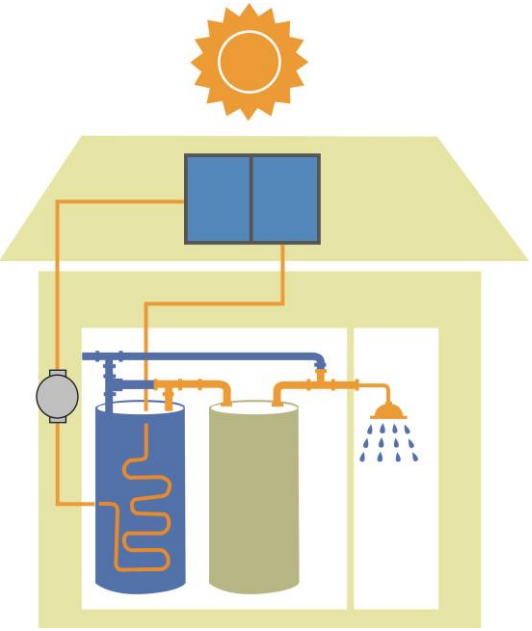
Solar Hot Water

Jim Huggins

Solar Rating & Certification Corporation



Training Workshop on Building Energy Efficiency Systems and Labeling

October 27, 2015 NIST, Gaithersburg

Outline

- Overview of Solar Water Heating
- Collector Design
- System Design
- History
- Collector Performance Theory
- Collector Performance Measurements
- Certification

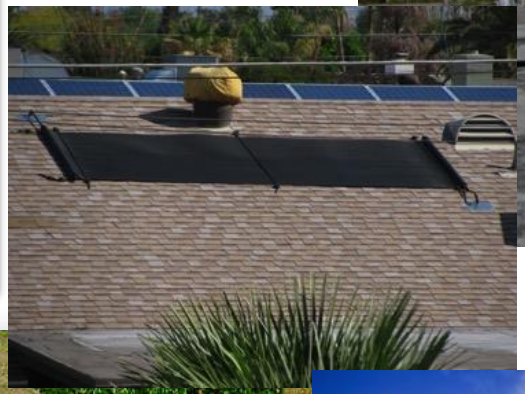
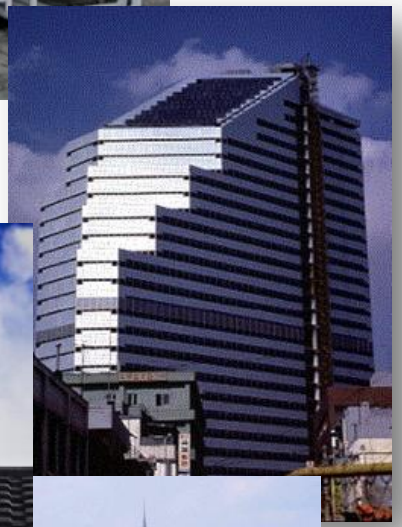
Solar Water Heating Applications

- Pool and spa heating
- Domestic water heating
- Space heating
- Combination domestic/space heating
- Snow melting systems
- Industrial processes

Wide Range of Sizes

Wide Range of Configurations

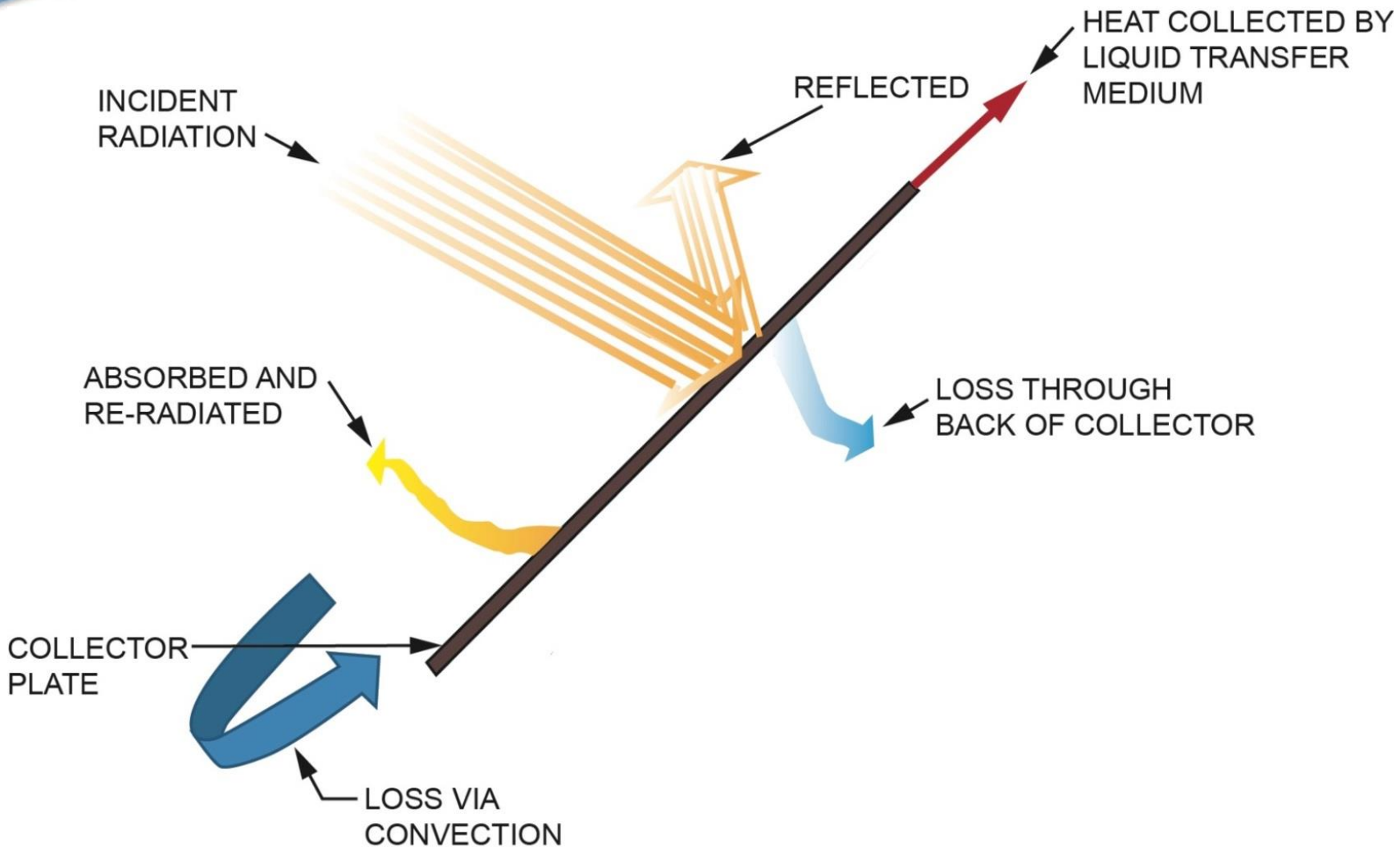




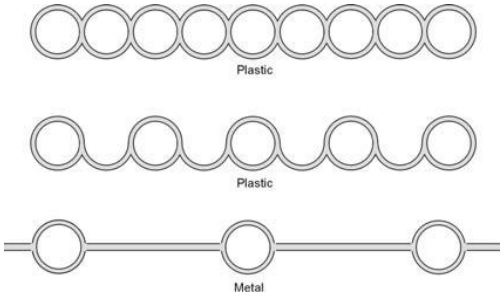


Solar Heating Mechanism Basics - Unglazed Collector



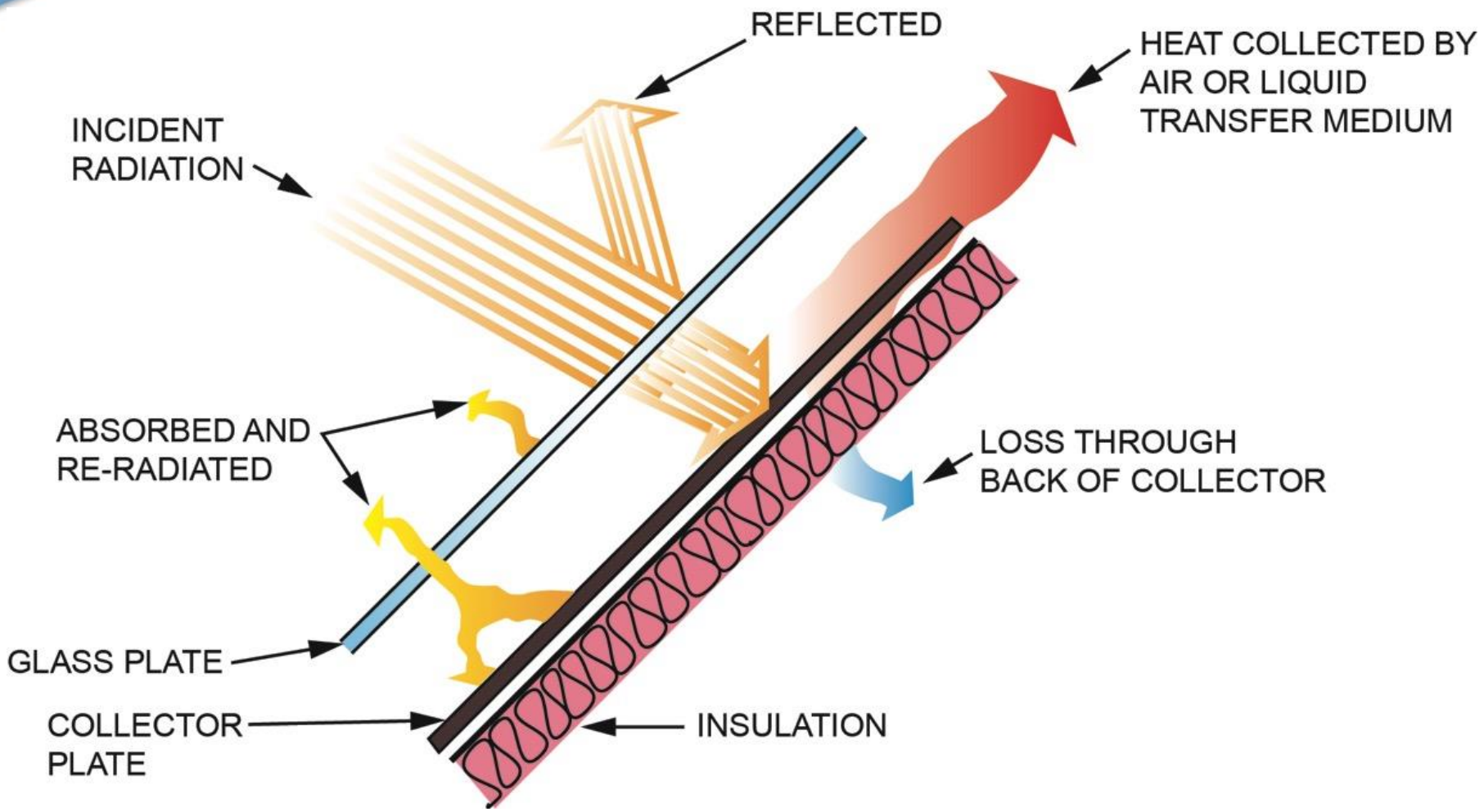
Unglazed Collector

- Converts solar radiation to heat energy
- Operates close to ambient air temperature
- Maximum temperature 15°C above ambient
- Typical sizes: 3 to 4 m^2



