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“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1 hour** of credit toward **Building Official and Residential Contractors code/energy** continuing education requirements.”

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Rural Renewable Energy Alliance

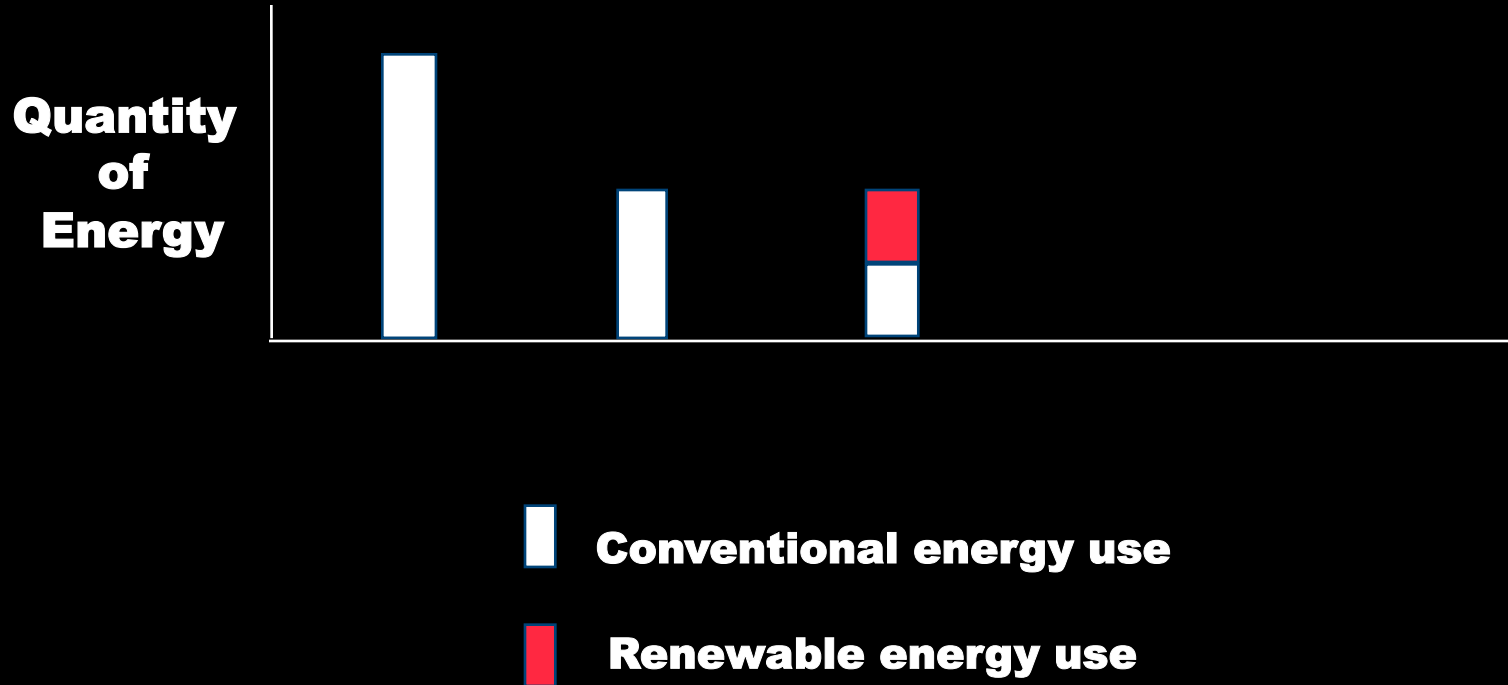
RURAL RENEWABLE ENERGY ALLIANCE

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jason@rreal.org
www.rreal.org



The Answer is NOT Solar...

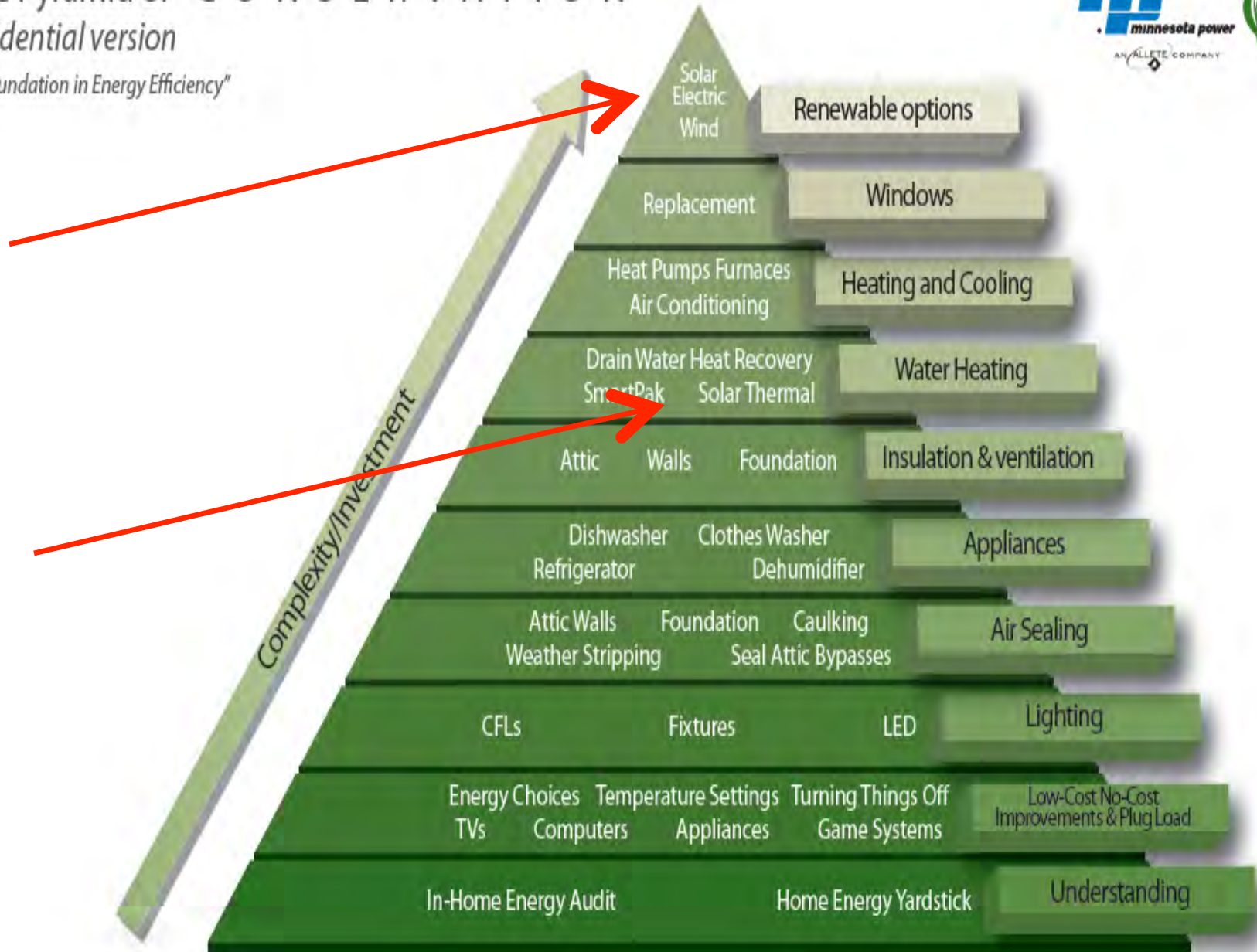
“Efficiency Before Renewables!”



The Pyramid of CONSERVATION

residential version

"A Foundation in Energy Efficiency"

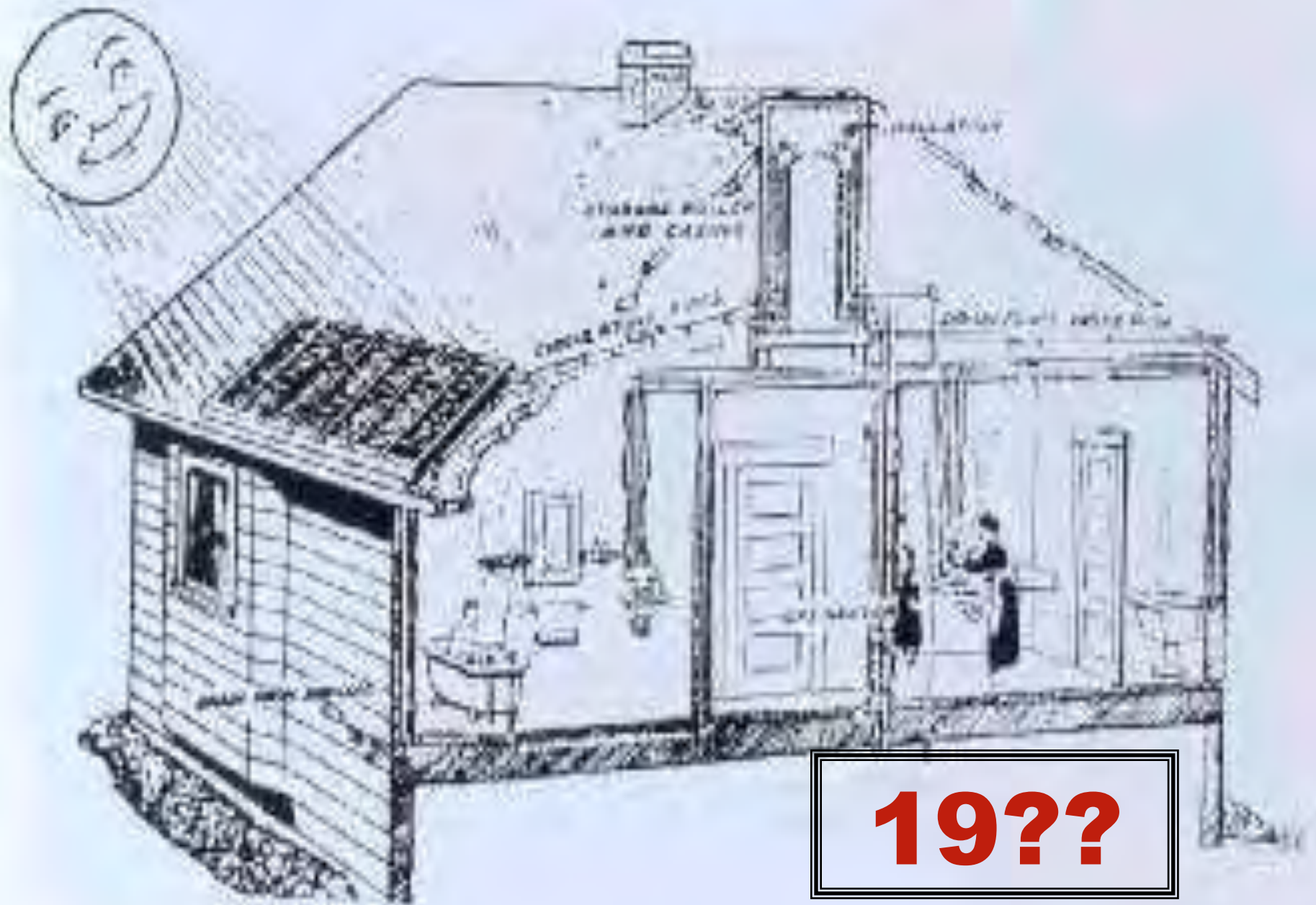


An Introduction to **Solar Energy for your** **Home or Business**





Nothing New...

