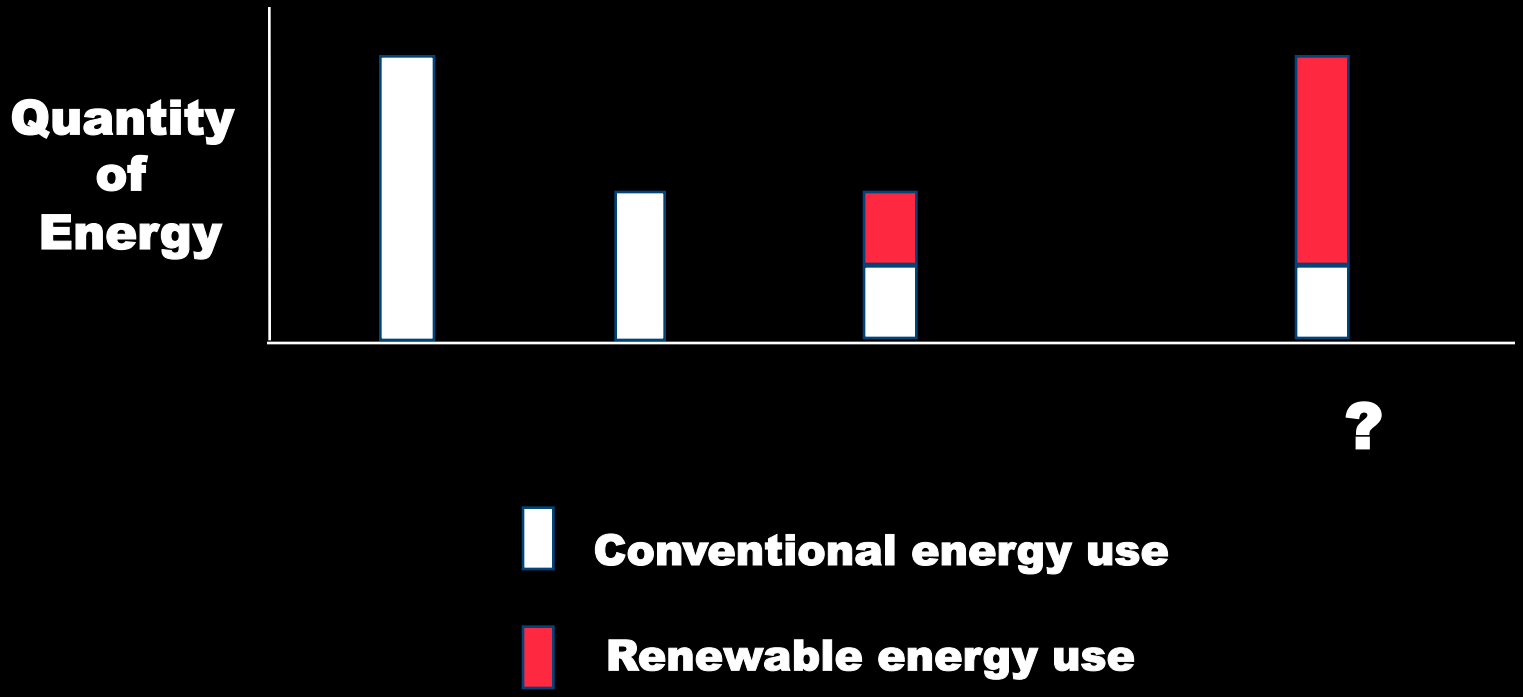

RREAL
Rural Renewable Energy Alliance
Jason Edens
jason@rreal.org
www.rreal.org

The Answer is NOT Solar...

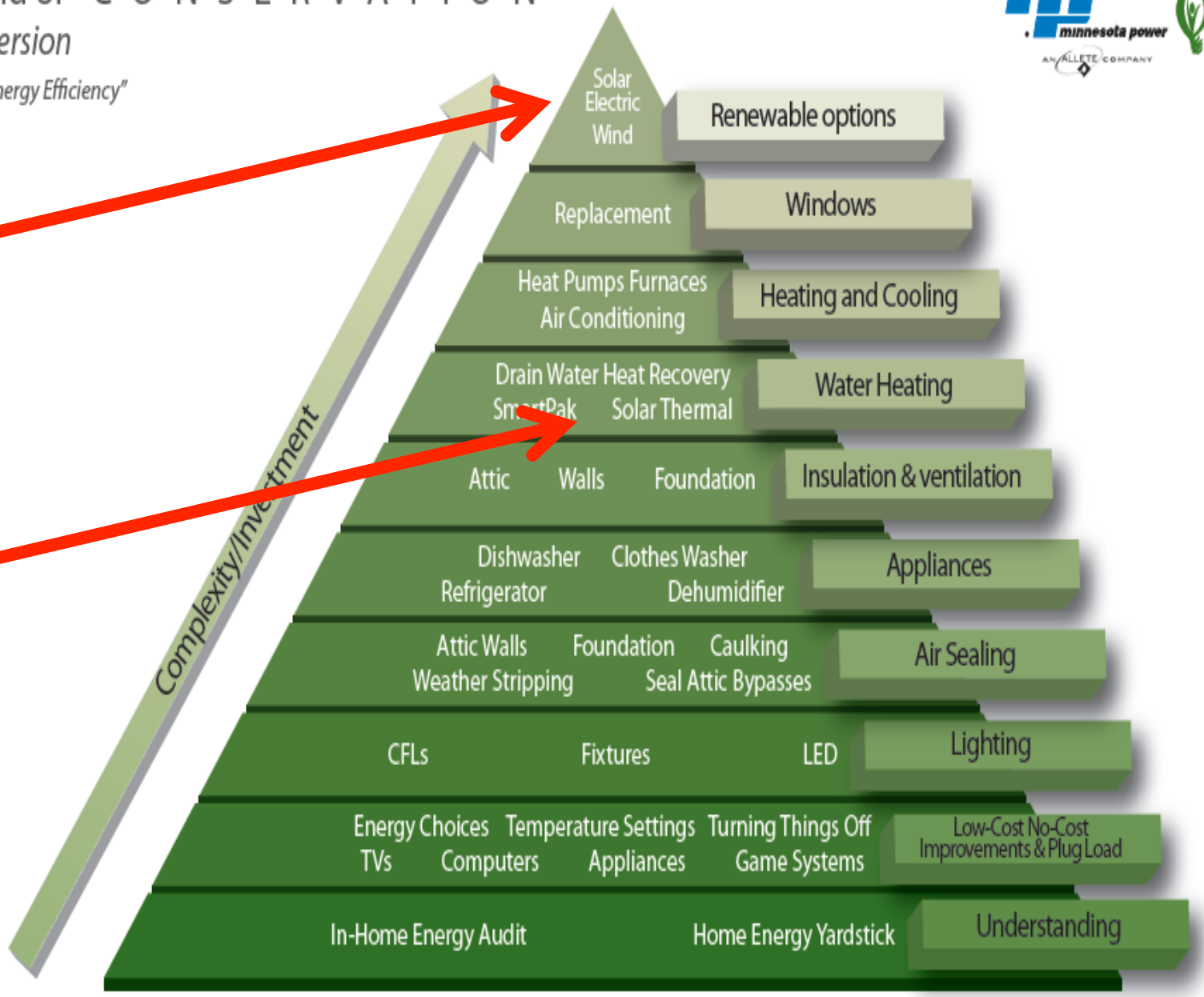
“Efficiency Before Renewables!”



