ENERGY
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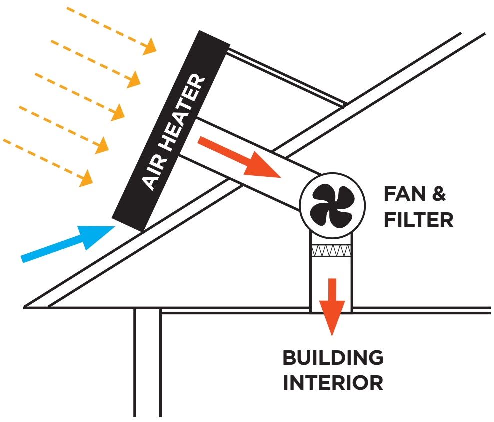
Solar Air Heating and Ventilation

Introduction

Solar air heaters convert incident solar radiation into heat. In addition to heating, these systems deliver fresh air and cooling (at night) into the building meeting the ventilation needs of highly sealed, high star rated residential buildings.



Solar air heater and fan configuration.

A commonly used configuration of an (outside) air heater is shown above. Ambient air passes through the collector and the heated air is directly delivered into the building for heating and ventilation. A fan is normally used to deliver the required heat into the building. A filter and ductwork make up an air heating and ventilation system. Unlike a liquid collector, air heaters do not require plumbing and have no freezing issues.

Some air collectors have an outer transparent cover designed to minimise heat loss. These are known as glazed collectors and are more common in Australia. Collectors can operate in an open loop (taking in fresh air) or in a closed loop (recirculating building return air). Open-loop systems deliver ventilation benefits. These collectors normally operate in the range of 20–45 °C outlet temperature.

In Australia, most collectors are designed to be installed on standard roofing. Similar to other solar systems, air collectors are installed at a tilt angle approximately equivalent to the latitude of the location. Façade or wall integrated air collectors are used mostly in Europe and the USA.

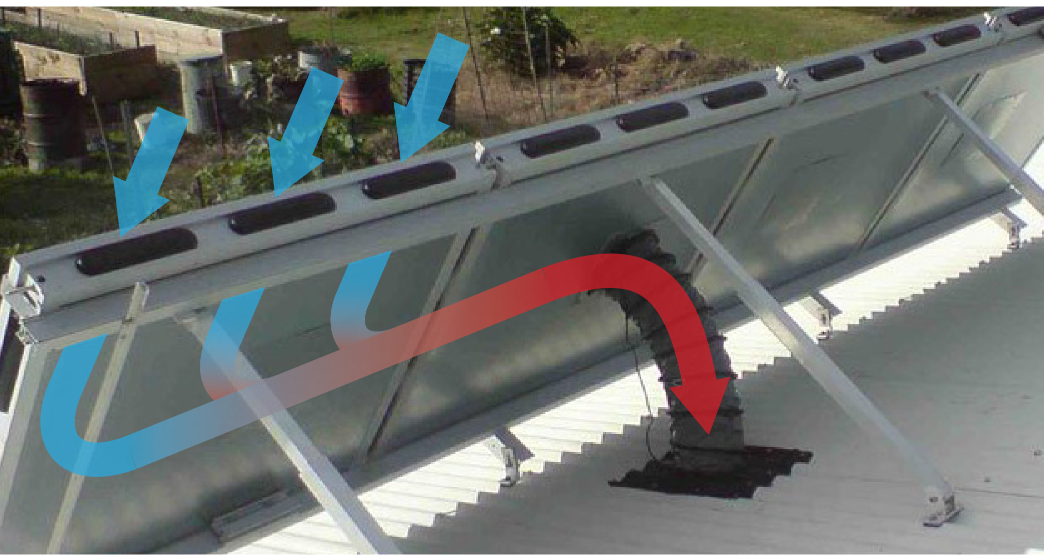
It is estimated that there are over 20,000 installations of solar air heaters, roof ventilators or hybrid systems in Australia. Glazed air collectors typically cost between cost between \$300 - \$600 per m^2. They are simple to install, and installation cost is dependent upon the roof conditions.

