Building Services Engineering

Sustainable Design

Simon Gaines MBA, BEng (Hons) MCIBSE

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Overview

- What is Building Services Engineering?
- Introduction to Sustainability
- Sustainable Building Services Engineering Design

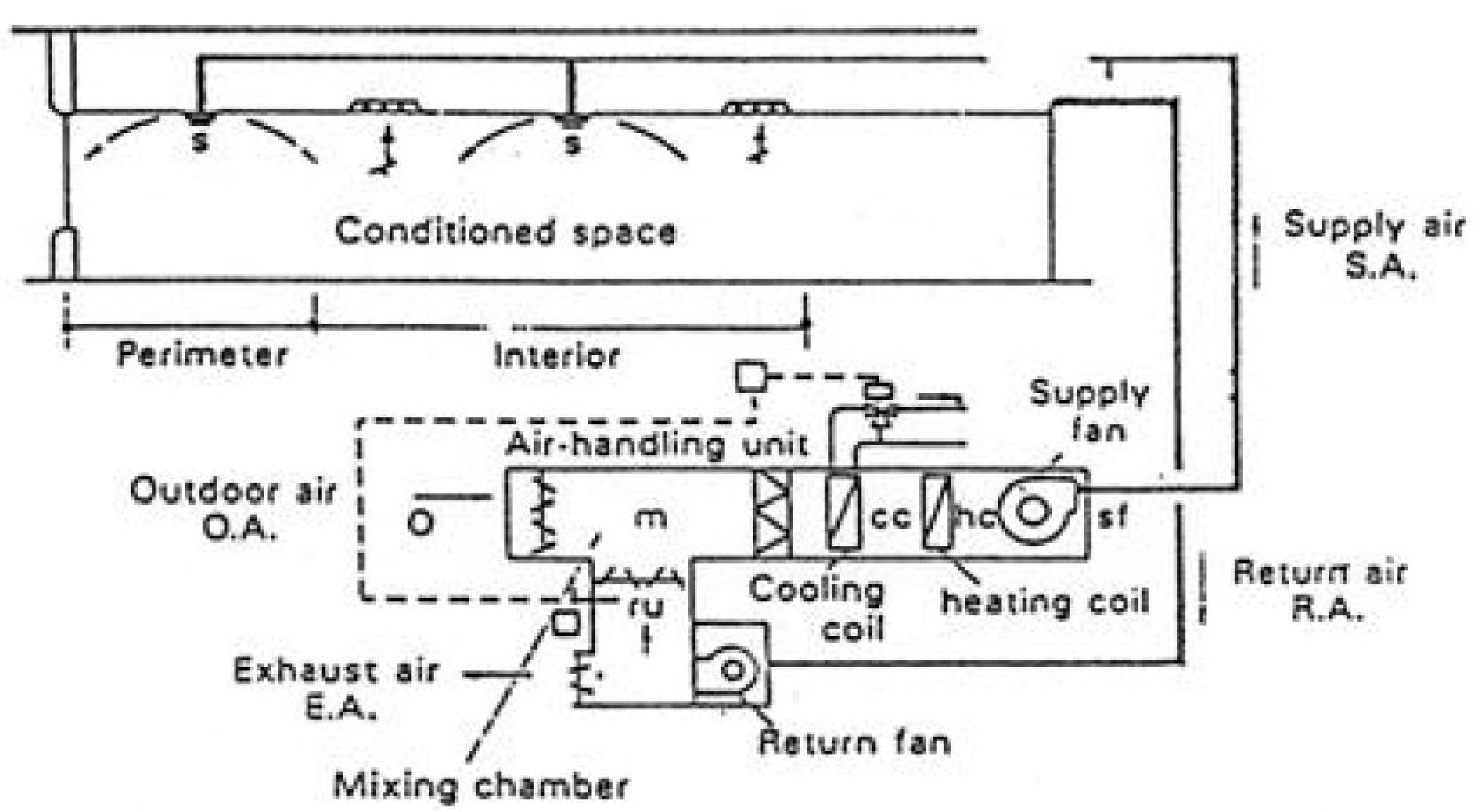
Building Services Engineering

- HVAC
- Electrical
- Hydraulics
- Fire Detection and Alarm Systems
- Security
- Data and Telecommunications
- Vertical Transportation
- Electrical Ancillaries

Heating Ventilation Air Conditioning

- Generally air conditioning is required when natural/mechanical ventilation is insufficient, mainly for the following reasons:
- Excessive building heat gains
- Excessive ventilation rates: Infiltration/ Cooling of air

