



# Solar Hot Air Collectors

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# Program Outline

- ✦ Solar Basics overview: Passive; Active-PV, Solar Thermal
- ✦ Solar Air Heaters (SAH) Types (Glazed, Unglazed)
- ✦ Applications: Space heat, Ventilation Air Preheat, Water Heating
- ✦ Efficiency, performance w/in SAH Group
- ✦ Comparison to other solar technologies with respect to economics, GHG reduction, solar efficiency
- ✦ Testing data, analytical software. SRCC, TRNSYS
- ✦ Government Incentives
- ✦ Product specific discussion
- ✦ Photos



# Active Solar Systems

- ☀ Photovoltaic

- ☀ Solar thermal

- Liquid- Flat Plate, Evacuated Tube, Pool Heaters

- Air-Transpired wall, Glazed Collectors

# Solar Photovoltaic-(PV)



- ☀ Converts Sunlight directly to electricity
- ☀ Several technologies available
- ☀ Rapidly growing, improving technology
- ☀ Most activity where government incentives are attractive
- ☀ Approx. 10% efficiency
- ☀ Average Cost \$9,000/KW



# Solar Thermal-Converts Sunlight to heat

- ☀ Liquid systems
  - Flat plate
  - Evacuated Tube



# Schuco-PV + Flat plate DHW-N Yarmouth



Most common  
usage worldwide

Proven, long lasting,  
reliable technology

# Apricus Evacuated Tubes DHW- Freeport





# Solar Thermal-Air

- ✦ Unglazed-transpired wall=Solarwall
- ✦ Glazed collectors-Manufacturers & Brands include:
  - ✦ Sunsiary (Northern Comfort Collector)
  - ✦ Environmental Solar Systems (Sunmate)
  - ✦ Your Solar Home (SolarSheat)
  - ✦ Cansolair



