Solar Thermal Energy Technology and Market Trends

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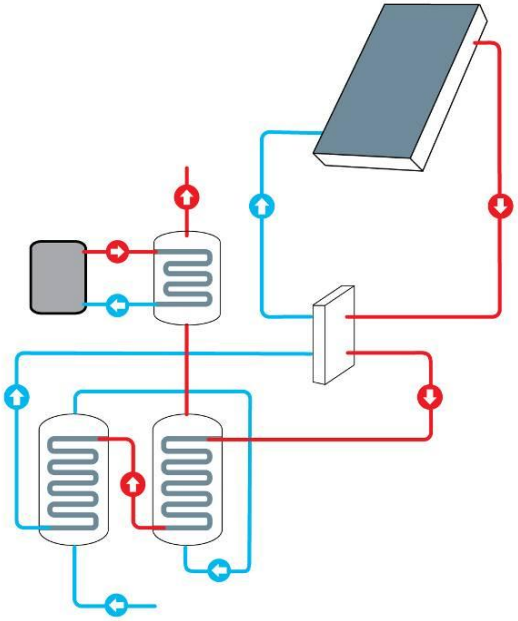


Topics

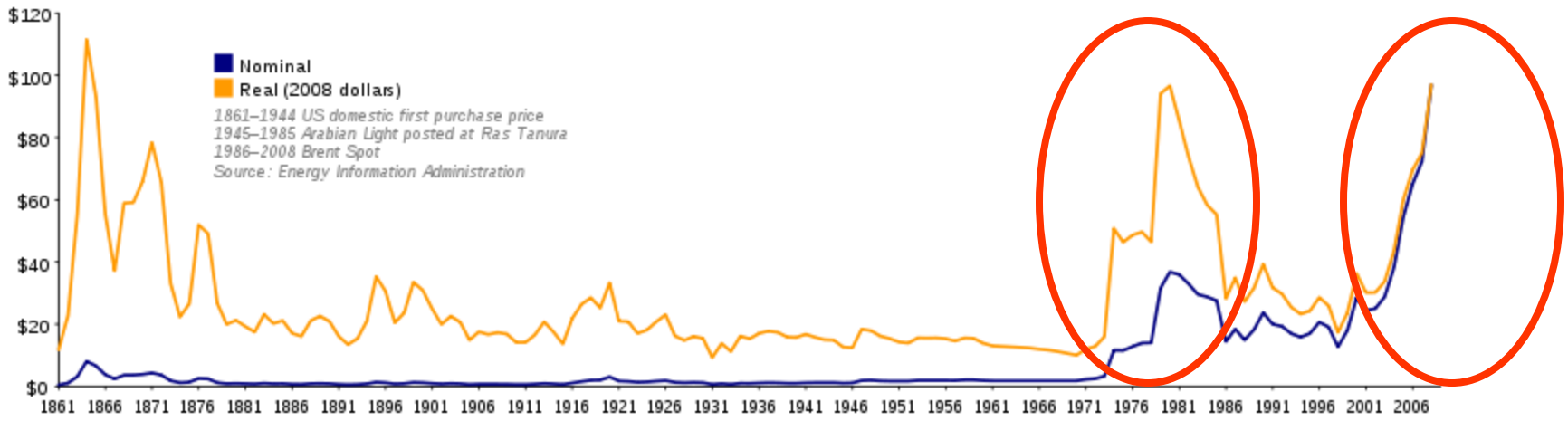
- Discussion of current market shaping trends affecting solar thermal industry: energy prices, environmental concerns, public awareness, incentives and information on where to find them, certification issues
- Types of solar thermal collectors and systems now used, pros/cons of evacuated tubes and flat plate collectors
- Examples of various residential and commercial system designs

Market Transformation

- Primary Drivers for Change
  - Increase in conventional energy costs as global demand for resources heats up
    - U.S. desire for energy independence
  - Need for U.S. job creation
    - Great Recession of 2009
  - Global Pressure to reduce carbon emissions
    - Global Warming
    - Green Initiative

Market Transformation

- 1970's vs. Today
  - In the 1970's prices spiked due to geo-political pressures…The Arab Oil embargo.



  - Today, Supply & Demand Pressures are driving prices…Growth of Emerging Markets (China, India, Brazil) and Global Warming Concerns

Market Transformation

- Incentives for Change
  - State Renewable & Alternative Energy Portfolio Standards
  - DOE Standards and New Construction Requirements
  - Federal & State Government incentive programs for the end-user

Market Transformation

Renewable Portfolio Standards

State	Target	Year	Legislation
Arizona	15%	2025	RPS
California	20%	2010	SB 107
*Colorado	20%	2020	HBl 1281
Connecticut	27%	2020	HB 7432
**Delaware	20%	2019	SB 19
Florida	20%	?	HB 7135 & EO 07-127
Hawaii	40%	2030	HB 1464
Illinois	25%	2025	Public Act 095-0481
***Iowa	105MW from Renewable		
Kansas	20%	2020	HB 2369
Maine	10%	2017	1999 RPS2007 Law
****Maryland	20%	2022	SB 209 & SB 595
Massachusetts	25%	2020	SB 2768
*****Michigan	10%	2015	SB 213
******Minnesota	25%	2025	SB 4
*******Missouri	15%	2021	SB 54
Montana	15%	2015	SB 415

* At least 4% Solar, Large investor owned 20%, municipal and Rural utilities 10% by 2020
** At least 2% Solar PV….Thermal Solar not mentioned
*** Alternative Energy Production Law…does not mention Thermal Solar
****Solar carve out of 2%...not clear if Thermal Solar qualifies or if only Solar PV
*****Up to 10% of the RPS can be met with advanced clean energy technologies
******Ecel Energy must reach 30% by 2020…currently product 1/1 of the states energy
*******2% must come from Solar energy

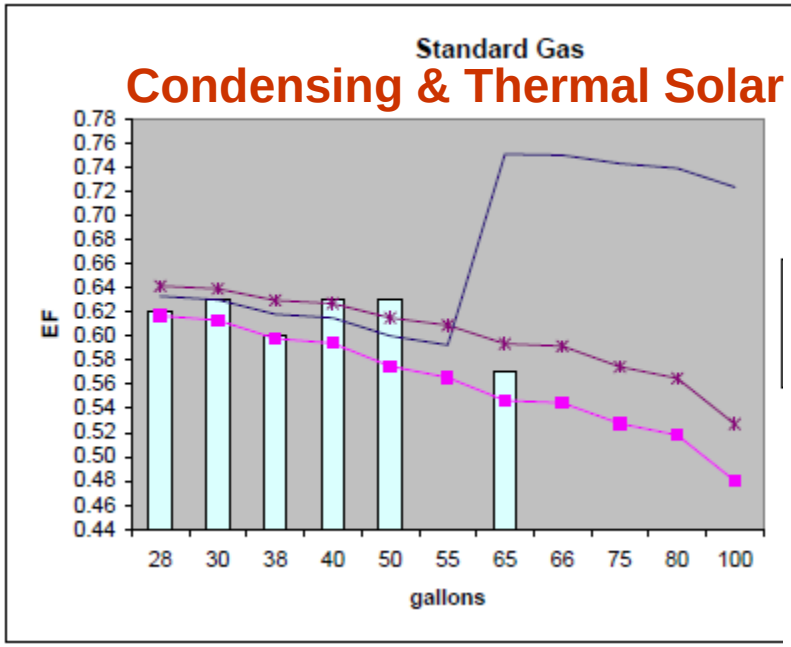
State	Target	Year	Legislation
*Nevada	25.0%	2025	AB 3 & SB 395
New Hampshire	25.0%	2025	HB 873
New Jersey	22.5%	2025	14 N.J.A.C. 8-2
New Mexico	20.0%	2020	SB 418
**New York	25.0%	2013	NY Public Service Comm.
North Carolina	12.5%	2021	SL 2007-397
Ohio	12.5%	2025	SB 221
***Oregan	25.0%	2025	SB 838 & HB 3039
Pennsylvania	18.0%	2020	Alternative Energy Portfolio
Rhode Island	16.0%	2020	Clean Energy Act
Texas	5,880 MW	2015	
Vermont	25.0%	2025	Energy Eff. & Affordability Act
Washington	15.0%	2020	Ballot Initiative 937
West Virginia	25.0%	2025	HB 103

* At least 6% from Solar
** Main Tier must account for 24% and the Customer-Sited Tier 1%
**** HB 3039 is a Bill for Solar PV only

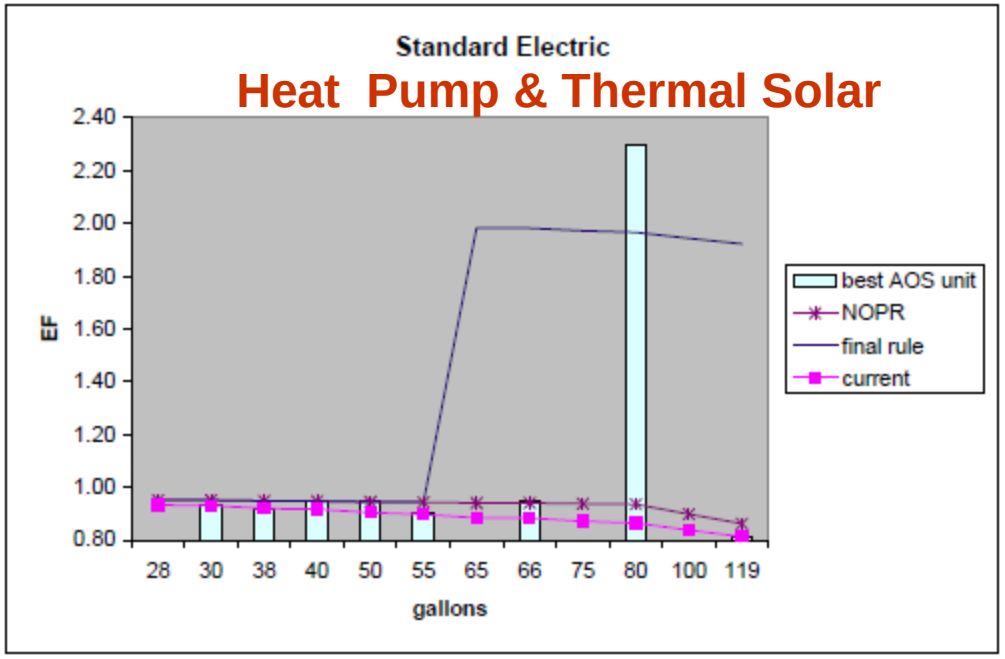
- **Electric utilities** generate a certain amount of electricity from renewable or alternative energy sources

Market Transformation

DOE NAECA III – Final



2009:Units over 55 gal.145,000



2009: Units over 55 gal. 355,000

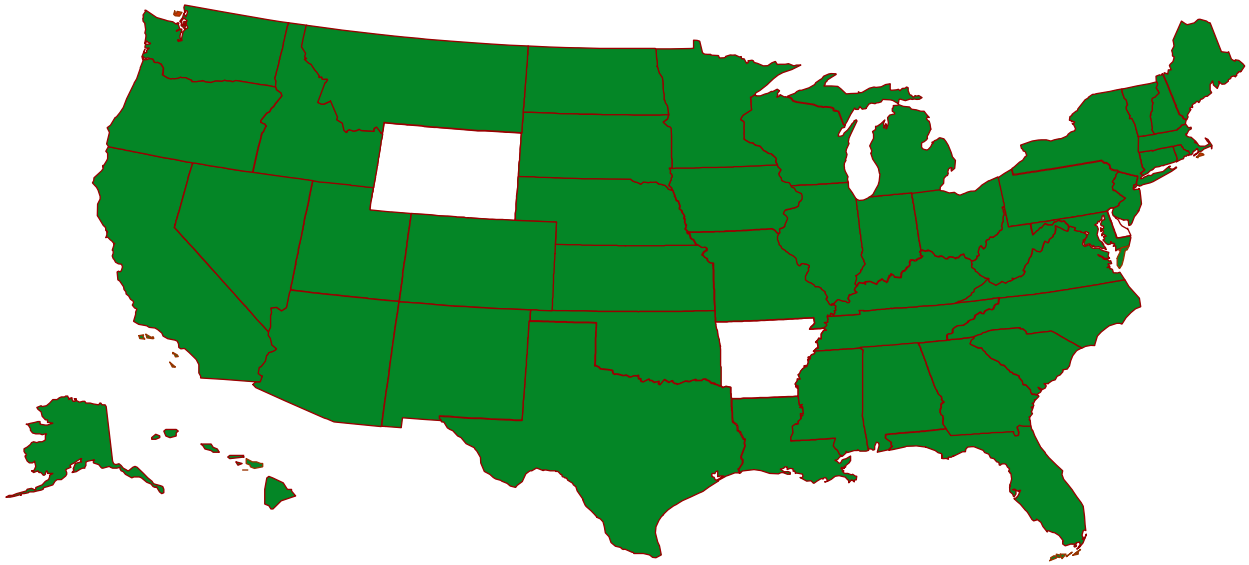
Gas tankless heater minimum set at 0.82 EF

Effective date will be in April, 2015

Market Transformation

Federal Incentives

- Energy-Efficient Mortgages (FHA or VA)
- Residential Renewable Energy Tax Credit 30%



www.dsireusa.org

State Incentives

- **Personal Tax Credit, State Rebate Programs**, **Utility Programs,** Sales Tax exemption, Property Tax Incentives**,** Grant Programs, Loan Programs, Public Benefit Funds

Market Transformation

U.S. Incentives

- Federal Tax rebate – equal to 30% of the systems cost, provided that installation is by Dec 31st 2017.

- State incentives – over half of states provide an additional incentive of 500$ and more.

Ohio: Green Energy Ohio - GEO Solar Thermal Rebate Program Amount: $30 per kBtu/day, Maximum Incentive: $2,400

Market Transformation

- Solar Rating and Certification Corporation
  - The corporation is an independent third-party certification entity. It is unique in that it is the only national certification program established solely for solar thermal energy collectors and systems
  - It is also the **only** national certification organization whose programs are the direct result of combined efforts of state organizations involved in the administration of standards and an industry association.
  - Six to Eight months required for **system certification** and confirmation of the Solar Energy Factor **(SEF)**

Market Transformation

Sample SRCC OG100 Certificate

SOLAR COLLECTOR CERTIFICATION AND RATING

SRCC OG-100

CERTIFIED SOLAR COLLECTOR

SUPPLIER:

MODEL:

COLLECTOR TYPE:

CERTIFICATION#:

COLLECTOR THERMAL PERFORMANCE RATING

Megajoules Per Panel Per Day				Thousands of BTU Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY	CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY
A (-5 °C)	54.9	41.6	28.4	A (-9 °F)	52.0	39.4	26.9
B (5 °C)	49.2	35.9	22.7	B (9 °F)	46.6	34.0	21.5
C (20 °C)	40.8	27.8	15.0	C (36 °F)	38.7	26.4	14.2
D (50 °C)	25.4	13.7	3.1	D (90 °F)	24.0	13.0	2.9
E (80 °C)	11.8	2.4	0.0	E (144 °F)	11.2	2.2	0.0

A- Pool Heating (Warm Climate) **B**- Pool Heating (Cool Climate) **C**- Water Heating (Warm Climate) **D**- Water Heating (Cool Climate) **E**- Air Conditioning

Original Certification Date: 24-APR-09

COLLECTOR SPECIFICATIONS

Gross Area:	3.710 m^2	39.93 ft^2
Dry Weight:	67.0 kg	148. lb
Test Pressure:	551. KPa	80. psg

Net Aperature Area: 3.44 m^2 37.03 ft^2

Fluid Capacity: 6.3 liter 1.7 gal

Market Transformation

- Arizona **(OG-300)**
  - Tucson Electric Power **(OG-300)**
- Georgia **(OG-300)**
- California
  - Sacramento Municipal Utility District **(OG-300)**
  - City of Thousand Oaks (OG-300)
  - California Energy Commission (OG-100 and OG-300)
  - Title 24
- Colorado (OG-300)
- Delaware (OG100 and OG300)
- Guam
- Hawaii
  - Hawaiian Electric (OG-100)
  - Hawaii Electric Light (OG-100)
  - Kauai Island Utility Cooperative (OG 100)
  - Maui Electric (OG-100)
- HUD (OG-300)
- Illinois (OG-300)
- Louisiana (OG-100 and OG-300 recommended)
- Maryland (OG-100 and OG-300)
- Minnesota (OG-100 and OG-300)
- Montana
  - National Center for Appropriate Technology
- Nevada
  - Public Utilities Commission (OG-300)
- New Mexico (OG-100 and OG-300)
- North Carolina (OG-100 and OG-300 highly recommended)
- Oregon (OG-300)
  - Eugene Water and Electric Board (OG-300)
  - City of Ashland
- Pennsylvania
  - Allegheny Power (OG-100)
  - GPU (OG-100)
  - PECO Energy (OG-100)
  - PPL (OG-100)
- Texas
  - Oncor (OG-300)
- Utah
  - Questar Gas (OG-100)
- Vermont (OG-100)
- Wisconsin (OG-100 and OG-300)
- Washington, D.C. (OG-100 and OG-300)
- Wyoming
  - Questar Gas (OG-100)

Market Transformation

What is SEF and how do I calculate Pay Back?

