CADDET renewable energy
IEA
OECD

Solar Wall Provides Economic Heating and Ventilation

Summary

A low-cost, high-performance solar "transpired air" collector saves over $4,300 (where $ is the US dollar) in annual energy costs at the Leadville Water Treatment Plant in Colorado, USA. The system provides space heating and preheats air for ventilation heating at an altitude of about 3,000 m. It is designed for outside temperatures as low as –29°C. The plant is housed in a 1,171 m^2 metal building together with equipment and chemicals used to treat contaminated run-off from the Leadville Mine Drainage Tunnel. The facility includes a process area, chemical storage and a control room.

Highlights

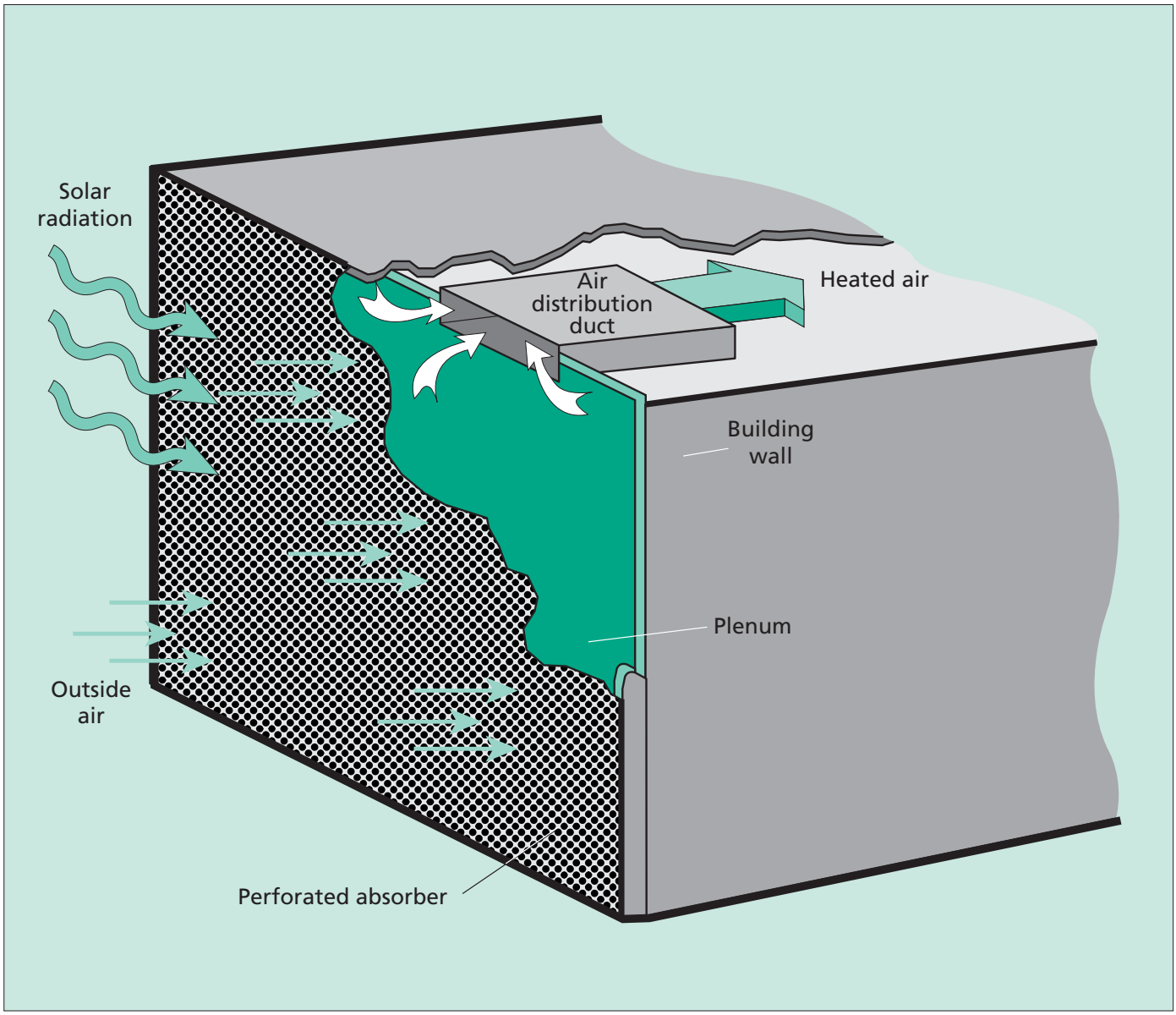
- **Cheap source of preheated ventilation air**
- **Energy savings worth over $4,300/year from this application**
- **Suitable for all large commercial buildings**

Leadville Water Treatment Plant, Colorado.

Project Background

Many industrial and commercial buildings require large amounts of ventilation air to maintain adequate indoor air quality, and heating the incoming air can be expensive. An unglazed, transpired solar air collector system, known as Solarwall®, developed by Conserval Systems, Inc and refined with assistance from the National Renewable Energy Laboratory, offers a simple, cost-effective solution.

A transpired air collector system consists of a dark-coloured metal absorber plate perforated with many small holes through which outdoor air can pass. The absorber is installed on the south-facing side of a building and heats up when exposed to sunlight. A fan draws air through the holes, and the solar energy is transferred to the air, preheating it by as much as 28°C. Convective heat loss is minimised by the continual flow of fresh air towards the absorber. Radiative heat loss is also relatively low, because the flow of outdoor air through the absorber keeps the absorber temperature within a few degrees of ambient air temperature.