Simple Single Zone- All Air System

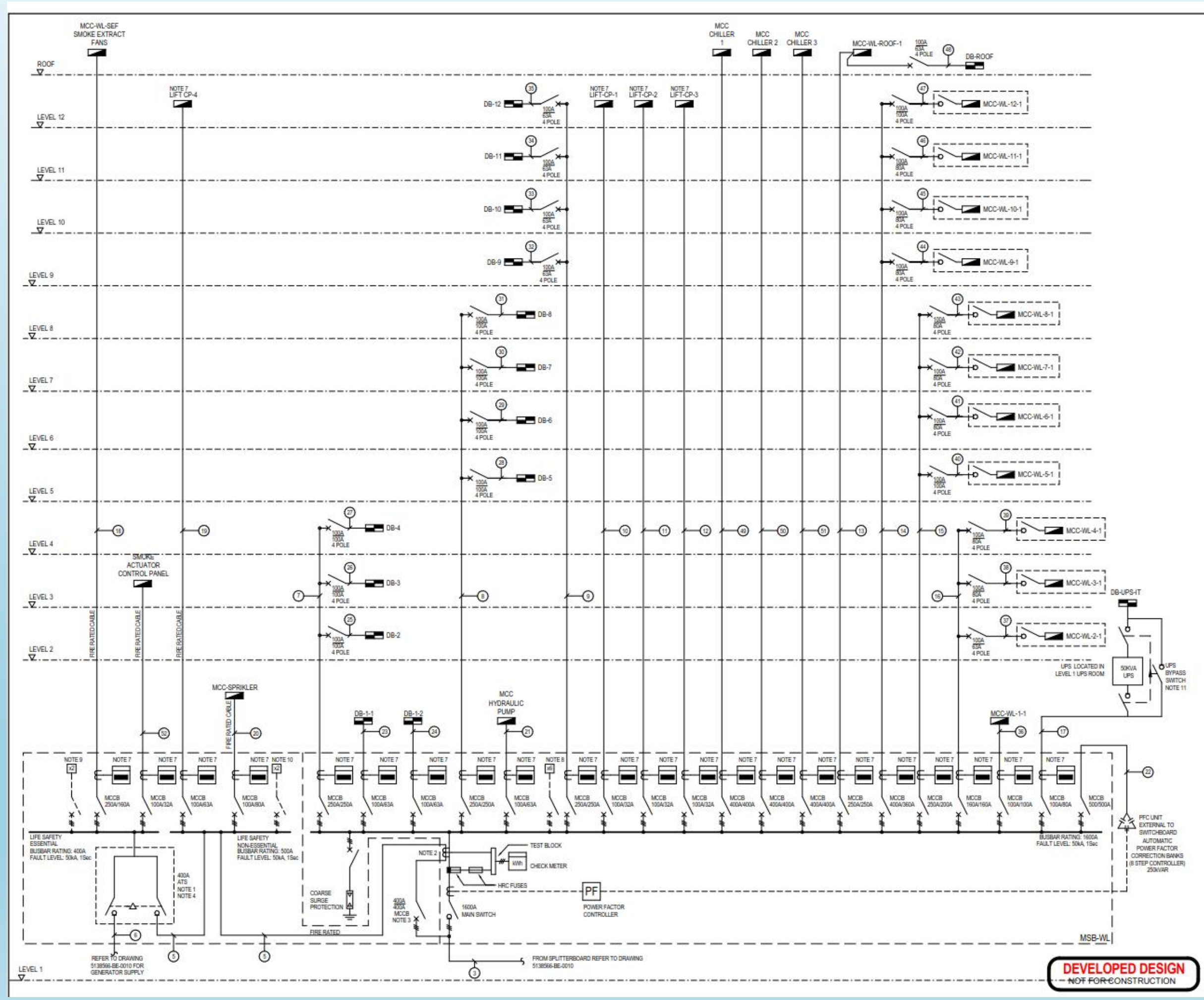


Electricity- The National Grid

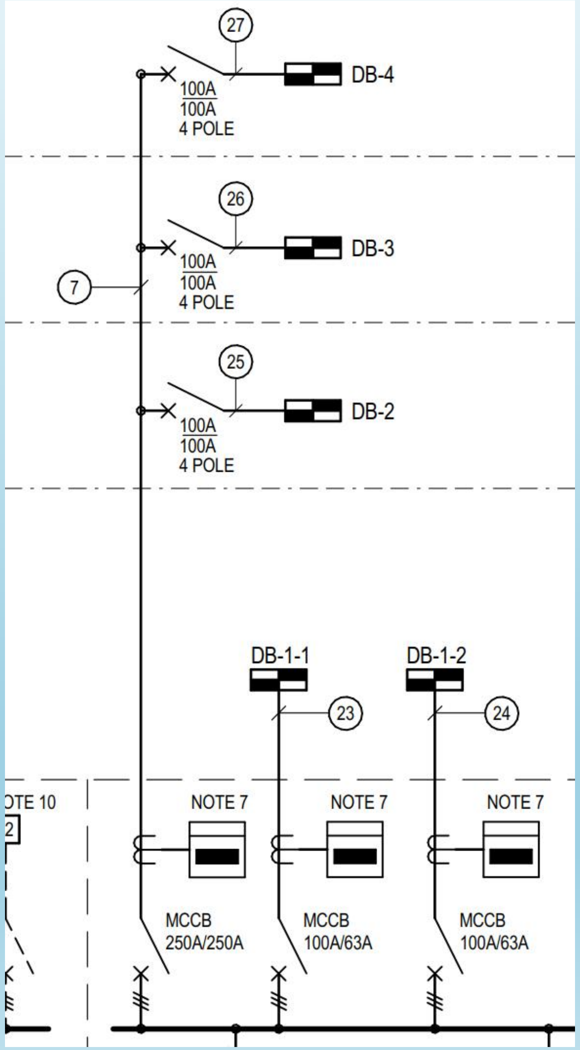
- The National Grid is made up of over 12,000 km of transmission lines and more than 170 substations.
- Electricity is transmitted over the grid at high voltages (up to 220,000 volts) from power stations to local lines companies and major industries.

Electrical Systems

- Small power 1ph (230v) socket outlets, DHWS
- 3ph motors/ plant
- Lighting requirements
- Heating
- UPS
- Generators



Electrical Systems



Hydraulics

- DHWS
- Toilets, showers, washing facilities
- Drainage
- Gas

Introduction to Sustainability

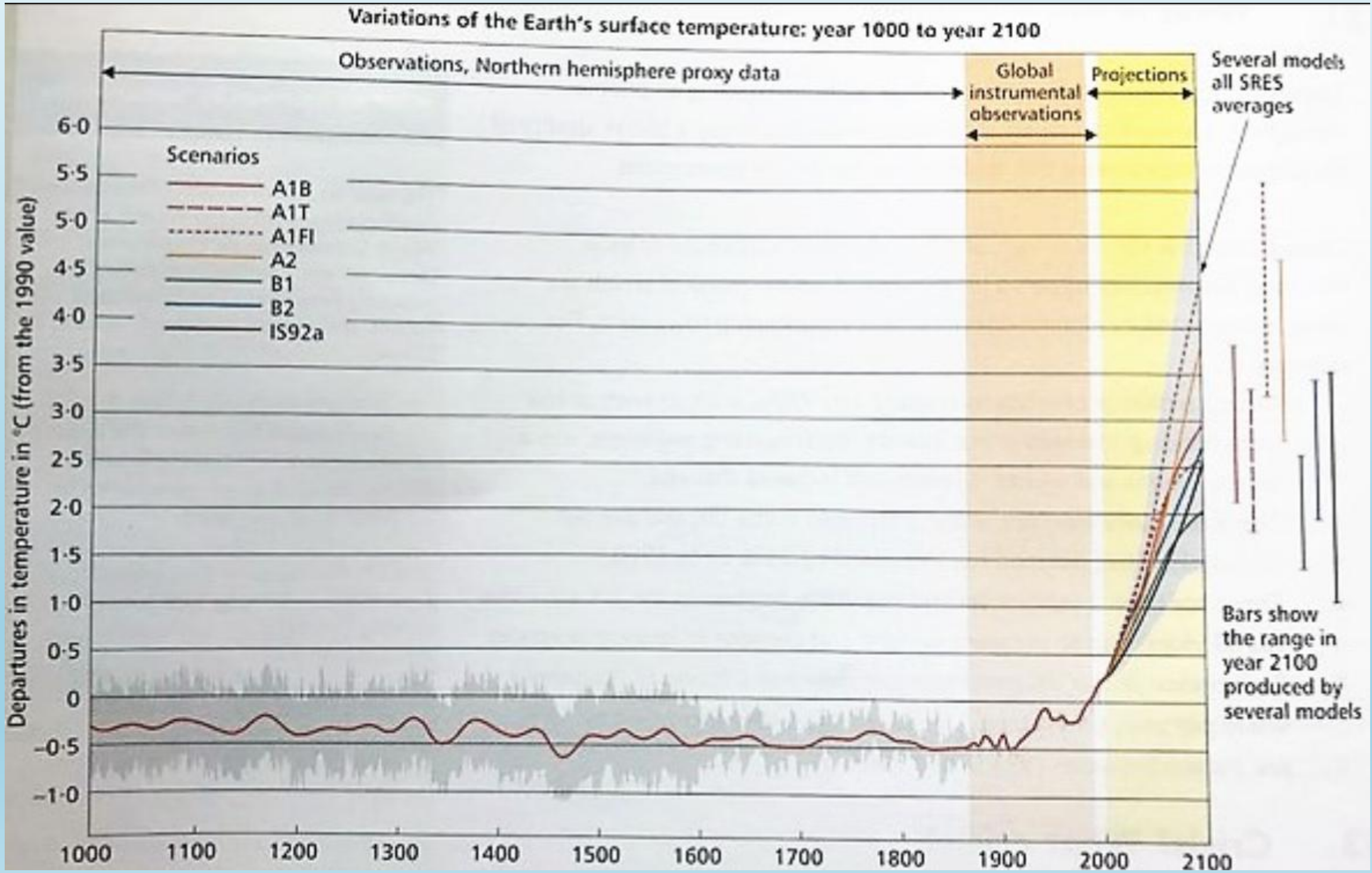
- Sustainable development is about enabling all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life for future generations.
- It is important to consider sustainability within the design of Building Services.