- "Solar Energy Factor" defined as the energy delivered by the system divided by the electrical or gas energy put into the system.

- The higher the number, the more energy efficient the system is. Solar energy factors range from 1.0 to 11. Systems with solar energy factors of 2 or 3 are the most common.

Market Transformation

- **Solar Gas Value Proposition – Payback?**

  Examples: (Assume that gas costs **$1.60/therm**)

  1. TYPICAL GAS WATER HEATER (**EF = 0.6**)

  Annual Operating Costs = 365*0.4105/0.6*1.60 = $399.55

  2. TYPICAL SOLAR SYSTEM (**SEF = 1.7**)

  Annual Operating Costs = 365*0.4105/1.7*1.60 = $141.02

  - Solar system saves $258.53 per year.
  - Payback (SEF 1.7 System):
    - Gas Solar system installed $6,000
    - 40 Gallon Gas installed price $800
    - Payback is with in **16 to 33 years**

Note: Does not account for escalation of energy cost or Incentives

Market Transformation

- **Solar Electric Value Proposition – Payback?**

  Examples: (Assume that electricity costs **$0.12/kWh**)

  1. TYPICAL ELECTRIC WATER HEATER (**EF = 0.90**)

     Annual Operating Costs = 365*12.03/0.90*0.12 = $585.46

  2. TYPICAL SOLAR SYSTEM (**SEF = 2.5**)

     Annual Operating Costs = 365*12.03/2.0*0.12 = $210.77

  - Solar system saves $374.69 per year.
  - Payback (SEF 2.5):
    - Electric Solar System install $5,500
    - 52 Electric installed cost $700
    - **Hawaii 7 years…Idaho 21 years**

Note: Does not account for escalation of energy cost or Incentives

Market Transformation

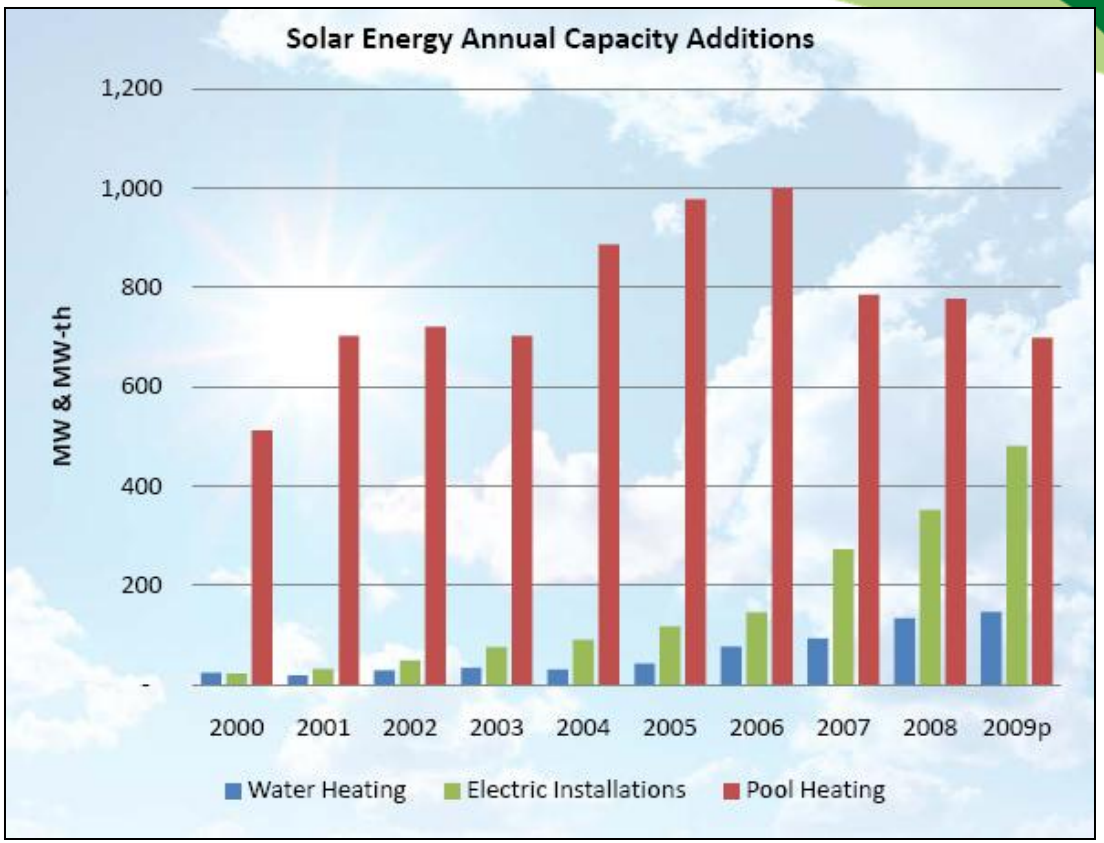
Solar Electric Value Payback with Incentives

State	Cost Std. Solar System Installed	Federal Tax Credit	State personal Tax Credit	State Rebate	Sales Tax	Utility Rebate	Net Cost Solar System	Cost Std Electric 52 + $400 Install	Diff,	Pay Back Years
New York	$8,000	$1,650	$2,000		$0	$1,200	$3,150	$700	$2,450	4.5
Rhode Island	$8,000	$1,650	$2,000		$560	$1,200	$2,590	$700	$1,890	4.1
Hawaii	$8,000	$1,650	$2,800			$1	$3,549	$700	$2,849	4.2
*Maryland	$8,000	$1,650		$2,800	$0		$3,550	$700	$2,850	6.2
Massachusetts	$8,000	$1,650	$1,200		$0	$1,200	$3,950	$700	$3,250	6.0
*Pennsylvania	$8,000	$1,650	$1,200	$2,400		$1	$2,749	$700	$2,049	5.5
Louisiana	$8,000	$1,650	$4,000				$2,350	$700	$1,650	6.1
*New Hampshire	$8,000	$1,650				$1,600	$4,750	$700	$4,050	8.0
Connecticut	$8,000	$1,650			$400		$5,950	$700	$5,250	8.2
California	$8,000	$1,650		$1,500		$1	$4,849	$700	$4,149	8.9
North Carolina	$8,000	$1,650	$2,800			$1	$3,549	$700	$2,849	9.0
Georgia	$8,000	$1,650	$2,800			$1	$3,549	$700	$2,849	9.2
*Oregon	$8,000	$1,650	$1,500	$1,500		$1	$3,349	$700	$2,649	9.7

Note: Includes annual solar savings…does not include escalation of energy costs

Market Transformation

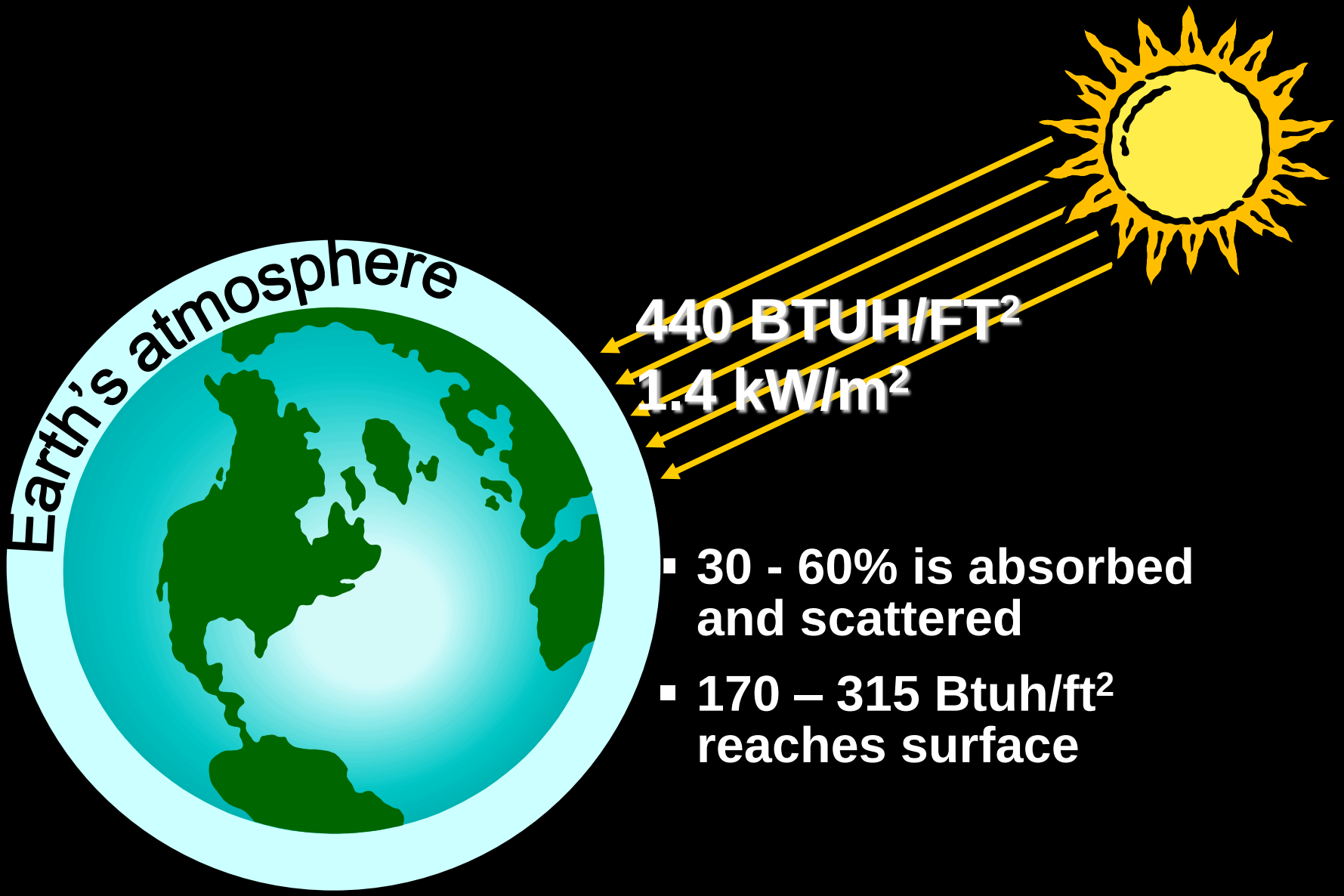
- Solar water heating installations grew by approximately 10%
- Pool Heating installations declined by 10% over 2008
- Annual electric installations grew by approximately 37%



Source: Solar Energy Industries Association

Solar Solutions and Collectors/Panels

THE SOLAR CONSTANT



- 30 - 60% is absorbed and scattered
- 170 – 315 Btuh/ft² reaches surface

Energy

Energy is measured in many ways.

• One of the basic measuring blocks is called a Btu. This stands for British thermal unit and was invented by, of course, the English.

• Btu is the amount of heat energy it takes to raise the temperature of one pound of water by one degree Fahrenheit, at sea level.

8.34 BTU's are required to raise 1 gallon of water 1 degree F.

• One Btu equals about one blue-tip kitchen match.

• One thousand Btus roughly equals: One average candy bar or 4/5 of a peanut butter and jelly sandwich.

• It takes about 2,000 Btus to make a pot of coffee.

Not all solar is created equal.

SOLAR PHOTOVOLTAICS (PV)

- Converts radiant solar energy into DC electricity.
- Efficiencies: 16% for mono-crystalline silicon, 12% for polycrystalline, 4-7% for amorphous silicon cells.

SOLAR WATER HEATING

Converts radiant solar energy into heat energy for fluid heating applications. Efficiencies range from 50% to 80%

Advantages of Solar Water Heating:

- *More efficient than solar PV*
- *Less costly to install*
- *Faster payback period (ROI) than PV*

Solar Electric or PV ?

- **Most expensive entry into residential solar energy without significant government incentive programs**

Source: *Home Power*, Oct/Nov 2008 issue

Technology	Collector or Module Efficiency	System Efficiency	Cost	System Cost Per KWH*
SHW: 64 sq. ft. of collectors + 80 gal. water heater	50%–70%	35%–50%	$8,000	$0.09
Grid-tied PV: 2 KW	5%–19%	4%–13%	20,000	0.27

*Over 30 yrs. in Richmond, Virginia; maintenance costs not included

Solar SHW vs. Conventional Heating

What is the difference between Solar Hot Water and "standard" gas or electric hot water system?

- **The Basics:**
  Solar Hot Water Heating uses simple principles and components to capture incoming solar radiation (sunlight) and transform it heat energy – providing the hot water needed for domestic, commercial, industrial, and other uses. Solar Hot Water Heating Systems have been around decades.

Water Heating Facts

- The average household with an electric water heater spends about 25% of its home energy costs on heating water

  [Source: Florida Solar Energy Center].

- Solar can save as much as 50-85% annually on the water heating portion of your utility bill (compared to electric water heaters).

  [Source: US Dept. of Energy]

Americans Want Solar!

- 79% feel that homebuilders should offer solar power as an option for all new homes
- 64% are willing to pay more for a home with solar. For every utility-bill dollar saved annually property value can increase $10 - $20. Reducing an annual electric bill by $1,000 through a solar power investment, can result in $10,000 to $20,000 rise in home value. [Source: CNNMoney.com October 2006]
- 73% believe that solar energy technology is more important today than ever
- 42% say that saving money on monthly utility bills is the most compelling argument for installing solar power. Others indicated it was to decrease the nation's dependence on oil (31%) or reduce environmental pollution (18%)

source: Roper survey commissioned by Sharp Electronics Corporation 2006

Does solar make sense?

