



STRINE
ENVIRONMENTS

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RESIDENTIAL ENERGY EFFICIENCY
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Strine

- colloquial for 'Australian'
- vernacular
- common sense, KISS

Australian Environmental Designers

PRINCIPLES

design excellence
sustainability
buildability



Residential Energy Efficiency

If its such a good idea...
why isnt everyone doing it?

Misconceptions: expensive, complex, does not work, can rely on technology

Doubt: science, facts

Education: basics, fundamentals, climate, comfort, construction

Thermal mass

Isolation of interior from external conditions



Residential Energy Efficiency

What is it?

Eliminating (minimising) energy costs
without compromising
residential amenity and comfort
or
design style

ENVIRONMENTAL DESIGN

Holistic design

Based on site context
and analysis

Context: outside to in

Site based
9 and 10th liners



COMMON SENSE

- to match the response pattern of a building to the climatic pattern and to the human use pattern
- to design the optimum built environment for each individual site
- to design buildings that don't need any inputs and create any outputs
- to use climatic design for thermal comfort
- to touch the earth lightly
- to use holistic design for human well being

PRINCIPLES

- right to sunlight – North façade and yard, not just solar access to roof
- vegetation needs to be included
- principal outdoor space POS to North of block (or E or W but with northern exposure)
- built form to South of block

Thermal efficiency
energy efficiency
sustainability



Thermal performance
energy consumption
greenhouse gas emissions



Thermal comfort & energy

heating and cooling loads x
house size x
appliance efficiency x
occupants' behaviour = **energy use**

The energy/greenhouse relationship

Greenhouse emissions depend on:

- The **amount** of energy used
- The **source** of the energy

	Renewable electricity	Natural gas*	Grid electricity**
kilograms of greenhouse gas emitted per unit of heat produced	0	0.33	1

* LPG is approximately 0.4

** National average. For electricity generated in Victoria this figure is 1.4. In Tasmania it is very low due to use of hydro. In the NT it is about 0.75 due to use of gas for electricity generation.

CLIMATE

- how the planet operates

COMFORT

- how the human body operates

PHYSICS

- how buildings operate

CLIMATE

Every site comes with one, for free!

All living organisms depend on climate for their existence

SUN is earth's primary source of heat and light

free "passive" heater...comes on each morning, goes off each night

RIGHT TO SUNLIGHT needed

Sun also creates wind and humidity

Interaction of the sun and its effects with the landscape creates climate/microclimate

Only 4 basic climates:

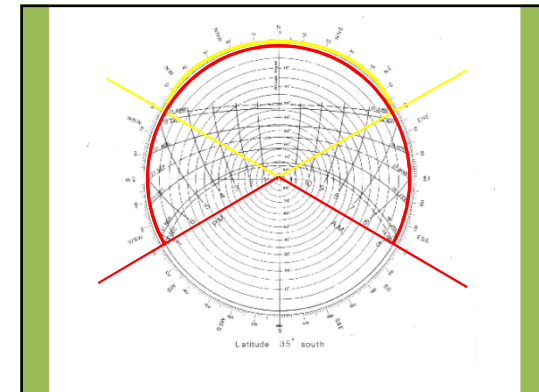
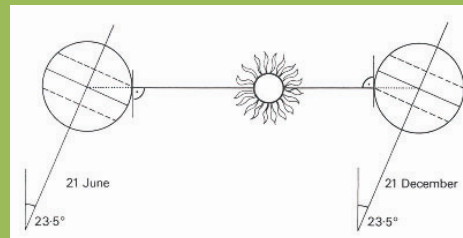
Cold; Temperate; Hot-dry; Hot-humid

Earth's air temp range -93°C to 57°C (150°C)

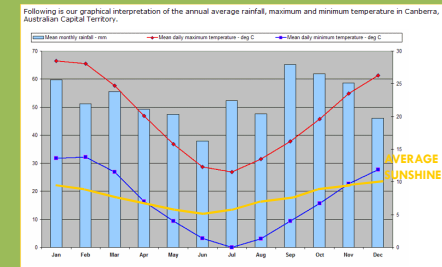
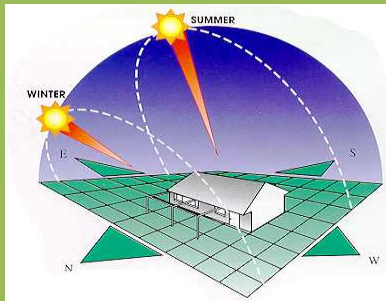
Solar geometry: summer, winter angles

Sydney and Canberra c35°S

SOLAR RADIATION Winter North façade 0.8 – 1kW/m²/hr
Summer West façade 1 – 1.2kW/m²/hr



The sun's path in the sky



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HUMAN COMFORT

Humans: living organisms that constantly react to their environment

Core body temp 37.2°C

Face, mouth temp 36°C

Core body temp range $\pm 1^{\circ}\text{C}$

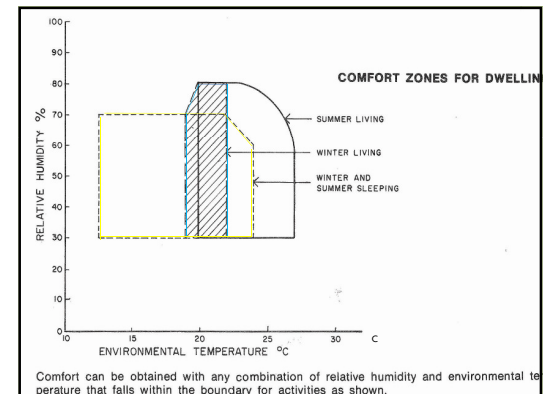
Evolution: bio-rhythms/circadian rhythms roughly-24-hour cycle in the physiological processes of living beings, triggered by...

$18-20^{\circ}\text{C}$ environment

Sensory deprivation = Discomfort (torture)...constant light & temp eg HVAC

- poor health
- loss of productivity

Sunlight – therapeutic, physiological and psychological



Activity	watts
Sleeping	min. 70
Sitting, moderate movement, e.g. typing	130-160
Standing, light work at machine or bench	160-190
Sitting, heavy arm and leg movements	190-230
Standing, moderate work, some walking	220-290
Walking, moderate lifting or pushing	290-410
Intermittent heavy lifting, digging	440-580
Hardest sustained work	580-700
Maximum heavy work for 30-minutes duration	max. 1100

(Average values of data published in many sources)

Air temperature alone is not an accurate description of human comfort

SENSIBLE / RADIANT HEAT GAIN / LOSS to surrounding surfaces is more important

Thermal comfort is not possible where air temp & mean radiant temp differ by more than 5°C

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BUILDING PHYSICS

Scientific analysis
Architectural science
Physics of buildings

- heat flow
 - Conduction (increases considerably with moisture, and with temperature)
 - * Resistance (reciprocal) improved by layers of materials and air spaces
 - Convection
 - Radiation
- thermal inertia
 - Mass-effect
 - Building materials do not react instantly and materials and thicknesses can be selected so that the heat of the day arrives after night fall
 - * Time lag
 - Decrement factor
- heat gain, heat loss
 - from warm air to building structure
 - through the structure
 - from the structure to the cooler air

Insulation
Ventilation
Materials
Energy
Solar
Evaporation

Thermal mass

Material	Volumetric Heat Storage Capacity (kJ/m³ deg K)
Water	4190
Steel	3900
Concrete	2110
Brick	1500
Fibre cement sheet	1250
AAC block	550
Air	13