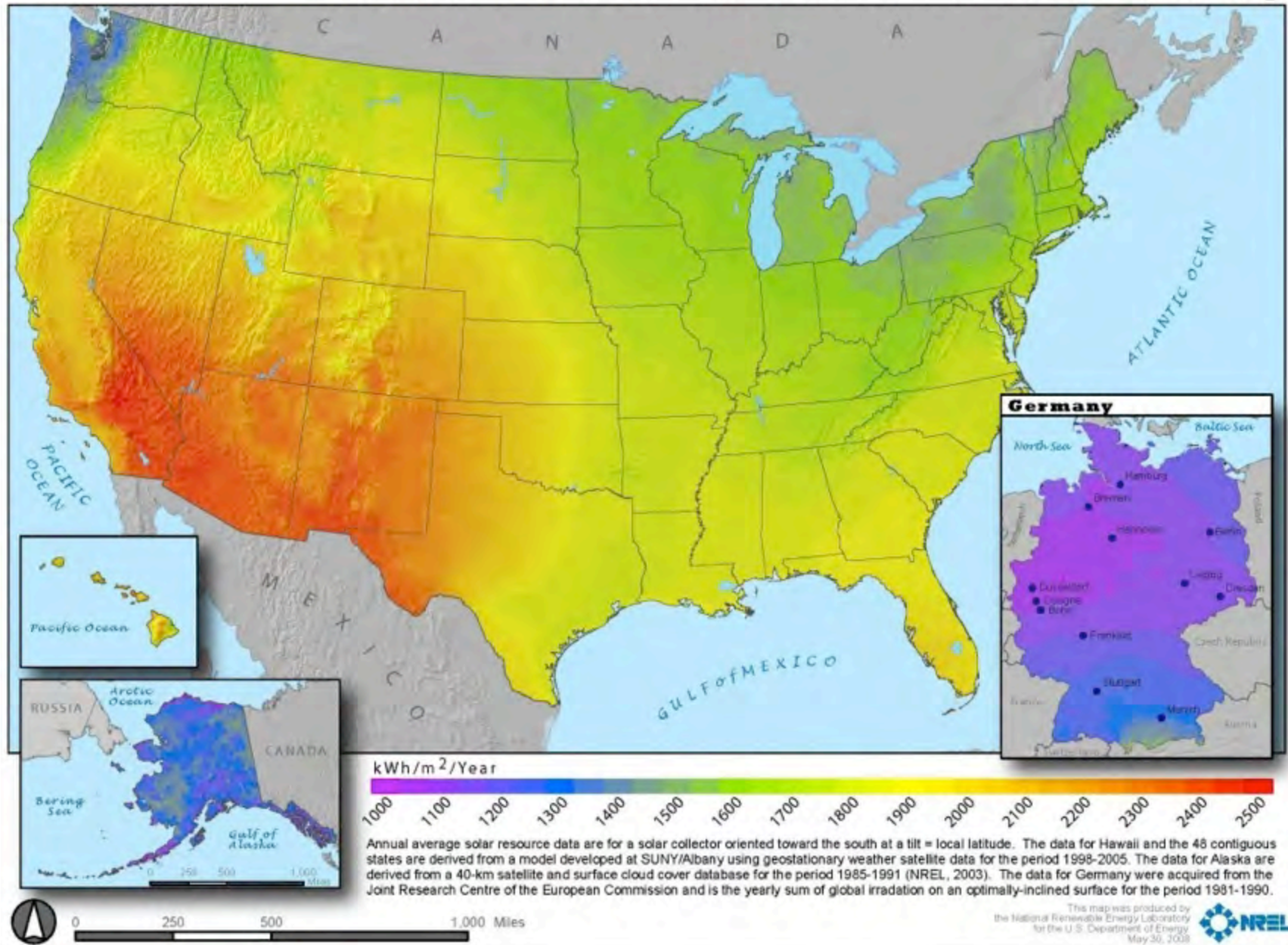


Is Solar Energy an Appropriate Technology?

MAYBE!

- 1.Regional Solar Resource***
- 2.Site-based Solar Resource***
- 3.Site-based needs,
opportunities and limitations***

Solar Resource : United States and Germany



Is your place solar compatible?

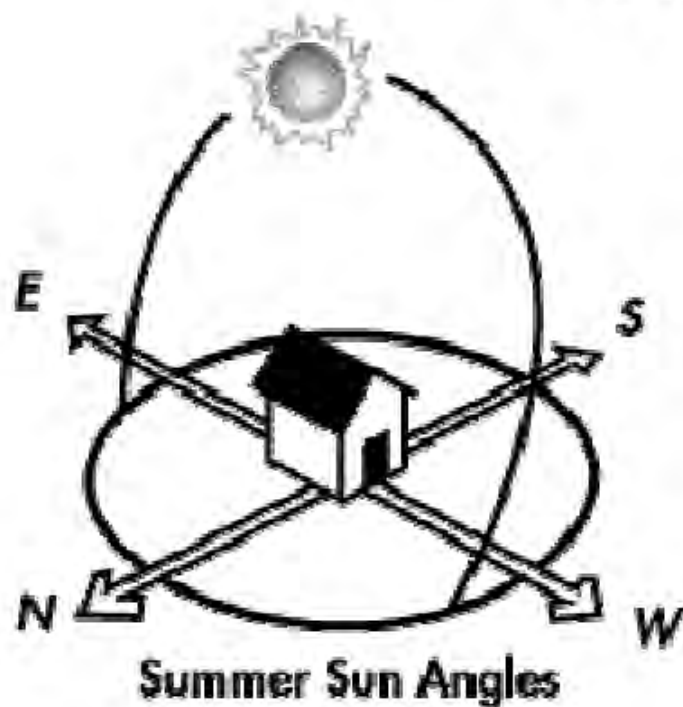


A



B

Sun Path



June 21st



December 21st



The Site Visit



Solar Power

Solar Thermal

Solar Electric



Solar Thermal

- Passive Solar
- Solar Air Heat
- Solar Water Heat

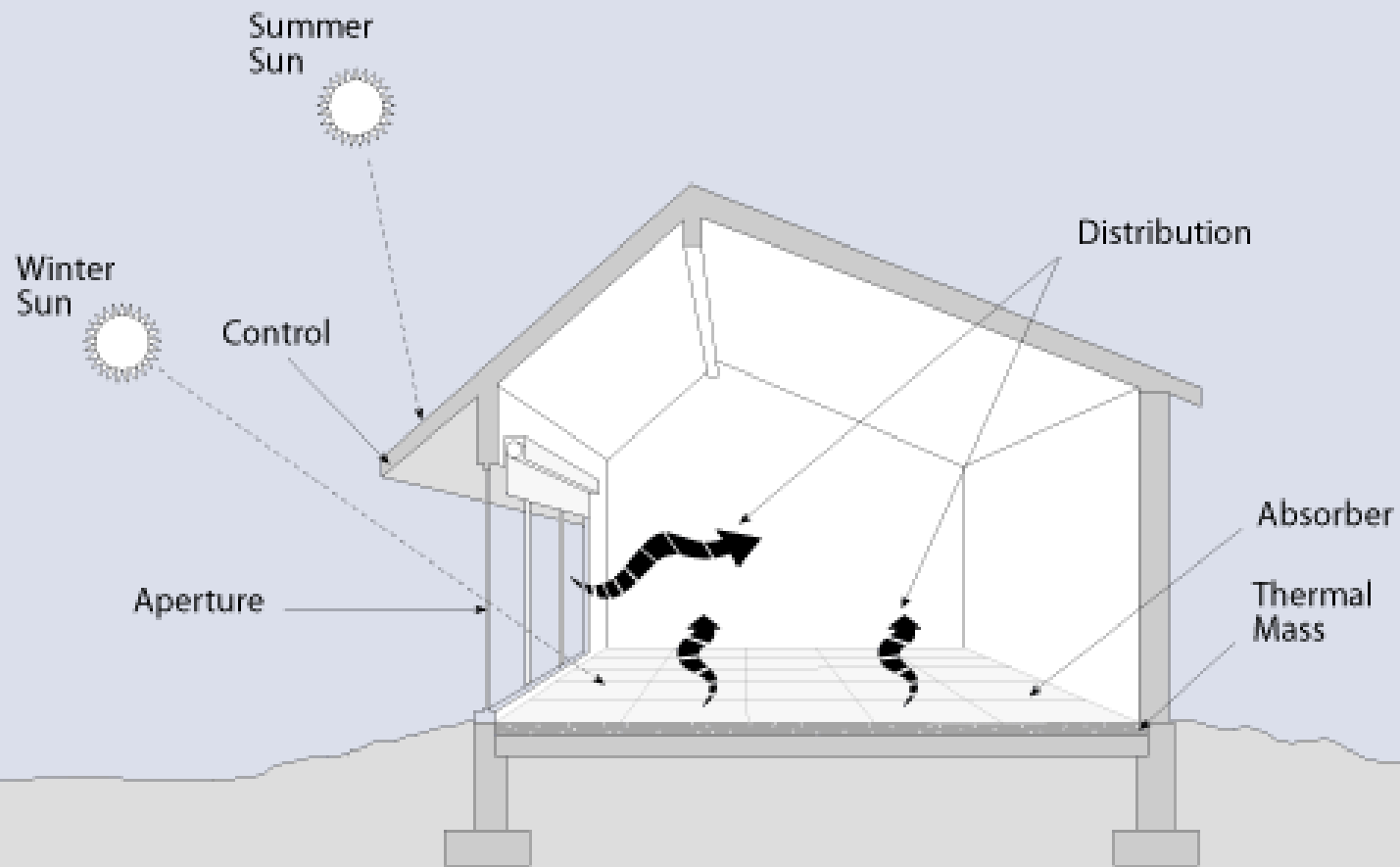
Solar Electric

- Direct drive
- Battery-based, off grid
- Grid-tied
- Grid-tied, battery back-up



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Passive Solar Design Principles