# Solarwall- Large Commercial

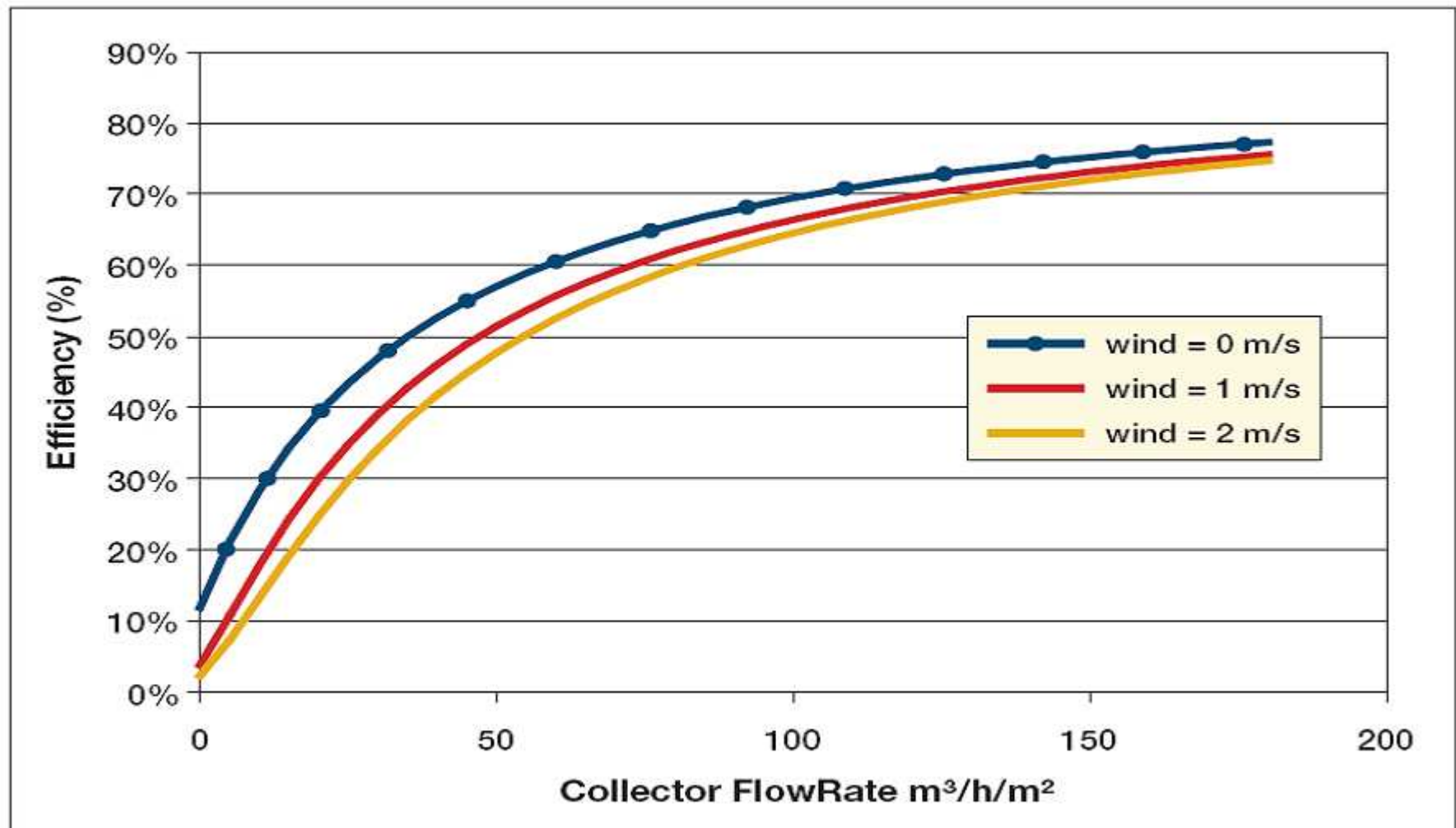




# Transpired Wall / Solarwall

- ✦ Industrial scale
- ✦ Building integrated
- ✦ Best use is preheating ventilation air
- ✦ \$ millions in testing
- ✦ Efficiency curve is instructive

# Solarwall performance chart



# Glazed Hot Air Solar Collectors





# Solarsheat- Cumberland



# SunMate- Cumberland Maine



- Installed over unused doorway
- Heats living room in 1800's Farmhouse



# Sunmate at Back Country Excursions



# Northern Comfort-Small Commercial





# Northern Comfort-Larger Commercial





# What are the applications?

- ✦ Space Heating
- ✦ Dual Mode-Space & Hot water
- ✦ Ventilation Preheat

## What are the design Guidelines?

- ✦ Think about 7% to 10% ratio between collector area to floor area
- ✦ Example  $24 \times 34' = 816 \text{ ft}^2 \times 7\% = 57 \text{ ft}^2$
- ✦ NC Collector =  $29 \text{ ft}^2$
- ✦  $57/29 = 1.9$  say 2 collectors
- ✦  $29 \times 2 = 58/816 = 7.1\%$
- ✦  $29 \times 3 = 87/816 = 10.6\%$
- ✦ Should do ~15%-35% of space heat load



# Other Considerations

- ✦ Orientation- Ideally within 20-30 degrees of true south
- ✦ Check out your house on Google Earth And or Virtual Earth
- ✦ Tilt- vertical Wall mount to ~55 degrees for space heat- catch the sun when it is low in the sky & you need the heat
- ✦ Shading- Trees other structures
- ✦ Wall & roof space available
- ✦ Architectural- can you fit it in- accept it





