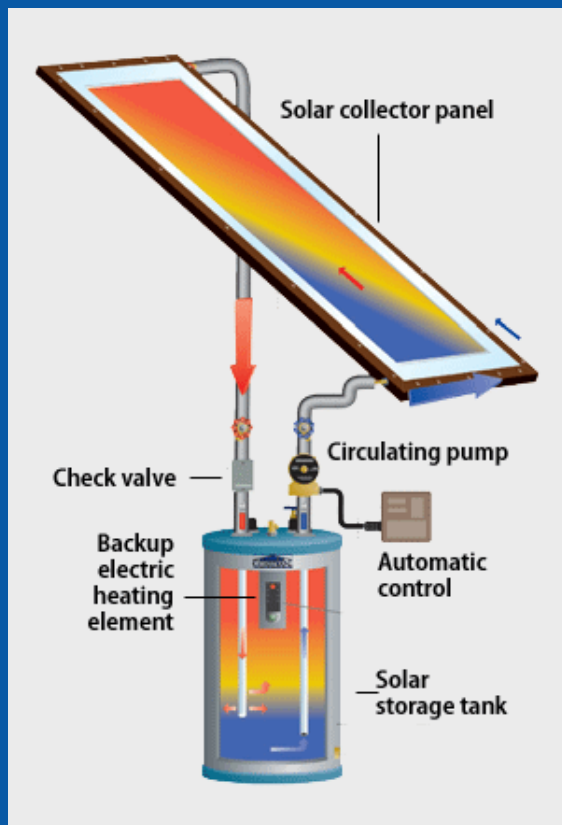


Introduction to Solar Water Heating Systems



Cécile Warner, P.E.

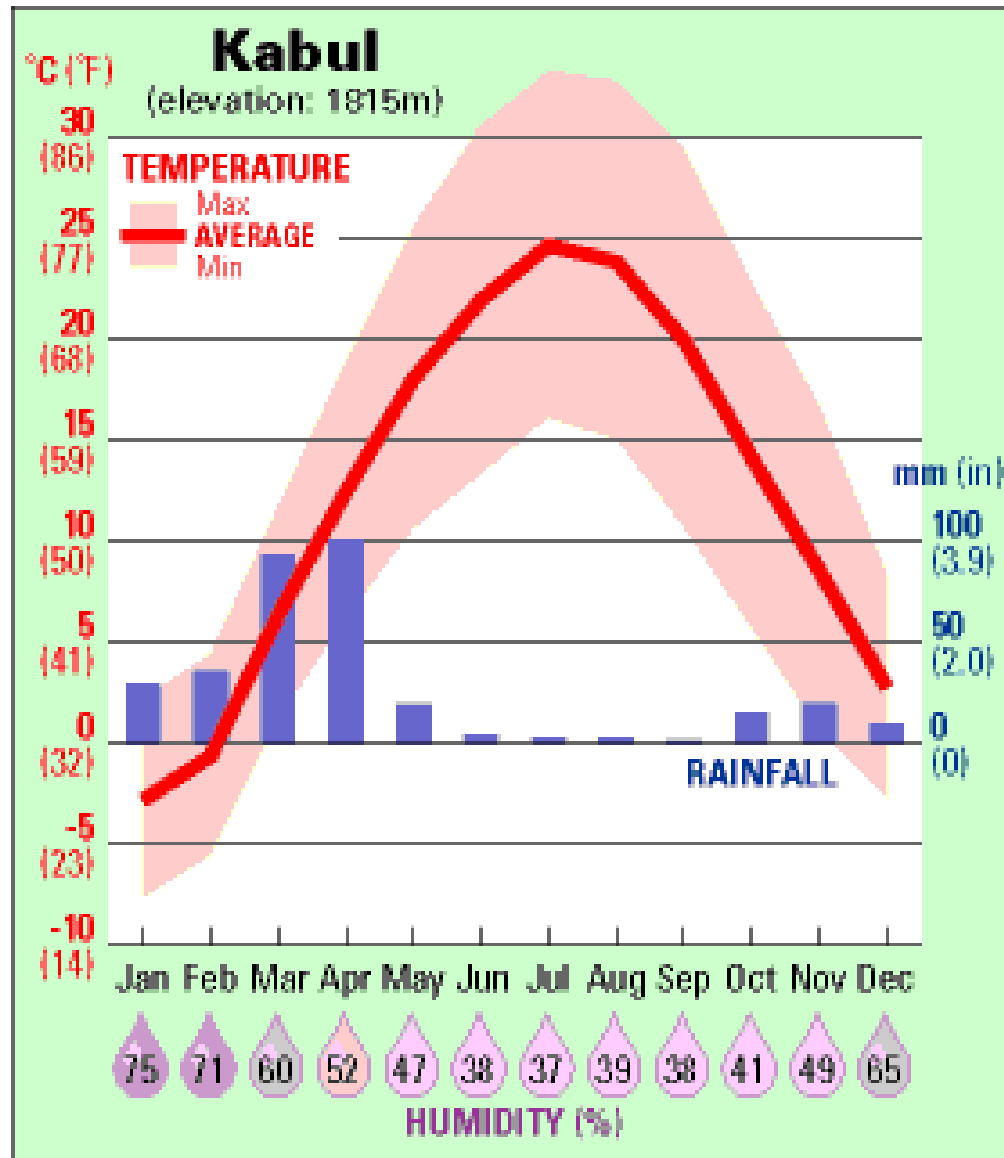
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Clean Energy Access