Appropriate Solar Air Heating Systems



Transpired Air

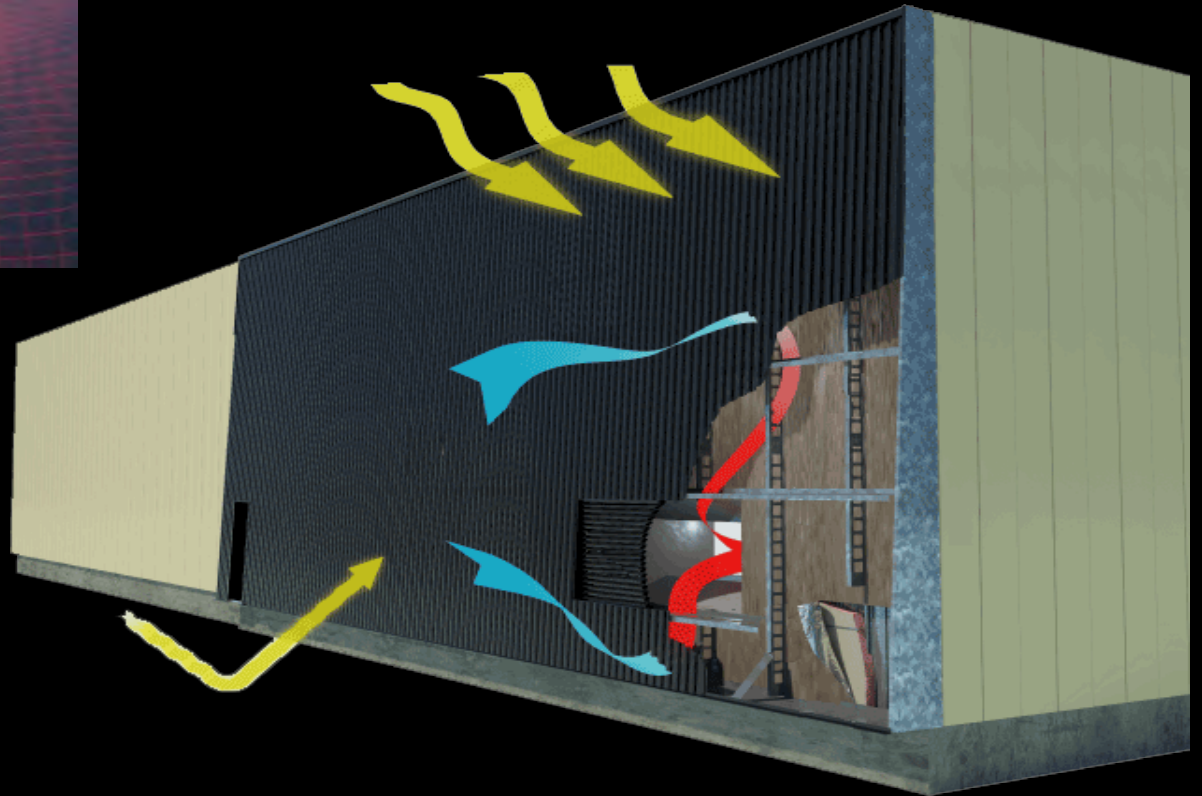
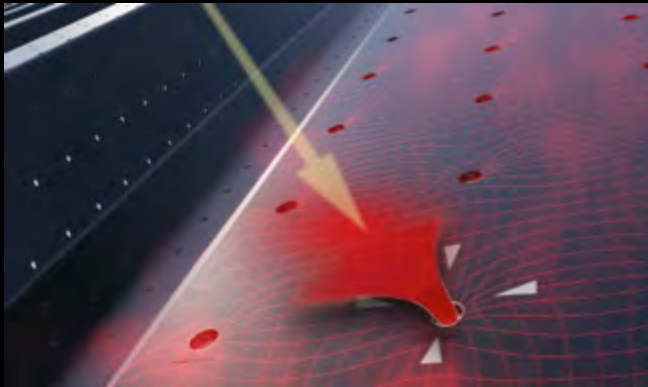


Recirculation Solar Air

Transpired Air



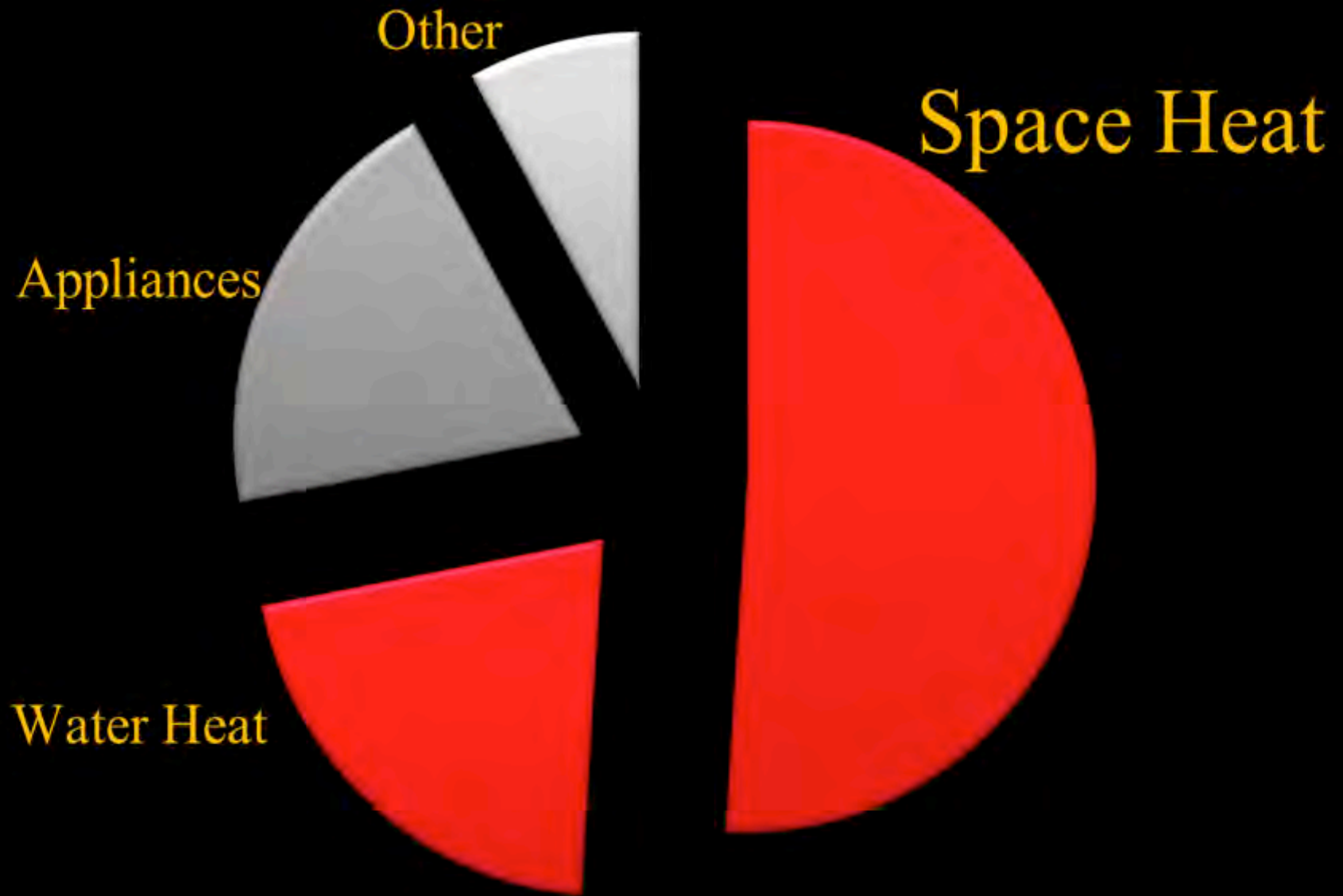
Ventilation Make-up Air



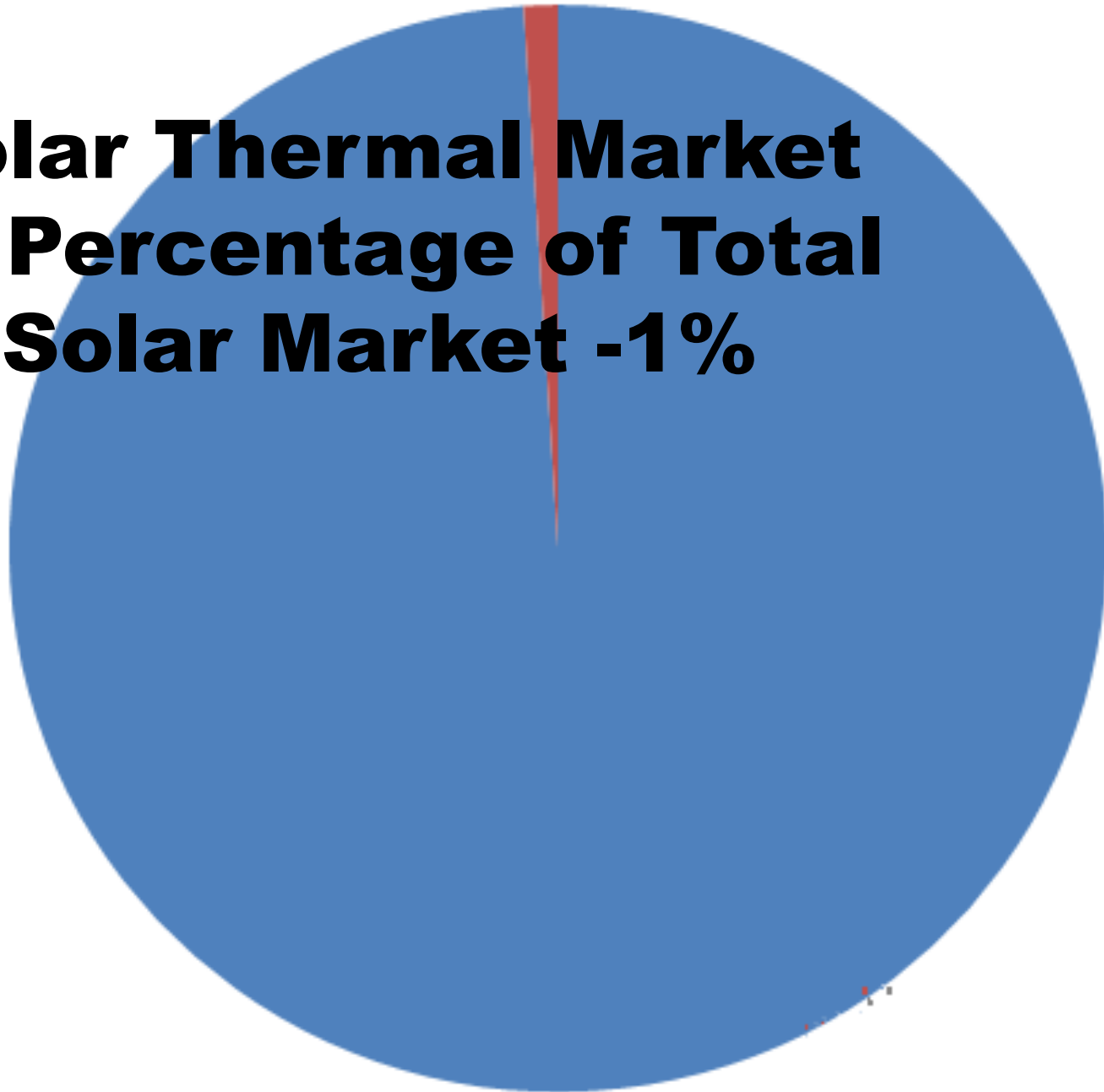
Transpired Air at Bemidji State



Why Solar Thermal?