Unglazed Collector

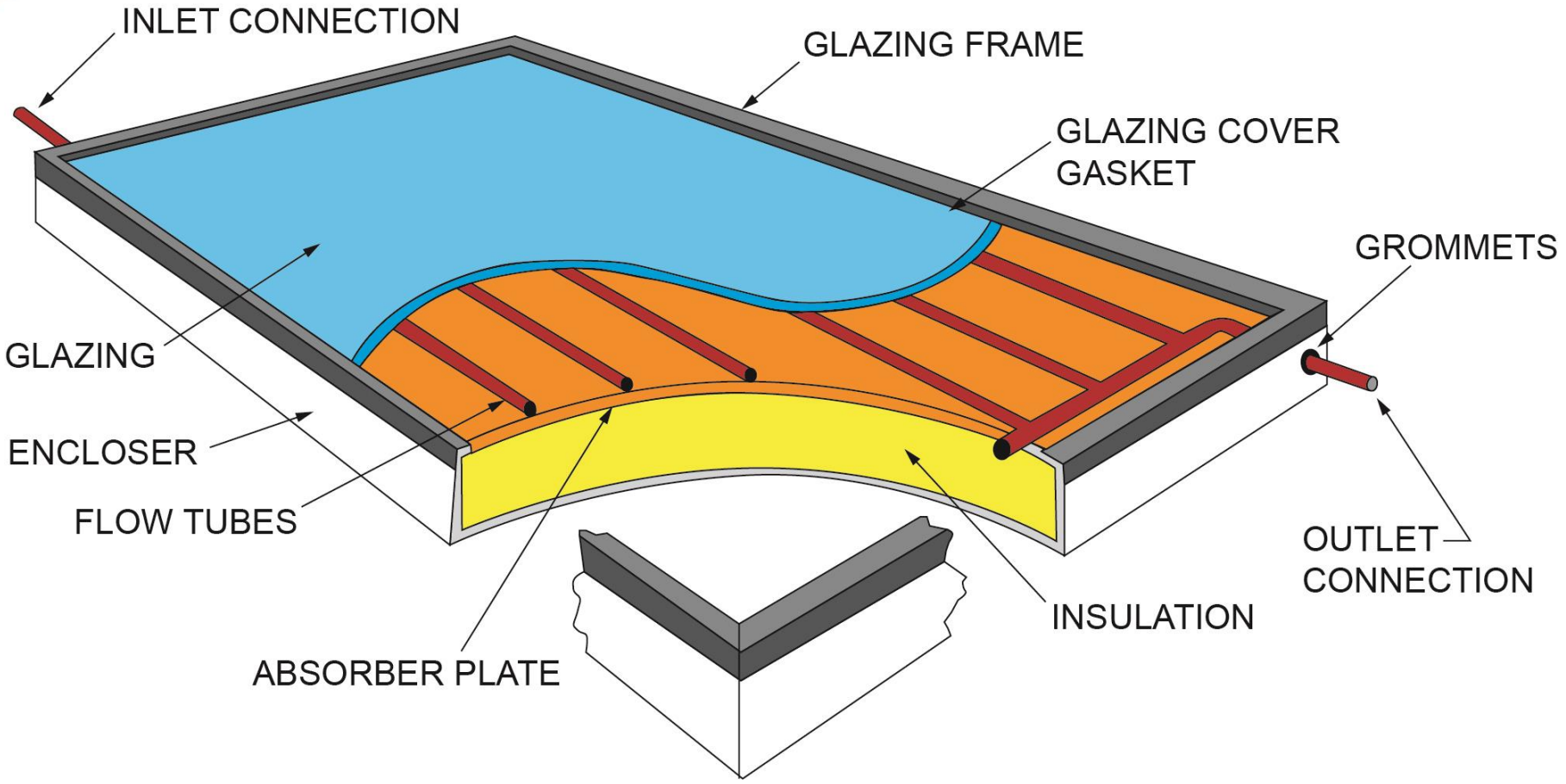
Solar Heating Mechanism Basics - Glazed Collector



Flat Plate Collector

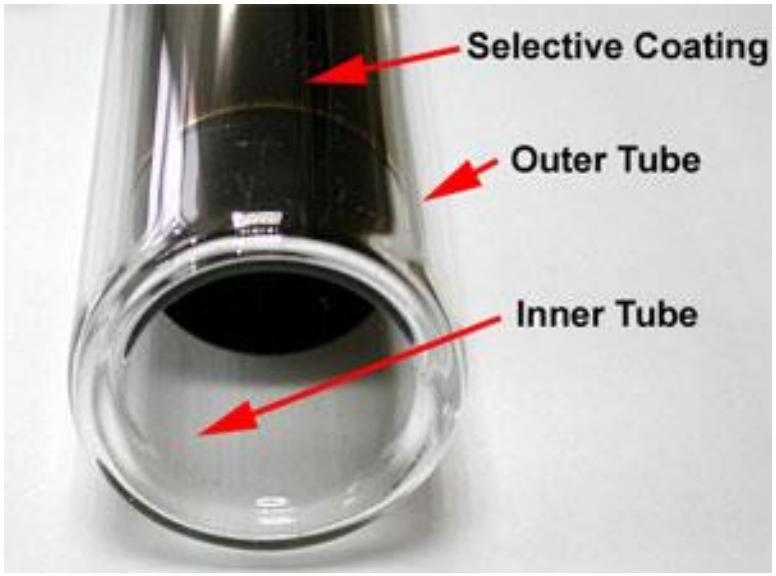
- Converts Solar Radiation to Heat Energy
- Hot box (greenhouse effect)
  - Car with windows up in summer
- Temperatures can exceed 175^{o}C in stagnant collector (no flow)
- Used in all climates
- Typical sizes: 2 to 4 m^2

Flat Plate Collector Components



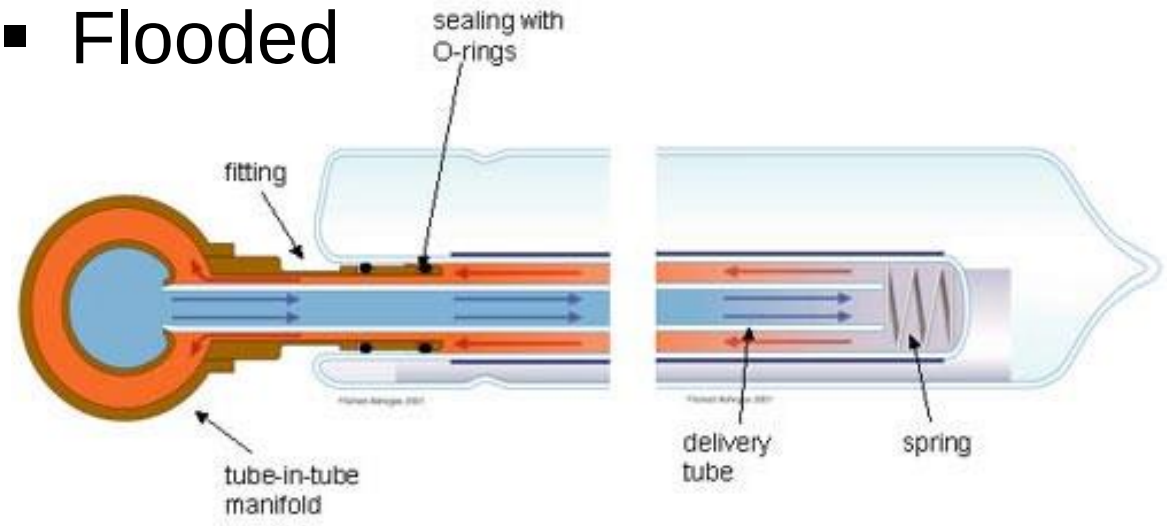
Evacuated Tube Collector

- Cylindrical glazing protects absorber
- Absorber surrounded by vacuum to reduce loss
- Temperatures can exceed 230^{o}C with no flow
- Used in cold climates or for high temperatures
- Typical sizes: 20 to 60 tubes

