In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1 hour** of credit toward **Building Officials and Residential Contractors** continuing education requirements."

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RREAL
Rural Renewable Energy Alliance
Jason Edens
MN BC 629837
NABCEP Certified
www.rreal.org

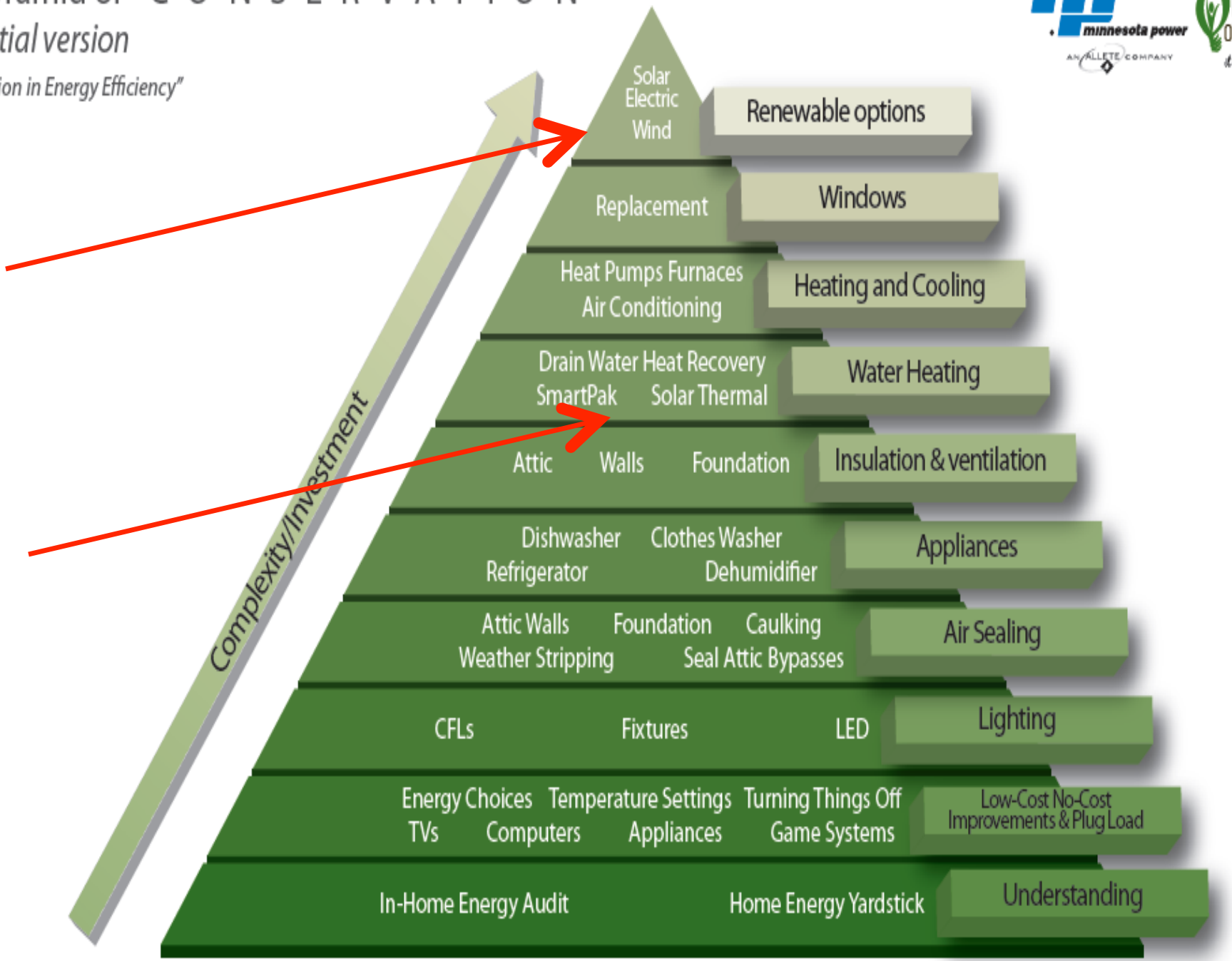
Form and Function: Solar Energy in Cold Climates

What about energy efficiency?