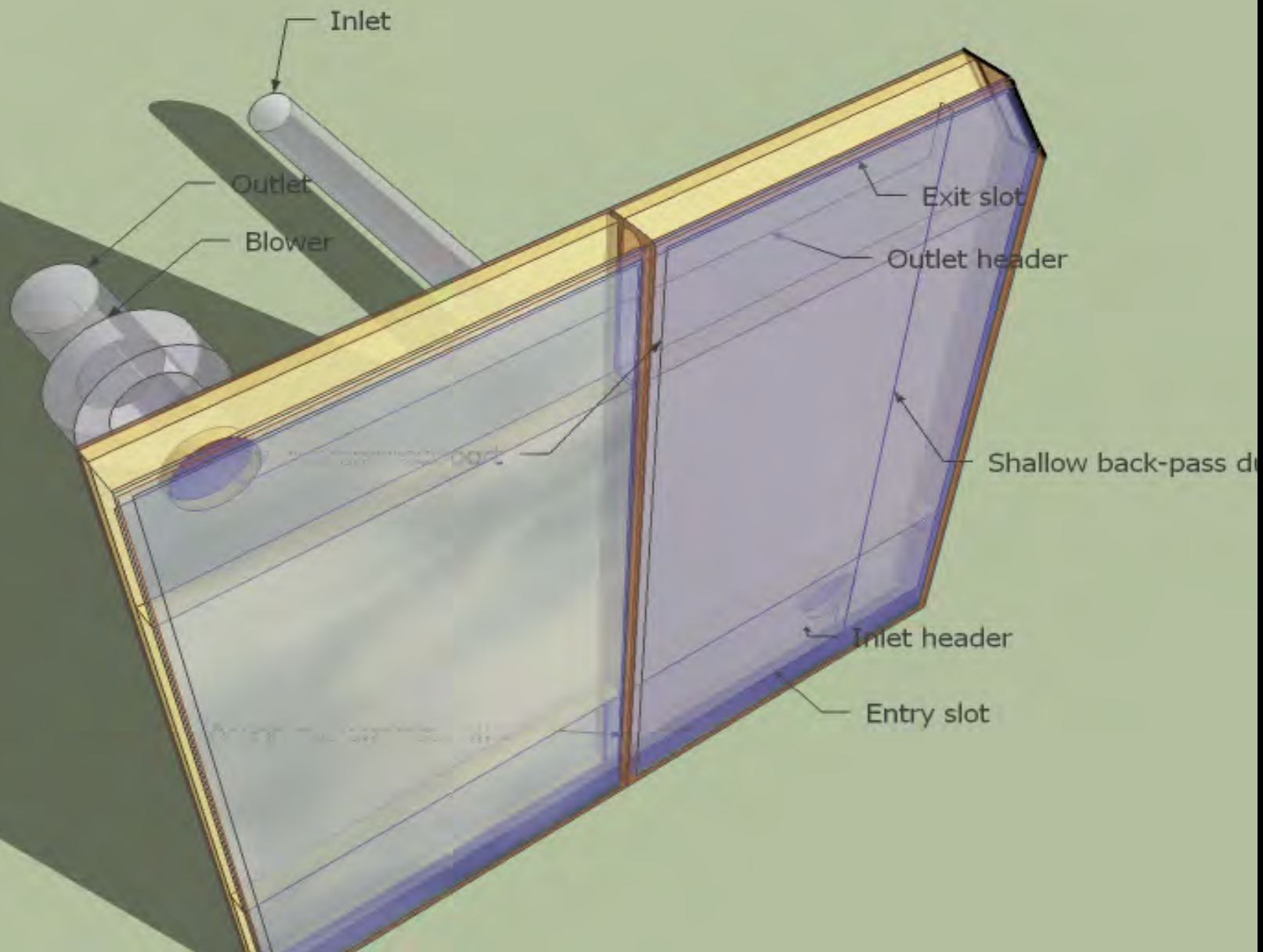


Solar Thermal Market as Percentage of Total Solar Market -1%



Solar air heat



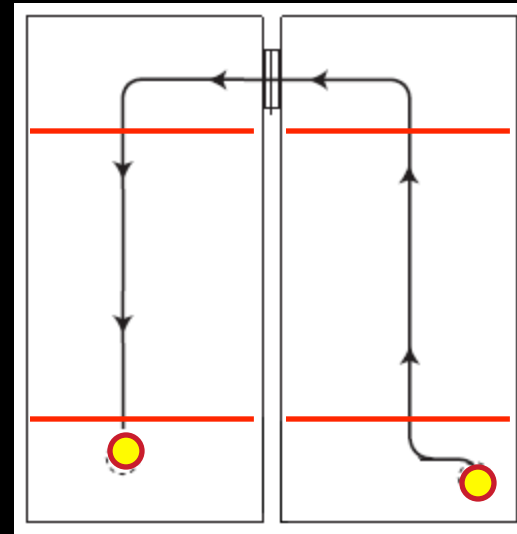
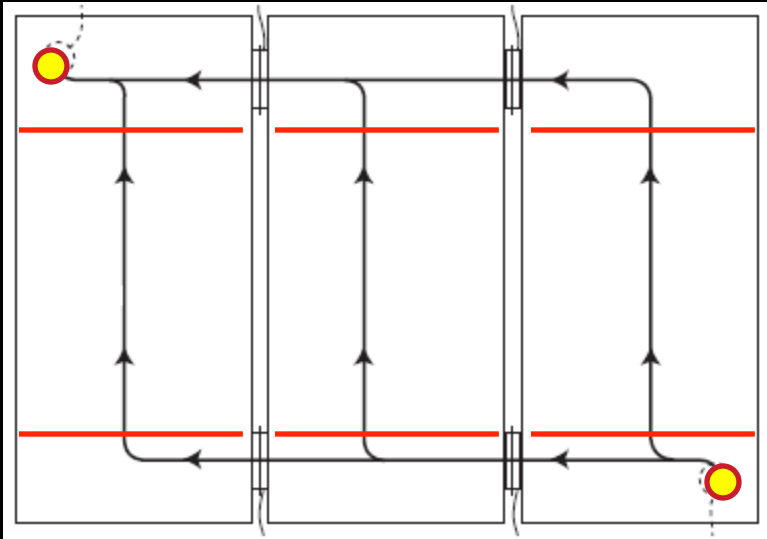
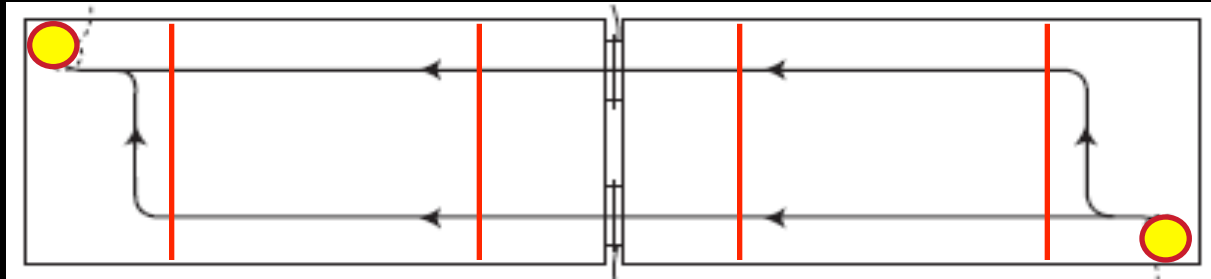




Site Selection



Parallel vs. Series Configuration





Payback

*Fuel Source
displaced*

*Return
invest*

Propane

Fuel oil

7.9%

No

5.0%

Es

city

6.0%

Site Specific!

Solar Space Heating Systems





Brainerd Lakes Regional Airport... Investing in America's Security

Solar Panels providing energy and
paying for themselves within 15 years.
How cool (or warm) is that?





SYSTEM SIZING

$$\text{Energysavings} = \sum_{\text{hour}=1}^{8760} (Q_{\text{usable}})_{\text{hour}}$$

$$Q_{\text{usable}} = \begin{cases} Q_u, & Q_u < E_L \\ E_L, & Q_u \geq E_L \end{cases}$$

$$E_L^* = \begin{cases} E_L \cdot (1 + \text{overheat}), & HDD > 0 \\ 0, & HDD = 0 \end{cases}$$

$$I_T = I_b R_b + \text{diffuse sky} + \text{diffuse ground}$$

$$Q_{\text{usable}} = \begin{cases} Q_u, & Q_u < E_L^* \\ E_L^*, & Q_u \geq E_L^* \end{cases}$$

$$E_L^* = E_L \cdot (1 + \text{overheat})$$

$$\eta = \max\left(0, F_R \tau \alpha - F_R U_L \cdot \left[\frac{T_i - T_a}{I_T}\right]\right)$$

