Energy resources

- Fossil fuels
  - Coal
  - Oil
  - Gas
  - Nuclear energy

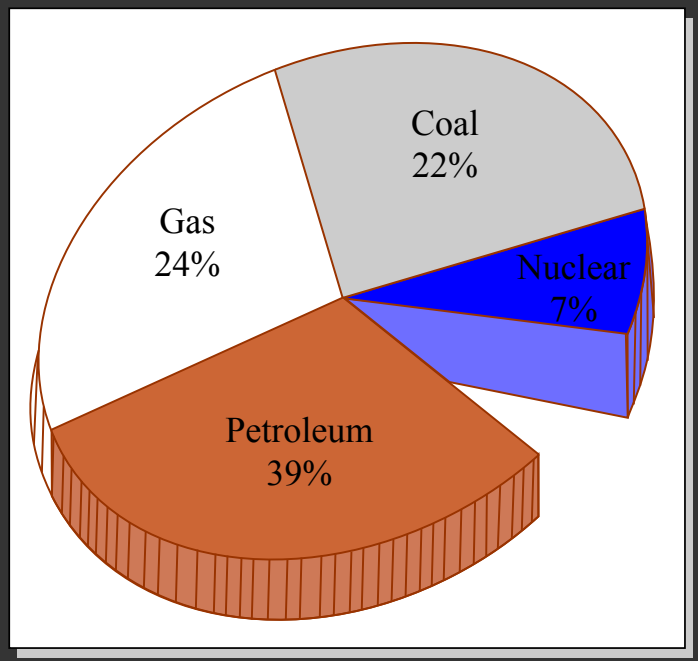
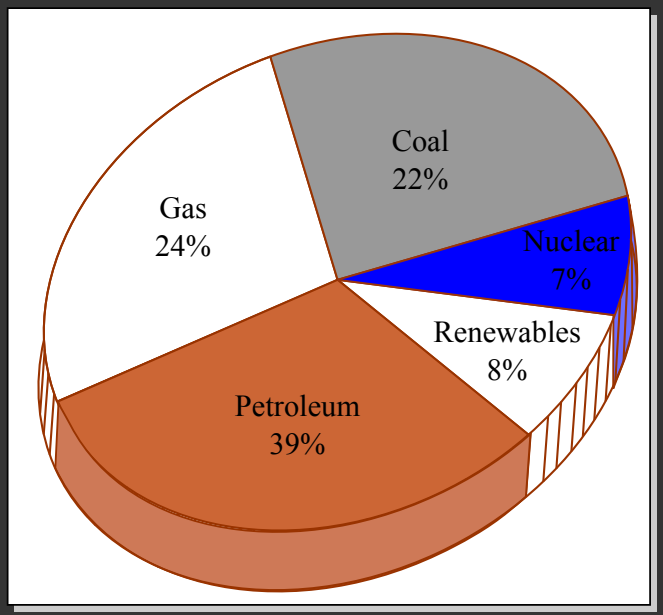


Image by MIT OCW.

Energy resources

- Renewable energies
  - Wind



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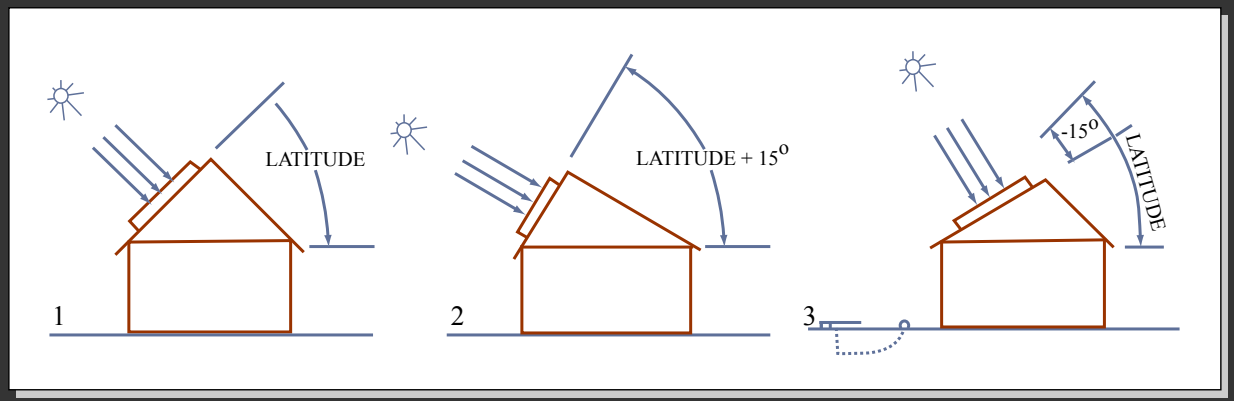
Energy resources