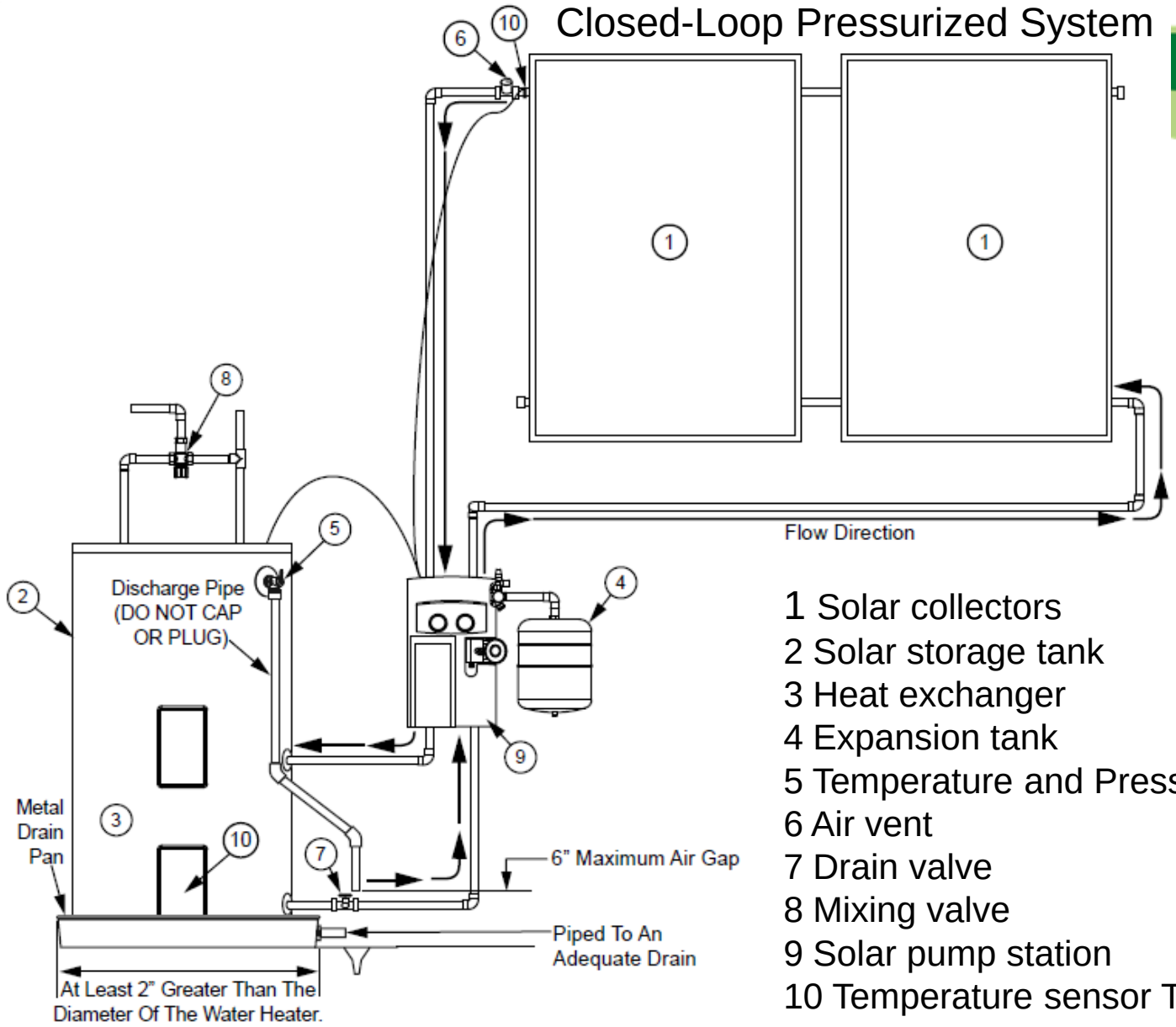
- ***YES*** if you want to…
- Save money on energy from day 1
- Add re-sale value to your home/businessa home's value is increased by $20,000 for every $1,000 reduction in annual operating costs from energy efficiency."
- Be more independent
- Protect our environment
- and can accept longer-term ROI's

Solar Thermal Applications

Solar DHW Solution

- Simplest, least expensive entry into solar energy for the home

Residential Solar – Packaged Systems

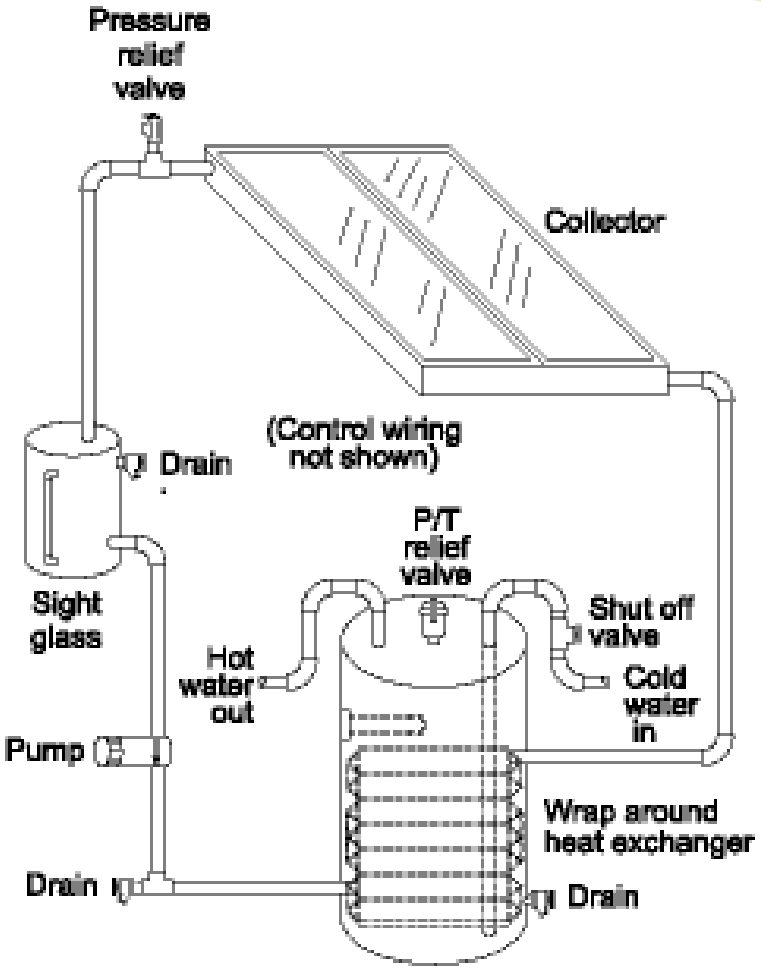


1 Solar collectors
2 Solar storage tank
3 Heat exchanger
4 Expansion tank
5 Temperature and Pressure relief valve
6 Air vent
7 Drain valve
8 Mixing valve
9 Solar pump station
10 Temperature sensor Tank and collector sensor

Drain Back Systems

What is the advantage of Drain Back?

- Better thermal efficiency since you can run just water through the panels (or a lower concentration of glycol)
- Allows the system to shut down at any time the tank temperature reaches set point, avoiding the "boiling" or "frying" of a glycol water solution.



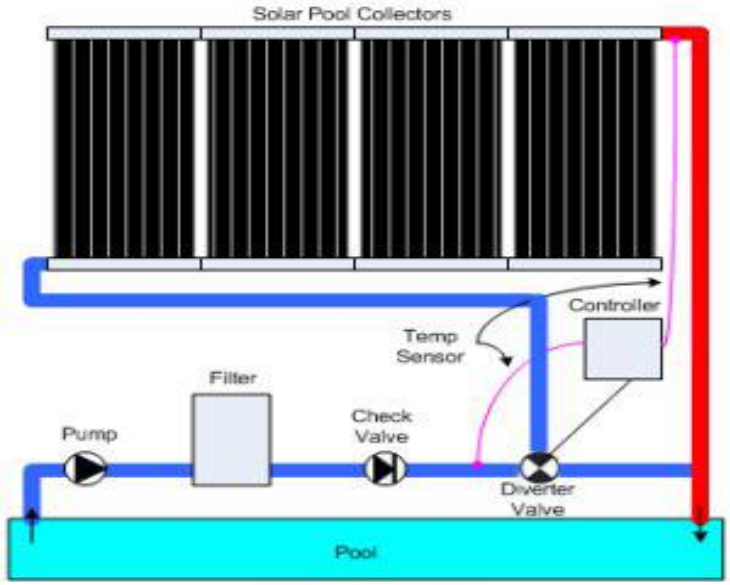
Drain Back Systems

What are the disadvantages of Drain Back?

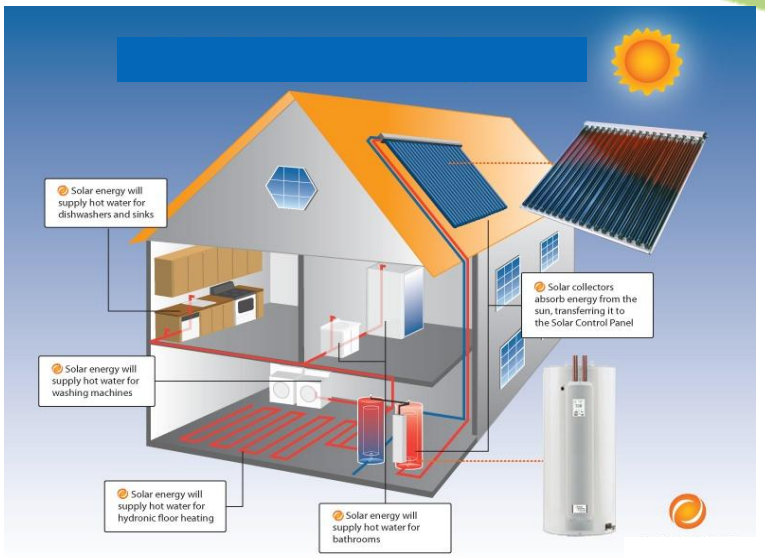
- Disadvantages include increased installation costs and difficulties installing properly pitched supply/return lines.

- Drainage and filling cycles are typically noisy and pump needs to be sized for lifting.

Solar Thermal Applications



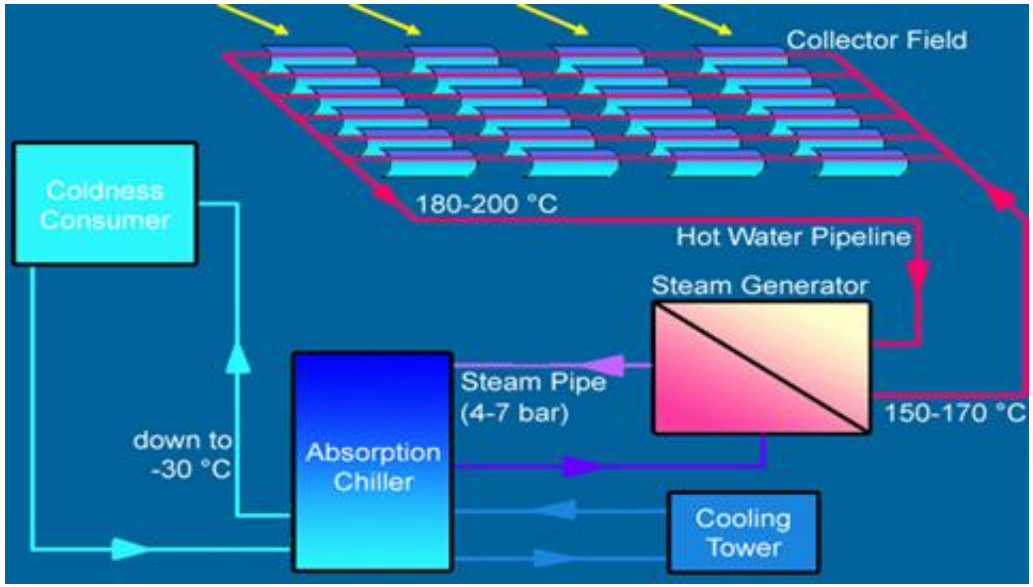
Solar Pool Heating Applications



Solar Hydronic Systems

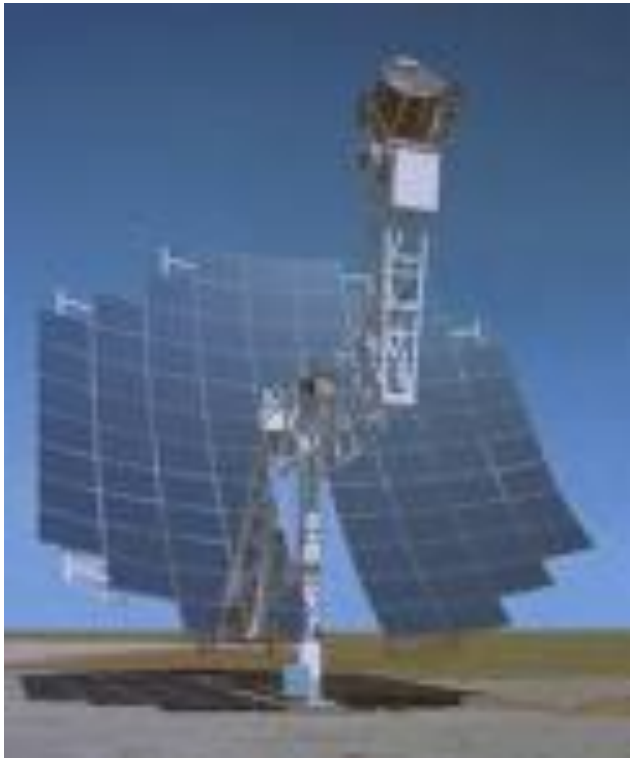
- **Indoor / Outdoor pools**
- **Combi-Systems**
- **Space Heating Support**

Solar Thermal Applications



Solar Cooling Applications

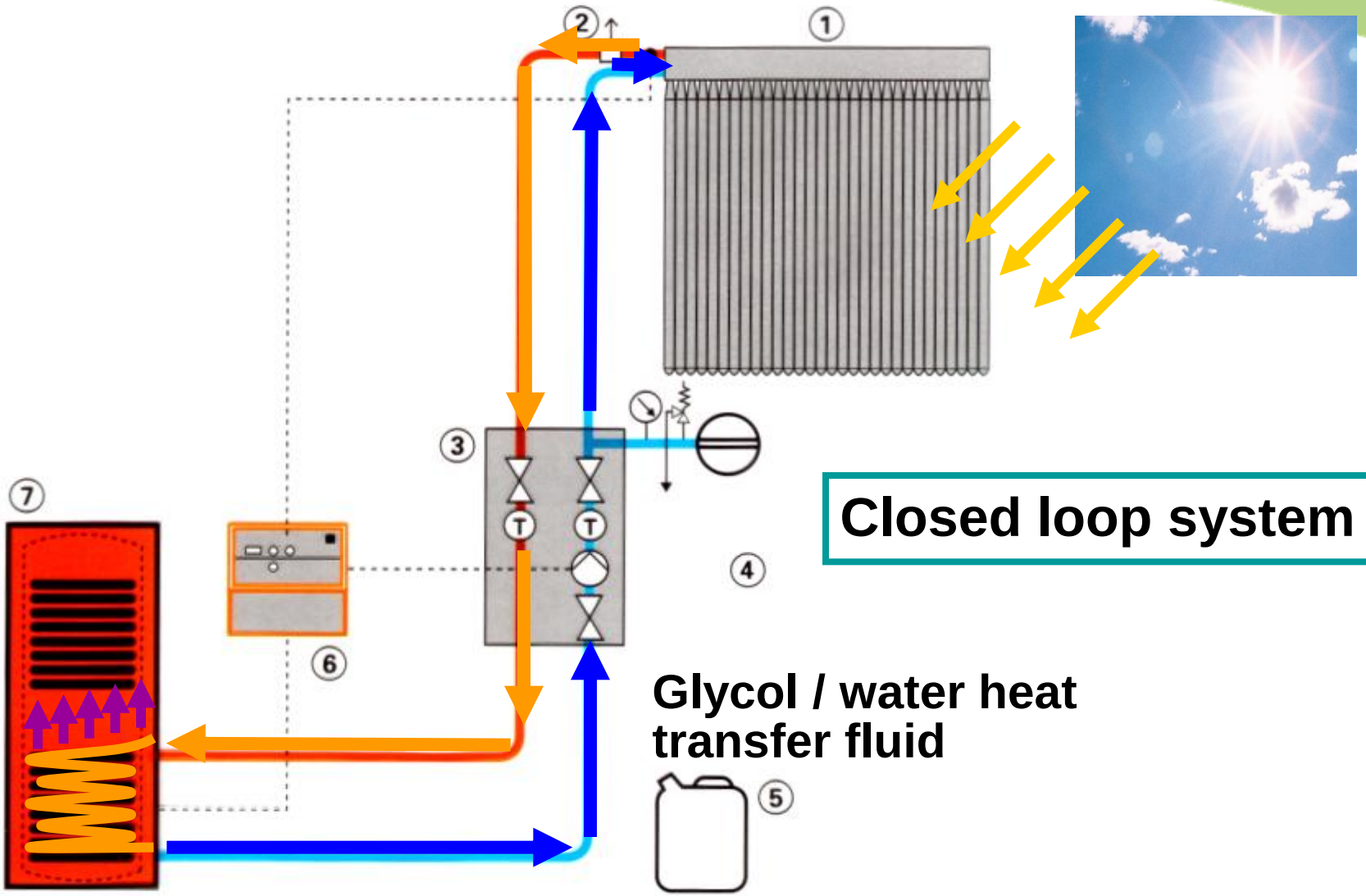
- **LiBr single effect absorption chillers**