The Pyramid of CONSERVATION

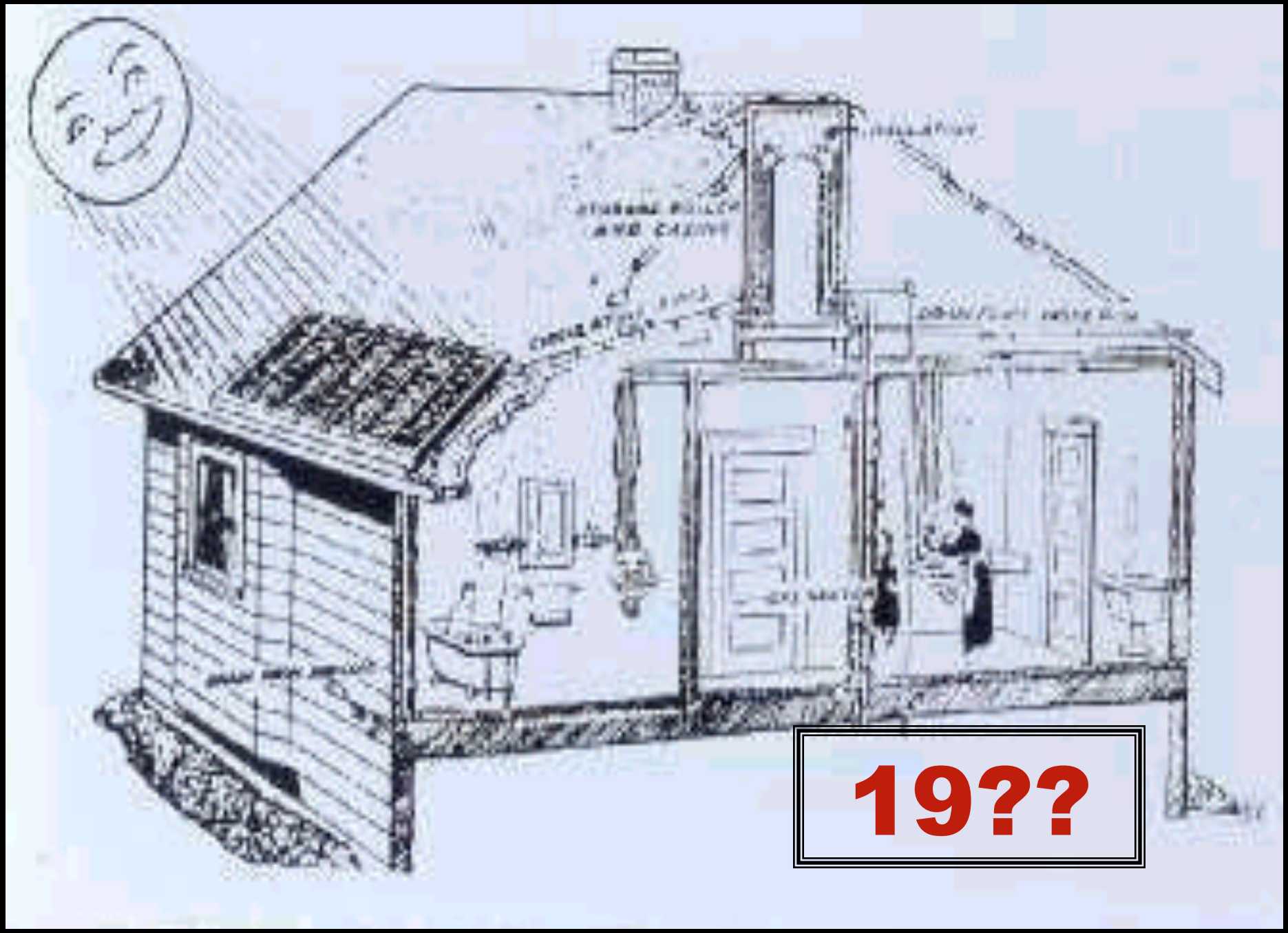
residential version

"A Foundation in Energy Efficiency"



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


Nothing New...

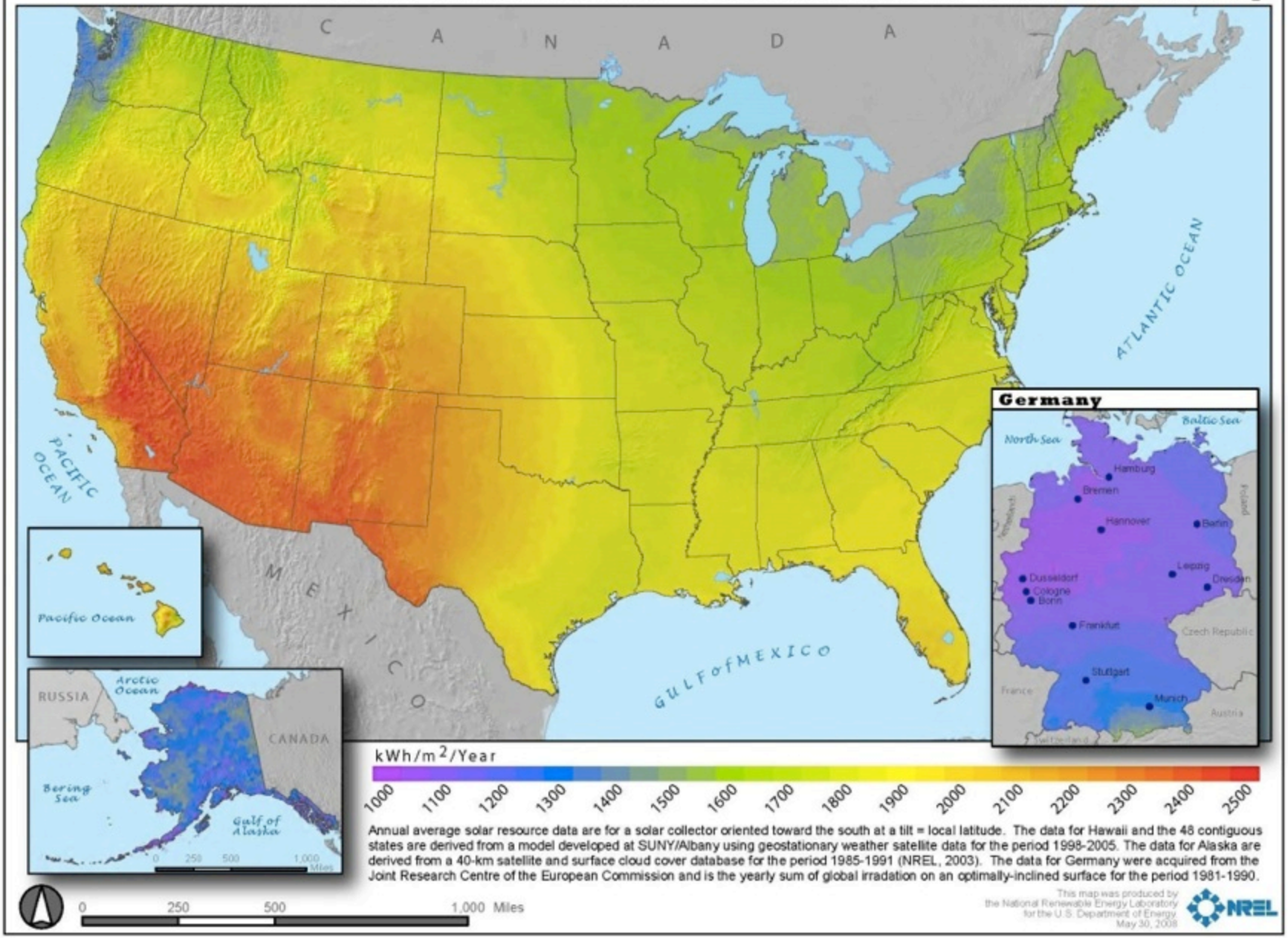

19??