$$E_B = b0 + b1^* \cdot \max(0, b2 - T_a)$$

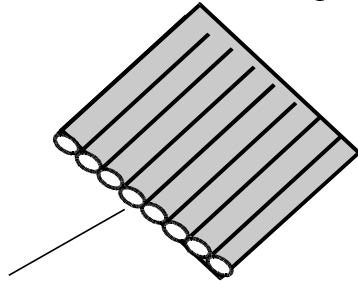
Solar Water Heat



Solar Thermal Collector Types

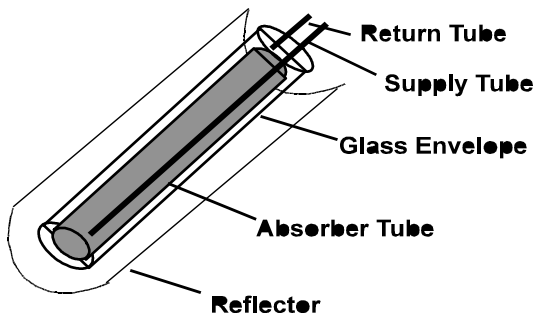
Unglazed EPDM Collector

Extruded 'Mat' with Flow Passages

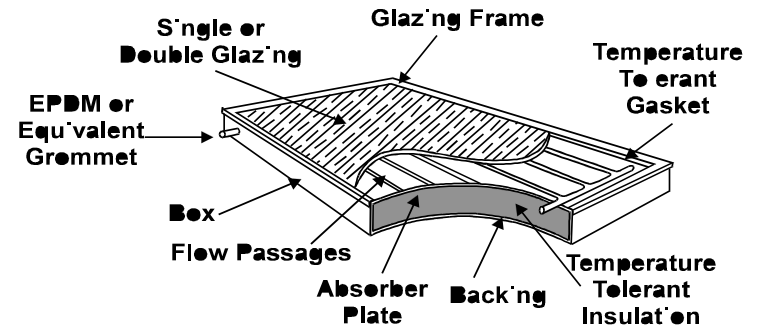


Flow from Manifold Through Passages

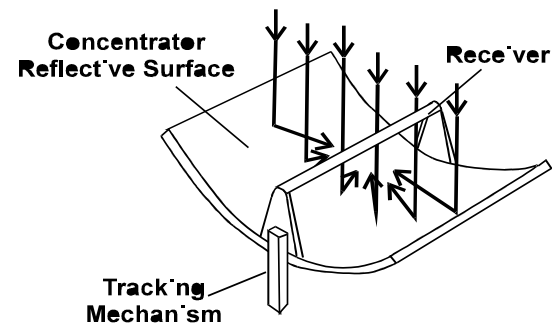
Evacuated Tubes



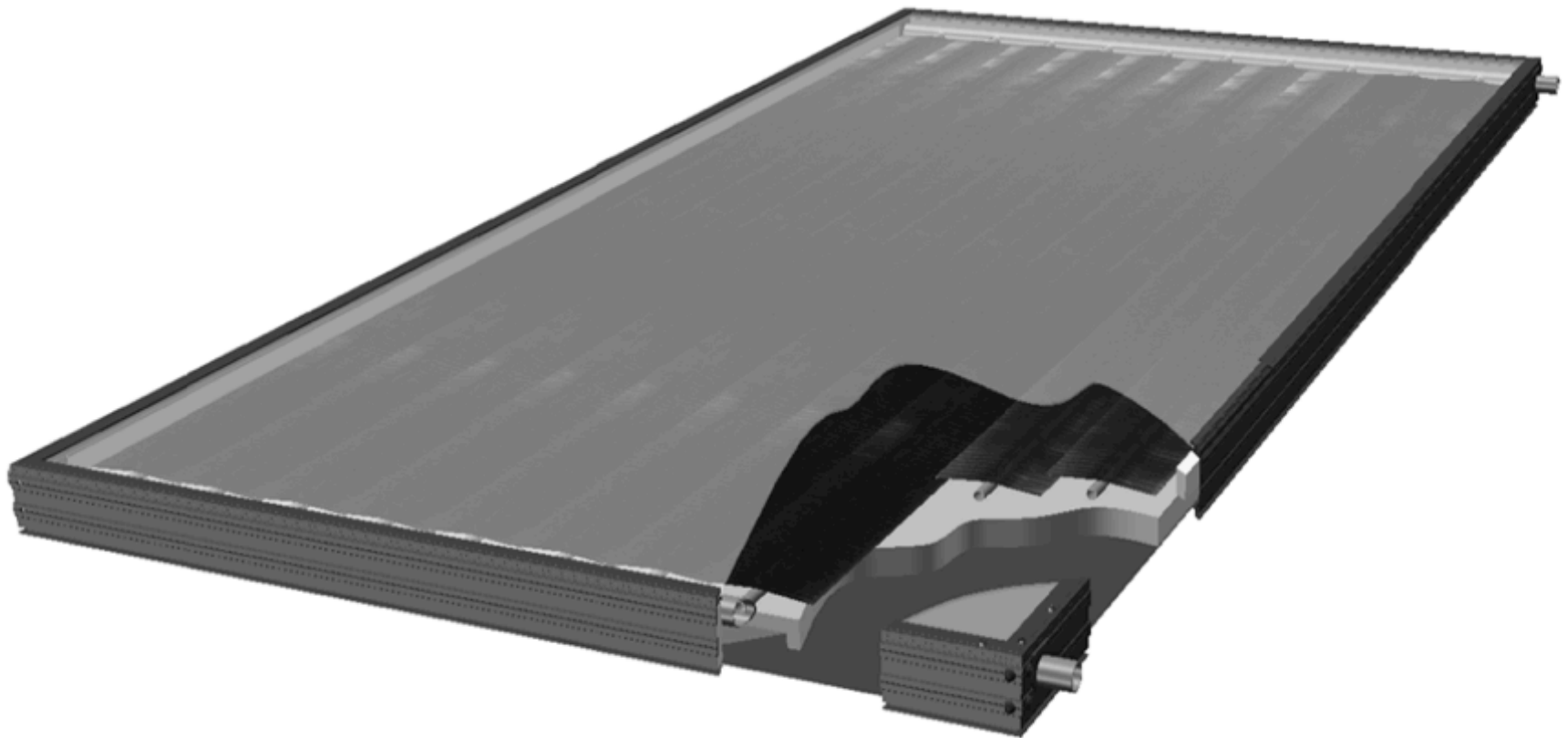
Flat Plate



Parabolic Trough

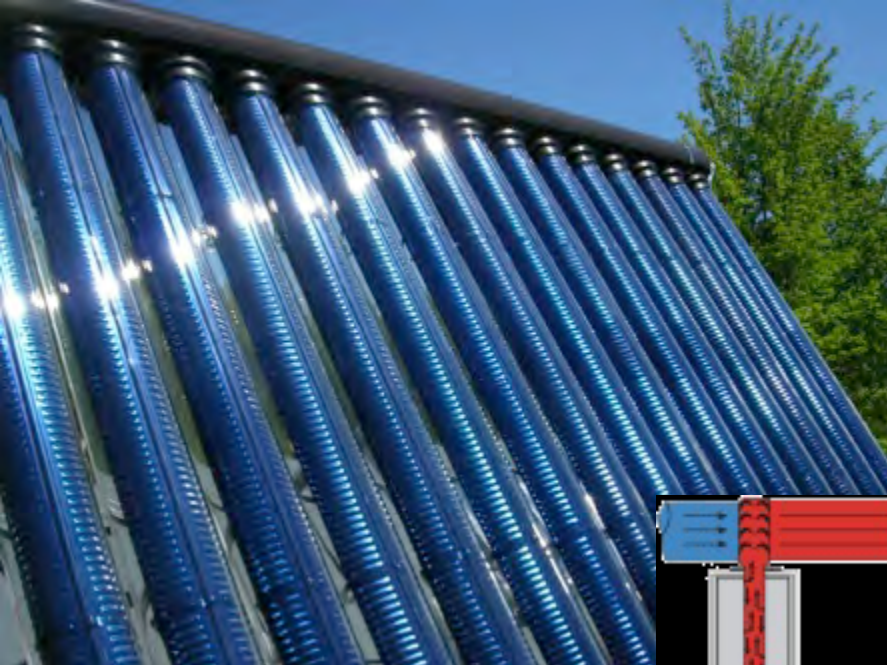


Modern Solar Thermal Panel

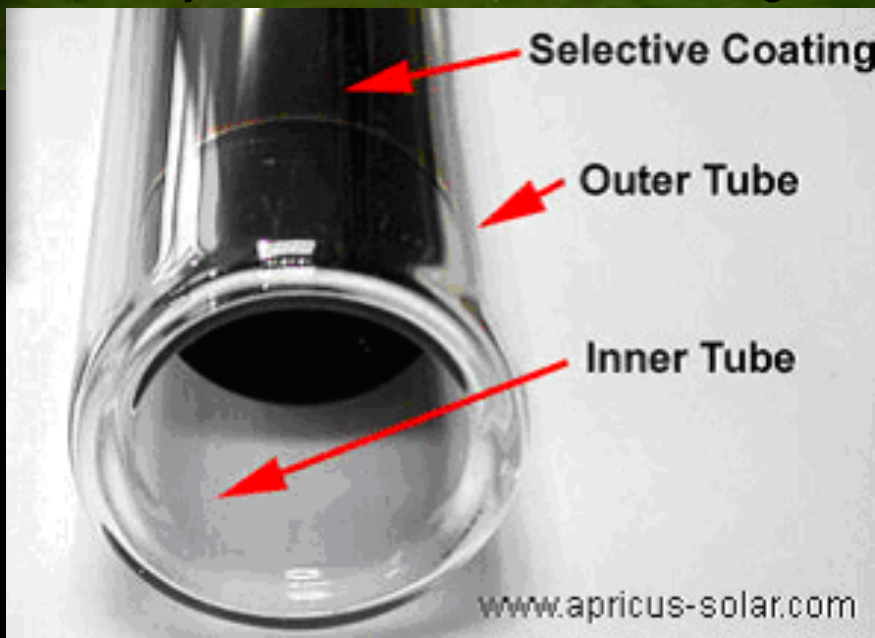


Glazed Flat Plates





Courtesy of Conservation Technologies



Evacuated tubes

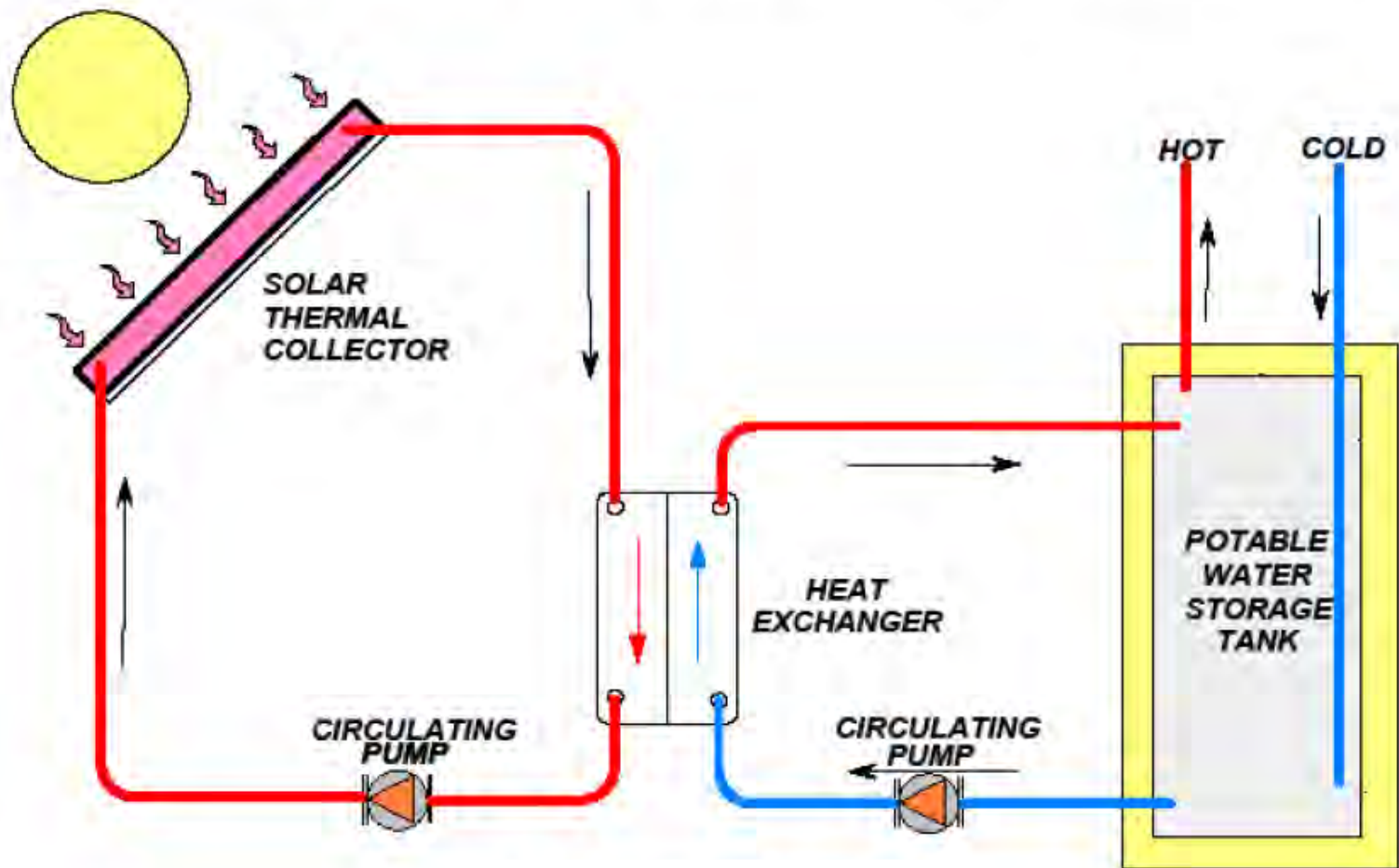
SOLAR WATER HEATING SYSTEM TYPES

1.DRAINBACK

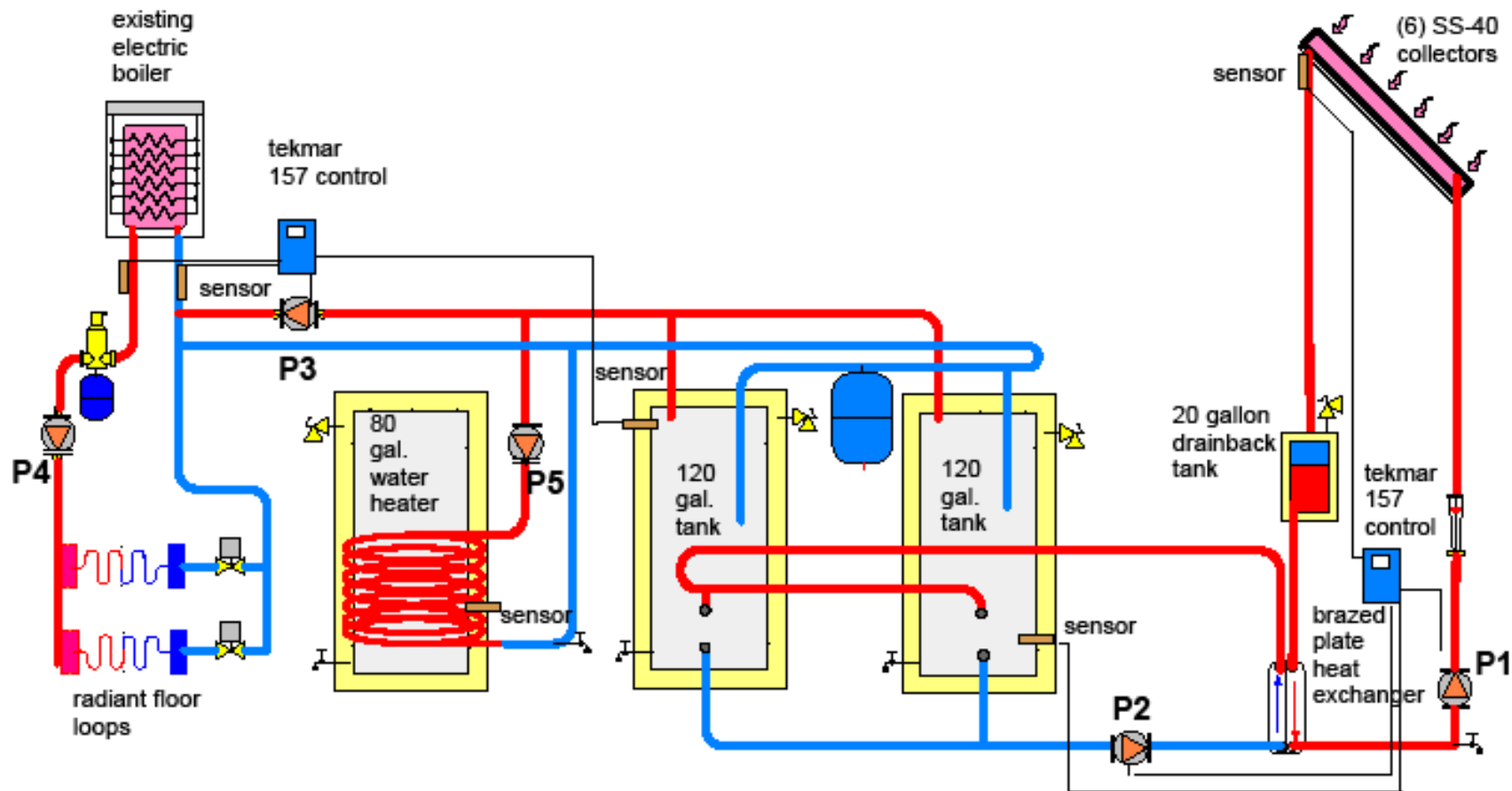
