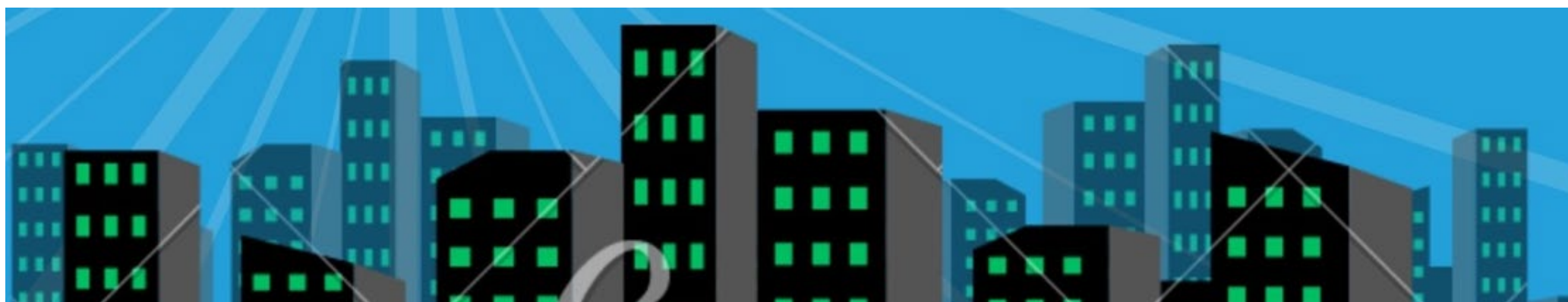


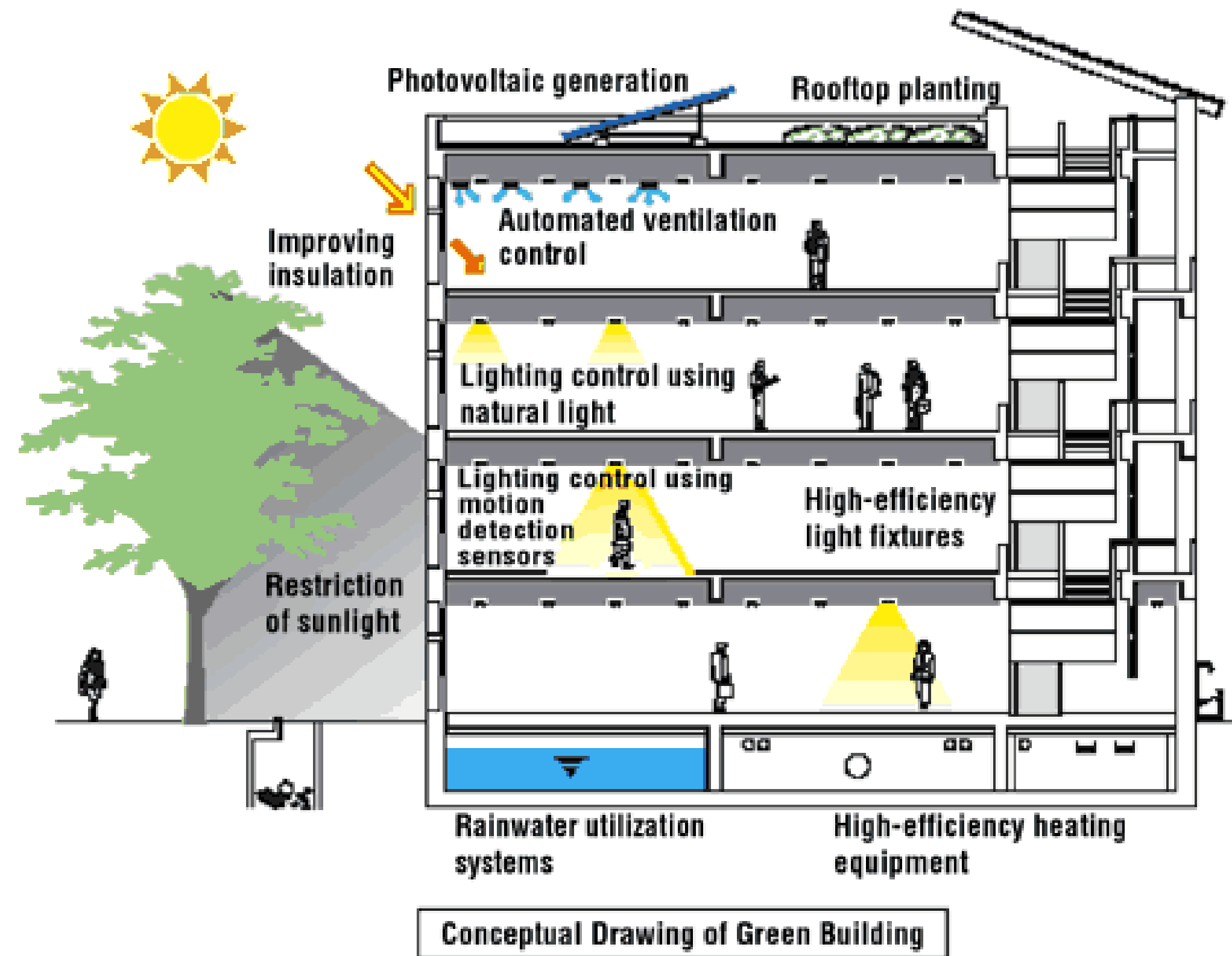
Buildings; Decarbonisation and Building Basics

- **Building BASICS**
 - Building Heating Options
 - Building Power Systems & Energy Efficiency
 - Building Controls & Management - Smart Building
 - Building Survey for Feasibility



What do buildings to provide?