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



Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1985-1991 (NREL, 2003). The data for Germany were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally-inclined surface for the period 1981-1990.

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy
May 30, 2008

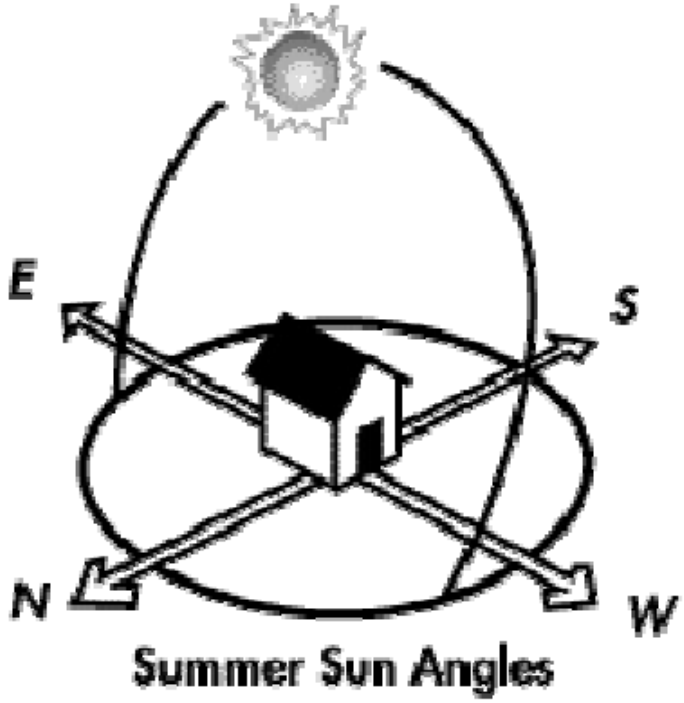
NREL

Is your place solar compatible?