2.CLOSED-LOOP

**PRESSURIZED ANTI-
FREEZE**

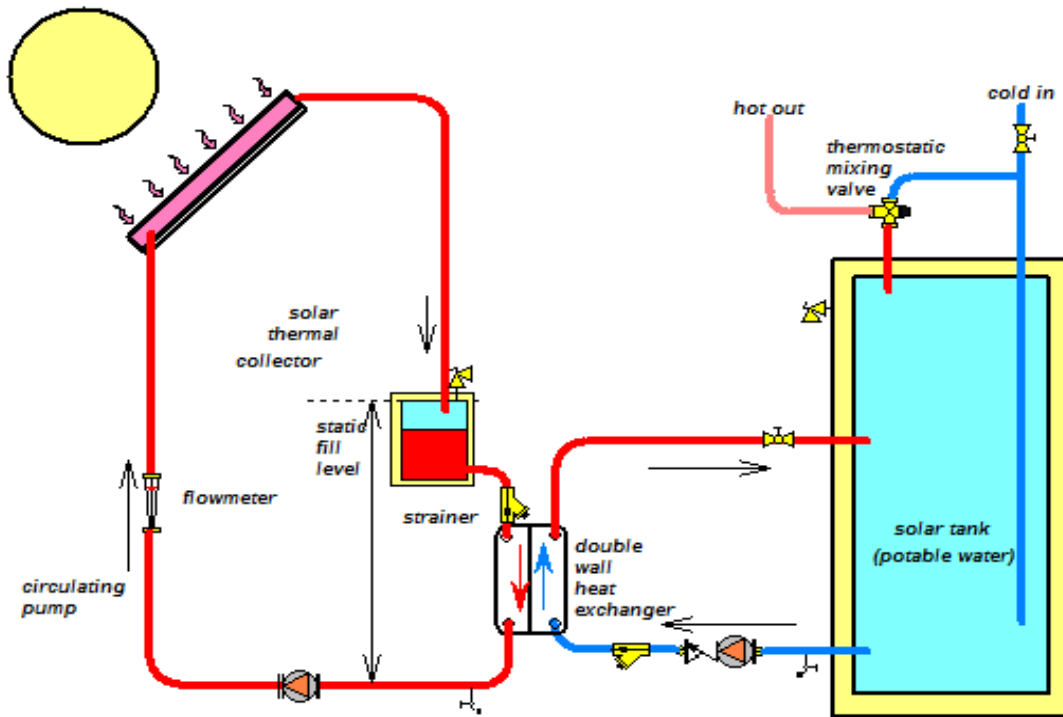
BASIC SOLAR THERMAL SYSTEM



DRAINBACK HEAT and DOMESTIC HOT WATER



DRAINBACK CLOSED LOOP SYSTEM

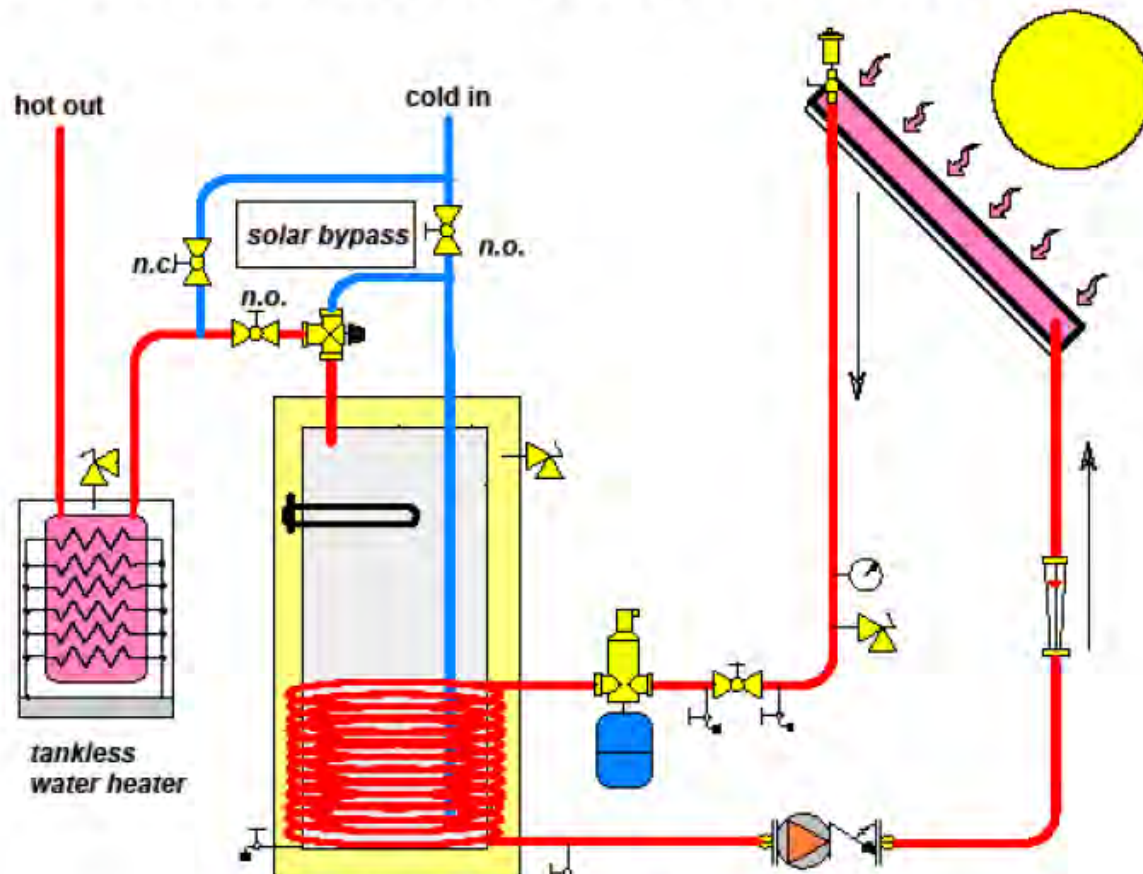


SOLAR SKIES MFG. LLC 2008

Drainback Schematic



SOLAR TANK W/ WRAP AROUND HEAT EXCHANGER PRESSURIZED SYSTEM

















Solar Heat Sizing

Method 1

- **Load Analysis for SDHW - # of gallons hot water/ day**
- **.75-1.0 square foot collector surface area / gallon**

Method 2

- **Load Analysis**
- **(Wc) (Ts-Ti) (Cp) 8.33**
- **(65) (70) (1 BTU/lb. F) 8.33 = 37901.5 btus**
- **Array Sizing**
- **PSH (4.3) / 10.76 = .399 kWh / sq. ft. / day**
- **.399 x 3413 = 1361 BTUs / sq. ft. / day**
- **Match with thermal collector rating**

