



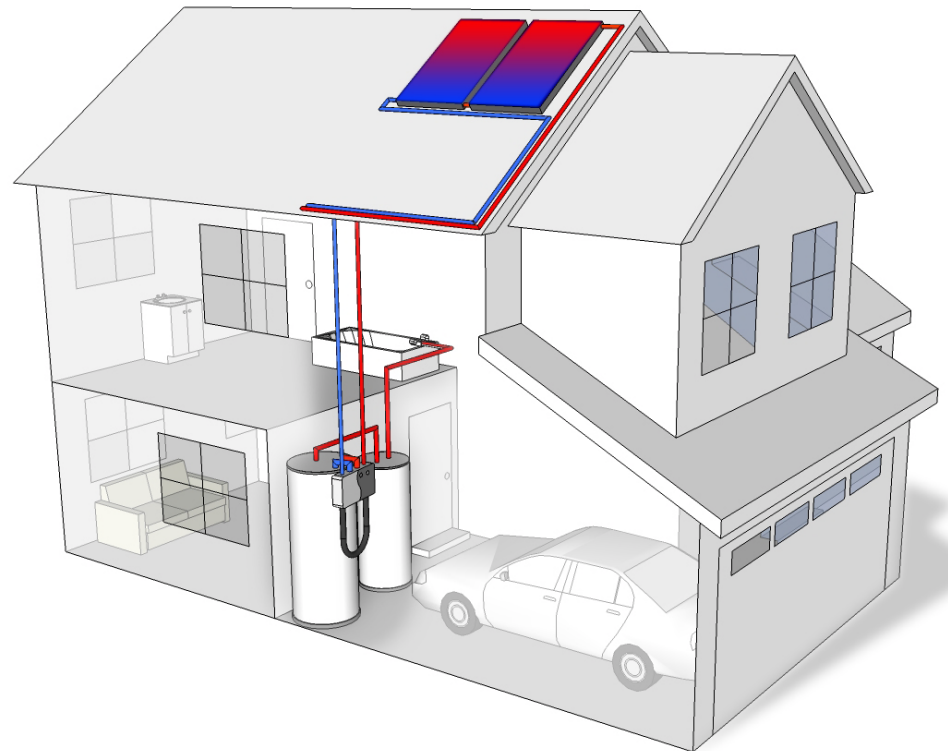
CONNECT 2011

September 21-24 Minneapolis, MN

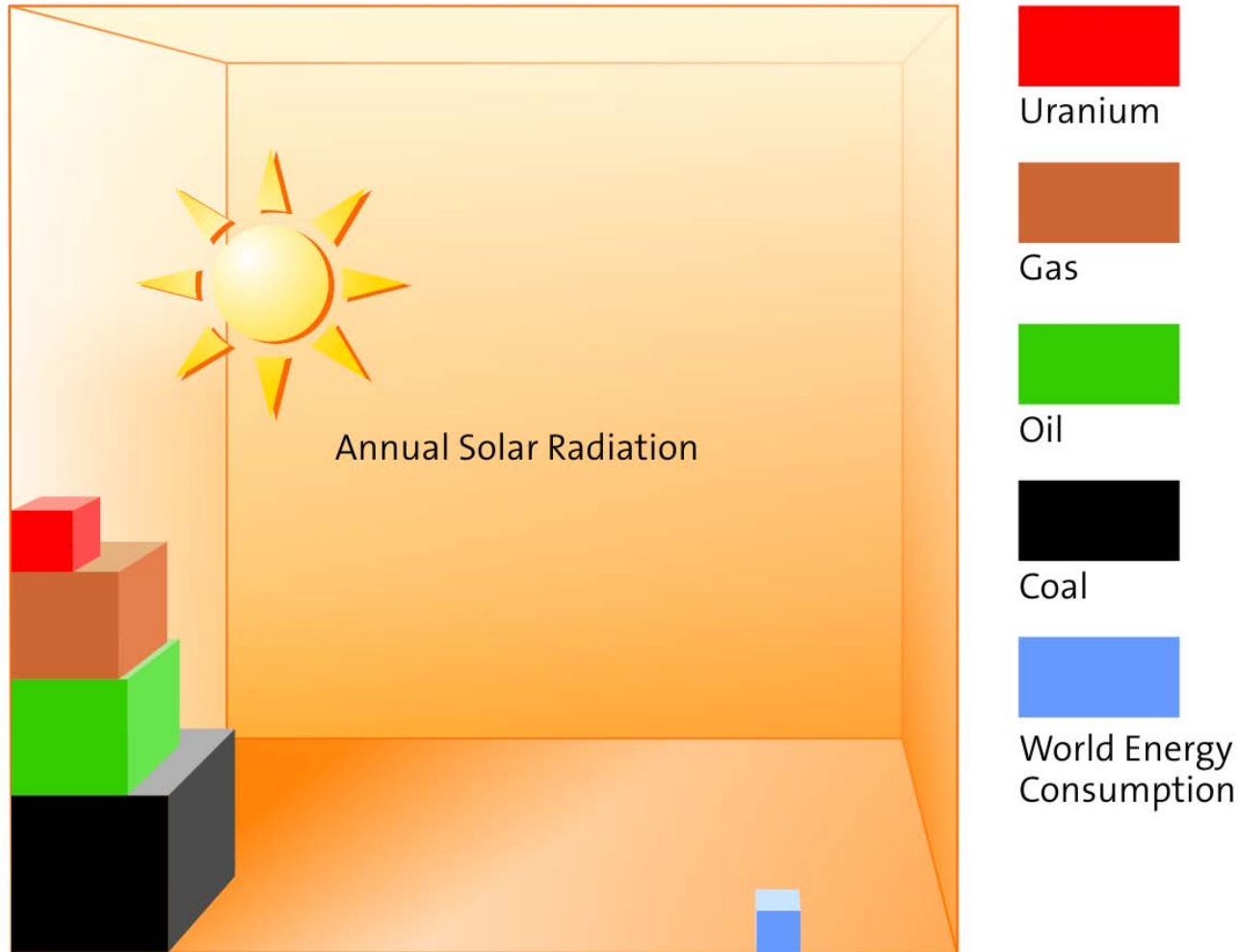
MAKING SOLAR THERMAL A PART OF YOUR BUSINESS

What is Solar Thermal?

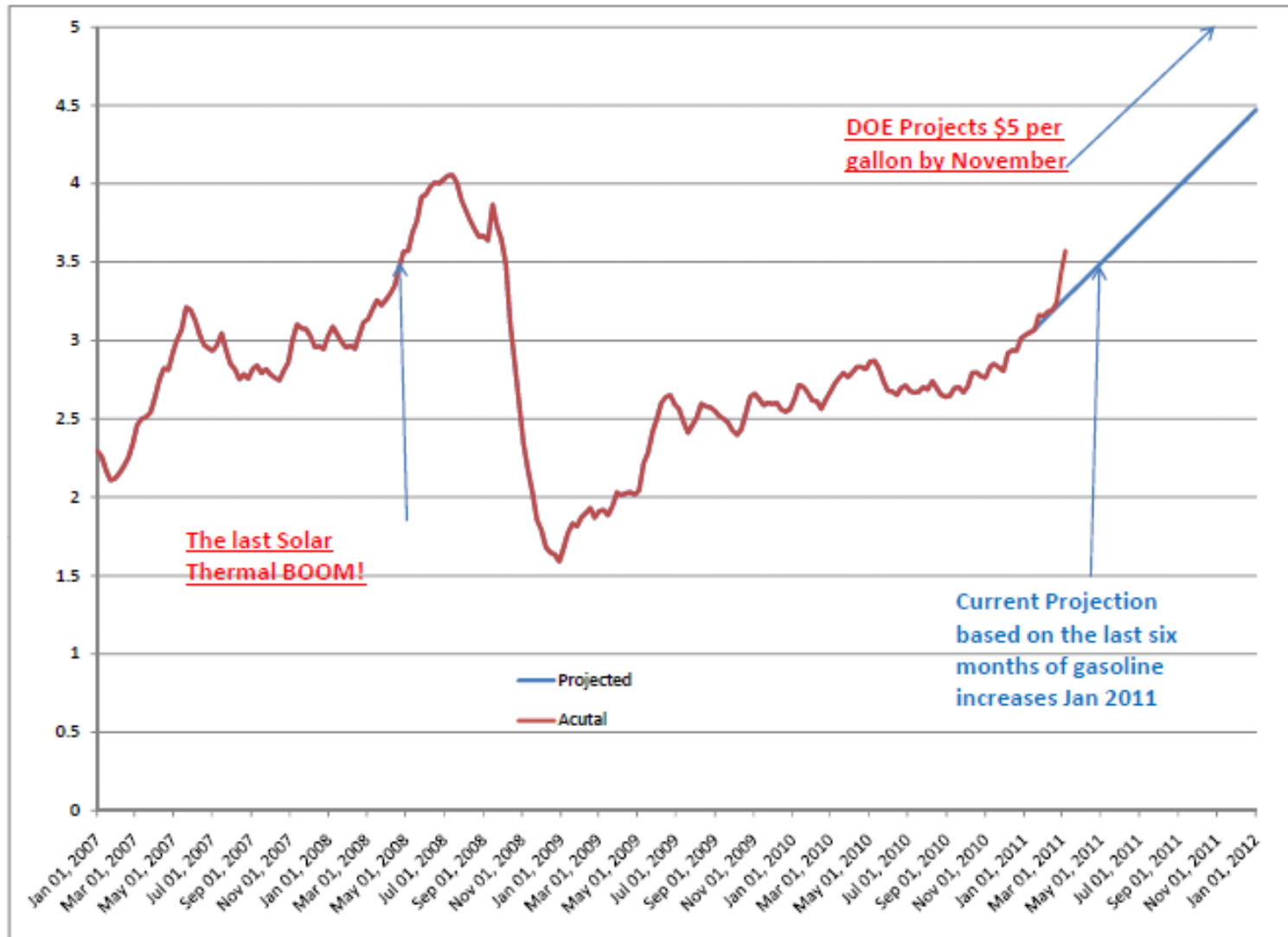
- Harness and convert solar energy into useful thermal energy.
- Applications
 - ▣ Domestic hot water
 - ▣ Space heating
 - ▣ Pool heating
 - ▣ Process heating
 - ▣ Absorption chillers



Why Solar - World Picture



Why Solar- U.S. Gasoline Prices



Why Solar Thermal?

