Solar Ventilation Preheating

A Special Sun-Absorbing Wall Helps to Heat Ventilation Air

The sun’s energy can be used to warm outside fresh air before it enters a building’s ventilation system. The outside air is warmed as it flows through tiny holes in a dark-colored, south-facing wall that is highly efficient in absorbing solar heat. This sheet-metal wall—or solar collector—is unglazed, which means that it is not covered by glass. And because glass reflects about 15% of the sunlight striking it, an unglazed system allows more sunlight to be absorbed.

The solar wall is mounted several inches from the building’s outer wall. As the air is warmed, it rises in this space between the two walls and is drawn into the building’s air-duct system. Additional heating required to bring the preheated air to the desired interior temperature is supplied by the building’s heating system. During the cooling months, the intake air bypasses the collector, which prevents the air from being warmed.

These systems have efficiencies on the order of 75%, making them the most efficient solar heating systems available. Any heat that escapes through the building’s main wall is captured in the space between that wall and the solar collector wall. Also, the preheat system prevents inside air from becoming stratified vertically into warmer and cooler layers. The preheated air is warmer than the ambient outside air, but cooler than the room-heated air. So it tends to sink, which causes beneficial mixing of the room’s air.

Using solar energy to preheat intake air for a building’s ventilation system provides numerous advantages:

- Preheats intake air by 30° to 50°F, reducing annual heating costs by $1 to $3 per square foot of collector wall, depending on the type of fuel used.
- Requires virtually no maintenance because of its simplicity: there are no liquids and no moving parts other than the ventilation system fans.
- Improves indoor air quality, adding to occupant safety and comfort, because better air flow is a key aspect of the system; the air delivery system used with the solar collector increases air mixing.
- Can be added on or designed as part of a building’s facade: Solarwalls®, a commercially available product, uses attractive, dark-colored metal sheeting.
- Allows for a smaller-sized heating system, which is less expensive, because the incoming air is already heated significantly above ambient temperatures.
What are the opportunities?

Solar ventilation preheat systems are practical for various building types and situations:
- Industrial and commercial buildings with large ventilation requirements
- Major manufacturing plants
- Storage facilities handling materials requiring continuous ventilation (e.g., chemical storage buildings)
- Laboratory facilities
- Animal-care facilities
- Motorpools
- School gymnasiums and high-rise apartments requiring corridor ventilation
- Central-heating plants or industrial furnaces for preheating combustion air
- Warehouses for drying crops.

What is required?

Heating applications that benefit the most from solar ventilation preheat typically involve buildings with sufficiently large ventilation loads (makeup air rates) and south-facing walls large enough for the required collector area. The solar wall can be designed as an integral part of a new building or can be added as a retrofit project. Retrofit expenses are minimized because a solar collector does not require much mechanical equipment in addition to the existing heating, ventilation, and air-conditioning system.

Several factors are important for assessing the practicality of solar preheat:
- The south-facing wall must have enough surface area to mount the collector in an aesthetically pleasing way—based on the rule of thumb that 1 square foot of collector area will heat 4 to 10 cubic feet of air per minute.
- Recovering building heat with heat exchangers is often not a cost-effective option, because the ventilation system usually has no centralized return ductwork. Office buildings generally are not ideal candidates for this technology.
- The building should have a relatively long heating season; that is, solar ventilation preheat works well in relatively cold climates.

What does it cost?

The cost-effectiveness of this technology depends on the fuel type and local utility costs. For retrofits, projects exist in which the solar collector pays for itself within 6 to 7 years. Almost the entire expense of a retrofit is in the capital cost of the collector and any air-distribution ductwork necessary to connect the collector to the existing ventilation system. For new construction, there are examples of projects having a payback of less than 3 years.