Climate Change

- Current climate models show that, if we take no action to reduce carbon dioxide emissions, then there is the risk of serious, irreversible climate change.
- The IPCC (The Intergovernmental Panel on Climate Change) report states that:

'….warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures widespread melting snow and ice, and rising global mean sea level.'

Variations of the Earth's Surface Temperature: year 1000 to 2100



Sustainable Building Services Design

- Energy and CO2: Reduce predicted CO2 emissions by applying energy efficient design principles and utilising low and zero carbon technologies.
- Water: Reduce predicated water use by integrating water efficient plant, appliances and fittings.
- Others: Waste, transport, adapting to climate change, flood risk, materials and equipment, pollution, ecology and biodiversity, health and wellbeing and social issues.

Sustainable Building Services Design

- Virtually every aspect of a building's design, construction and services has an effect on it's energy consumption.
- In order to reduce the energy consumption to a minimum, whilst maintaining comfort, we must first identify the role these design aspects play in energy performance.
- This knowledge will then indicate the methods we can use to restrict energy use.
- This can be by careful design, adoption of new or improved technologies and materials or utilisation of traditional architectural techniques.

Sustainable Building Services Design

- Siting and climate
- Form of the building (internal and external)
- Building fabric
- Building ventilation
- Natural daylight
- Artificial lighting
- Passive solar heating
- Heating systems
- Cooling
- Post Occupancy Energy Management

Siting and climate

- Energy is used to create a comfortable internal environment when the external environment is too severe for comfort.
- It follows that the more severe the external climate the more energy is used.
- Landscaping can be used to create a less severe microclimate in which to place a building i.e. considerations to microclimate differences across New Zealand in your design.

Form of the building

- The form of the building dictates the size of the surface area and volume.
- These two factors in turn are directly proportional to the fabric and ventilation heat loss rates respectively.
- Form also dictates the ability with which natural energy can be collected such as solar heat, light and natural ventilation.

Building fabric

- The heat transfer characteristics of the external envolpe determine fabric heat loss rates.
- Low density materials, insulators, can be used to slow the passage of heat.
- Dense, thermally massive materials can be used internally to help cool a building in summer.

Building ventilation

- Uncontrolled infiltration involves cold air entering a building and warm air being lost from it.
- The motors in mechanical ventilation systems consume electricity.
- Infiltration should be minimized and mechanical systems should operate efficiently and only as necessary.

Natural daylight

- Natural light can be used to displace the use of artificial light created by electricity.
- The glazed openings of a building have the strongest influence on natural light utilisation.

Artificial lighting

- Artificial lighting consumes electricity and so should be produced efficiently and only used as required.

Passive solar heating

- Passive solar heating can be used to displace the use of mechanical heating.
- This requires well thought out controls that allow full advantage to be made of natural energy flows.

Heating systems

- Mechanical heating systems consume fossil fuels to create heat and so should be operated efficiently and only as required.

Cooling

- Mechanical cooling systems consume electricity.
- To avoid this means of cooling, passive methods such as shading and exposing mass with night time ventilation should be used as a first option.
- Where passive cooling is inadequate efficient mechanical systems should be chosen and operated only as required.

General services

- Lifts, escalators, emergency lighting and other systems consume electricity and so efficient systems should be chosen.

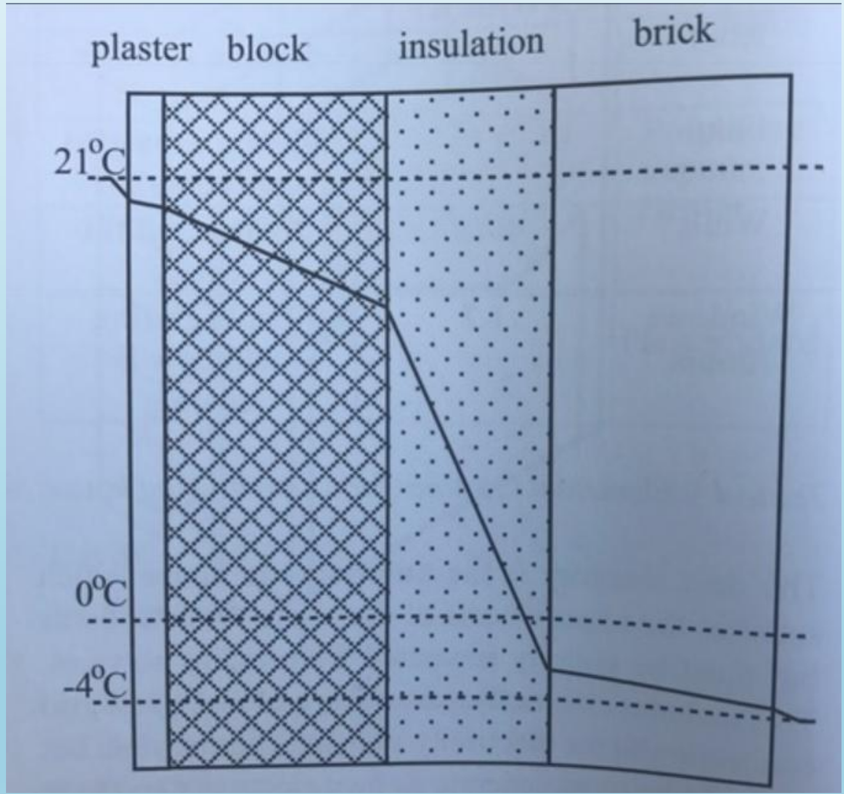
Post occupancy energy management

- Loss of adjustment in controls or faults can cause energy consuming equipment to operate inefficiently.
- Building energy consumption can increase if it is not monitored and managed to remain on target.

Form of the building

- The form of the building dictates the size of the surface area and volume.
- These two factors in turn are directly proportional to the fabric and ventilation heat loss rates respectively.
- Form also dictates the ability with which natural energy can be collected such as solar heat, light and natural ventilation.