- Energy independence/Fluctuating fuel prices
- Reduce carbon footprint
- Low Upfront Investment
- Fast ROI
- 3-6 Times More Efficient than Solar PV



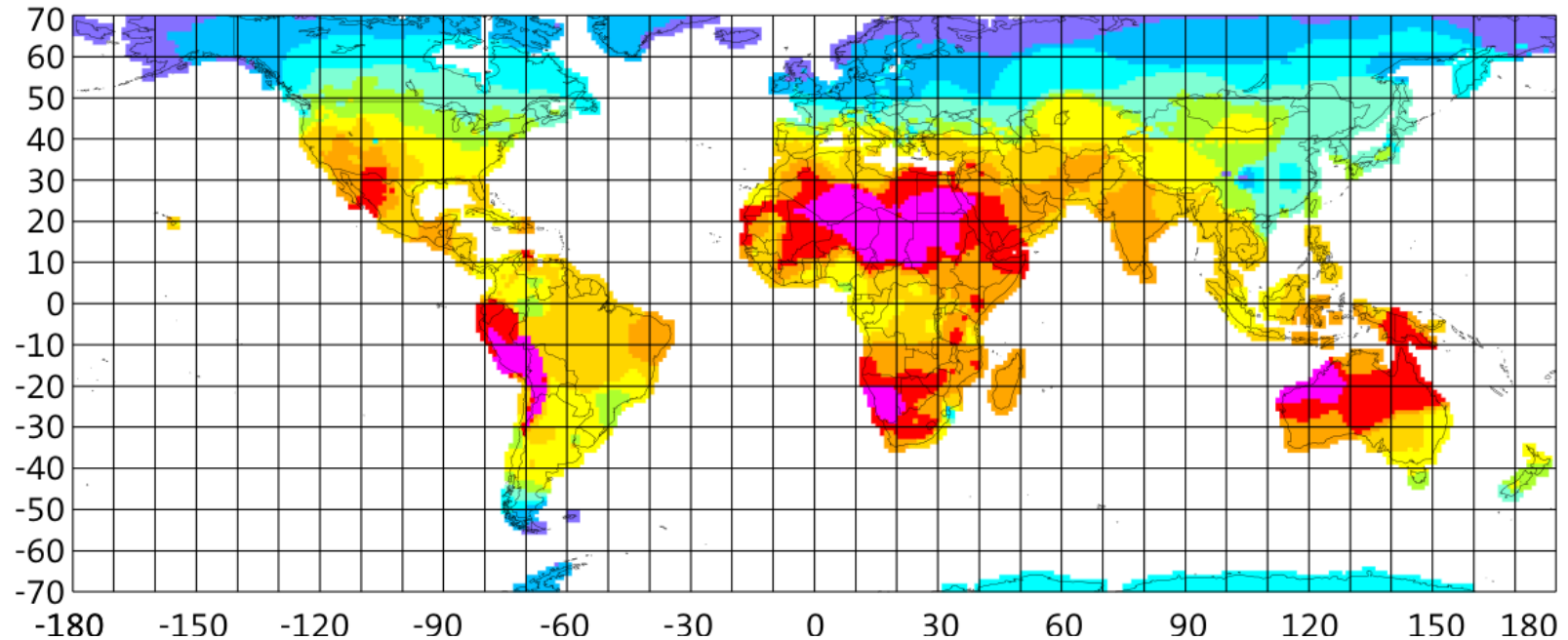
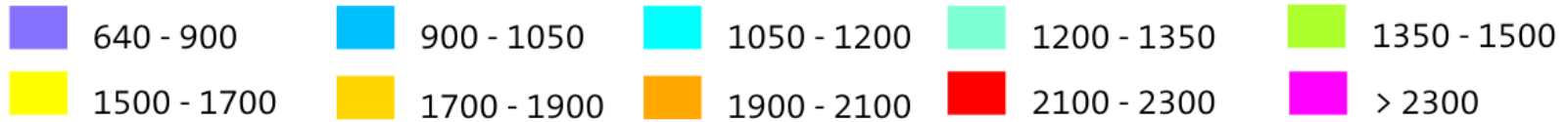
Output/day: 22.7 kWh
Area: 80 ft²
Installed Cost: \$10,000

Output/day: 22.3 kWh (76,100 Btu)
Area: 456 ft² (18 panels)
Installed Cost: \$30,000



But We Don't Get Enough Sunlight...

KWh/m² year



© Meteotest, Bern, Switzerland

Boston Insolation ~ 500,000 Btu/ft² annually



Three Components

Collectors

- Flat Plate
- Evacuated Tube

Pump Station/HX

- External HX
- Pump-only
- Controller included

Storage Tank

- Storage tank
- Indirect tank
- Dual Coil tank



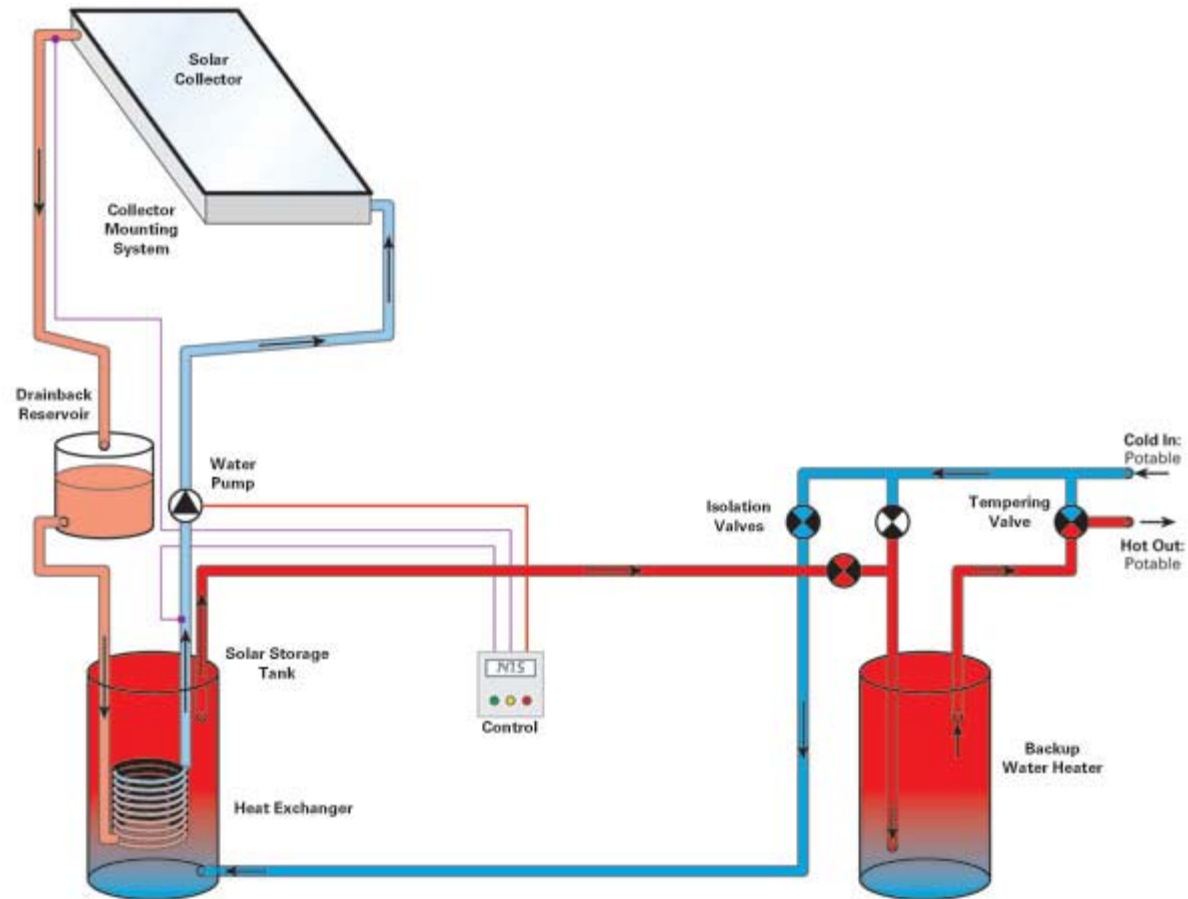
Drain Back Systems

Advantages:

- Uses Water
- No Expansion Tank, Air Vent, Check Valve
- Safe from power outages