March 2010



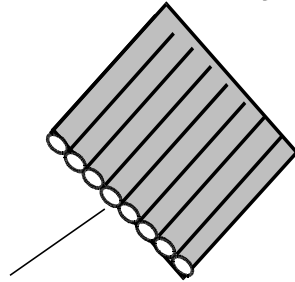
Climate considerations



Collector Types

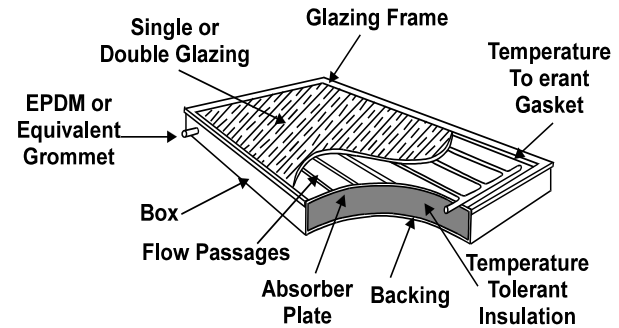
Unglazed EPDM Collector

Extruded "Mat" with Flow Passages

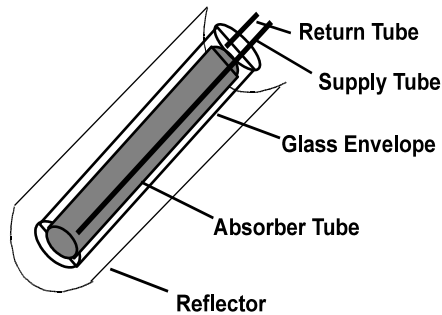


Flow from Manifold Through Passages

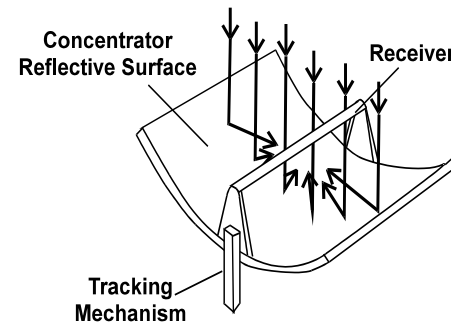
Flat Plate



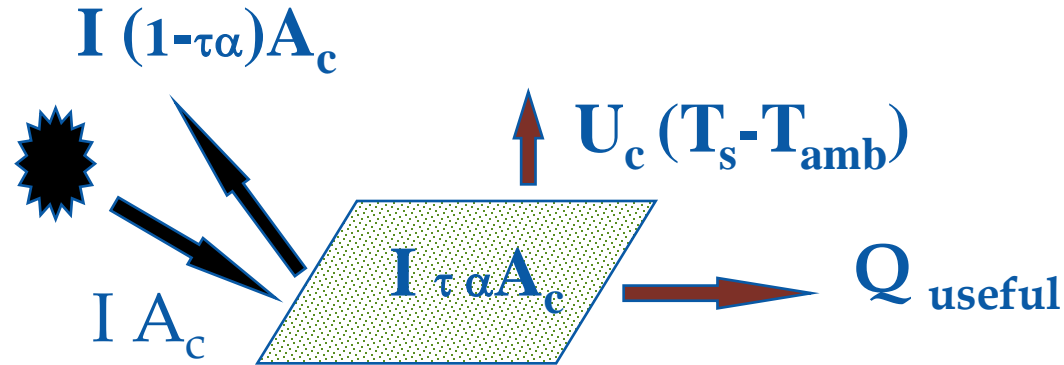
Evacuated Tubes



Parabolic Trough



Collector Efficiency (Rating)



Energy Collected = optical gains - thermal losses

$$Q_{useful} = \tau \alpha I A_c - U_c A_c (T_s - T_{amb})$$

Efficiency = energy collected / incident solar

$$\eta_{solar} = \tau \alpha - U_c (T_s - T_{amb}) / I$$

(a line of intercept $\tau \alpha$ and slope U_c)

I = incident solar radiation (W/m^2)

τ = transmissivity of cover glass

α = absorptivity of absorber plate

A_c = collector area (m^2)

Q_{useful} = useful heat from collector (W)

U_c = thermal loss coefficient of collector (W/C)