Heat transfer and heat loss



Temperature profile through a highly insulated wall

Fabric Heat Loss Equation

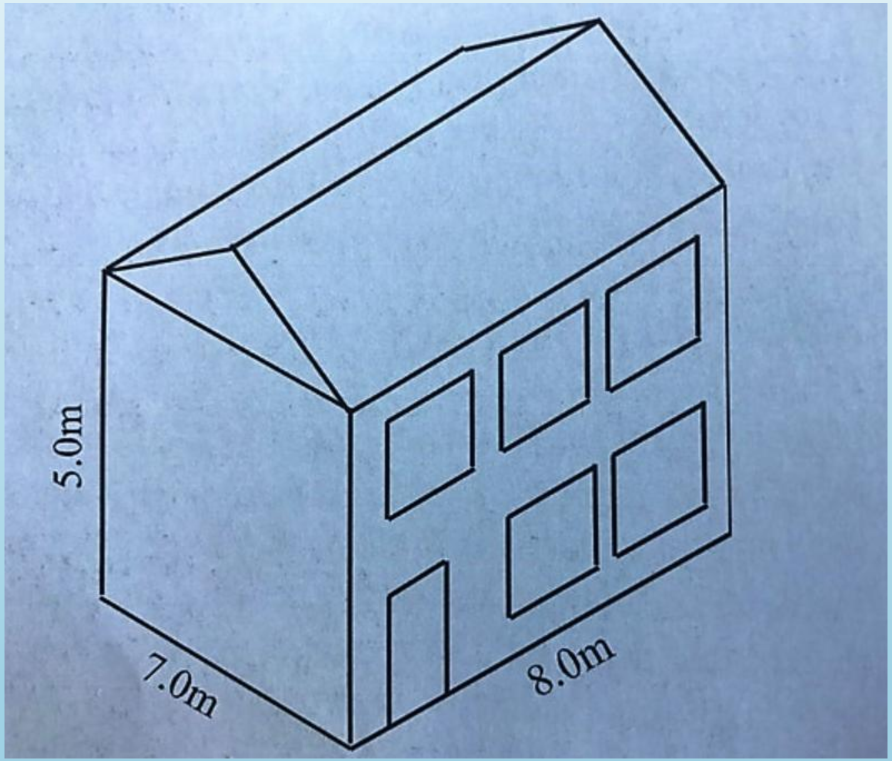
- U_x is the thermal transmittance of element x, also known as the U value, measured in W/m^2K. ($1^oC = 273K$)
- This is the heat loss rate in watts through $1m^2$ of the element with 1K temperature difference across its faces.

- Q = U x A x DT
- Q = Heat loss rate (w)
- U = thermal transmittance
- A = area of element (m2)
- DT = temperature difference between inside and outside air temperatures

Example calculation

- To determine the heat loss rate through the entire element we must multiply the U-value by the area of the element and the actual temperature difference across its faces.
- Formula is Q = U x A x DT

Example calculation: Fabric Heat Loss

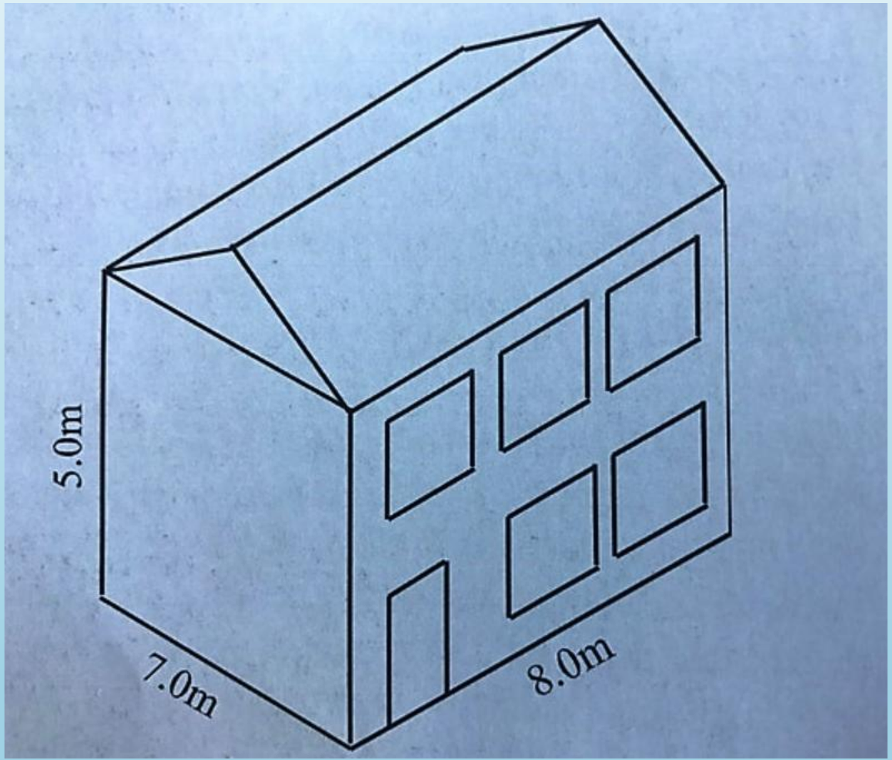


Element	Area (m^2)	U value (W/m^2K)
Floor	?	0.25
Roof	56	0.16
Walls	?	0.35
Window/door	35	2.00

Element	U	A	DT (21°C)	Q
Walls			21	
Floor			21	
Roof			21	
Windows/ door			21	

What is the total heat loss rate in watts = ?

Answers

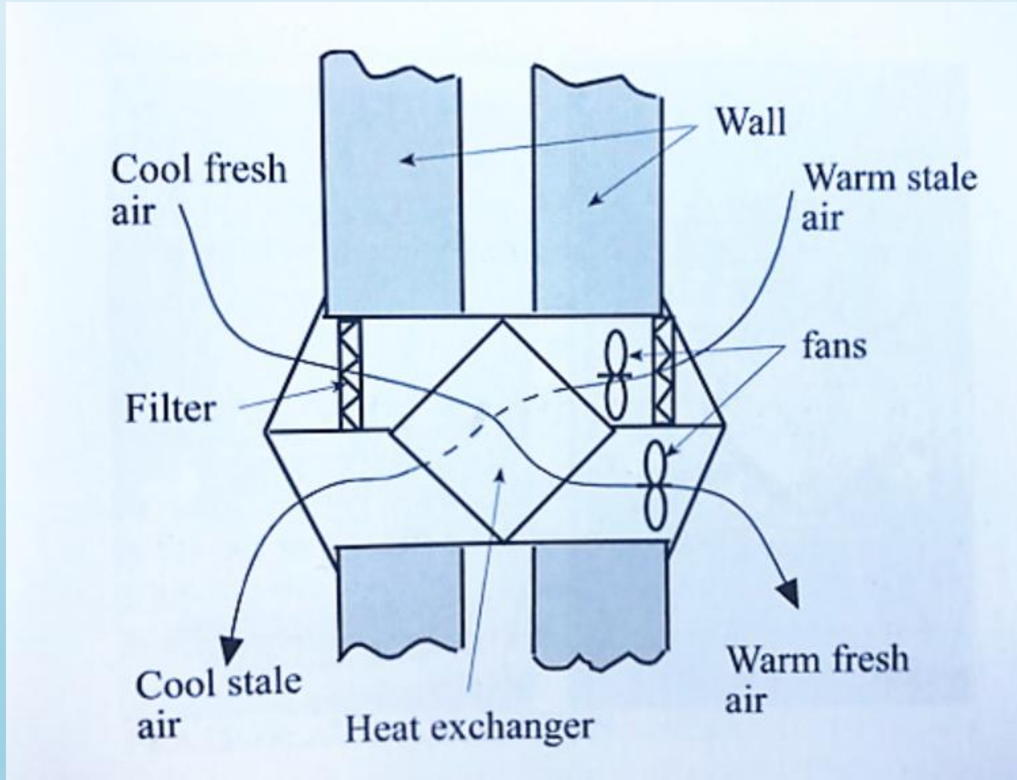


Element	Area (m^2)	U value (W/m^2K)
Floor	56	0.25
Roof	56	0.16
Walls	115	0.35
Window/door	35	2.00