How Solarwall works.

The Project

The Leadville Water Treatment Plant is located in a very cold region and water from the mine flows through the building at a rate of 126 litres/second at a temperature of 7°C, constantly drawing heat from the air. The building therefore has to be heated all year round and the plant also requires a large volume of air to ventilate noxious vapours from chemicals used to treat the contaminated water. These conditions made the plant a particularly suitable application for transpired air collectors.

The plant's original space heating system consisted of twelve 5 kW electric resistance heaters, and a gas-fired make-up air system provided ventilation. Before the Solarwall was installed, the building was often so cold that plant personnel had to work in heavy clothing, despite the heaters running continuously. The transpired air collector installation is designed to maintain an indoor temperature of at least 13°C so employees no longer have to dress so warmly inside the plant.

The installation consists of: a dark bronze-coloured, unglazed Solarwall® transpired solar air collector, 162.8 m^2 in area with a 22.5 cm plenum and 1.6 mm perforations; a 3.7 kW, 1 bar, 4.7 m^3/s fan; and 37 m of ducting. The Solarwall panels are made of 24-gauge galvanised steel. A mechanical timer and fan temperature sensor within the Solarwall ensure that air is introduced into the building only when the wall temperature is higher than 16°C. The Solarwall is installed on a south-southeast-facing wall, 28° off true south, with good solar exposure. The fan, mounted at the top of the collector wall, pulls outside air through the absorber perforations and distributes the warmed air through flexible ducts mounted near the ceiling.

The system is virtually maintenance-free except for an occasional need to oil the fan. The electric resistance heaters were replaced with four natural gas-fired radiant space heaters in autumn 1999. Each new heater is rated at 38 kW but is expected to produce only about 29 kW at this altitude.

The system is equipped with recirculation and summer by-pass dampers; however, the designers subsequently decided that dampers are probably unnecessary in such a cool climate. Automated controls are needed to maximize the Solarwall's efficiency and the fan must be sized accurately to ensure efficient operation, especially at high altitude.

The project is operated by the US Bureau of Reclamation and was installed in collaboration with the Federal Energy Management Program (FEMP).

Performance

The Solarwall absorber is an effective solar radiation-to-air heat exchanger with no transmission losses, small radiant heat losses and has an efficiency of 70% or higher. Operating at 70% efficiency (based on the incident radiation), the Leadville Solarwall installation produces about 768 GJ/year.

Two modifications improved performance. Bureau personnel replaced the original 2.2 kW, 1 bar, 3.6 m^3/s fan with a larger model when they discovered that they could not achieve the fan's specified output of 3.6 m^3/s at an altitude of 3,000 m. The new 3.7 kW, 1 bar unit is rated at 4.7 m^3/s. Adding a mechanical timer and moving the fan temperature sensor inside the Solarwall also improved the system.

Economics

The project cost of $31,000 was shared between the Bureau ($16,000) and the FEMP ($15,000). Hardware cost $16,000 and installation and construction drawings totalled $15,000. Electric heating costs averaged over $4,000/month over the course of a year, with gas costs for warming the ventilation air averaging more than $350/month in winter.

Energy savings are estimated at $3,057/year based on an annual output of 768 GJ and 70% Solarwall efficiency. The installation will pay for itself through energy savings in about 10 years, and is expected to last for at least 20 years.

Environment

Made of recyclable galvanised steel, the Leadville Solarwall installation demonstrates a number of environmental benefits. The new gas heaters produce fewer emissions than the coal plant which generated electricity for the old heaters. By avoiding the use of power generated mainly (95%) from coal-fired plant, the Solarwall will prevent an annual release of around 211 tonnes of CO_2, 724 kg of NO_x and 476 kg of SO_x. By offsetting the use of natural gas for heating, the Solarwall avoids annual emissions of around 39 tonnes of CO_2, 30 kg of NO_x and 13 kg of CO.

Host Organisation
US Bureau of Reclamation
PO Box 25007
Denver, Colorado 80225, USA
Contact: Harry Remmers
Tel: +1 303 445 2261
Fax: +1 303 445 6353

Equipment Supplier
Conserval Systems Inc
4254 Ridge Lea Road, #1
Buffalo, New York 14226–1016
USA
Contact: Richard A Grainger
Tel: +1 716 835 4903
Fax: +1 716 835 4904
E-mail: conserval@aol.com

Information Organisation
NREL
1617 Cole Boulevard
Golden, Colorado 80401–3393
USA
Contact: David Warner
Tel: +1 303 275 4373
Fax: +1 303 275 3619
E-mail: david_warner@nrel.gov

Please write to the address below if you require more information.

CADDET Centre for Renewable Energy
ETSU, 168 Harwell, Didcot
Oxfordshire OX11 0RA
United Kingdom
Tel: +44 1235 432719
Fax: +44 1235 433595
E-mail: caddet.renew@aeat.co.uk

International Energy Agency
The International Energy Agency (IEA) is an autonomous body which was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

Printed on environmentally friendly paper.

CADDET
CADDET was set up in 1988 as an IEA Centre for the Analysis and Dissemination of Demonstrated Energy Technologies. Today, there are two CADDET operations: one is for energy-efficient technologies and the other for renewable energy technologies. The Centres co-operate with member countries in the exchange of high quality information on energy technologies.

See the whole range of CADDET Renewable Energy projects on www.caddet-re.org

US 95 507 First printed: March 2000