Disadvantages

- Careful installation- Everything must slope
- Larger pump(s)
- Can be noisy



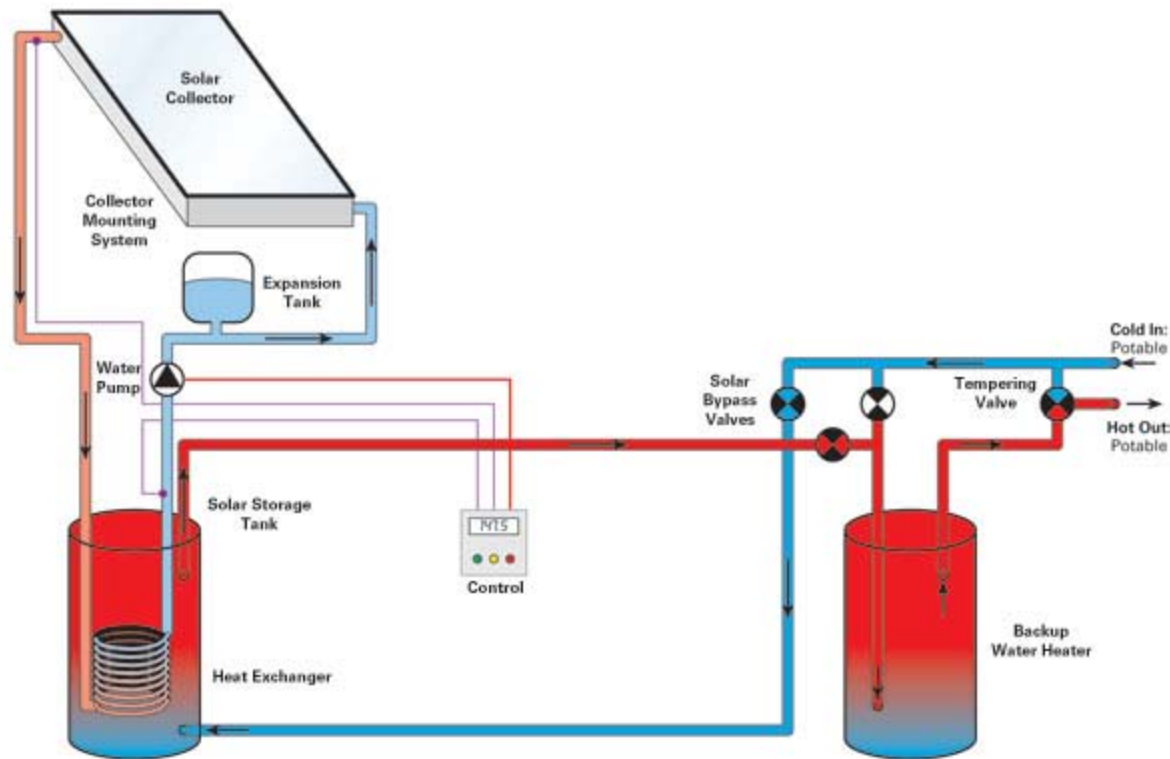
Pressurized Systems

Advantages:

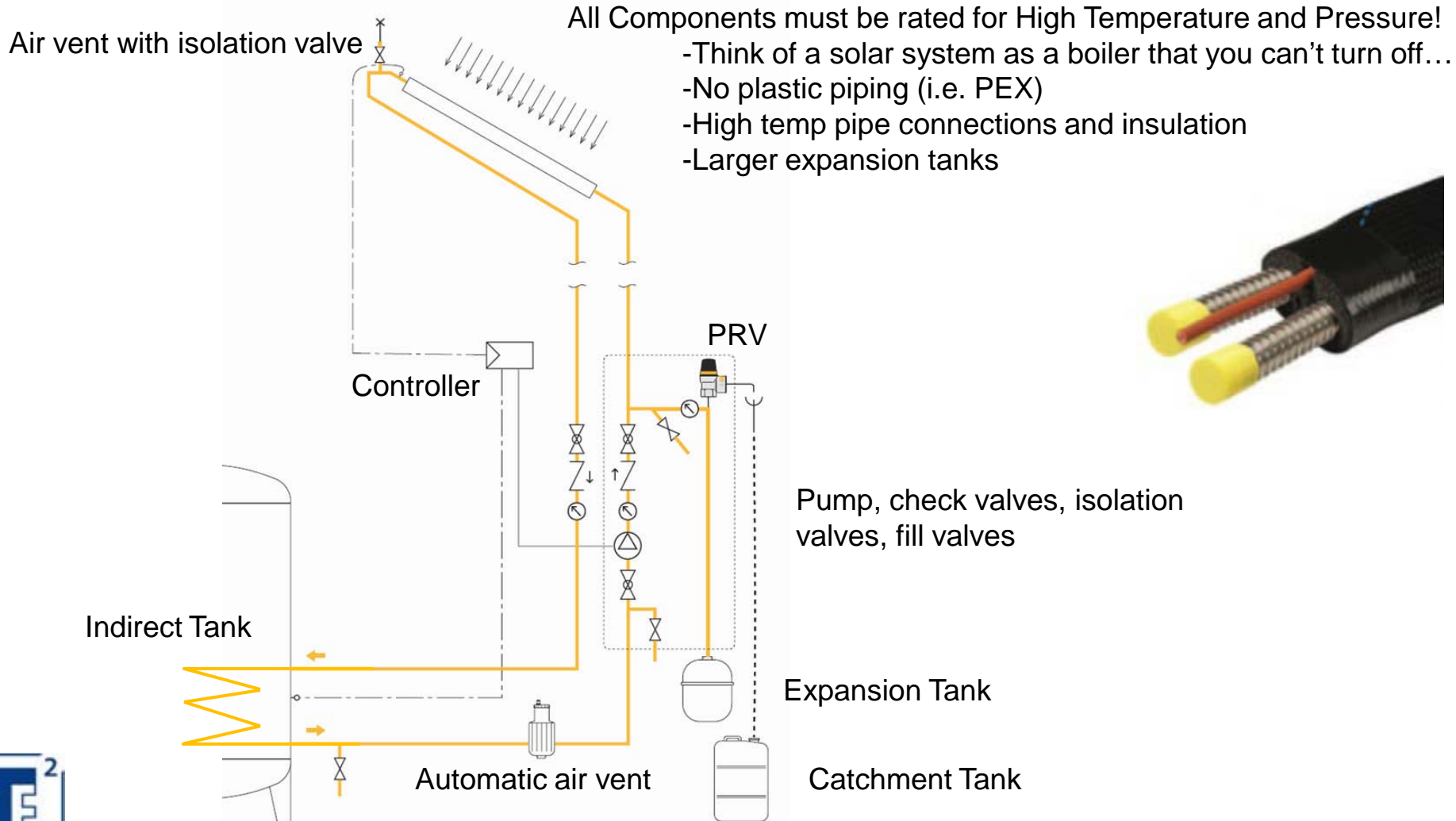
- Freeze protected
- Components do not need to be sloped
- Low Wattage Pump

Disadvantages:

- Check glycol annually
- Overheat during power outage or low load
- Heat dissipation components or controller (may be required)



