Renewable Energy Technologies for Federal Facilities

FEMP
FEDERAL ENERGY MANAGEMENT PROGRAM

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.

This solar collector preheats ventilation air for a hanger at the Fort Carson Army Post near Colorado Springs, Colorado.

U.S. Department of Energy

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

What are the important terms?

Make-Up Air—the air drawn into the intake ducts of a ventilation system to be used for heating, cooling, or ventilating a building's space.

Plenum—the space between the perforated metal wall and the main building wall.

Stratification—occurs when cool air sinks and settles near the floor, and warm air rises and settles near the ceiling.

Transpired—refers to the movement of air through the small holes in the solar wall. The perforated wall is also called a transpired solar collector.

Unglazed—refers to the absence of glass or plastic covering on the outside of the perforated wall.

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.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

FEMP

FEDERAL ENERGY MANAGEMENT PROGRAM

For More Information

For technical information on solar ventilation preheating, contact:

Charles Kutscher
National Renewable Energy
Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393
(303) 384-7521

Peter Lowenthal
Solar Energy Industries Association
122 C Street, NW, 4th Floor
Washington, DC 20001
(202) 383-2600

To inquire about renewables design assistance available through FEMP, contact:

Nancy Carlisle
National Renewable Energy
Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393
(303) 384-7509

FEMP Help Line: 1-800-566-2877

Fax: 1-202-586-3000

Internet: <http://www.eren.doe.gov/femp>

12
6-28-96
250

Produced for the U.S. Department of Energy (DOE) by the National Renewable Energy Laboratory, a DOE national laboratory

DE96007883

DOE/GO-10096-268

A revision of NREL/TP-472-7029

May 1996

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste

DISCLAIMER

**Portions of this document may be illegible
in electronic image products. Images are
produced from the best available original
document.**