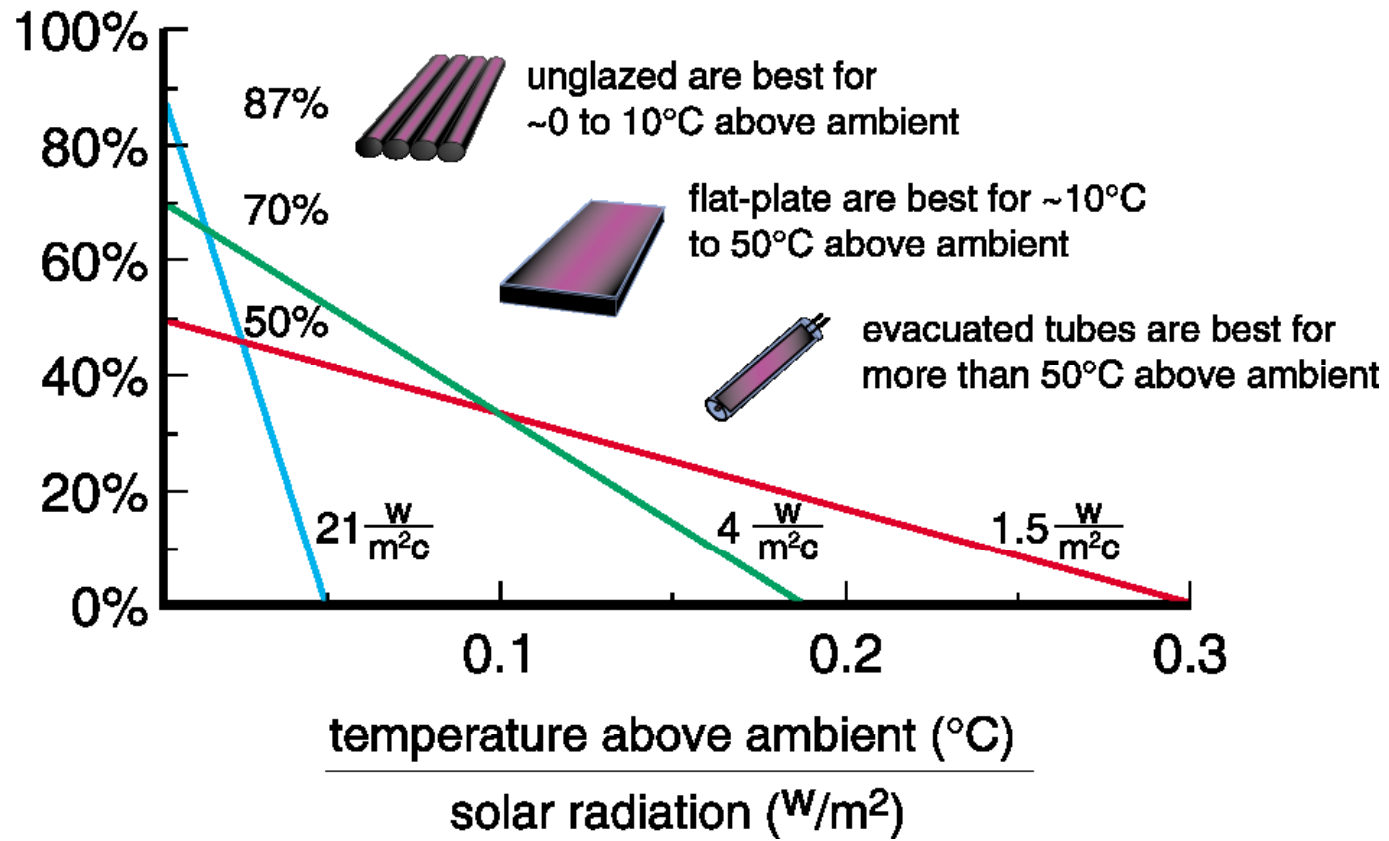
T_s = storage water temperature (C)

T_{amb} = outdoor ambient temperature (C)

Which collector is best depends ...

