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# CLEANTECH NEWS

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**Welcome** to QUT's May edition of CleanTech News, a regular electronic newsletter providing information concerning Clean Technologies (Cleantech) and related areas.



Cleantech and in particular clean energy generation are critical issues for our society. Whichever side of the partisan debate on carbon taxes and electricity prices you sit on, you can't deny the importance of ensuring we have an environmentally-responsible energy sector, and an environmentally-responsible manufacturing sector. QUT's focus on efficient electricity generation, effective electricity distribution and efficient end-use of energy are targeting the development of a new energy future for Queensland and Australia. Working with local industry, ranging from small start-up companies to some of our largest utilities, we are helping to transform the way energy is delivered.

This newsletter contains several examples of projects underway and concepts under development which will play important roles in our future.

### Professor Martin Betts

Executive Dean,  
Faculty of Built Environment and Engineering

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## CLEAN TECHNOLOGY TO BE A BIG PART OF QUEENSLAND'S FUTURE

The Queensland Government has moved to establish clean technology as a new industry force in Queensland. Launching Australia's first Cleantech Industry Development Strategy recently, Minister for Tourism, Manufacturing and Small Business Jan Jarratt said cleantech was one of the world's fastest-growing industries due to international concerns over global climate change and moves toward low-carbon economies.

The global market for environmental products and services is predicted to double to US\$2740 billion by 2020. The phenomenal growth of the cleantech industry worldwide was due to increasing consumer demand for cleaner products and services.

Queensland's cleantech industry generates more than \$3.1 billion annually and employs over 12,500 people. This industry includes environmental services, green building and materials, clean energy, resource recovery and recycling, sustainable transport, and water and wastewater management.

Queensland has internationally competitive strengths in sustainable water and wastewater management, green building and environmental services with major opportunities emerging in renewable energy, waste recycling and bio-based industrial products. Examples of our strengths include some major ground-breaking research into the use of renewable resources, such as algae and sugar, to produce a new generation of 'green' plastics and chemicals. Revegetation and land rehabilitation using a locally developed product which stabilise slopes quickly and other technology that controls sewerage treatment plants to prevent spillage into floodwater.

The cleantech industry in Queensland is characterised by a predominance of small businesses and a strong focus on services. The industry is also recognised as having a strong culture of innovation and entrepreneurship. With 20 per cent of cleantech businesses now manufacturing, the scene is set for future expansion.

The Queensland Government's Cleantech Industry Development Strategy is

## NEWS BRIEFS

### [Groundbreaking solar energy project announced in Queensland](#)

The Gillard Labor Government has given the green light to one of the biggest solar thermal projects in the world.

[Read more...](#)

### [5 Cleantech Trends to Watch in 2011](#)

Here are five solid trends you can likely count on for the global clean energy industry, courtesy of a new report from Clean Edge.

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### [Stan Ovshinsky's Solar Revolution](#)

His inventions from 50 years ago enabled cell phones, laptops, and flat-screen TVs. Now, at age 88, he's aiming to make solar power cheaper than coal.

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### [Will Asia Own Cleantech?](#)

The most common objection to any form of industrial policy is that governments, as opposed to markets, are considered unqualified to select those sectors most worthy of investment. But what happens when governments do pick the right targets and then back that up with the resources, influence and patience needed to guide and support these fledgling industries to long-term success?

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### [ABC's science journalism series Catalyst looks at the global oil crunch](#)

Catalyst's Dr Jonica Newby talks to experts across the globe to find out why so many industry insiders now say we'll soon look back on 2011 as the good old days when fuel was cheap.

[Watch this episode...](#)

designed to strengthen the industry by increasing its capacity to supply innovative products and services, provide new green jobs for Queenslanders, and help Queensland and the global community to address the challenges of climate change, water security and other environmental pressures.

Initiatives include an innovative network for the emerging waste recovery and recycling sector to demonstrate new technologies, a reference site program to trial green building products, and a program that brings cleantech firms together to build business capability and networks, explore investment, market and export opportunities and accelerate growth.

The Government's strategy aims to help the industry grow its revenue by 20 per cent over the next five years and create an additional 2500 jobs.

Cleantech companies wishing to discuss business opportunities in Queensland or government support programs can telephone +61 7 3225 2947 or email: [cleantech.industry@deedi.qld.gov.au](mailto:cleantech.industry@deedi.qld.gov.au)

[View full media release here.](#)

[View the Queensland Government Cleantech Strategy here.](#)

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## FATAL FLAWS MUST BE ADDRESSED IN NEW CLIMATE CHANGE LAWS

If the Federal Government is to reduce carbon emissions, it needs to learn from its previous errors in designing the failed Emissions Trading Scheme (ETS) of 2009-10, according to Dr Nicola Durrant, a leading climate change legal expert from Queensland University of Technology (QUT).