- Renewable energies
  - Wind
  - Solar thermal



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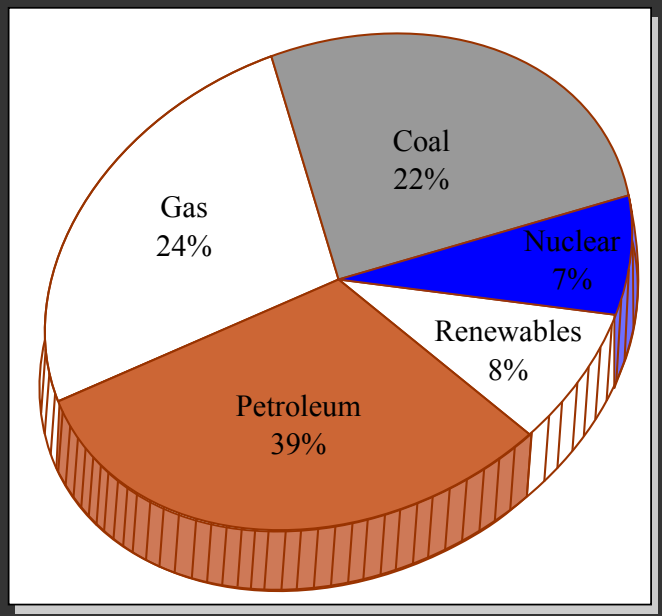

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Energy resources

- Renewable energies
  - Wind
  - Solar thermal
  - Photovoltaic

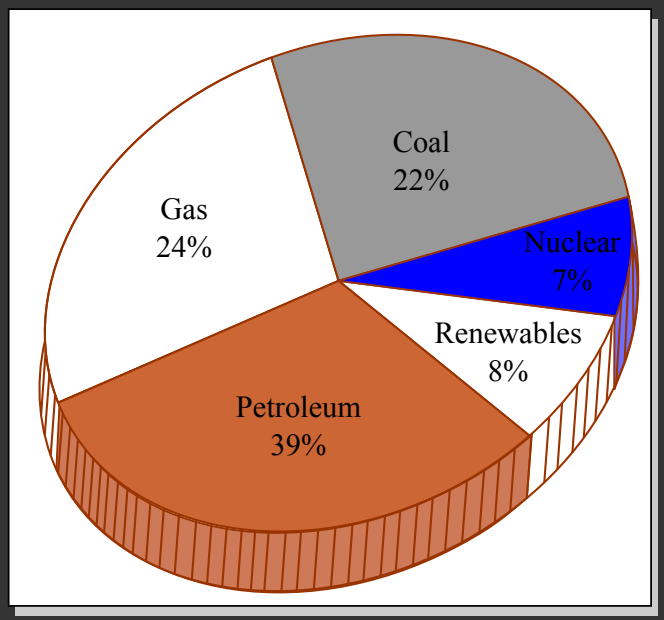


Image by MIT OCW.

