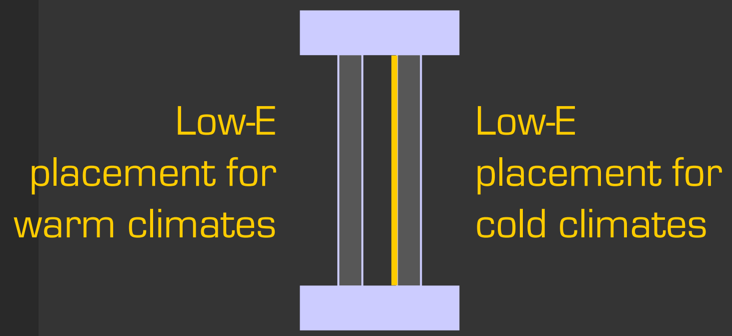
Passive controls

- Passive solar heating
  - Direct gain and control of heat flow
    - control of sunlight penetration
    - good thermal quality of window (thermal insulation, thermal bridges)
    - proper orientation
    - other factors



Passive controls

- Passive solar heating
  - Direct gain and control of heat flow
  - Heat storage wall (transparent insulation)
    - stores heat in wall mass
    - adds to direct gain

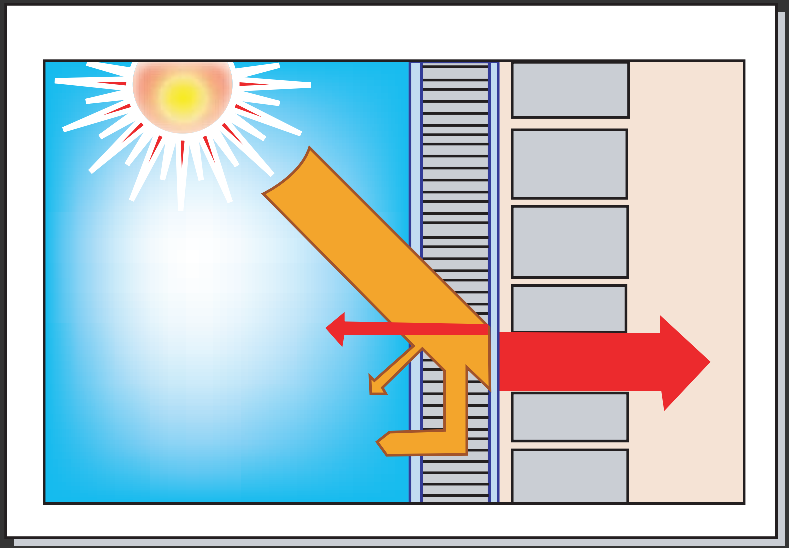
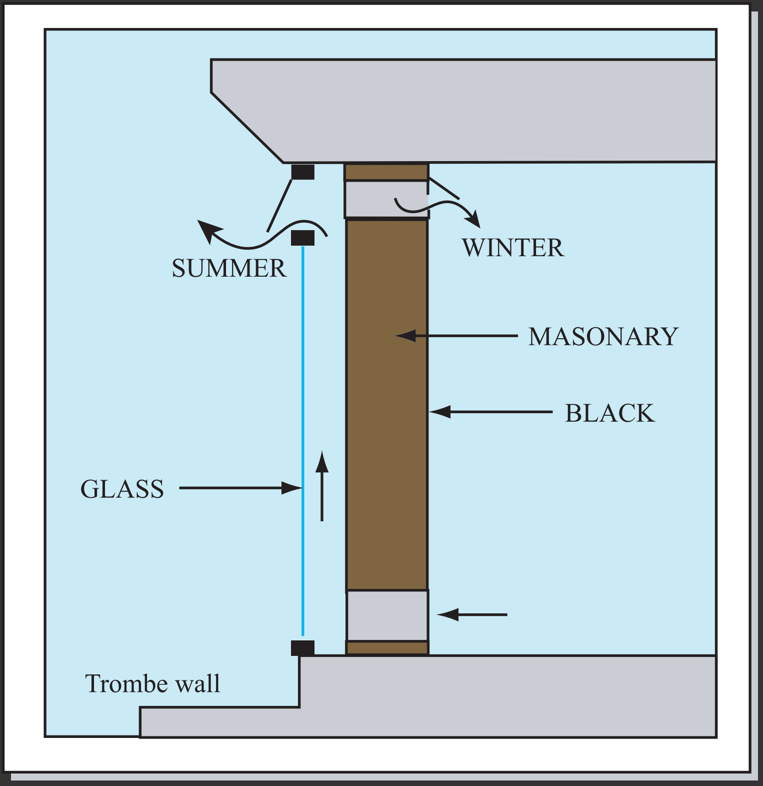


Image by MIT OCW.