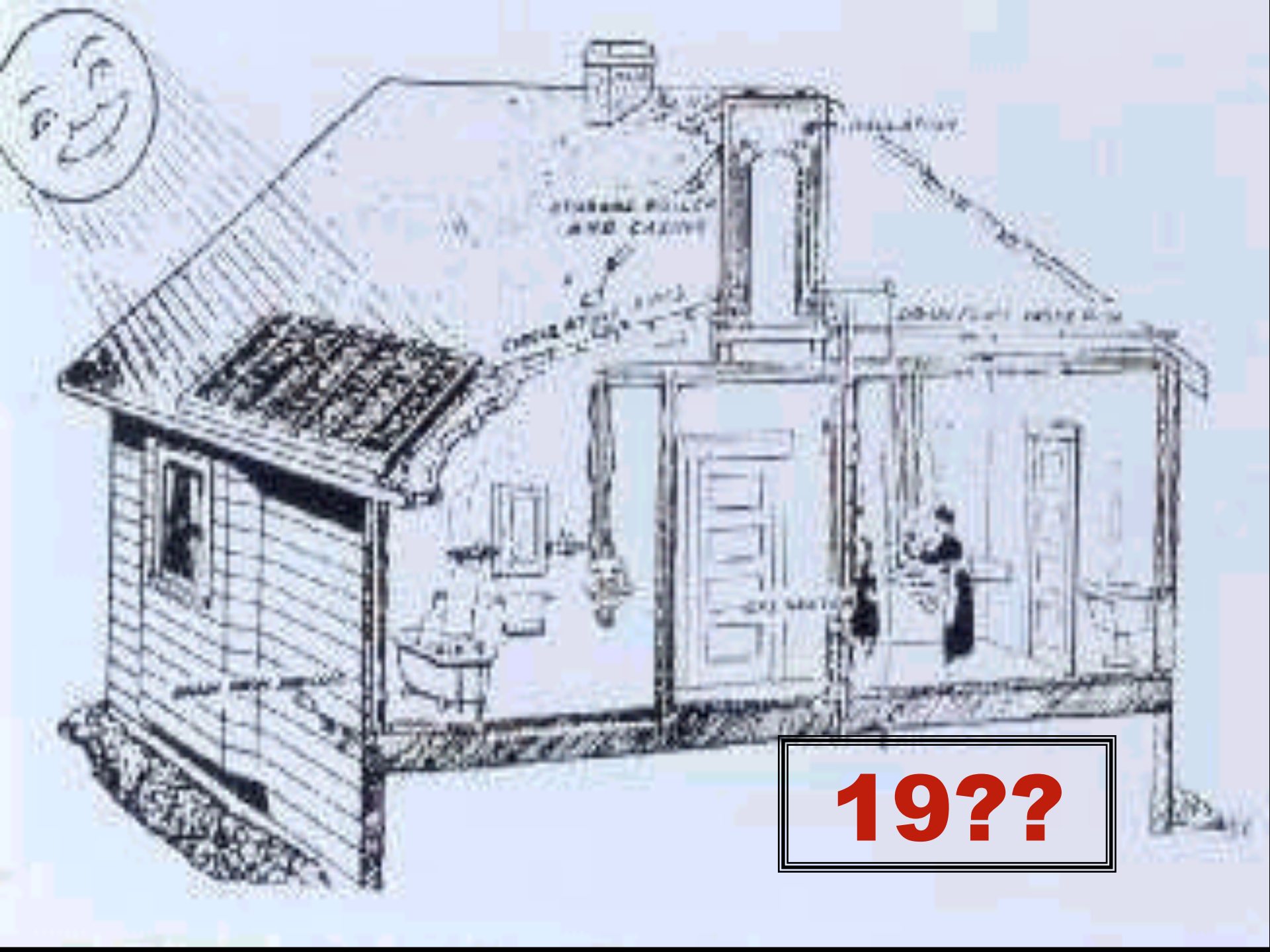
The Pyramid of CONSERVATION

residential version

"A Foundation in Energy Efficiency"




Nothing New...

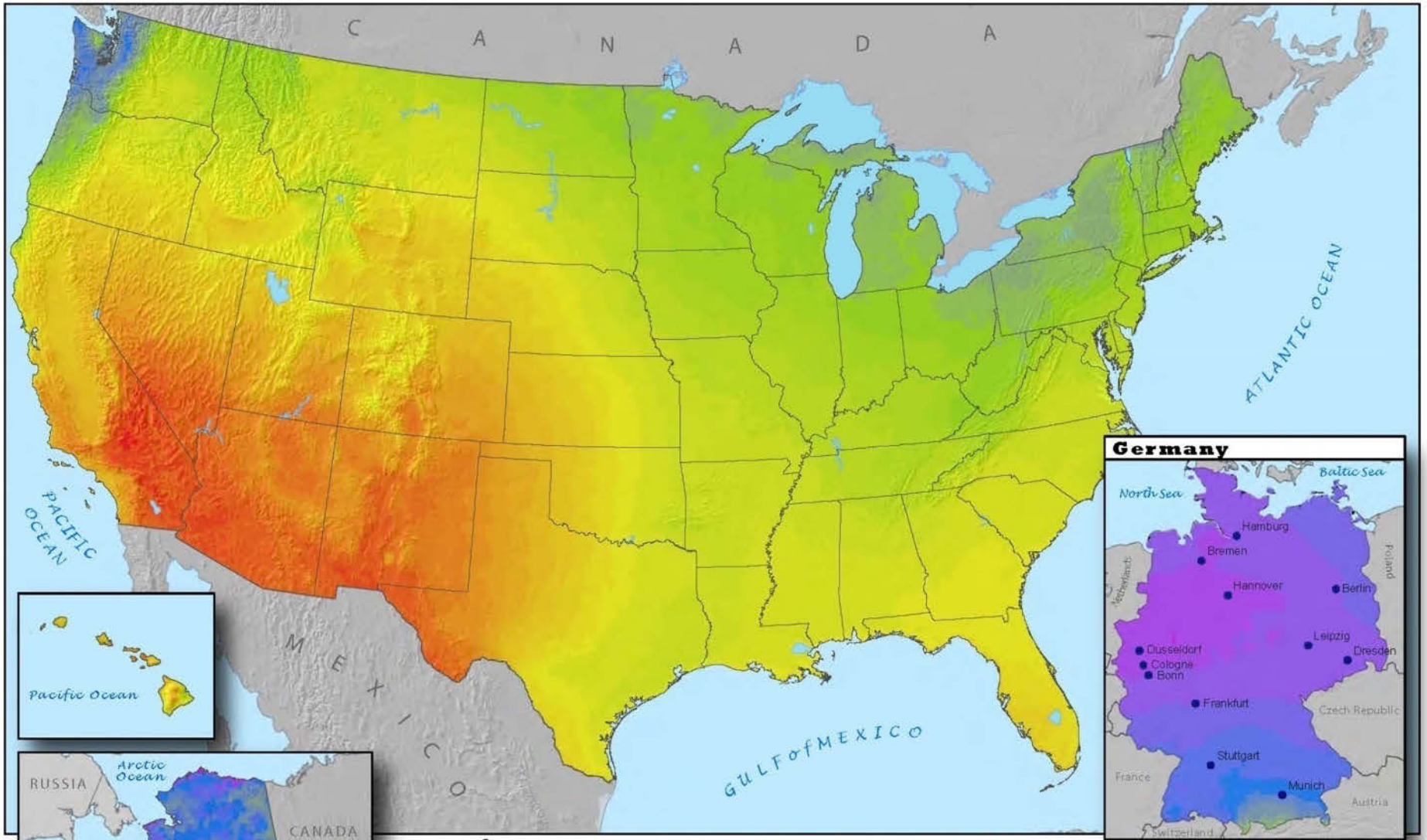

19??

Is Solar Energy an Appropriate Technology?

MAYBE!

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

Photovoltaic Solar Resource : United States and Germany



kWh/m^2/Year

1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500

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.

