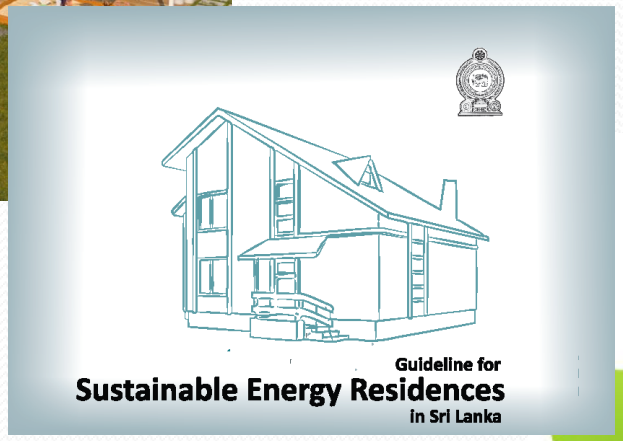
Guideline for Sustainable Energy Residences in Sri Lanka



Contents

1. Sustainable Design - Climate and Thermal Comfort

1.1 Climate of Sri Lanka

- Classification

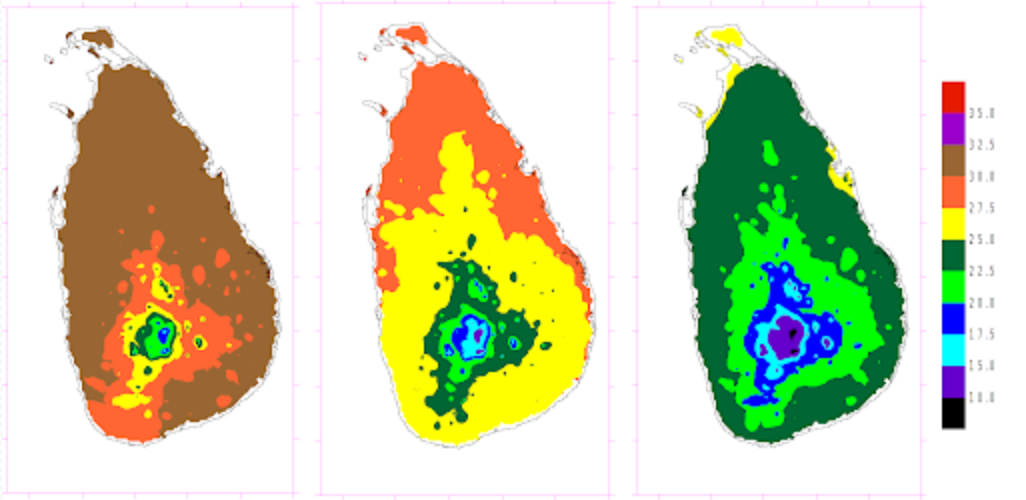
  Location - 5°55' to 9° 51' North latitude and between 79°42' to 81°53' East longitude

  TROPICAL climate

- Topography
  - Central part - Mountainous, remainder - flat except for several small hills
- Rainfall
  - mean annual rainfall varies from under 900mm in the driest parts (South-Eastern and North-Western) to over 5000mm in the wettest parts (Western slopes of the central highlands)
- Temperature
  - mean annual temperature varies from 27°C in the coastal lowlands to 16°C at Nuwara Eliya, in the central highlands

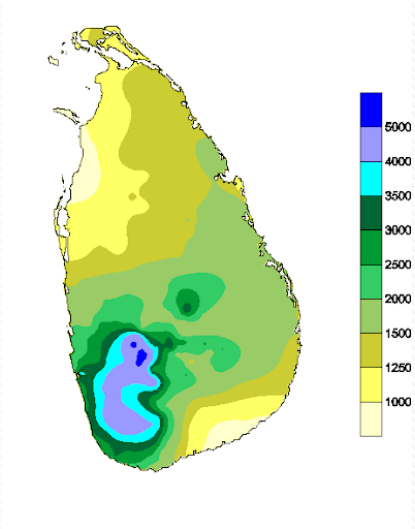
Average Annual Temperature and Rainfall

Average Annual Temperature (°C)



Maximum Average Minimum

Average Annual Rainfall (millimeter)



Thermal Comfort

- Thermal comfort is generally defined as that state of mind which expresses satisfaction with the thermal environment (ANSI/ASHRAE Standard 55-2013)

- Measured by considering following comfort variables
  - Air temperature
  - Mean radiant temperature (depends on the surface temperature)
  - Air velocity
  - Relative humidity
  - Activity levels
  - Thermal resistance of clothing

Passive design

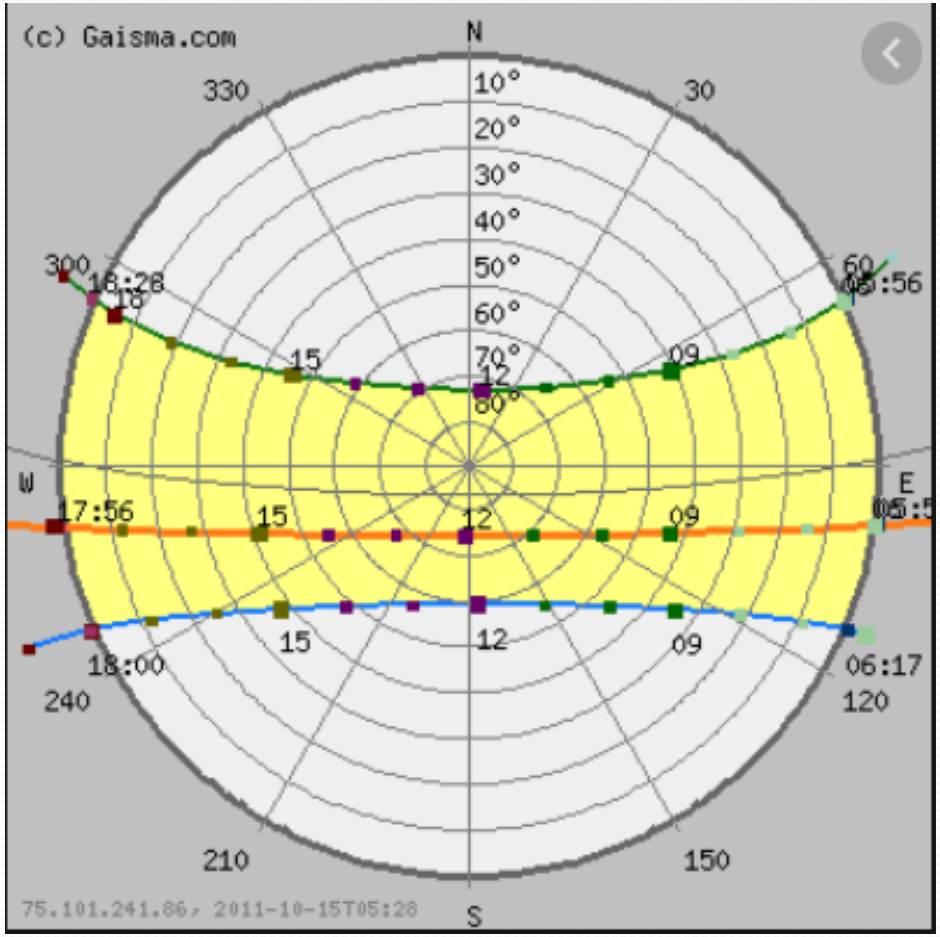
- Way of improving indoor thermal comfort, without using an active system such as electric fans, air conditioners thereby reducing the overall energy usage.