- Shelter
- Comfort
- Security
- Function



Building Basics

Building Structures and Form

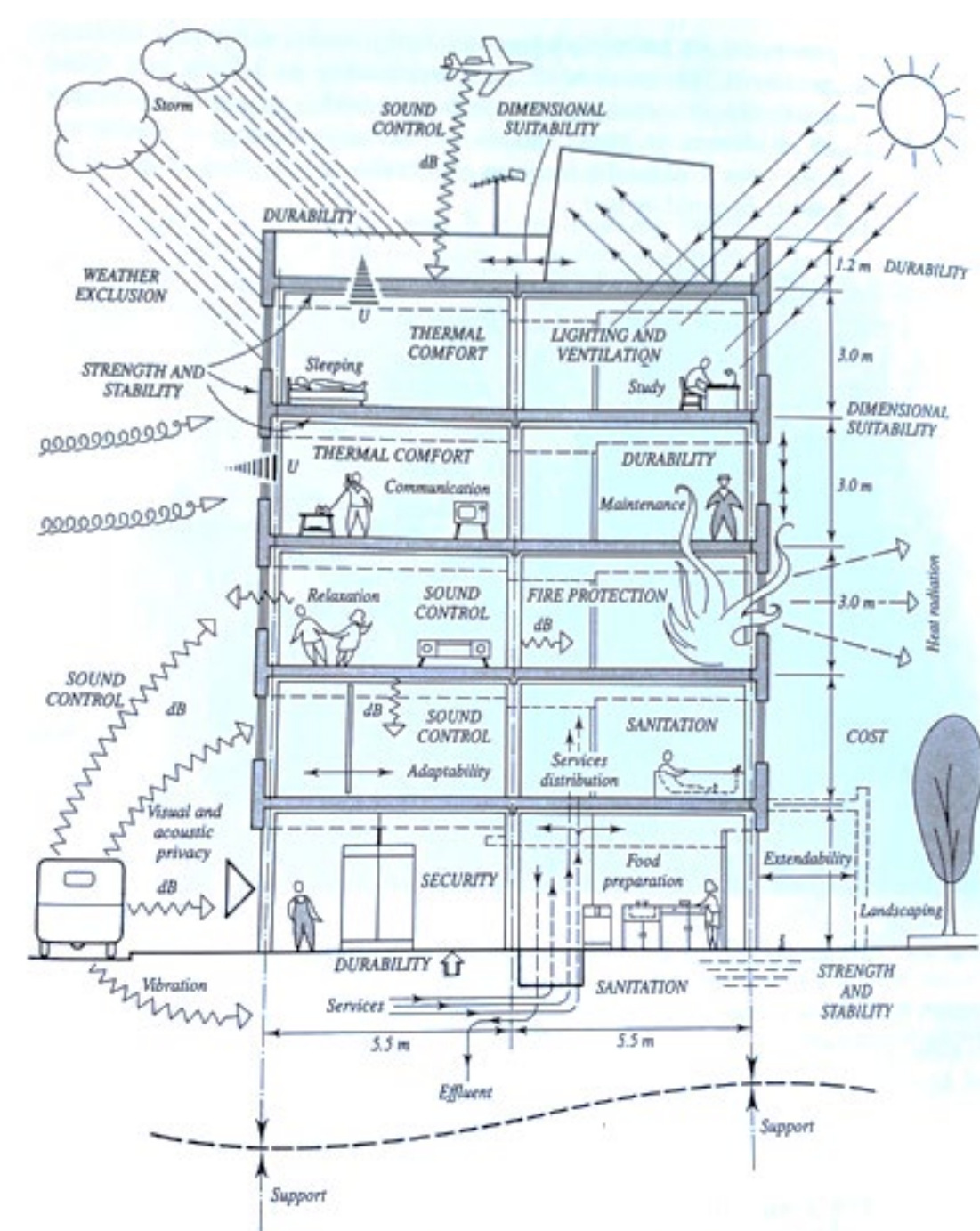


Fig. 2.5 Performance requirements for buildings. Reproduced from Osbourn & Greeno (1997). (Reprinted by permission of Addison Wesley Longman Limited.)

4 Important Aspects to consider

- Orientation
- Thermal Mass
- Heat loss and U values
- Building Use



Orientation

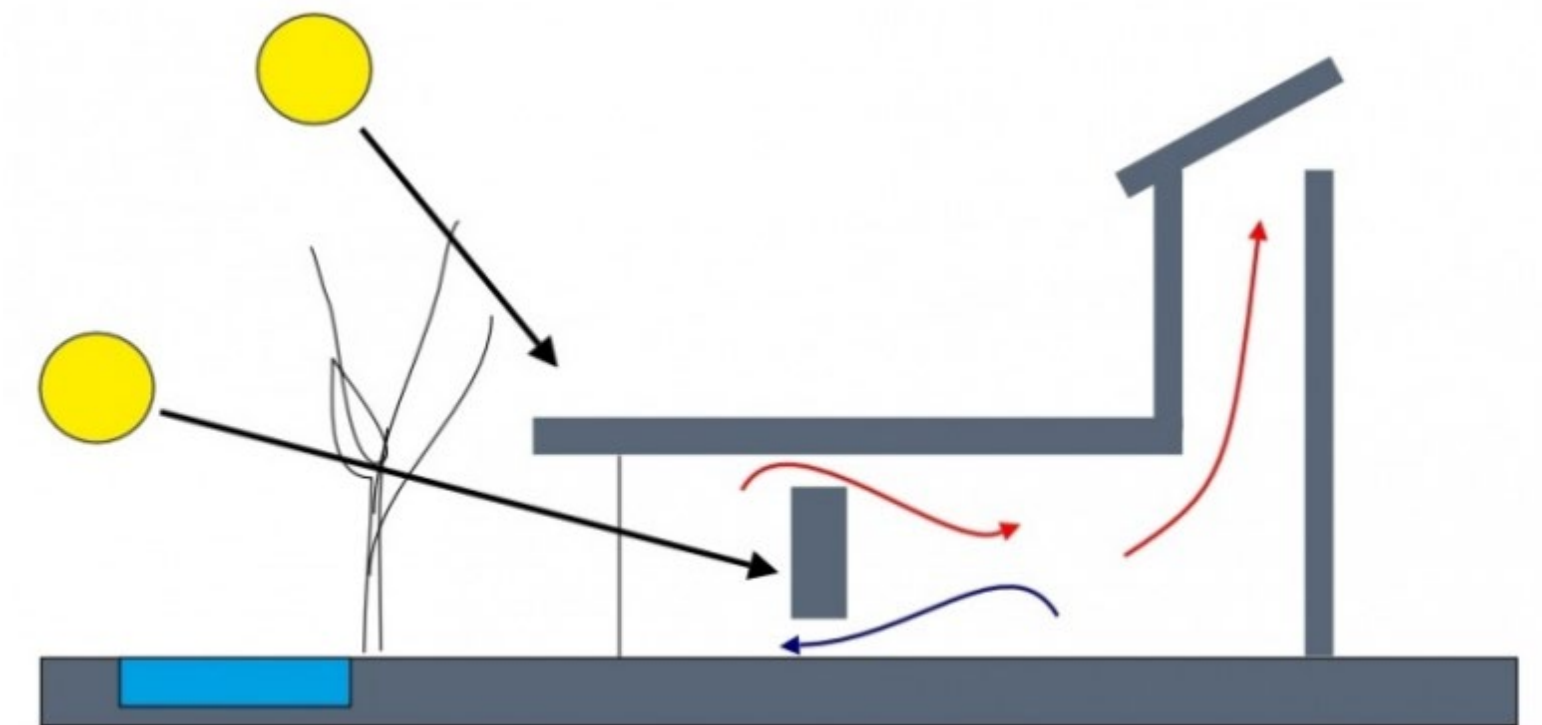
NOT POSSIBLE TO CHANGE

- This is important to take note of as it will be a factor in how the building responds to the environment.
- Overheating & draughts
- Solar energy potential
- Passive ventilation
- Free Cooling & Daylighting



Solar Gain

- Orientation
- Glazing and window size
- Insulation
- Internal layout
- Construction - Thermal Mass
- Heating Strategy
- Ventilation strategy