A

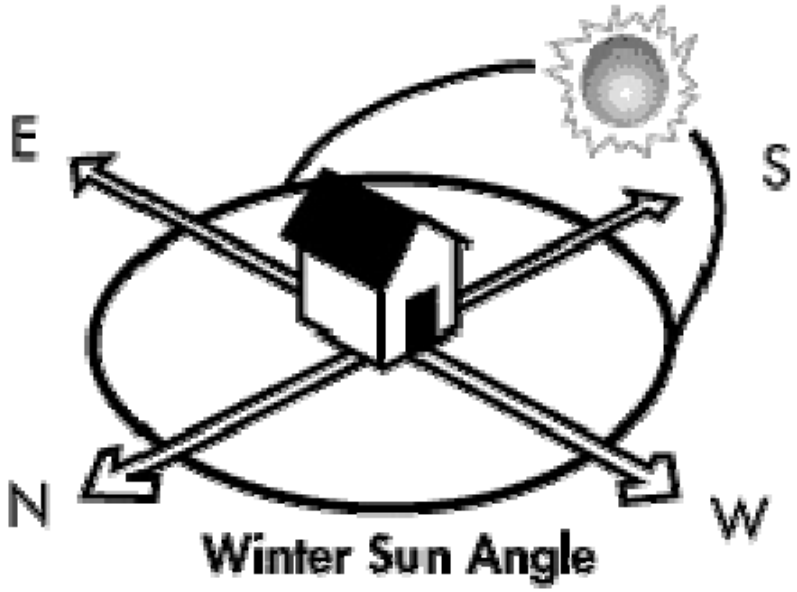
B

Sun Path



Summer Sun Angles

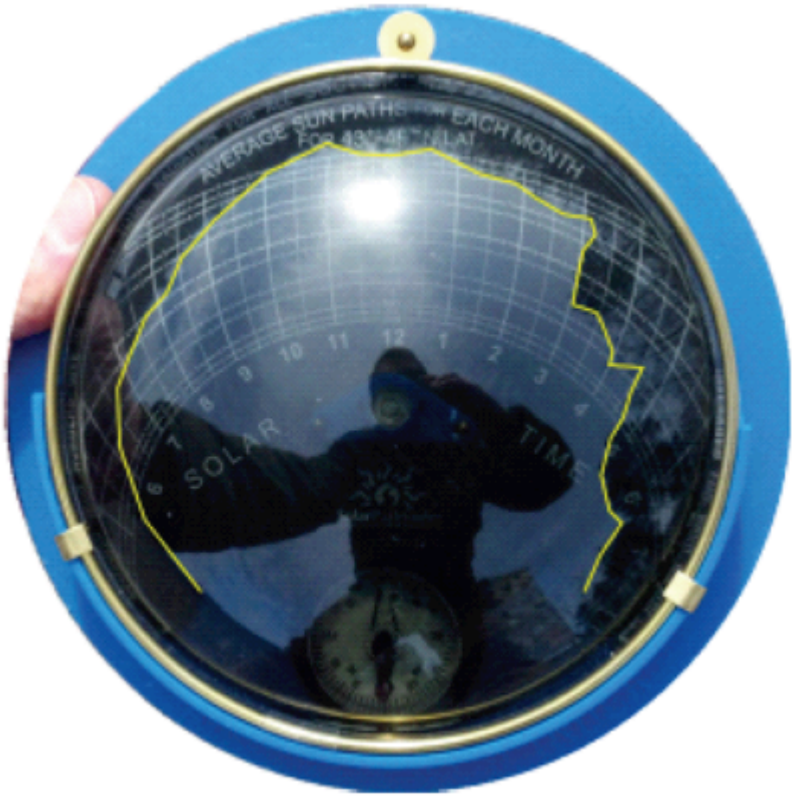
June 21st

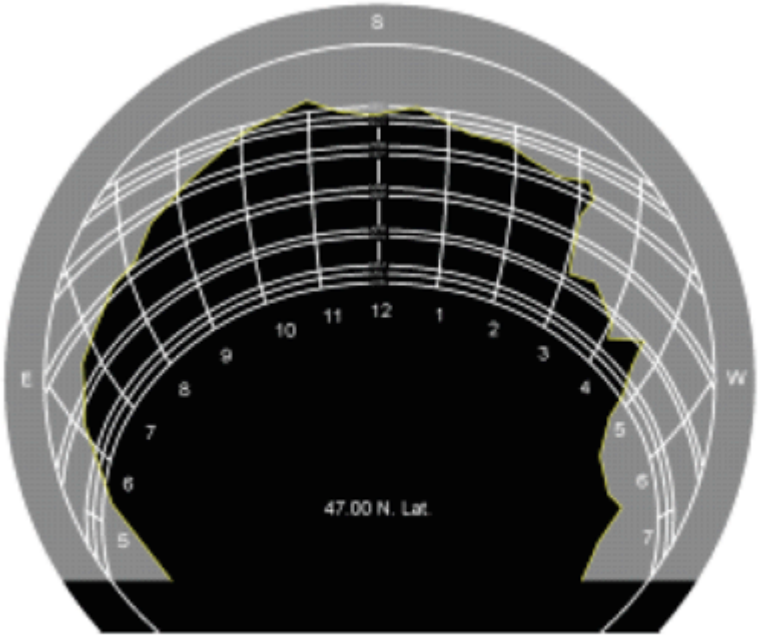


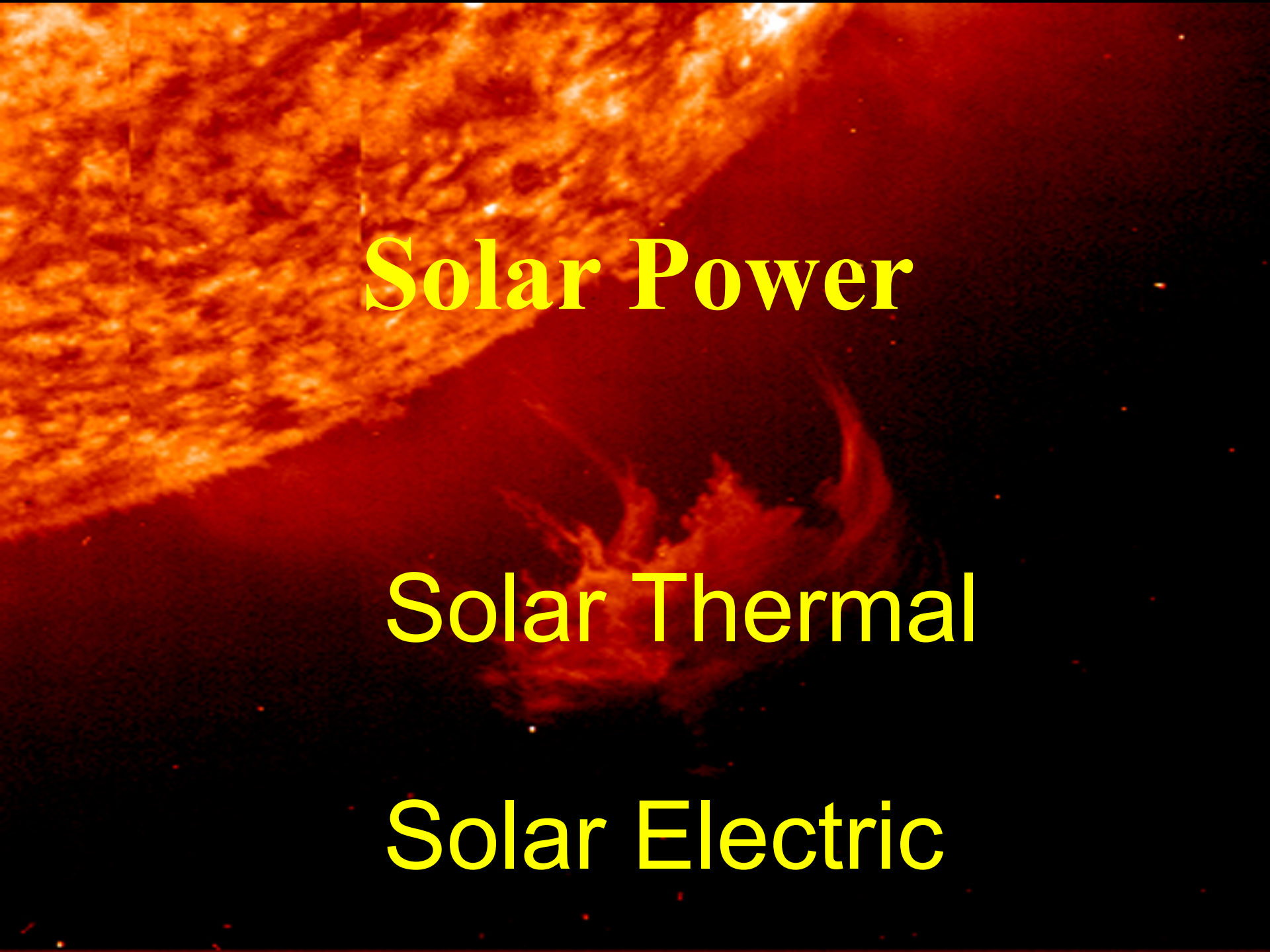
Winter Sun Angle

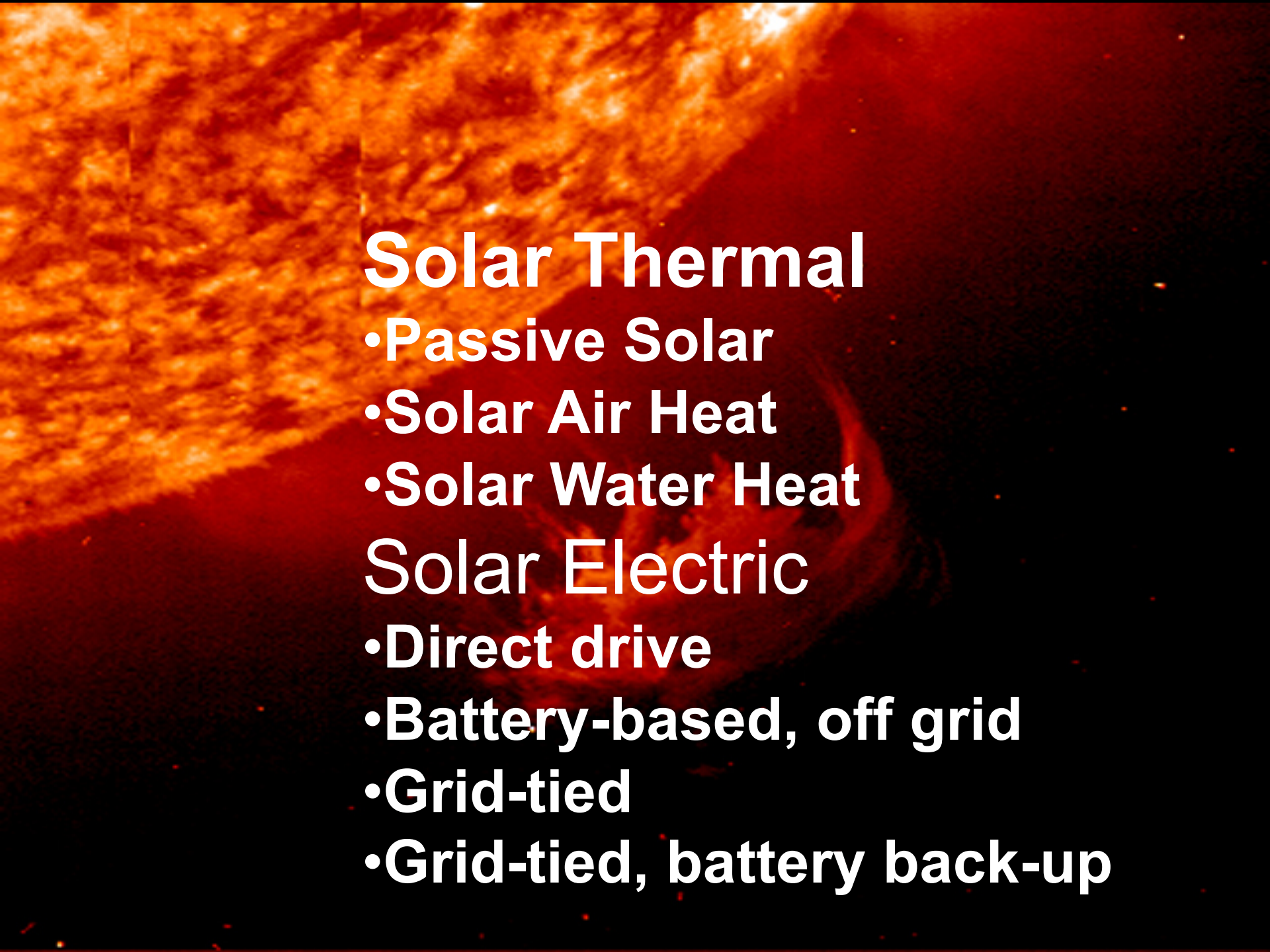
December 21st