Energy resources

- Renewable energies
  - Wind
  - Solar thermal
  - Photovoltaic
  - Hydroelectric (& Tidal)

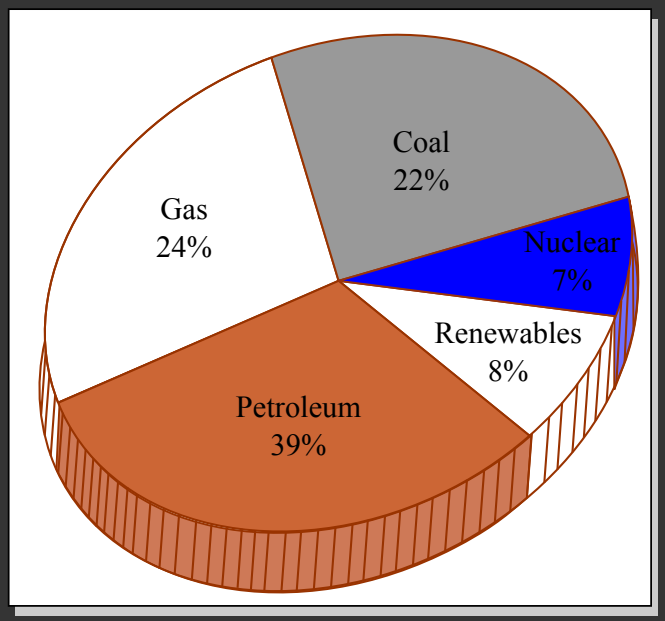


Image by MIT OCW.

Energy resources

- Energy conversion → Electricity
  - Electric heating only half as efficient as direct fuel combustion

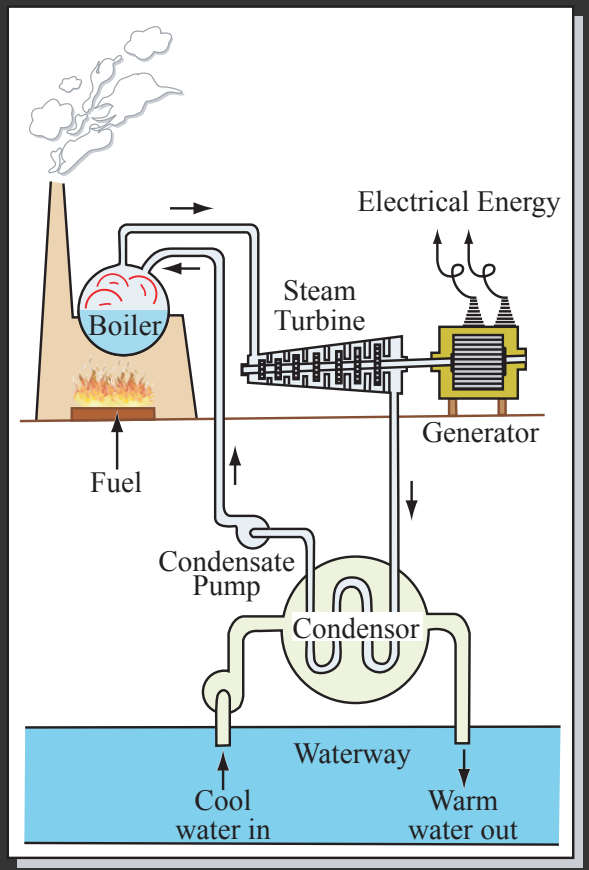


Image by MIT OCW.

Conversion	Device	Efficiency, η
Chemical-to-heat	Open fireplace	0.30
	Coal fired boiler, manual feed	0.60
	Coal fired boiler, automatic	0.70
	Oil fired boiler	0.70
	Gas fired boiler	0.75
Heat-to-mechanical	Steam piston engines	0.05-0.20
	Steam turbines	0.18-0.40
Chemical-to-mechanical	Petrol engines	0.20-0.28
	Diesel engines	0.32-0.38
	Gas turbines	0.30-0.35
Electrical	AC generator	0.97
	AC motor	0.92
	Transformer	0.98
	Lead-acid battery (input-output)	0.75
	Electric heating	0.99

Image by MIT OCW.