Passive design strategies

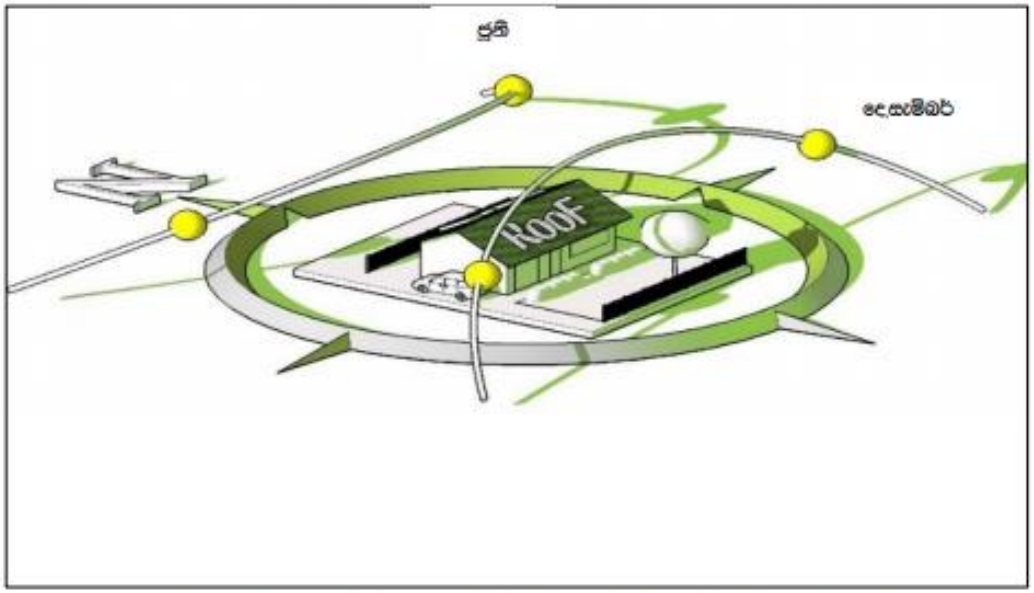
Strategy 1	Strategy 2
Start at the neighbourhood ❑ Sun and building orientation ❑ Laying out of streets/building Plots	**Shading** ❑ Shading by external features ❑ Shading by building features
Strategy 3	**Strategy 4**
Ventilation ❑ Wind directions and building siting ❑ Building shell and openings	**Material selection** ❑ Thermal mass ❑ Insulation ❑ Colour of surfaces

Strategy 1
Start at the neighbourhood

- Understanding the sun path diagram



- Building Orientation- long axis in east west direction



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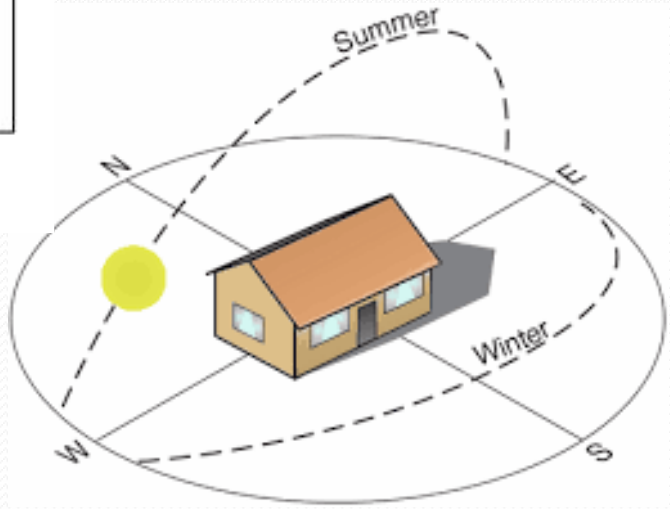
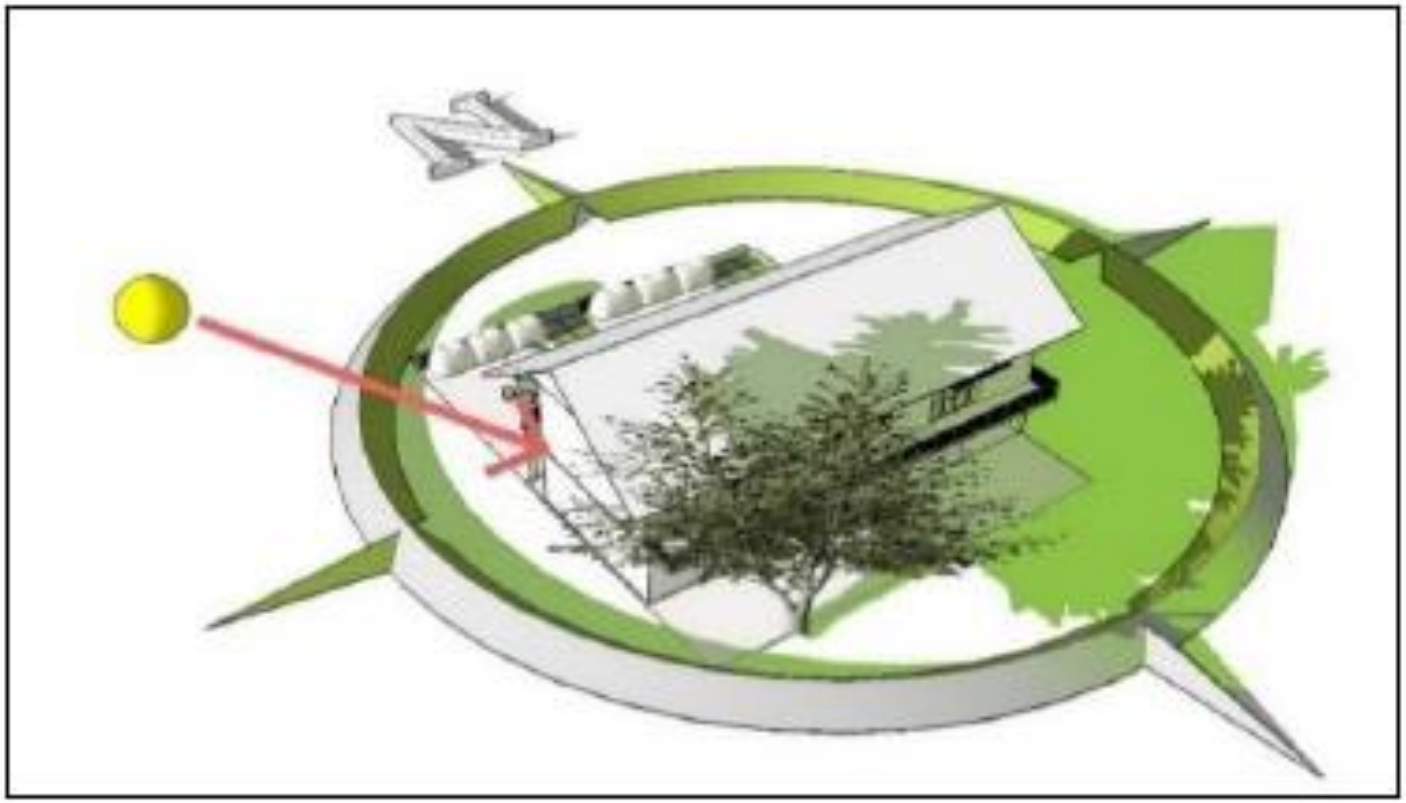