The Site Visit





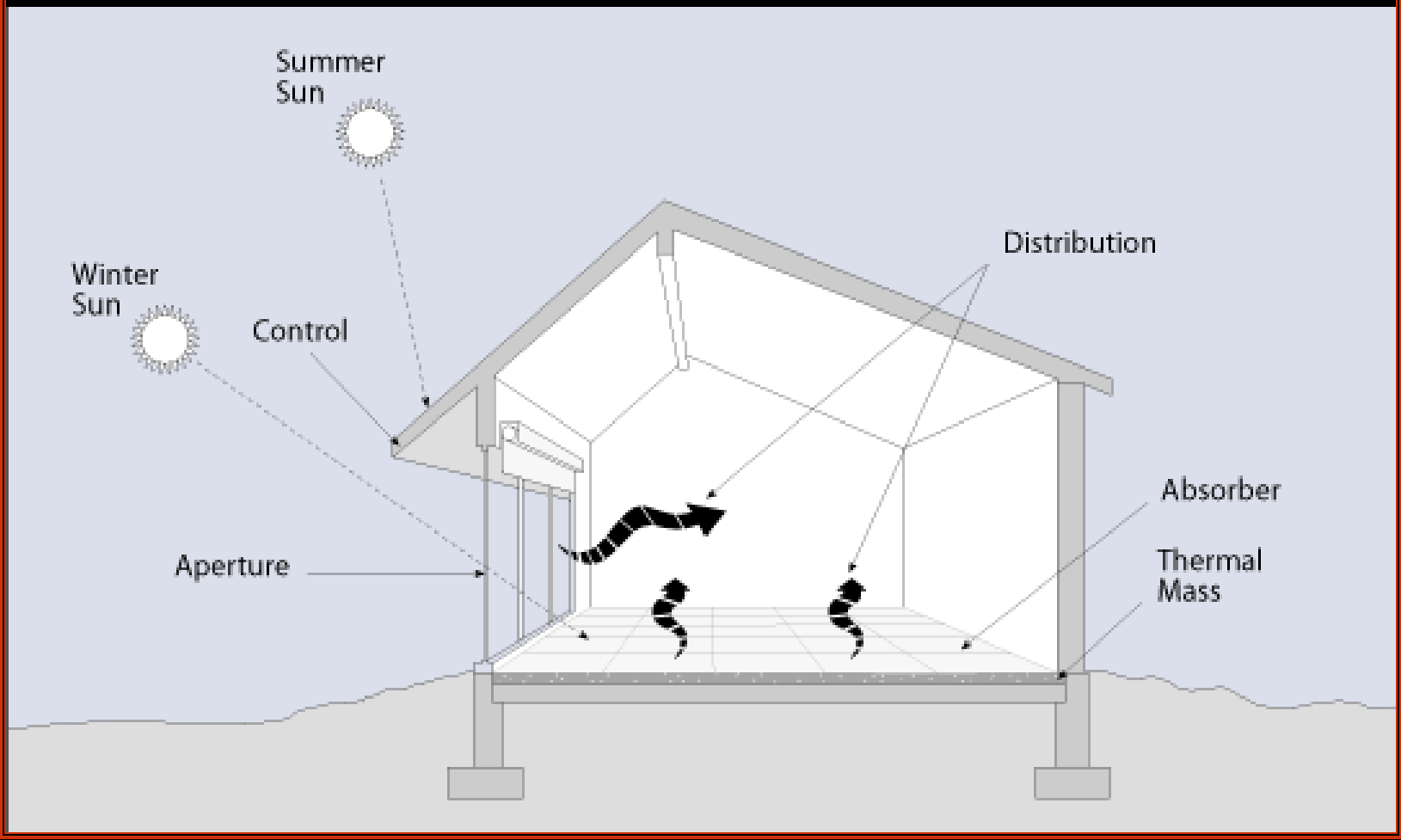

Solar Power
Solar Thermal
Solar Electric


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

Passive Solar


Copyright (c) 2002 Brian A. Nadworny

Passive Solar Design Principles




Solar Air Heat
Reconsidered