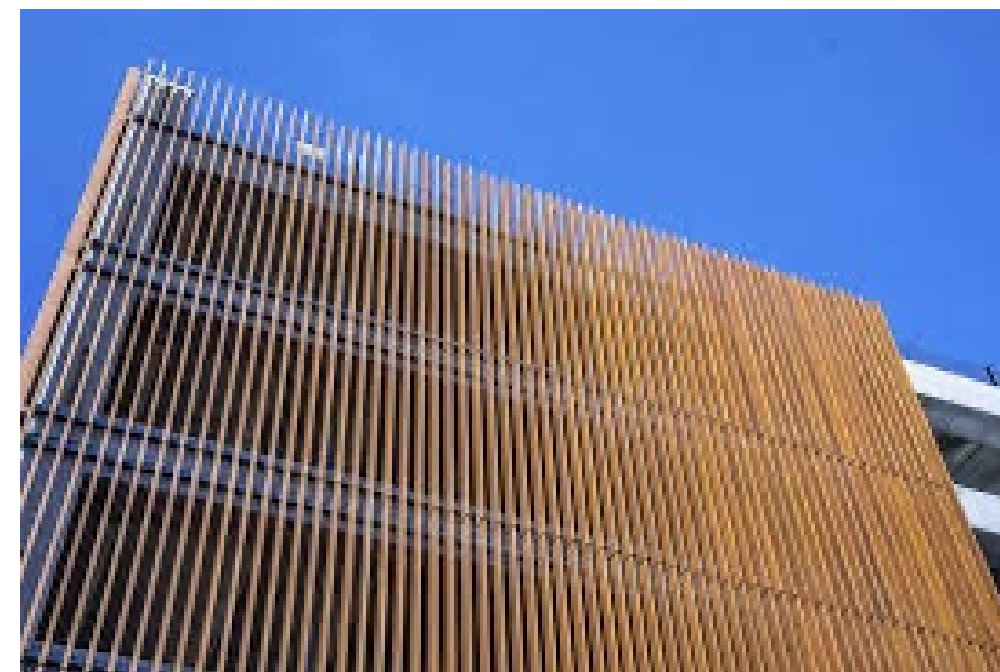
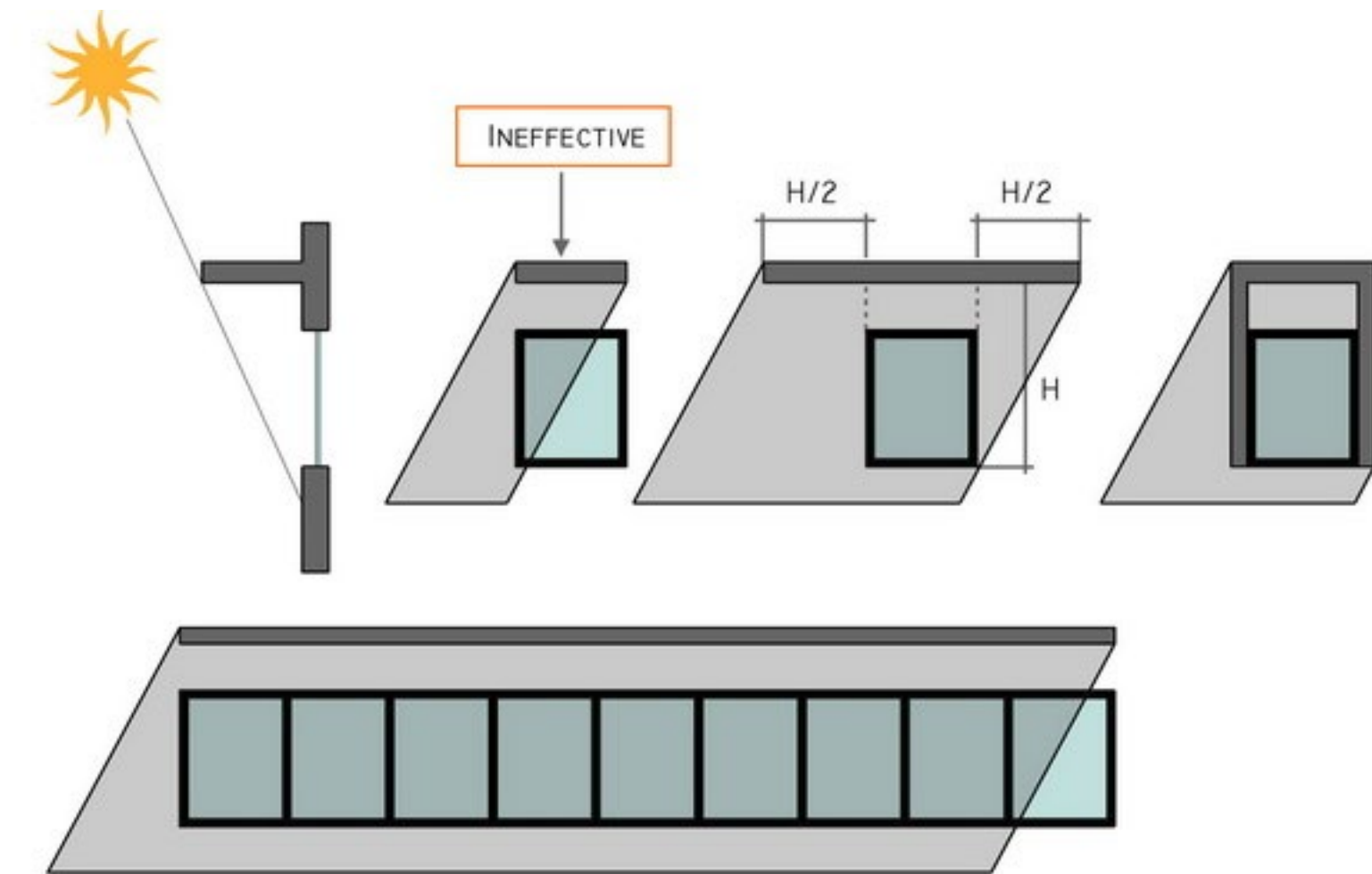


Ref: Construction Wiki

Solar Energy can be used to a positive impact

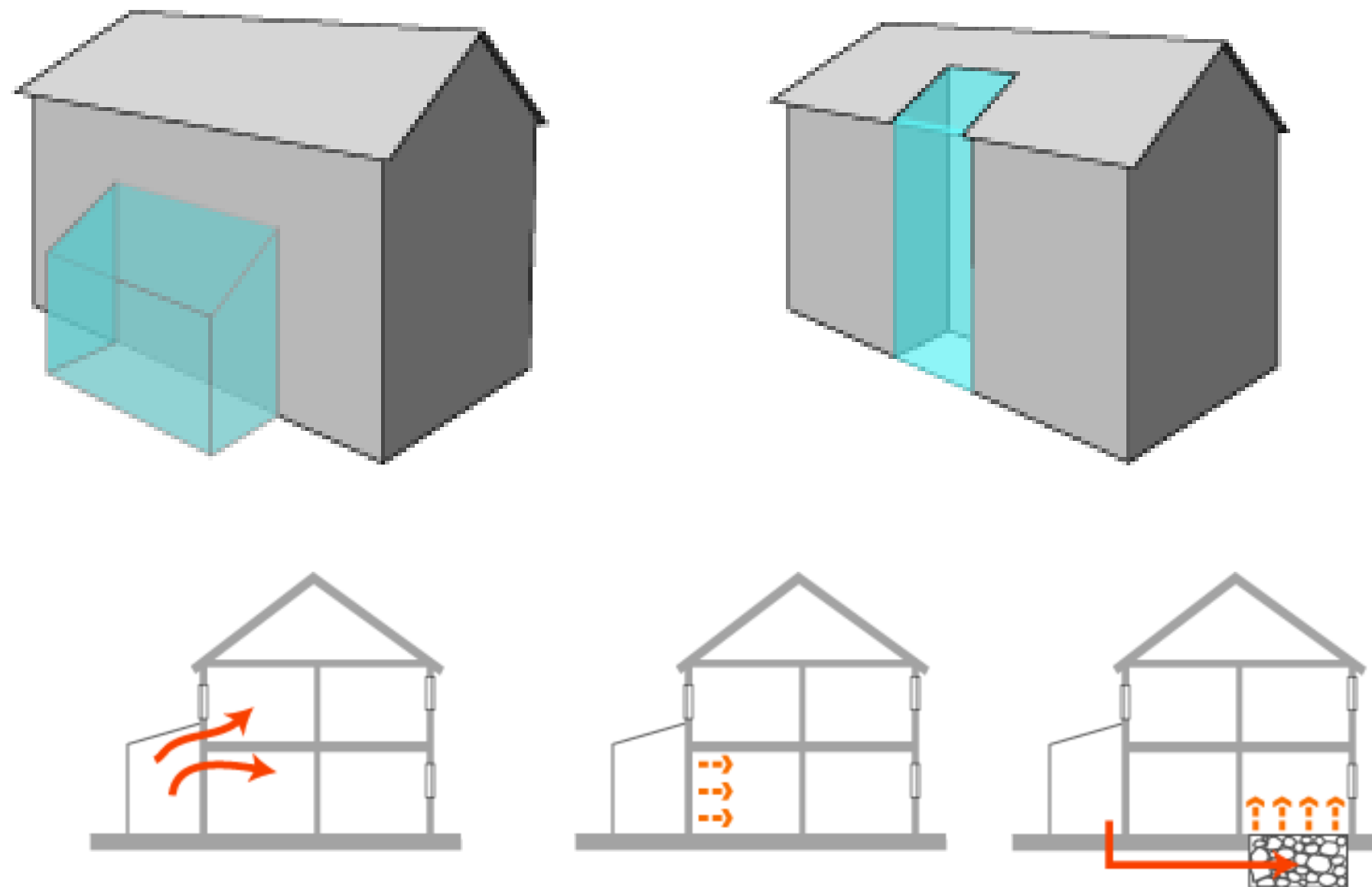
Solar Shading

- Blinds
- Shutters
- Brise Soliel – incorporate PV?