Strategy 2
Shading

- Shading by external features
  - Use neighbourhood land forms, structures and vegetation

Shading by external features

- Use ground cover and planting to cool



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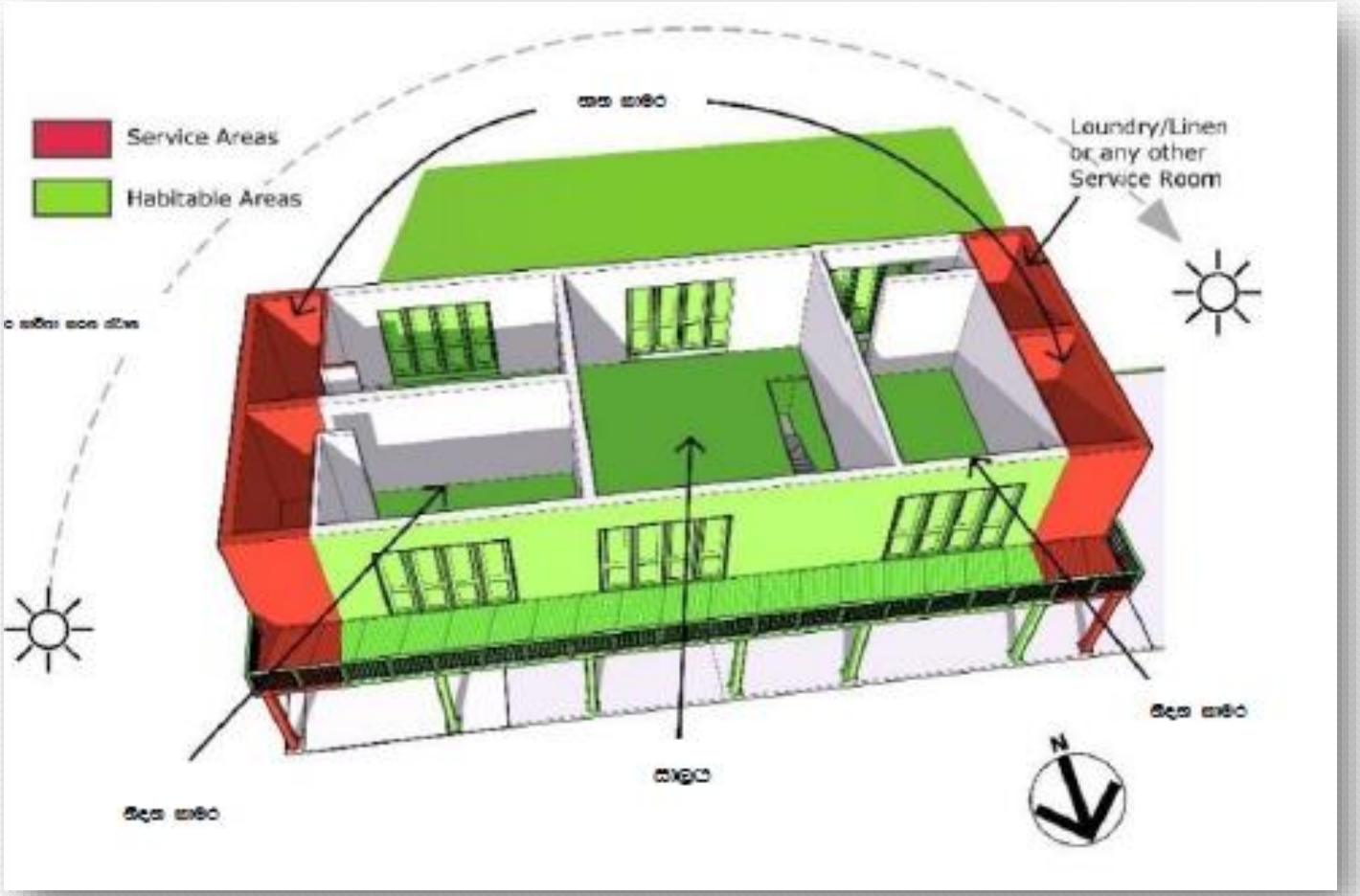
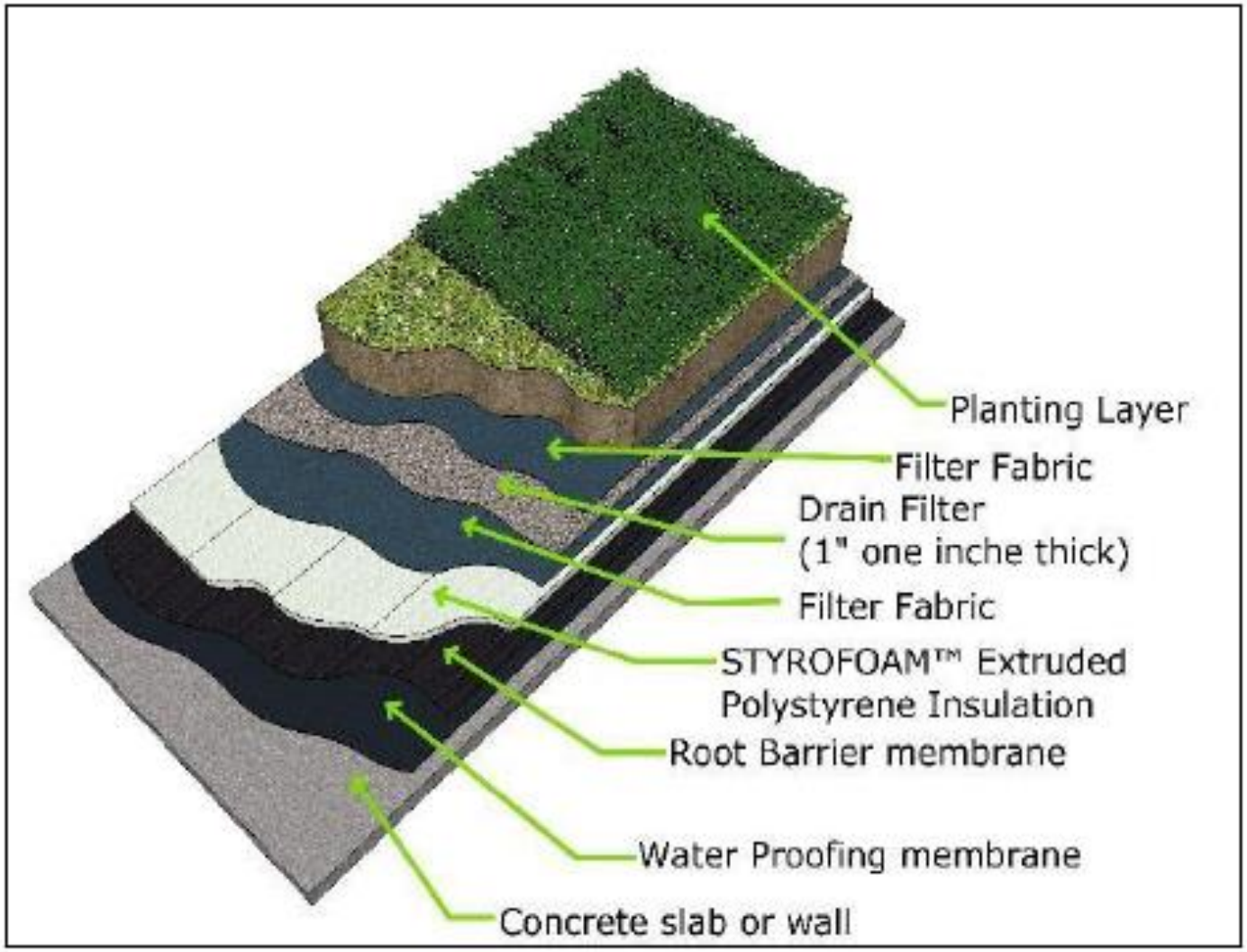
Shading by internal features