Solar Electric Power Plants

- **Concentrating solar arrays**

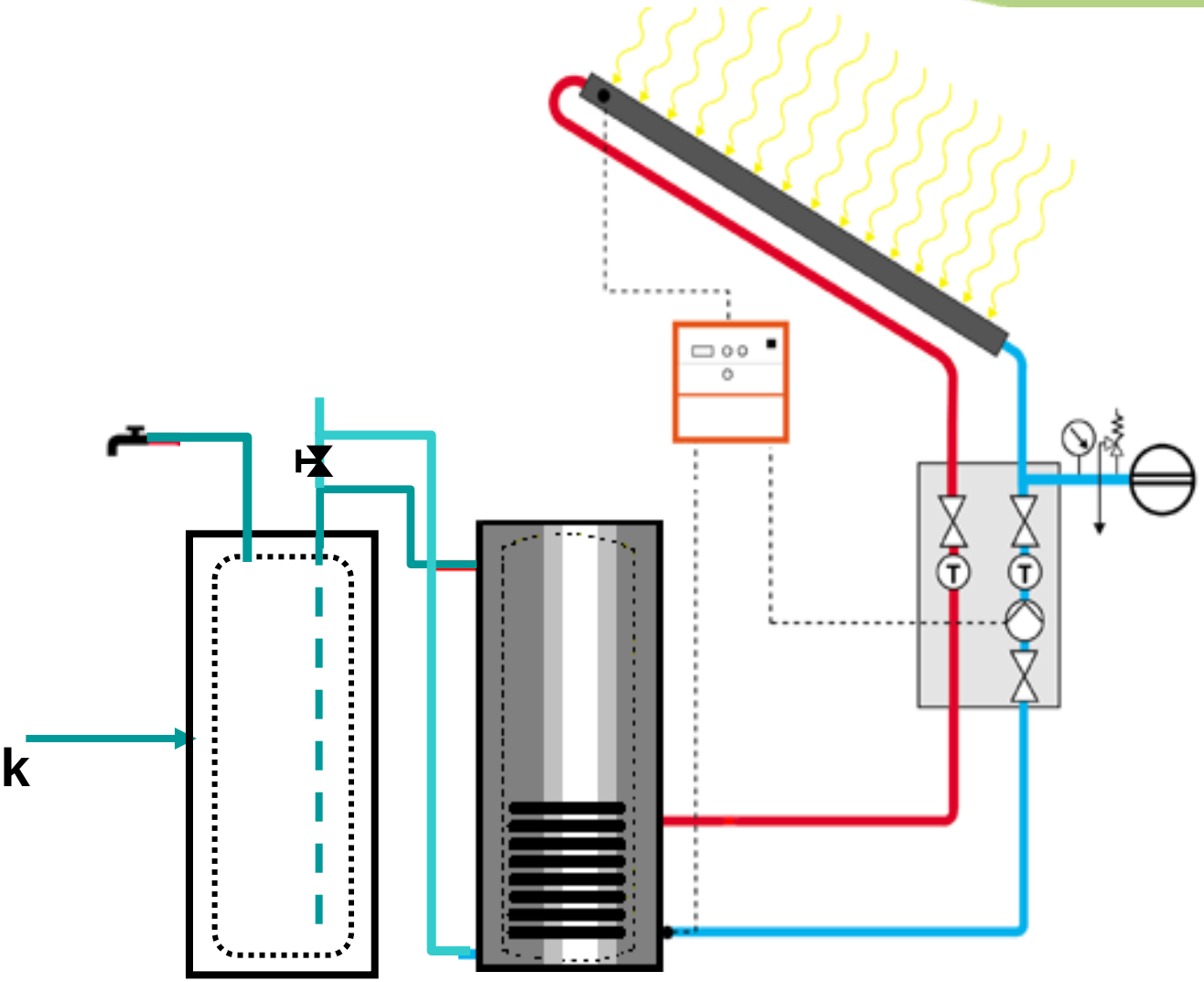
SOLAR THERMAL SYSTEMS



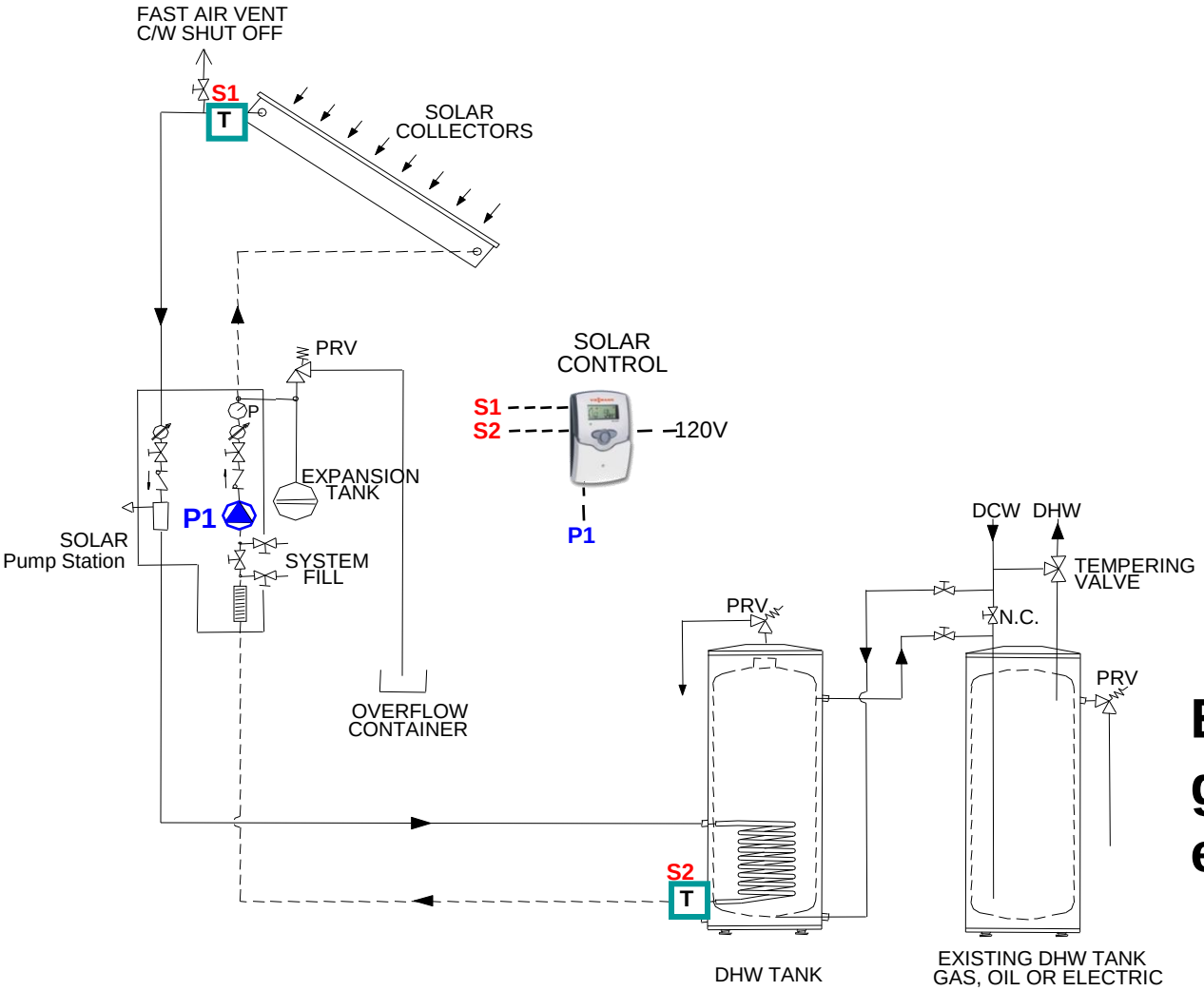
Closed loop system

Glycol / water heat transfer fluid

SOLAR DHW HEATING SYSTEM
Retrofit / Preheat system

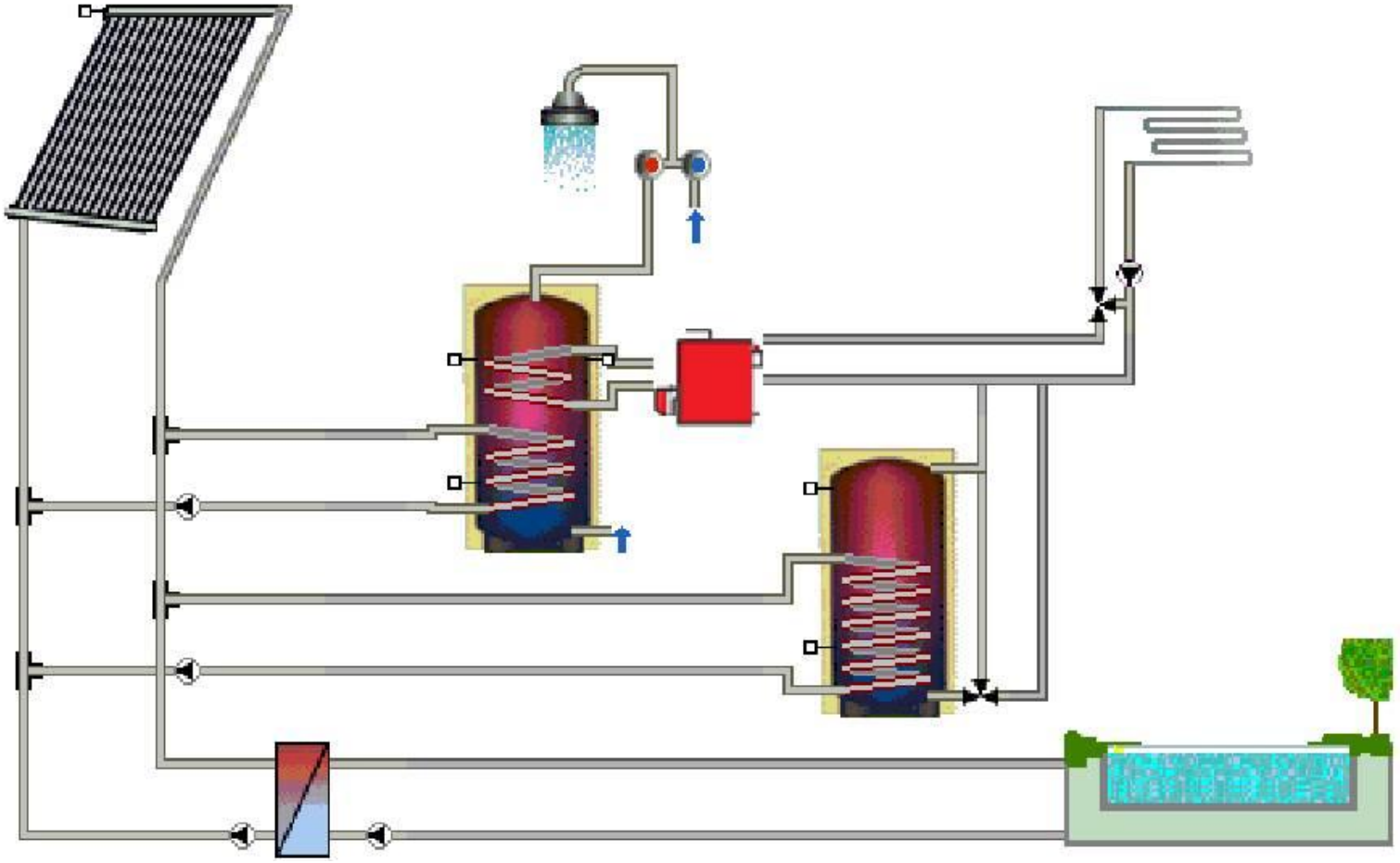


SOLAR DHW HEATING SYSTEM
Retrofit / Preheat system

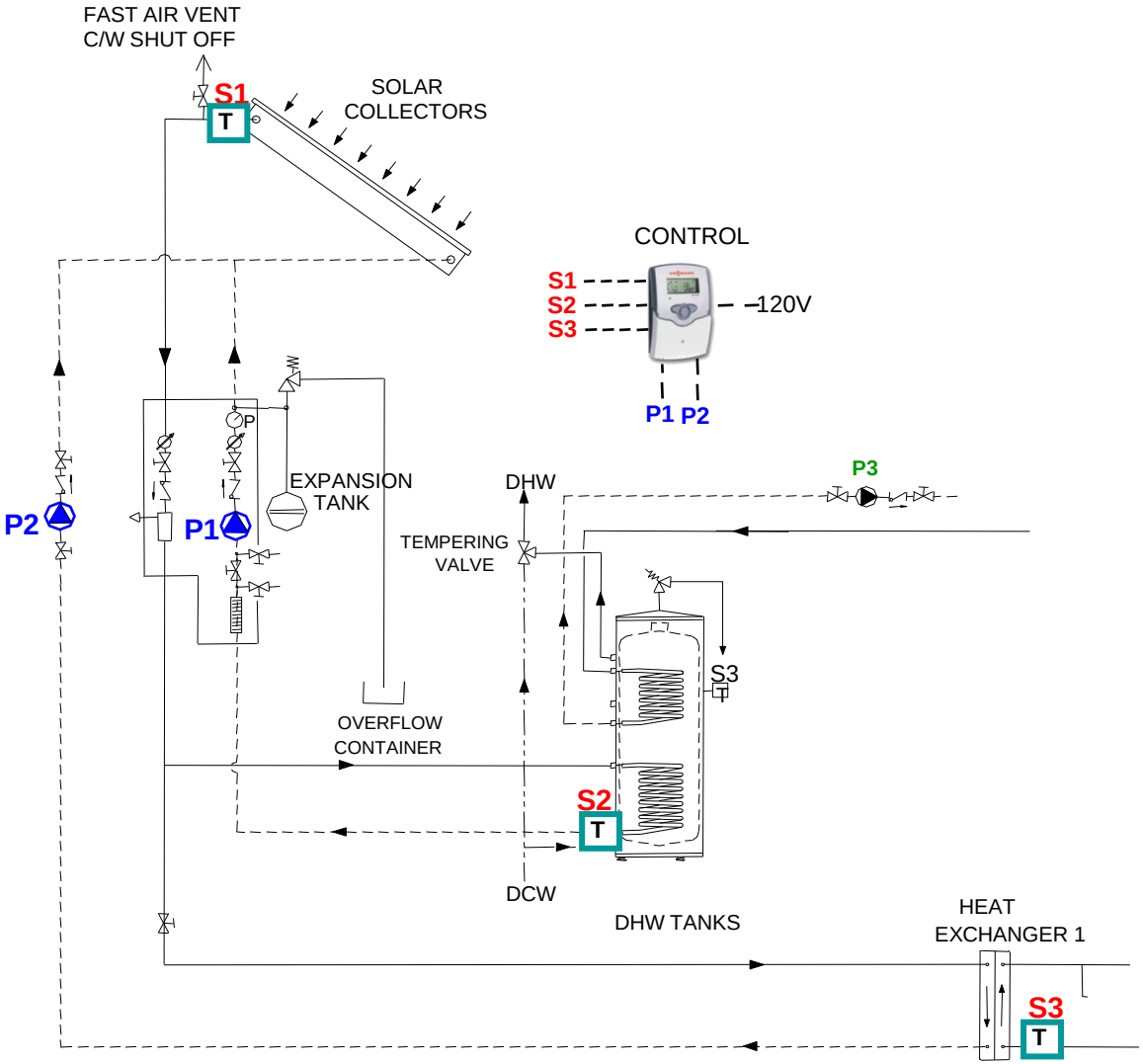


Existing gas/oil or electric tank

Generic Combi-System



SOLAR DHW - POOL HEATING SYSTEM
DHW + Pool heating supplement



Collectors/Panels

- There are (4) proven commercially available technologies for solar water heating. Which one is right depends on the application and the location and climate.
  - Flat Plate Collectors
  - Plastic, Non-Insulated Collectors
  - Evacuated Tube Collectors
  - Concentrating Collectors

Concentrating Collectors

Much higher temperatures than flat-plate collectors or evacuated tubes (steam generation possible)

Focuses direct solar radiation, hence poor performance on hazy or cloudy days

Most practical in areas with high insolation (exposure to the sun's rays), such as those close to the equator and in the desert southwest United States

Systems may use tracking mechanisms to move the collectors during the day to keep them focused on the sun