Potential applications include:

- Residential space heating and ventilation, specifically for areas such as basements and rooms without access to sunlight.
- Space heating and ventilation for schools and aged care facilities.
- Wall or façade mounted systems for commercial and industrial space heating.

Points to consider before installing a solar air heating system

- Whether the system provides fresh air ventilation modes during summer and/or winter.
- Power consumption is typically very low. Some systems use a small photovoltaic panel to provide power.
- Systems work best when allowed to operate automatically.
- Most systems don't store energy and so can't provide heating at night. However, they can warm the house during the day so that it's more comfortable in the evening.
- Systems should last much longer than conventional air-conditioners, but always check the manufacturer's warranty.



Air is drawn through the heated panel before being filtered and introduced into the building via ducting and a fan, warming the home and driving out mould and damp.

Performance parameters

Collector heat gain

Heat energy delivered by the collector is dependent on the temperature gain across the collector and the flow rate handled by the collector. If the building heating load requirement is known, this metric can be used to estimate the number of collectors required to maintain indoor conditions for a given area. Due to low thermal capacity of air (compared to water), air collectors need to handle large volumes of air to deliver heat into a building.

Electrical energy use efficiency

- Forced ventilation air collectors use a fan to circulate air through the collector and distribute the air inside the building. Their electricity consumption is dependent on the pressure drop and the volume of air handled.
- The ratio of heat delivered relative to the electrical energy used in the system is known as the coefficient of performance. Using only 1 unit of electricity, air collectors can distribute over 10 units of heat into the building.
- Thus the Coeffficient of Performance (COP) of solar air heaters can be 10. This metric can be used for comparing energy saving benefits of this system compared to other heating solutions that use electrical energy, for example an air conditioner.
- AS5389 (interim standard currently undergoing revisions) provides a test method for estimating the annual performance and energy savings from air heaters. The testing approach in the standard is similar to ISO 9806:2013.
- Due to their energy efficiency, these systems may be eligible for initial cost rebates.

Application suitability

Global operational experience with solar air collectors show typical benefit scenarios for a few applications.

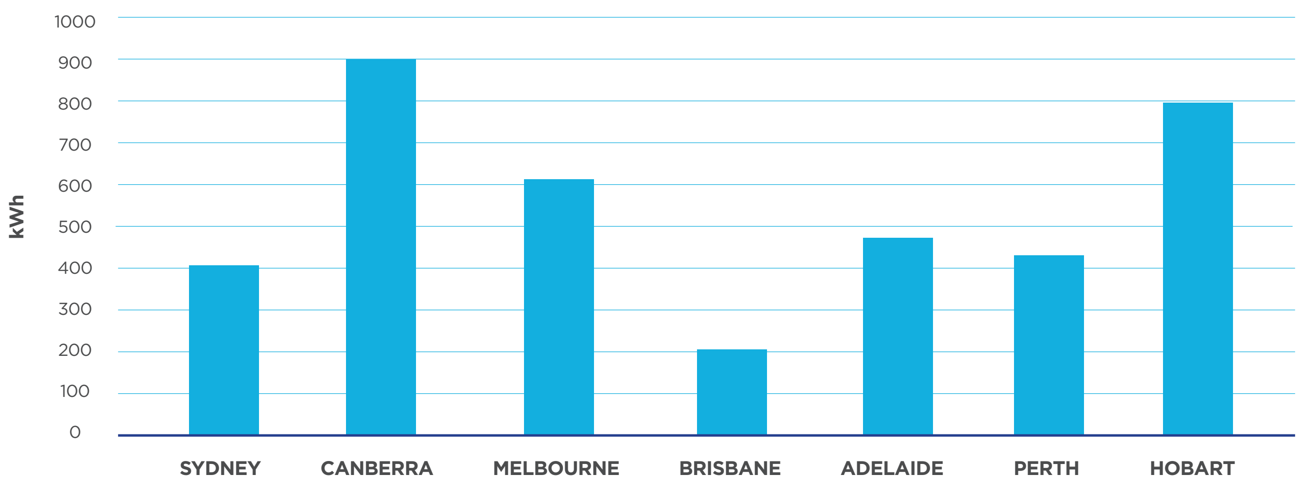
- Facilities with day-time operation such as schools and day-care facilities are ideally suited to solar air heating. Solar air-heaters can be used to pre-heat the fresh air to conventional heating systems to reduced heating costs.
- Better heat distribution: solar air heaters can deliver heating to locations in a building that have no scope for passive heating during the day (e.g. rooms with no windows or rooms facing south).
- Maintain interiors: the supply of warm air into the building can dry out moisture and prevent mould growth in walls.