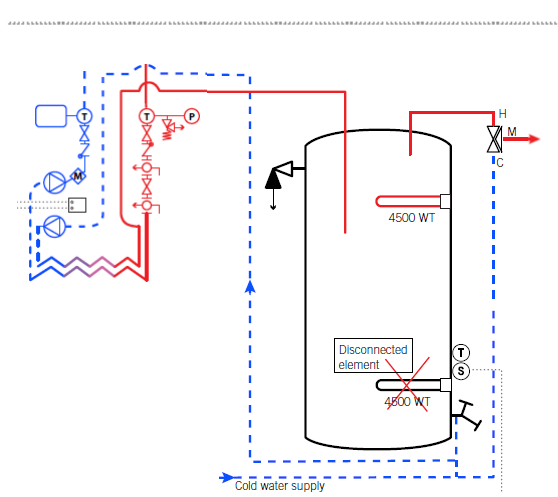
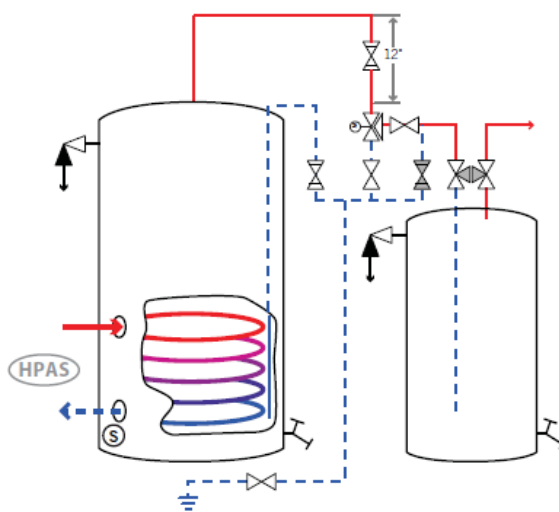
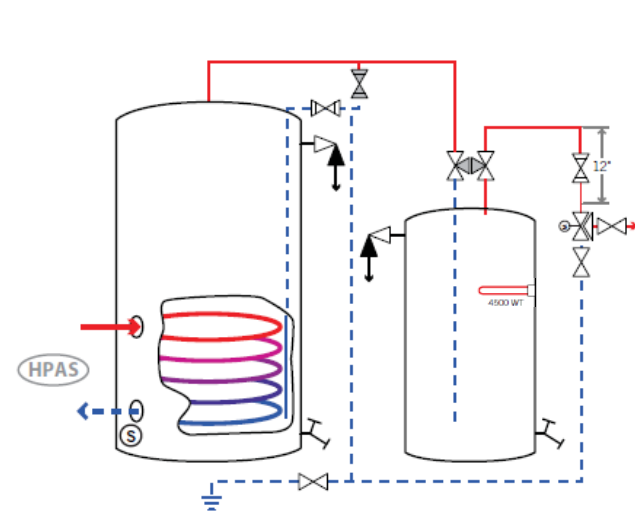
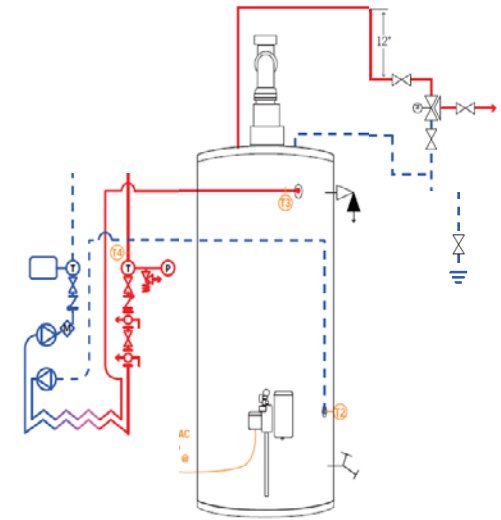
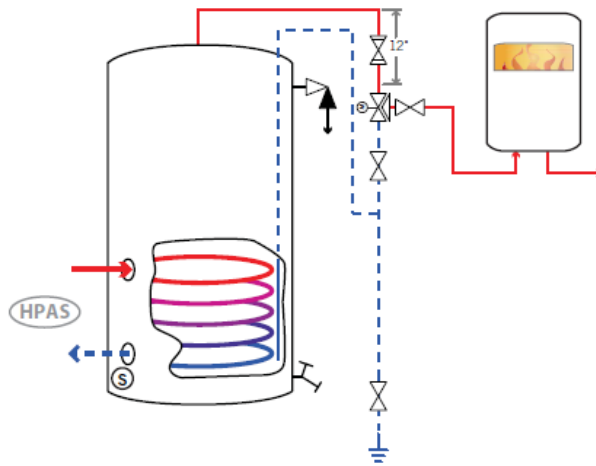
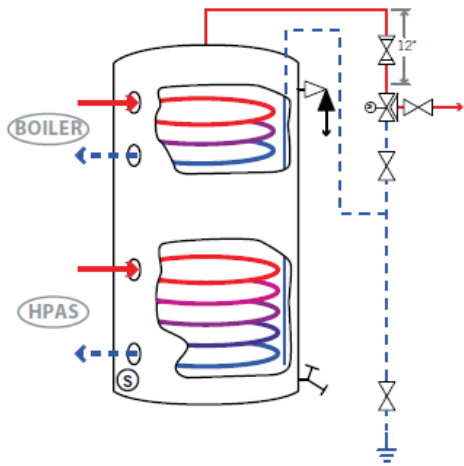
Piping Components



SHW System Layouts




Storage = 1.25 gal/sq. ft of collector area



Collector Performance

- SRCC OG-100 Rating
 - Collector Rating only
 - Glazed Flat Plate
 - Evacuated Tube
 - Snapshot view of collector performance
 - Plot Efficiency or Use Table
 - Collectors must have OG-100 to receive tax credits

www.solar-rating.org

SOLAR COLLECTOR CERTIFICATION AND RATING  SRCC OG-100	CERTIFIED SOLAR COLLECTOR SUPPLIER: Heliodyne, Inc. 4910 Seaport Avenue Richmond, CA 94804 USA GOBI408 001 MODEL: COLLECTOR TYPE: Glazed Flat-Plate CERTIFICATION#: 2010115D
---	--

COLLECTOR THERMAL PERFORMANCE RATING							
Kilowatt-hours 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)	13.5	10.2	6.9	A (-9 °F)	46.2	34.9	23.7
B (5 °C)	12.3	9.0	5.7	B (9 °F)	42.0	30.8	19.5
C (20 °C)	10.5	7.3	4.1	C (36 °F)	35.8	24.8	13.8
D (50 °C)	7.2	4.2	1.3	D (90 °F)	24.5	14.2	4.6
E (80 °C)	4.3	1.6	0.0	E (144 °F)	14.6	5.6	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: 28-MAR-11

COLLECTOR SPECIFICATIONS

Gross Area: 2.993 m² 32.22 ft²
 Dry Weight: 46.3 kg 102. lb
 Test Pressure: 1103. KPa 160. psig

Net Aperture Area: 2.78 m² 29.93 ft²
 Fluid Capacity: 2.6 liter 0.7 gal

COLLECTOR MATERIALS

Frame: Aluminum
 Cover (Outer): Tempered glass
 Cover (Inner):

Pressure Drop

Flow		ΔP	
ml/s	gpm	Pa	in H ₂ O

Absorber Material: Tube - Copper / Plate - Aluminum
 Absorber Coating: Selective coating

Insulation Side: Foam
 Insulation Back: foam

TECHNICAL INFORMATION

Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta] Y INTERCEPT SLOPE

SI Units: $\eta = 0.749 - 3.69060 (P)/I - 0.00551 (P)^2/I$ 0.752 -4.029 W/m²·°C

IP Units: $\eta = 0.749 - 0.65010 (P)/I - 0.00054 (P)^2/I$ 0.752 -0.710 Btu/hr.ft²·°F

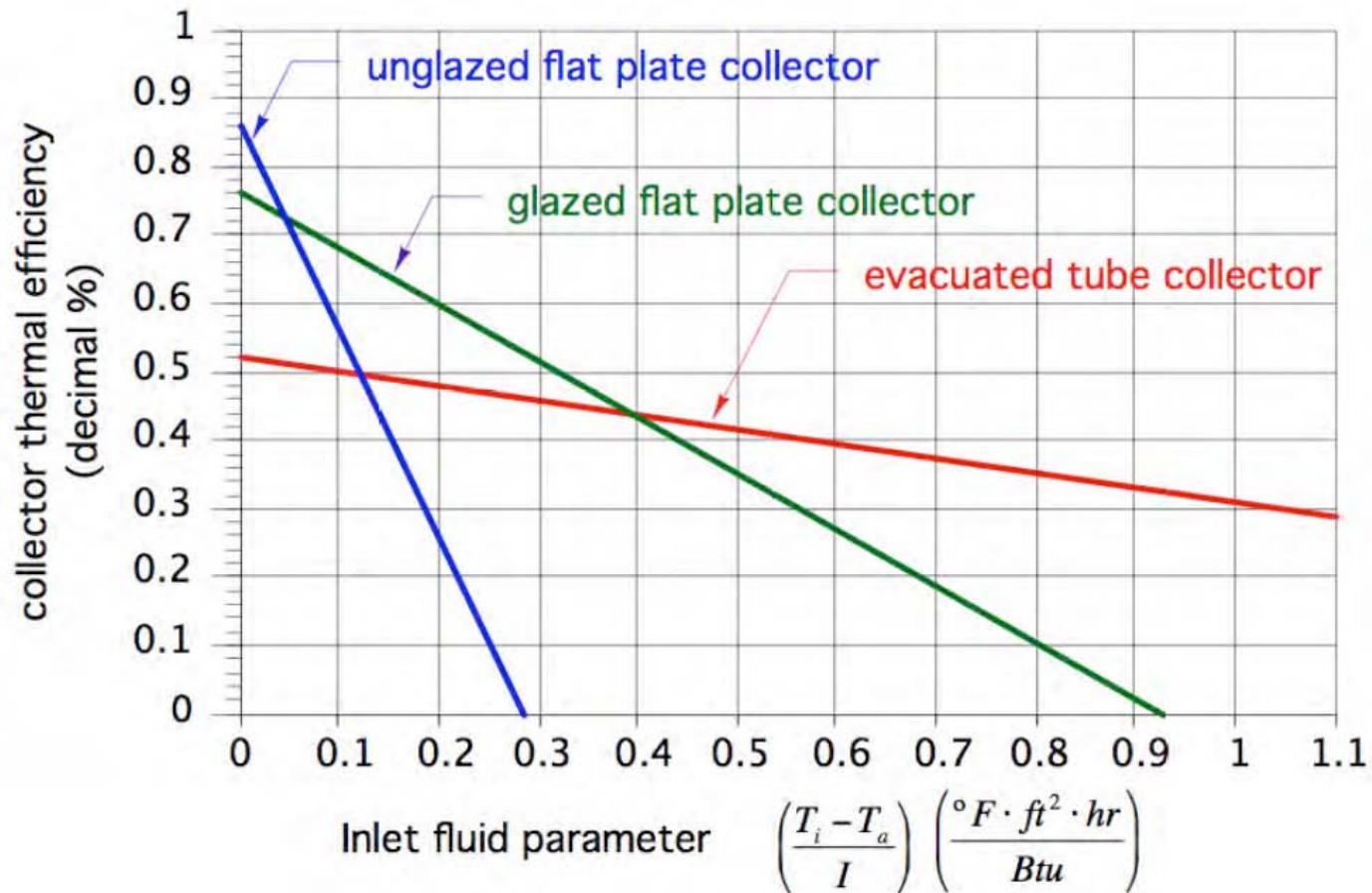
Incident Angle Modifier [(S)=1/cosθ - 1, 0°<θ<=60°] Test Fluid: Water

K_{τα} = 1 -0.078 (S) -0.086 (S)² Test Flow Rate: 27.7 ml/s.m² 0.0408 gpm/ft²

K_{τα} = 1 -0.17 (S) Linear Fit



Which is More Efficient?