Efficiency=

% of solar captured
by collector



System Types

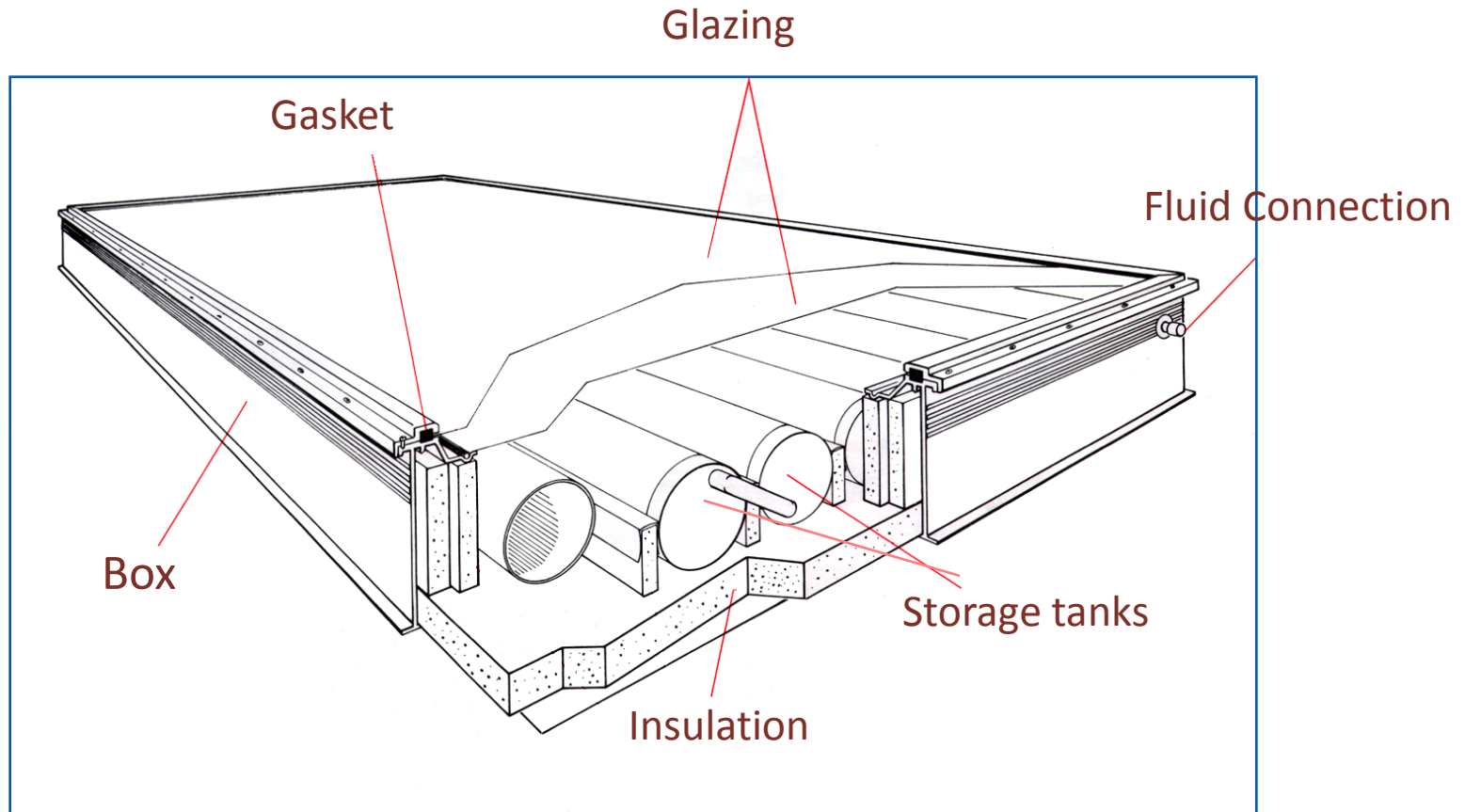
Passive Systems

- Integral Collector Storage (ICS)
- Thermosyphon

Active Systems

- Direct:
 - Recirculation
 - Drain Down
- Indirect:
 - Drain Back
 - Antifreeze

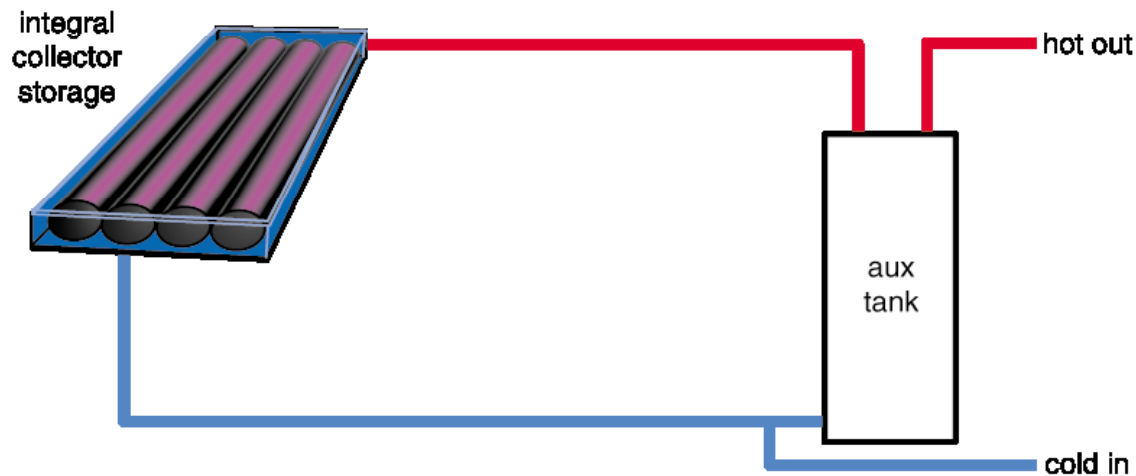
ICS Collector



ICS Collector