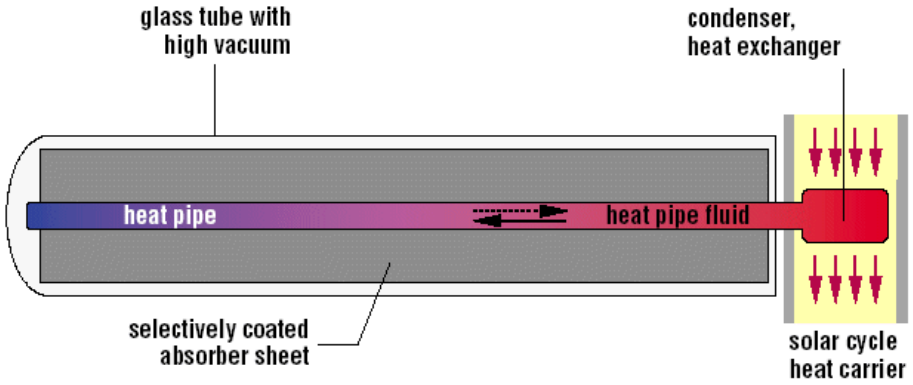


Tubular Flow Configurations

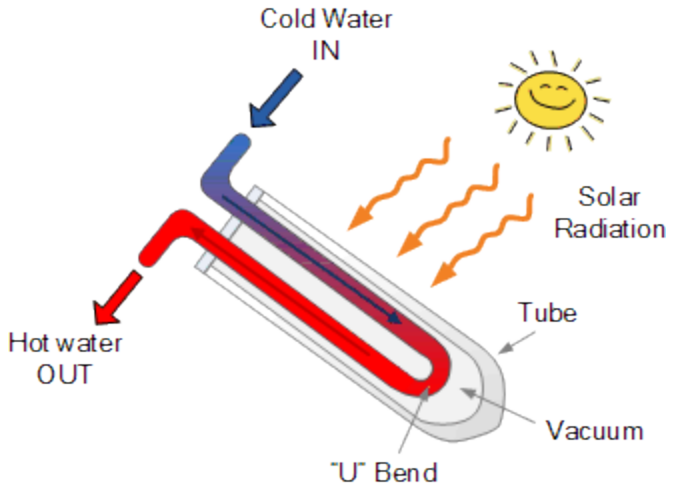
- Flooded



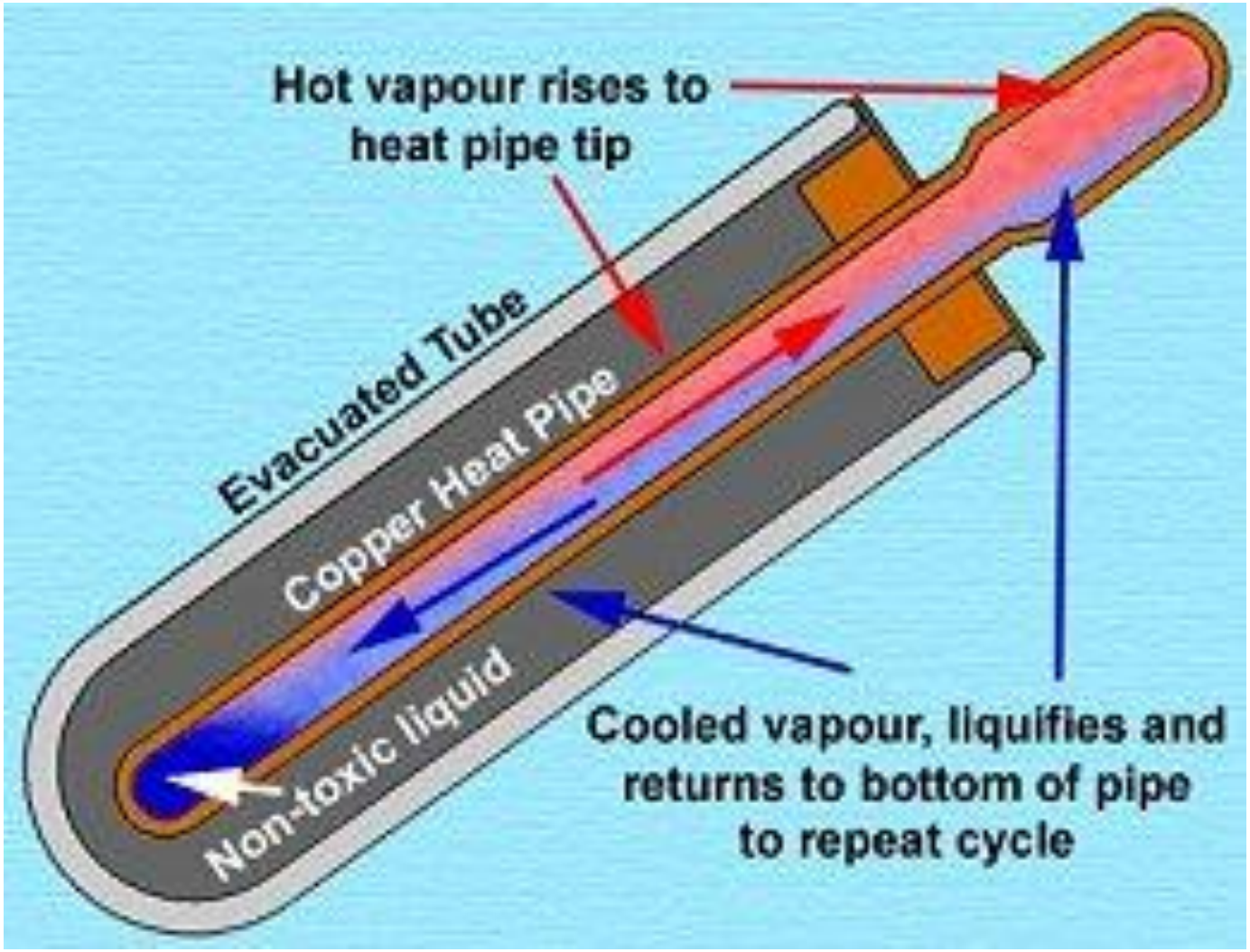
- Heat pipe



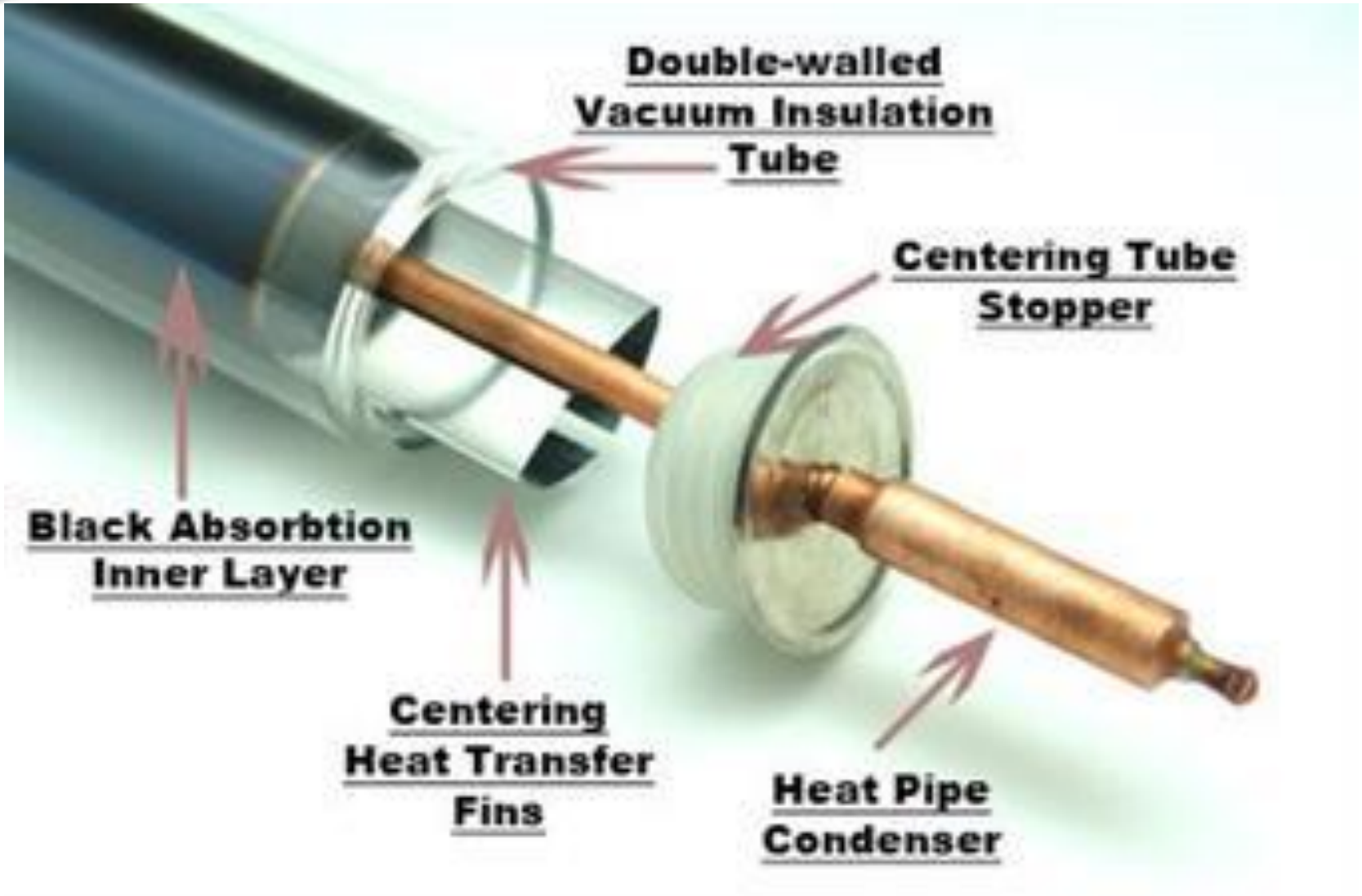
U-tube



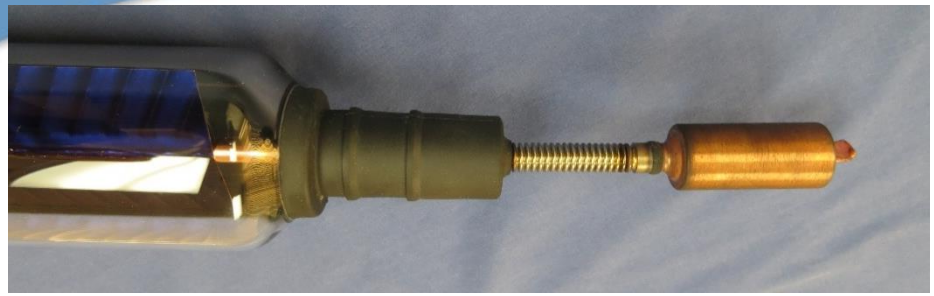
Heat Pipe Operation

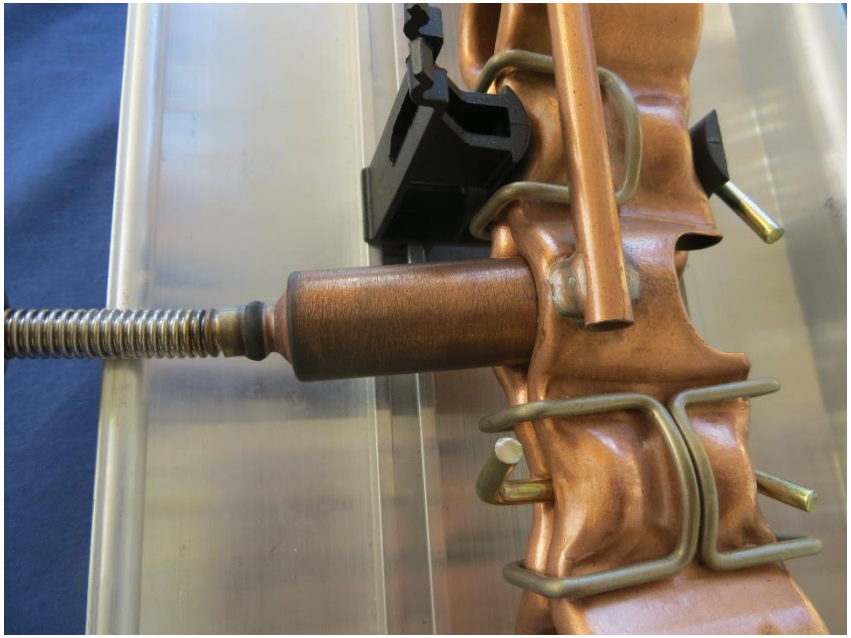


Evacuated Tube with Heat Pipe



Condenser Inserted in Header

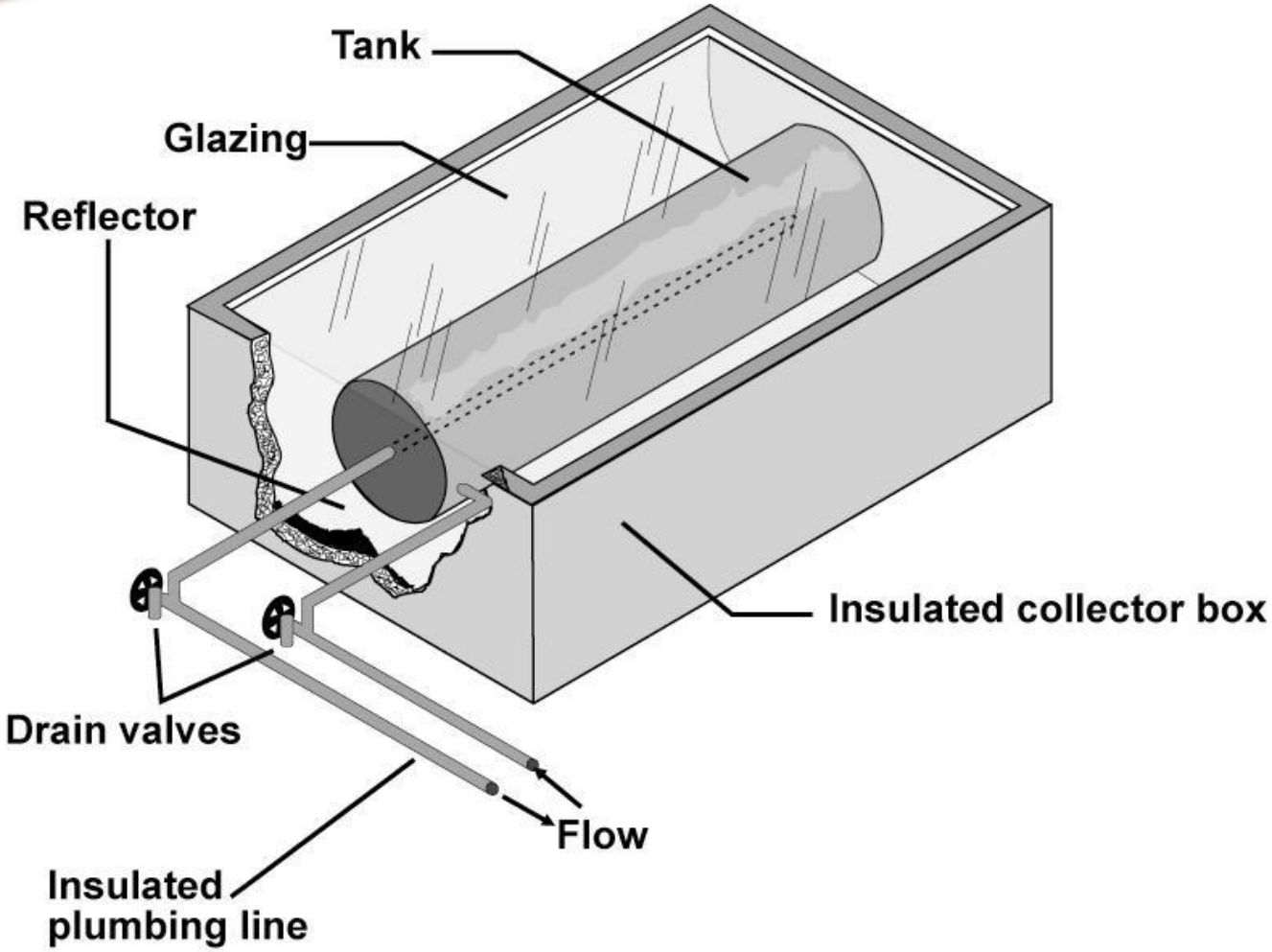




Evacuated Tube Collector

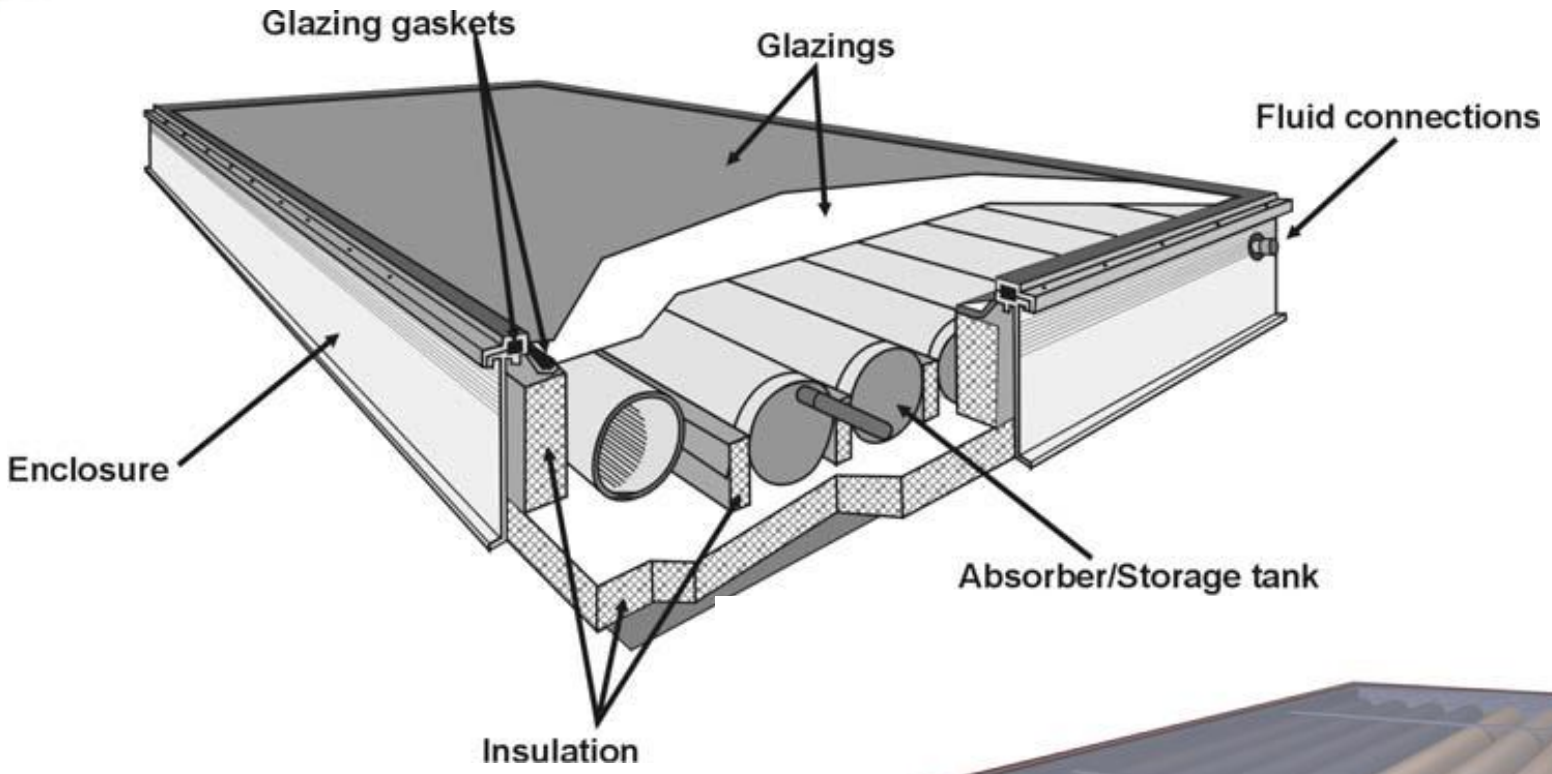
Failed Tube (lost vacuum)