High installation and maintenance costs

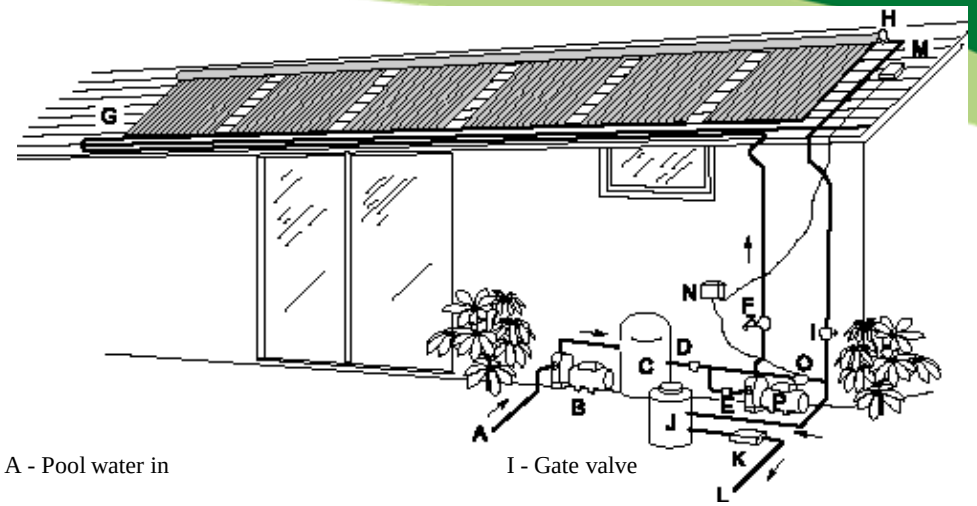
Used primarily for large-scale electric power generation using steam powered turbines

Plastic Collectors

Pool Heating Only
collector area = 75% to 100% of the exposed pool area

Seasonal use

Low cost – not for DHW



A - Pool water in

B - Pump

C - Filter

D - Check valve

E - Gate valve 1

F - Drain valve

G - Solar collectors

H - Vacuum breaker and auto air relief

I - Gate valve

J - Fossil fuel heater (if existing)

K - Chlorinator (if existing)

L - Warm water returns to pool

M - Sensor

N - Automatic control box

O - Electric or constriction valve (collector bypass)

P - Booster pump

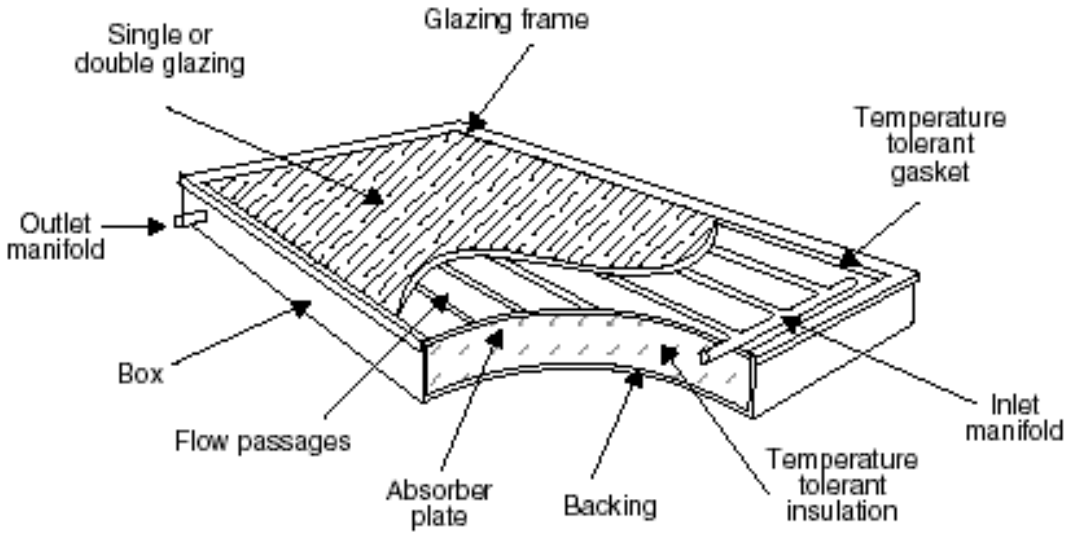
Typical solar pool heating system with automatic control
[Source: Florida Solar Energy Center]

Flat Plate Collectors

Residential & Commercial water heating applications

Medium Cost, robust proven performance, all climates, tempered glass

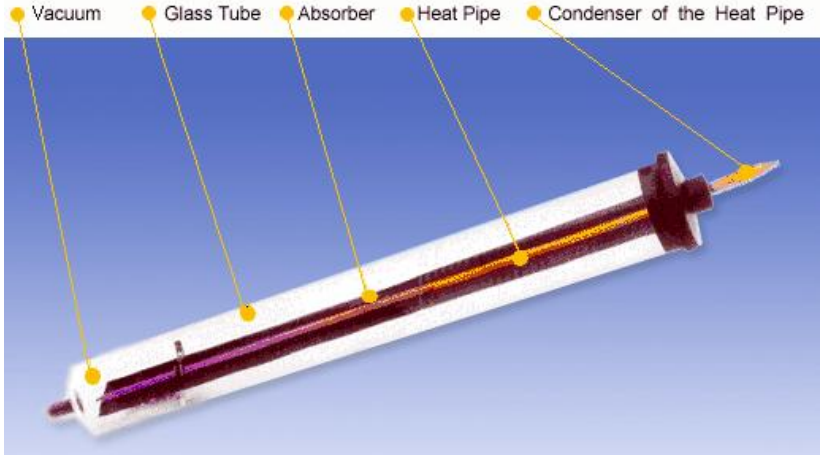
Common Sizes:
3’x7’, 4’x8’, and 4’x10’



<u>Rule of thumb for sizing (DHW):</u>

20 ft^2 (2 m^2) of collector area for each of the first two family members
8 square feet (0.7 square meter) for each additional family member in the Sun Belt.
12 - 14 additional square feet (1.1-1.3 m^2) per person in the northern US [US DEPT OF ENERGY]

Evacuated Tube Collectors

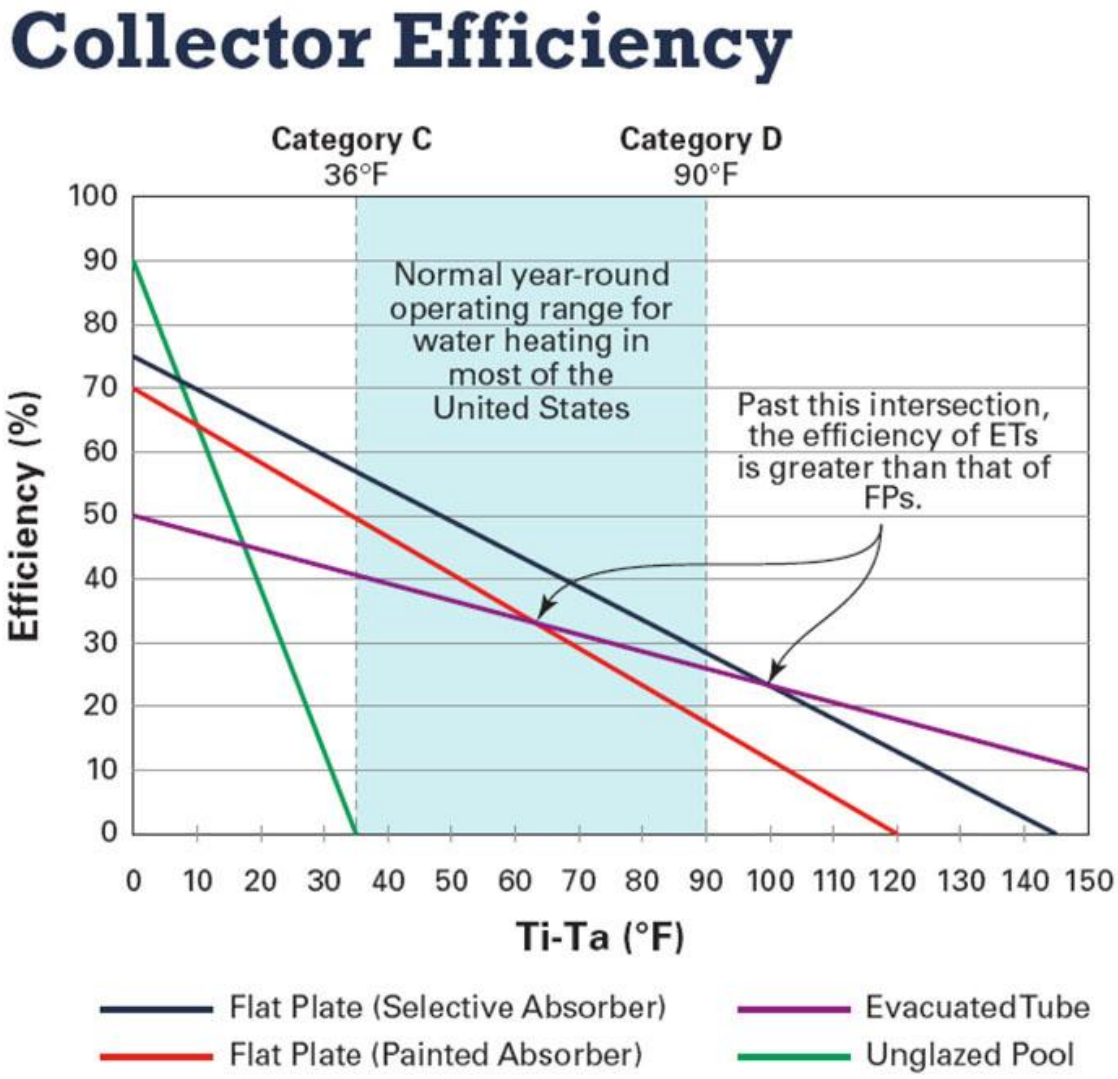


Residential & commercial water heating applications
Medium to High Cost (16, 20, and 30 tube collectors common), all climates, non-tempered glass, snow melt problems with shallow incline angle

<u>Rule of thumb for sizing (DHW):</u>
4-10 tubes per person depending on tube diameters and lengths, or 7.5 square feet (0.7 square meter) per person. Typical family of 4 DHW system would use 16 to 30 tubes and an 80 gal storage tank.

Flat Plate vs. Evacuated Tube

Flat-plate collectors are the most cost effective technology for applications where the temperature rise above ambient is less than about 50ºC (90ºF)

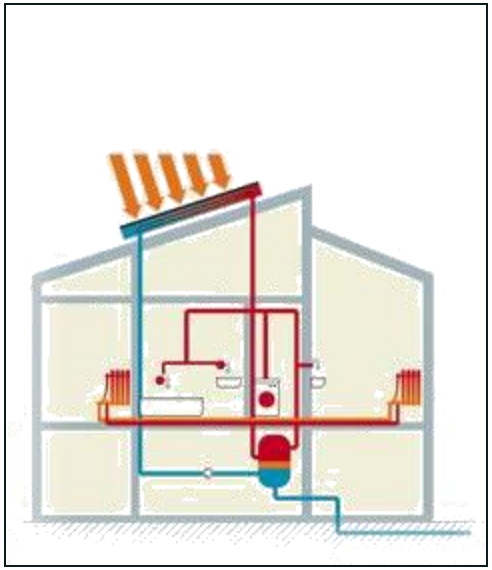


Flat Plate vs. Evacuated Tube

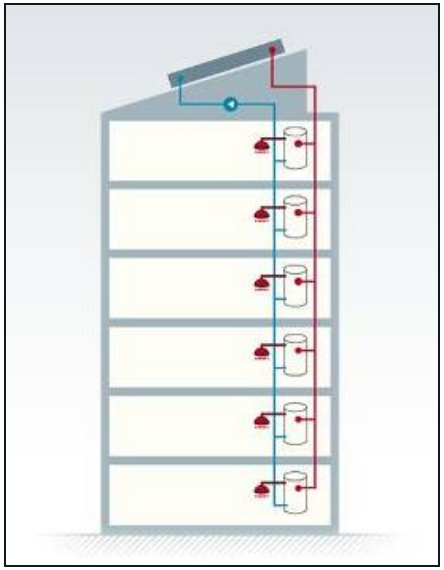
- Flat plates use tempered safety glass while evacuated tubes use borosilicate or soda-lime glass, which breaks into shards
- Evacuated tubes are only efficient as long as the vacuum seals are in-tact. No vacuum loss issues with flat plates
- Flat plates are able to shed snow more easily compared to tubes, resulting in possibly more heat production in the winter
- Flat plates can be used to regulate excessive tank temperatures by emitting heat in reverse control cycle – not possible with tubes

Solutions for any application

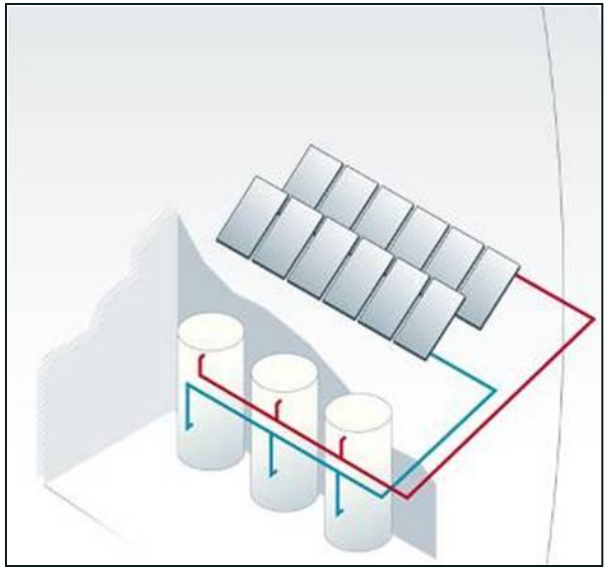
Typical Applications



Single homes

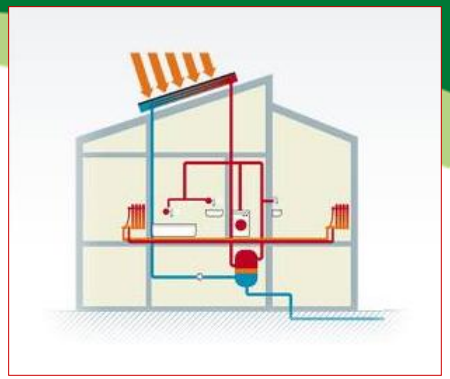


Apartment buildings



Industrial / Commercial

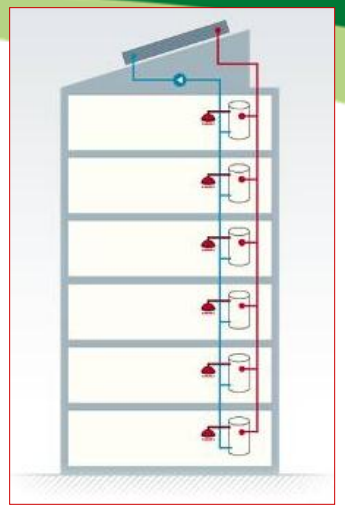
Single homes



Individual Home Systems

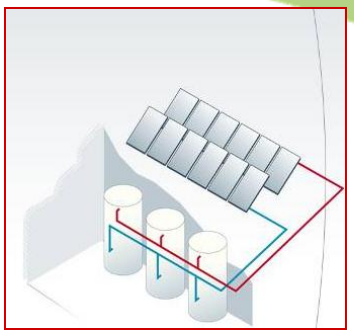
From left to right - North Carolina, Florida and Maine

Apartment buildings



Central Systems

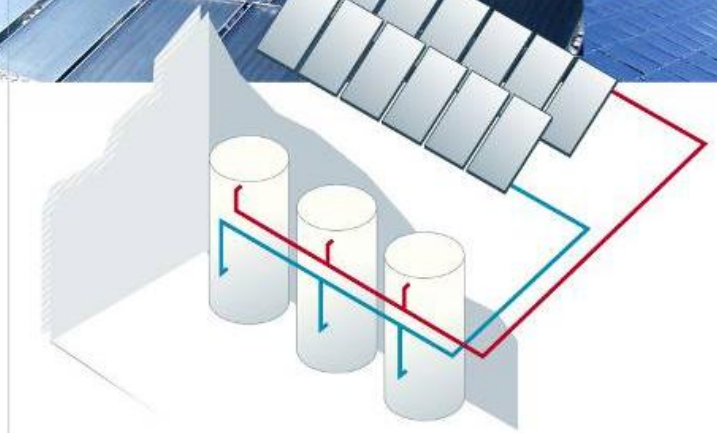
Industrial/Commercial



Mega solutions

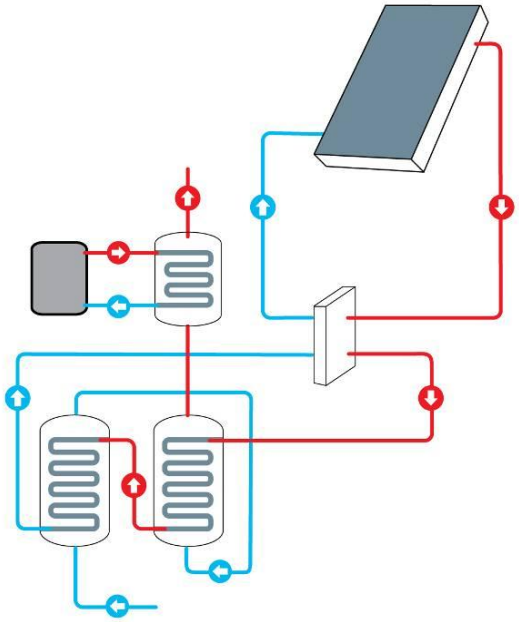
Industrial / Commercial

Mega Systems



Commercial Project Sequence

- Complete questionnaire or review RFP
- Analyze questionnaire or RFP and climate data
- System design, performance modeling and ROI – PolySun, T-SOL, F-Chart, RET Screen simulation software
- Quotation
- Purchase Order
- Detailed system design
- System delivery
- Installation and supervision
- After sale support



