Cooling with the sun

It may seem odd, but you can use the plentiful energy from the sun to cool your home. Lance Turner shows how.

Depending on where you live, and the style, design and orientation of your home, you may need a bit more cooling on hot summer days than passive methods such as window shading and roof insulation can provide.

Active cooling usually involves using an energy source of some sort to produce the cooling, whether it just be moving hot air out of the house, or fully-active cooling such as refrigerated air conditioning. That energy source is usually in the form of electricity, but with ever increasing electricity costs, keeping your home livable in the summer months is becoming an expensive proposition.

But that energy need not come from your local electricity company. There's a number of cooling methods that can be powered from the energy of the sun. The sun's energy can be used in either the form of direct heat, or sunlight can be converted into electricity and that electricity be used to power the cooling system.

This house in Spain has a Climate Well solar air conditioner. The same system is also available in Australia.

Ventilation

The simplest cooling system is ventilation. In many cases, providing adequate ventilation to the roof cavity of the home will reduce heat flow into the living space to such a degree that no other cooling will be needed.

Passive roof vents are not usually up to the task, as you need to change all of the air in the roof space around once every 10 minutes to keep ahead of the heat. Wind-powered vents rarely move enough heat to have much effect and are often least active when needed most, such as on hot, still days.

The most easily installed sun-powered ventilation is the solar ventilator. These are manufactured by a number of companies but are all similar. They consist of a solar panel, usually in the 10 to 20 watt range, directly coupled to an electric fan inside a roof vent cap. The concept is simple—the more sun, the hotter the roof cavity, but also the faster the solar fan runs and the more hot air it extracts from the roof. This makes them very well matched to the amount of heat needing to be removed.

There are several brands of solar roof vents, including the Solar Whiz from Global Eco Solutions, the Solar Star from Solatube and the Maestro from Edmonds. Prices for these vents are generally under $1000 and in many cases you may only need one or two fans to reduce the temperature in the roof cavity by 20°C or more on a hot day, which will make a big difference to the temperature inside the home.

An important aspect of roof ventilation is the installation of vents in the eaves or in walls low down in the roof cavity. After all, you can't extract hot air efficiently if cooler air can't flow in easily to take its place. Inlet vents need to be placed so that there is as much cross flow as possible in the roof so that the entire roof cavity is ventilated.

Solar vents can do more than vent out the roof cavity. You can use ducting to allow the vent to extract hot air from the living space itself. For homes where hot air accumulates on upper floors or in cathedral ceilings, this can also considerably reduce the overall temperature. However, in this case, there must be a suitable source of cooler air that can replace the hot extracted air. This cooler air may come from under the house or even through an earth tube system. Earth tubes consist of arrays of metal, ceramic or plastic pipes buried in the ground. Air is drawn through them into the house and is cooled on its way through the pipes. An article on earth tubes appeared in *ReNew 110*.

Solar powered vents are the simplest solar cooling available, but there are much more complex—but not necessarily more effective—systems on the market.

Solar collector systems

These broadly fall into two groups—ones that use the entire roof cavity as heat collectors, such as the HRV systems, and ones that have externally mounted solar box collector panels, such as the Solar Venti. Note that HRV the brand should not be confused with HRV the acronym, which stands for Heat Recovery Ventilation. This is where heat from the outgoing air is recovered and introduced into the cold incoming air in winter (and the reverse in summer) in order to reduce energy costs.

Both whole-of-roof-cavity and solar collector systems are used primarily as air warmers/dehumidifiers for the cooler months, but they can usually be used to exhaust hot air from living spaces during hot evenings, giving them some level of cooling ability. However, in this mode they are really just exhaust fans, and if you are considering installing one primarily for its cooling ability, you would be better off with simple exhaust fans or solar fans.

Filtration is often used on whole-of-roof-cavity systems to prevent contaminants from the cavity, such as dust and insulation glass fibres, from entering the home. External panel systems may or may not have filters—as they draw air from outside, filters may not be needed in many instances.

Effectiveness of these systems varies, but when used in a well insulated and sealed house, they can make a significant difference to the temperatures inside the home in both winter and summer—but they must be used in energy efficient homes to be effective. Energy consumption of these systems is low, as they are generally just powering fans, and in some cases, such as the Solar Venti, those fans are solar powered, so there are no running costs at all.

Air conditioning

If your house has been well insulated and sealed, appropriate shading installed and yet it still gets hot (you might live in an extreme environment such as central Australia), then you might have to resort to some form of air conditioning.

Evaporative air conditioners work well in drier climates, and because their main energy use is for the large internal fan, continuous power consumption can be only a couple of hundred watts or even less. This level of power is easily supplied in the form of solar panels. However, you would rarely attempt to drive such a system directly; normally you would install a grid-interactive system (or an independent system if you don't have mains electricity) with enough capacity to offset the air conditioner's energy use. This makes it a solar powered air conditioning system, even if it is in an indirect manner.