Passive controls

Passive solar heating

- Direct gain and control of heat flow
- Heat storage wall
  - stores heat in wall mass
  - adds to direct gain



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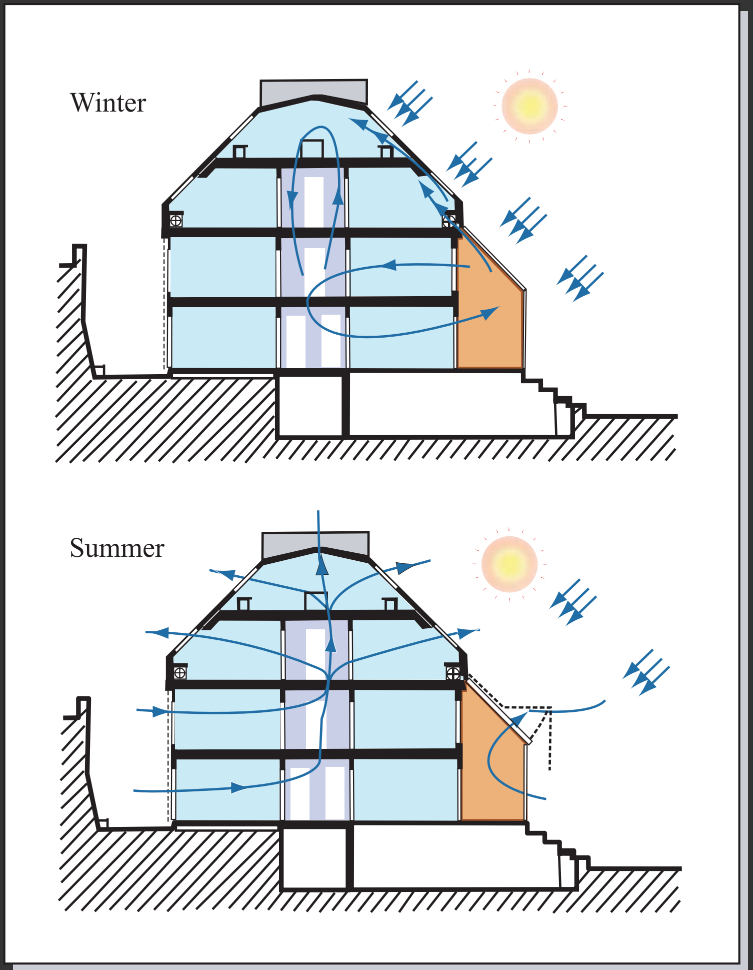
Passive controls

- Passive solar heating
  - Direct gain and control of heat flow
  - Heat storage wall
  - Greenhouse
    - heat collection during the day
    - buffer during the night



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Passive controls

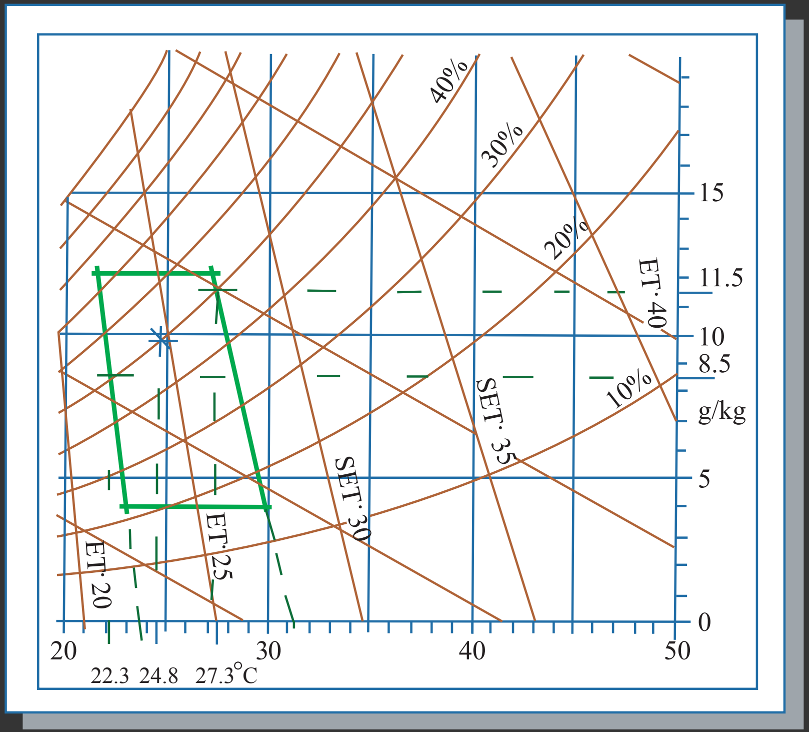
- Passive solar heating
  - Direct gain and control of heat flow
  - Heat storage wall
  - Greenhouse
    - heat collection during the day
    - buffer during the night
    - design constraints
    - draw-backs