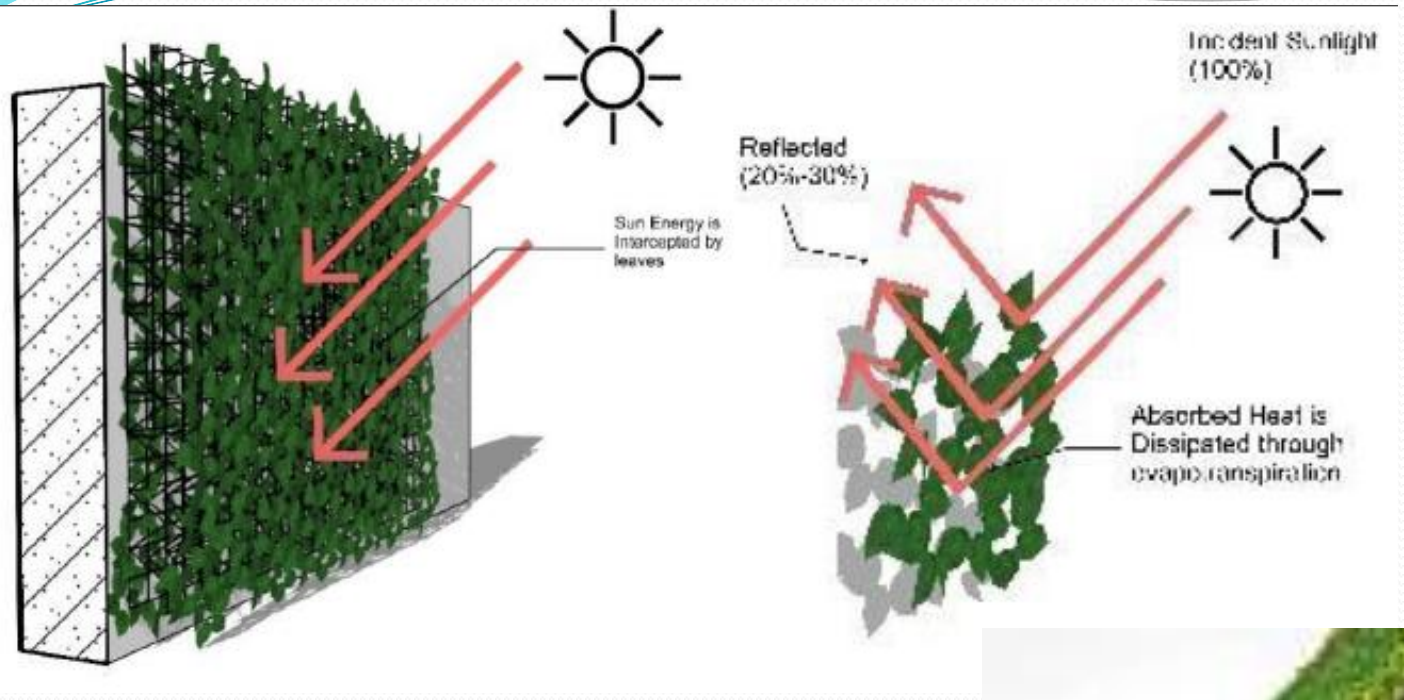
- Zone the house and avoid direct heat gain to habitable spaces