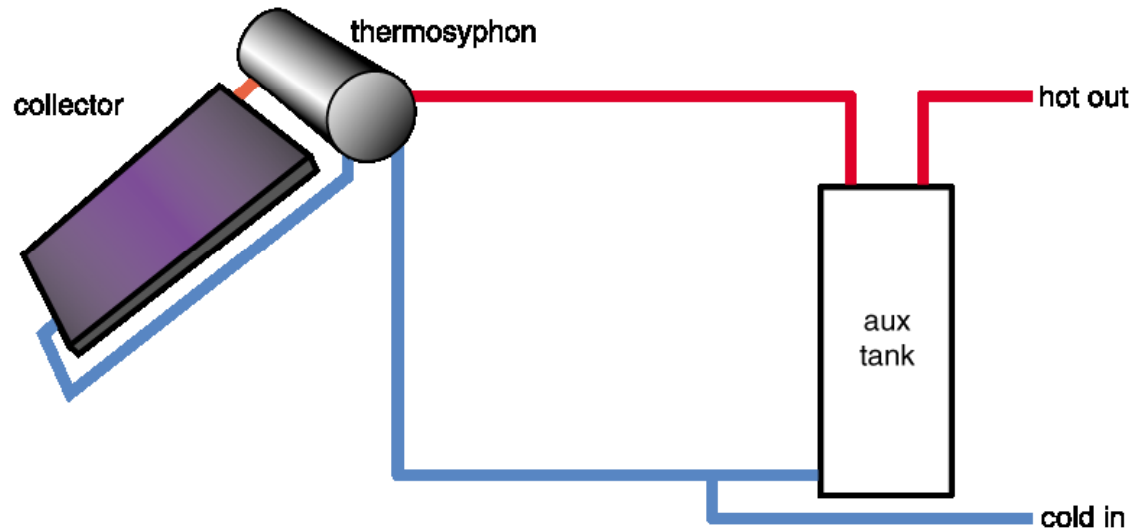


Passive, Integral Collector Storage (ICS) Direct System



- Moderate freeze protection (pipes at risk)
- Very low maintenance requirements

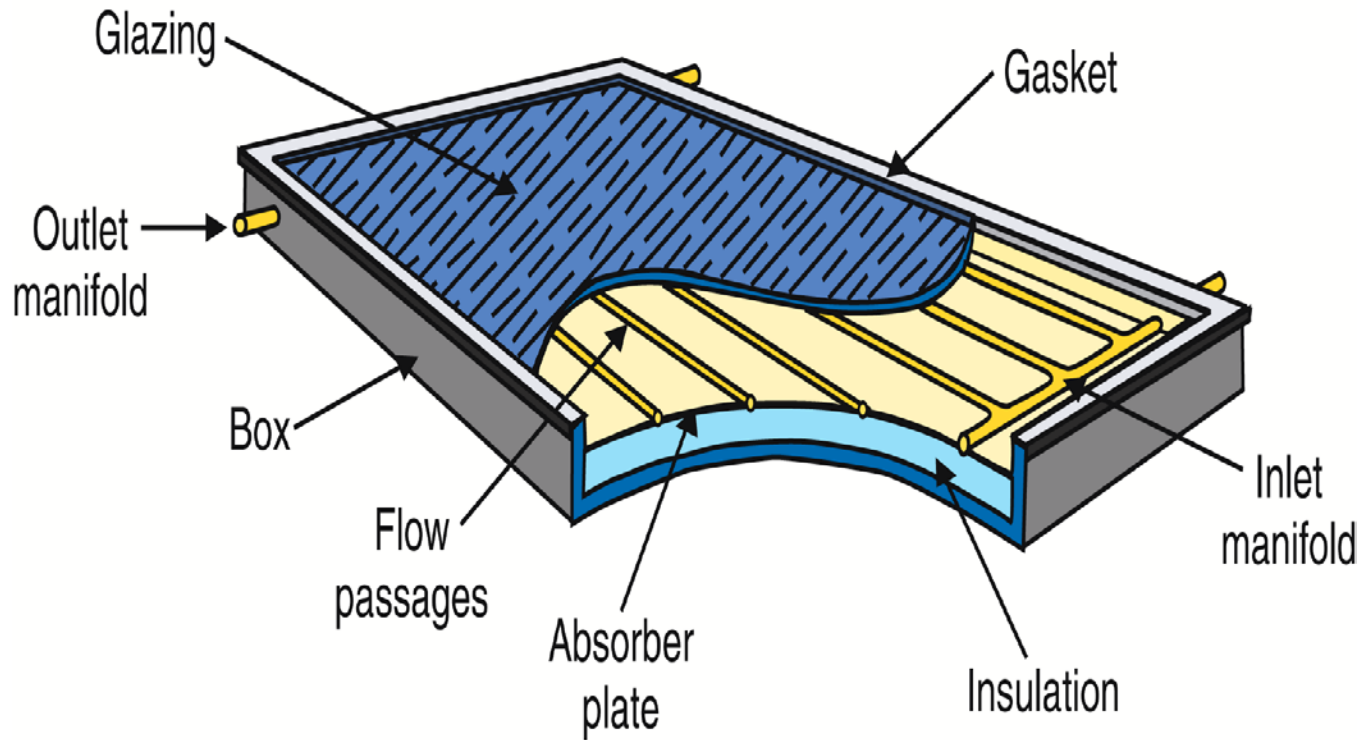
Passive, Thermosyphon, Direct System



- No freeze protection
- Minimal hard water tolerance
- Low maintenance requirements