Passive controls

- Passive solar heating
  - Control Potential Zone
    - limit temperature(s) achievable with passive control:

$D_v \times A \times \eta = q \times (T_i - T_o)$

    - report on psychrometric chart and determine CPZ



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Passive controls

- Passive solar heating
- Thermal mass

Passive controls

- Jacobs House II in Wisconsin (Frank Lloyd Wright)

Photographs and floor plans removed due to copyright restrictions.

Passive controls

- Theuer House in Phoenix AZ (William Bruder)

Photograph and floor plan removed due to copyright restrictions.

Passive controls

- Passive solar heating
- Thermal mass
  - mass distribution
  - continuous occupation
  - cold or hot-dry climates
  - specific mass
  - night ventilation

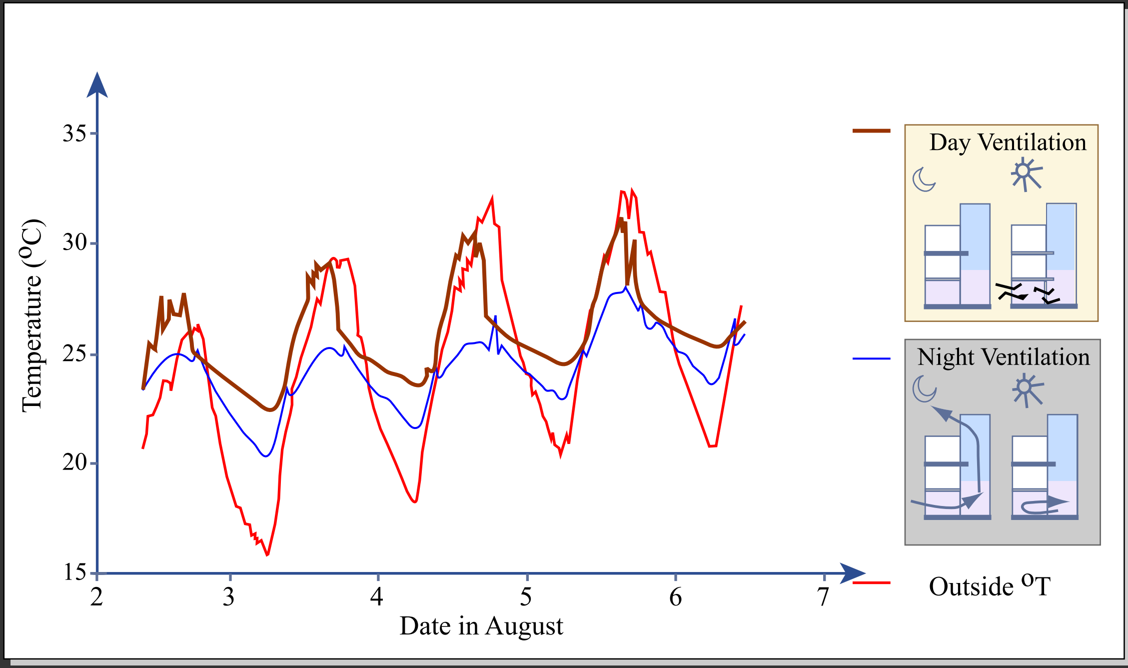
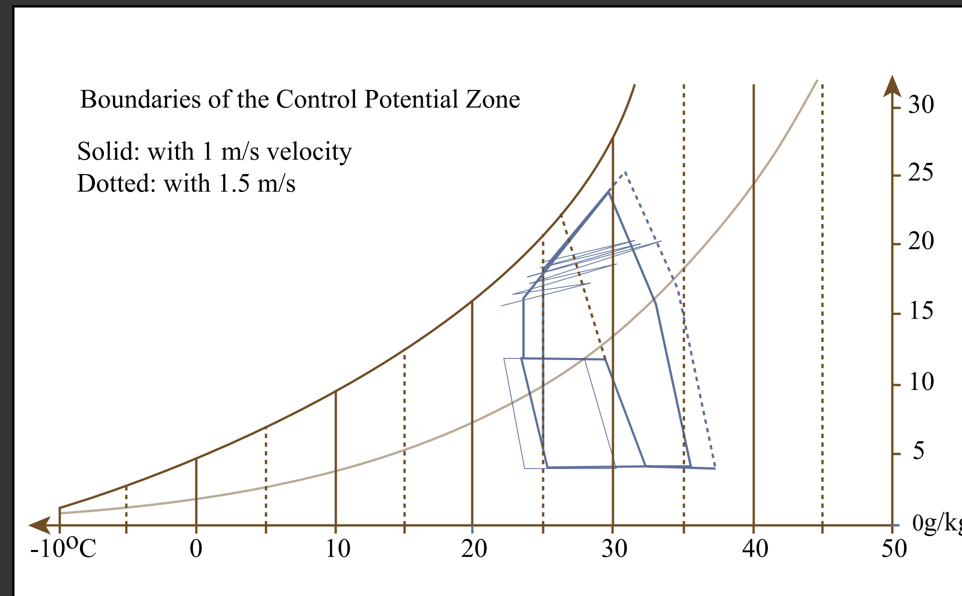