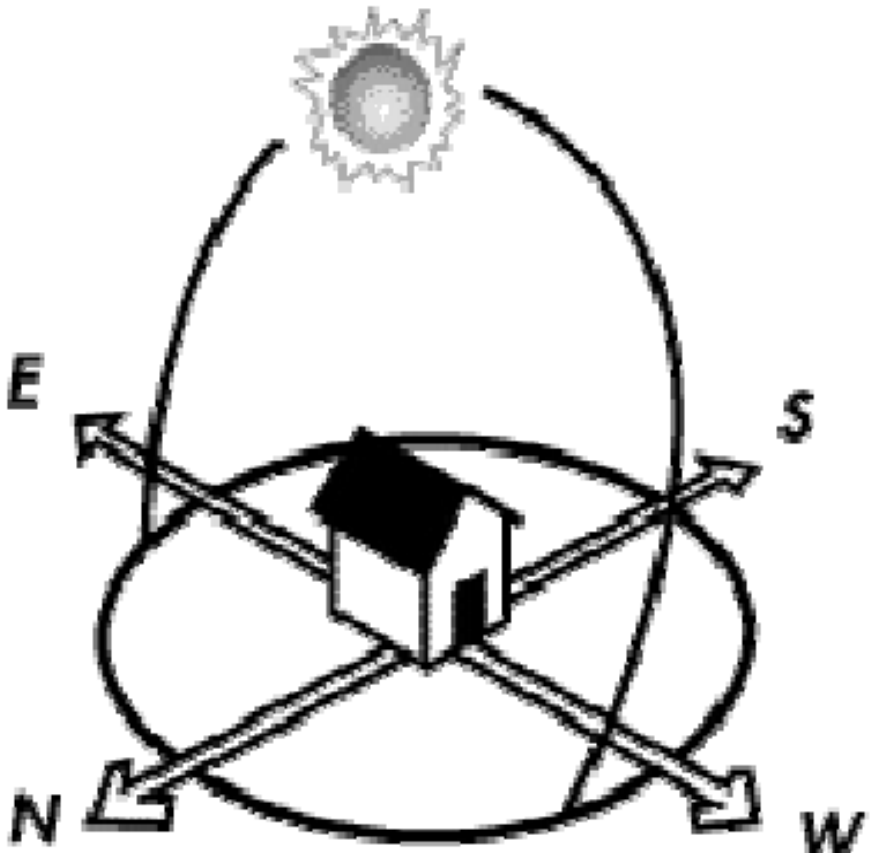
0 250 500 1,000 Miles

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

NREL

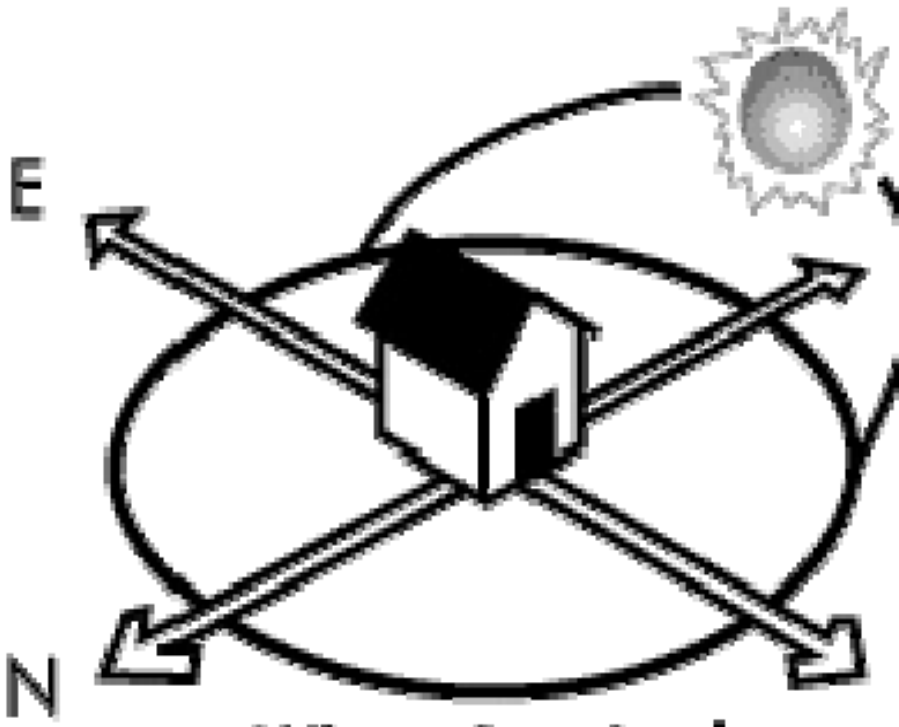

Is your place
solar compatible?