Active controls: HVAC

- Two parameters to be known
  - capacity
    - depends on building's heat losses
    - depends on ΔT between comfort °T and worst outside °T
  - heating requirements
    - depends on time of the year

Active controls: HVAC

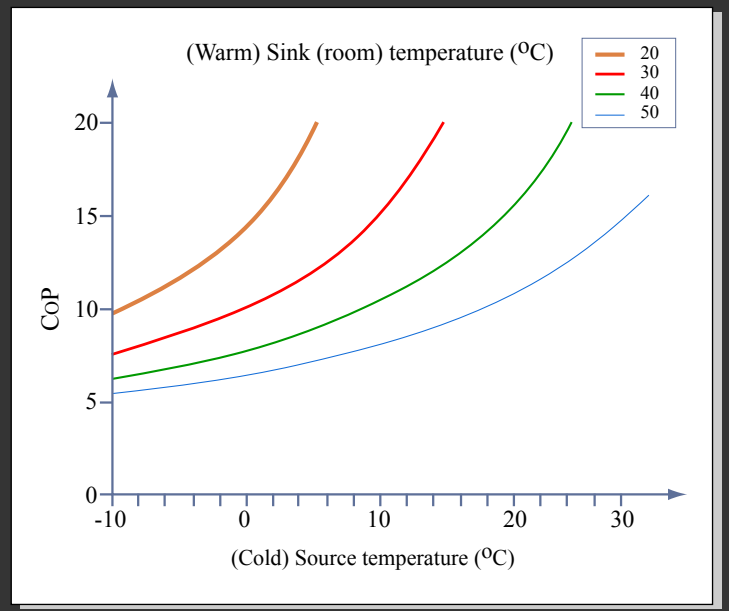
- Local heating
  - Oil heater
  - Stove (solid fuel)
  - Gas heater
  - Electric heater

Type	Heat emission (%)	
	Radiant	Convective
Infrared lamps	100	—
Incandescent radiators	80	20
Medium temperature (tube or panel) radiators	60	40
Low temperature panels (oil filled)	40	60
Convectors	20	80
Fan-convectors	—	100
Storage (block) heaters	10	90
Floor warming	20	80
Ceiling warming	70	30

Image by MIT OCW.

Active controls: HVAC

- Local heating
  - Oil heater
  - Stove (solid fuel)
  - Gas heater
  - Electric heater
    - Heat pump



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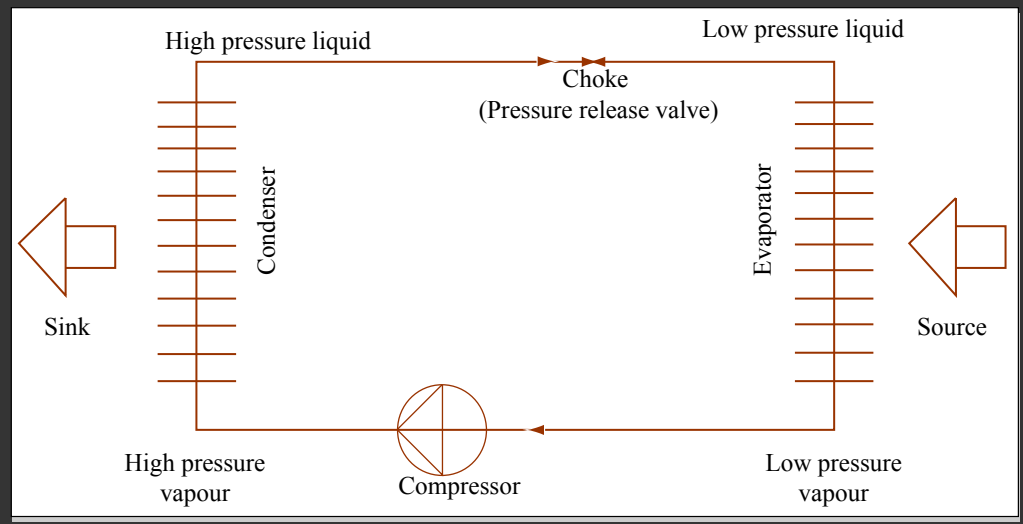