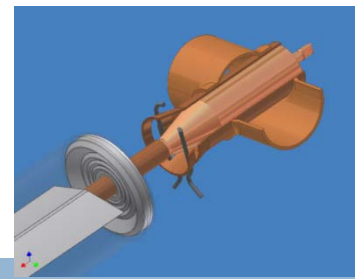


Where do the lines intersect?

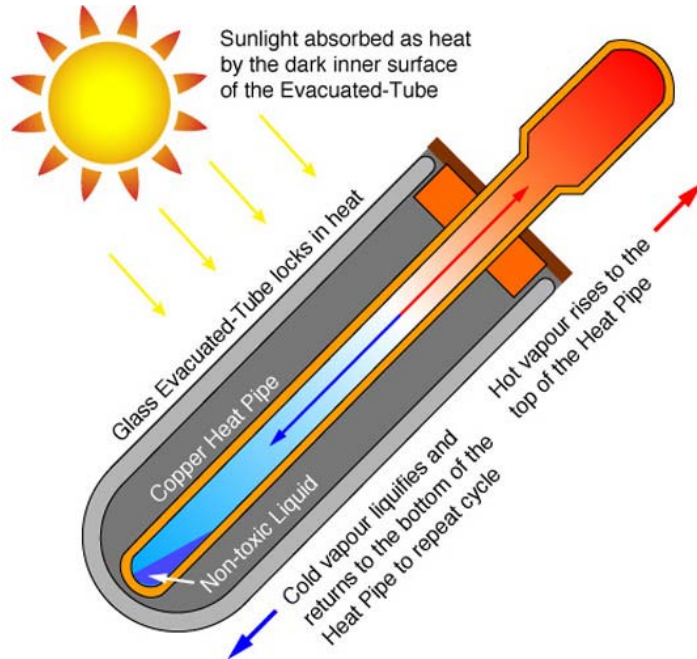
20°F Ambient, Reasonably Bright Day (250 Btuh/sq. ft), with 120°F fluid temp = Fluid Parameter 0.4



