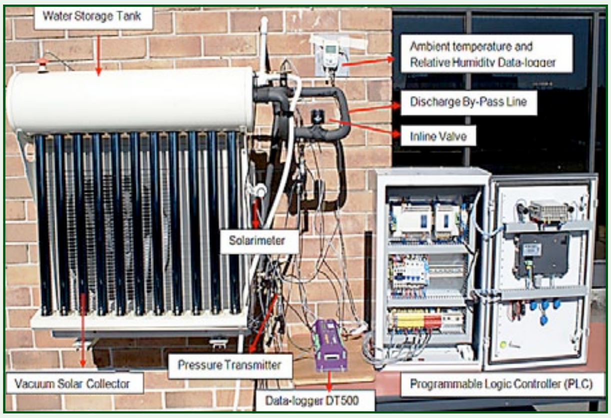
*2012 Research Seeding Grant* **$20,000**

# HYBRID SOLAR AIR CONDITIONING SYSTEMS

## *overview of the project*

Buildings are responsible for about half of the total energy consumption of our modern society, and a large proportion of this is due to the operation of heating and cooling systems. Small capacity air conditioners, although economically attractive, do not usually offer much better energy consumption levels compared to large air conditioners, due to unreliable controls. There is increasing interest amongst researchers and industry in the use of solar panels to reduce electricity consumption.

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*The experimental solar DX hybrid air conditioner and programmable logic controller device*

The University of Technology used a Research Seeding grant to test the operation of a newly developed direct expansion hybrid solar air conditioning system, to determine how to best optimise its performance and energy consumption. Direct expansion (DX) air conditioning plants are simpler in configuration and more cost-effective to maintain than central cooling plants that use chillers and cooling towers. Known as 'Green Automation' this area of research focusses on the use, control and automation technologies required to achieve reliable use of renewable energy sources and the reduction of greenhouse gas emissions.

## *how the project was carried out*

The research was carried out using an experimental solar DX hybrid air conditioner together with its programmable logic controller device. The air conditioner was installed in a 38m2 room with an external condensing unit which was combined with a solar vacuum collector.

The air conditioning system was fully-instrumented with high precision sensors to measure a variety of operating variables including meteorological parameters (solar radiation, air temperature and relative humidity), water temperature in the solar storage tank, temperature and humidity in the test room, refrigerant temperature and total power consumption of the plant. The system performance was tested under various weather conditions. Day-long tests were carried out for 24 hours with all measured data being monitored at 10 minute intervals.

The energy efficiency of a DX air conditioner is closely dependant on the thermodynamic properties of the refrigerant before and after it leaves the condensing system. The key aim of the research was therefore to minimise the temperature of the refrigerant leaving the condenser in order to increase operating performance.

## *outcomes now and in the future*

The research has tested a new design that uses a three-way valve to regulate the flow of the refrigerant depending on ambient conditions and cooling demand. During periods of low demand (when condensing temperature is low), the control valve sends the refrigerant directly through a new bypass line to the condenser. During periods of high demand (when condensing temperature is high), the refrigerant goes through the normal pathway to a copper coil inside the water tank where a heat exchange occurs.

The new design allows the system to operate at a lower temperature after the refrigerant passes through the air-cooled condenser which results in a significant increase in the overall operating performance. Furthermore, the lower refrigerant temperature leaving the condenser decreases the refrigerant temperature entering the evaporator which in turn increases the cooling or refrigeration effects. The research has concluded that optimising refrigerant temperature in solar air conditioners can result in an average power saving of 11.4% compared to uncontrolled operating conditions.

## *benefits, challenges & lessons learned*

The Research Seeding project has substantially increased researchers' understanding of the operation of solar hybrid air-conditioning systems and provided key evidence that the modified design tested is capable of saving energy and reducing greenhouse gas emissions. Two larger research projects are now being proposed to further explore the use of green automation technology in reducing greenhouse gas emissions and energy costs associated with residential air conditioning systems.

The research findings have generated interest from other research organisations including Macquarie University, CSIRO and Royal Melbourne Institute of Technology. The findings of the project have been disseminated through five conference presentations and the publication of seven scientific journal articles.

OEH 2014/0678 Published September 2014