Shading by internal features

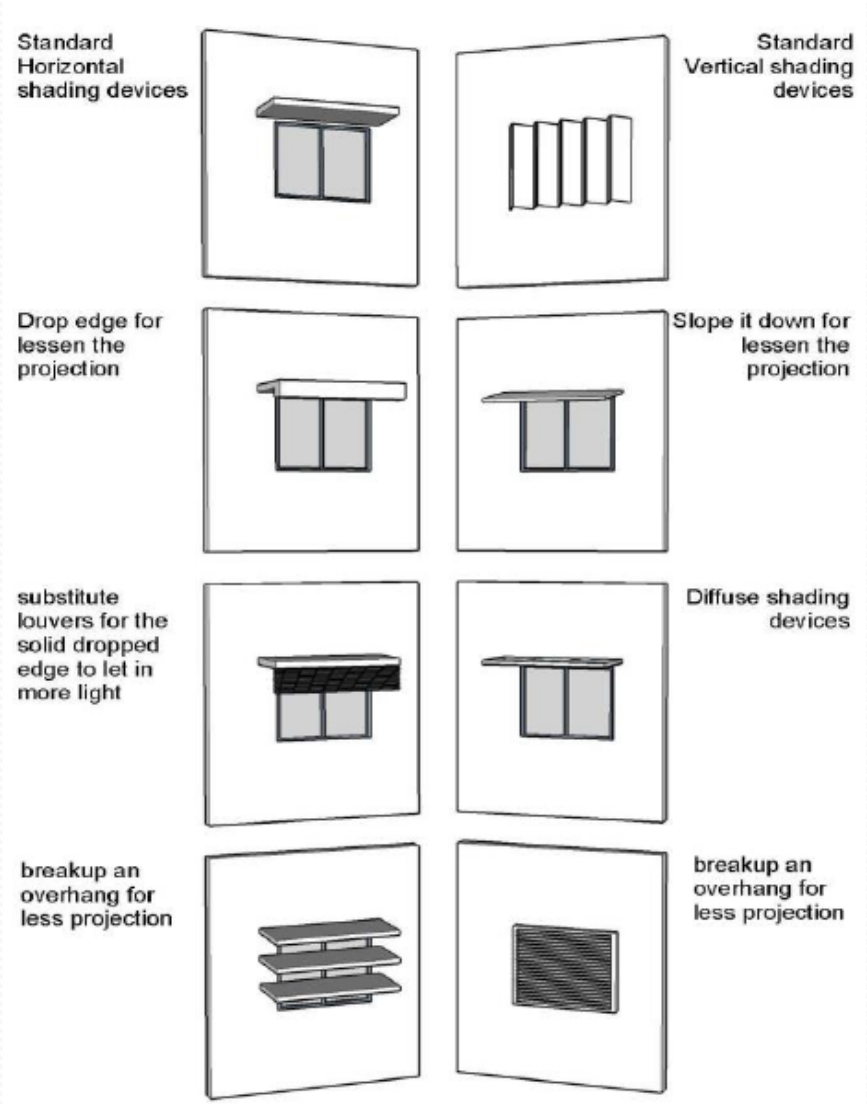
- Use green facades and green roofs

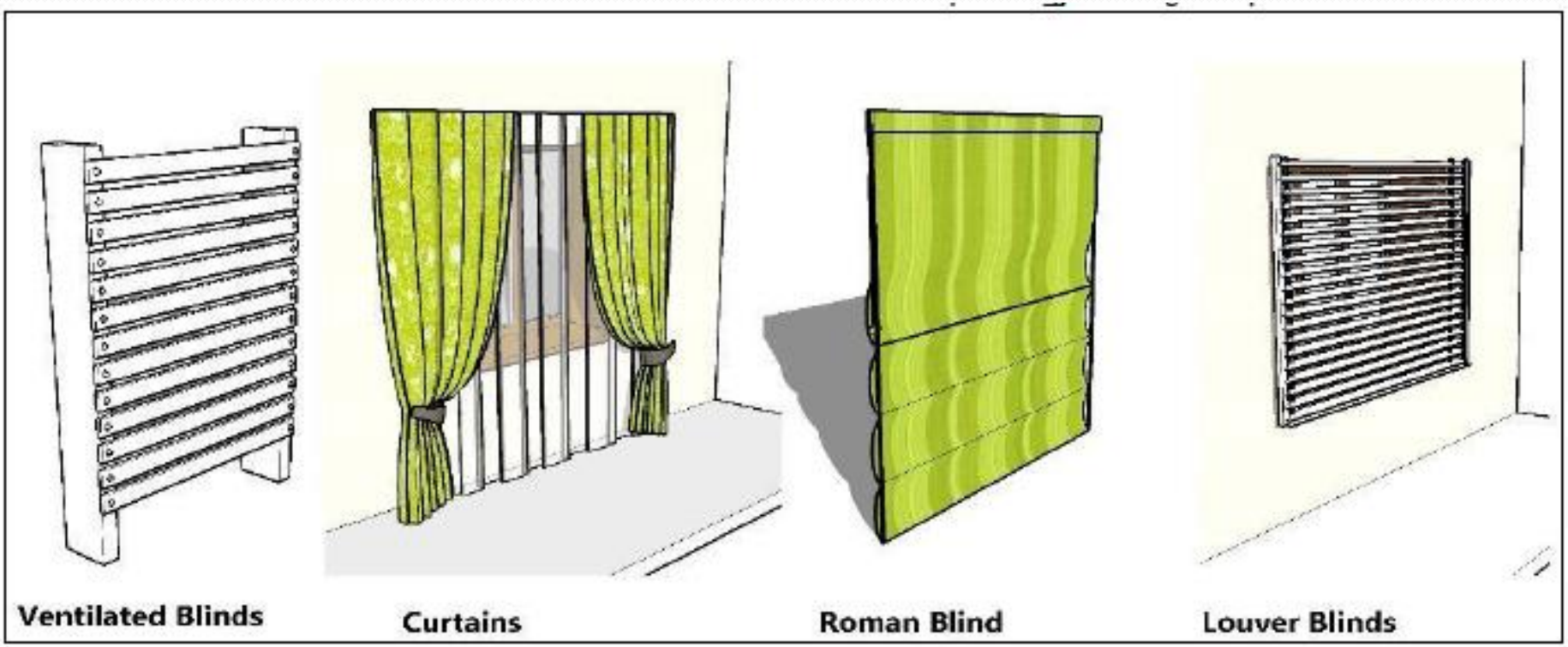



Incident Sunlight
(100%)
Reflected
(20%-30%)
Sun Energy is
Intercepted by
leaves
Absorbed Heat is
Dissipated through
evapotranspiration