Sun Path



Summer Sun Angles

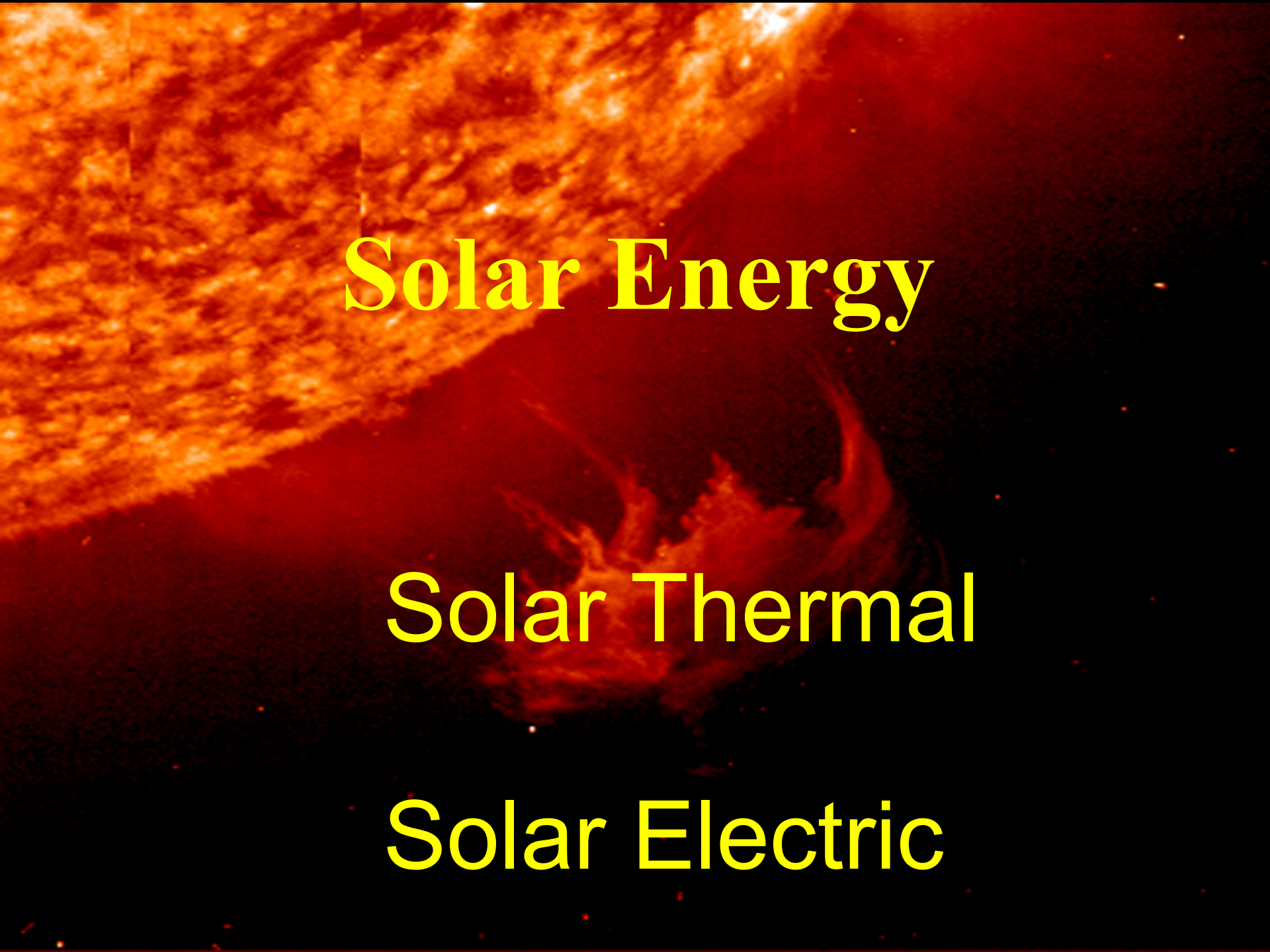
June 21st



Winter Sun Angle

December 21st


The
Site
Visit

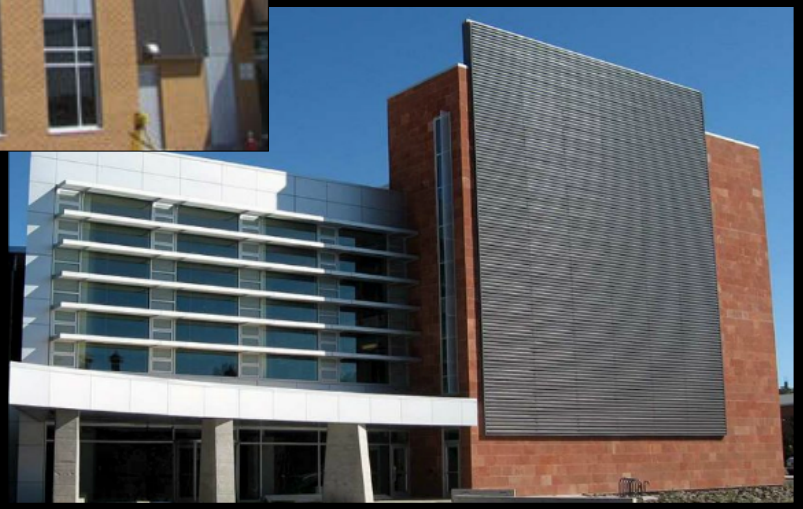

Solar Energy
Solar Thermal
Solar Electric

Appropriate Solar Air Heating Systems