CSIRO has developed a pre-design tool to help home owners benefit from a solar air heating system. This work is supported by the Australian Renewable Energy Agency (ARENA). The tool is available on the AIRAH website at:

https://www.airah.org.au/PUSCH

AIRAH

Indicative annual heat delivered from a 4m² glazed collector



Case study

System installation

Solar heater and ventilation systems were installed on two houses in Sydney dwellings for study and monitoring. The systems operate year round delivering warmth during winter months and fresh air ventilation during summer months.

Install details

- Retrofit application into already existing forced ventilation units.
- Collectors installed in the roof with ducts connected to a 130W fan unit mounted in the roof cavity. Air flows through a 0.3 micron filter into the building.
- System installation time: 3 hours (technician qualified to work on roof required).
- System draws external air through collector heated by solar radiation to deliver space heating.

Additional sensors installed for monitoring include:

- Ambient/room/collector outlet temperature
- Air flow rate
- Power consumption
- Incident solar radiation on collector.

"There is no mold growth now. The house feels warm."

(Occupant comment)

System performance

- One annual cycle of operation.
- Control settings reconfigured based on observations.
- Typical winter operating data for Northern facing collector (shown below).
- Temperature gain across the collector ~15°C with an outlet temperature of ~32.2°C at peak solar gain, ambient air between 13–17°C during the day.
- Unit operation typically between 8:00 am and 4:30pm.

Year of installation	Nov 2016
Location	North Sydney ~33.7 °S, 151.3o E
Collector type	Glazed flat plate
Collector size (1 unit)	3.0m x 1m (3.0m^2)
Orientation	North (2 units), East (1 unit)
System details	Open loop system with forced circulation
Air flow rate per unit	150 litres per second nominal
Building type	Semi-detached Insulated light-weight slab on ground (house I), Free standing weatherboard suspended timber floor (house II)
Service area	~ 40 to 90 m^2 in each house respectively
Air change rate	2.5–4 per hour
System operation	A controller drives the fan operation and speed based on indoor set point temperature, ambient temperature and collector duct outlet temperature

System benefits summary

Temperature rise across the collector	Peak ~ 15.3°C
Typical heat delivered	11.5 kWh (day)
Peak heating power	1.8kW
Collector efficiency	Peak ~ 0.55 Ave ~ 0.49
System COP	Peak ~ 15.0 Ave ~ 11.1
Annual savings ($)	~$350

Observations and lessons learnt

1. Collectors are performing according to standard correlations.
2. Benefits were found for rooms that do not have north facing windows.
3. Ensure no shading during installation.
4. Eastern collectors could deliver heating during morning hours. Control set points should be adjusted.

More details of the case study, installed site pictures and the energy saving calculator can be found at: https://www.airah.org.au/PUSCH

The performance and cost numbers provided in the brochure are indicative. Actual values may vary depending upon location, type of collector etc. This work is supported by the Australian Renewable Energy Agency (ARENA).

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