Prof. Peter Grace, Hon. Cameron Dick MP, Dr Nicola Durrant, Mr Jim Reeves. Image credit: Leon Frainey, QUT

Dr Durrant believes that while proposing a carbon tax or trading scheme is a positive step for Australia, an effective legal framework is essential to ensure that it is possible to achieve the goal of reducing carbon emissions in a significant way. One major legal flaw of the former ETS was the failure to state Australia's emissions reduction targets in the legislation, and the failure to detail a timeframe for achieving those reductions. Any new carbon pricing legislation must address this issue in the scheme's design. Appropriate medium and long-term emission reduction targets, with corresponding caps for the carbon pricing scheme, should be deep enough to contribute to global efforts to mitigate climate change.

Another significant error made by Australian law-makers in the past was the proposed offering of free carbon permits to some industry sectors. A key objective of 'carbon pricing' is to impose a duty on intensive carbon polluters to pay for the social cost of their polluting behaviours. The principal of 'polluter pays' is clearly not achieved where certain industries or sectors under the scheme are provided with free allocations of carbon permits.

Dr Durrant believes that another major error in the past was the proposal to allow an unlimited number of import credits from overseas carbon trading markets. The Federal Government is suggesting we allow the import of international carbon instruments from overseas markets after an initial three to five year period. The rules surrounding this have not been announced yet. However, with the previous ETS it was proposed that the

## [At Cleantech Forum, Investors Thinking Outside U.S. Borders](#)

In his keynote speech, Kleiner Perkins Caufield & Byers Partner John Denniston wasted little time in making the point that clean technology companies — driven by low costs and government subsidies — are booming in China, India, Korea and other locales outside of the U.S.

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## [QWESTNet's first forum in Townsville](#)

QWESTNet held its first business sustainability forum in Townsville conducted in association with Townsville Enterprise Limited on 13 April 2011. Presentations included keynote '[Environmental gains at James Cook University](#)'.

[View more from the forum...](#)

## [The Cleantech Renaissance Is Coming](#)

The growth of the cleantech industry may have started slowly, but it is surely happening.

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## [Making the business case for sustainability](#)

In 2010, the United Nations Global Compact conducted a survey on sustainability and found that 93% of businesses consider it important to their future success. But most companies also have investors to please, and — let's face it — making the business case for sustainability can be difficult.

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## [Cleantech 2.0 Is on Its Way](#)

A learning curve — it's starting to happen slowly but surely for investors in the cleantech industry. Or as Adam Grosser, former Foundation Capital partner and the lead investor of a new clean energy fund for private equity company Silver Lake, explained he thinks a cleantech "renaissance" is coming.

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## EVENT WATCH

### **CSP Yield Optimization Conference EU**

Sevilla, Spain. 31 May - 1 Jun 2011

<http://tinyurl.com/3qz2kqb>

### **QWestNET Water and Wastewater Technologies for Business**

Brisbane, QLD, Australia. 10 Jun 2011

<http://tinyurl.com/3qxck58>

### **Clean Technology Conference & Expo 2011**

Boston, USA. 13-16 Jun 2011

[www.techconnectworld.com/Cleantech2011/](http://www.techconnectworld.com/Cleantech2011/)

### **Richard Conant lecture: Agriculture and greenhouse gases**

Brisbane, QLD, Australia. 16 Jun 2011

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### **5th Annual Concentrated Solar Power Summit US**

number of imports of international offsets would be unlimited - which would be very undesirable. Unlimited offsets would undermine the cap set for the carbon pricing scheme - resulting in excess supply of carbon instruments to the market and, ultimately, lower carbon prices. Like the other potential loopholes, this would also undermine the objective of considerably reducing carbon emissions.

Dr Durrant details a comprehensive analysis of climate change laws in Australia and overseas in her book, *Legal Responses to Climate Change*. (Available through [www.federationpress.com.au](http://www.federationpress.com.au))

Las Vegas, USA. 29-30 Jun 2011  
<http://tinyurl.com/3mx9lvk>

**2011 Global Carbon Market & Green Energy Conference**  
Dubai, UAE. 10 Jul 2011  
[www.cleantech.org/events/profile/57](http://www.cleantech.org/events/profile/57)

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## 'URBAN WATER IN AUSTRALIA' REPORT WARNS CURRENT POLICIES NEED CHANGE

The Australian Government's National Water Commission recently issued a [report](#), warning "[water supplies of cities and towns cannot handle future droughts, floods and other climatic shocks](#)" under current policies. With rising water and energy costs in Queensland, there is growing pressure for businesses to reduce their overheads while gaining a competitive advantage.