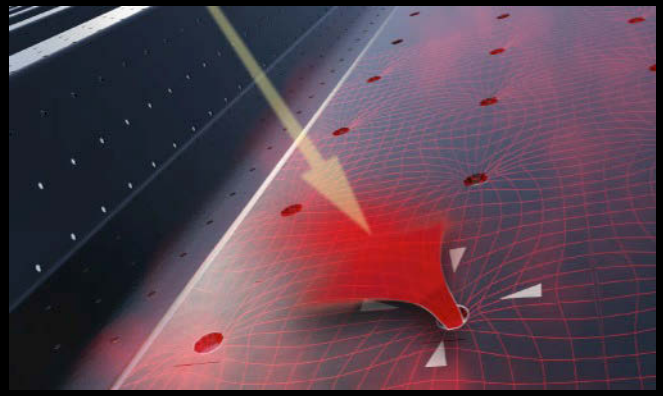
Transpired Air

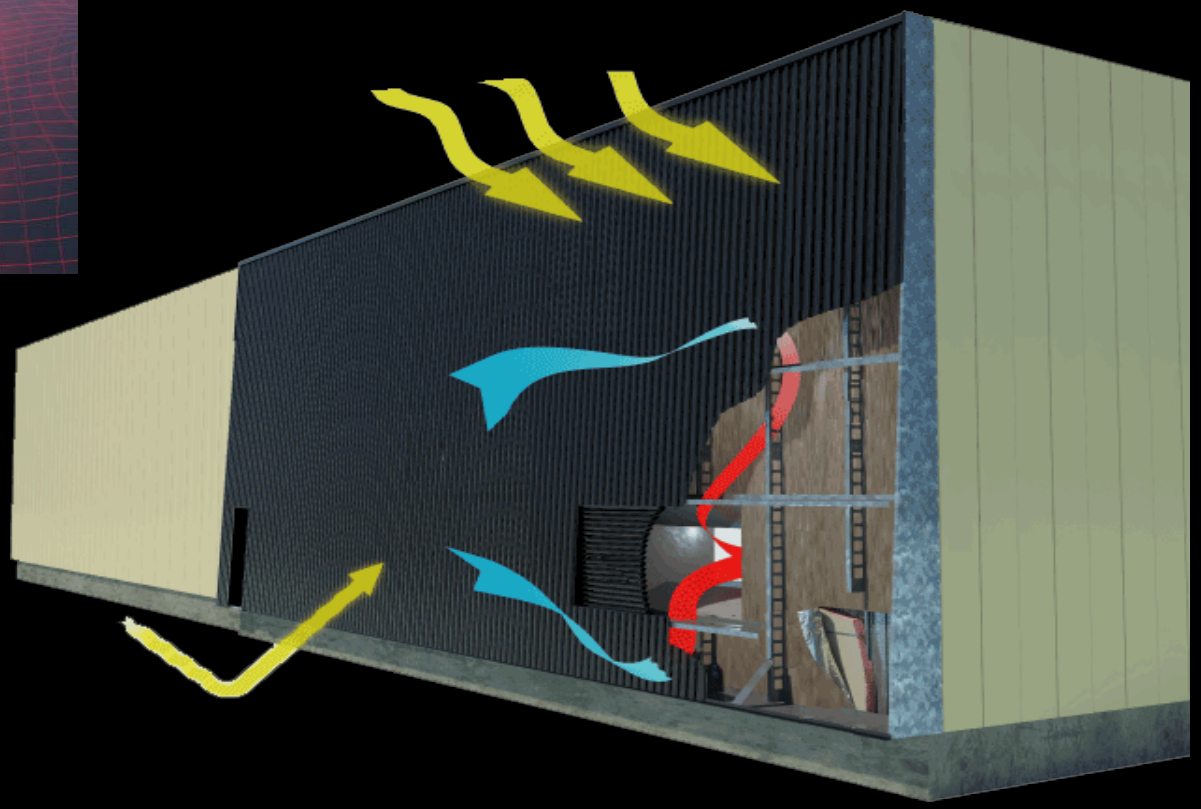
Recirculation Solar Air

Transpired Air



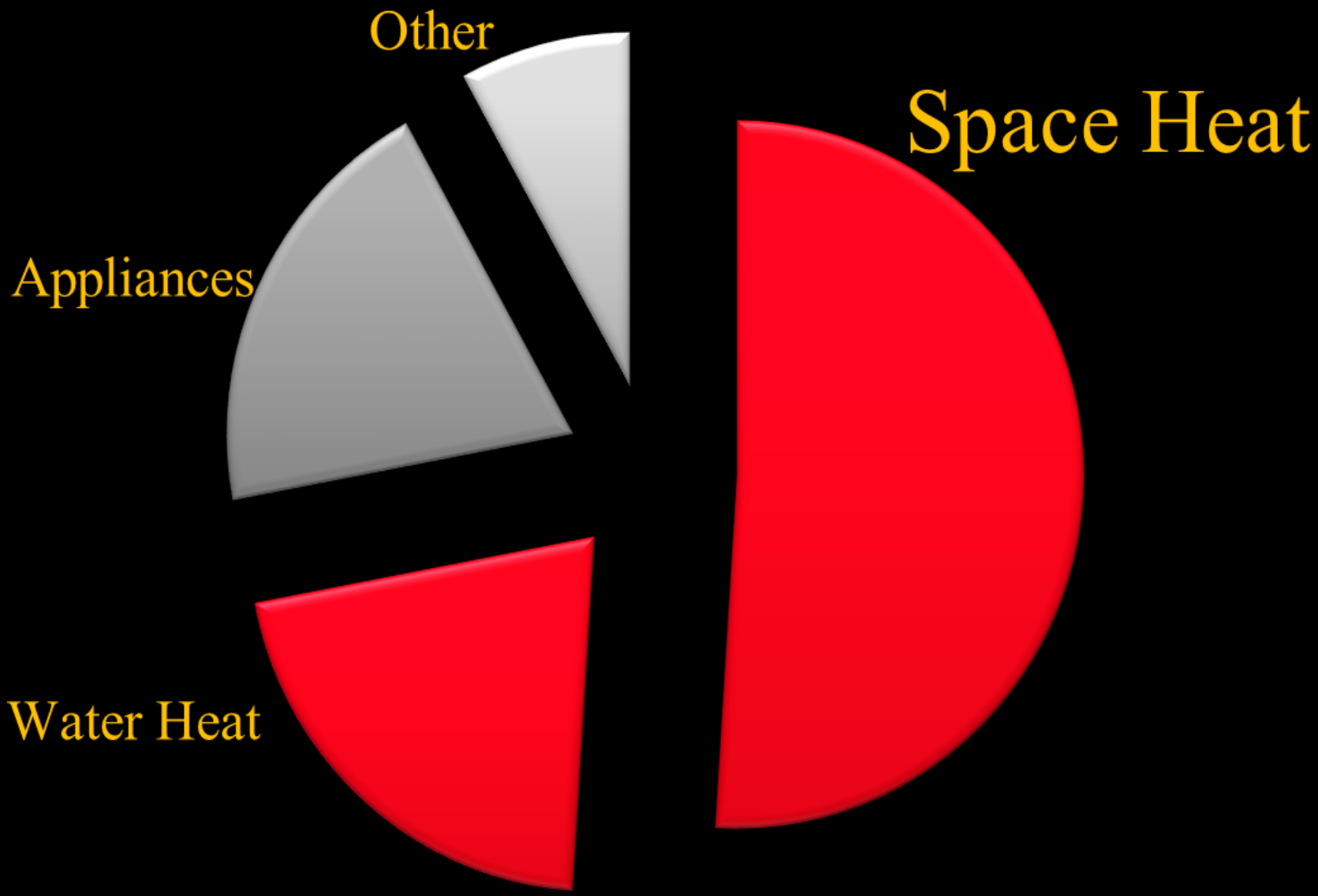
Pre-heating Ventilation Make-up Air with Solar Heat