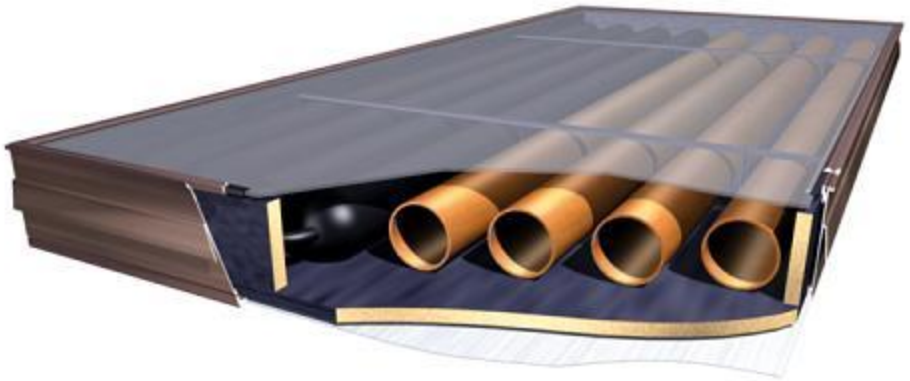
Integral Collector Storage Concept



- aka: Breadbox, Batch Heater, Tank-in-a-box, ICS

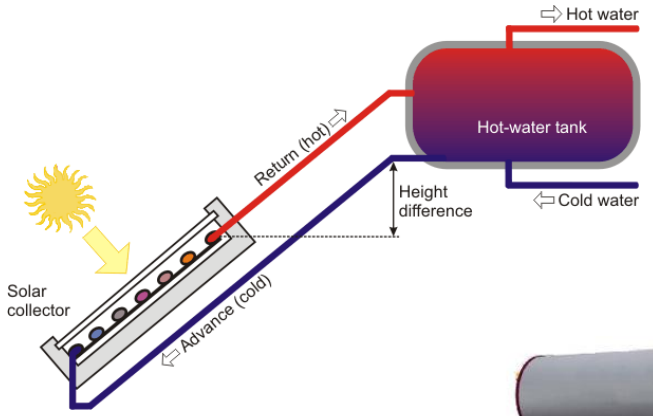
Modern ICS

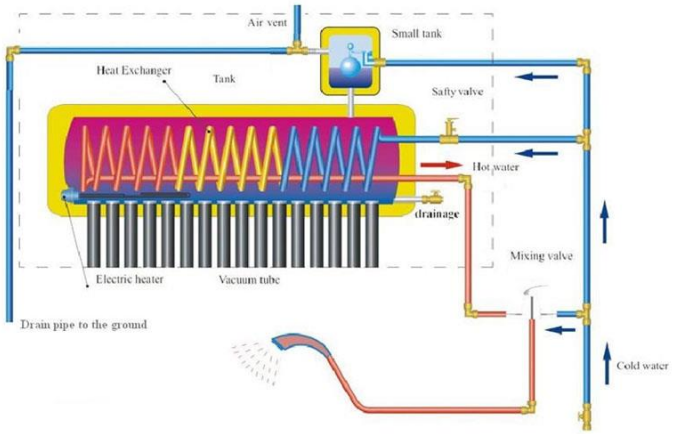

Glazing gaskets
Glazings
Fluid connections
Enclosure
Absorber/Storage tank
Insulation



Thermosiphon Collector

- Natural convection resulting from buoyancy
- Integrates storage with collection





Solar Water Heating Systems

Passive

Direct

Active

Indirect

ICC-SRCC
SOLAR RATING & CERTIFICATION CORPORATION

ICC INTERNATIONAL CODE COUNCIL

Solar Water Heaters

Active

Passive

- Direct Active
- Indirect Active
- Direct Passive
- Indirect Passive

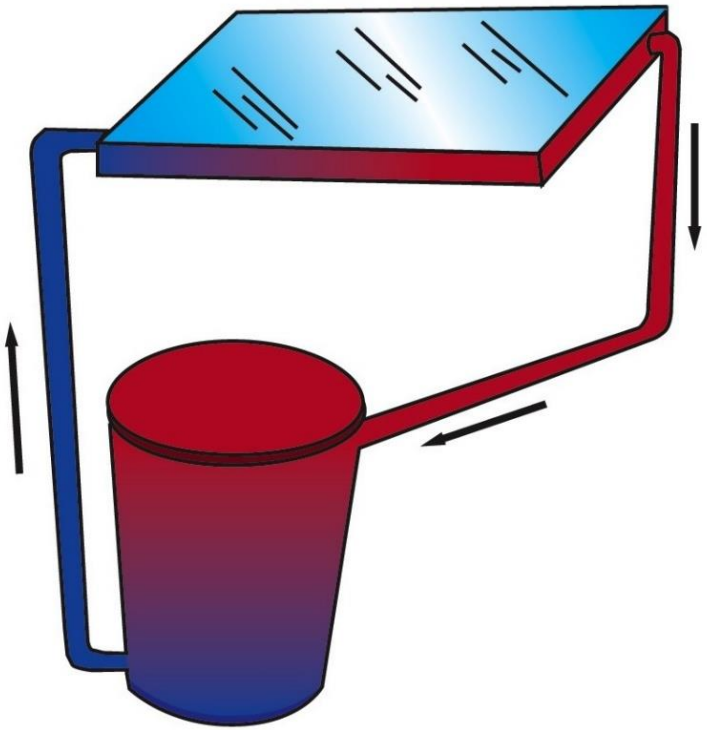
Circulation Types

Distinguished by mechanism used to circulate water through the system:

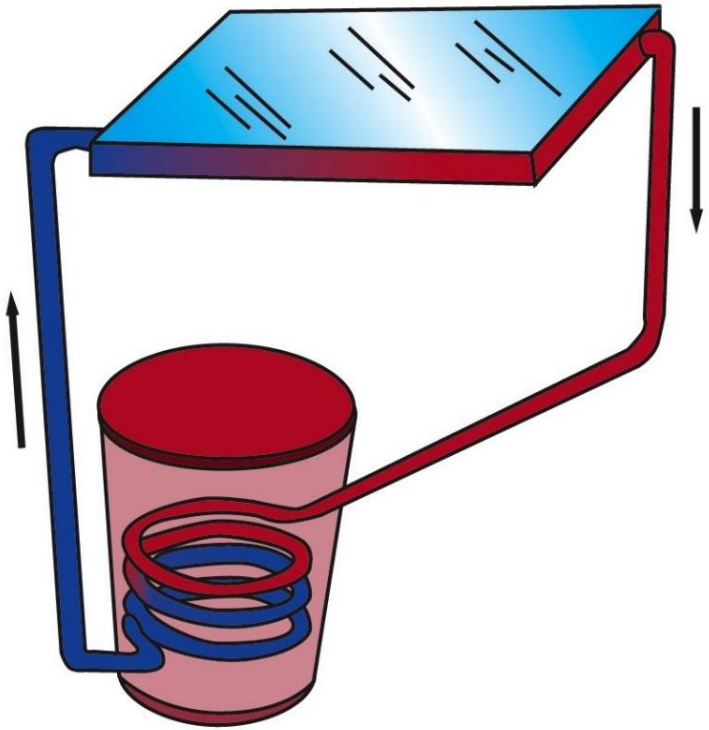
- ACTIVE
  - Uses one or more pumps

- PASSIVE
  - Uses natural convection via gravity and density

System Heating Categories



Direct



Indirect

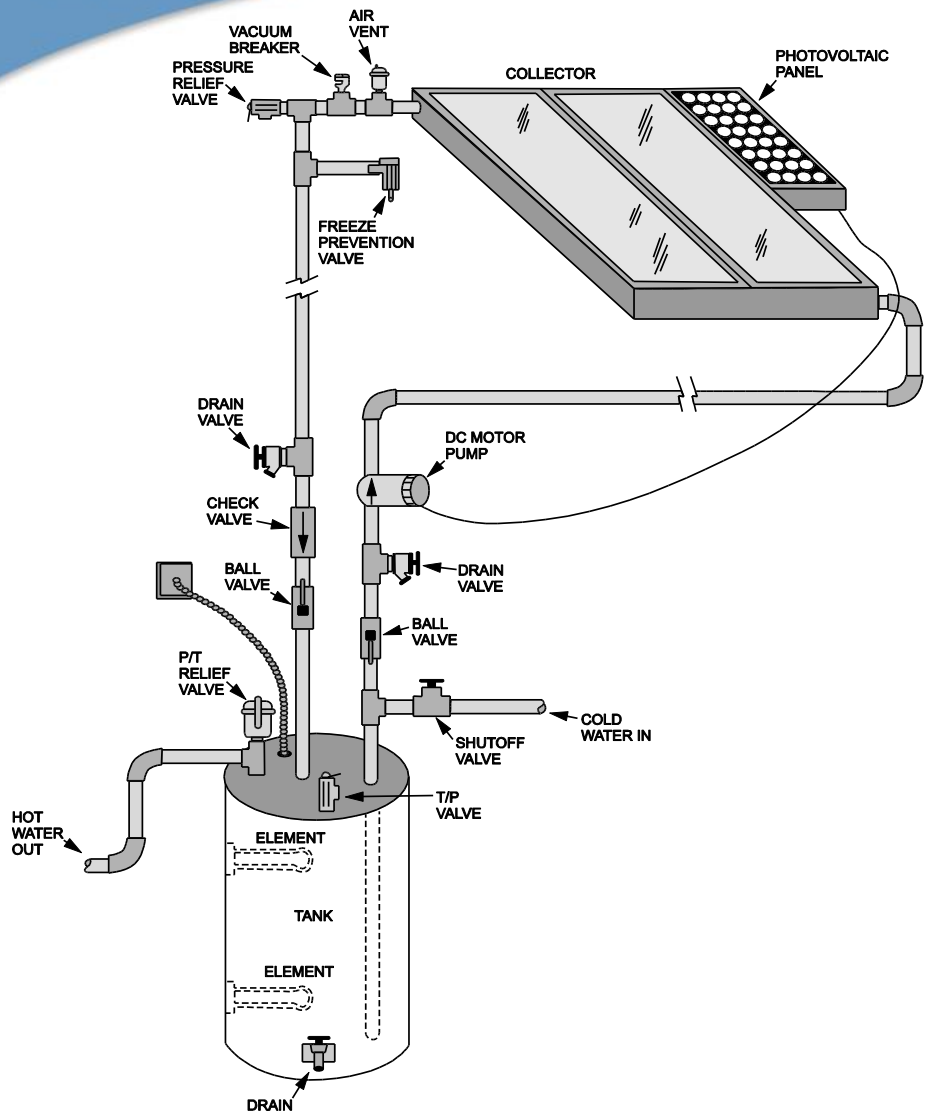
Thermosiphon System

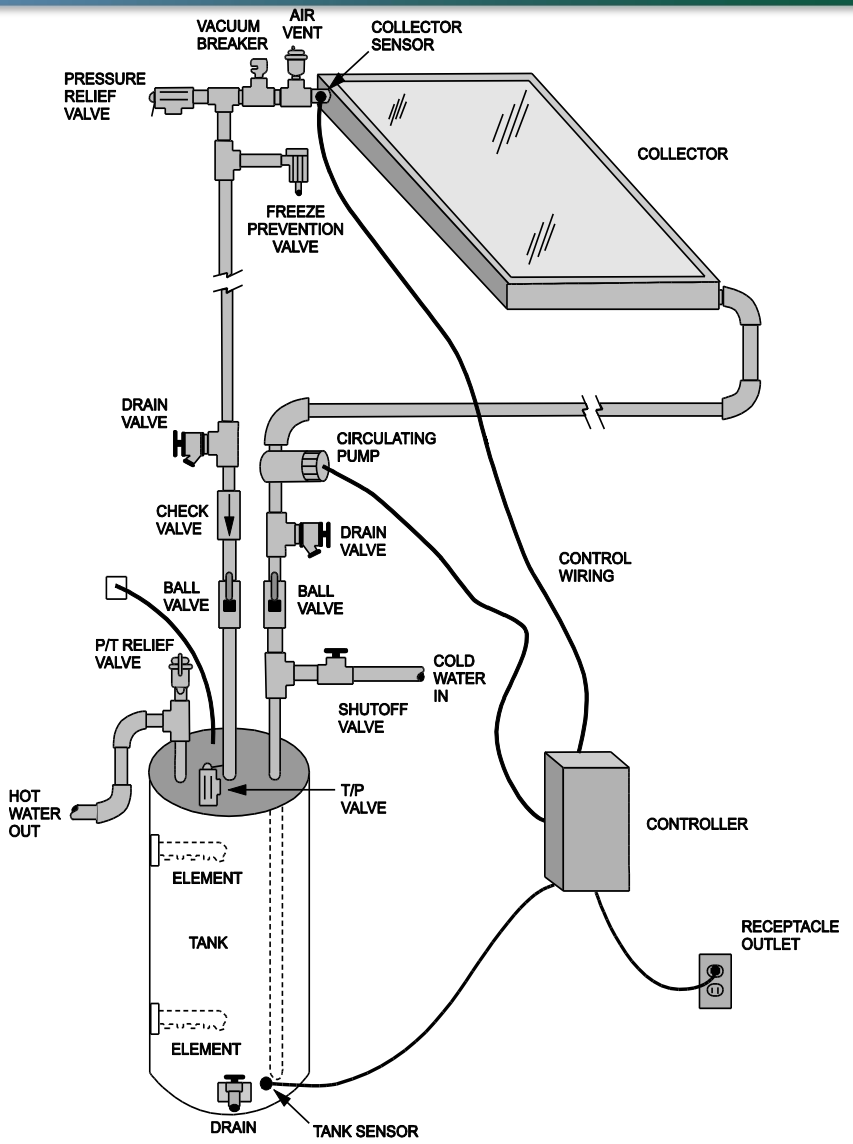
- Passive – Direct or Indirect

Tubular Thermosiphon System

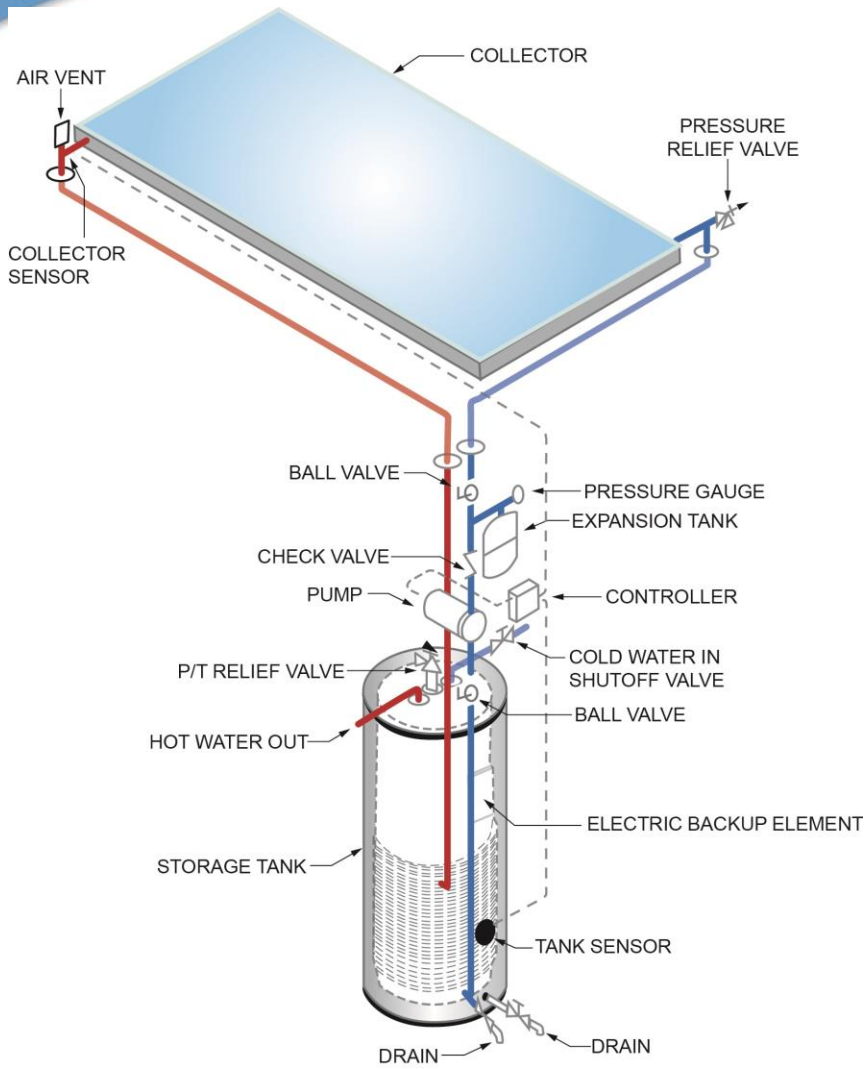
- Passive Indirect

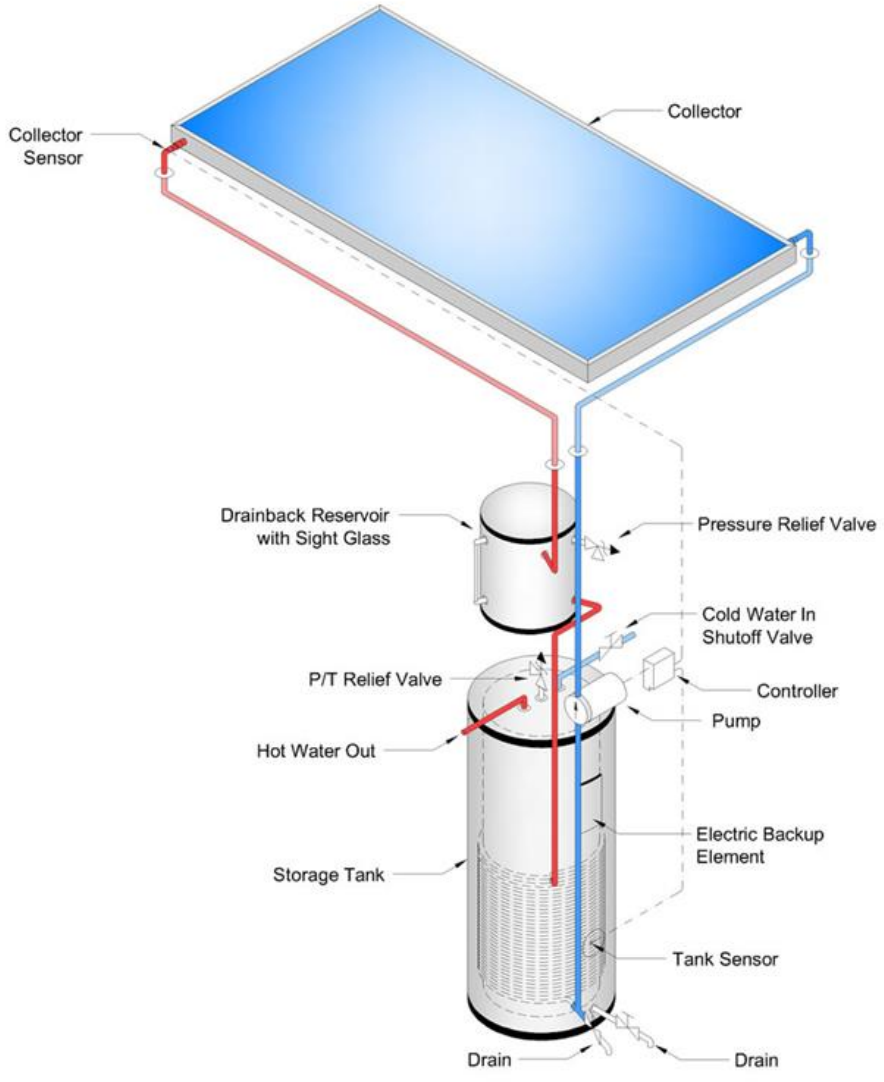
Active Direct Systems





Active Indirect System





Maintenance Considerations

- Active
  - Pumps (bearings, seals)
  - Control sensors (sensor/PV failure, wire damage, lightning strikes)
  - Valves (air vent, P and P&T, freeze)
  - Fluid - indirect systems (pH, viscosity)
- Passive
  - Fluid - indirect systems (pH, viscosity)

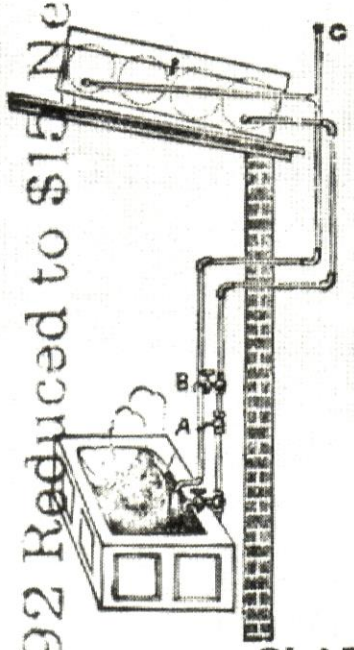
Solar Hot Water History

Climax Solar-Water Heater

UTILIZING ONE OF NATURE'S GENEROUS FORCES

THE SUN'S HEAT { Stored up in Hot Water for Baths, Domestic and other Purposes.

Price Of No. 1 Heater for 1892 Reduced to $15 Net



GIVES HOT WATER at all HOURS OF THE DAY AND NIGHT.

NO DELAY.

FLOWS INSTANTLY.

NO CARE. NO WORRY.

ALWAYS CHARGED. ALWAYS READY.

THE WATER AT TIMES ALMOST BOILS.

Price, No. I, $25.00

This Size will Supply sufficient for 3 to 8 Baths.

CLARENCE M. KEMP, BALTIMORE, MD.

Solar Water Heating in the U.S.

- 1970's Oil embargo increased interest in renewable energy
- Several states set up testing, certification & rating programs to:
  - Ensure quality and protect the industry's reputation
  - Provide consumers with a way to compare equipment
  - Provide utilities and state programs reliable ratings for incentives and rebates

Standards Development

SOLAR RATING & CERTIFICATION

INTERNATIONAL CODE COUNCIL

NBS TECHNICAL NOTE 899

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Development of Proposed Standards for Testing Solar Collectors and Thermal Storage Devices

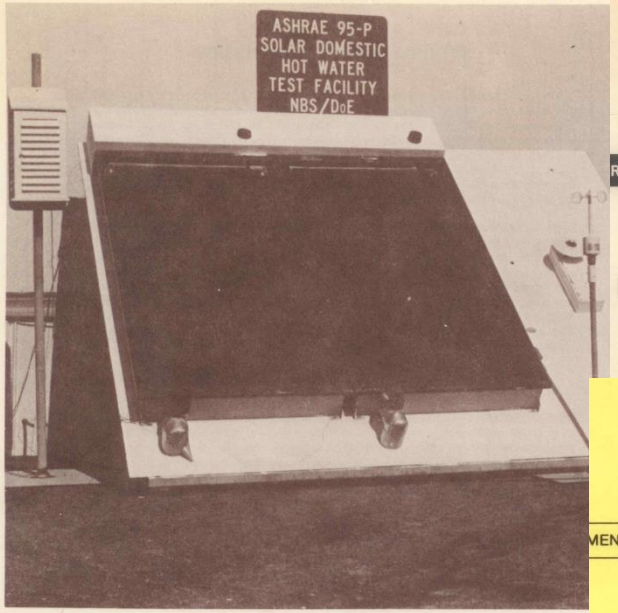
NBSIR 77-1305

Provisional Flat Plate Solar Collector Testing Procedures

NBSIR 78-1305A
Supersedes NBSIR 77-1305

Provisional Flat Plate Solar Collector Testing Procedures: First Revision

David Waksman
Elmer R. Streed
Thomas W. Reichard



NBS BUILDING SCIENCE SERIES 140

Analytical and Experimental Analysis of Procedures for Testing Solar Domestic Hot Water Systems

U.S. DEPARTMENT OF COMMERCE • NATIONAL BUREAU OF STANDARDS

NBSIR 77-1314

Solar Energy Systems - Survey of Materials Performance

NBS TECHNICAL NOTE 1140

RTMENT OF COMMERCE / National Bureau of Standards

Uncertainty in Determining Thermal Performance of Liquid-Heating Flat-Plate Solar Collectors

NBS TECHNICAL NOTE 1196

MENT OF COMMERCE/National Bureau of Standards

NBS Solar Collector Durability/Reliability Test Program: Final Report

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SOLAR RATING & CERTIFICATION CORPORATION

ICC INTERNATIONAL CODE COUNCIL

ASHRAE STANDARD

Methods of Testing to Determine the Thermal Performance of Solar Collectors

INTERNATIONAL STANDARD

ISO 9806

First edition
2013-11-15

Solar energy — Solar thermal collectors — Test methods

Énergie solaire — Capteurs thermiques solaires — Méthodes d'essai

Collector Performance

Efficiency =

(collected energy) / (available energy)

$= m \times C_p \times (To - Ti) / (\text{solar radiation})$

Collector Performance Measurements

Efficiency =

(collected energy) / (available energy)

$= m * C_p * (To - Ti) / (\text{solar radiation})$

Measure:

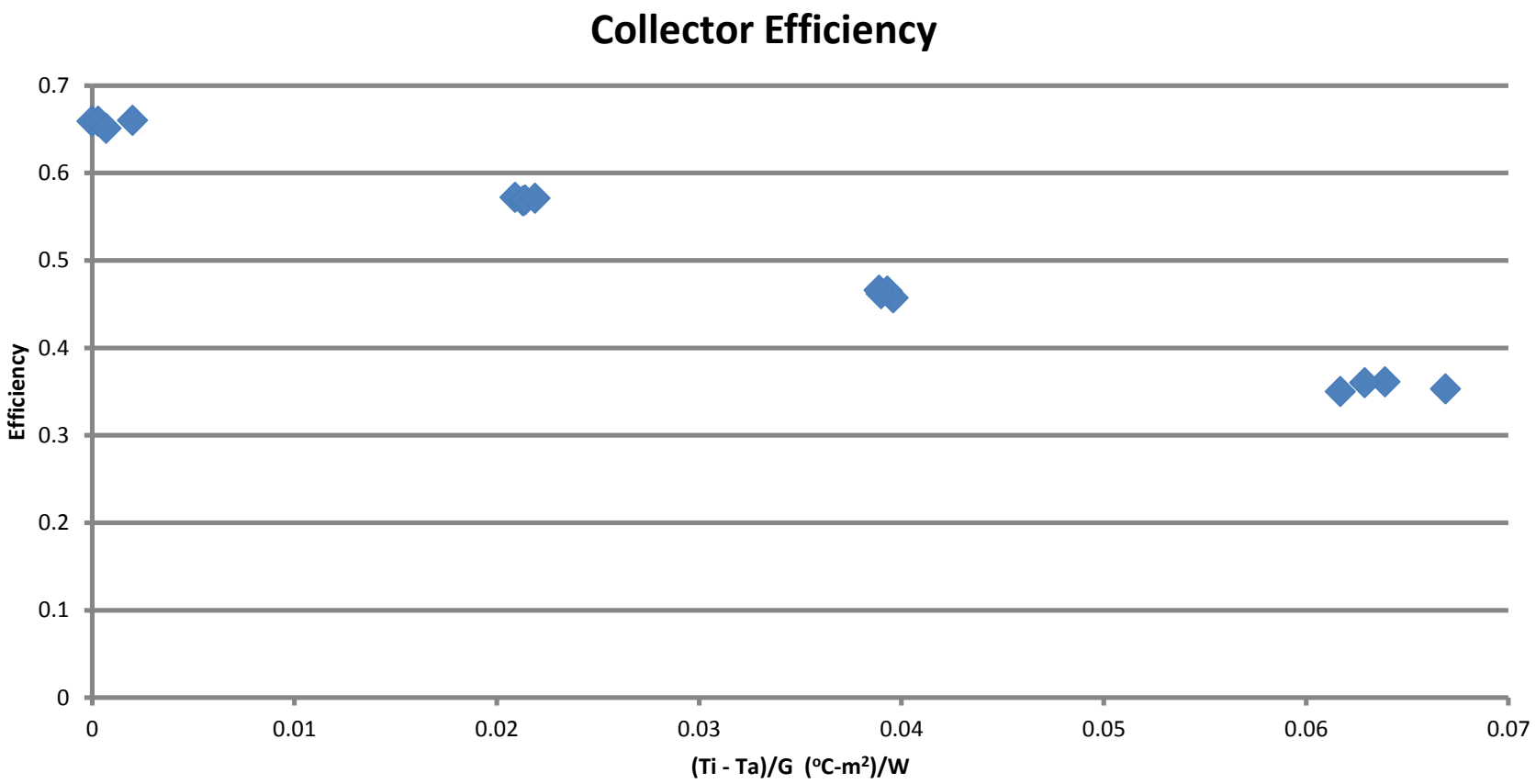
- Mass flow rate (m)
- Fluid outlet (To) and inlet (Ti) temperatures
- Solar radiation

Measurement Accuracy

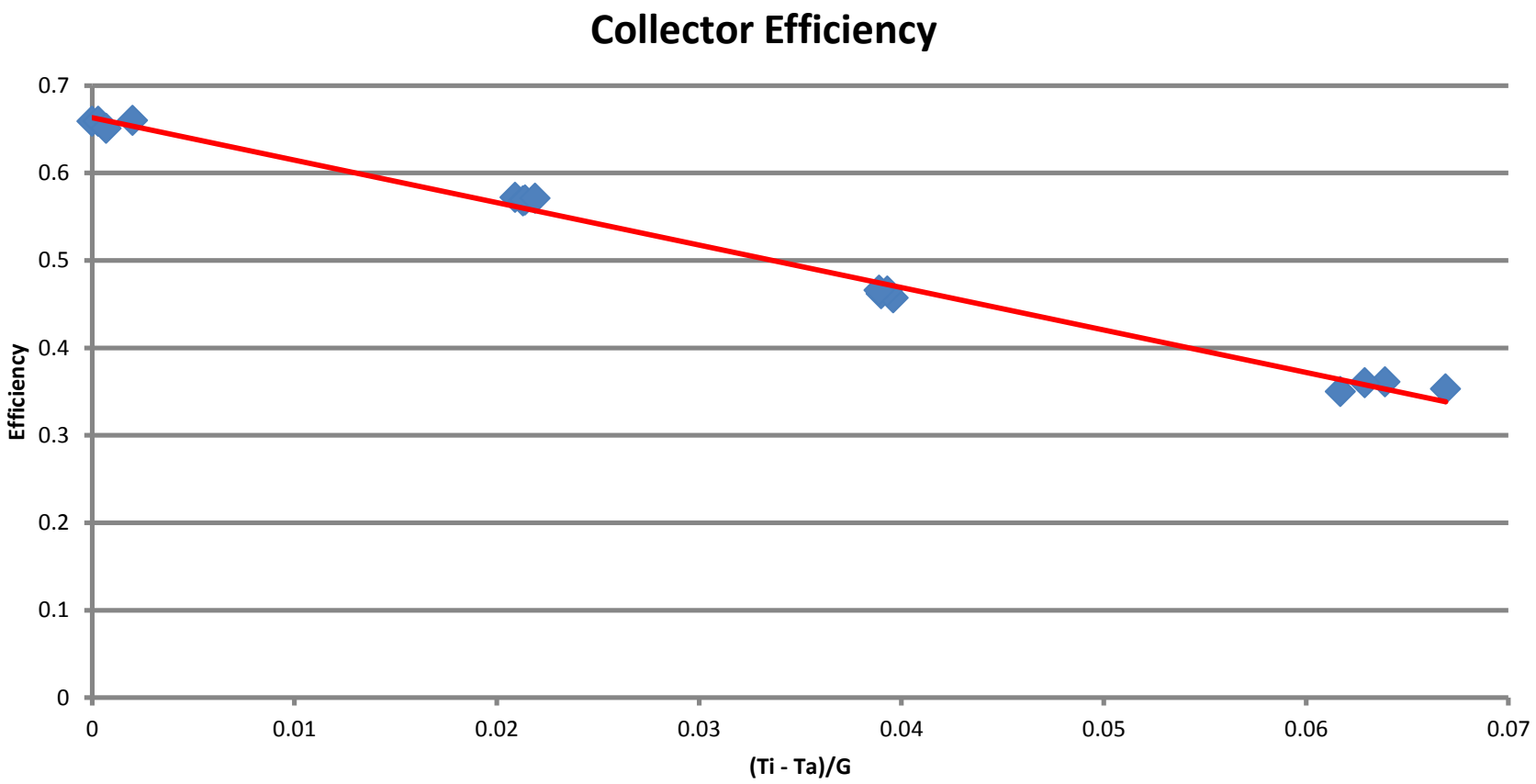
Measured Parameter	Sensor	Range	Accuracy* (Standard Uncertainty)	Resolution
Fluid (liquid) Temperature	Thermistor, Platinum Resistance Thermometer	0°C to 100°C	+/- 0.1 K	+/- 0.02 °C
Differential Fluid Temperature	Thermistor, Platinum Resistance Thermometer	0°C to 20°C	+/- 0.05 K	+/- 0.01 °C
Liquid Flow Rate	Turbine, Coriolis (Mass Flow)	0.01 to 0.1 kg/sec	+/- 1%	
Solar Radiation	Pyranometer, Pyrheliometer	0 to 1200 W/m^2	Class I per ISO 9060 (~ 2%)	
Ambient Air Temperature	Thermistor, Platinum Resistance Thermometer, Thermocouple	-5°C to 45°C	+/- 0.5 K	+/- 0.1 °C
Ambient Air Speed	Anemometer (3-cup, ultrasonic)	0 to 5 m/s	+/- 0.25 m/s	+/- 0.1 m/s

* Reference: ISO 9806

Solar Collector Test Data



Solar Collector Test Data

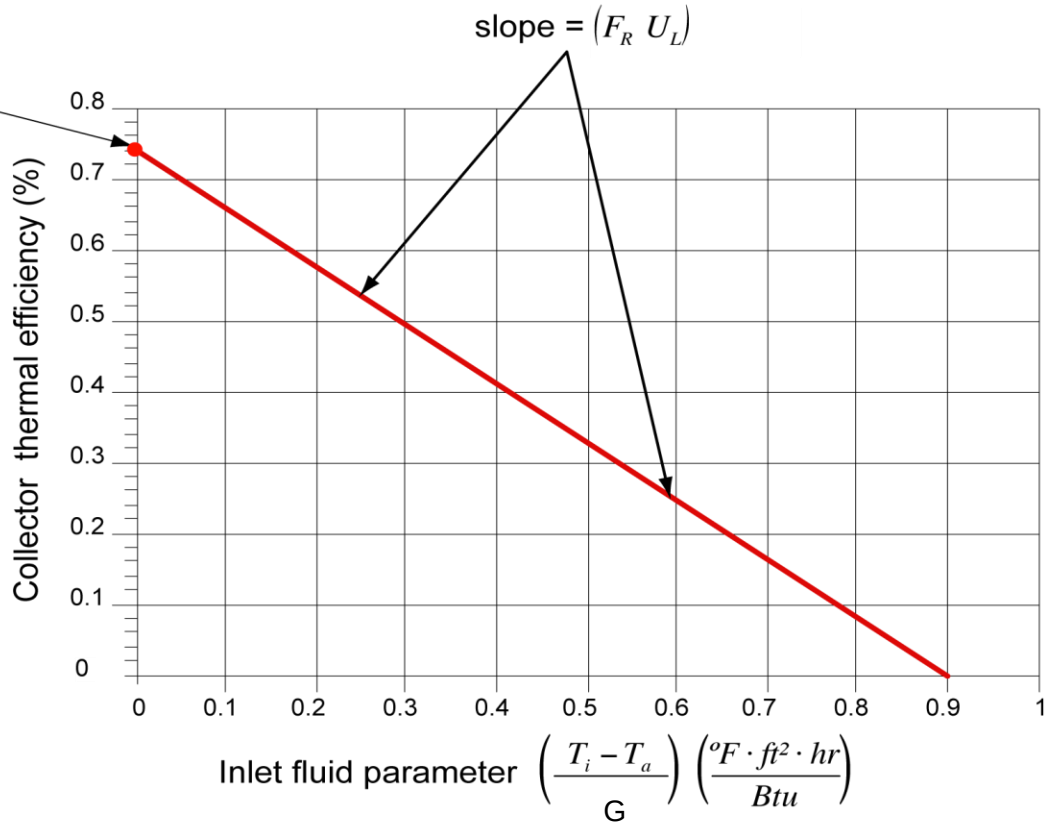


Collector Efficiency

Efficiency = Absorbed Energy – Lost Energy

$$\eta_{collector} = (F_R ta) - (F_R\ U_L) \times \left[\frac{T_i - T_a}{G}\right]$$

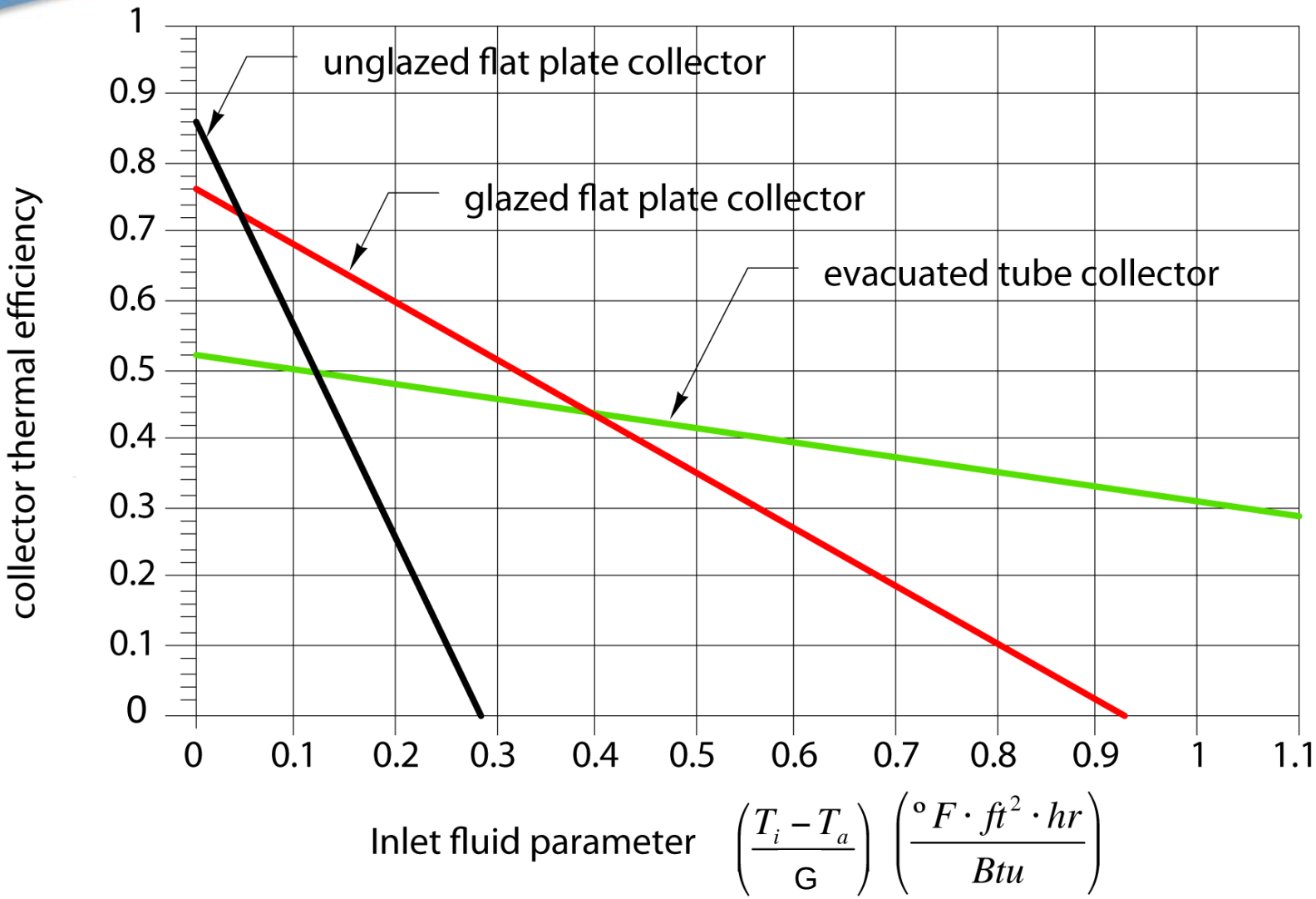
Where
T_i = Inlet fluid temperature to collector (ºF)
T_a = ambient air temperature surrounding collector (ºF)
G= solar radiation intensity incident on collector ($^oF \cdot ft^2 \cdot hr$)
$F_R ta$ = Y-intercept (determined through testing)
$F_R\ U_L$ = slope of efficiency line (determined through testing)