Swimming Pools

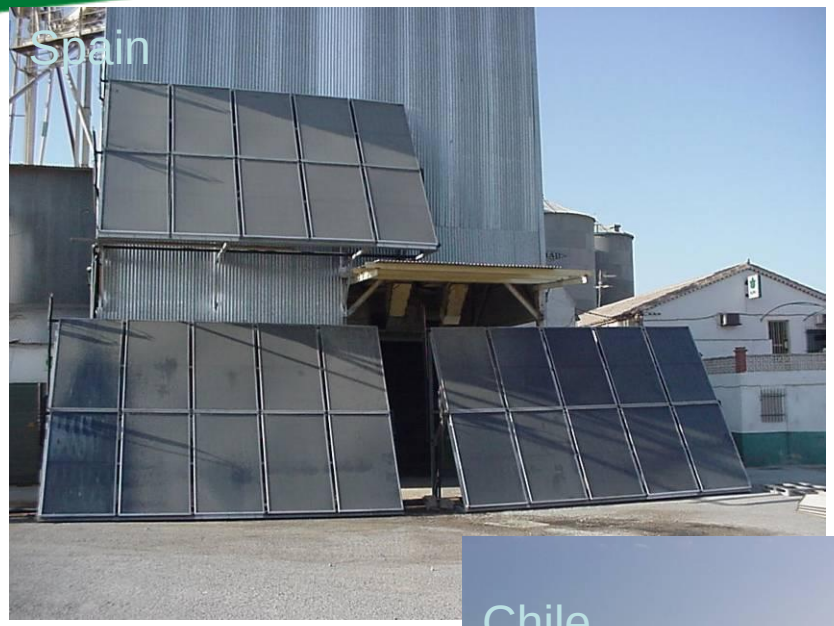
- Exposed surface area?
- Average depth of water?
- Desired pool water temperature?
- Indoor or outdoor pool?
- If indoor – what is the room ambient temperature and relative humidity?
- Hours of use per day?
- Seasonal use? If yes, auxiliary heat dumps available?
- Cover used?
- Back-up heating system information?
- Yearly energy needed and cost of back-up energy?
- Solar panel installation location specifics – orientation to South, type of mounting proposed, distance from panels to pool mechanical equipment?

Sport Facilities

Apartment Buildings

Hospitals

Factories

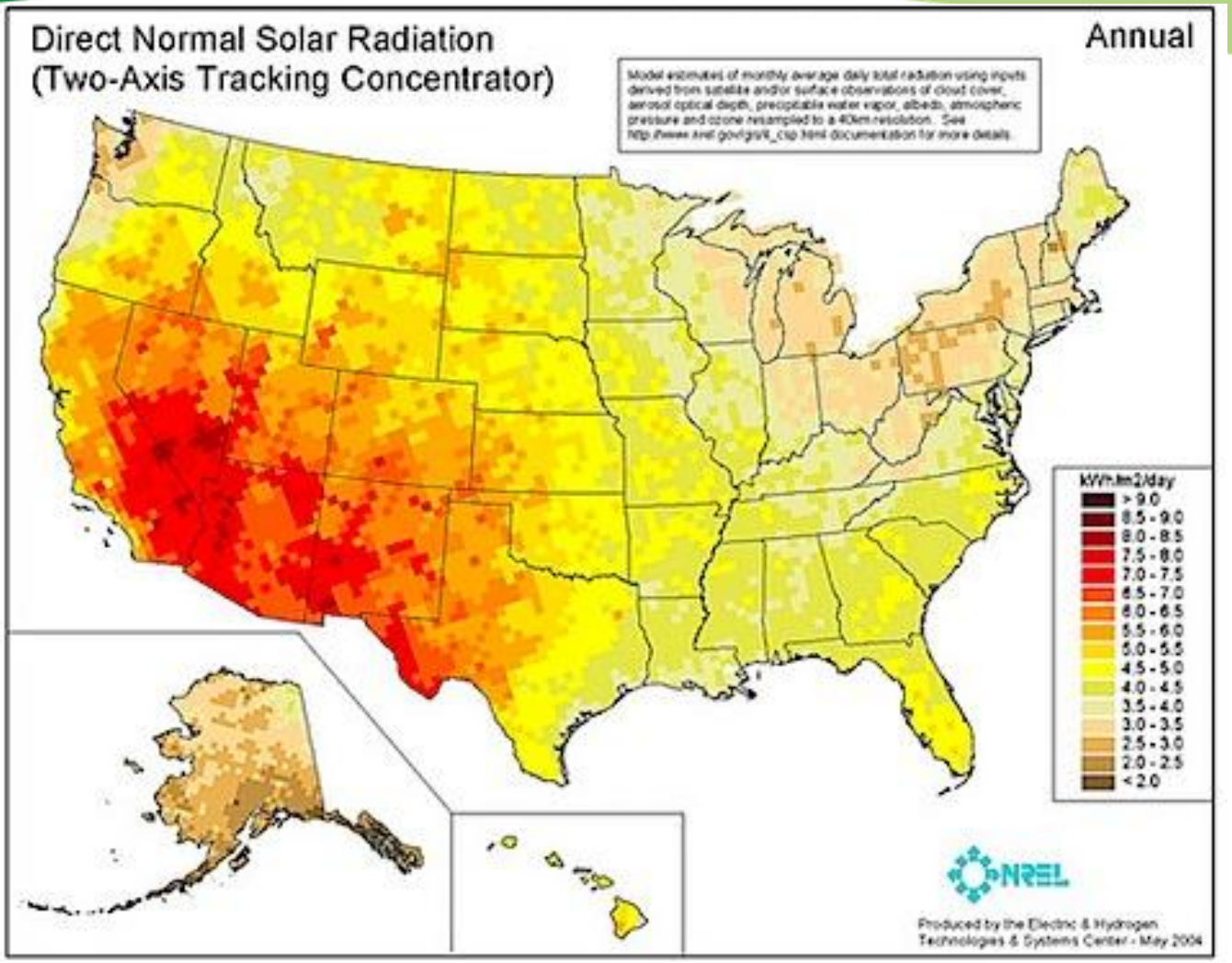


Schools

Solar in USA ?

- Ideal climate for Solar in the sun belt as well as most areas of the country using the right panel and design
- **"Green"** awareness
- Volatile Energy prices
- 30% Federal tax rebate & local, state, utility incentives
- Feasible Return On Investment
- Accessible room for large arrays of collectors

USA Radiation Map



Source: www.nrel.gov

Can solar work in New England ?

Examples of Insolation Data (kWh/m^2)

- **The following is a table of insolation data for Boston, Massachusetts**
- **Jan 1.66**
- **Feb 2.50**
- **Mar 3.51**
- **April 4.13**
- **May 5.11**
- **June 5.47**
- **July 5.44**
- **Aug 5.05**
- **Sept 4.12**
- **Oct 2.84**
- **Nov 1.74**
- **Dec 1.40**
- **Daily Average: 3.58 kWh/m^2 (1135 Btu/ft^2)**
- **Total for year: 1,307 kWh/m^2 (414,317 Btu/ft^2)**

Munich, Germany … which has a higher latitude than Boston has a level of 1,088. In other words Boston gets about 20% more sunlight than Munich.

SOLAR INSTALLATION

- SITE SELECTION
- PANEL INSTALLATON
- TANK INSTALLATION & PUMP STATION INSTALLATION
- CHARGING WITH HEAT TRANSFER FLUID

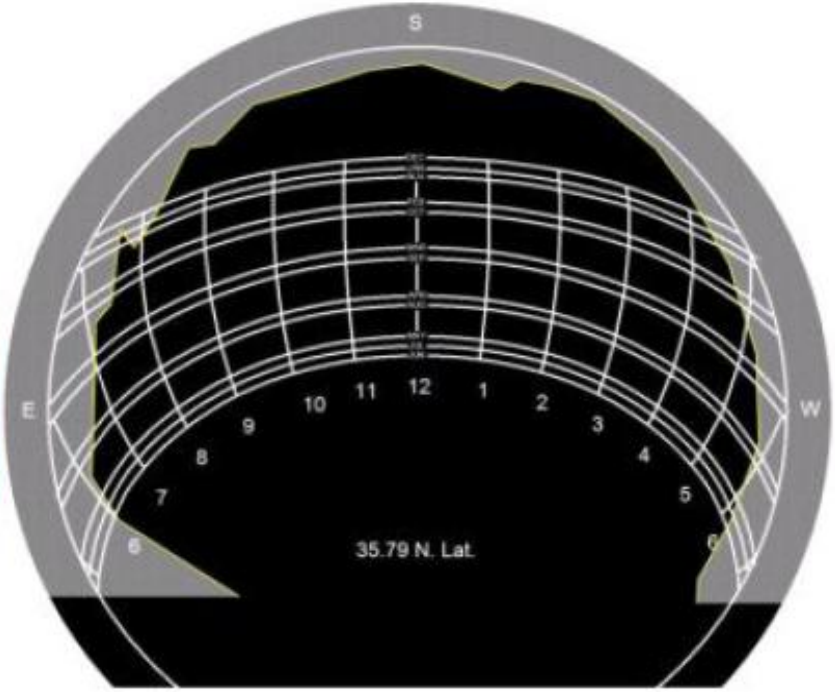
SITE SELECTION IS VERY IMPORTANT!!!

Software Programs Available:

SOLAR PATHFINDER, Bing™ Map

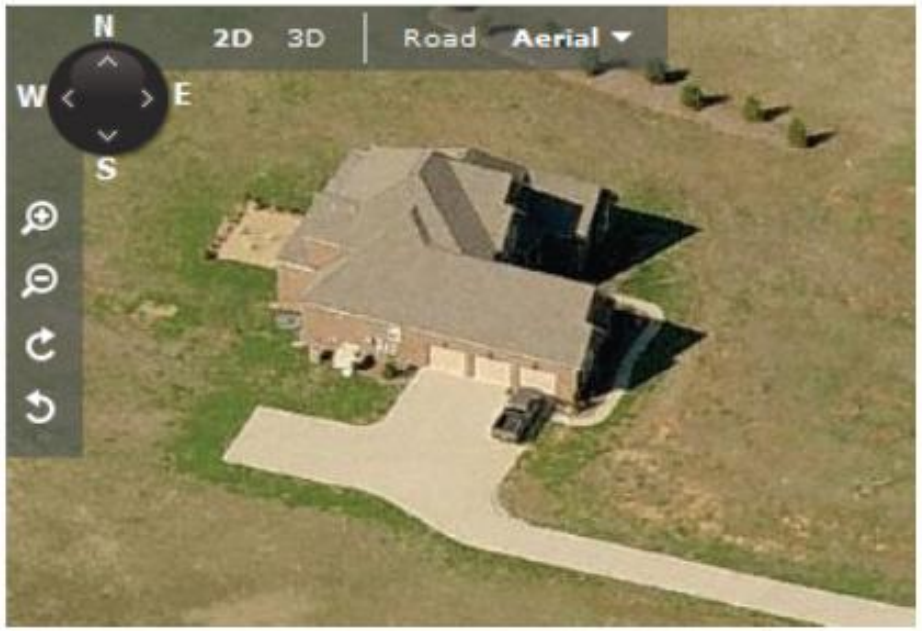
RETScreen & POLYSUN

SOLAR PATHFINDER™



BING™ MAP

Solar Site Analysis
6209 Lampkins Bridge Rd
College Grove, TN 37046



Aerial View
Notice the South Facing Direction

SOLAR SITE

Summary:
Excellent Solar Site!. Very few solar obstructions as indicated by Solar Pathfinder analysis of 97.87%.

SOLAR PATHFINDER™

Report Name	6209 Lampkins Bridge Rd.
Report Date	3/26/2010 11:15:42 AM
Declination	-3d 04m
Location	COLLEGE GROVE, TN 37046
Lat/Long	35.791 / -86.726
Weather Station	Nashville Intl AP, TN, Elevation: 581 Feet, (36.117/-86.683)
Site distance	23 Miles
Report Type	Thermal
Array Type	Fixed
Tilt Angle	35.79 deg
Ideal Tilt Angle	35.79 deg
Azimuth	180.00 deg
Ideal Azimuth	180.00 deg

SOLAR PATHFINDER™

Collector Make	
Collector Model	
Collector Area	23.1 Sq. Feet
Collector Count	3
Total Collector Area	69.4 Sq. Feet
Solar Fraction	0.74
Annual Production	10.10 Million BTU
Electricity Saved	3,218.0 KWH
Annual Savings	$321.80
Collector Fluid	Glycol
Layout Configuration	SinglePicture
Layout Point Count	1

SOLAR PATHFINDER™

Layout Type	Single Picture
Layout Point Count	1

Energy Source Used to Heat Water

Energy Source	Electricity
Energy Efficiency	100.0 %
Energy Cost	$0.10 per KWH
Total Electricity Saved	3,218.0 KWH

SOLAR PATHFINDER™

Estimated Average Daily Hot Water Usage

January	60.0
February	60.0
March	60.0
April	60.0
May	60.0
June	60.0
July	60.0
August	60.0
September	60.0
October	60.0
November	60.0
December	60.0

Other Assumptions

Tank Temperature	120.0 °F
Water Supply Temperature	55.0 °F
Main Tank Volume	120.0 Gallons
Secondary Tank Volume	0.0 Gallons
Heat Exchanger Efficiency	70.00 %

SOLAR PATHFINDER™

Estimated Monthly Savings

January	$16.08
February	$21.23
March	$27.92
April	$30.19
May	$31.06
June	$32.87
July	$33.03
August	$33.50
September	$28.63
October	$29.18
November	$20.78
December	$17.33
Annual Savings	$321.80

SOLAR PATHFINDER™

Solar Obstruction Data

Month	Unshaded % of Ideal Site Azimuth=180 Tilt=35.79	Actual Solar Rad w/ Shading Azimuth=180.0 Tilt=35.79 KWH/m^2 /day	Solar Hot Water Actual Cost Savings Electricity $0.10/KWH	Solar Hot Water Solar Fraction Azimuth=180.0 Tilt=35.79	Solar Hot Water Produced Azimuth=180.0 Tilt=35.79 MMBTU	Solar Hot Water Demand Azimuth=180.0 Tilt=35.79 MMBTU
January	94.84%	2.95	$16.08	0.44	0.50	1.16
February	97.65%	4.15	$21.23	0.64	0.67	1.05
March	98.78%	4.82	$27.92	0.76	0.88	1.16
April	98.89%	5.45	$30.19	0.84	0.95	1.12
May	98.38%	5.32	$31.06	0.84	0.98	1.16
June	98.89%	5.90	$32.87	0.92	1.03	1.12
July	98.88%	5.64	$33.03	0.89	1.04	1.16
August	99.15%	5.76	$33.50	0.91	1.05	1.16
September	98.32%	4.97	$28.63	0.80	0.90	1.12
October	97.19%	5.00	$29.18	0.79	0.92	1.16
November	96.56%	3.66	$20.78	0.58	0.65	1.12
December	95.16%	3.09	$17.33	0.47	0.54	1.16
Totals	**97.72%**	**56.70**	**$321.80**	**0.74**	**10.10**	**13.65**
	Unweighted Yearly Avg	**Effect: 97.66% Sun Hrs: 4.73**				