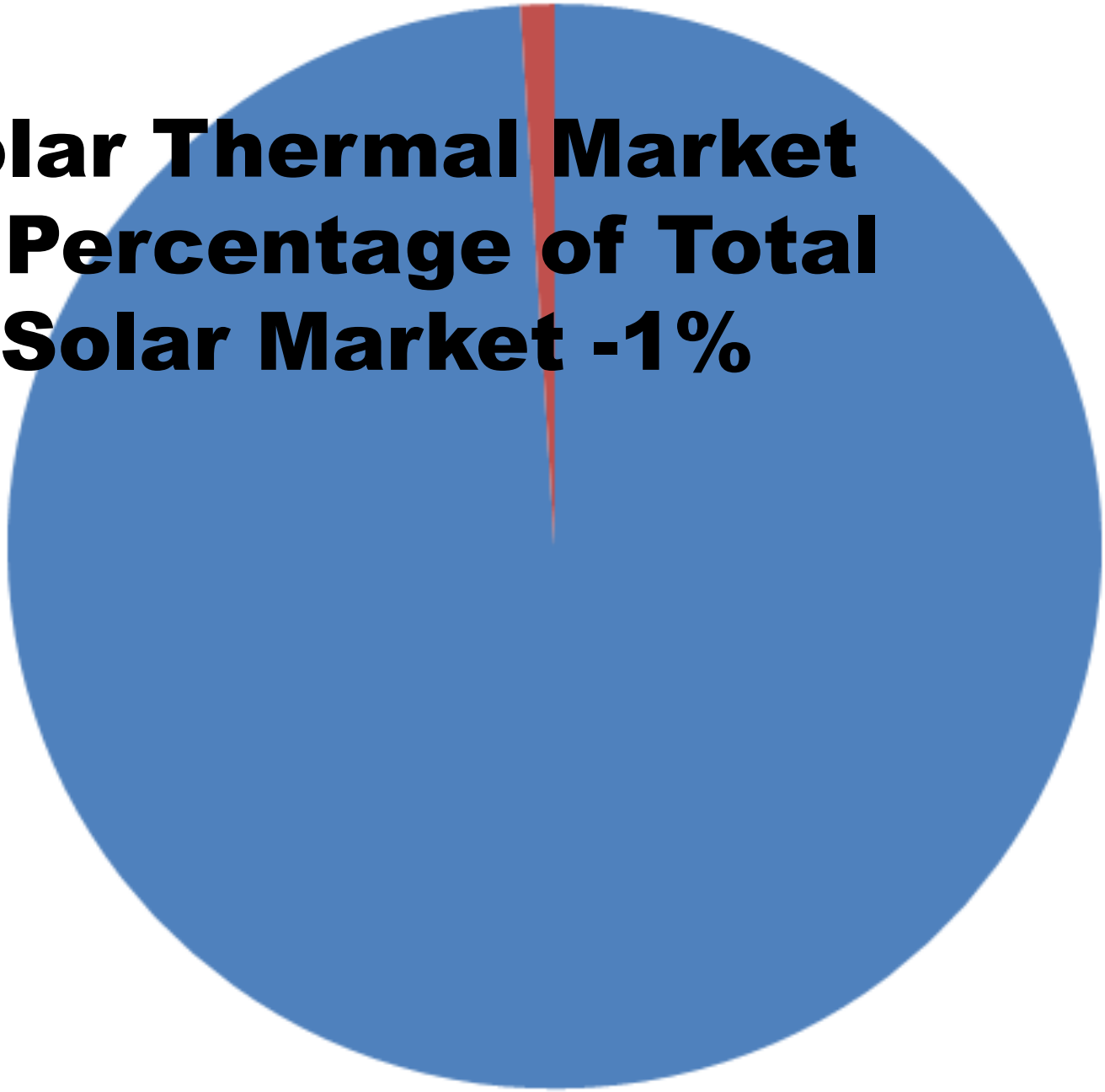


Transpired Air at Bemidji State

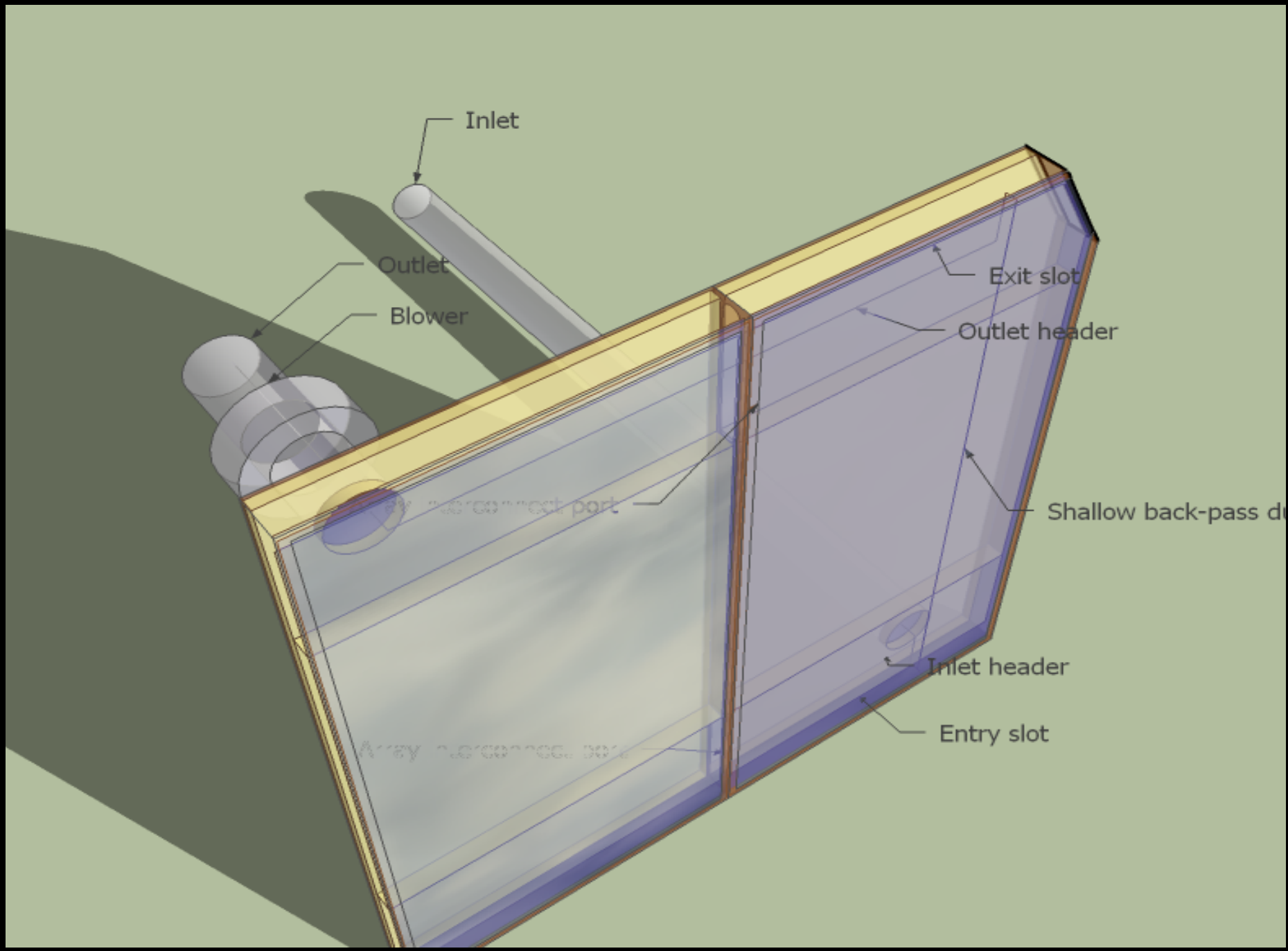
Why Solar Thermal?