Image by MIT OCW.

Passive controls

- Passive solar heating
- Thermal mass
- Air movement
  - heat dissipation
  - cross-ventilation or fans
  - apparent cooling effect:

    $dT = 6v - 1.6v^2$



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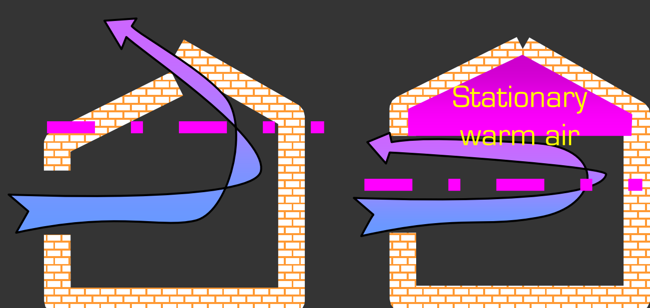

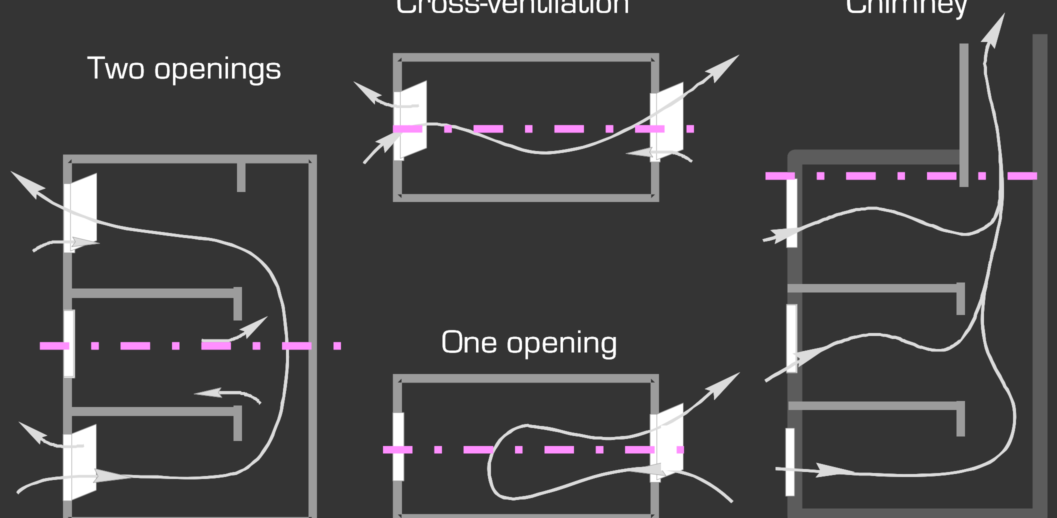

Passive controls