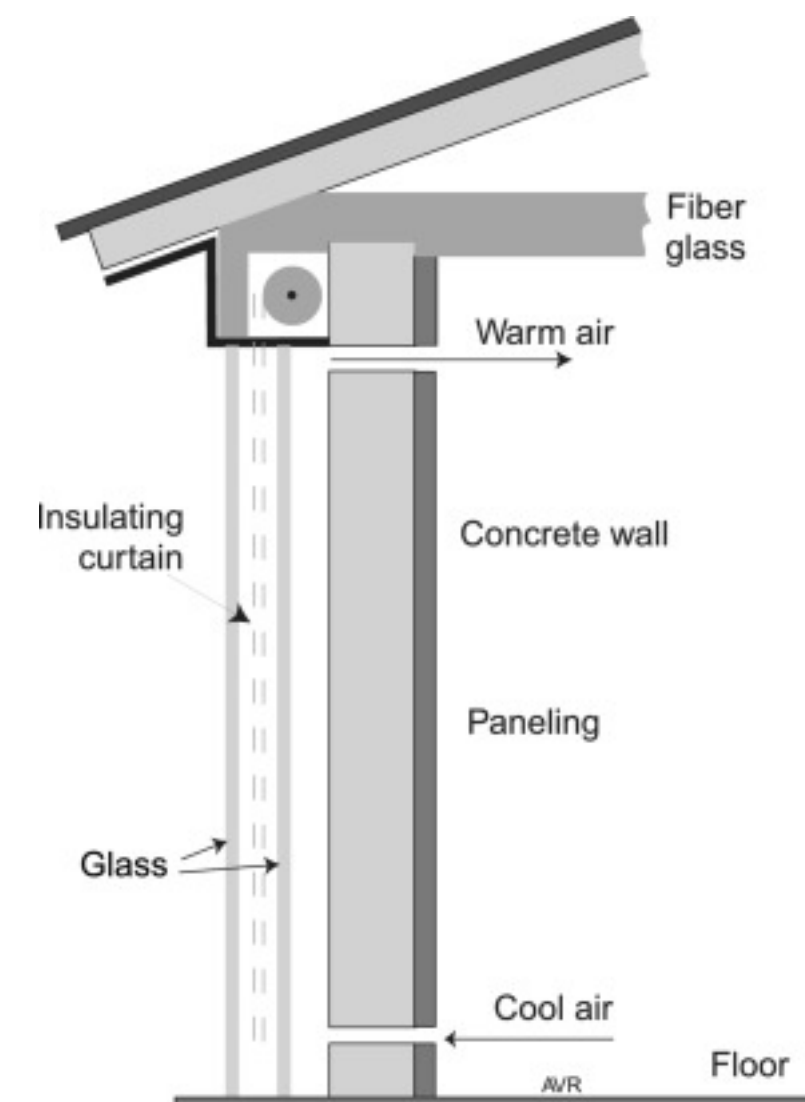


Solar Benefit

- Trombe Wall
- Solar space



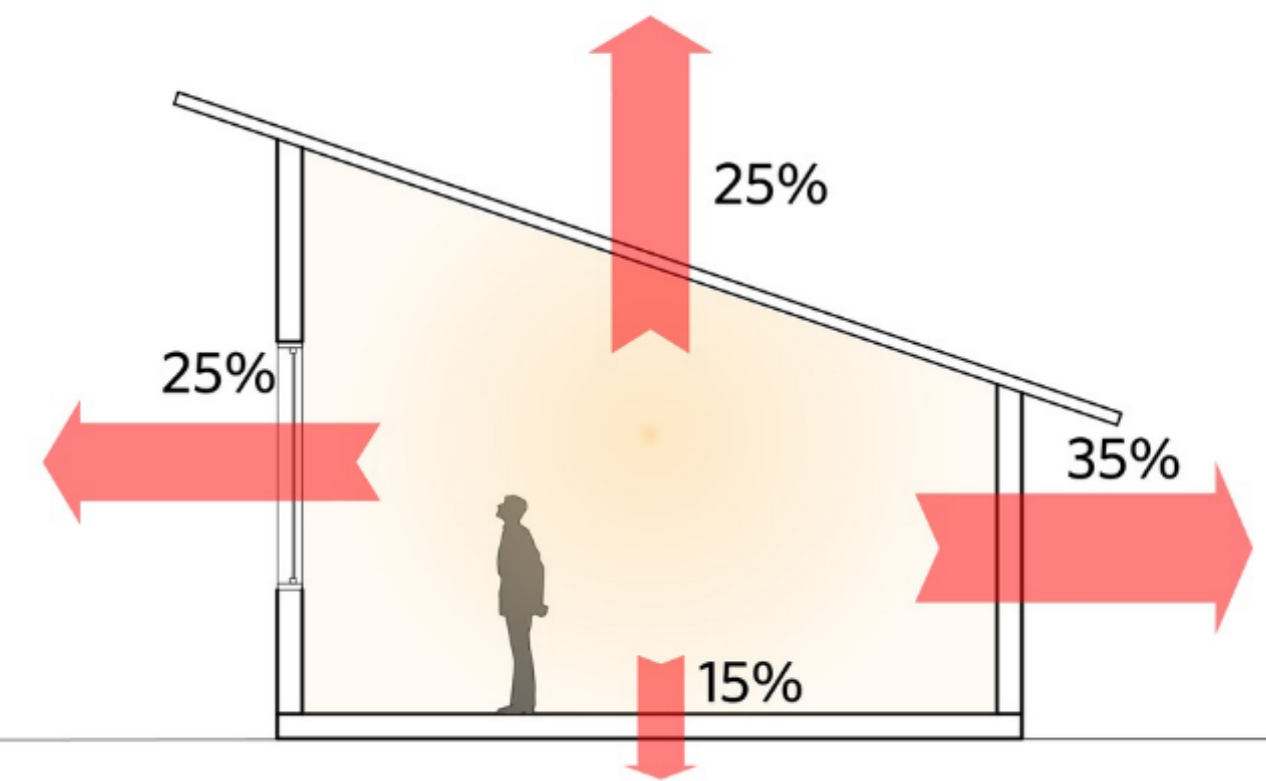
Ref: Greenspec



Ref: Construction Wiki

Heat Loss

- What can cause heat loss?