Shading by internal features

- Provide shading for glazing exposed to sun




Ventilated Blinds
Curtains
Roman Blind
Louver Blinds

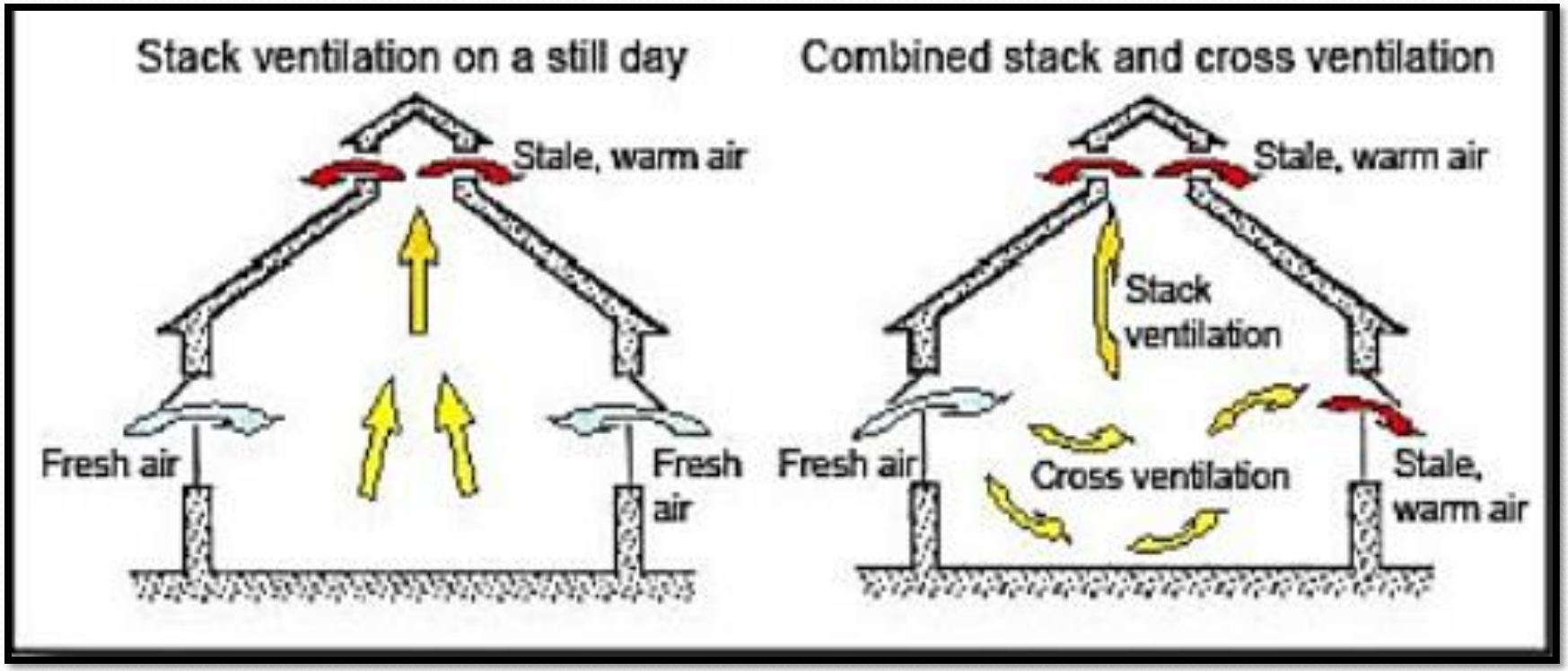
Strategy 3
Ventilation

- Main Wind Directions and Building Siting

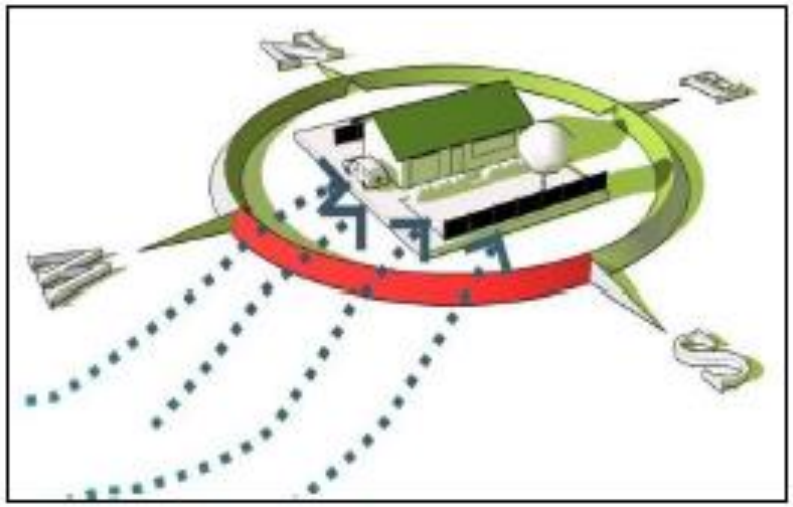
Two main wind patterns : From North East (December to February)
From South West (May to September)

- Types of Ventilation
  - Cross ventilation (Pressure Difference)
  - Ventilation using stack effect (Temperature Difference)

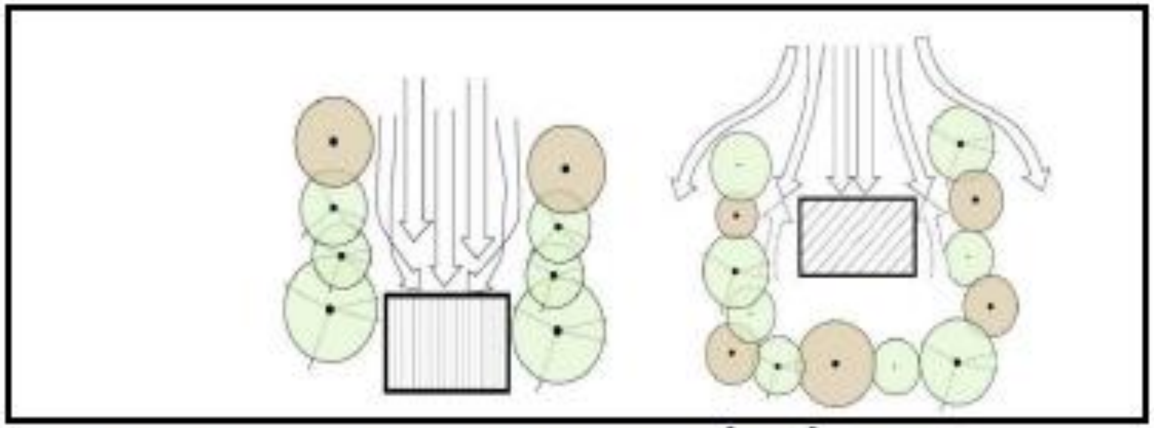
Cross Ventilation and Stack Effect



- Orient the building to catch maximum wind



- Use neighbourhood land forms, structures and vegetation to increase exposure to wind



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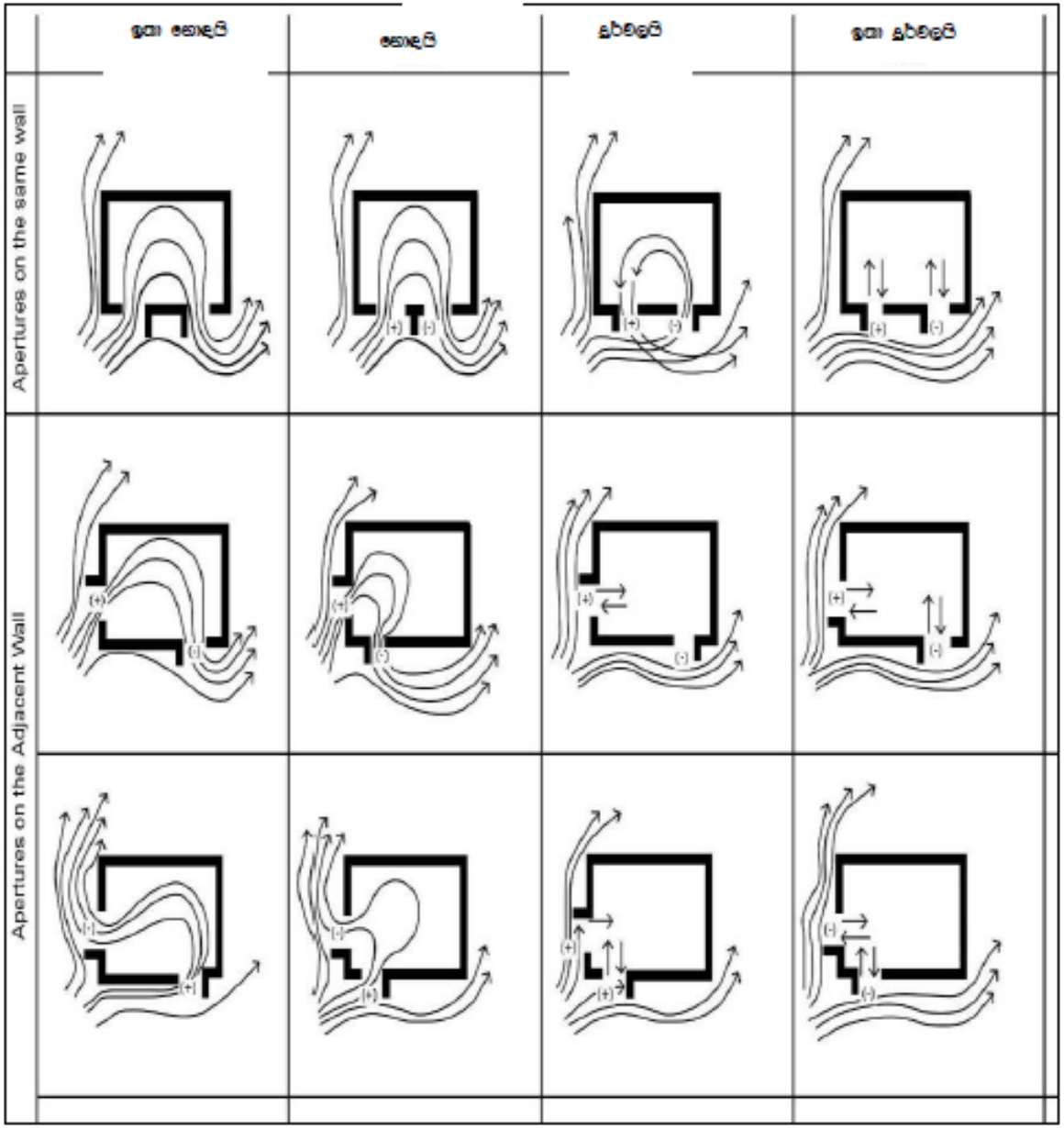
Building Shell and Openings