- Passive solar heating
- Thermal mass
- Air movement
- Evaporative cooling

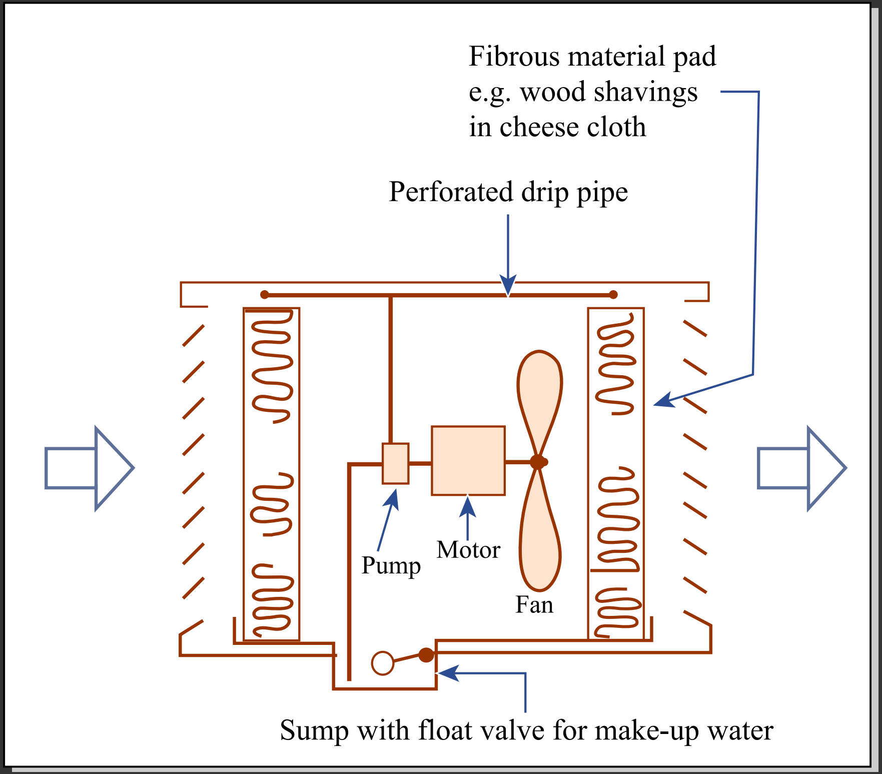

Image by MIT OCW.

Thermal balance

- Equilibrium of heat gains and losses

$$Qi + Qc + Qs + Qv + Qe = 0$$

Thermal balance

- $Qi + Qc + Qs + Qv + Qe = 0$
  - Qi = internal gain (±)

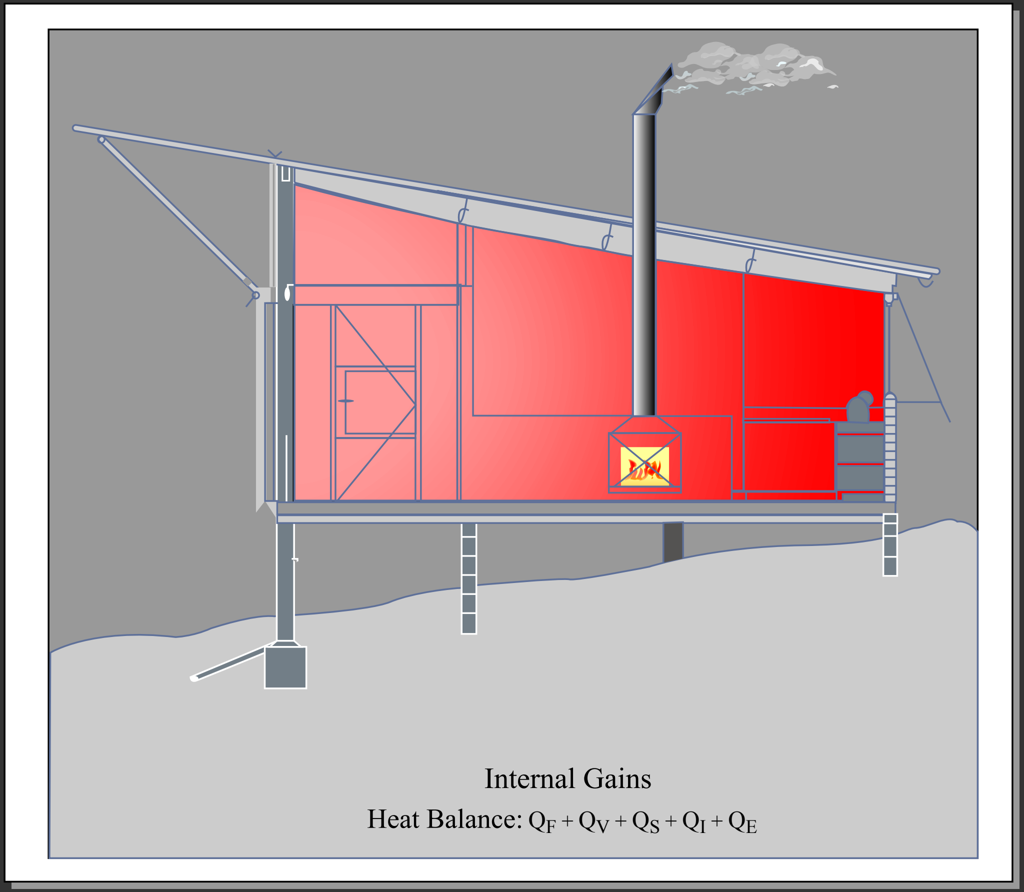

Image by MIT OCW.