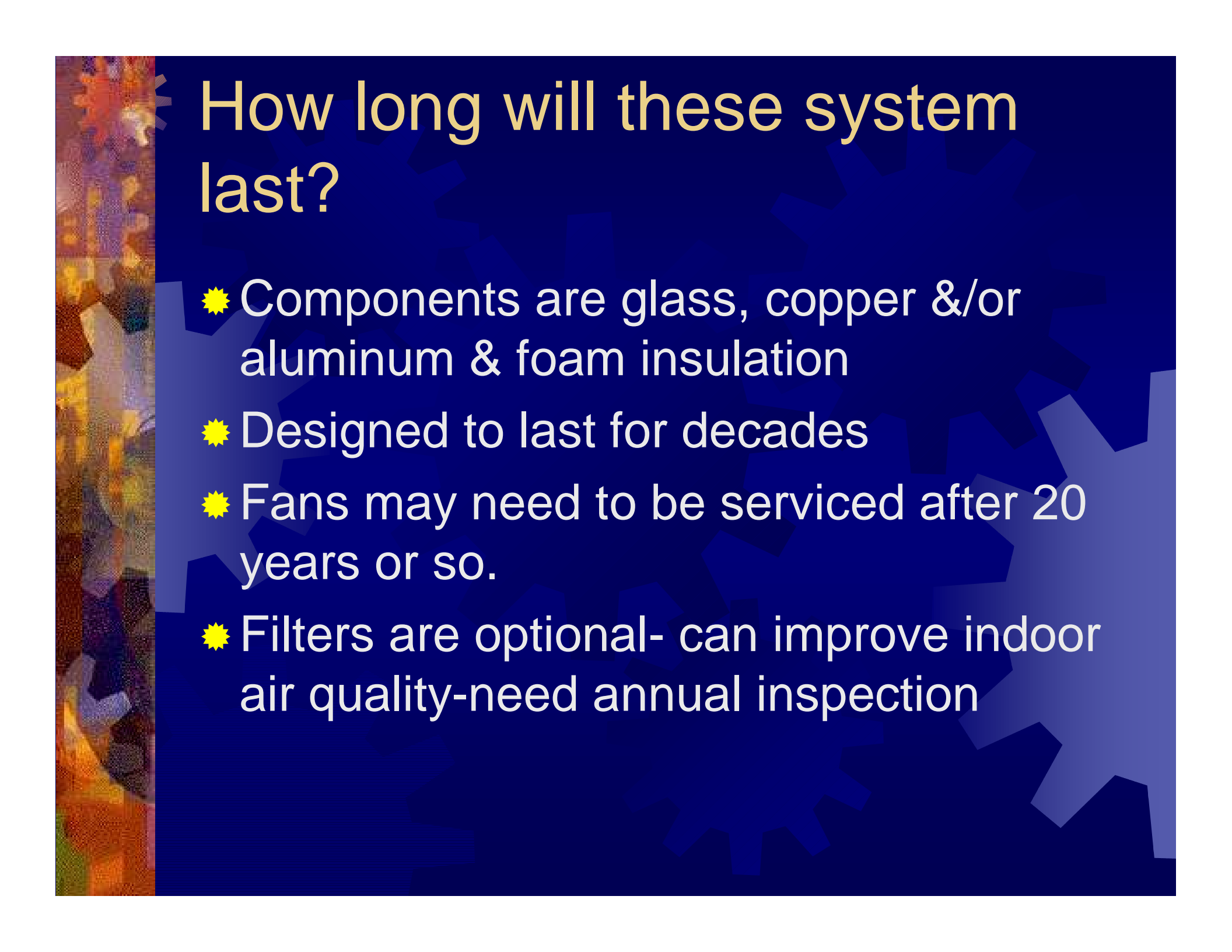
# What's the Payback?

- ☀ Tell me what price fossil fuel will be in 5 years
- ☀ Energy gets delivered free to your house
- ☀ 4 billion year record of free delivery, no shortages and no price increases
- ☀ Satisfaction of not sending money overseas
- ☀ Satisfaction of doing something to reduce carbon footprint
- ☀ Security of controlling part of your energy costs for next 25+ years

# Payback Comparisons

(compliments of RREAL in MN)

Heating bill reduction method	Initial cost	Years until savings exceed initial cost	Years savings will last
Weatherization	<b>\$3,000</b>	<b>8-12</b>	<b>15</b>
New HE furnace	<b>\$6,000</b>	<b>20</b>	<b>20</b>
Fuel Assistance	<b>\$467</b>	<b>NEVER</b>	<b>1</b>
Solar Air Heat	<b>\$4,500</b>	<b>7-15</b>	<b>25+</b>