Calculating the solar array required is simple, but you have to decide if you want to offset the air conditioner on a daily basis (do you want to produce as much energy each day as the air conditioner uses, even though it is not used every day) or on a yearly basis (as you won't use the air conditioner in winter, you can use a smaller solar array and accumulate 'credit' towards the summer energy use). It all depends on how you want to look at it.

As an example, if your air conditioner uses an average of 200 watts for eight hours a day for 40 days a year, then you would be using 64kWh per year for your air conditioning. This means that, using an annually averaged sun-hours per day figure of 3.5 (typical for Melbourne), you would need a solar array of 64/(365 x 3.5) = 50 watts—a rather small solar power system!

However, to offset it daily, then you would need to generate 0.2 x 8 = 1.6kWh. This would mean that you need an array of 1.6/3.5 = 0.46kW, or 460 watts.

These figures are assuming no losses elsewhere in the solar power system of course, but they are a good guide.

If you prefer (or require because you live in a humid climate) a refrigerative air conditioner, then you can also offset your energy use using a solar array. These types of air conditioners use a lot more energy than evaporative systems and so will need larger solar arrays to offset them, but the methodology is the same. However, as they have a variable energy consumption rate due to compressors being turned on and off (or varying in speed with the newer inverter units) then you need to monitor the energy used by the air conditioner to get an accurate idea of energy use. You can do this with either a plug-in energy meter such as the PowerMate, or an energy meter wired into that circuit in the circuit breaker box (you need an electrician to install the latter).

You also need to make sure you buy the most efficient air conditioner avail-

This is a cut-away of the Solar Star solar vent. Solar vents are simple and effective.

able that will suit your purposes. For an easy comparison of all models currently available use the Energy Rating website at www.energyrating.gov.au

DC air conditioning

Other forms of solar air conditioning also exist. For instance, Securus of California make split system refrigerated air conditioners that run directly from 48 volt DC solar power systems, without the need for a DC to AC inverter. This eliminates one level of inefficiency that comes from running AC air conditioners from batteries in independent renewable energy systems.

The Securus systems require a minimum of 800 watts of solar panels and a 48 volt battery bank of at least 225Ah capacity.

At the time of writing, we are not aware of any similar systems in Australia. If readers know of such systems, we would love to hear about them!

Other developments

Now that we have considered the more common options for cooling, let's look at some slightly newer ideas.

One idea that has been developed and redeveloped many times over is solar thermal air conditioning—that is, air conditioning powered directly from the heat of the sun.

There are several systems in use, one of which involves the use of dessicants to produce dry air for more efficient evaporative cooling. The dessicant is then 'regenerated' (the moisture driven off) by the use of solar heat.

More active forms of solar thermal cooling have been developed and are used in commercial installations in a number of countries.

In these systems, heat is collected using high temperature, high efficiency collectors, such as double glazed flat plate collectors or evacuated tube collectors. The collected heat is used to drive adsorption or absorption cooling units.

Absorption chillers work in a similar way to compressor-based systems in that they use a refrigerant that absorbs heat as it evaporates. The refrigerant is then converted back into a liquid using only heat, and there are no moving parts. This system lends itself well to solar use as heat is so easily collected from the sun.

Because there are a number of technologies that can be used in each stage of the solar air conditioning process, it is difficult to predict which ones will become readily available in the future. To date, most solar thermal powered cooling systems have been commercial installations in Europe and the US, although a few have found their way to Australia.

One system that is currently available in Australia through Eco Kinetics is the Climate Well system, which uses solar collectors to provide heat that operates a compressorless heat pump. It can provide hot water for general use as well as heating and cooling, and includes heat (energy) storage.

Solar collector ventilators like the Solar Venti can help exhaust hot air and also work in the cooler months as air warmers.

Hybrid systems

Hybrid systems use regular compressor driven heat pumps which are assisted by solar heat. The only system we know of is the EEGreen which combines a Toshiba high efficiency inverter air conditioner and a solar heat collection system. The suppliers claim savings of up to 65% of energy use over a regular non-solar system, depending on the operation cycle. ✲

Resources

Australian Solar Cooling Interest Group: ausscig.com.au

Australian National University solar cooling page: solar-thermal.anu.edu.au/low-temperature/solar-cooling-using-ejectors

CSIRO solar cooling page: www.csiro.au/science/solar-cooling-facilities.html

Smartbreeze: www.smartbreeze.com.au

Solar Breeze: www.solarbreeze.com.au

Solar Venti and Solar Whiz: www.ges.com.au

Solar Star: www.solatube.com.au

Climate Well: www.climatewell.com and www.eco-kinetics.com/solar-airconditioning.html

EEGreen www.eegreen.com.au

Securus: www.securusair.com

Wikipedia solar air conditioning page: en.wikipedia.org/wiki/Solar_air_conditioning