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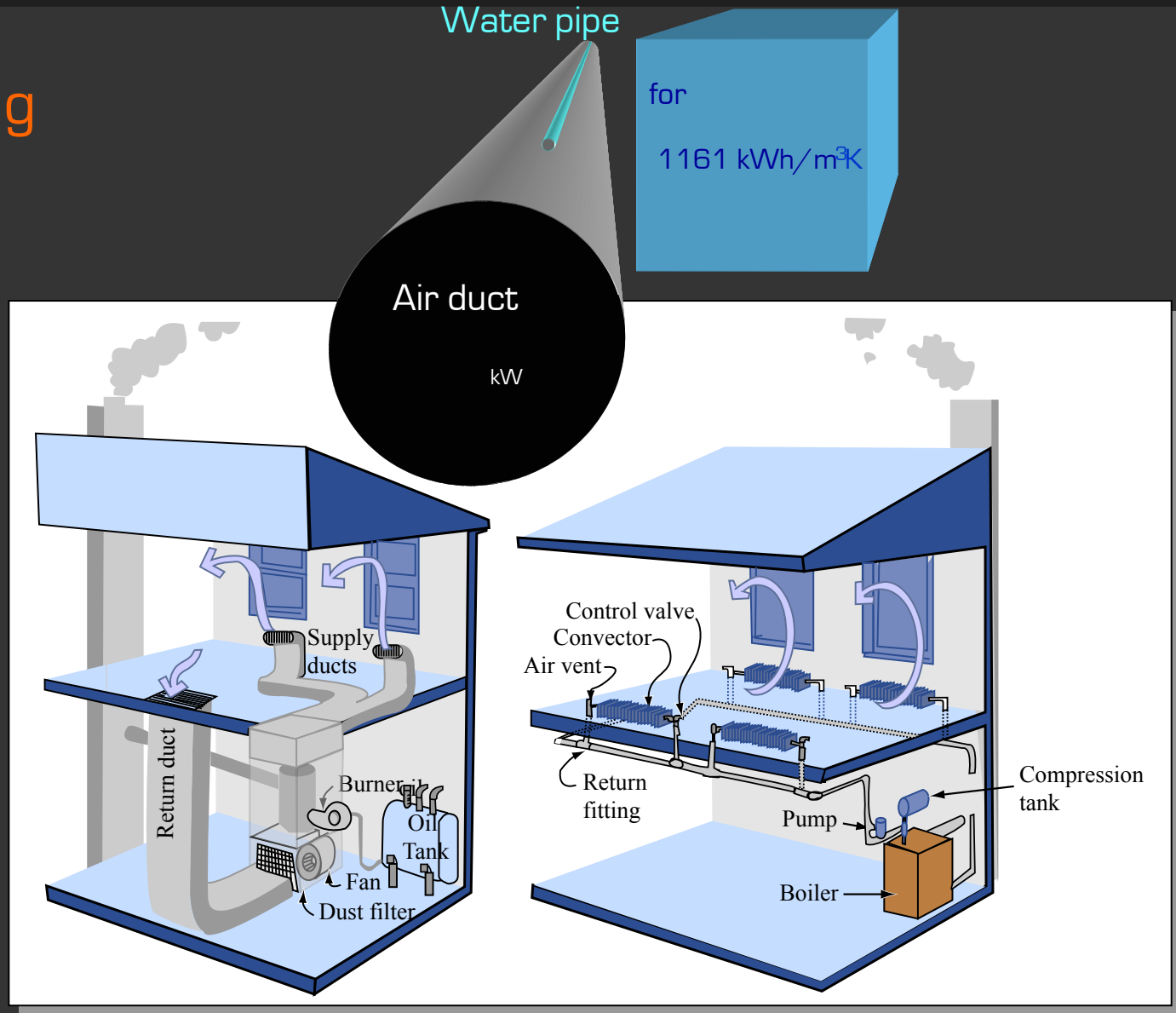
Active controls: HVAC