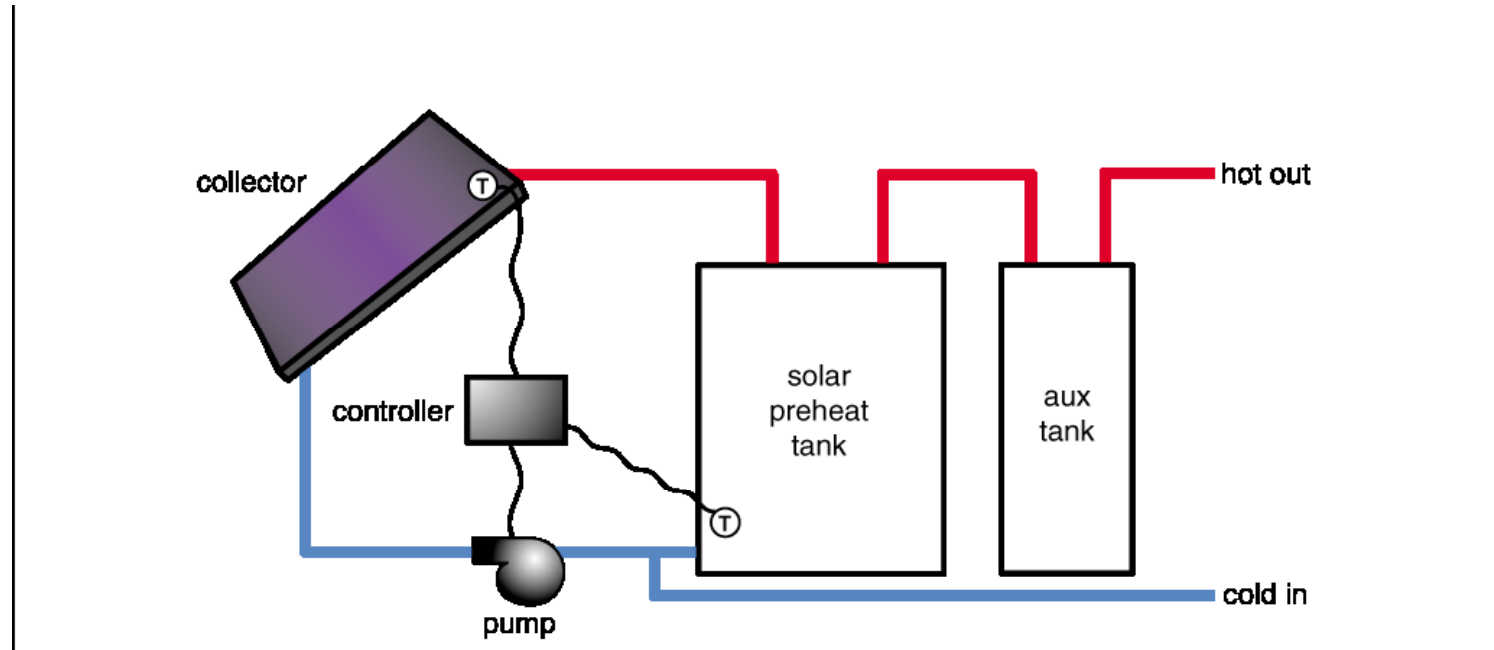
Flatplate Solar Collector

(glazed, fin-tube, copper absorber)



02426122m

Active, Open-loop, Pumped Direct System



- Minimal freeze protection
- Minimal hard water tolerance
- High maintenance requirements