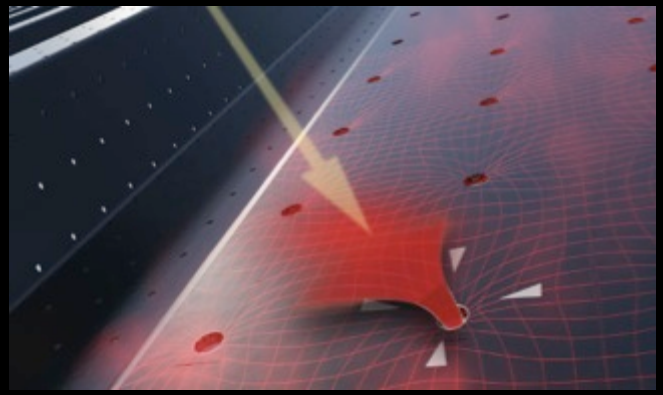
Appropriate Solar Air Heating Systems

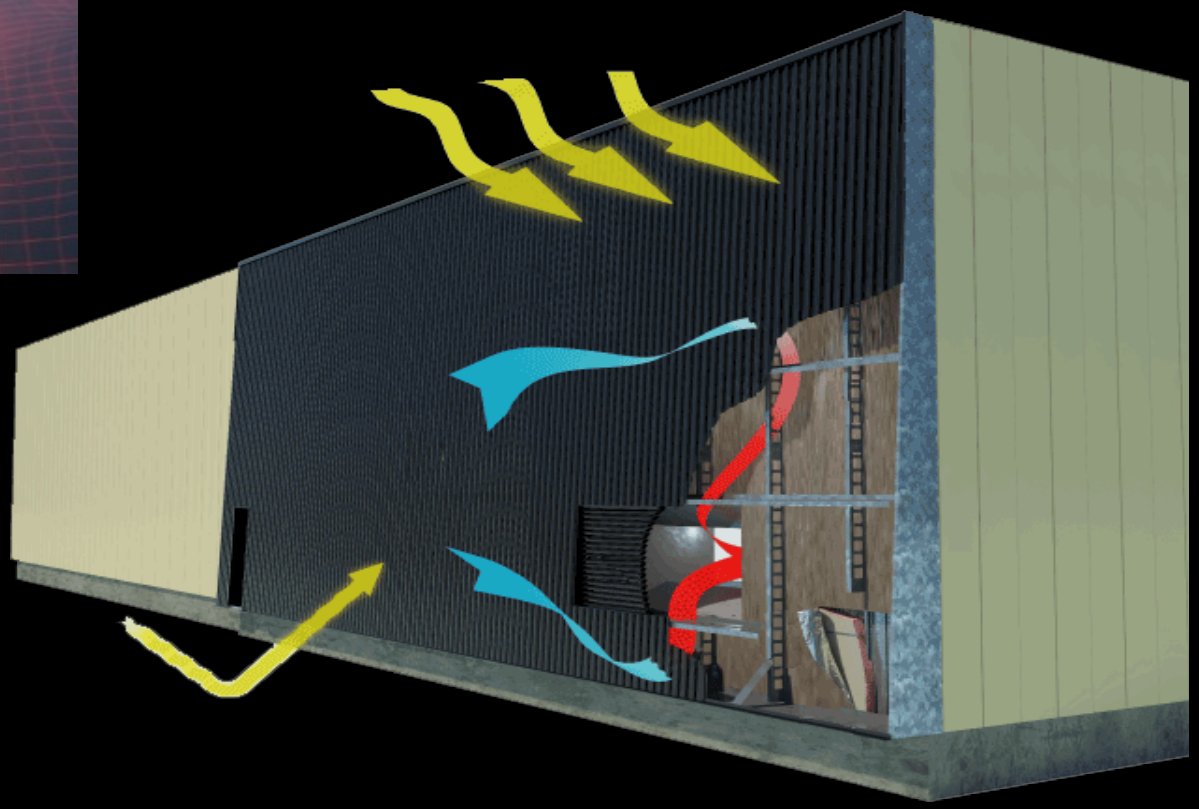
Transpired Air

Recirculation Solar Air

Transpired Air

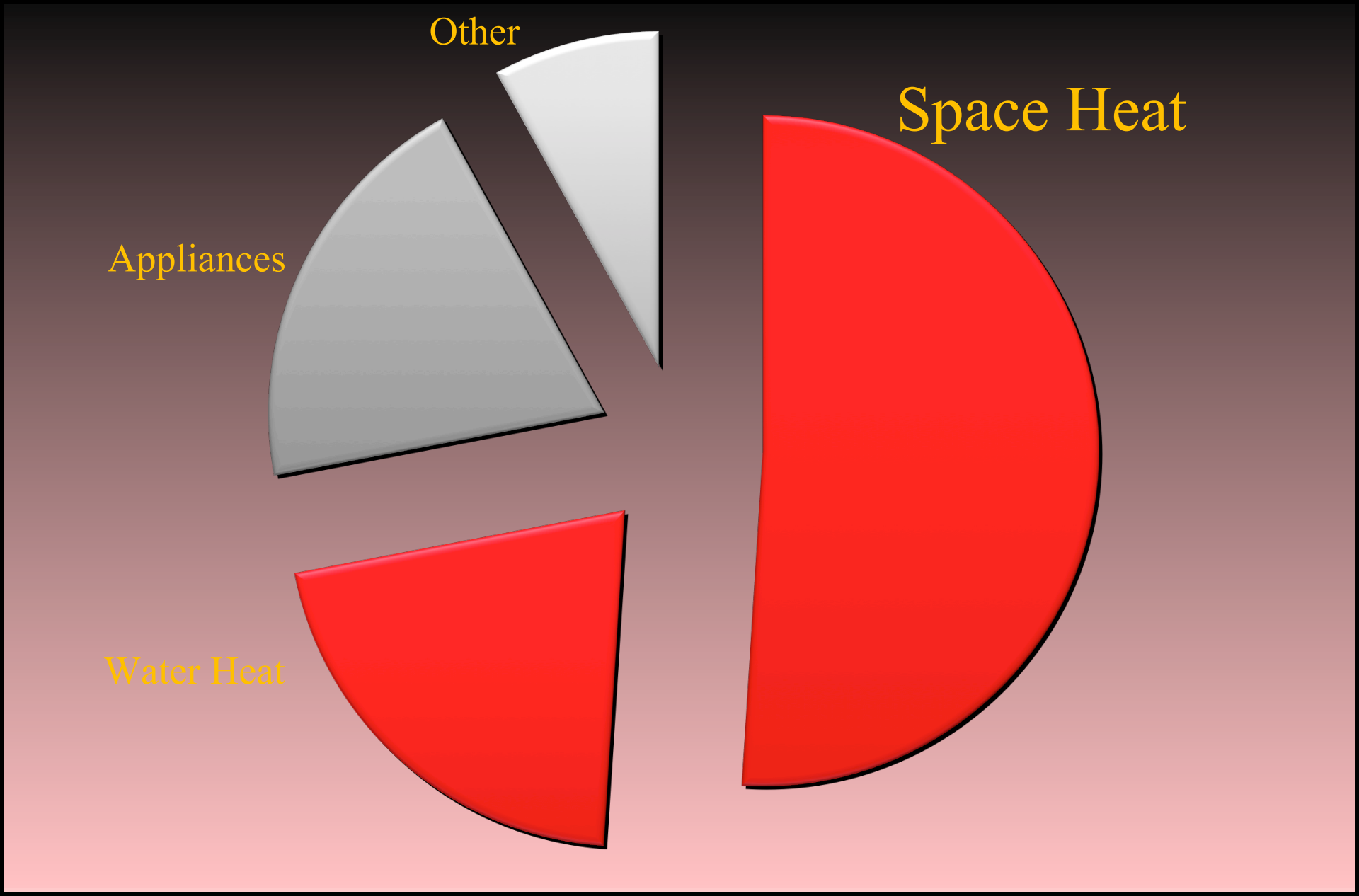
Ventilation Make-up Air

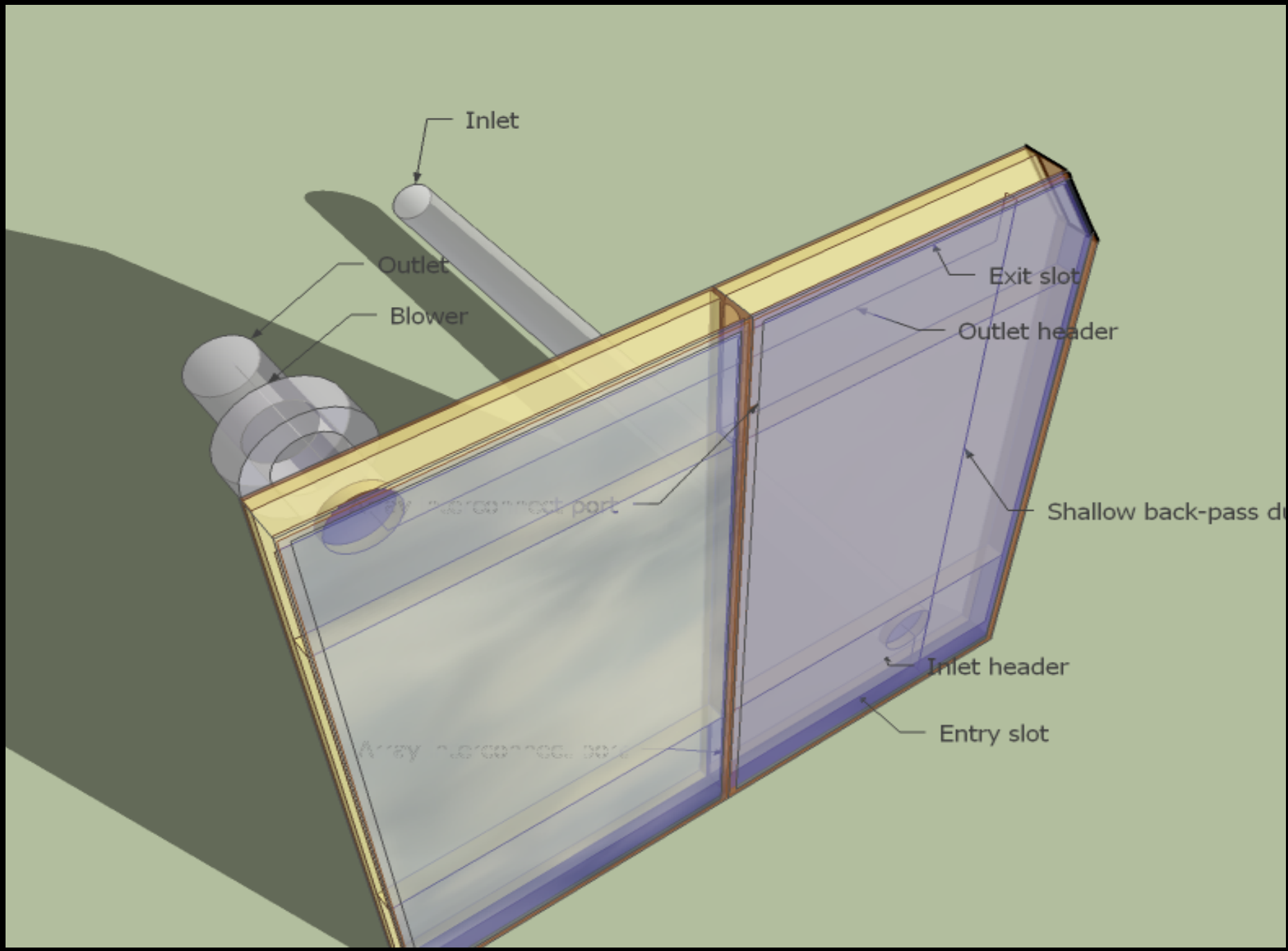




Transpired Air at Bemidji State