- Shape and orient building shell and openings to catch maximum wind



- Use open plan interior to promote air flow

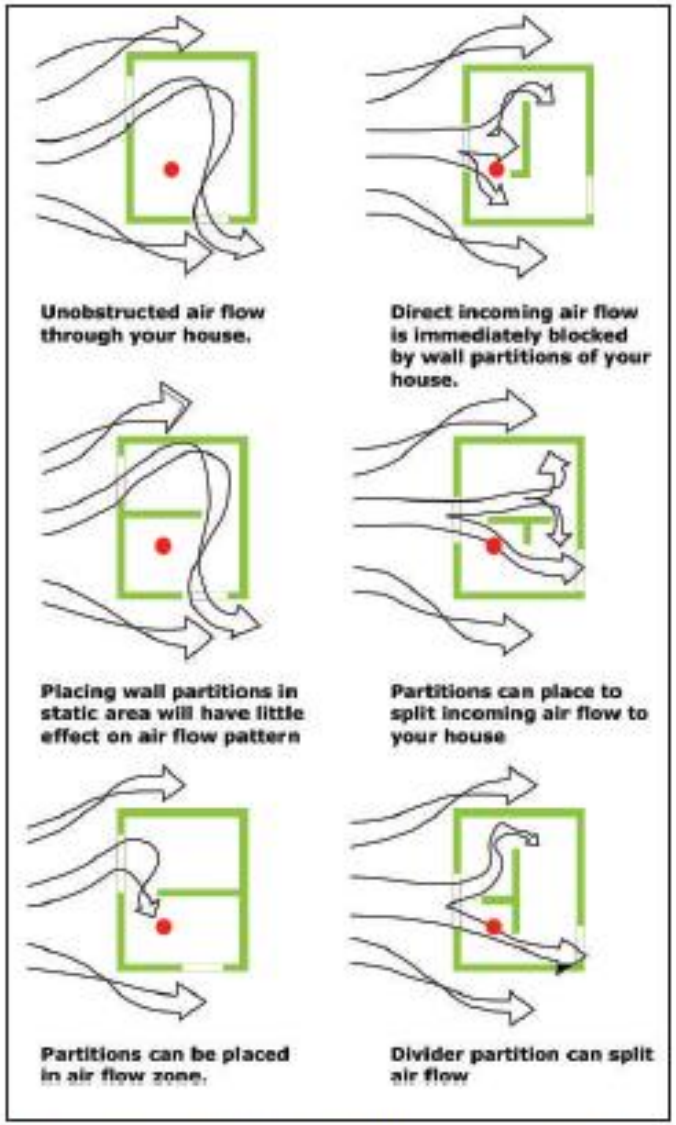
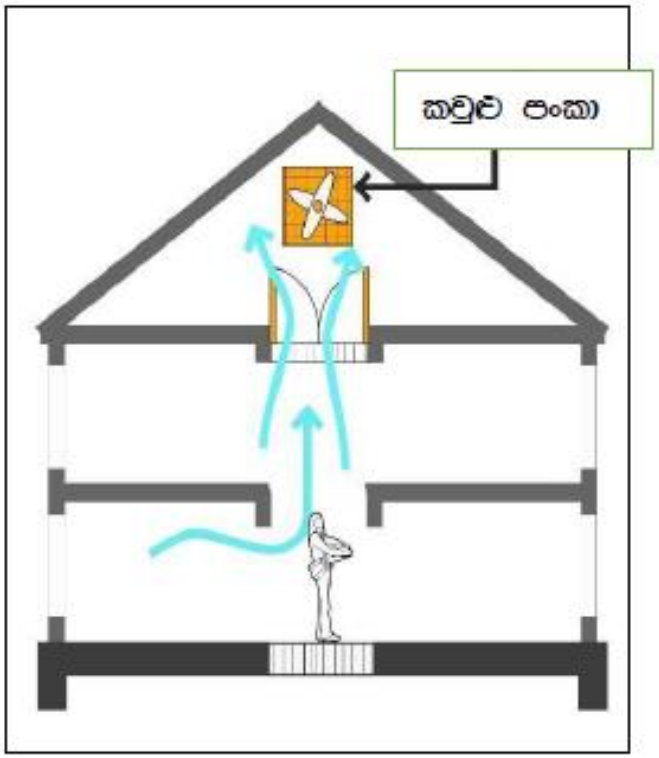


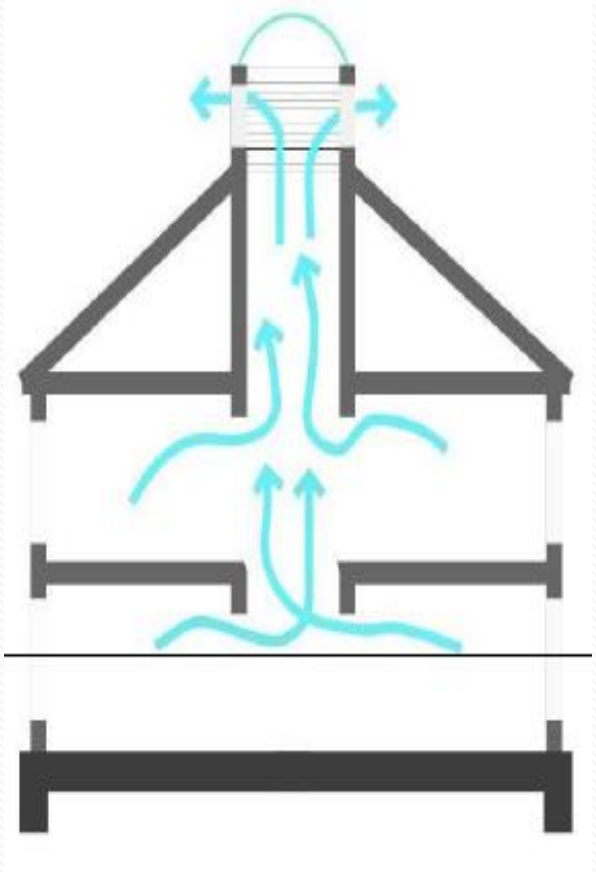
Fig | 27: Use Open Plan Interior to Promote Air Flow.

Demonstrates the effect of the partition on air flow. The marker denotes the crucial zone where ventilation is most needed.