PANEL INSTALLATION

- The best orientation is achieved when the collectors are facing due south +/- 45°
- Should be tilted at an angle from the horizontal equal to the latitude of the location + 10°.
- The + 10° tilt gives better winter performance

PANEL INSTALLATION

UNDER ROOF

PANEL INSTALLATION

APPLY SEALANT

PANEL INSTALLATION

MARKING FOR MOUNTING

PANEL INSTALLATION

MOUNTING HARDWARE

PANEL INSTALLATION

FIRST PANEL

PANEL INSTALLATION

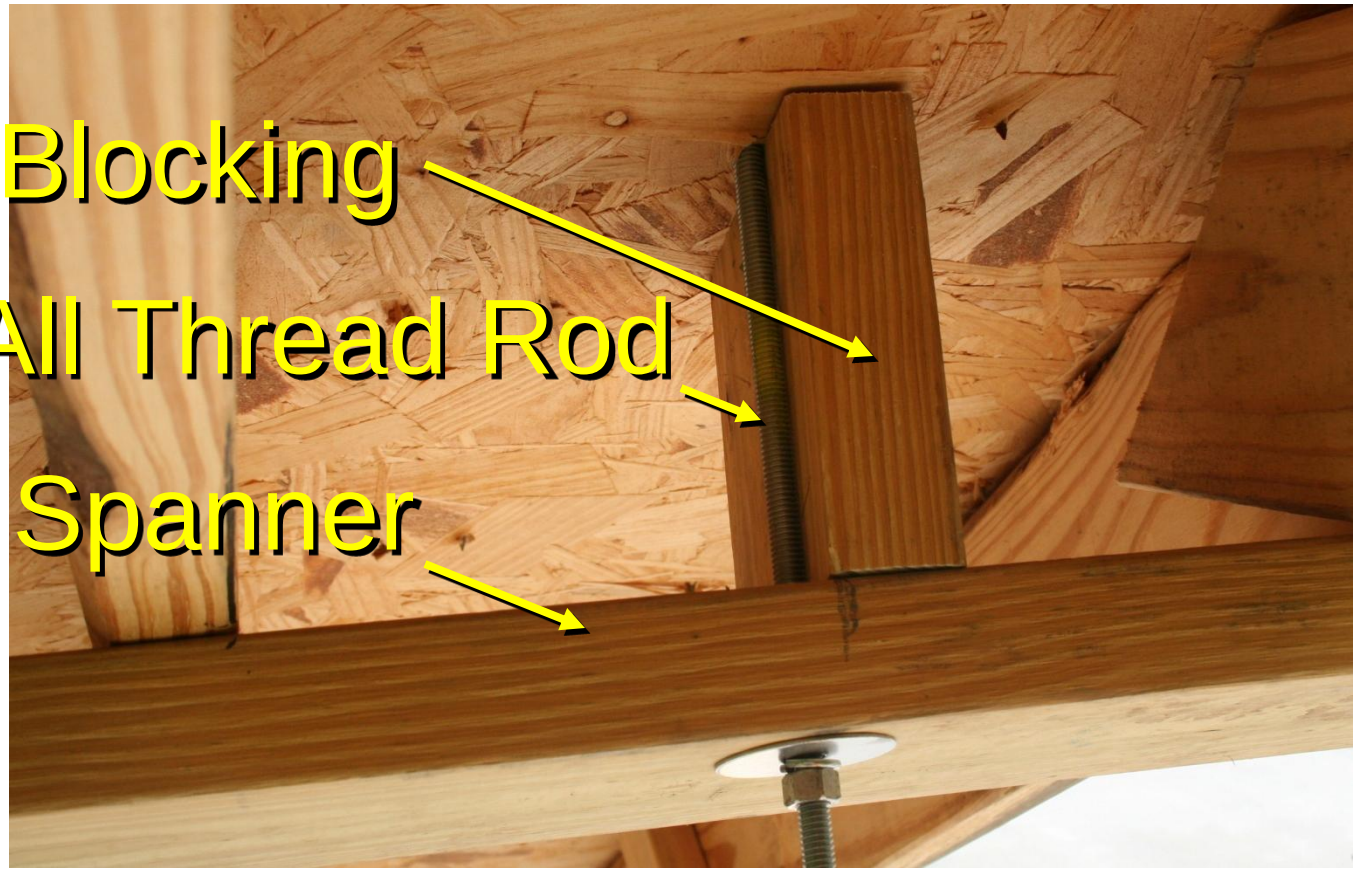
MOUNTING CLIP DETAIL

PANEL INSTALLATION

MOUNTING CLIP DETAIL

PANEL INSTALLATION

PANEL SUPPORTS



PANEL INSTALLATION

LAG BOLTS GONE WRONG!

PANEL INSTALLATION

UNION INSTALLED

PANEL INSTALLATION

UNION CONNECTED

PANEL INSTALLATION

Panels Installed

PANEL INSTALLATION

Can collectors be placed horizontally on the roof?

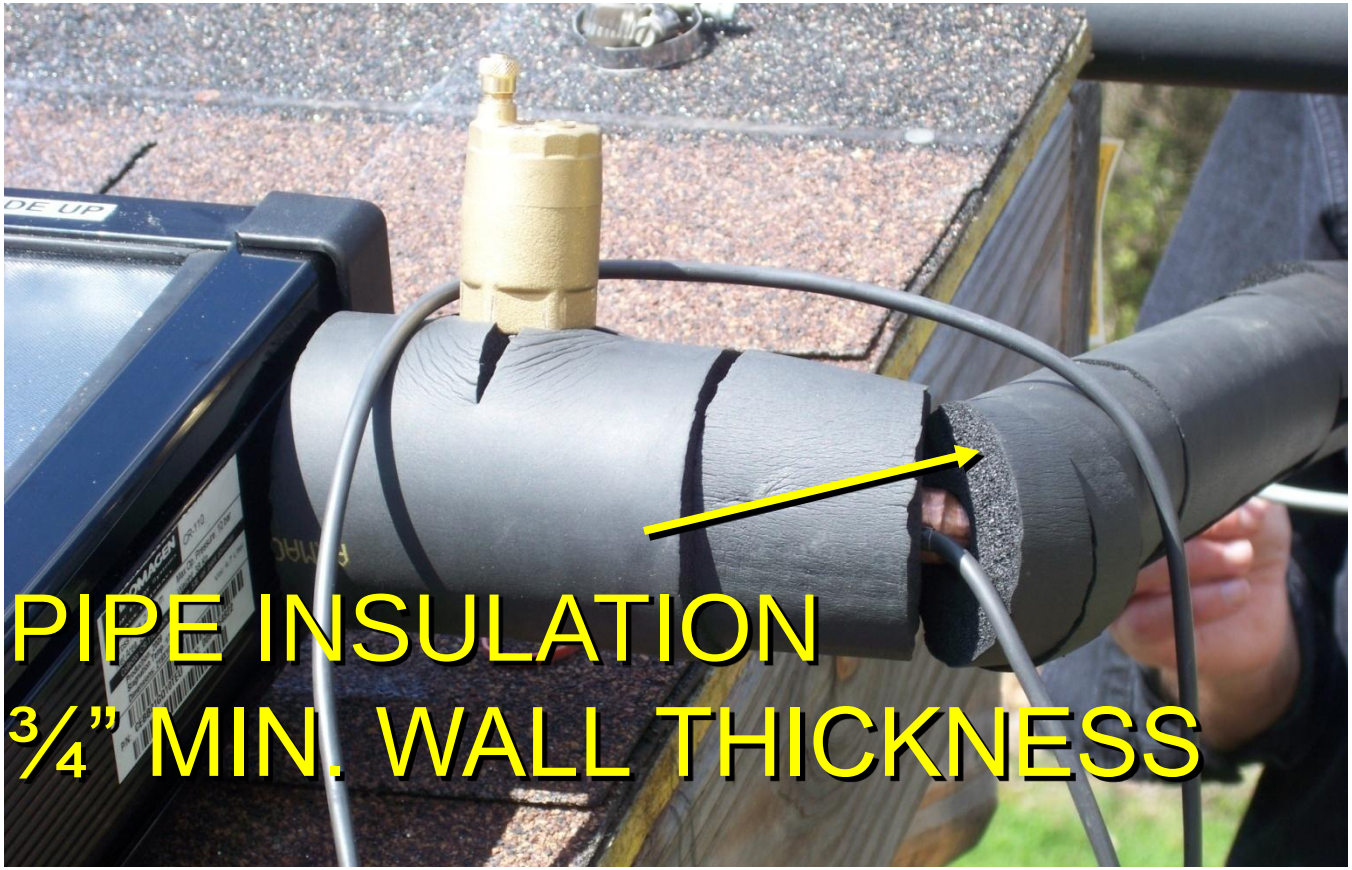
- On closed loop pressurized systems yes, but it complicates the plumbing and raises installation costs.
- Also, panels will not drain well during servicing in this configuration when the risers are running the long axis of the panel.
- Panel vents will trap moisture unless they are plugged.

PANEL INSTALLATION

- Install at the highest point in the system
- Leave vent cap open for 5 days
- Close cap to prevent loss of heat transfer liquid

PANEL INSTALLATION

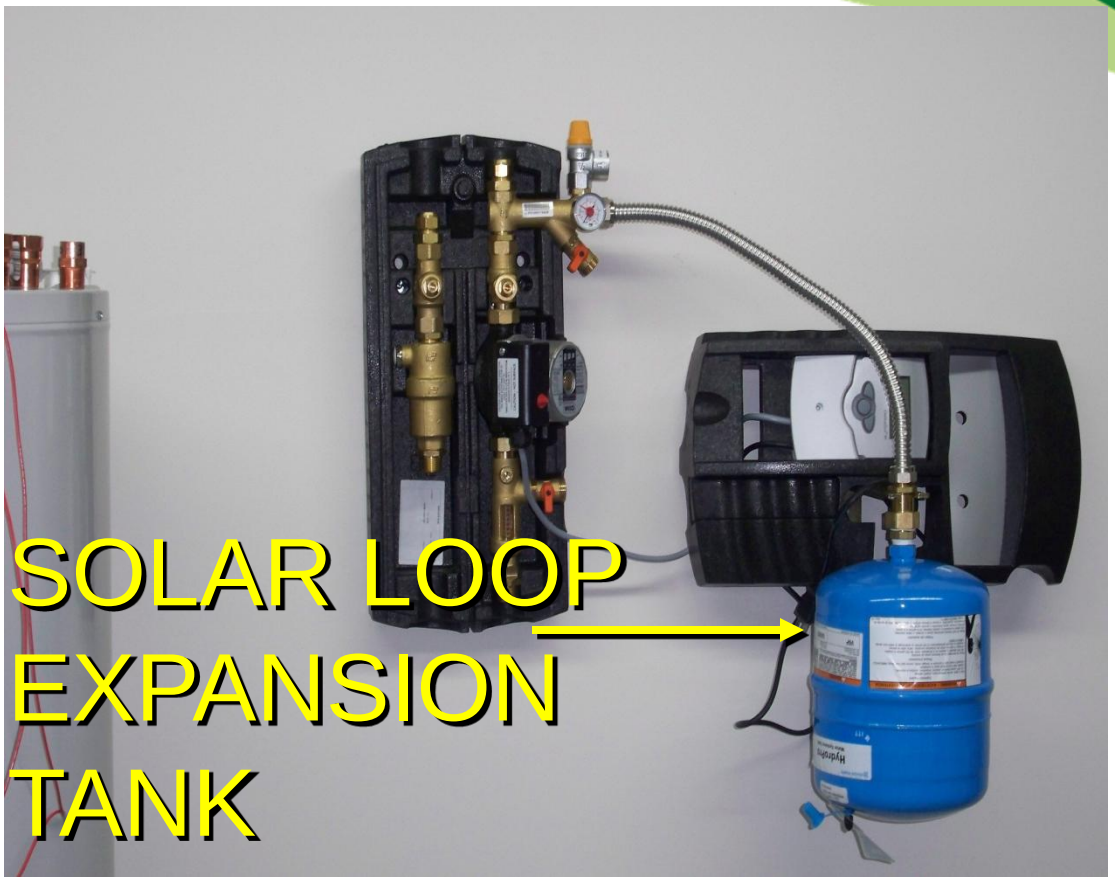
PIPE INSULATION



Tank & Pump Station Installation

SOLAR LOOP EXPANSION TANK

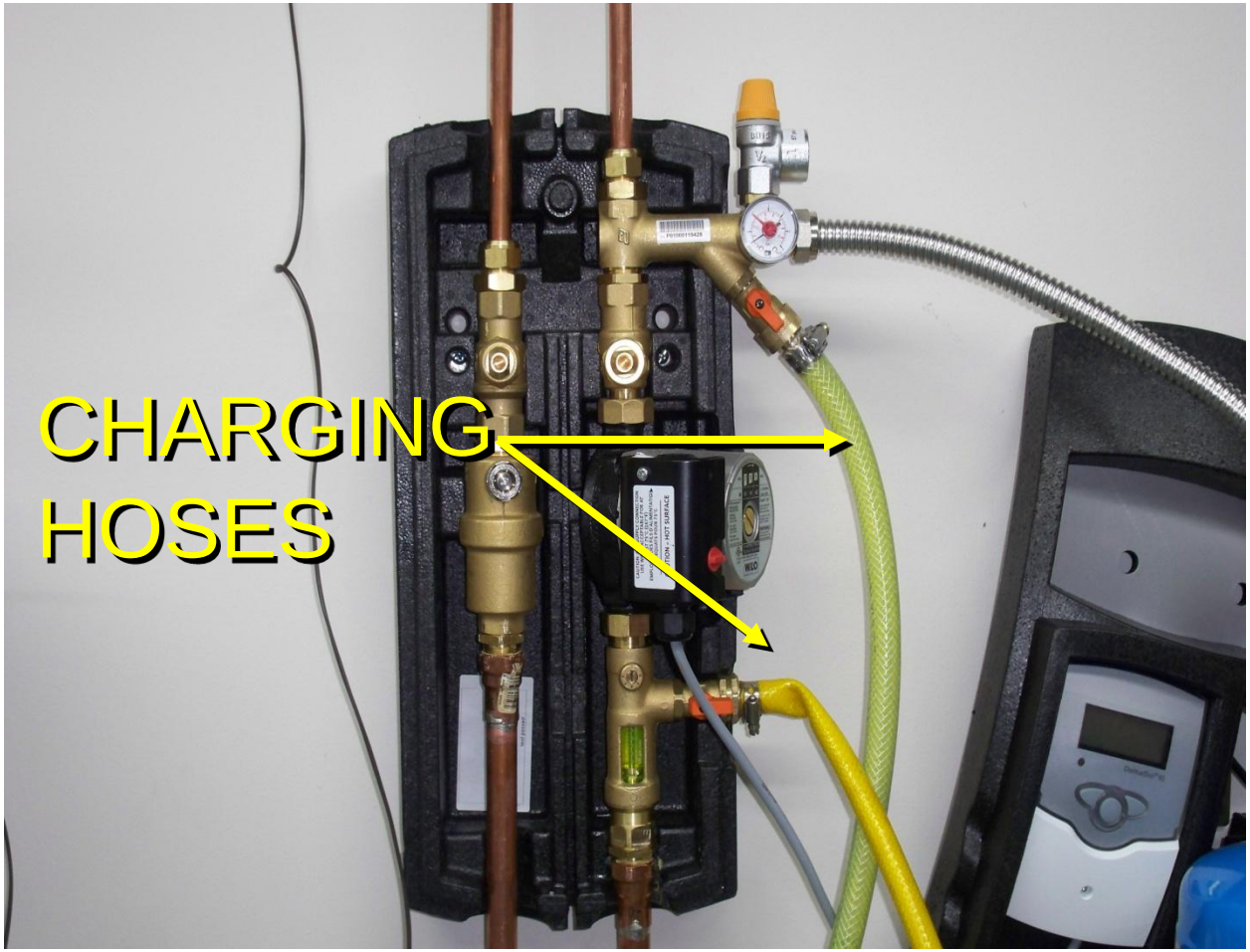
- Relieve pressure if more than 25 PSI.
- If it is lower than 25 PSI use a bicycle pump or air compressor to set the charge pressure to 25 PSI.