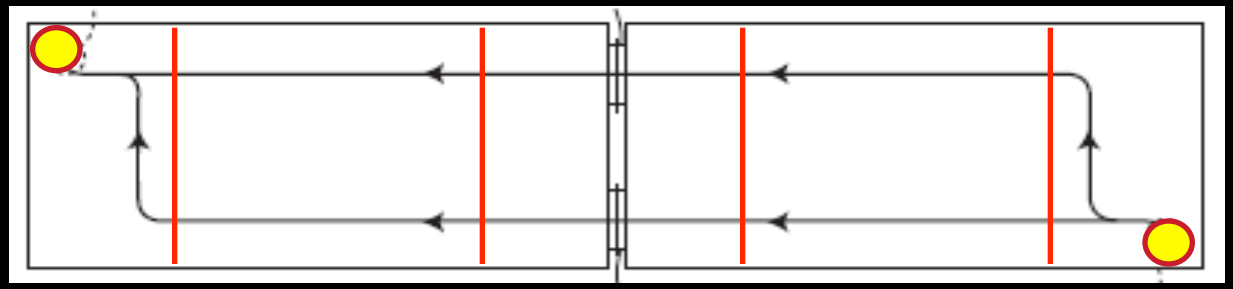
Why solar air heat?

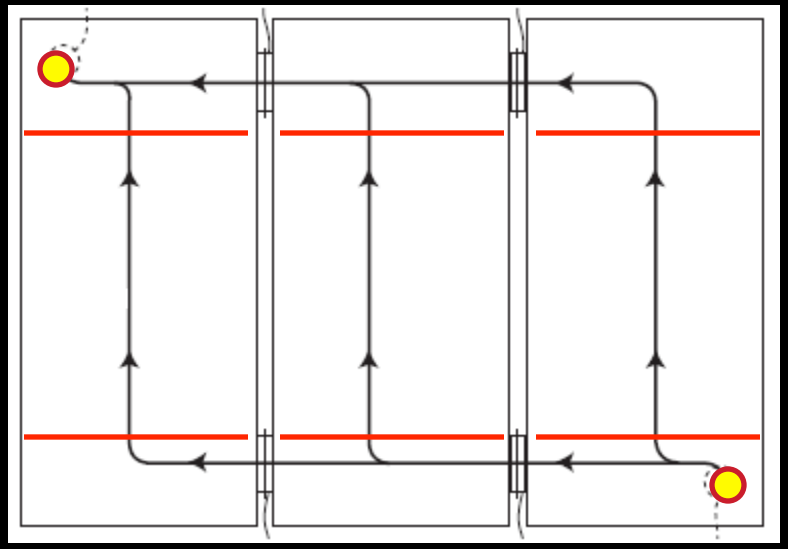

Other
Space Heat
Appliances
Water Heat

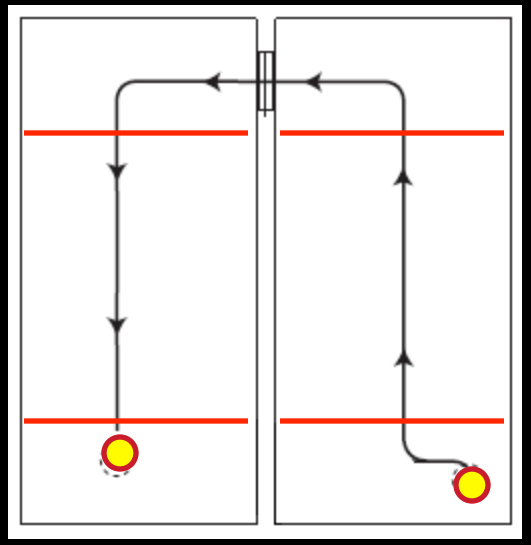

Inlet
Outlet
Blower
Exit slot
Outlet header
Shallow back-pass du
Inlet header
Entry slot