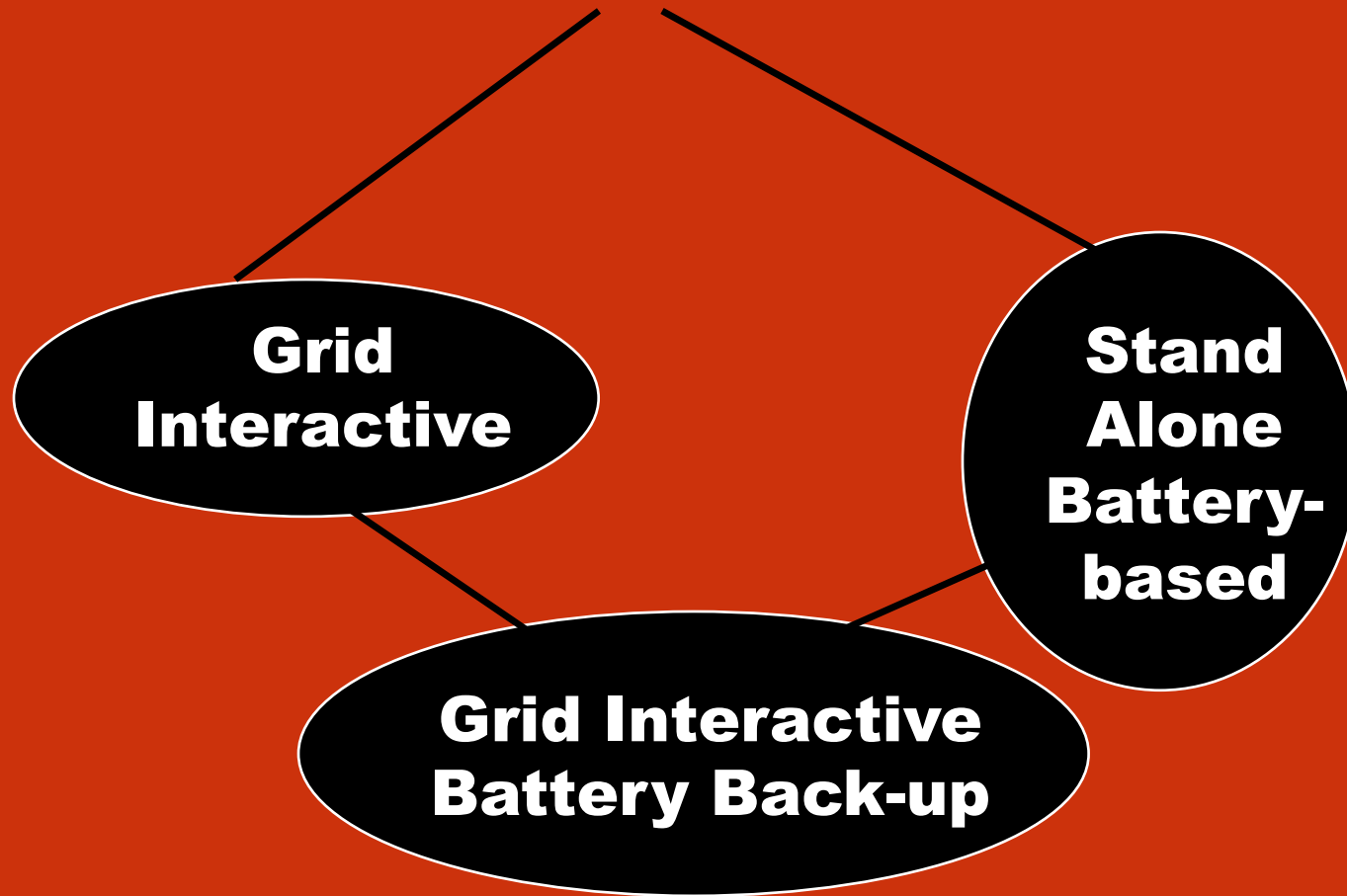


Solar Electricity

Types of PV Modules

- 1. Mono-crystalline Si**
- 2. Poly-crystalline Si**
- 3. Amorphous Si**
- 4. CIGS**
- 5. CdTe**

Types of Solar Electricity

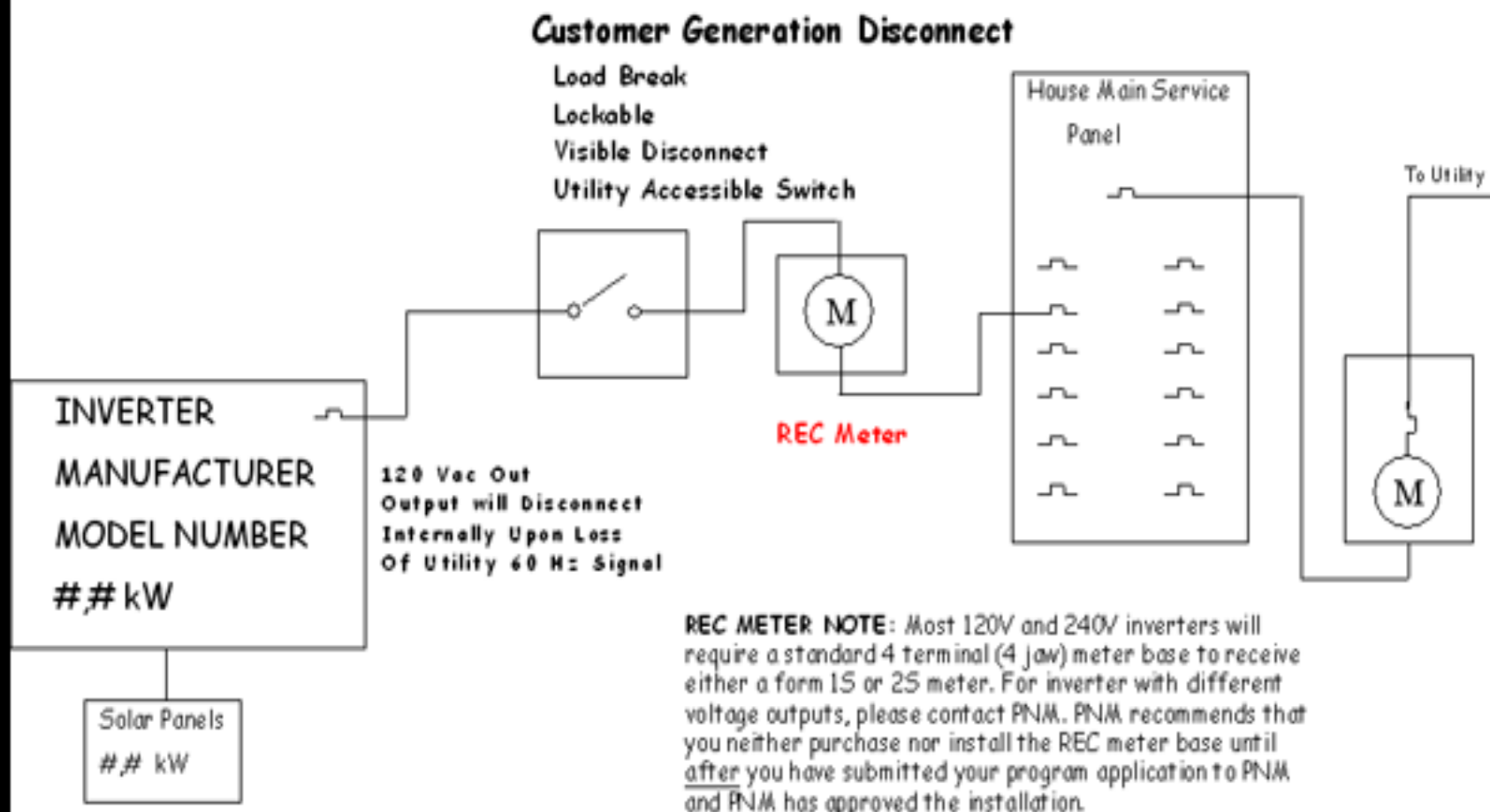


Grid-Interactive Solar Electric System

- **Rebates**
- **Battery Free**
- **Flexible budgeting**



SAMPLE ONE-LINE DIAGRAM: GRID-TIED SYSTEM



**If the grid goes down,
so do you!**



Stand-alone Battery- Based System



Pros

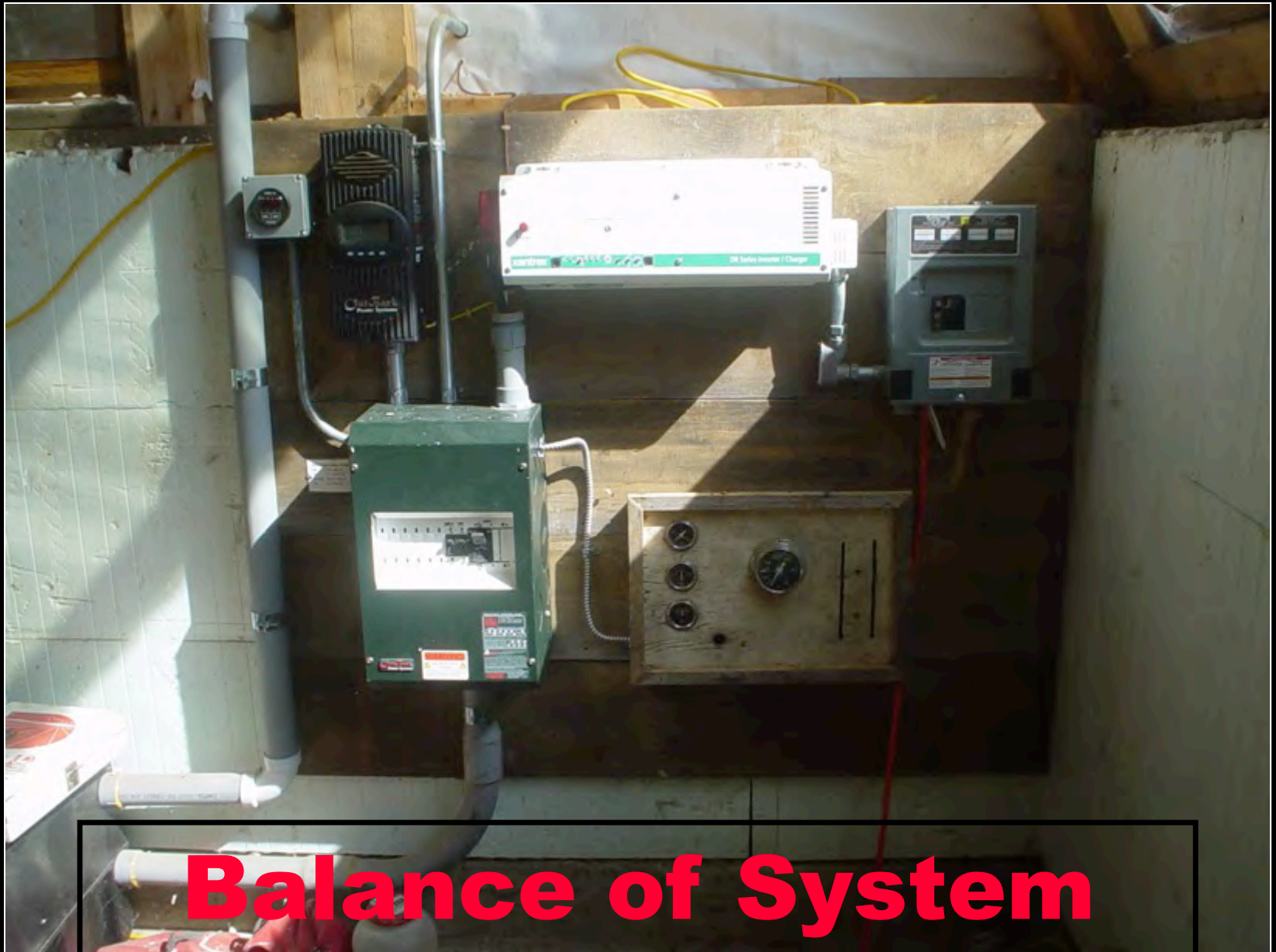
**If grid power not
available**

Self-reliance

Cons

**Batteries require
maintenance and
care**

**System sizing
demanding**



Grid-tie Battery Back-up Balance of System



The Snowy Climate Reality Check



A photograph of a wooden building, possibly a ski lodge or cabin, with a thick layer of snow on its roof. The building has a small bell tower on the left side. In the foreground, there are large, uneven snowdrifts that appear to be blocking the path or entrance. The sky is clear and blue, and the overall scene suggests a winter setting.