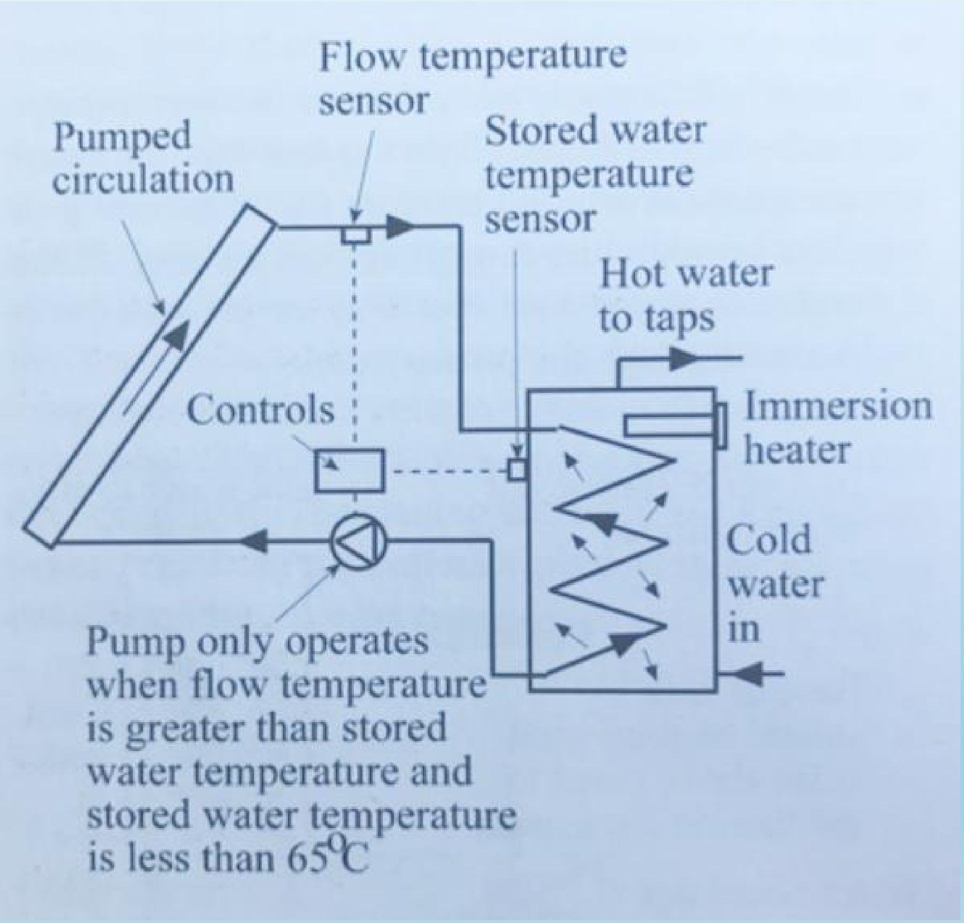
Element	U	A	DT (21°C)	Q
Walls	0.35	115	21	845.3
Floor	0.25	56	21	294.0
Roof	0.16	56	21	30.0
Windows/ door	2.00	35.0	21	1470.0

