SolarWall with Heat Recovery Systems

SolarWall® solar heaters are ideally suited for preheating fresh air required in buildings. Heat recovery ventilators (HRV) and heat wheels are designed to recover heat from exhaust air to also preheat fresh air. Designers have asked whether the two technologies can work together and, if so, what economic and technical issues need to be addressed.

The answer to the first question is yes, solar perheating of the air to HRV's is common and, in fact, offers unique benefits for both solar heating and heat recovery technologies.

There are several types of air-to-air heat/energy recovery devices available such as fixed plate, run-around, energy wheel, heat pipe and direct contact. A schematic layout for an air-to-air heat/energy recovery device in counter-flow is shown in Figure 1. The air flow layout is similar for plate, regenerative wheel and heat pipe energy recovery devices; two inlet airstreams, the building supply and the building exhaust airstreams, are joined together side-by side using an indirect coupling. Run-around and direct contact systems use a liquid coupling scheme that allows the exhaust and supply heat exchangers to be separated by large distances. The method used to couple the two airstreams is the primary means of characterizing each type of energy recovery device.

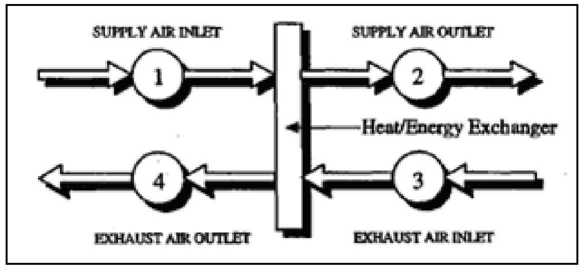

Figure 1 - Scheme for air counter-flaw in air-to-air heat/ energy exchangers.

Advantages of Solar Preheating

- Free renewable energy source
- Typical day time supply air heat gain is 5° to 30° K
- No additional fan requirements
- Low pressure drop heat exchange (25 to 60 pa)
- No maintenance
- No moving parts
- 30+ year life expectancy
- Displaces space heating load during Spring & Fall
- Qualifies for solar energy grants and tax credits
- Provides dynamic insulation value of up to R 50
- Perforated wall panel acts as primary filter eliminates need for wall façade material in new construction

Disadvantages of Solar Preheating

- Primarily a day time energy source
- Requirement for auxiliary heat source
- Requires damper for summer bypass
- Higher initial cost in retrofit

Advantages of Heat Recovery Systems

- Preheats incoming air during heating season
- Precools incoming air during cooling season
- 24 hour a day operation

Disadvantages of Heat Recovery Systems

- All exhaust air must be ducted to supply air location
- Requires warm exhaust air
- Requires space heaters to supply additional heat
- Requires multiple units for large air volumes
- Requires additional fan for exhaust side
- High pressure drop for both fans (50 to 400 pa)
- Semi-annual maintenance
- Moving parts with energy wheels
- Frosting problems in cold climates
- Cross air contamination possible with energy wheels
- Susceptible to dirt buildup on heat exchanger
- High initial cost
- Does not qualify for solar energy grants or tax credit

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It is obvious that both solar preheating and heat recovery devices have advantages and disadvantages. There is actually a synergistic solution by combining the two technologies.

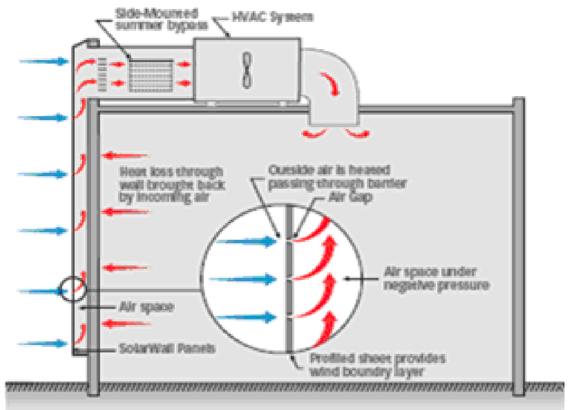

Figure 2 - Solar preheating air for Heat Recovery/HVAC

Advantages of Solar Preheating Air for HRV's

- Solar preheating virtually eliminates day time frosting problems with HRV's
- SolarWall prefilters air before reaching HRV which lowers filter maintenance/replacement
- Solar heating HRV combination can provide up to 100% of day time ventilation heating needs
- Solar heating HRV combination may be eligible for renewable energy grants or tax credits
- Solar preheating allows usage of lower efficiency and lower cost heat exchangers

According to a 2005 report prepared by Enermodal Engineering for Natural Resources Canada, titled "Comparison of Combined SolarWall + HRV System with SolarWall Only and HRV Only Systems" (for residential systems) "The Solarwall™ system provides the same heat energy whether it performs on its own, or in combination with the HRV. The HRV provides the most savings when operating on its own, and its energy recovery is reduced by approximately 80% when combined with the Solarwall™. The energy savings of the combined system is higher than either system alone, but less than the sum of the individual systems."

Fort Smith Recreation Centre NWT
In 2000 a combination SolarWall and HRV was installed at the Fort Smith Recreation Centre located in Fort Smith NorthWest Territories. The ventilation air heating system was monitored over 22 months from May 2000 to March 2002 by Enermodal Engineering with funding from Natural Resources Canada.