Reality Check: Flush Mount and Snow







Racking Options

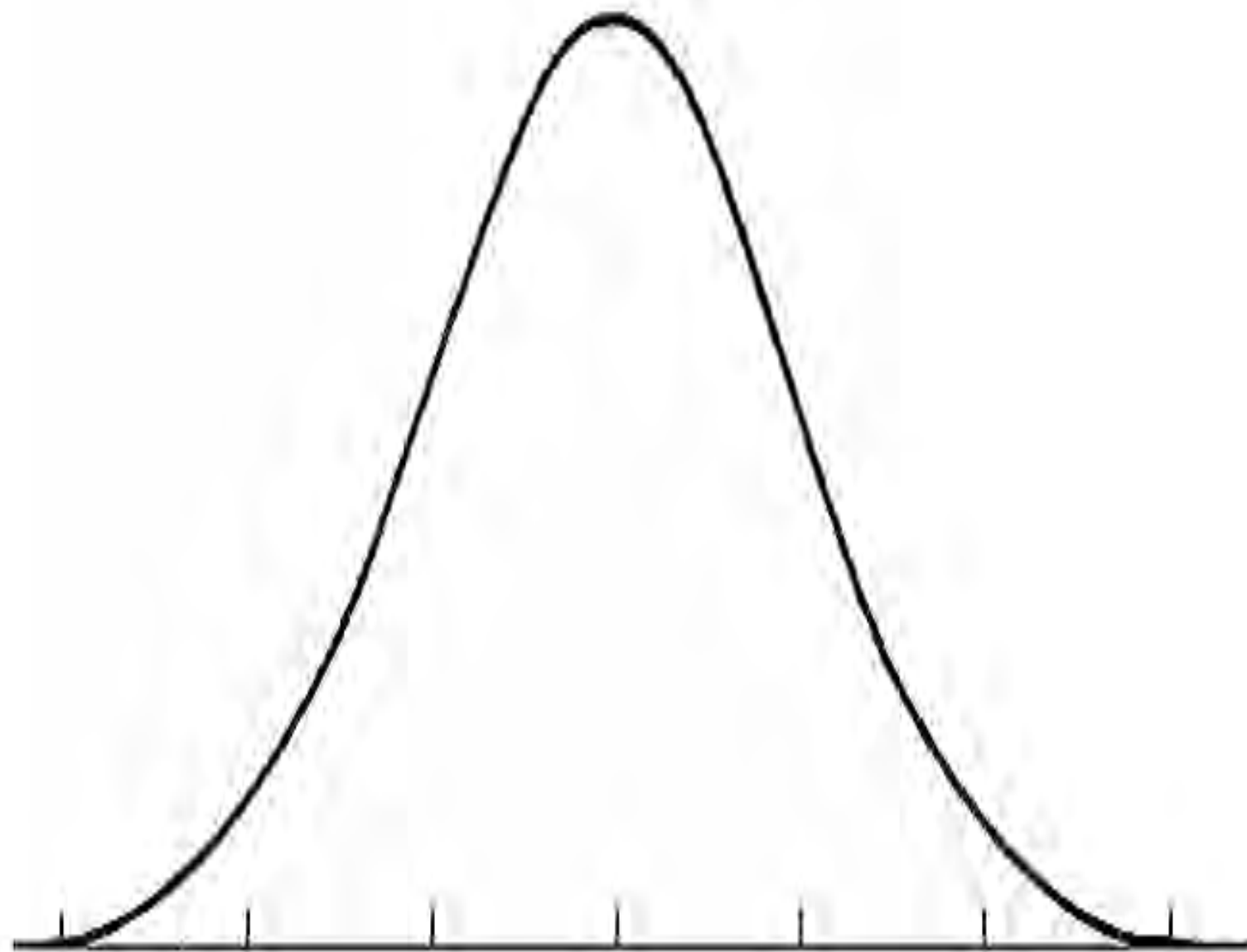






Solar Electric Sizing

- Load Analysis - Determine ADC (Average Daily Consumption)
- Site Analysis - Determine PSH (Peak Sun Hours)
- $ADC / PSH = PV \text{ Array Size}$
- Determine PV Make and Model
- De-rate PV module for real world application (.7 multiplier)
- Determine # of modules necessary to meet array size



Incentives for Solar

**[http://mn.gov/commerce/energy/
topics/resources/energy-
legislation-initiatives/made-in-
minnesota/](http://mn.gov/commerce/energy/topics/resources/energy-legislation-initiatives/made-in-minnesota/)**

Incentives for Solar

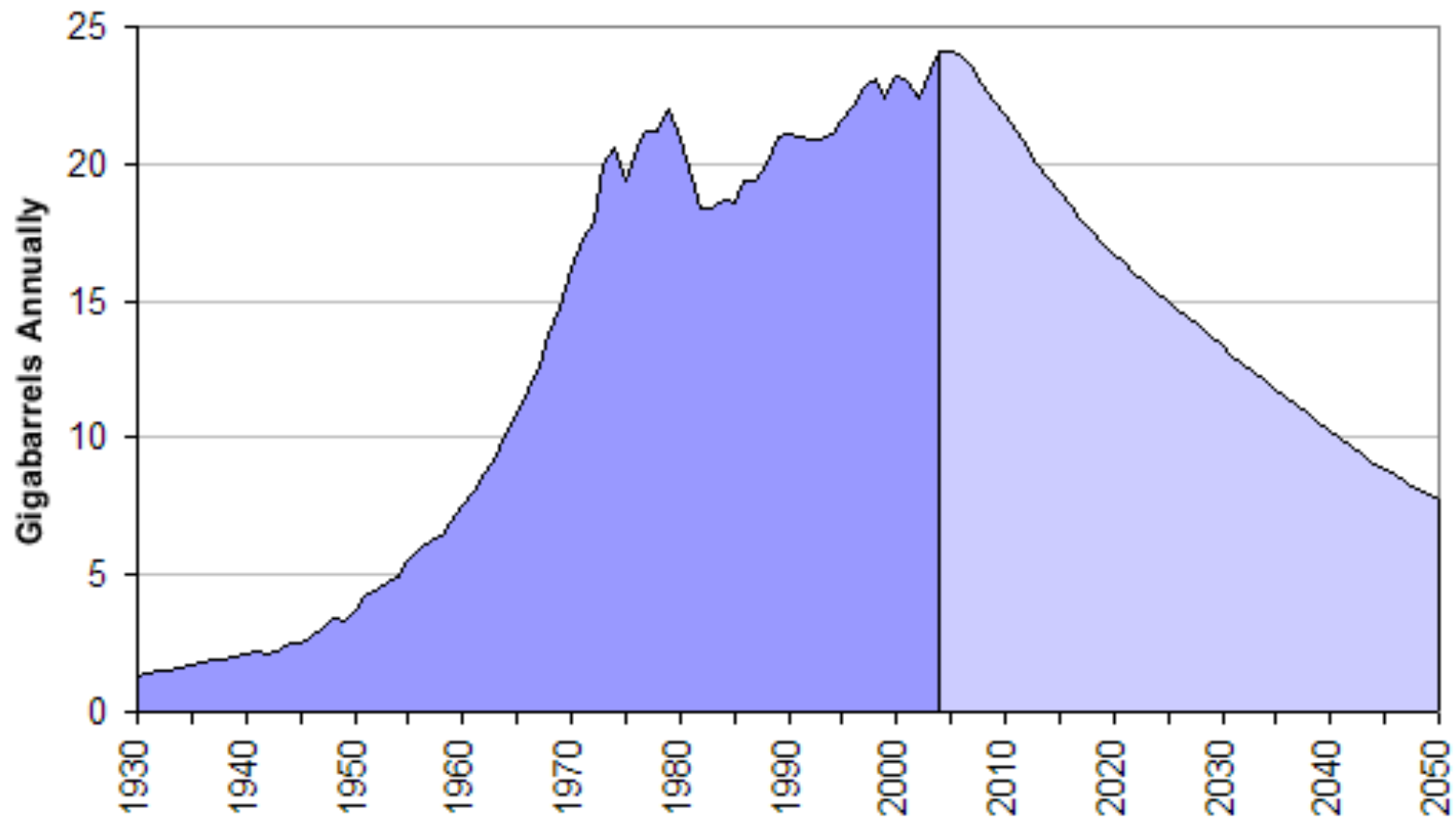
www.dsireusa.org

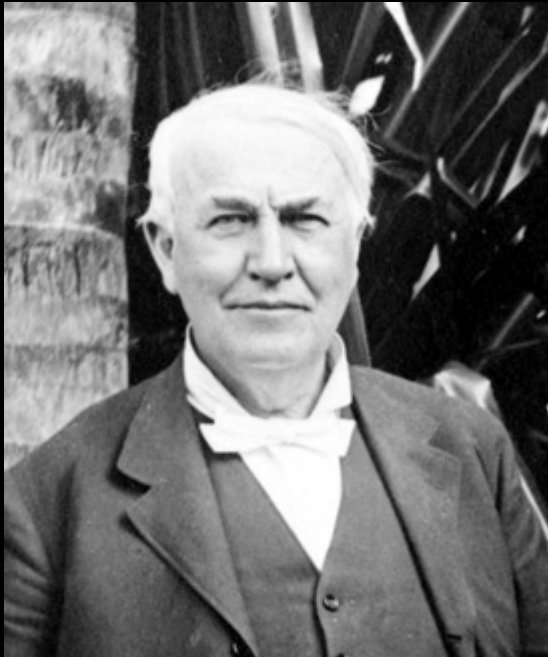
Database of State

Incentives for

Renewable Energy

World Oil Production





“I'd put my money on
the sun and solar energy.
What a source of power!
I hope we don't have to
wait until oil and coal
run out before we tackle
that.”

Thomas Edison 1931

**Thank you and
sunny regards.**