Thermal balance

- $Qi + Qc + Qs + Qv + Qe = 0$
  - Qi = internal gain (±)
  - Qc = conduction gain (±)

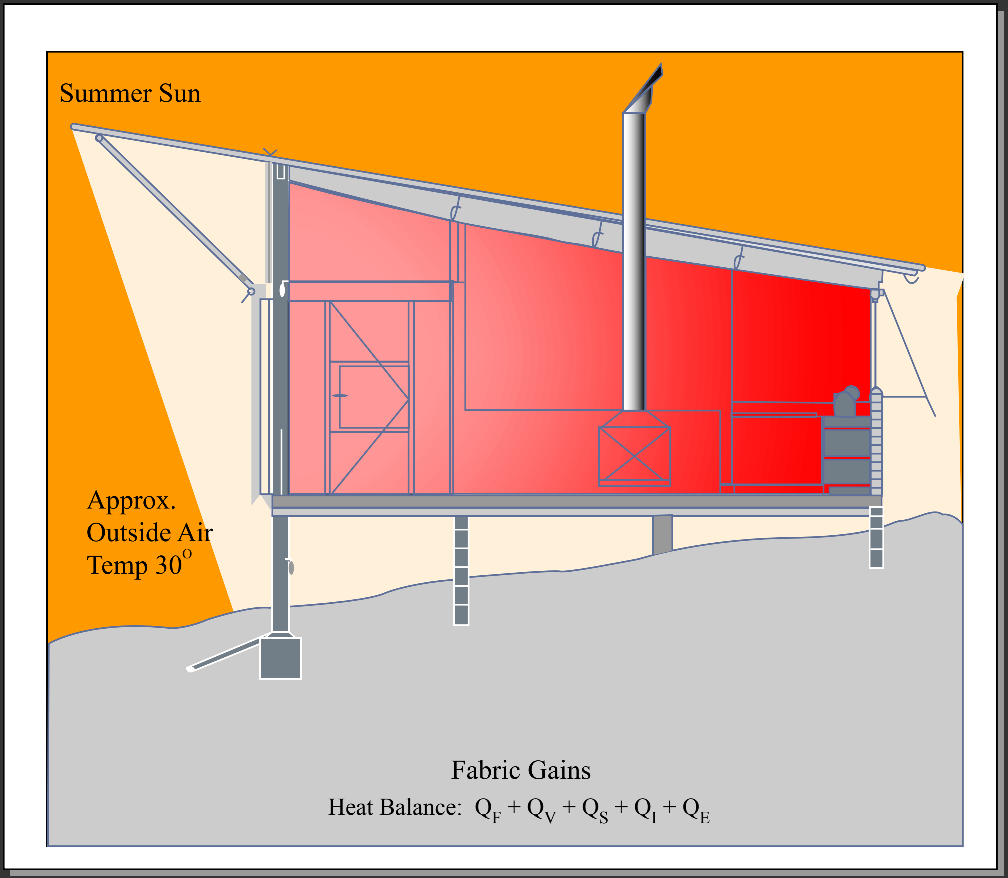

Image by MIT OCW.

Thermal balance

- $Qi + Qc + Qs + Qv + Qe = 0$
  - Qi = internal gain (±)
  - Qc = conduction gain (±)
  - Qs = solar gain (+)