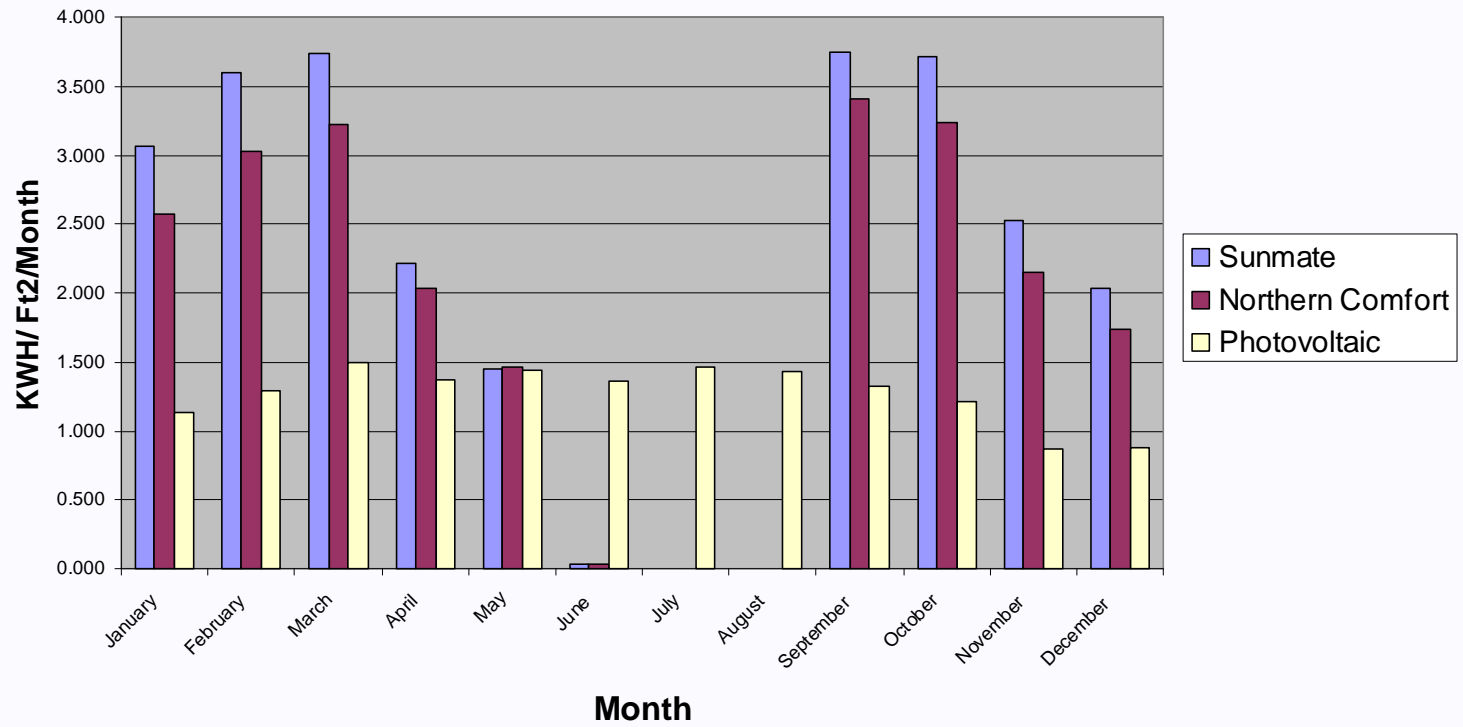


# How long will these system last?

- ✦ Components are glass, copper &/or aluminum & foam insulation
- ✦ Designed to last for decades
- ✦ Fans may need to be serviced after 20 years or so.
- ✦ Filters are optional- can improve indoor air quality-need annual inspection

# TRNSYS Data

Square Foot Output Comps 90 Deg Portland ME



# SRCC Data

- ★ Solar Rating & Certification Corporation
- ★ Tests solar thermal collectors-air & liquid
- ★ Publishes results, available online:
- ★ [www.solar-rating.org](http://www.solar-rating.org)
- ★ Rating & testing geared toward liquid collectors & systems
- ★ Air collectors are tested





# Collector Output

- ✦ Collector output or performance is reported

# Test conditions /definitions

- ☀ Collectors are tested under various combinations of light intensity or insolation described as Clear, Mildly Cloudy and Cloudy
- ☀ Clear Day conditions are defined as 2000 BTU per square foot per day.
- ☀ Mildly cloudy=1500 BTU per square foot per day.
- ☀ Cloudy = 1000 BTU per square foot per day.