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




Solar Air
Heat


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

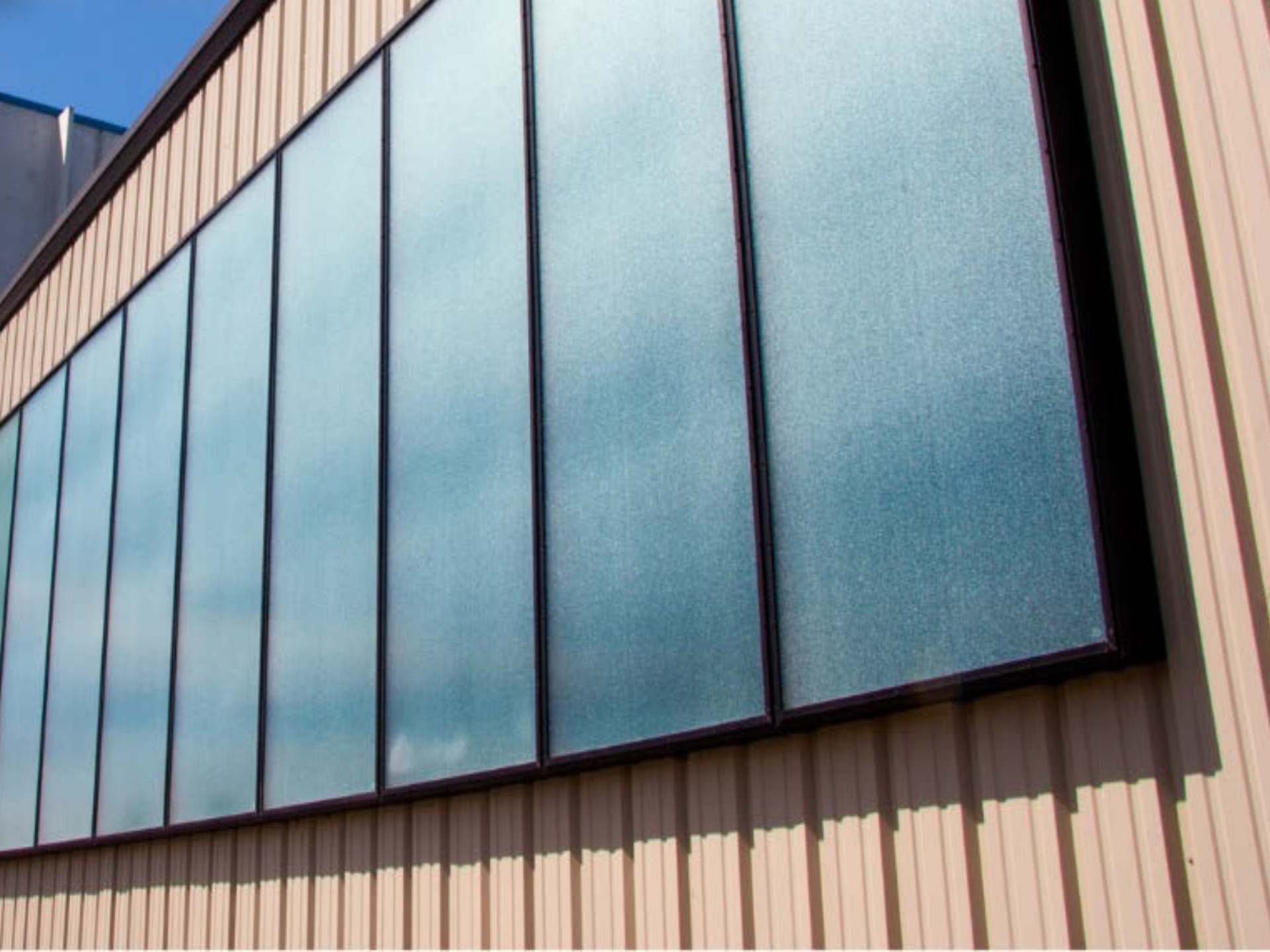
Site Selection

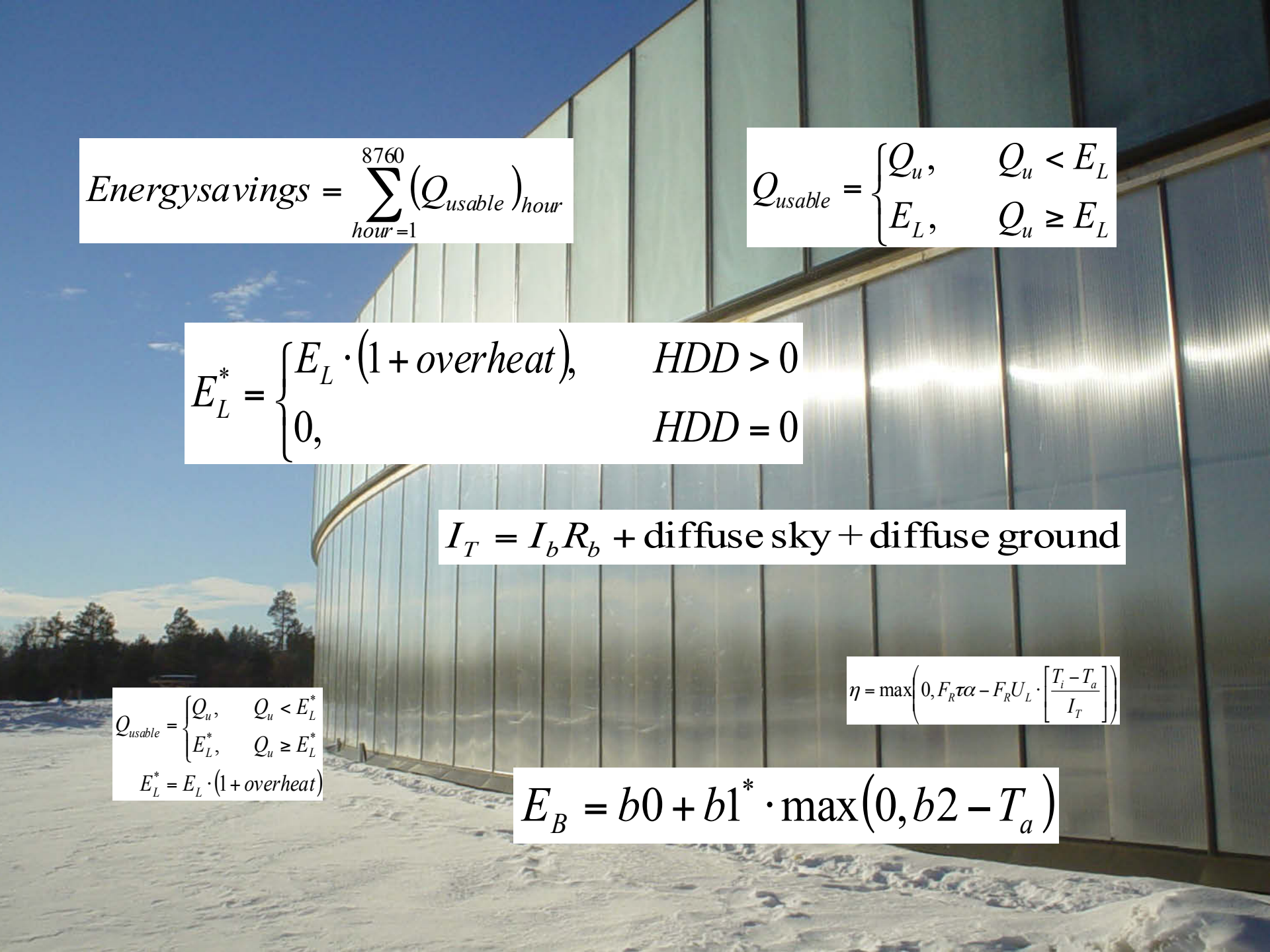
uel Source displaced	*Return on investment***
ropane	*0*
uel oil	
atural Gas	*5.0%*
lectricity	*6.0%*

Payback

Site Specific!