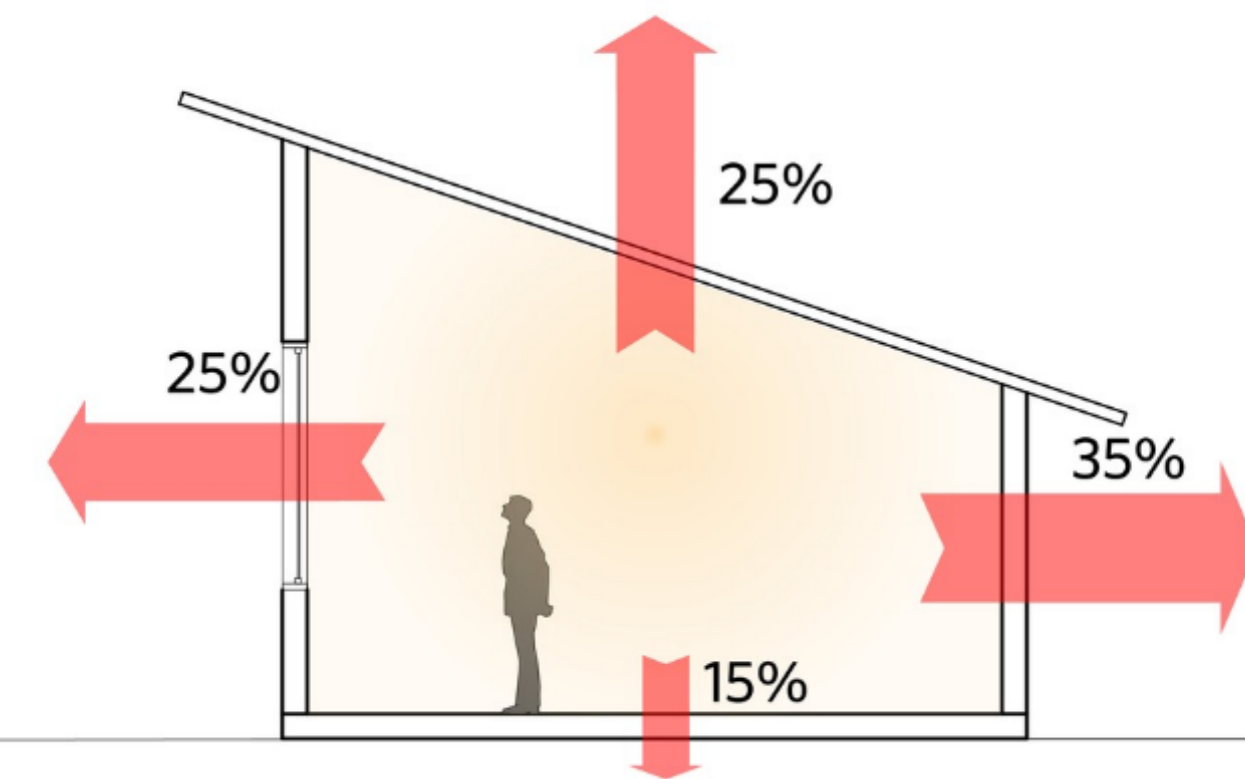


Ref: Architects Daily

Heat Loss

- Orientation
- Building materials
- Glazing and window door size
- Insulation
- Building layout
- Construction - Thermal Mass

The heat loss is the total amount of energy transmitted through the surfaces and elements of a building's construction



Ref: Architects Daily

The heat loss can be measured or calculated - a Thermal Model is the digital version of this.
Most Common :- IES Apache

U Values

- U-Value or Thermal Transmittance
- Measured in $\text{W/m}^2\text{K}$
- U-Values are published for materials
- Building Regulations have minimum requirements

The heat loss is the total amount of energy transmitted through the surfaces and elements of a building's construction

The U Value indicates how well a material is in retaining (heat) energy, it is a measure of the rate of heat transfer.

In June 2022, Approved Document **Part L** was updated, specifying U-values for both new and existing dwellings. Understanding U-values is crucial in creating more sustainable, efficient buildings and reducing our environmental impact.

- U-value requirement External Walls $0.18 \text{ W/m}^2\text{K}$
- U-value requirement Party Walls $0.0 \text{ W/m}^2\text{K}$
- U-value requirement Floor $0.13 \text{ W/m}^2\text{K}$
- U-value requirement Roof $0.11 \text{ W/m}^2\text{K}$
- U-value requirement Windows (whole window U-value) $1.2 \text{ W/m}^2\text{K}$

The U Value indicates how well a material is in retaining (the heat flow in Watts through 1m² of a material.

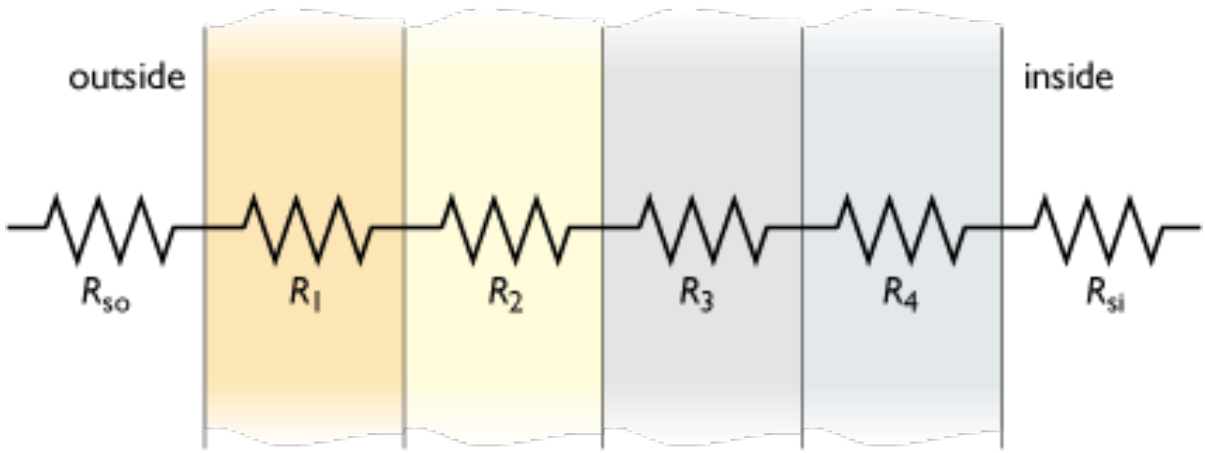
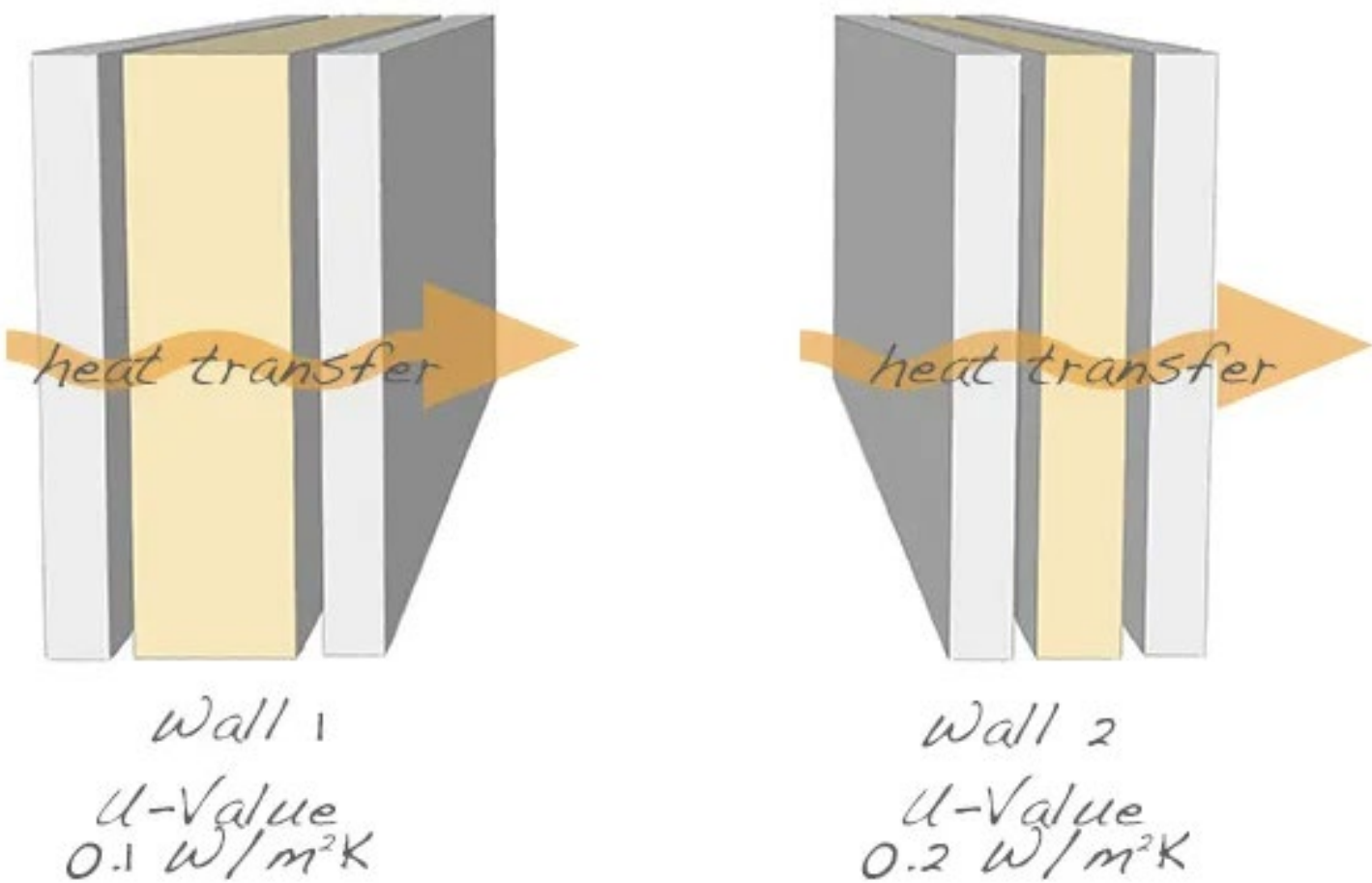
U Values