What is the total heat loss rate in watts = 2639.3 w

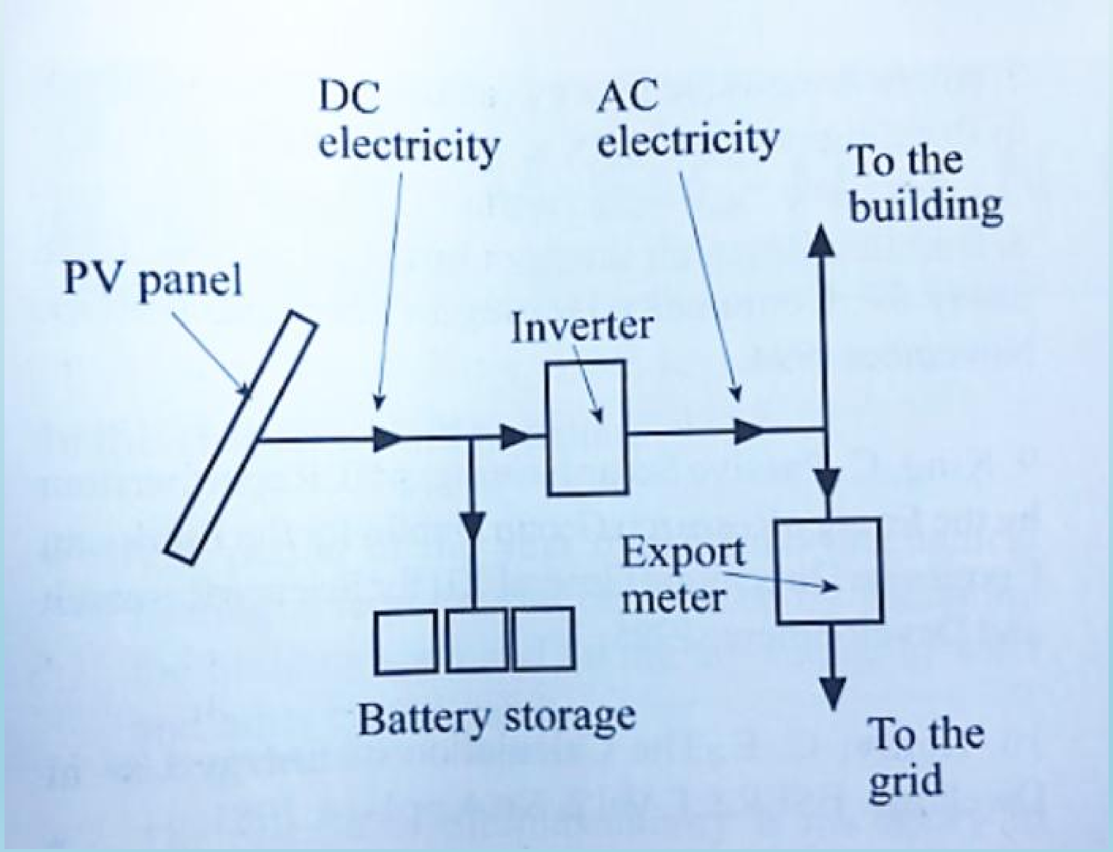
Heat recovery



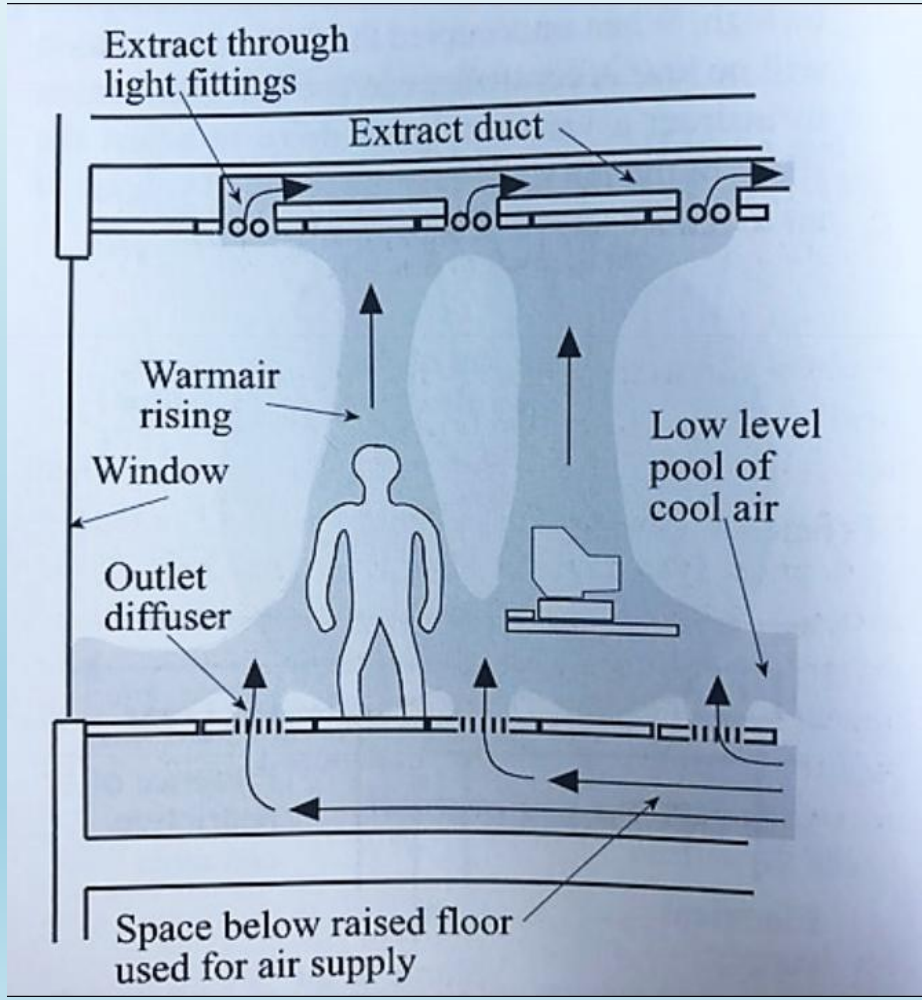
Solar collectors



Photovoltaics (PV)