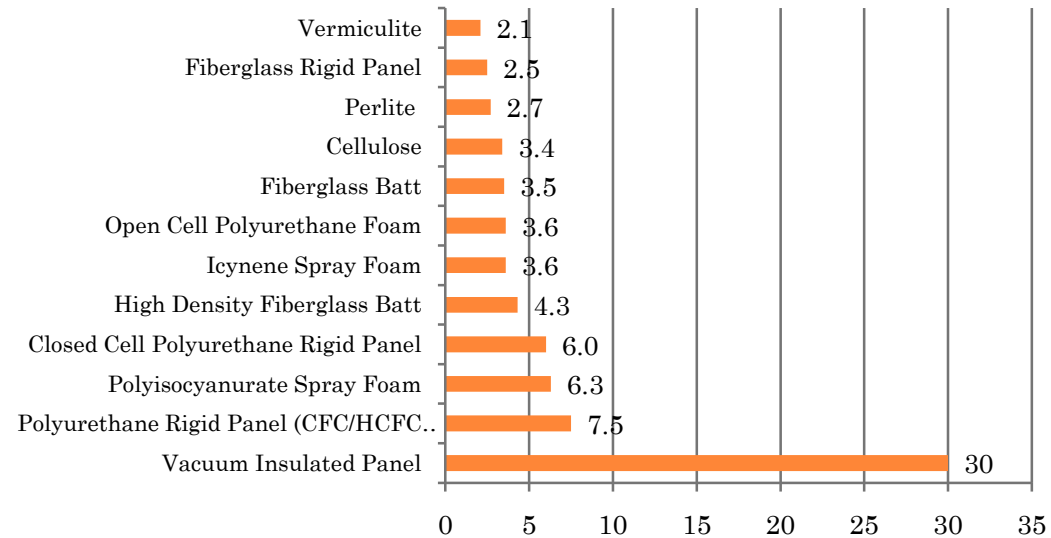
Evacuated Tubes



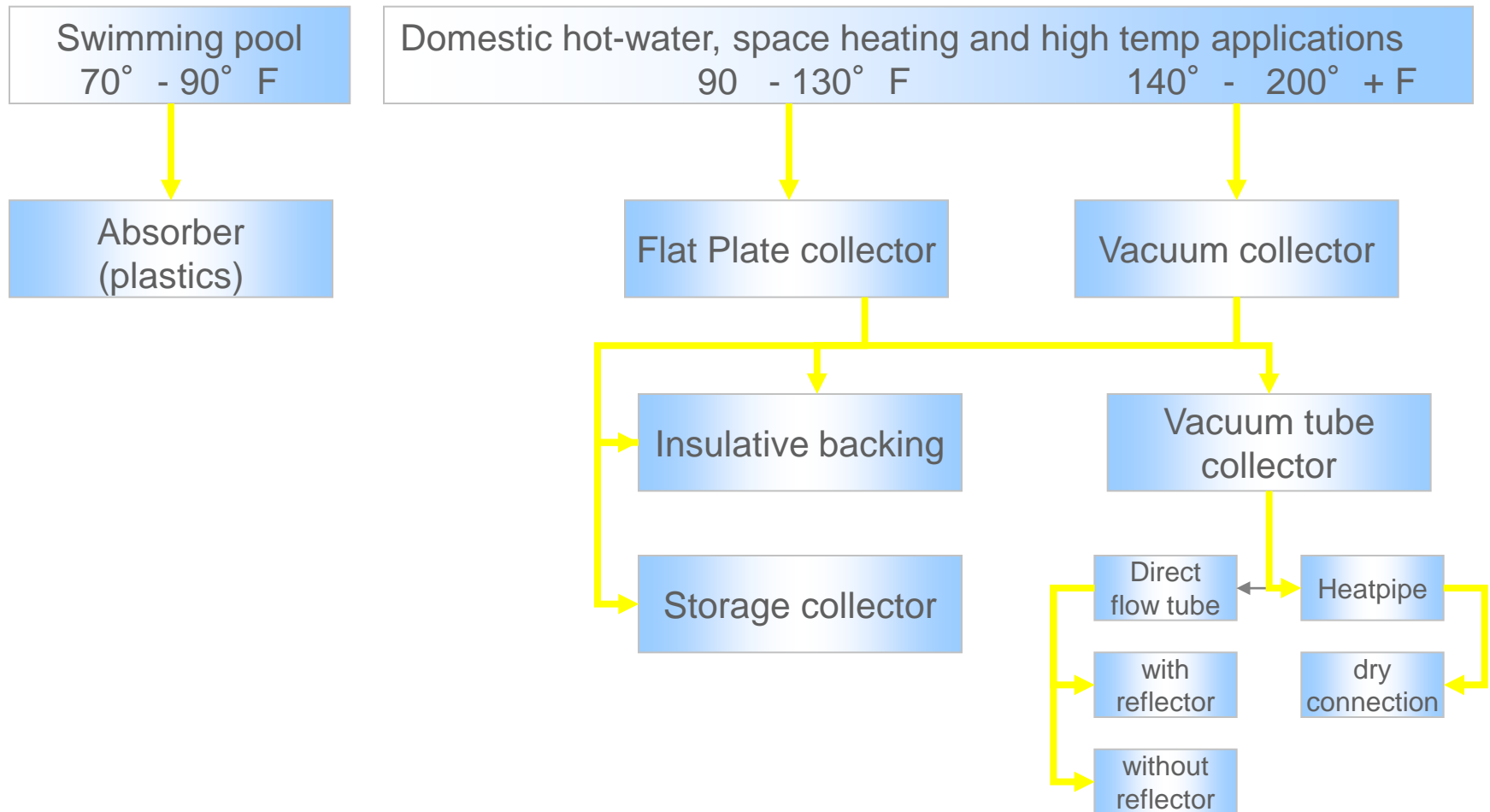
□ Heat Pipe and Direct Flow



Average R-Value per Inch of Various Materials

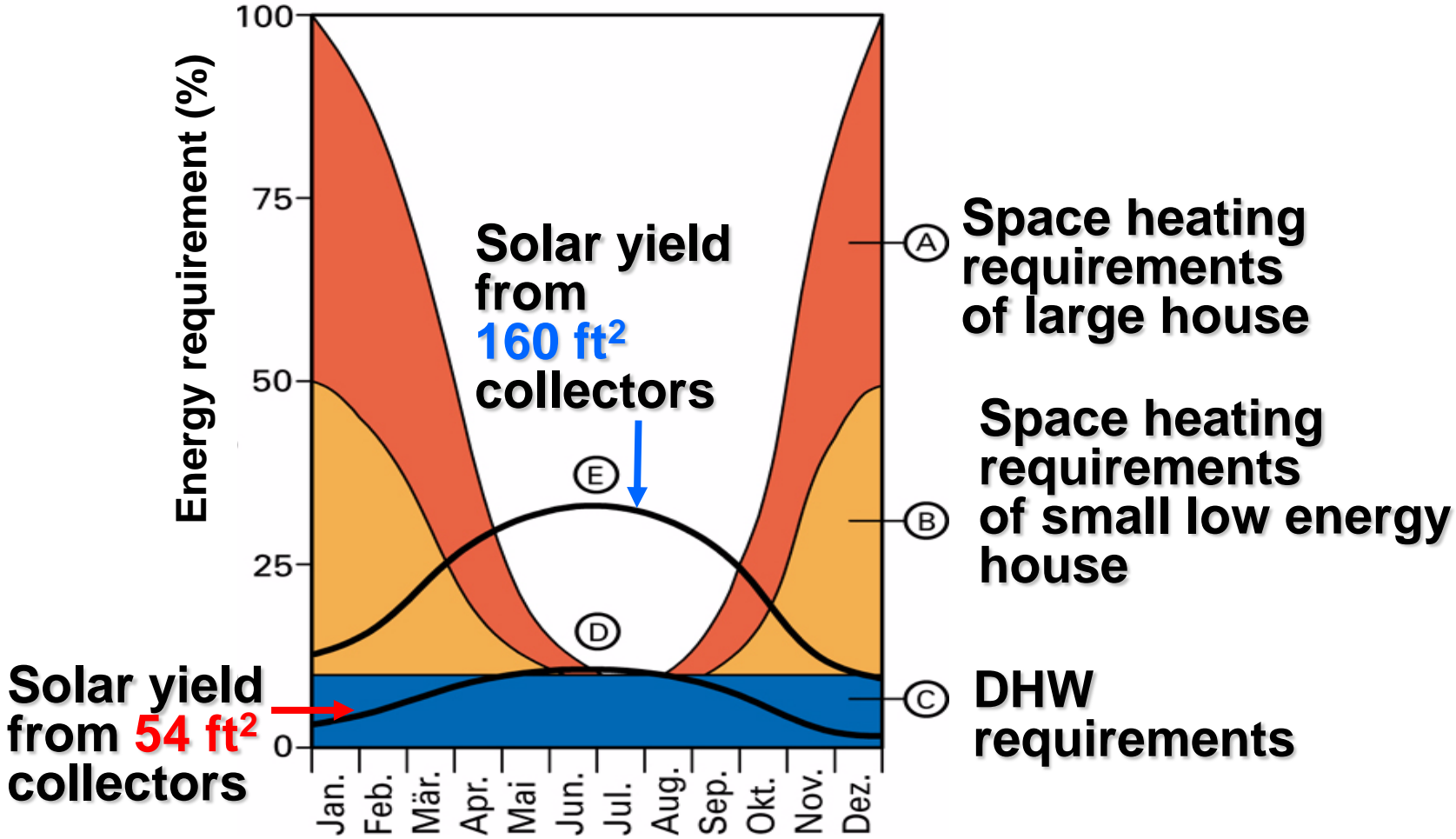


Which Collector to Use?

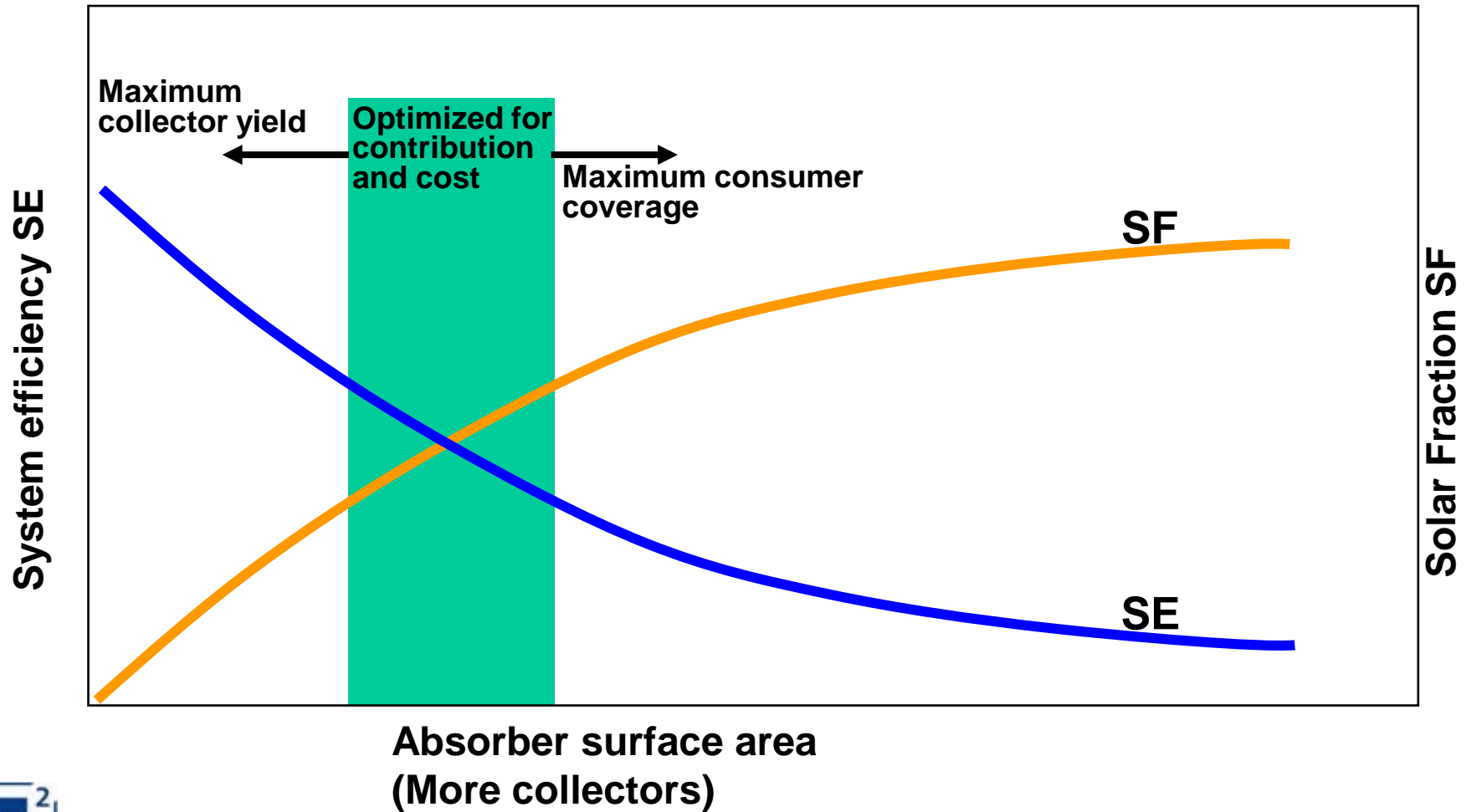


*Efficiency is not the only factor. Quality, Durability, Service and Cost must also be evaluated!

Space Heating vs. Domestic Water Heating



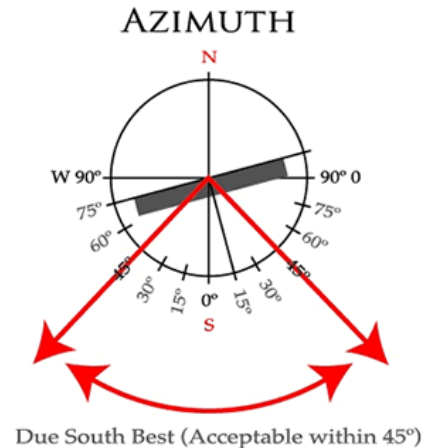
System Design



Project Siting

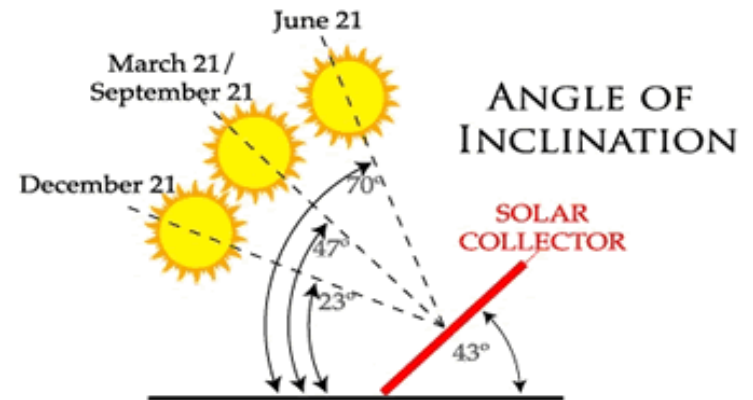
□ Azimuth angle

- Solar South
- Shading



□ Inclination angle

- Annual \sim Latitude - 5°
- Winter \sim Latitude + 15°



Sales Process

- Identify quality leads/applications
- Site Visit
 - Solar checklist
- Design the system
 - Follow tables for residential systems
 - T*SOL/PolySun report
- Quote the system
 - Show Tax Credits/Rebates and System Payback
- Get ready to install!
- Things that may sneak up on you...
 - Roof mounting/attachments
 - Structural engineering fees

PROJECT DATA SHEET
COMMERCIAL SOLAR HOT WATER SYSTEMS
Please fill out both pages of this form as best you can (page 1 of 2)

YOUR INFORMATION
Company Name _____ Address _____
Contact Person _____ City, State, Zip _____
Telephone Area/No _____ Phone _____ Email _____
Holiday/Sales Rep _____

PROJECT INFORMATION
Project Name _____ Roof Mount Type _____
Address _____ To S Street To N Street West Complex
City, State, Zip _____ On Off existing roof New
Budget _____ Target Solar Fraction _____
Commercial Installation Date _____ Existing New Frame
Installation Type _____ New Build Replacement
Roofing Type _____ Asphalt Slate Tile
 Weather Resistant Concrete Metal
 Insulated Non-insulated
 Other _____

ROOF INFORMATION
Roof Structure _____ Other Frame Roof Frame
Number of Stories _____
Approx. Roof Pitch _____
Roof Orientation _____
Number of Slopes _____
Slope 1 _____ Slope 2 _____
Slope 3 _____ Slope 4 _____