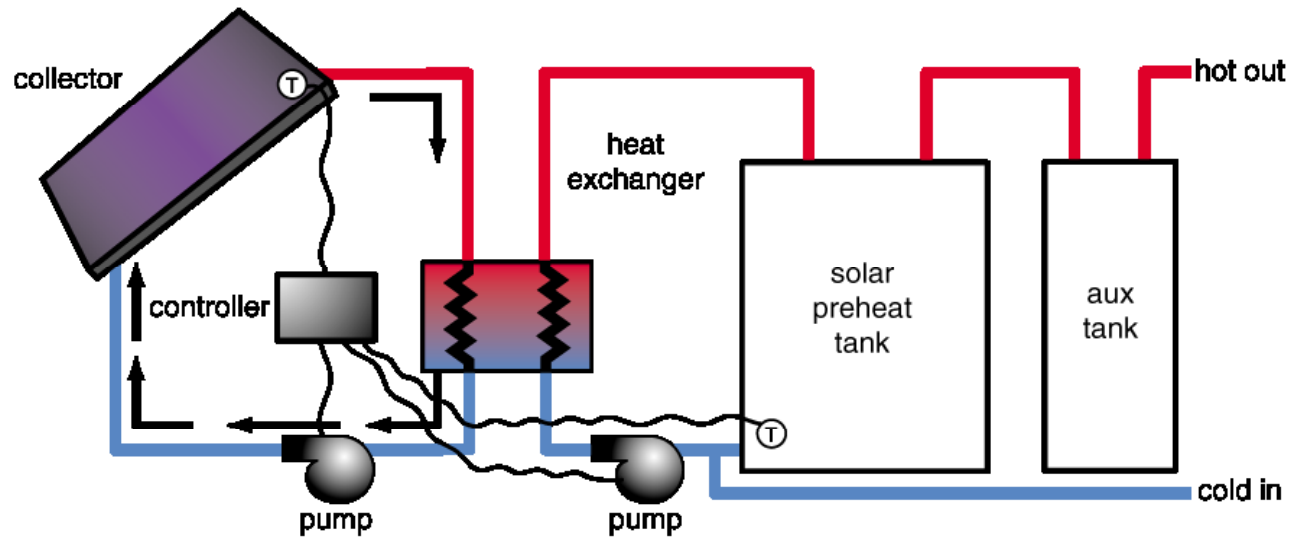
Differential Temperature Controllers



Circulator Pumps

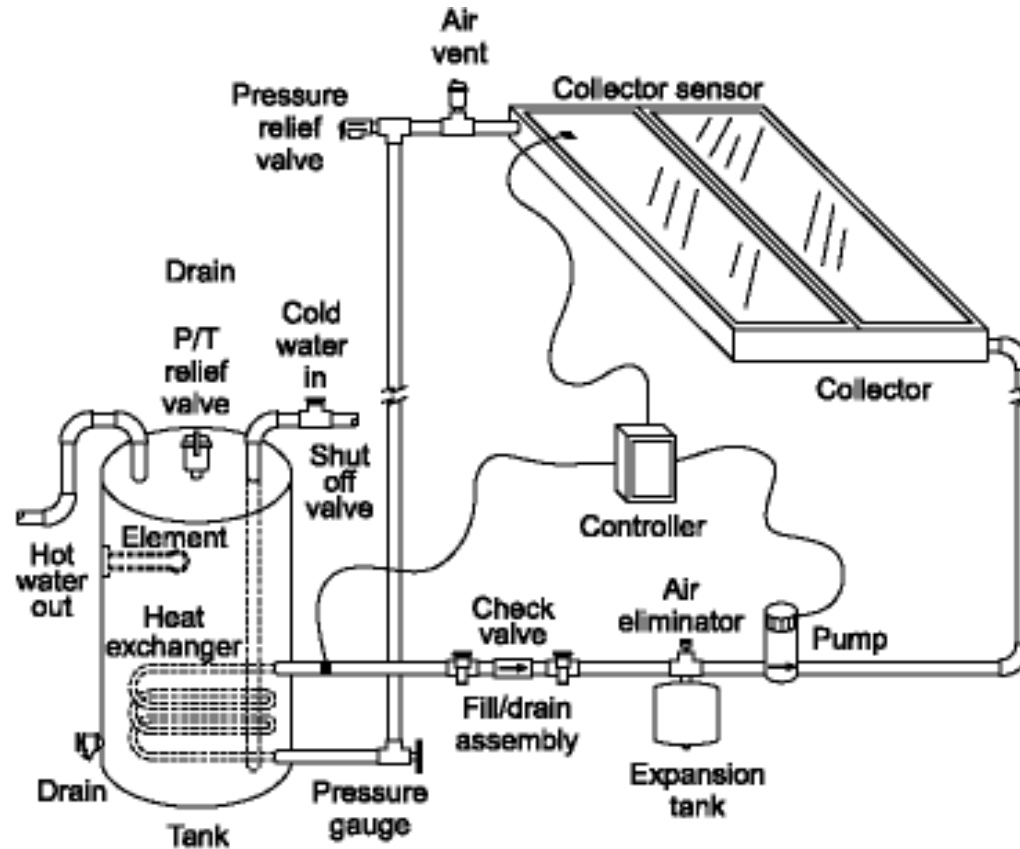


Active, Closed-loop (antifreeze), Indirect System

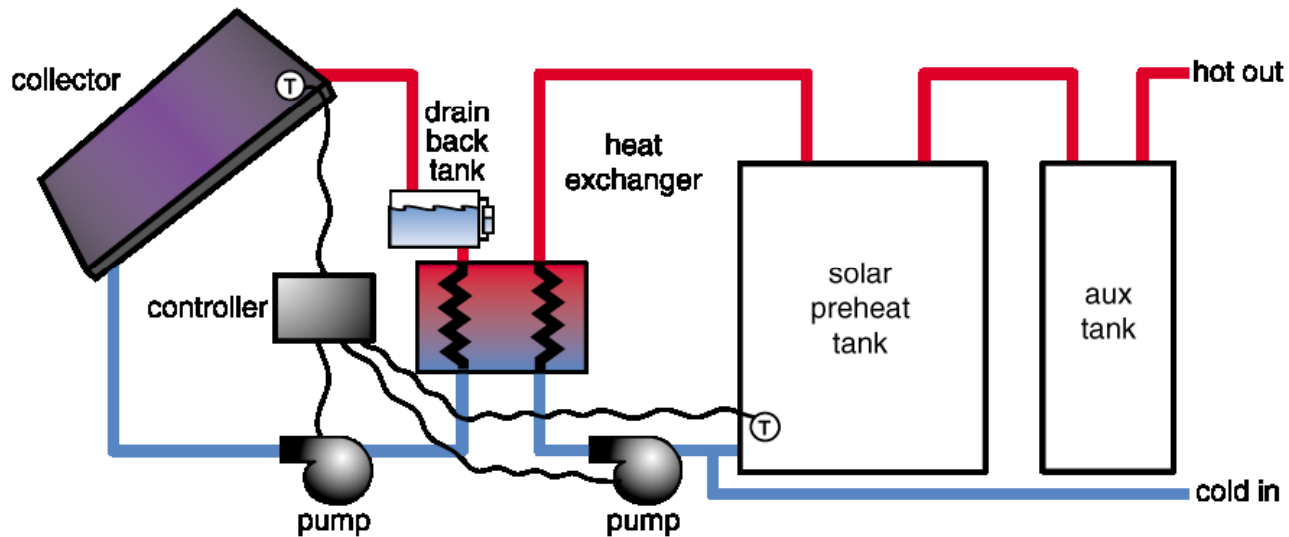


- Excellent freeze protection
- Good hard water tolerance
- Very high maintenance requirements

Indirect System

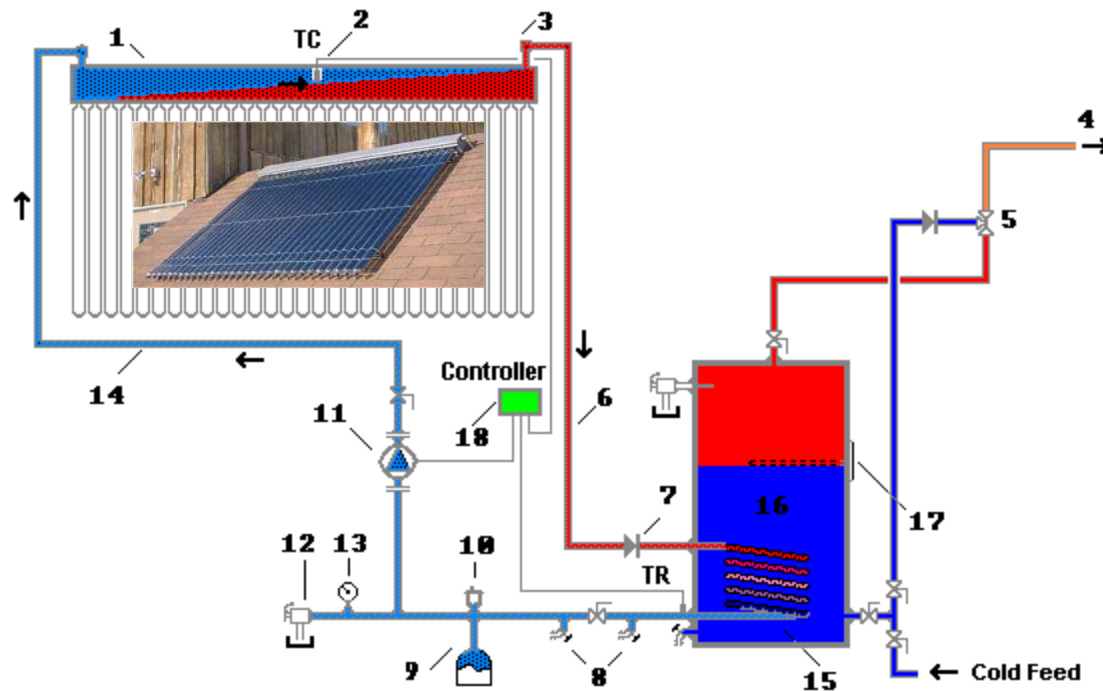


Active, Closed-loop, Drainback, Indirect System



- Good freeze protection
- Good hard water tolerance
- High maintenance requirements
- High pumping power requirements

Active, Closed-loop, Evacuated Tube Indirect System



- Good cold-climate performance
- Good hard water tolerance
- Good freeze protection
- High maintenance requirements

Resources and References

American Society of Heating, Air Conditioning and Refrigeration Engineers, Inc.

- ASHRAE 90003 -- Active Solar Heating Design Manual
- ASHRAE 90336 -- Guidance for Preparing Active Solar Heating Systems Operation and Maintenance Manuals
- ASHRAE 90346 -- Active Solar Heating Systems Installation Manual

Solar Rating and Certification Corporation

- SRCC-OG-300-91 -- Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems



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