Solar Space Heating Systems





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

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

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

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

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

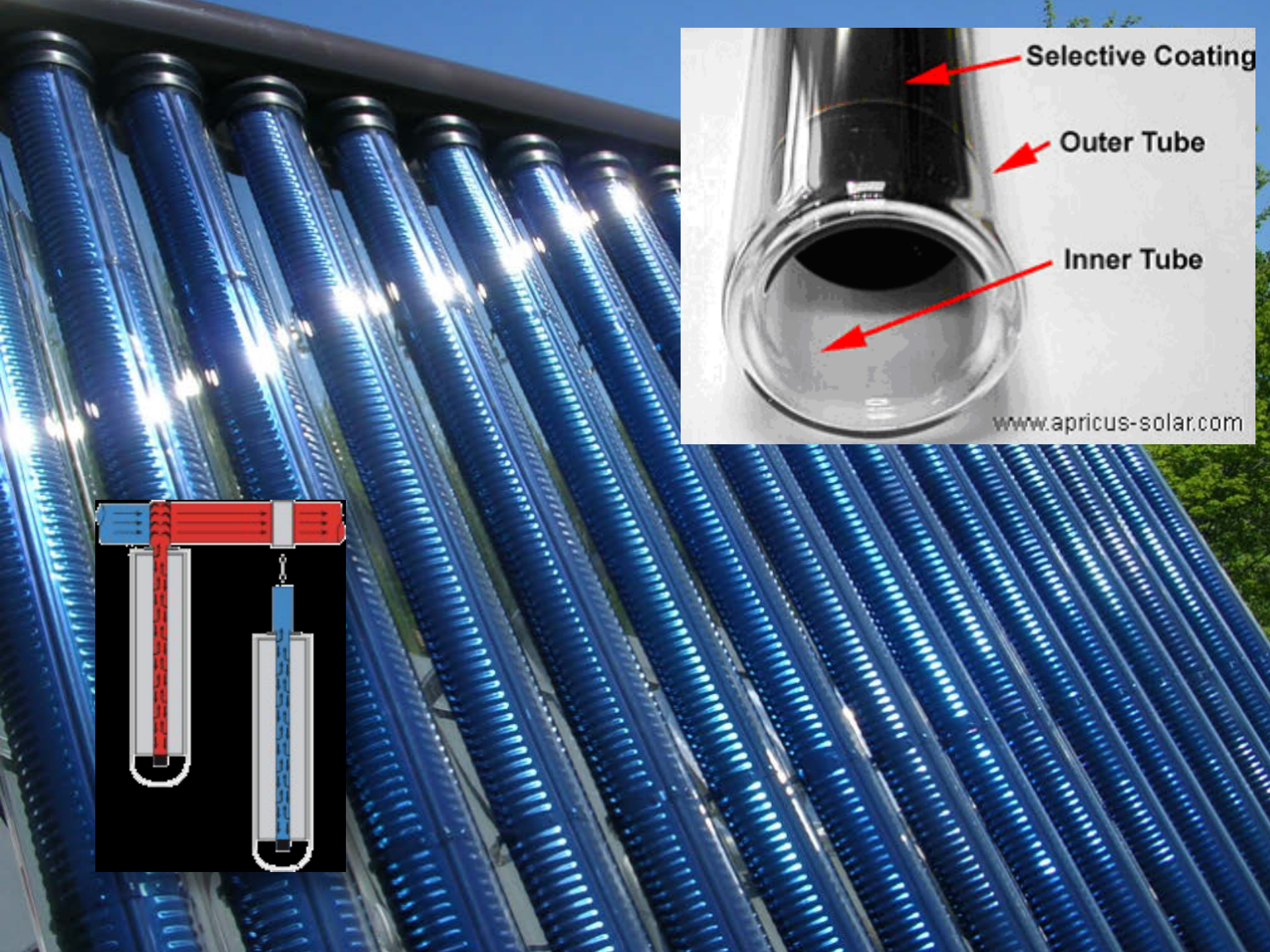
$$Q_{usable} = \begin{cases} Q_u, & Q_u < E_L^* \\ E_L^*, & Q_u \geq E_L^* \end{cases}$$

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

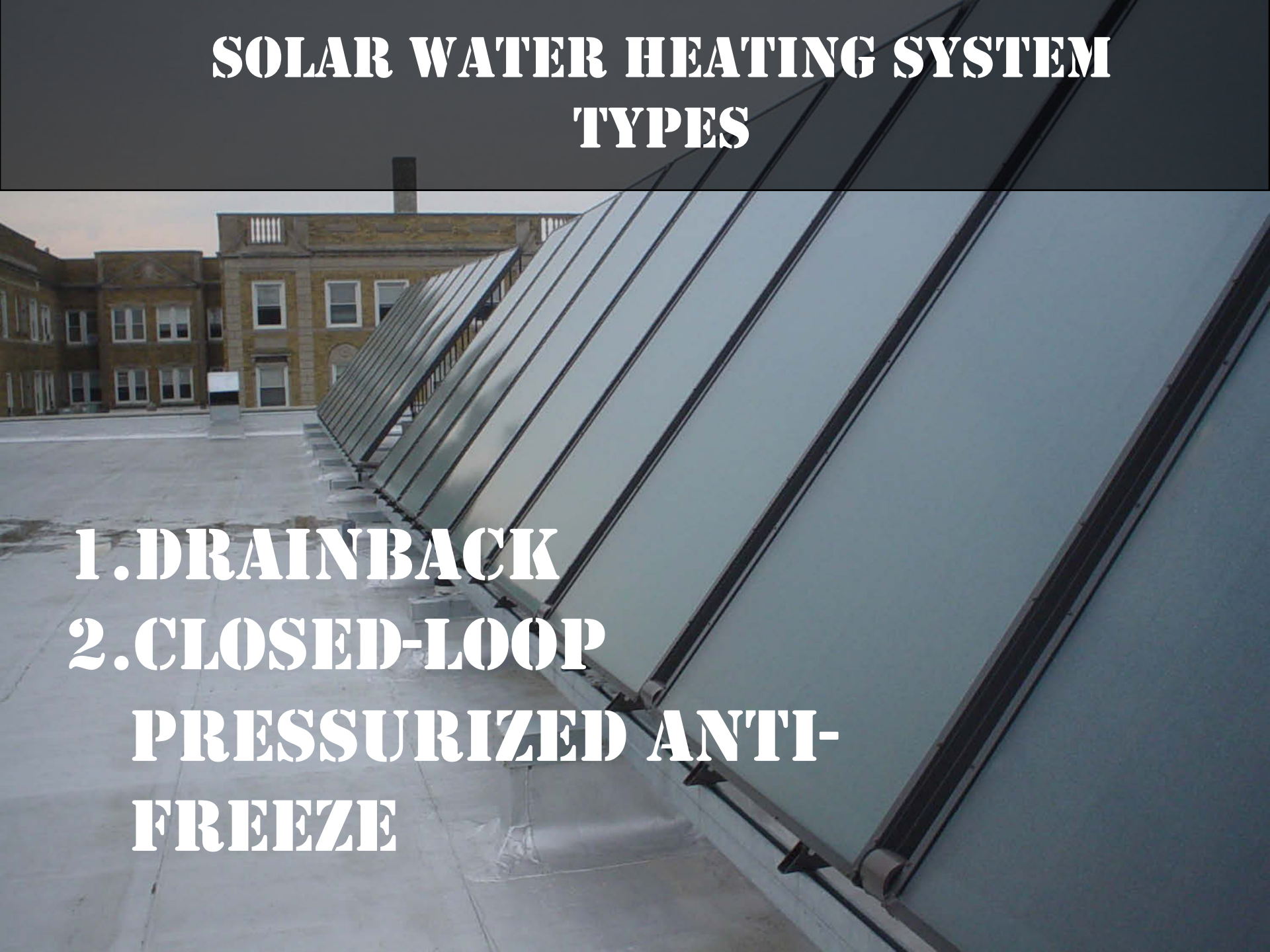
$$E_B = b0 + b1^* \cdot \max(0, b2 - T_a)$$

Solar Water Heat

Glazed Flat Plate Collectors


Selective Coating
Outer Tube
Inner Tube
www.apricus-solar.com

SOLAR WATER HEATING SYSTEM TYPES



1. DRAINBACK
2. CLOSED-LOOP PRESSURIZED ANTI-FREEZE

BASIC SOLAR THERMAL SYSTEM