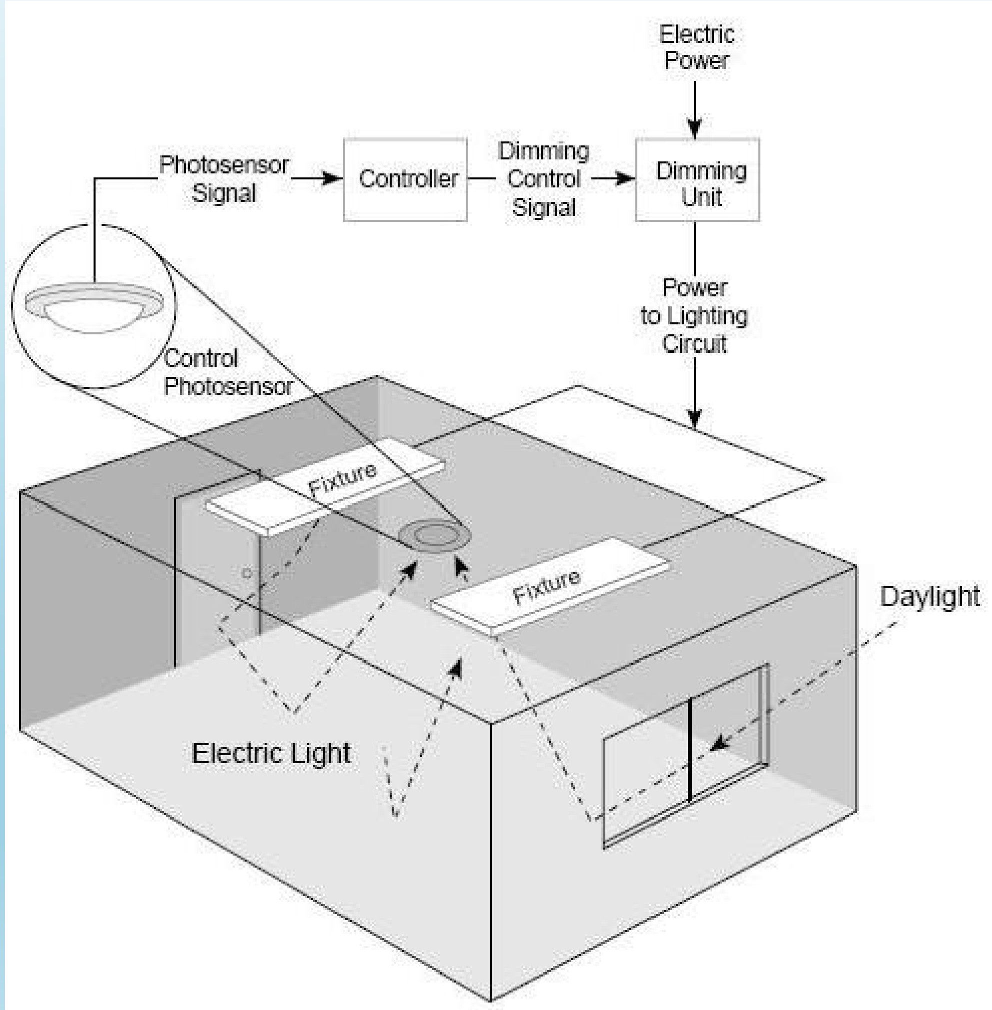


Buoyancy



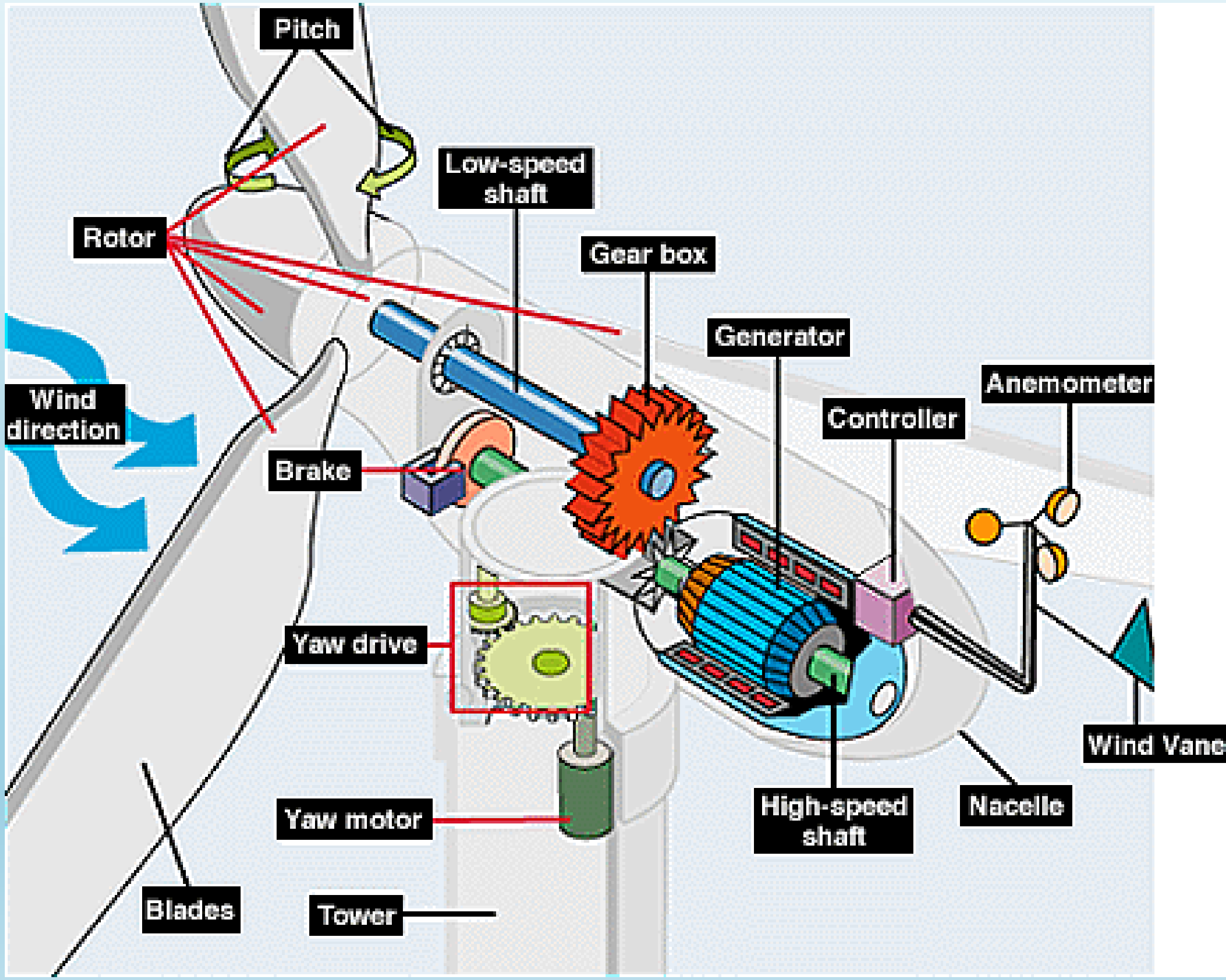
Extract through
light fittings
Extract duct
Warmair
rising
Window
Low level
pool of
cool air
Outlet
diffuser
Space below raised floor
used for air supply