Table 6 Calculation of thermal resistances

Layer	Thickness /m	Conductivity/ W m ⁻¹ K ⁻¹	Resistance/ m ² K W ⁻¹
Outside thermal resistance			0.04
Brick	115 mm	0.77	0.115/0.77 = 0.15
Mineral wool	115 mm	0.035	0.115/0.035 = 3.29
Aerated concrete block	115 mm	0.11	0.115/0.11 = 1.05
Dense plaster	13 mm	0.57	0.013/0.57 = 0.02
Inside thermal resistance			0.13
Total thermal resistance			4.67

The overall U-value is then:

$$U = 1 / R = 1 / 4.67 = 0.21 \text{ W m}^{-2} \text{ K}^{-1}$$



$$R_T = R_{so} + R_1 + R_2 + R_3 + R_4 + R_{si} \text{ m}^2 \text{ K W}^{-1}$$

The U-value of this wall is its inverse = $1/R_T \text{ W m}^{-2} \text{ K}^{-1}$

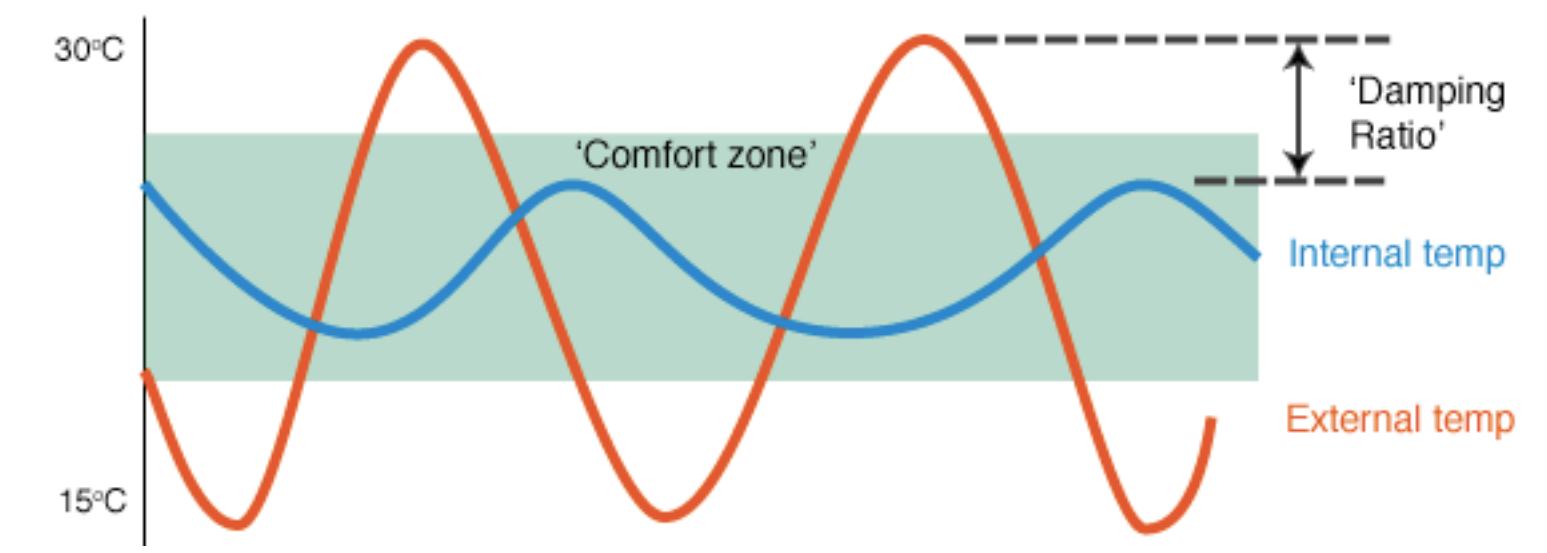
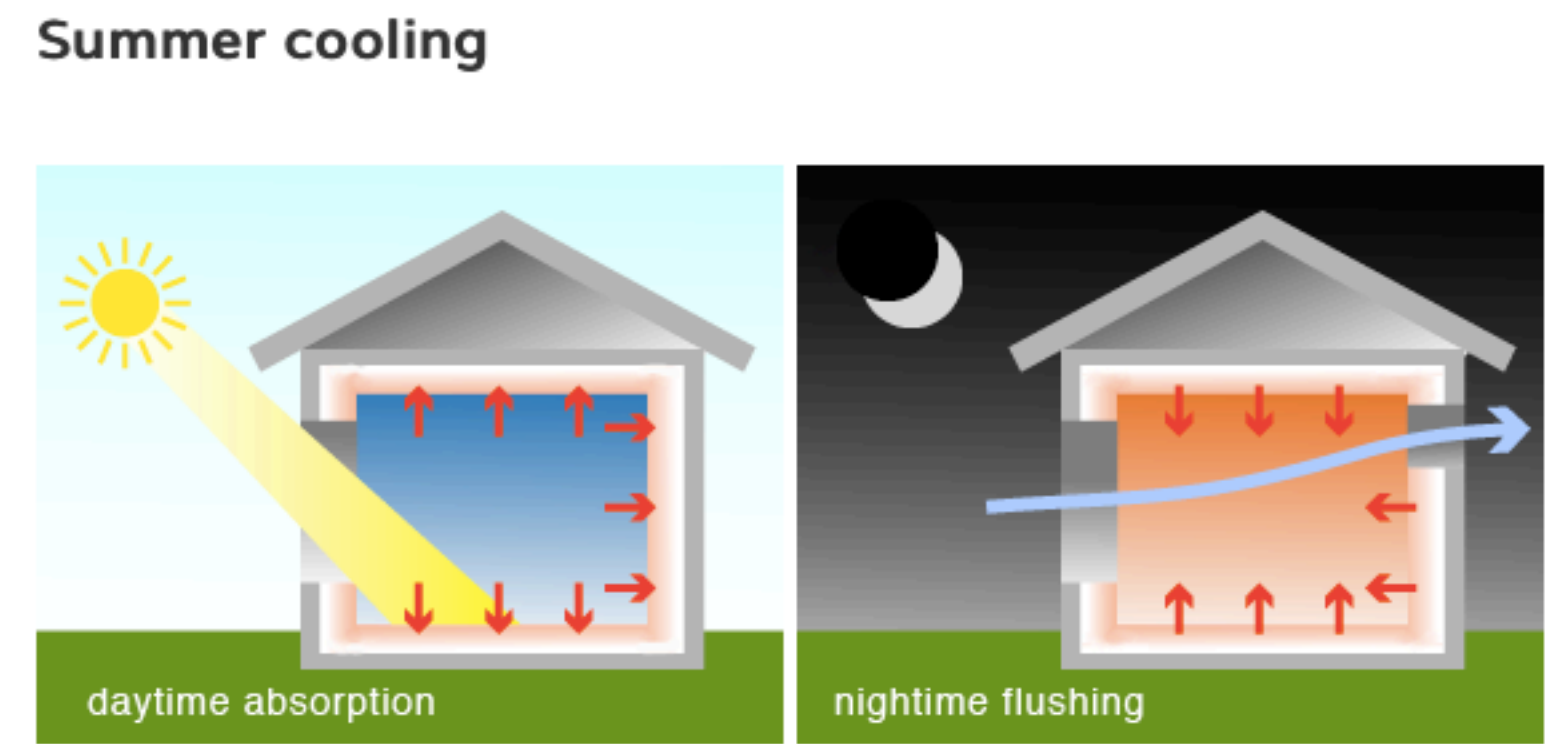
Resources available