Site Selection

Parallel vs. Series Configuration



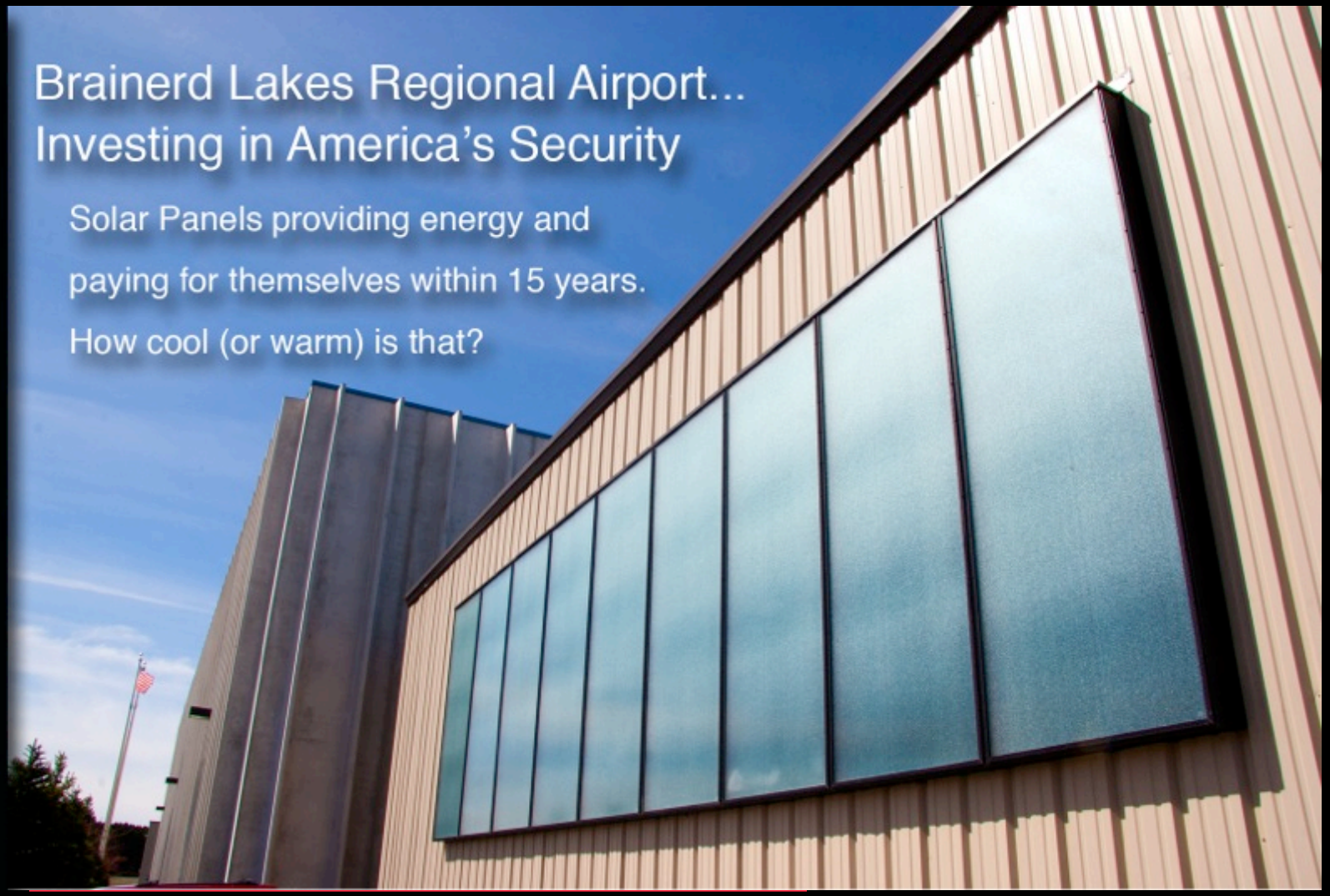




Payback

Fuel Source displaced	*Return on investment***
Propane	*9.2%*
Fuel oil	*7.9%*
Natural Gas	*6.6%*
Electricity	*6.0%*


Solar Forced Air
Commercial Installation


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?

Fan Sizing

PARALLEL CONFIGURATION

# Collectors	SPF40	SPF32	SPF26
1	6" Duct	5" Duct	5" Duct
CFM	4	3	4
Fan	AXC150A	AXC125A	AXC125A
Elec Consumption	68W	41W	60W
2	6" Duct	6" Duct	5" Duct
CFM	2	2.7	2
Fan	AXC150A	AXC150A	AXC125A
Elec Consumption	59W	100W	345W
	8" Duct		6" Duct
CFM	4		3.4
Fan	AXC200A		AXC150A
Elec Consumption	60W		125W
3	8" Duct	8" Duct	6" Duct
CFM	2.8	3.5	2.4
Fan	AXC200A	AXC200A	AXC150A
Elec Consumption	70W	83W	222W
	8" Duct		8" Duct
CFM	3.5		4
Fan	AXC200B		AXC200A
Elec Consumption	<175W		61W

SERIES CONFIGURATION

# Collectors	SPF40	SPF32	SPF26
2	8" Duct	8" Duct	6" Duct
CFM	3	4	3.2
Fan	AXC200A	AXC200A	AXC150A
Elec Consumption	68W	72W	61W
CFM	4		
Fan	AXC200B		
Elec Consumption	169W		
	10" Duct		
CFM	4		
Fan	AXC250		
Elec Consumption	120W		
3	Not recommended	Not recommended	Not recommended

SYSTEM SIZING

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

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

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

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

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

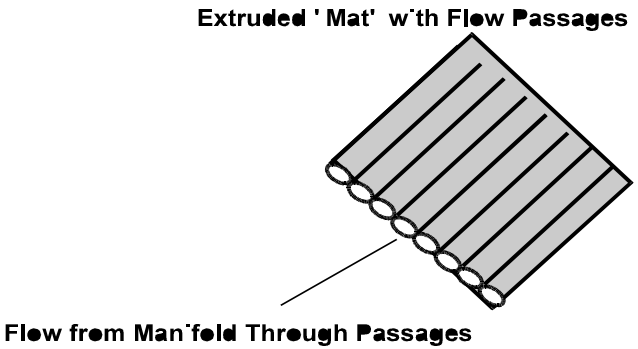
$$Q_{usable} = \begin{cases} Q_u, & Q_u < E_L^* \\ E_L^*, & Q_u \geq E_L^* \end{cases}$$
$$E_L^* = E_L \cdot (1 + overheat)$$

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

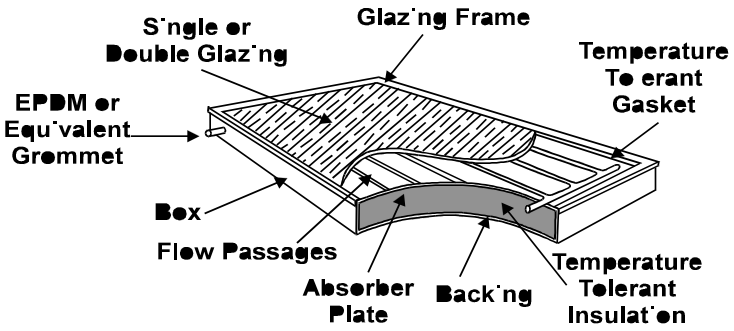

Solar Water Heat

Solar Thermal Collector Types

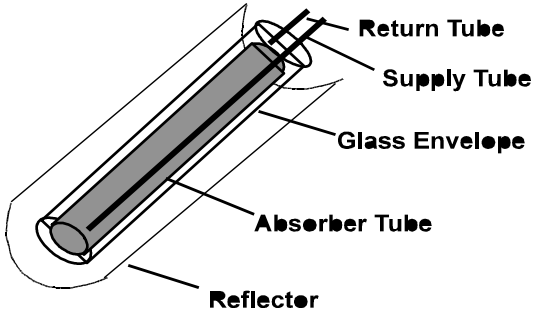
Unglazed EPDM Collector



Flat Plate



Evacuated Tubes



Parabolic Trough