The Department of Environment and Resource Management (DERM) is hosting a QWESTNet forum on water and waste water technologies in Brisbane on 10 June 2011. Held in partnership with Queensland University of Technology (QUT), the forum provides information about new sustainable practices and technologies, local case studies and the latest information to help businesses utilise their water needs more efficiently and improve their waste water recovery to improve profitability. It also provides attendees with the chance to meet and collaborate with producers and current users of sustainable technologies.

The QWESTNet forum is being held on Friday 10 June 2011 at The Pavilion, Albion (QLD). All interested businesses are invited to attend. Registration is AUD\$44.00. For more information and to register visit [www.derm.qld.gov.au/qwestnet](http://www.derm.qld.gov.au/qwestnet).

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## SOLAR POWERED NANO-SENSORS FOR REMOTE AREA DATA COLLECTION

Obtaining data from remote areas in Australia is crucial, particularly in Queensland, where sparsely populated regions are often of high economic importance for agriculture, mining operations, water supply, wildlife, and tourism. Small solar powered detectors for gases and environmental pollutants will help to control pollution, monitor crops and wildlife environment without the need of direct human intervention.

The Solar Powered Nano-Sensors (SPNS) project, funded by the Queensland State Government through the National and International Research Alliances Program (NIRAP), aims to develop a new class of gas sensors for data collection in remote areas, by using integrated nano-materials, powered by state-of-the-art solar cells.

The project targets three gases: Ammonia (NH<sub>3</sub>), coming from fertilizers and cattle manure, Nitrogenous dioxide (NO<sub>2</sub>) coming from engines and combustion, and Nitrous oxide (N<sub>2</sub>O) coming from the ground and the breaking down of the fertilizers.

Although N<sub>2</sub>O release is tiny compared to other greenhouse gases, it is 300 times more potent than carbon dioxide. A 2008 study by Nobel Laureate Paul Crutzen, the renowned Dutch atmospheric chemist, suggests that the amount of N<sub>2</sub>O attributable to agricultural nitrate fertilisers is seriously underestimated. At the moment, we simply don't have enough information. Establishing sensing arrays in remote areas of the State to specifically collect data on N<sub>2</sub>O emissions will go a long way to building up a picture of how big a problem this is and help to develop an effective mitigation strategy.

The team is working very closely with QUT's Institute of Sustainable Resources who is concerned about the significance of nitrous oxide emissions in agriculture and its global warming implications.

The SPNS project works at developing reliable nano-sensor networks in remote areas based on three key technologies:

1. **Nano-materials:** metal oxides as a sensing layer can be produced in nanoscale morphologies like nanowires or nanotubes in order to

## ABOUT CLEANTECH

The umbrella term, Cleantech, includes technologies in renewable energy, green transportation, water, air & environment, nanomaterials, waste recycling, sustainable communities, clean manufacturing, agriculture and industrial biotechnology. Innovation in Cleantech is about changing the way we manufacture, what we produce and how we consume it in order to decrease our environmental footprint, minimise pollution and maximise use of natural resources. Undertaken strategically, the uptake of Clean Technologies is a paradigm shift that can bring about economic growth and development while responding to global environmental and social challenges.

*CleanTech News* shares information relevant to companies and organizations who are either undertaking research and development in the Cleantech space or those firms who are keen to take up new technologies to improve productivity and decrease their carbon footprint.

The newsletter provides information on the latest research, new technologies and trends, government initiatives, grant schemes, upcoming events (including webinars) and leaders in the Cleantech arena. *CleanTech News* will include information from QUT, industry groups and government agencies, as well other Cleantech news outlets from around the world.

This newsletter is one of the ways that QUT contributes to what Malcolm Gladwell (from his book, *Outliers*) refers to as the "right ecosystem". A system that encourages the transference of knowledge into economic and social benefits through the emergence of innovative, high-performing, revolutionary technologies developed by talented risk-takers.

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increase the surface area for gas adsorption resulting in enhanced sensor performance and reduced power consumption.

2. **Dye-sensitized solar cells (DyeSol)**: this new kind of solar cell, based on a principle similar to photosynthesis, can be produced in large scale at low prices and with minimal energy requirement, making them the ideal support for the nano-sensors.
3. **Low-power wireless transmission** technology allows an easy to develop sensor network, which can transmit data to a central location or to an unmanned aircraft.

### Nano-materials

Semiconducting metal oxides have been commonly used in gas sensing applications for many years. However, their use in outdoor applications is limited by their high power consumption, as they work at high temperatures (300-400°C) requiring a continuous power supply for reliable operation.