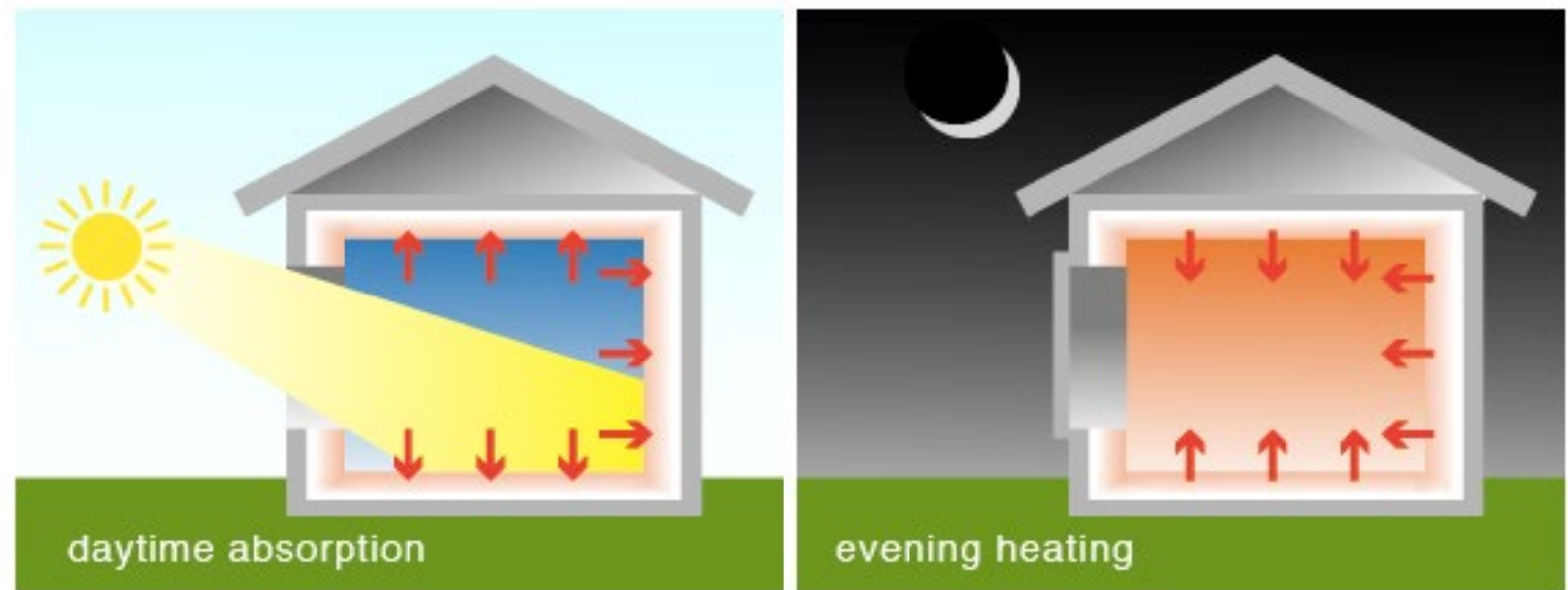
Thermal Mass

- Construction - Thermal Mass

How a building stores and gives off heat.
(The ability to store heat relative to the material mass.)



Winter heating



Wall build-up	U-value	Thermal admittance	Thermal mass
• 200mm brick • 13mm 'wet' plaster	2 W/m ² K	4.26 W/m ² K	169 kJ/m ² K
• 100mm brick • 150mm mineral wool-filled cavity • 100mm aerated concrete block • 13mm plasterboard drylining on 10mm dabs	0.19 W/m ² K	1.86 W/m ² K	9 kJ/m ² K

Wall build-up	U-value	Thermal admittance	Thermal mass
• 100mm brick • 150mm mineral wool-filled cavity • 100mm aerated concrete block • 13mm 'wet' plaster	0.19 W/m ² K	2.74 W/m ² K	60 kJ/m ² K

Ref: NBS

Ref: Greenspec

Solar Energy

- How can we use Solar energy in buildings?