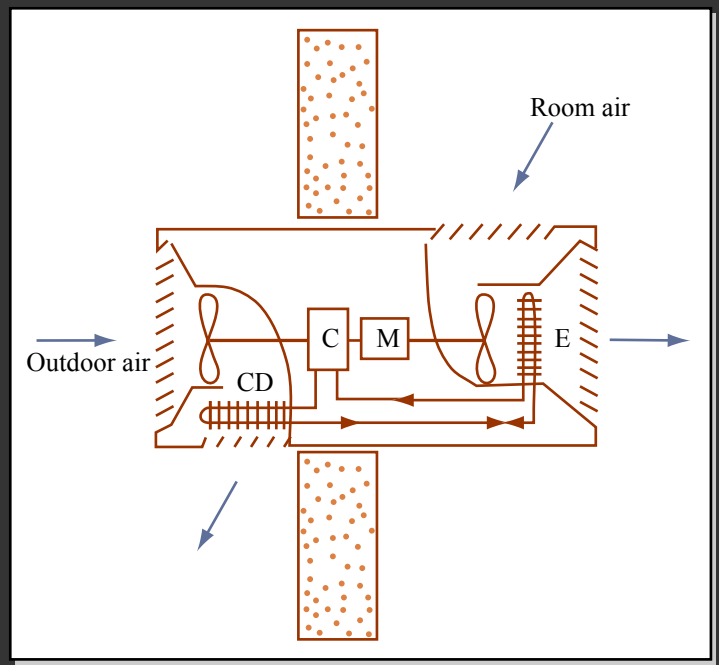
- Central heating
  - Air based
  - Water based

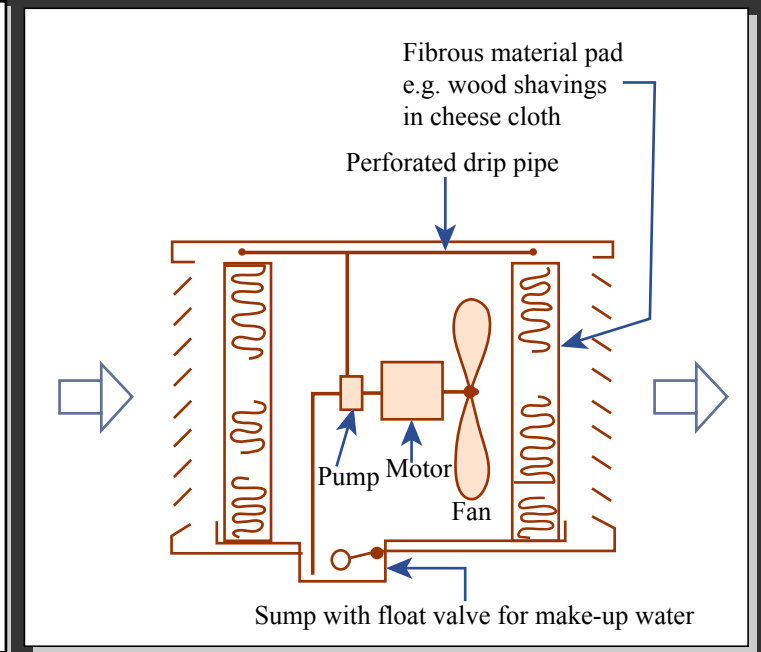


Images by MIT OCW.

Active controls: HVAC

- Ventilation and air-conditioning
  - Mechanical ventilation
  - Air-conditioning
    - Conventional room conditioner
    - Open-cycle cooling
  - Radiating surfaces





Images by MIT OCW.