The report concluded that the SolarWall and HRV combination contributed 78% of the total energy needed for ventilation air heating over the monitored period. These results indicate that the combined SolarWall/HRV system provided a greater reduction in fuel oil usage than either could provide alone. The total volume of oil displaced over the monitored period was 6369 liters.

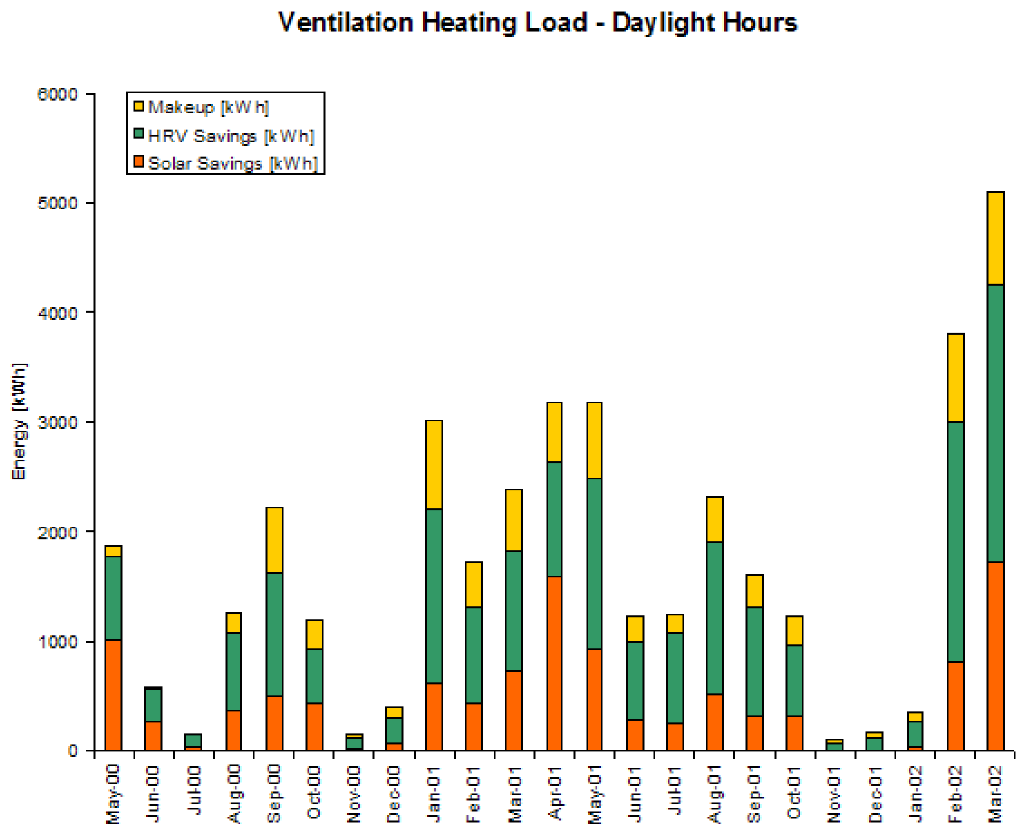

Figure 3 - Monthly Summary Chart for May 2000 to March 2002

Figure 3 shows the measured daytime ventilation air-heating loads by month. The total height of each column represents the monthly daytime ventilation-heating load (i.e. the ventilation-heating load occurring during daylight hours for the month). If there were no SolarWall or HRV, this is the amount of heat that would have been provided by the conventional building-heating system (using fossil fuels) for daytime ventilation. The bottom portion of each column shows the contribution to the daytime load from SolarWall (i.e. the amount of energy saved by SolarWall). The middle portion shows the contribution to the daytime load from the HRV system. The top portion shows the remainder of the load that was made-up by the building heating system (i.e. makeup air-heating).

Figure 4 - Photo of grey SolarWall panels on wall of gym

As shown in Figure 3, the ventilation-heating load varied considerably over the monitoring period, but remained significant even during the summer months due to the northern location of the Recreation Centre. Figure 3 shows that the ventilation system was not operating for most of November and December (of both years) and the solar energy contribution at these times is very low. However, when the monthly load is large and the solar resource is available, solar energy can contribute up to 50% of the total load (as in April 2001).

The solar energy contribution peaked for the month of March 2002, coincident with the largest monthly ventilation load. The load was particularly high for February and March 2002 since the system operated almost continuously and with low outdoor air temperatures (averaging –10 °C to –12 °C).

Table 1: Two-Year Performance Summary

	DAYTIME		NIGHTTIME		TOTAL	
	[kWh]	[%]	[kWh]	[%]	[kWh]	[%]
Solar Savings	11376	30%	2042	6%	13418	19%
HRV Savings	19652	51%	22413	69%	42064	59%
Make-up Heating	7500	19%	7911	25%	15411	22%
Ventilation Heating Load	38527	100%	32366	100%	70893	100%

Table 1 provides a summary of the performance of the SolarWall/HRV system over the 2-year monitoring period.

The SolarWall heater contributed 30% of the daytime ventilation-heating load over the monitoring period. For the nighttime ventilation-heating load, SolarWall contributed 6%. This nighttime contribution can be attributed to the recapture of building envelope heat losses by the air in the SolarWall plenum. Overall, SolarWall reduced ventilation air-heating load by 20%.