# Operating Categories

- ★ Categories A-D refer to operating conditions as a function of temperature at collector inlet ( $T_i$ ) minus Ambient Temperature ( $T_a$ ) :  $(T_i - T_a)$
- ★ When hot air collectors are used in space heating mode inlet Temp ( $T_i$ ) is indoor air temperature.
- ★ Ambient is outdoor air temp.

# Categories A-D

- ✦ Category A results are for the condition when  $(T_i - T_a) = -9$
- ✦ This is generally not a condition found when air collectors are used for space heating
- ✦ When it is 9 degrees warmer outside than inside, you open the windows and doors and thank God that spring has finally arrived!



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- ✦ The following slide is a compilation of SRCC Data on the some of the rated hot air collectors
  - ✦ It also includes analysis of that data on an output per square foot of collector and percent efficiency.

	Rating conditions	Clear	Mild	cloudy		Clear	Mild	cloudy		Clear	Mild	cloudy
	BTU/FT <sup>2</sup> /Day	2000	1500	1000		2000	1500	1000		2000	1500	1000
Sunsiary	NC-32					Net Aperture		CFM	CFM/FT <sup>2</sup>			
						29.7 Ft <sup>2</sup>		178	6.0			
Category	(Ti-Ta)	Thousands BTU Per collector /day				Output- thousand BTU per Ft <sup>2</sup> day				Percent Efficiency		
A	-9	36	28	20		1.21	0.94	0.67		61%	63%	67%
B	9	30	22	14		1.01	0.74	0.47		51%	49%	47%
C	36	23	14	7		0.77	0.47	0.24		39%	31%	24%
D	90	10				0.34				17%	0%	0%
YSH	1500G					Net Aperture		CFM	CFM/FT <sup>2</sup>			
						20.41 Ft <sup>2</sup>		85	4.2			
	(Ti-Ta)					Output per Ft <sup>2</sup> day						
A	-9	21	16	12		1.03	0.78	0.59		51%	52%	59%
B	9	16	12	7		0.78	0.59	0.34		39%	39%	34%
C	36	10	6	2		0.49	0.29	0.10		24%	20%	10%
D	90	2				0.10	0.00			5%	0%	0%
ECS	Solarway 6000					Net Aperture		CFM	CFM/FT <sup>2</sup>			
						29.1 Ft <sup>2</sup>		58.2	2.0			
	(Ti-Ta)					Output per Ft <sup>2</sup> day						
A	-9	29	23	16		1.00	0.79	0.55		50%	53%	55%
B	9	23	26	10		0.79	0.89	0.34		40%	60%	34%
C	36	14	8	3		0.48	0.27	0.10		24%	18%	10%
D	90	2				0.07				3%	0%	0%
ESS	Sunmate SM-14					Net Aperture		CFM	CFM/FT <sup>2</sup>			
						17.26 Ft <sup>2</sup>		100	5.8			
	(Ti-Ta)					Output per Ft <sup>2</sup> day						
A	-9	22	17	12		1.27	0.98	0.70		64%	66%	70%
B	9	19	14	9		1.10	0.81	0.52		55%	54%	52%
C	36	15	10	5		0.87	0.58	0.29		43%	39%	29%
D	90	7	2			0.41	0.12			20%	8%	0%

# Examples

- ★ You keep your home indoor temp at 65 F
- ★ It is 35 degrees outside
- ★  $T_i=65$   $T_a=35$   $(T_i-T_a)=30$
- ★ This puts you between Category B and C
- ★ Using an NC-32 for the example clear day output would be between 23 and 30 thousand BTU's per day Per collector.
- ★ Percent solar efficiency would be between 39% and 51%



# Preheating Ventilation air

One of the new dictums of energy efficient building is “ **Build it tight—ventilate right**”

Ashrae 62.2 suggest the average house should be bringing in 75 cfm continuously.

All this air needs to be heated to the desired room temperature



# Efficiency in preheat mode

- ★ Ambient air is brought through inlet
- ★  $T_i - T_a = 0$
- ★ Collector is operating at its highest practical efficiency
- ★ Halfway between Cat A & B
- ★ Clear day output is ~32,000 BTU/ day