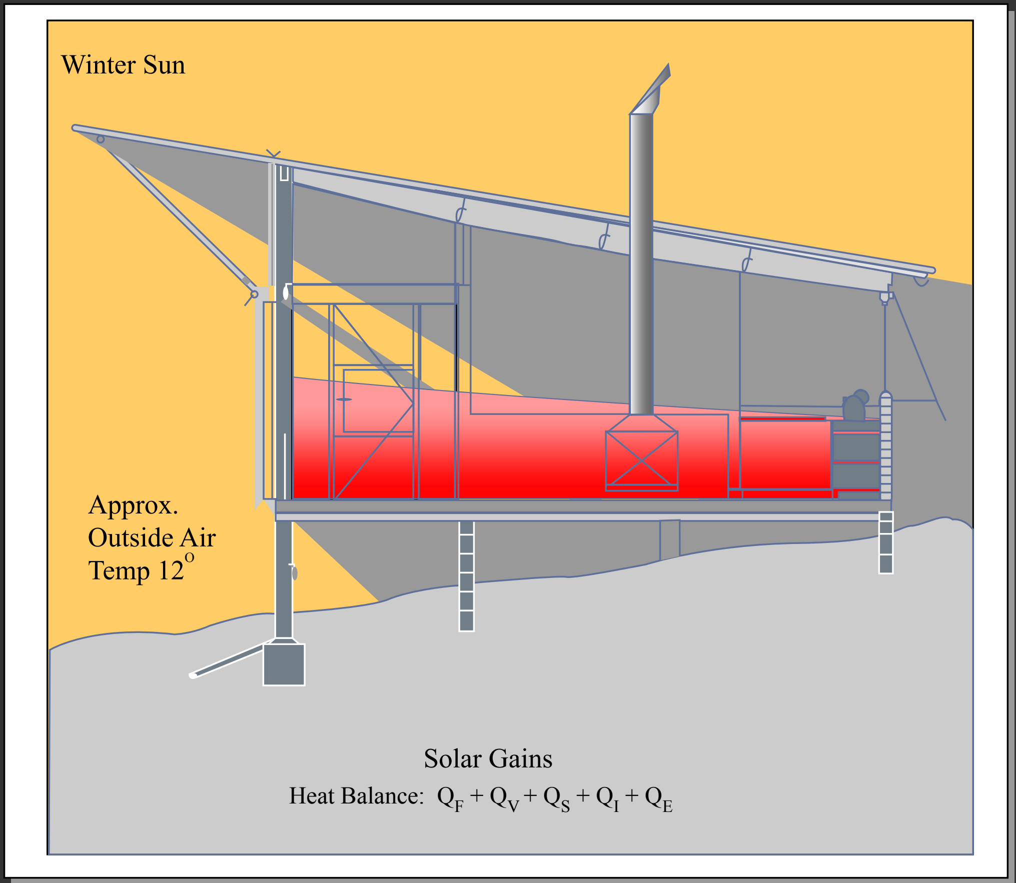

Image by MIT OCW.

Thermal balance

- $Qi + Qc + Qs + Qv + Qe = 0$
  - Qi = internal gain (±)
  - Qc = conduction gain (±)
  - Qs = solar gain (+)
  - Qv = ventilation gain (±)

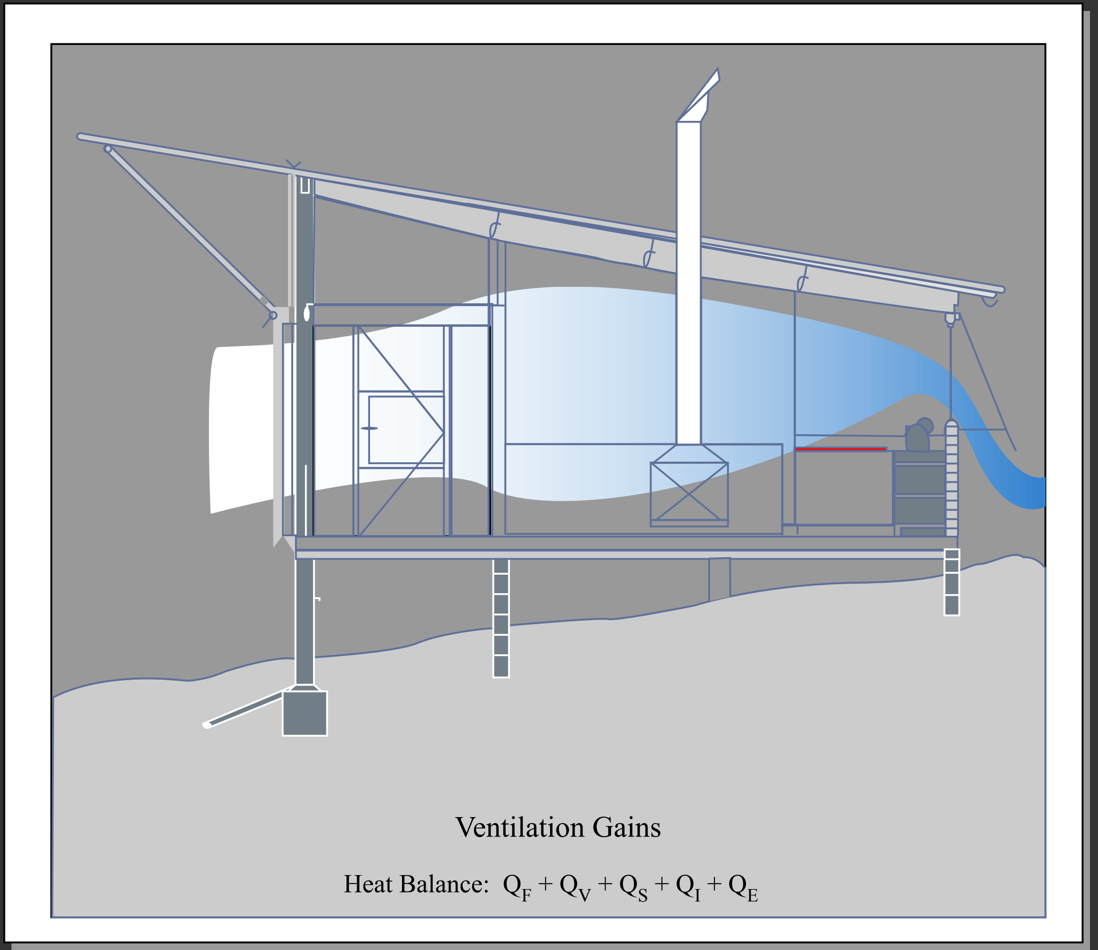

Image by MIT OCW.

