oxford Ecohouse
- Ateic, C.A.T.
- Passivhaus Standard
- Malmo, Sweden
- Lindas, Sweden
- U.K. average