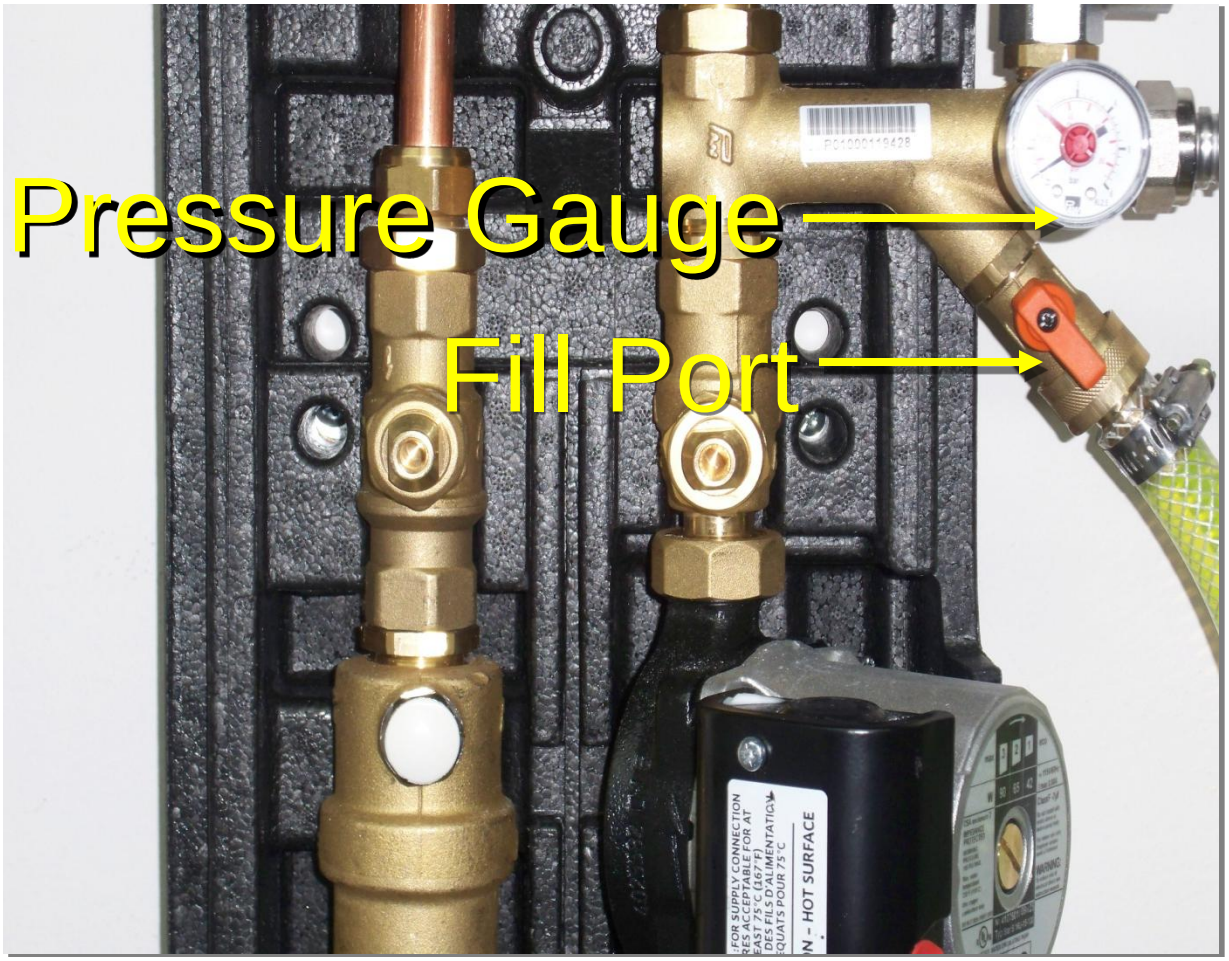
Glycol solution (PLASTIC TUB)

- The use of regular tap water as a mixing agent is prohibited.
- Distilled, de-ionized, or de-mineralized water is often available from grocery stores and drugstores.
- This solution provides freeze protection down to -30° F and burst protection down to -60° F

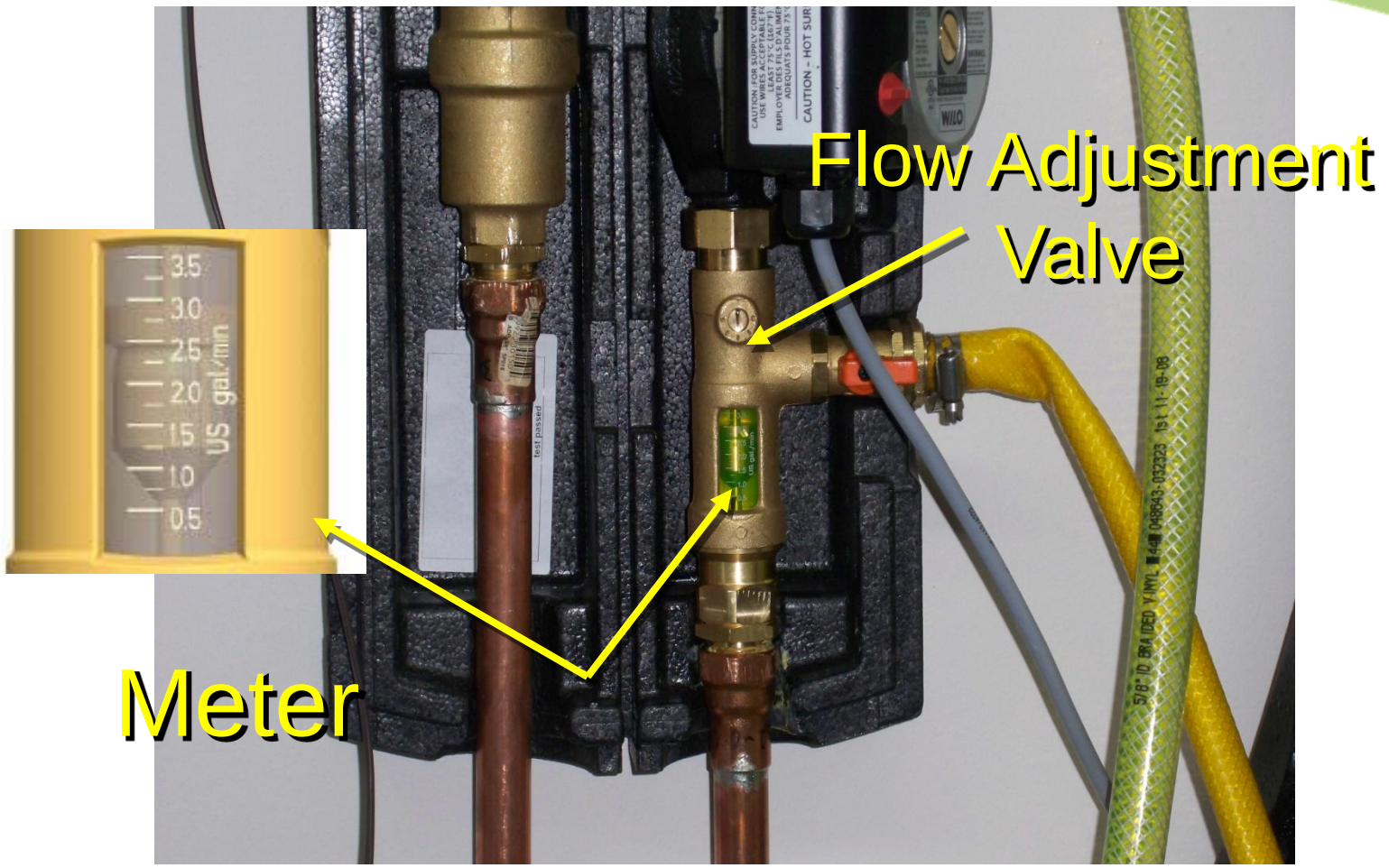
GLYCOL CHARGE



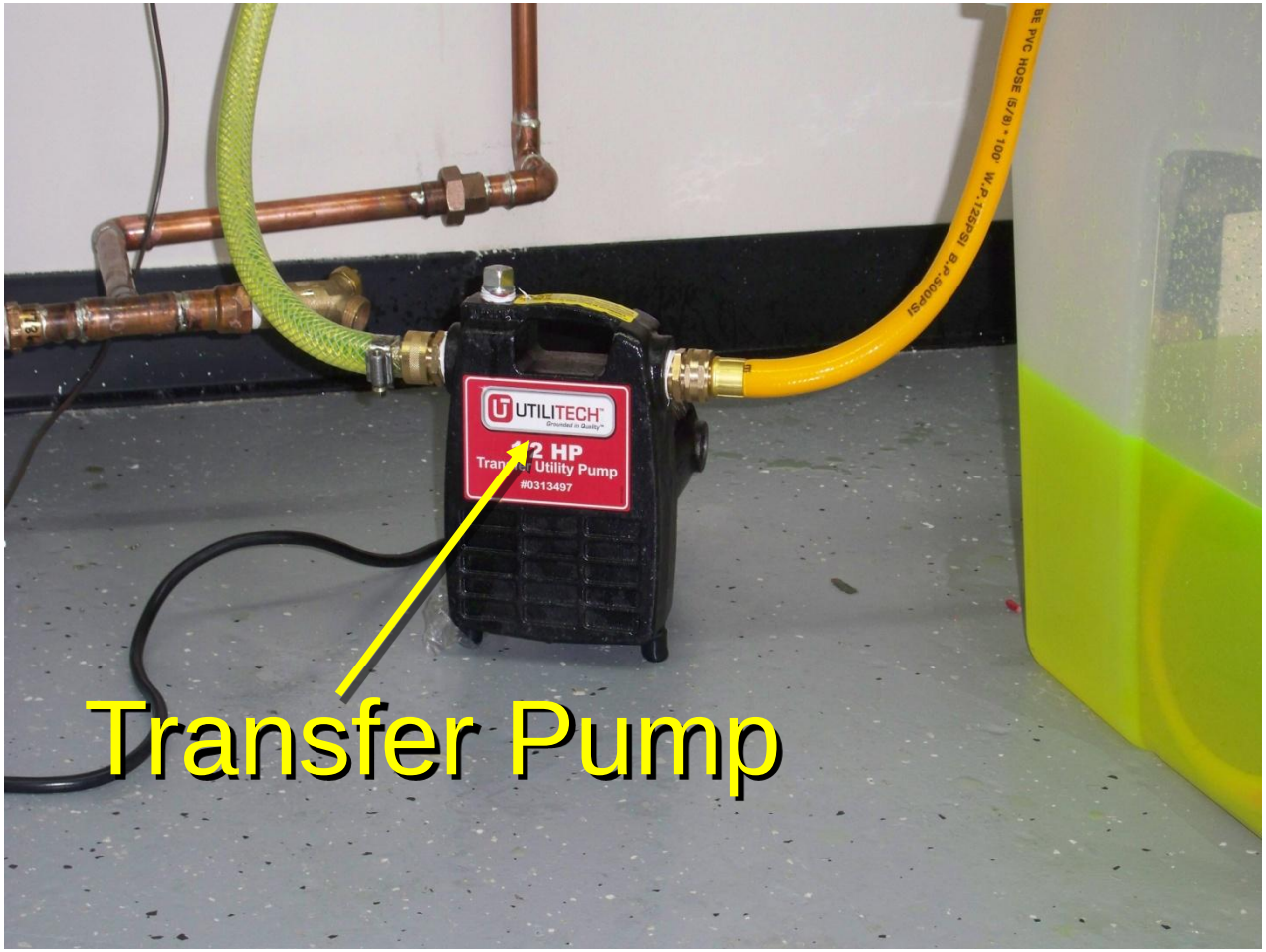
GLYCOL FILL PORT



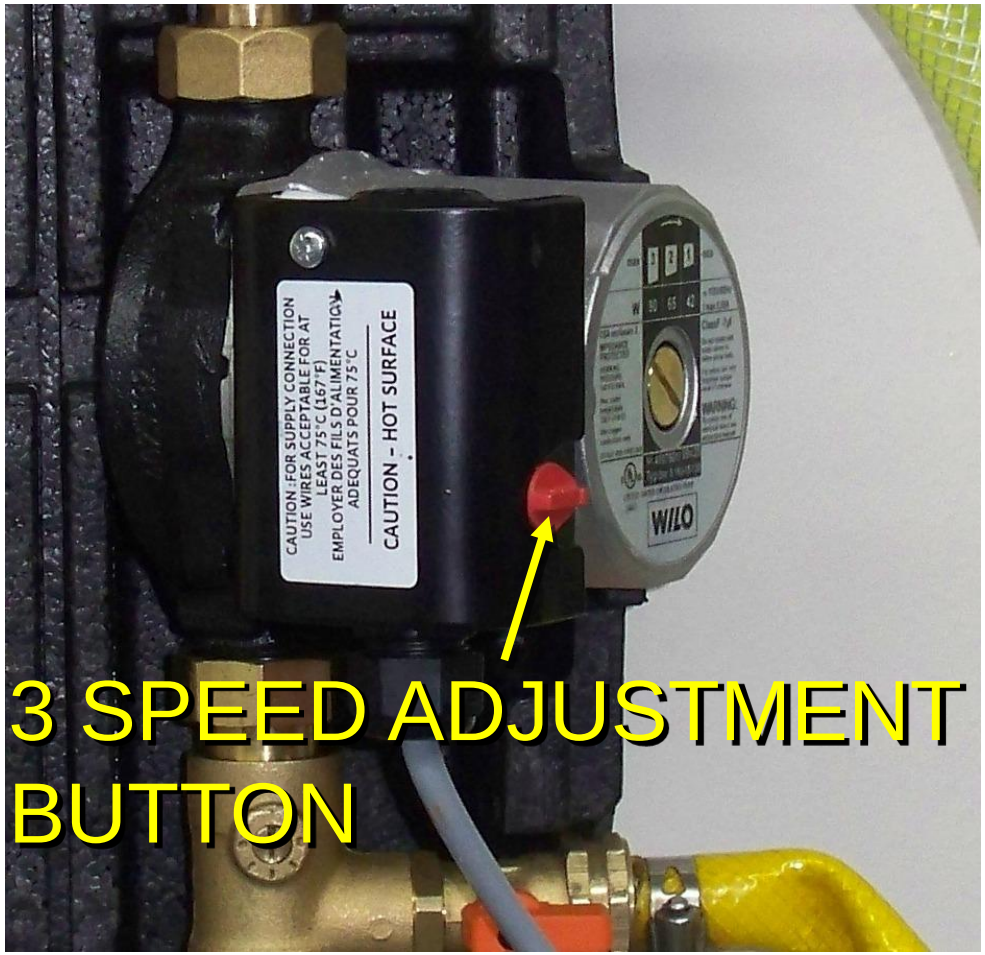
FLOW ADJUSTMENT



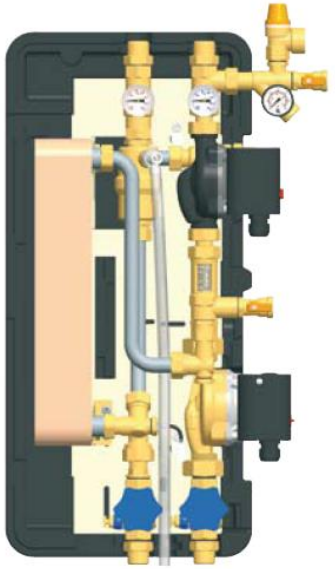
GLYCOL CHARGING PUMP



PUMP SPEED ADJUSTMENT



FINISHED TANK INSTALL



External Plate Heat Exchanger Version

MAINTENANCE

- Check the system pressure every 6 months.
- Pressure loss might indicate the existence of a leak. The pressure should remain above 30 PSI. If necessary, pressurize the system again and check for leaks.
- Flush a bit of water through the pressure relief valve on the tank every 6 months to ensure proper operation.
- Wash the glass on the collectors once a year; more often if dirty.

MAINTENANCE

How often should the glycol be replaced in the system?

- Every three years or -
- When the results of a pH and refractometer tests indicate it is necessary - check annually
- The pH should be 8.0+. At 7.0 and below, replace fluid.
- Refractometer (calibrated for propylene glycol) shows frost protection level of the solution. If it drops below that level re-charge the loop.

MAINTENANCE

Digital Refractometer

- $300+
- Show glycol %
- Analog version $60

MAINTENANCE

Analog Refractometer
- $60+
- Automotive for glycol

Automotive Glycol Tester
$13.99

Pool pH Test Kit
$8.99

Questions