Active controls: HVAC

- Integration and occupants' comfort
  - Floor warming slow but comfortable
  - Convectors quick but not for massive/badly insulated spaces
  - Local radiative heating towards people for large spaces

Passive and active heating combination

- Heating system coherent with solar gains
  - stops when gains overcome needs
  - requires temperature or solar radiation sensor (separation N/S)

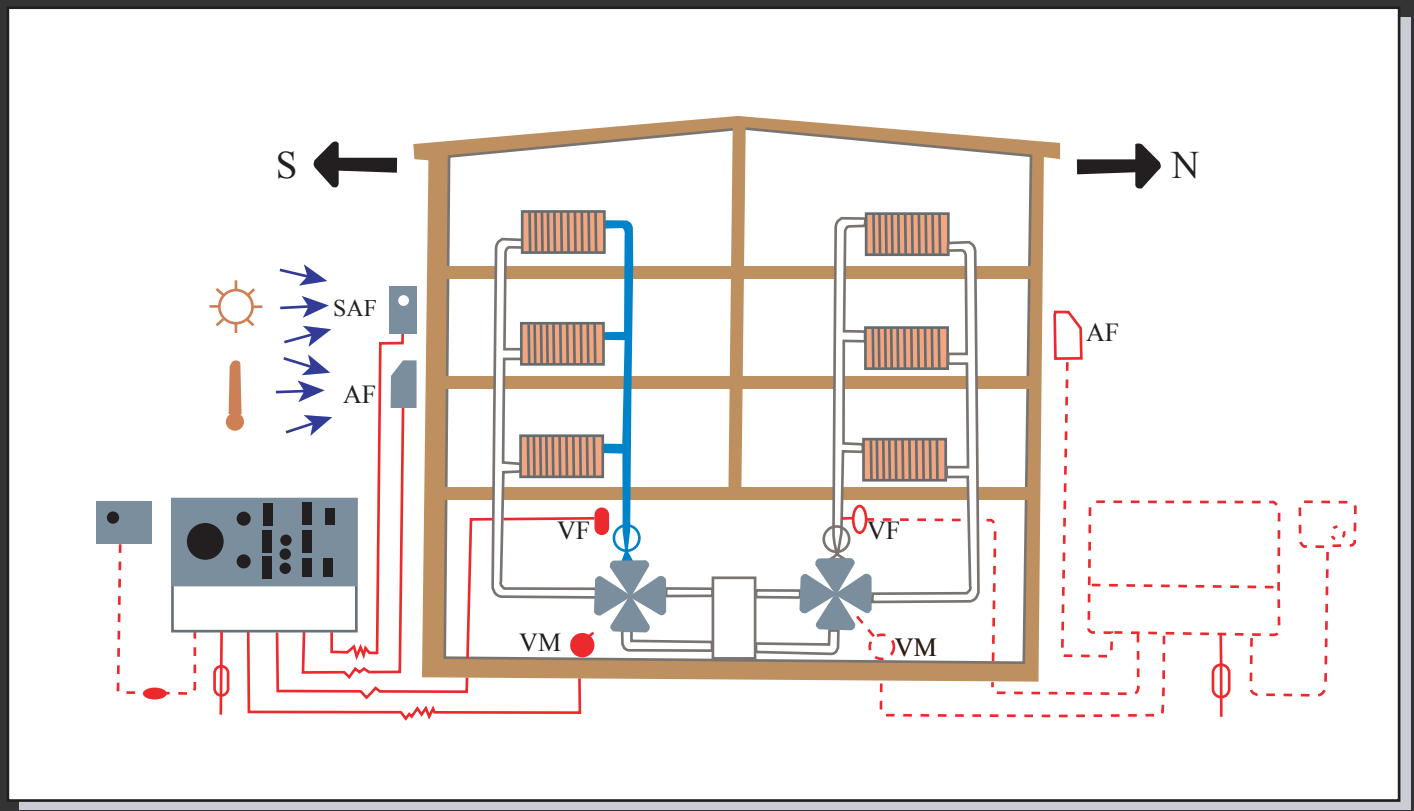


Image by MIT OCW.