WATER DEMAND
Approx. gal hot water used daily (high season) _____
Heating water temp _____ hot water usage temp _____
Load information: _____
Temperature _____
Flow rate _____
Water use _____
Water use _____
Water use _____
Water use _____
Water use _____

Additional information
Roof Orientation _____
Roof Structure _____
Roof Pitch _____
Roof Orientation _____
Roof Structure _____
Roof Pitch _____

STANDARD PACKAGES	People: 1-2	2-4	4-5
Collectors		x2	x3
Model Type*	GOBI 406 001S	GOBI 406 001S	GOBI 406 001S
Surface Area	26.94 ft ²	53.88 ft ²	80.82 ft ²
Hello-Pak includes:			
Controller (Delta-T)	HPAK 016 000	HPAK 016 000	HPAK 016 000
Recommended Tank Size	60 gal.	80 gal.	120 gal.
Includes:			
Expansion Tank	EXPT 002 000	EXPT 002 000	EXPT 002 000
Dyn-O-Seal™ Kit	✓	✓	✓
Glycol**	3 gal.	4 gal.	4 gal.
MSRP with Flush-Mount Kit (flange feet standard)	\$2,817	\$4,061	\$5,306
Order Number	50180	50190	50022
MSRP with Rack-Mount Kit (47"Hi legs)	\$3,064	\$4,211	\$5,456
Order Number	50185	50195	50205

Project Feasibility Assessment

2011 Installation

Category	Item	Cost	Percentage
Project Description	Project Name	1	0.01%
	Address	2	0.02%
Site Data	Type of Facility	3	0.15%
	Roofing	4	0.20%
	Structure	5	0.30%
	Orientation	6	0.40%
	Construction	7	0.50%
Installation	Number of Collectors	8	0.05%
	Area under Collector Health	9	0.10%
	Mount System Budget	10	0.20%
	Roofing Reinforcement	11	0.30%
	Roofing Reinforcement	12	0.40%
	Roofing Reinforcement	13	0.50%
	Roofing Reinforcement	14	0.60%
	Roofing Reinforcement	15	0.70%
	Roofing Reinforcement	16	0.80%
	Roofing Reinforcement	17	0.90%
Total Cost	Roofing Reinforcement	18	1.00%
	Roofing Reinforcement	19	1.10%
	Roofing Reinforcement	20	1.20%
	Roofing Reinforcement	21	1.30%
	Roofing Reinforcement	22	1.40%
	Roofing Reinforcement	23	1.50%
	Roofing Reinforcement	24	1.60%
	Roofing Reinforcement	25	1.70%
	Roofing Reinforcement	26	1.80%
	Roofing Reinforcement	27	1.90%

Project Feasibility

Category	Item	Cost	Percentage
Project Description	Project Name	1	0.01%
	Address	2	0.02%
Site Data	Type of Facility	3	0.15%
	Roofing	4	0.20%
	Structure	5	0.30%
	Orientation	6	0.40%
	Construction	7	0.50%
Installation	Number of Collectors	8	0.05%
	Area under Collector Health	9	0.10%
	Mount System Budget	10	0.20%
	Roofing Reinforcement	11	0.30%
	Roofing Reinforcement	12	0.40%
	Roofing Reinforcement	13	0.50%
	Roofing Reinforcement	14	0.60%
	Roofing Reinforcement	15	0.70%
	Roofing Reinforcement	16	0.80%
	Roofing Reinforcement	17	0.90%
Total Cost	Roofing Reinforcement	18	1.00%
	Roofing Reinforcement	19	1.10%
	Roofing Reinforcement	20	1.20%
	Roofing Reinforcement	21	1.30%
	Roofing Reinforcement	22	1.40%
	Roofing Reinforcement	23	1.50%
	Roofing Reinforcement	24	1.60%
	Roofing Reinforcement	25	1.70%
	Roofing Reinforcement	26	1.80%
	Roofing Reinforcement	27	1.90%



Financial Info

- Federal Tax Credit
 - 30% of installed cost (no cap)
- State Tax Credit (MA)
 - Residential-15% (\$1000)
- State Rebate (MA)
 - \$25*SRCC Category C rating (\$3500)
- Utility Rebates
 - National Grid (Gas/Residential)- 15% of installed cost (cap of \$1500)
 - National Grid (Gas/Commercial)- Based on energy output (cap of \$100,000)
 - Other incentives are available....just go to www.DSIREUSA.org

Data Input		
Number of Collectors	#	25
Area per Collector (sqft)	GOBI 410	800.00
Solar System Output	kWh	57,542
Backup Gas Heater Efficiency	%	75.0%
Type of energy being displaced	Gas	Therms
Energy cost	\$/unit	1.700
Annual Energy cost Increase	Gas	5.00%
Yearly Maintenance Cost	\$	25
Cost of Capital	%	0.0%
State Tax credit	%	0.0%
State/local rebates	\$	9,000
Federal Tax Credit/Grant	%	30.0%
General Inflation	%	2.0%
Sales Tax	%	6.0%
Corporate Income Tax Rate	%	30.0%

Total system costs (including equipment and installation - sales tax opti		51,900
Sales Tax (input or calculate)	3,114	
Water heater replacement costs (if replaced anyway)	0	
Incremental solar costs		55,014
State/local Rebate	9,000	
Total Incremental Cost after state rebate		46,014
State Tax Credit	0	
Federal Tax Credit/Grant	16,504	
2011 100% Deduction	0	
Federal tax on State Rebate	2,700	
Total Cost after credits & rebate		32,210
2011 Bonus Depreciation (Basis minus 50% of Federal Credit)	46,762	
Total Cost after credits & rebate		37,762

*Pool Heating solar systems do not qualify for tax credits!



Expanding Your Business

- Installing Solar
 - New revenue stream
 - Distinguish yourself
- Service Contract
 - Annually check solar system
 - And provide regular maintenance on HVAC system



Case Study- Laundromat

□ Laundromat

- 2000 gal/day
- Existing 3x 400 gallon tanks
- Auxiliary Gas-Fired Water Heater

□ Solar

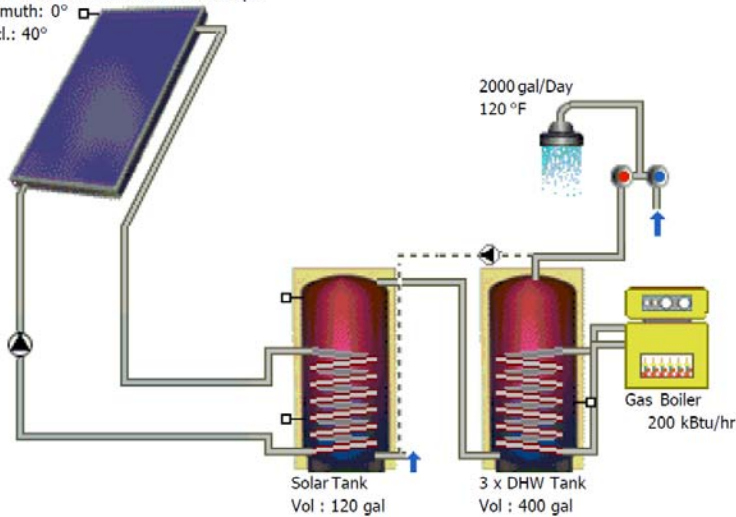
- 25 Flat Plate Collectors
 - 800 Square Feet
- Solar Indirect Tank
- Solar Pump Station



Picture source:
BCMedia 2007

Case Study- Solar Simulation

25 x Flat Plate Collectors
 Total Gross Surface Area: 674.90 sq.ft
 Azimuth: 0°
 Incl.: 40°



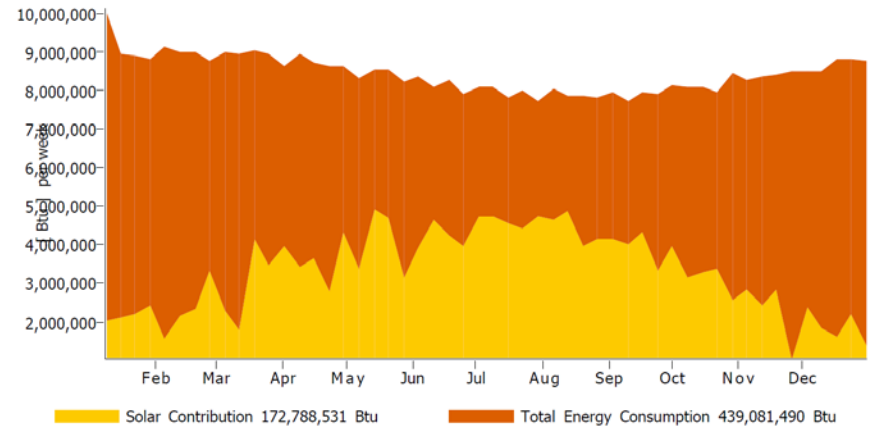
Results of Annual Simulation

Installed Collector Power:	149.75 kBtu/hr	
Installed Gross Solar Surface Area:	674.9 sq.ft	
Collector Surface Area Irradiation (Active Surface):	321.47 MMBTU	513.39 kBtu/sq.ft
Energy Produced by Collectors:	173.04 MMBTU	276.34 kBtu/sq.ft
Energy Produced by Collector Loop:	171.98 MMBTU	274.66 kBtu/sq.ft