Y Intercept / Slope

TECHNICAL INFORMATION		Tested in accordance with: Standard 100			
ISO Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta]					
SI UNITS:	$\eta = 0.691 - 3.39600(P/G) - 0.01968(P^2/G)$	Y Intercept:	0.706	Slope:	-4.910 W/m².°C
IP UNITS:	$\eta = 0.691 - 0.59852(P/G) - 0.00193(P^2/G)$	Y Intercept:	0.706	Slope:	-0.865 Btu/hr.ft².°F

Collector Efficiency Comparison



Generalized Collector Performance

Collector Output =

$$\eta_{o,b} * K_b(\theta_L,\theta_T) * G_b + \eta_{o,b} * K_d * G_b -$$

(gain from direct beam radiation) (gain from diffuse radiation)

$$c_1(Ti - Ta) - c_2(Ti - Ta)^2 -$$ (loss to ambient temperature)

$$c_3\, u(Ti - Ta) - c_6 uG -$$ (loss due to wind)

$$c_4(E_L - \sigma T_a^4) - c_5(dT_i/dt)$$ (collector capacitance)

(radiation loss to sky)

Why Certification?

- Assures Quality
  - Independent third party evaluation of design
  - Ensures minimum standards are met
  - Participants benefit from reputable credentials
  - Comparable data on certified products in consistent formats
  - Regulatory Bodies/Code Inspectors can verify products meet minimum requirements

Quality ?

Certification Body (SRCC)

- Non-profit certification body, established in 1980, certifying solar thermal systems and components
- Develops consensus standards referenced in incentive programs and building codes
- Awards certifications that provide authoritative, standardized performance ratings for collectors and systems
- Expert recommendations and advice to government programs and other incentive entities by staff of internationally recognized experts
- Guidance and protection for consumers and various stakeholders

SRCC Certification Programs

- OG-100 – Solar Collectors
- OG-300 – Solar Water Heating Systems
- OG-400 – Swimming Pool Heating Systems (in development)

Approved Test Laboratories

Test Laboratories (16)

- U.S. (2)
- Canada(1)
- Europe (9)
  - Germany, Austria, Spain, Switzerland, Sweden
- Australia (2)
- China (2)

SRCC Certification Marks

Certification and Rating Process

- Standards define certification requirements
  - Collector:
    - Qualification Tests
      - Pressure, exposure, shock, impact tests from ISO 9806
    - Collector efficiency Test
      - Measure collected energy using procedures from ISO 9806
    - Standardized collector tests conducted by an approved laboratory
  - System:
    - Components requirements set for storage vessels, controls, heat exchangers, collectors, pumps, and balance of system (piping, insulation, wiring, etc.)
    - Stringent review of system design ensuring standards are met
- Rating conditions
  - Establish consistent operating conditions for all certified products

Collector Certification

- OG-100 Collector Certification
  - SRCC Standard 100 - “Test Methods and Minimum Standards” for Glazed and Unglazed Flat Plate and Tubular Collectors
  - Standard 600 for concentrating collectors
  - TM-1 for ICS and non-separable thermosiphon collectors
  - Standardized tests conducted by an SRCC-approved lab

Certificate

SOLAR RATING & CERTIFICATION CORPORATION

ICC INTERNATIONAL CODE COUNCIL

SOLAR RATING & CERTIFICATION CORPORATION

CERTIFIED SOLAR COLLECTOR

SUPPLIER:
Guangdong Fivestar Solar Energy Co., Ltd
Liuchongwei Administrative
Wanjiang District
Dongguan City, GUANGDONG 523051 China
www.fivestarsolar.com

In Accordance with:
SRCC Standard 100-2010-08

BRAND:	Fivestar
MODEL:	FS-PTY95-2.0
COLLECTOR TYPE:	Glazed Flat Plate
CERTIFICATION #:	2012043A
Original Certification:	August 30, 2012
Expiration Date:	July 18, 2024

The solar collector listed below has been evaluated by the Solar Rating & Certification Corporation™ (SRCC™), an ISO/IEC 17065 accredited and EPA recognized Certification Body, in accordance with SRCC OG-100, Operating Guidelines and Minimum Standards for Certifying Solar Collectors, and has been certified by the SRCC. This award of certification is subject to all terms and conditions of the Program Agreement and the documents incorporated therein by reference. This document must be reproduced in its entirety.

COLLECTOR THERMAL PERFORMANCE RATING

Kilowatt-hours (thermal) Per Panel Per Day				Thousands of Btu Per Panel Per Day			
Climate -> Category (Ti-Ta)	High Radiation (6.3 kWh/m².day)	Medium Radiation (4.7 kWh/m².day)	Low Radiation (3.1 kWh/m².day)	Climate -> Category (Ti-Ta)	High Radiation (2000 Btu/ft².day)	Medium Radiation (1500 Btu/ft².day)	Low Radiation (1000 Btu/ft².day)
A (-5 °C)	8.1	6.1	4.2	A (-9 °F)	27.8	21.0	14.2
B (5 °C)	7.4	5.4	3.4	B (9 °F)	25.1	18.3	11.6
C (20 °C)	6.1	4.2	2.2	C (36 °F)	20.9	14.2	7.6
D (50 °C)	3.5	1.8	0.3	D (90 °F)	12.0	6.1	1.0
E (80 °C)	1.2	0.1	0.0	E (144 °F)	4.1	0.2	0.0

A- Pool Heating (Warm Climate) B- Pool Heating (Cool Climate) C- Water Heating (Warm Climate)
D- Space & Water Heating (Cool Climate) E- Commercial Hot Water & Cooling

COLLECTOR SPECIFICATIONS

Gross Area:	2.000 m²	21.53 ft²	**Dry Weight:**	35 kg	77 lb
Net Aperture Area:	1.896 m²	20.41 ft²	**Fluid Capacity:**	1.7 liter	0.4 gal
Absorber Area:	1.896 m²	20.41 ft²	**Test Pressure:**	900 kPa	131 psi

TECHNICAL INFORMATION						**Tested in accordance with:** ISO 9806:1994
ISO Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta]						
SI UNITS:	η= 0.675 - 3.51220(P/G) - 0.02140(P²/G)		**Y Intercept:**	0.678	**Slope:**	-4.426 W/m².°C
IP UNITS:	η= 0.675 - 0.61900(P/G) - 0.00209(P²/G)		**Y Intercept:**	0.678	**Slope:**	-0.780 Btu/hr.ft².°F

Incident Angle Modifier								**Test Fluid:**	Water	
θ	10	20	30	40	50	60	70	**Test Mass Flow Rate:**	0.0200 kg/(s m²)	14.75 lb/(hr ft²)
Kτα	1.00	0.99	0.97	0.94	0.89	0.81	0.63	**Impact Safety Rating:** 11		

REMARKS:

Technical Director

ICC-SRCC OG-100 Certified

Print Date: October, 2015 Page 1 of 3
Please verify certification is active on the SRCC website.
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www.solar-rating.org ♦ 400 High Point Drive, Suite 400 ♦ Cocoa, Florida 32926 ♦ (321) 213-6037 ♦ Fax (321) 821-0910

Why Ratings?

- Product Comparison and Improvement
  - Performance is estimated
    - Standard rating conditions
  - Products can be compared
  - Participants strive to improve their products
  - Regulatory Bodies can calculate incentives
  - Buyers can make informed decisions

SRCC Collector Rating

- Based on:
  - 3 climates: High, Medium, Low Radiation
  - 5 operating temperatures (Ti – Ta):
    - - 5 = pool heating where pool is colder than air
    - 5 = pool heating where pool is warmer than air
    - 20 = domestic water heating (warm climate)
    - 50 = domestic water heating (cool climate)
    - 80 = air conditioning, process heating

SOLAR RATING & CERTIFICATION CORPORATION

ICC INTERNATIONAL CODE COUNCIL

CERTIFIED SOLAR COLLECTOR

SOLAR RATING & CERTIFICATION CORPORATION

SUPPLIER:
Guangdong Fivestar Solar Energy Co., Ltd
Liuchongwei Administrative
Wanjiang District
Dongguan City, GUANGDONG 523051 China
www.fivestarsolar.com

In Accordance with:
SRCC Standard 100-2010-08

BRAND:	Fivestar
MODEL:	FS-PTY95-2.0
COLLECTOR TYPE:	Glazed Flat Plate
CERTIFICATION #:	2012043A
Original Certification:	August 30, 2012
Expiration Date:	July 18, 2024

The solar collector listed below has been evaluated by the Solar Rating & Certification Corporation™ (SRCC™), an ISO/IEC 17065 accredited and EPA recognized Certification Body, in accordance with SRCC OG-100, Operating Guidelines and Minimum Standards for Certifying Solar Collectors, and has been certified by the SRCC. This award of certification is subject to all terms and conditions of the Program Agreement and the documents incorporated therein by reference. This document must be reproduced in its entirety.

COLLECTOR THERMAL PERFORMANCE RATING

Kilowatt-hours (thermal) Per Panel Per Day				Thousands of Btu Per Panel Per Day			
Climate -> Category (Ti-Ta)	High Radiation (6.3 kWh/m².day)	Medium Radiation (4.7 kWh/m².day)	Low Radiation (3.1 kWh/m².day)	Climate -> Category (Ti-Ta)	High Radiation (2000 Btu/ft².day)	Medium Radiation (1500 Btu/ft².day)	Low Radiation (1000 Btu/ft².day)
A (-5 °C)	8.1	6.1	4.2	A (-9 °F)	27.8	21.0	14.2
B (5 °C)	7.4	5.4	3.4	B (9 °F)	25.1	18.3	11.6
C (20 °C)	6.1	4.2	2.2	C (36 °F)	20.9	14.2	7.6
D (50 °C)	3.5	1.8	0.3	D (90 °F)	12.0	6.1	1.0
E (80 °C)	1.2	0.1	0.0	E (144 °F)	4.1	0.2	0.0

A- Pool Heating (Warm Climate) B- Pool Heating (Cool Climate) C- Water Heating (Warm Climate)
D- Space & Water Heating (Cool Climate) E- Commercial Hot Water & Cooling

COLLECTOR SPECIFICATIONS

Gross Area:	2.000 m²	21.53 ft²	Dry Weight:	35 kg	77 lb
Net Aperture Area:	1.896 m²	20.41 ft²	Fluid Capacity:	1.7 liter	0.4 gal
Absorber Area:	1.896 m²	20.41 ft²	Test Pressure:	900 kPa	131 psi

TECHNICAL INFORMATION						Tested in accordance with: ISO 9806:1994
ISO Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta]						
SI UNITS:	η= 0.675 - 3.51220(P/G) - 0.02140(P²/G)		Y Intercept:	0.678	Slope:	-4.426 W/m².°C
IP UNITS:	η= 0.675 - 0.61900(P/G) - 0.00209(P²/G)		Y Intercept:	0.678	Slope:	-0.780 Btu/hr.ft².°F

Incident Angle Modifier								Test Fluid:	Water	
θ	10	20	30	40	50	60	70	Test Mass Flow Rate:	0.0200 kg/(s m²)	14.75 lb/(hr ft²)
Kτα	1.00	0.99	0.97	0.94	0.89	0.81	0.63	Impact Safety Rating: 11		

REMARKS:

System Certification

- SRCC Standard 300 for Residential and Commercial Systems
  - Design Review
    - Functional evaluation
    - OG-300 requirements:
      - Component design
      - Reliability and Durability
      - Safety
      - Installation
  - Installation and Operation Manual(s)

System Ratings

- TRNSYS computer model
- One-day profile
  - Weather and load like DOE water heater test
  - Solar Energy Factor (SEF)
  - Solar Fraction (SF)
- Annual profile
  - Annual weather with daily load profile
  - SEF, SF, and energy savings
  - 100+ Cities

SOLAR RATING & CERTIFICATION CORPORATION

ICC INTERNATIONAL CODE COUNCIL

CERTIFIED SOLAR SYSTEM

SOLAR RATING & CERTIFICATION CORPORATION

SUPPLIER:
Solahart Industries
101 Bell Road
Montgomery, AL 36117 USA
www.solahart.com.au

In Accordance with:
SRCC Standard 300-2014-07

BRAND:	Solahart
MODEL:	ASG 444SP
SYSTEM TYPE:	Thermosiphon, Indirect
CERTIFICATION #:	30004134
Original Certification:	August 04, 2015
Expiration Date:	August 04, 2020

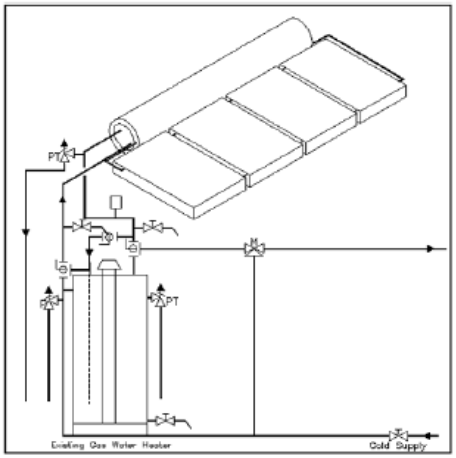
The solar system listed below has been evaluated by the Solar Rating & Certification Corporation™ (SRCC™), an ISO/IEC 17065 accredited and EPA recognized Certification Body, in accordance with SRCC OG-300, Operating Guidelines for Certifying Solar Water Heating Systems, and has been certified by the SRCC. This award of certification is subject to all terms and conditions of the Program Agreement and the documents incorporated therein by reference. This document must be reproduced in its entirety.