Passive and active heating combination

- Heating system coherent with solar gains
  - stops when gains overcome needs
  - requires temperature or solar radiation sensor (separation N/S)
  - requires low inertia of heating system

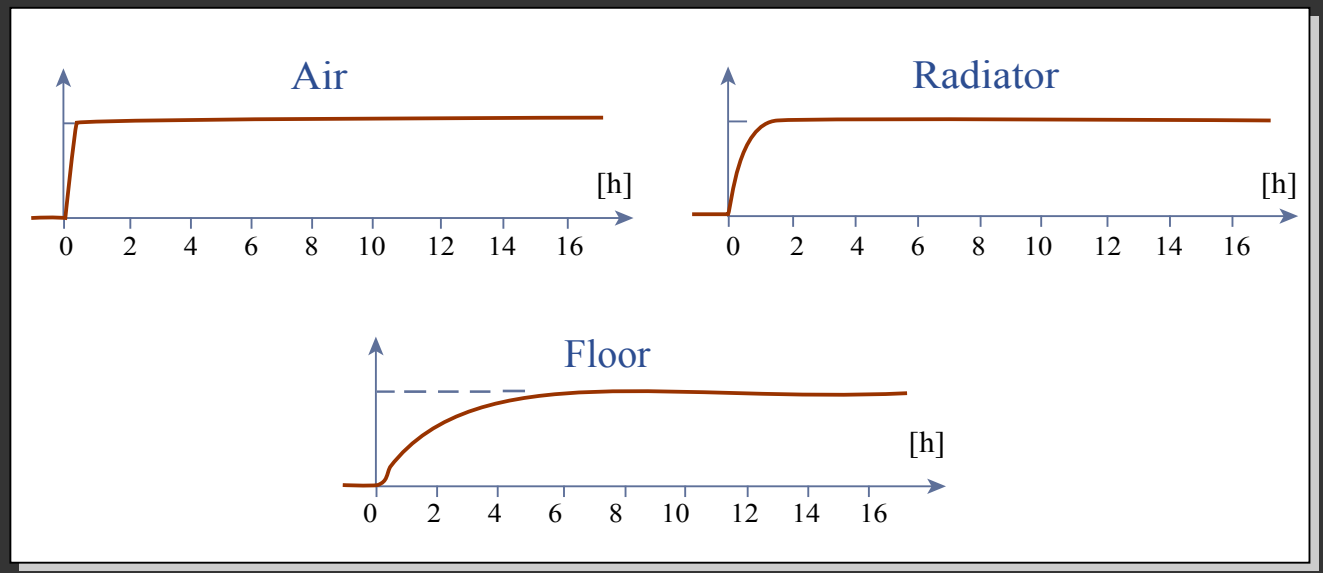


Image by MIT OCW.

Passive and active heating combination

- Heating system coherent with solar gains
  - stops when gains overcome needs
  - requires temperature or solar radiation sensor (separation N/S)
  - requires low inertia of heating system
  - autoregulation difficult with high temperature heating systems

Active Heating and Cooling

- Reading assignment from Textbook:
  - “Introduction to Architectural Science” by Szokolay: § 1.6 + § 4.1 - 4.2
- Additional readings relevant to lecture topics:
  - "How Buildings Work" by Allen: pp. 77 - 88 in Chap 10 + Chap 15
  - "Heating Cooling Lighting" by Lechner: Chaps 2 + 8 + 16
  - “The Technology of Ecological Building“ by Daniels: Chaps 10 – 12
- More detailed information about renewable energy
  - "Sustainability at the cutting edge – Emerging technologies for low energy buildings" by Smith