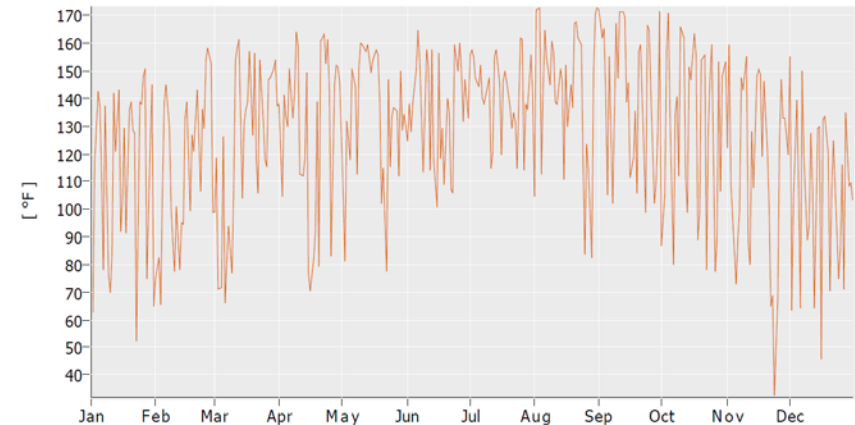
DHW Heating Energy Supply:	423.85 MMBTU
Solar Contribution to DHW:	172.15 MMBTU
Energy from Auxiliary Heating:	265.31 MMBTU

Natural Gas (H) Savings:	7,813.9 m³
Natural Gas (H) Savings:	2,788.37 therm
CO2 Emissions Avoided:	36,428.34 lbs
DHW Solar Fraction:	39.4 %
Fractional Energy Saving (EN 12976):	39.0 %
System Efficiency:	53.6 %

Solar Energy Consumption as Percentage of Total Consumption

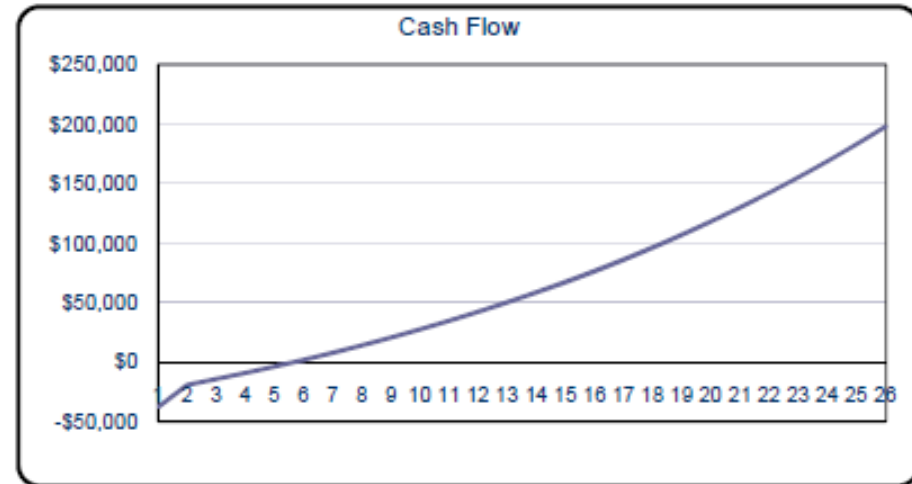


Daily Maximum Collector Temperature



Case Study-Feasibility

Year	Savings/Year (\$)	Acc. Savings (\$)	Depreciation (tax \$ effect)	Acc. Cash Flow
0	0	0	0	-37,762
1	4,646	4,646	14,029	-19,088
2	4,878	9,524	0	-14,210
3	5,122	14,646	0	-9,088
4	5,378	20,024	0	-3,710
5	5,647	25,670	0	1,937
6	5,929	31,600	0	7,866
7	6,226	37,825	0	14,092
8	6,537	44,362	0	20,629
9	6,864	51,226	0	27,493
10	7,207	58,433	0	34,700
11	7,567	66,000	0	42,267
12	7,946	73,946	0	50,213
13	8,343	82,289	0	58,556
14	8,760	91,049	0	67,316
15	9,198	100,247	0	76,514
16	9,658	109,905	0	86,172
17	10,141	120,046	0	96,313
18	10,648	130,694	0	106,961
19	11,180	141,875	0	118,141
20	11,739	153,614	0	129,881
21	12,326	165,941	0	142,207
22	12,943	178,883	0	155,150
23	13,590	192,473	0	168,740
24	14,269	206,742	0	183,009
25	14,983	221,725	0	197,992



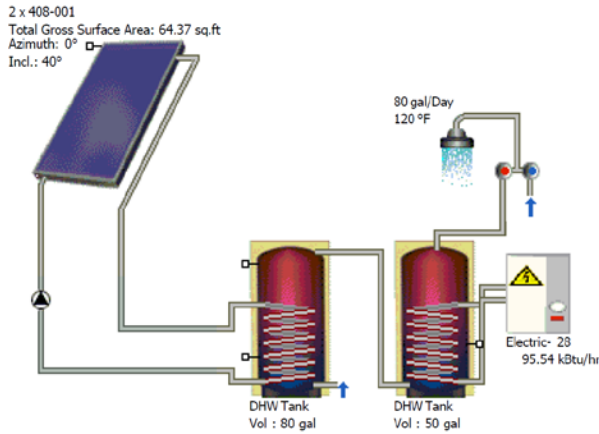
Financial Feasibility

Net present value	\$	197,992
Return on investment	%	358%
Payback	Years	5

$$\text{Solar Thermal Rate} = \frac{\$37,762}{2788 \text{ therm/yr} * 25 \text{ yr}} = \$0.54 \text{ per therm}$$



Case Study-Residential



Annual Savings with “Standard Equipment”

Electric: 4250 kWh (@ \$0.16/kWh) = **\$680.00**

Oil: 180 gal (@ \$3.00/gal) = **\$540.00**

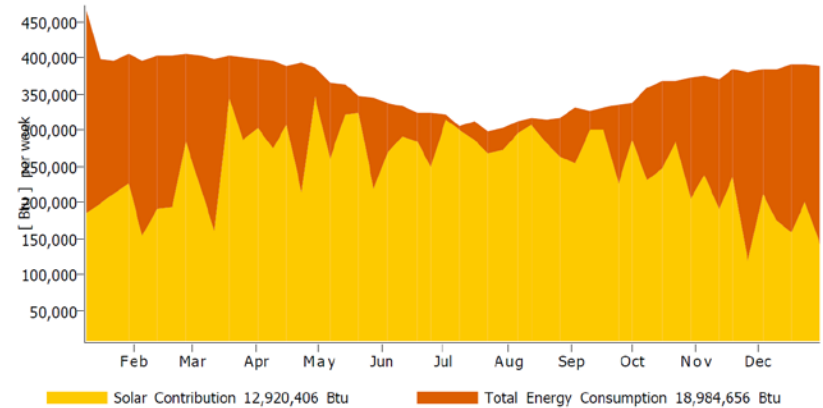
Natural Gas: 250 therms (@ \$1.80/therm) = **\$450.00**

Results of Annual Simulation

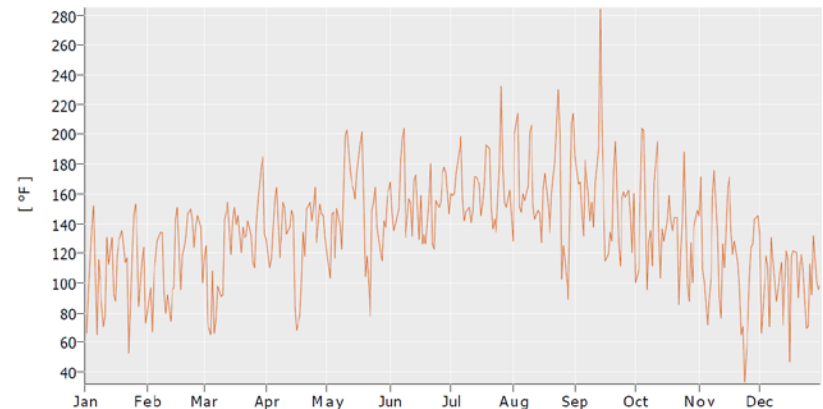
Installed Collector Power:	14.28 kBtu/hr	
Installed Gross Solar Surface Area:	64.37 sq.ft	
Collector Surface Area Irradiation (Active Surface):	30.72 MMBTU	513.39 kBtu/sq.ft
Energy Produced by Collectors:	15.00 MMBTU	250.65 kBtu/sq.ft
Energy Produced by Collector Loop:	14.03 MMBTU	234.49 kBtu/sq.ft
DHW Heating Energy Supply:	17 MMBTU	
Solar Contribution to DHW:	12.87 MMBTU	
Energy from Auxiliary Heating:	6.04 MMBTU	

Electricity Savings:	4,256.2 kWh
CO2 Emissions Avoided:	6,249.29 lbs
DHW Solar Fraction:	68.1 %
Fractional Energy Saving (EN 12976):	68.5 %
System Efficiency:	41.9 %

Solar Energy Consumption as Percentage of Total Consumption



Daily Maximum Collector Temperature



Let's Examine A Live System in Operation...

Correctional Facility in NH

- Closed loop pressurized system (Ground mount)
- DHW Load: 7000 gal/day
 - Kitchen, Laundry, Showers
- 64 Collectors (2560 sq. ft)
- 2250 gallons of storage
- ~50% SF



Any Questions?

Contact: ross@te2engineering.com