Daylight harvesting

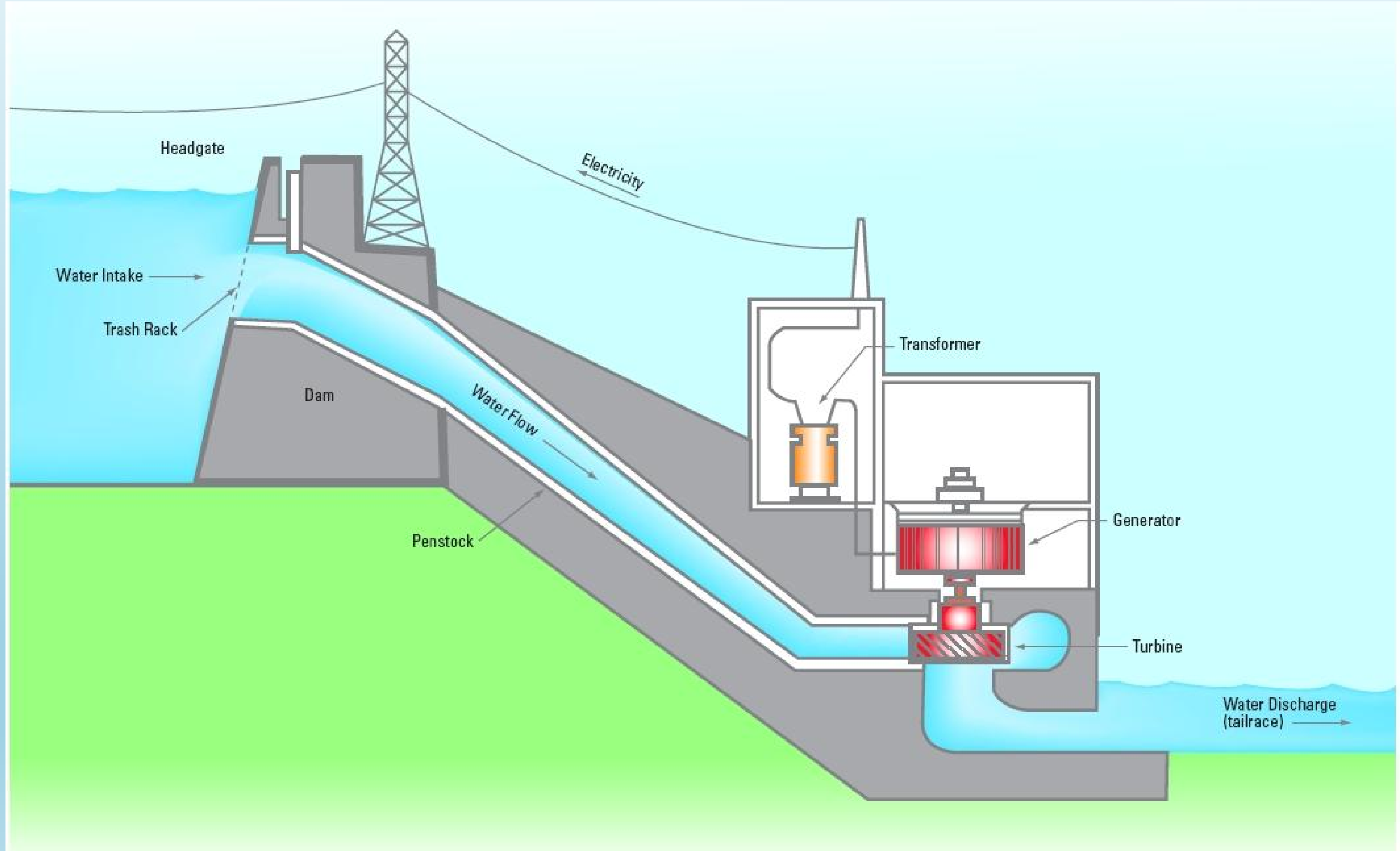


Rainwater harvesting

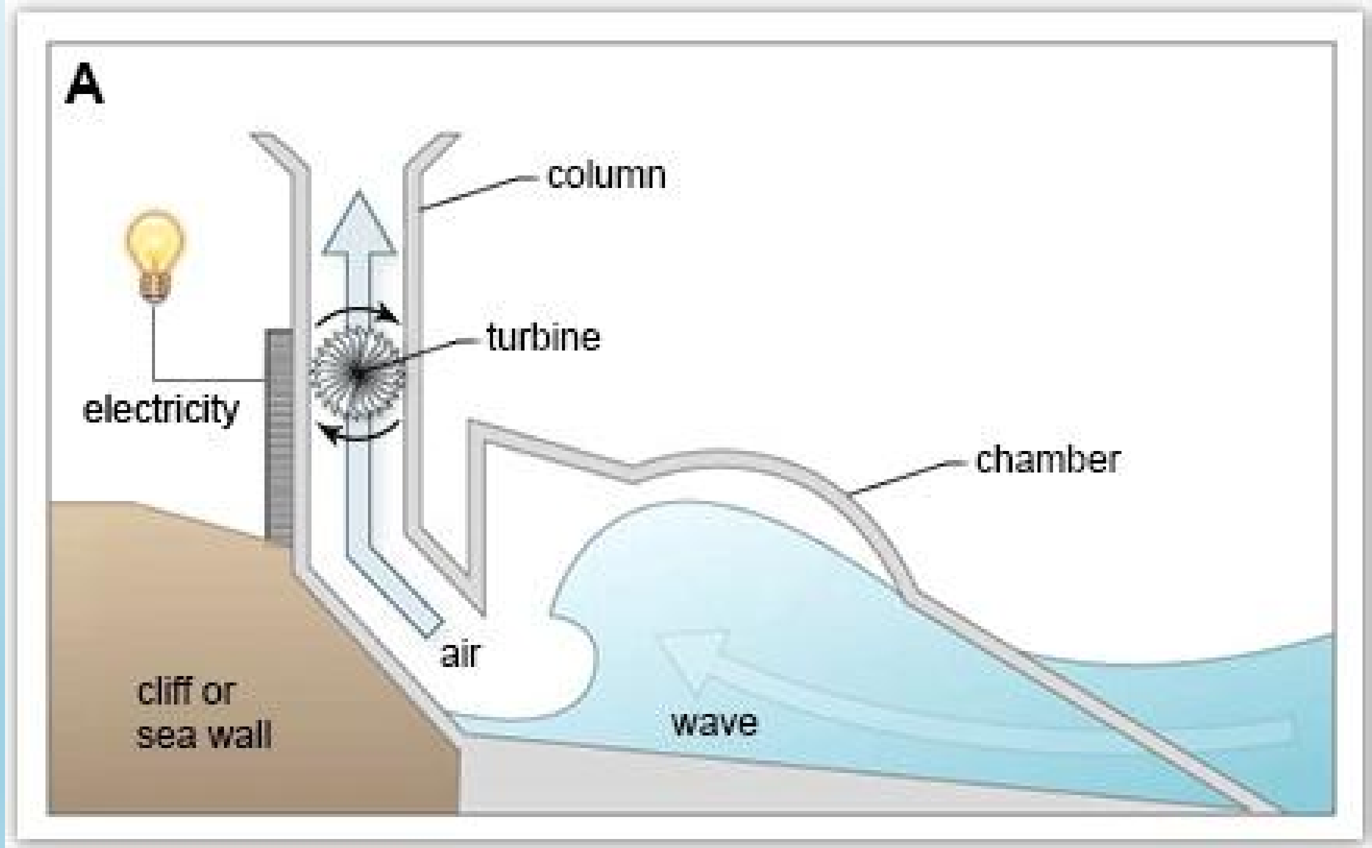
Wind Turbines



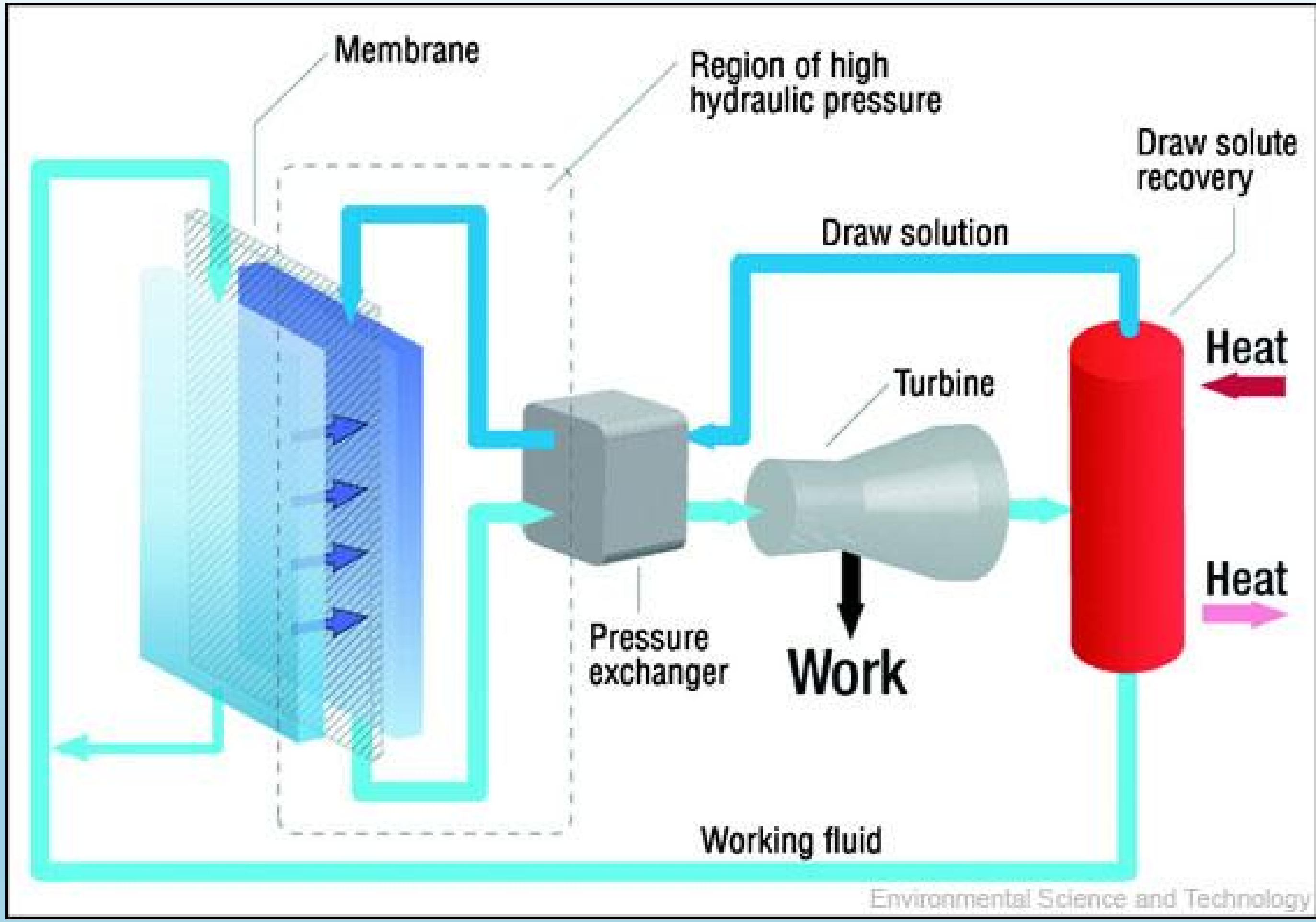
Hydro Electric Power



Wave Power


A
column
turbine
electricity
chamber
air
cliff or
sea wall
wave

Osmotic Power



https://www.youtube.com/watch?v=mHoBYt3n-vA

Thank You