Solar Energy

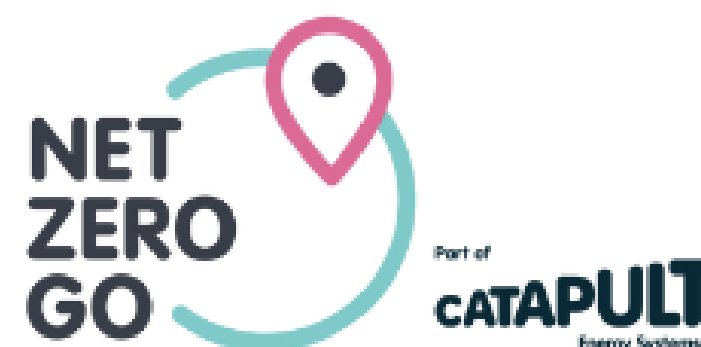
- Heat
- Light
- Renewable Energy



Inside Climate News

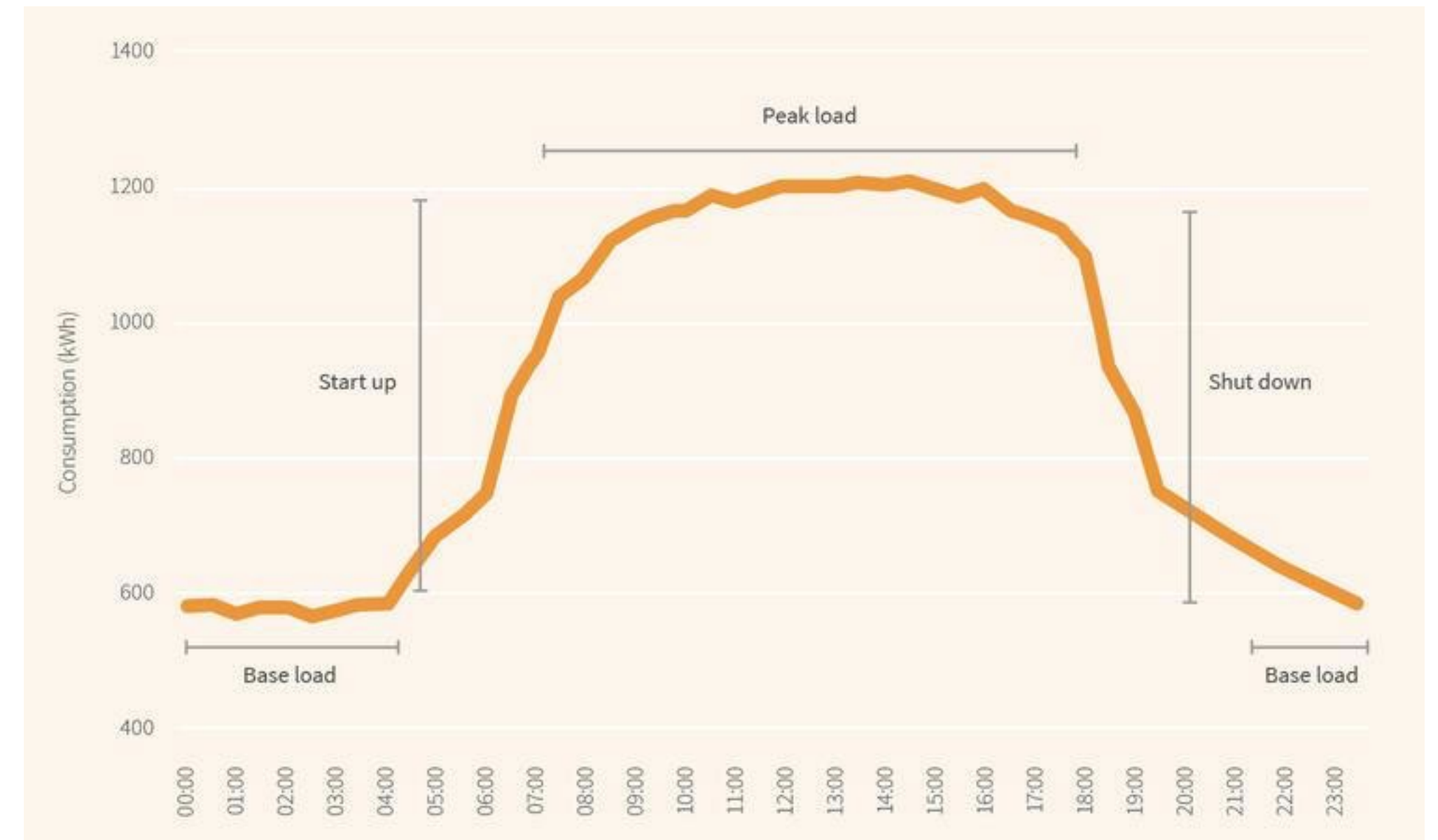


Resources available



Energy Use

- Building Use
- Energy Efficiency
- Controls
- Behavioural impact



Example weekly half-hourly profile of electricity consumption of an office building



The troughs in the graph show the baseload of the building i.e. the minimum amount of electricity consumed by the building. This occurs overnight when the building is empty. An optimised standard occupancy building operating during normal working hours should have a baseload of between 10% and 15% of peak consumption, with 24/7 operated buildings having approx. 40% baseloads.

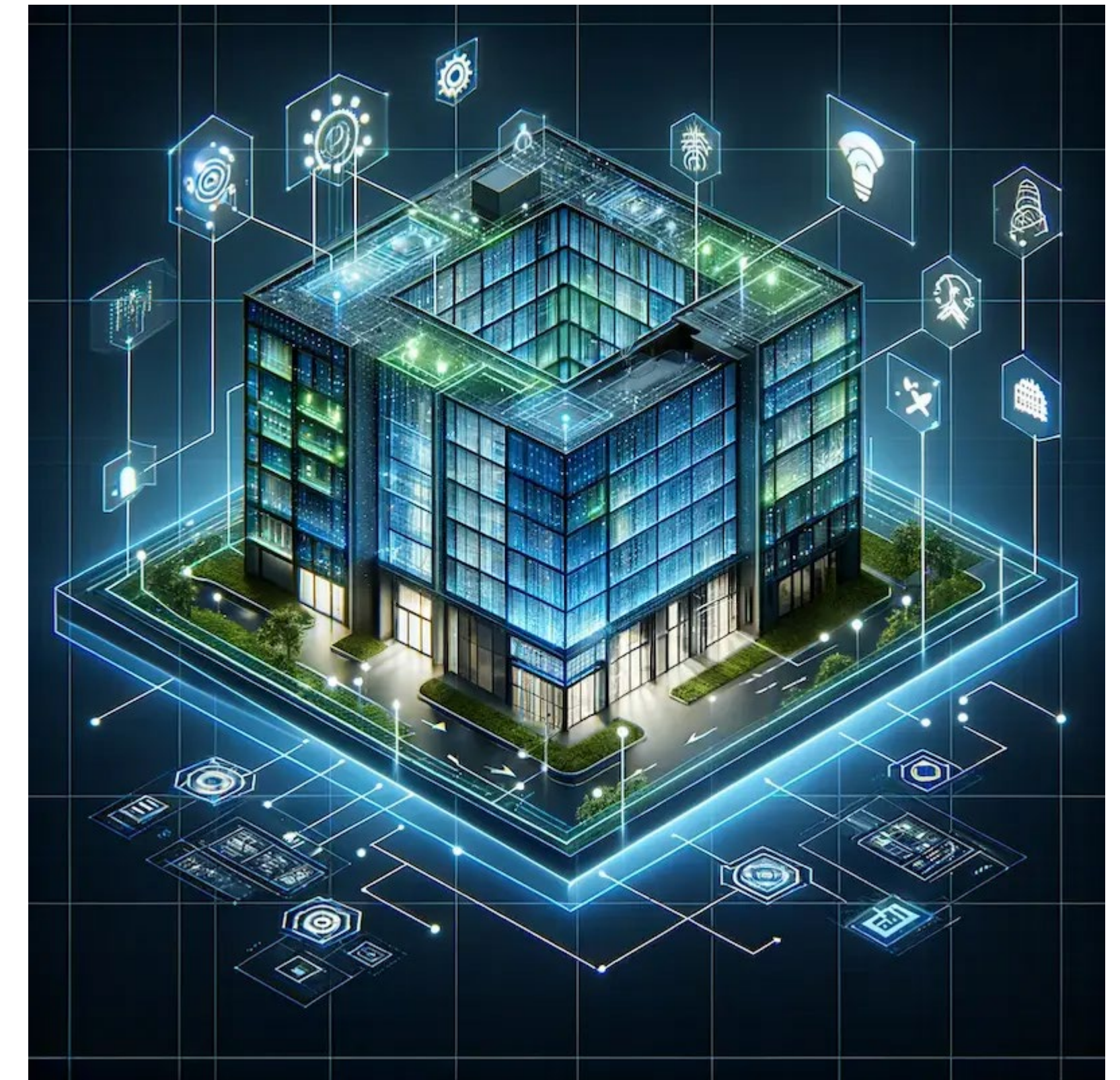
Occupied Unoccupied

Resources available

CATAPULT
Energy Systems

Energy Use

- SMART Buildings
- Intelligent monitoring systems
- Feedback and alerts
- Automated function on routines
- Questioning of change



Buildings; Decarbonisation and Building Basics

Questions?

- **Building BASICS**
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