• Use Vertical air shafts to promote air flow



• Use monitor roofs for stack effect ventilation



Impact of wind direction – simulation models

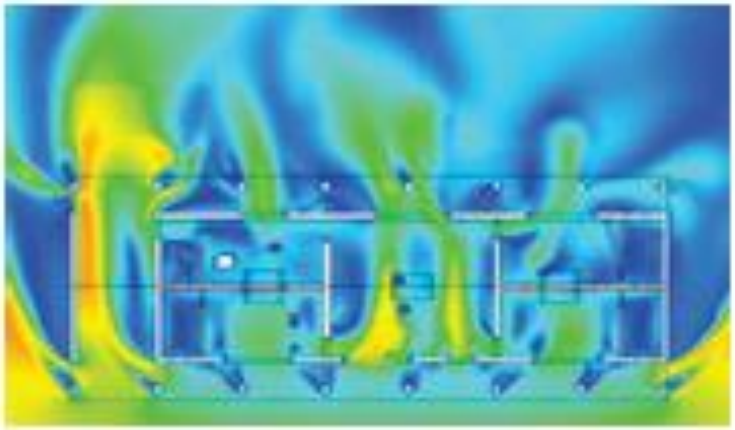


Fig | 31: Plan View of Wind from South - Single Storey House

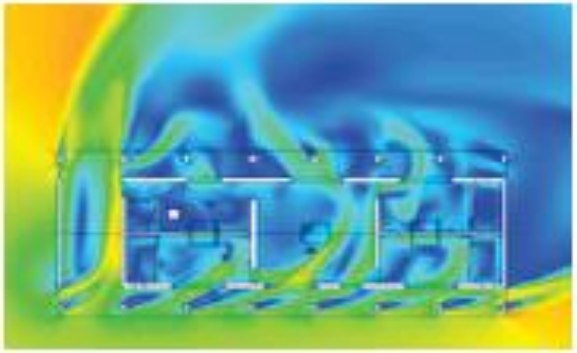


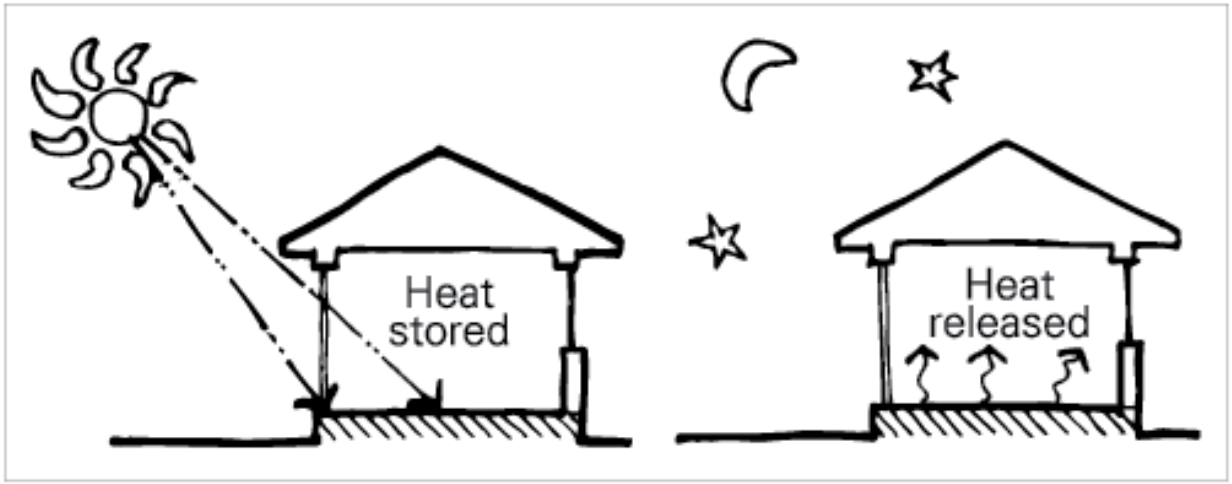
Fig | 32: Plan View of wind from South-West - Single Storey House

Strategy 4

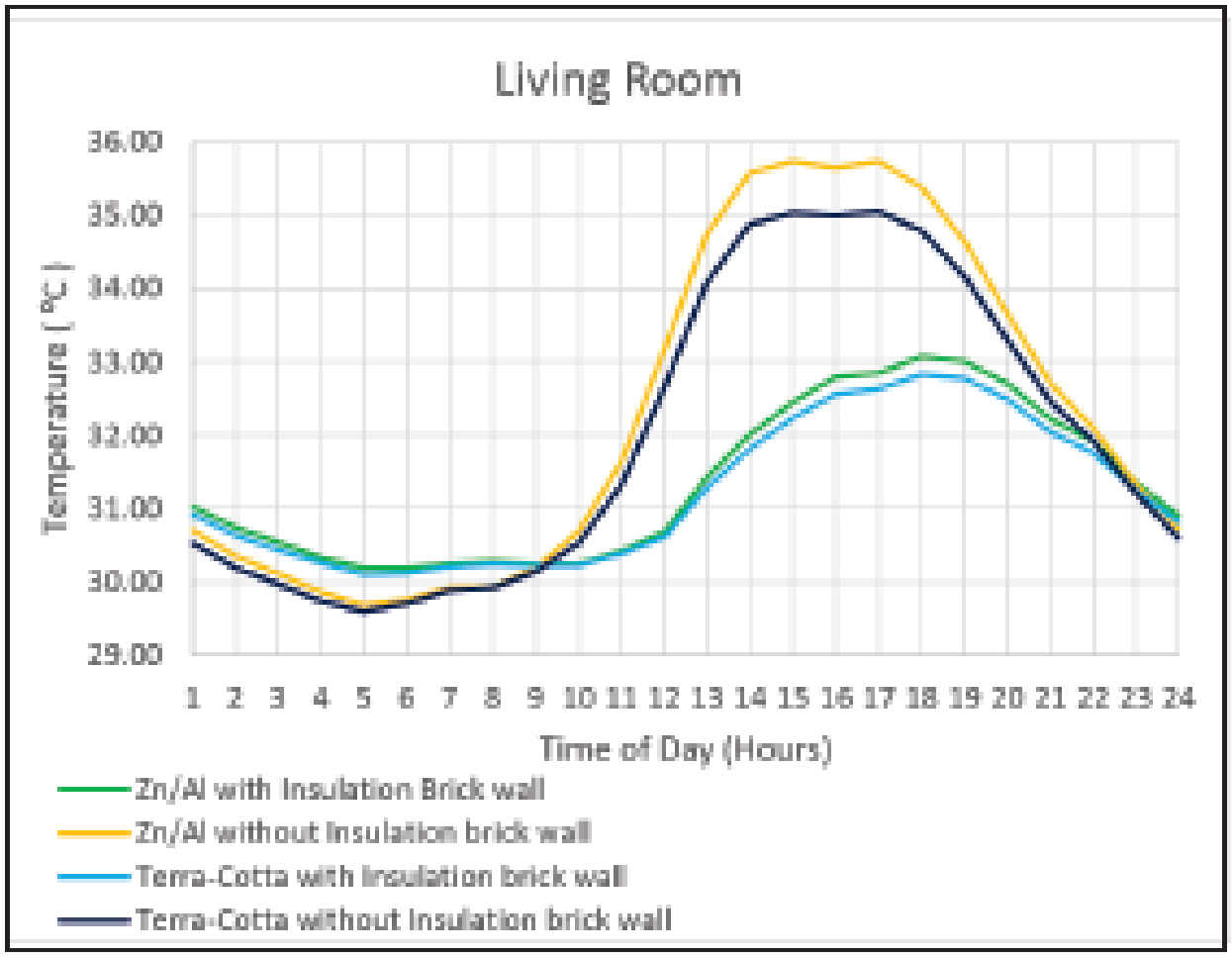
Material Selection

- Use Insulation for roof and walls (reduce overall U value)
- Apply High Reflectance material/paint for walls and roofs (reduce surface temperature)
- Low thermal mass material is better for Sri Lanka, where the day night temperature difference is low
- Use low e-glass (double glazed) or coatings for windows exposed to sun (reduce solar radiation/conduction heat gain)

Thermal mass



Effects of roof insulation



Solar reflectance index of selected material

Material	SRI
Unpainted cement tile	25
Red clay tile	36
Light gravel on build up roof	37
Aluminium coating	50
White coating gravel on built up roof	79
White coating on metal roof	82
White cement tile	90

Thank you