Thermal balance

- Qi + Qc + Qs + Qv + Qe = 0
  - Qi = internal gain (±)
  - Qc = conduction gain (±)
  - Qs = solar gain (+)
  - Qv = ventilation gain (±)
  - Qe = evaporative loss (-)

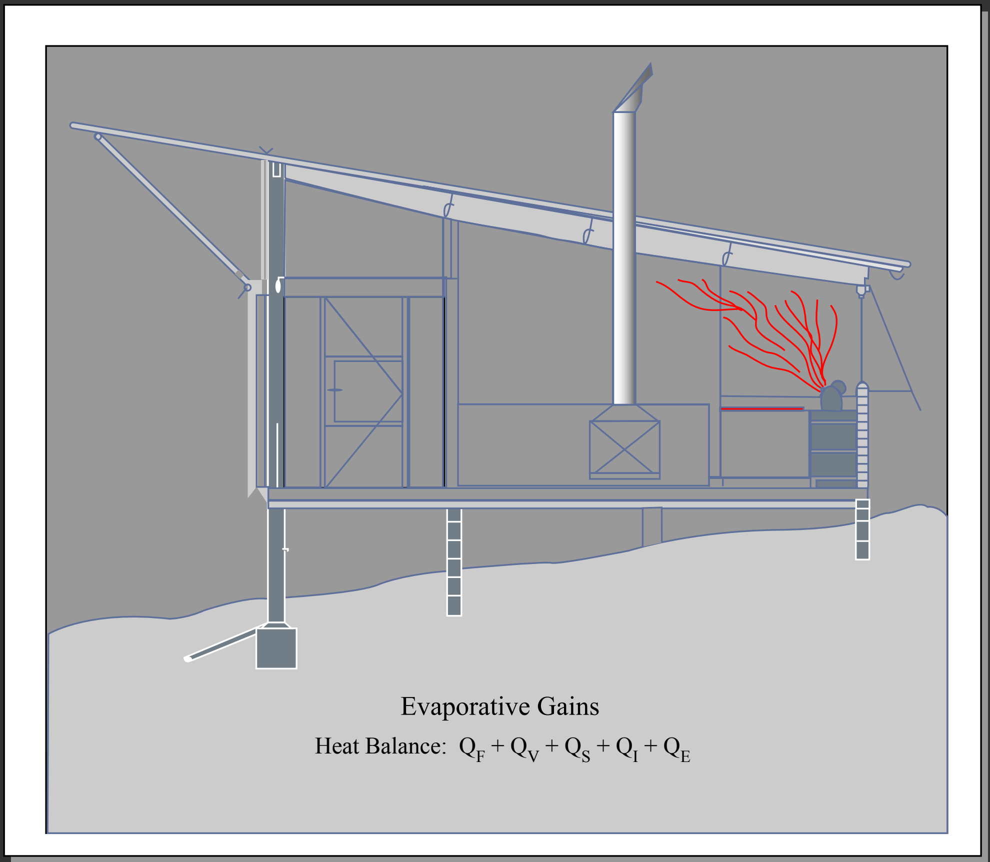

Image by MIT OCW.

Thermal balance

- Qi + Qc + Qs + Qv + Qe = 0 for design project
  - Qi = internal gain (+) = secondary heat sources + primary heating
  - Qc = conduction gain (-)
  - Qs = solar gain (+)
  - Qv = ventilation gain (-)
  - Qe = evaporative loss (-) ≈ 0

Passive gains/losses (for early March)

⇒ determine active ("primary") heating component in Qi

Integrated approach: new classroom at MIT

- Criteria and risks for
  - site
  - envelope
  - materials
  - …

Passive controls, Thermal Balance

- Reading assignment from Textbook:
  - “Introduction to Architectural Science” by Szokolay: § 1.4 (Intro) + § 1.5.1 - 1.5.2
- Additional readings relevant to lecture topics:
  - "How Buildings Work" by Allen: Chap 9 + pp. 73 - 77 in Chap 10
  - "Heating Cooling Lighting" by Lechner: Chaps 7 + 10