Description: Glazed Flat Plate, -7 °C 19 °F, GRAS, UL listed electric tank, Fluid, Other

Single-day Rating	
Solar Energy Factor (SEF_D)	Solar Fraction (SF_D)
1.2	0.48

Single-day Rating Conditions:
SEF_D = Solar Energy Factor (info link)
SF_D = Solar Fraction (info link)

SINGLE DAY RATING CONDITIONS	SI Units	Inch-Pound Units
System Set Temperature	57.2 °C	135 °F
Environmental Temperature	19.7 °C	67.5 °F
Ambient Temperature Profile Average	14.4 °C	58 °F
Water Mains Temperature	14.4 °C	58 °F
Delivered Load	43.3 MJ/day	41,045 Btu/day
Solar Irradiance	4,733 Wh/m^2-day	1,500 Btu/ft^2-day



Storage Tank(s)			
Solar Tank Vol (l)	Solar Tank Vol (gal)	Aux Tank Vol (l)	Aux Tank Vol (gal)
400	106	189	50
Note: The auxiliary tank can have a volume between 132 and 246 liters (35 and 65 gallons).			
Approximate Collector Area: 8.3 m², 89.6 ft²			

The solar water system listed here has been certified by the SRCC as meeting the minimum standards for testing, installation, operation, maintenance, performance, reliability and safety as specified in SRCC Document OG-300. Thermal performance ratings are based on the successful durability and performance testing of a sample collector, where said tests have been conducted by an independent laboratory approved and listed by the SRCC. The system has been modeled using the computer simulation program TRNSYS to calculate the ratings.

Before the Supplier can make any change in design, materials, specifications, parts, or construction, the change(s) must be reported to the SRCC for evaluation of continued certification.

REMARKS:

Jeri Huggins
Technical Director

ICC-SRCC OG-300 Certified

Please verify certification is active on the SRCC website.
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Specific Locations

SOLAR RATING & CERTIFICATION CORPORATION

ICC INTERNATIONAL CODE COUNCIL

SOLAR RATING & CERTIFICATION CORPORATION

CERTIFIED SOLAR SYSTEM

SUPPLIER:
Solahart Industries
101 Bell Road
Montgomery, AL 36117 USA
www.solahart.com.au

In Accordance with:
SRCC Standard 300-2014-07

BRAND:	Solahart
MODEL:	ASG 444SP
SYSTEM TYPE:	Thermosiphon, Indirect
CERTIFICATION #:	30004134
Original Certification:	August 04, 2015
Expiration Date:	August 04, 2020

The solar system listed below has been evaluated by the Solar Rating & Certification Corporation™ (SRCC™), an ISO/IEC 17065 accredited and EPA recognized Certification Body, in accordance with SRCC OG-300, Operating Guidelines for Certifying Solar Water Heating Systems, and has been certified by the SRCC. This award of certification is subject to all terms and conditions of the Program Agreement and the documents incorporated therein by reference. This document must be reproduced in its entirety.

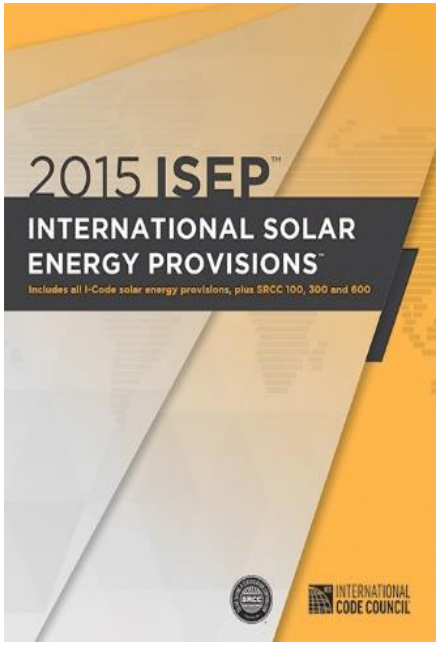
Annual Ratings in AZ - Phoenix		
Solar Energy Factor (SEF_A)	Solar Fraction (SF_A)	Energy Savings (kWh)
2.5	0.77	4160

Annual Rating using hourly weather data for the chosen city:
SEF_A = Solar Energy Factor (info link)
SF_A = Solar Fraction (info link)
Energy Savings = Estimated annual energy saved compared to a conventional water heater using the same type of backup

Only the following options for the collector array are approved:

Option	Collector Panel Manufacturer	Collector Panel Request Number	Collector Panel Model Number	Collector Panel Name	Quantity	Total Panel area(m²)	Total Panel area(ft²)
1	Solahart Industries	10001951	SPA2000	Solahart	4	8.33	89.64

Building Codes



Global Solar Certification Network

Members in Network and Board

Europe
- Certification schemes
  - Solar Keymark
- Industry representatives
  - ESTIF
  - National associations

North America
- Certification schemes
  - SRCC
  - IAPMO
  - CSA
- Industry representatives
  - SEIA
  - CANSIA

Asia / Oceania
- Certification schemes
  - Golden Sun
  - …
- Industry representatives
  - …

Global Solar Certification Network

From each certification scheme in each region:
- All industry representatives
- All certification bodies
- All test labs
- All inspectors

All members shall be official members of a regional certification scheme.

Global Solar Certification Board

From each Region two representatives from:
- Industry
- Certification bodies
- Test labs

Members of Board are elected by Network
Members in board: 6 x no. active Regions
Elected Board propose GSC Chairman to be confirmed by Network
Elected Board decides it self on other Board Officers

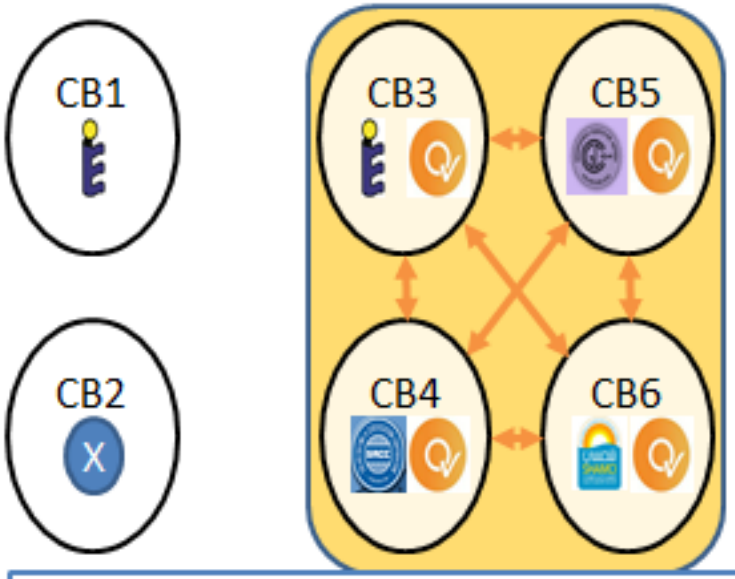
Africa / Middle East
- Certification schemes
  - SHAMCI
  - …
- Industry representatives
  - …

South America
- Certification schemes
  - …
- Industry representatives
  - …

J.B.Nielsen, 2014-04-04

Global Solar Certification Concept

CB = Certification Body



= Keymark (EU)

= SRCC mark (US)

= Golden Sun (CN)

= SHAMCI (North Africa / Middle East)

X = not participating in the GSC

Global Solar Certification makes it possible for manufacturers to utilize existing local certification to obtain certification around the world without re-testing and re-inspection.

If a manufacturer obtains the Global Mark at e.g. CB3, he will have easy access to other Local Marks via CB4, CB5 and CB6.

ICC-SRCC
SOLAR RATING & CERTIFICATION CORPORATION

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Global Solar Certification - from Industry Point of View

First certification (participating scheme):

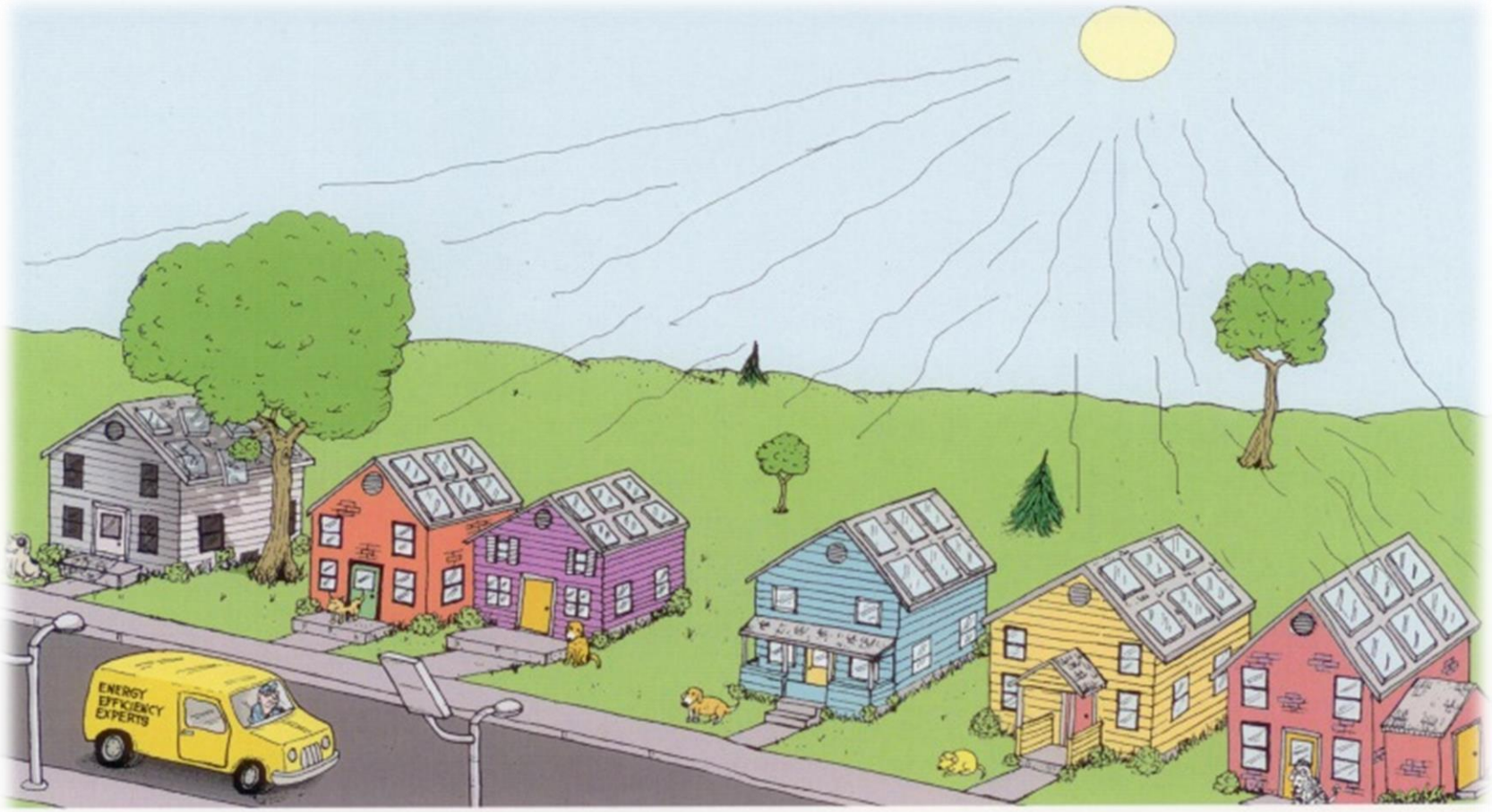
- Initial inspection and sampling
- Testing
- Annual inspection
- Certification

Next certification (other participating scheme):

- No further inspections
- No re-testing (supplementary tests may apply)
- New certificate (fee)

Global Solar Certification makes it possible for manufacturers to utilize existing local certification when obtain other local certification

Credentials Matter



Quality is quiet. **MISTAKES** are not.

Contact Information

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