The continuous evolution of nanotechnology in recent years has led to the production of quasi-one dimensional structures in a variety of morphologies, like nanowires, nanotubes and quantum dots. These nanostructures have been identified as promising candidates for gas sensing due to their highly active surfaces which have large surface-to-volume ratios and unique properties. The nanostructures are expected to exhibit physical properties that are significantly different from their coarse-ground polycrystalline counterparts due to the high surface-to-volume ratio and other properties related to electron confinement. Nanowires and nanotubes, used in sensing devices, display increased sensor performance as well as lowered power consumptions.

During the first 18 months the SPNS project team achieved considerable success in growing tungsten oxide ( $WO_3$ ) nanoparticles, tin oxide ( $SnO_2$ ) nanowires and carbon nanotubes on patterned and non-patterned substrates using chemical vapor deposition in a furnace. The team also synthesized zinc oxide ( $ZnO$ ) and  $SnO_2$  nanoparticles (<5 nm) and nanowires by chemical methods at low temperature.



### ZnO Quantum Dot rod assembly

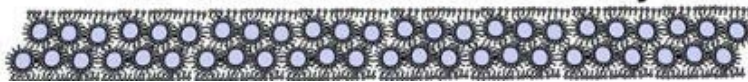
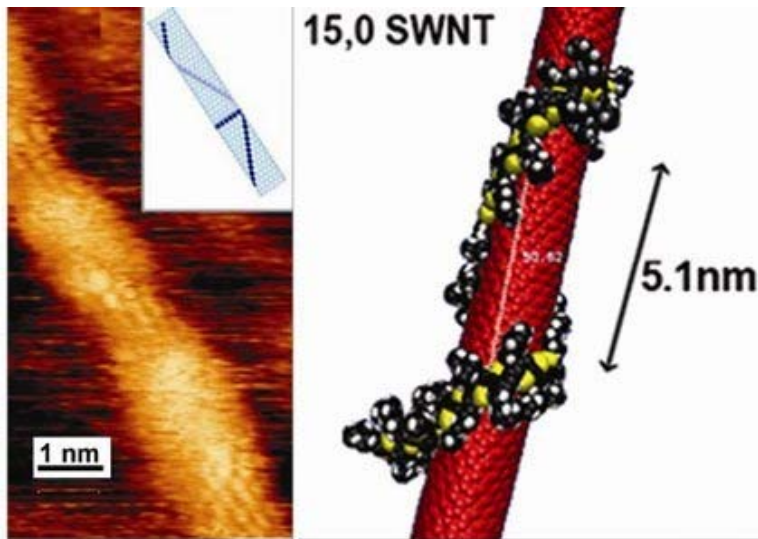


Figure 1 Top: ZnO nanowires at the Transmission Electron Microscope. Bottom: Nanowire internal structure made by assembling ZnO quantum dots.

ZnO nanowires and carbon nanotubes have also been functionalized with dodecanethiol (DDT) molecules in order to increase sensitivity towards the nitrogen-based gas analytes through direct chemical binding events, while keeping the ZnO nanowires water-free. The aim of this study was to improve the response of the gas sensor elements towards  $N_2O$  by chemical treatment of the sensor surface in order to progress field testing of these types of sensors in a prototype gas sensor network.

Carbon nanotubes have also been wrapped with conducting polymer in order to create new sensors and electronic devices. The nanotube's microscopic structure has been investigated via a scanning tunnelling microscope (STM) in an ultra high vacuum and confirmed by a theoretical model. The wrapping of the polymer has been clearly visualised (see picture) and connected to the electric behaviour of the nano-assembly. Future exciting developments of these studies include the exploitation of of this nanostructure in polymer solar cells and nano-electronics.



Carbon nanotube wrapped by polymer. Microscopic image (left) and model (right)

Dye-sensitized solar cells (DSC) technology can be defined as 'artificial photosynthesis', as it is based on a mechanism similar to that used by plants to collect energy from the sun. DSC technology incorporates an electrolyte, a layer of titania (a pigment used in white paints and tooth paste) and ruthenium dye sandwiched between glasses. When the light strikes the dye, electrons are excited and absorbed by the titania to generate an electric current, which is many times stronger than that found in natural photosynthesis in plants. DSCs are environmentally friendly and less sensitive to the angle of incidence of the sun hence they produce a constant energy output throughout the day. Light from the sun is converted into electrical energy and stored in a Li-ion battery system or used by the sensor electronics on demand.

#### Electronics and Wireless Transmission

The data, obtained by a sophisticated state-of-the-art circuitry developed in Italy, is stored in a memory of the electronic system and then released to a central station through a wireless network, based on Fleck™ cards produced by CSIRO. In very remote areas, data collection can be periodically provided by Unmanned Aerial Vehicles (UAV).

The first test station is being installed at QUT providing real time data and information on the solar cells performance, temperature and level of CO<sub>2</sub>. Data will be retrieved through the wireless connection and fed to a website to be visualized in real time.

During the final year of the project, sensor networks will be deployed in various locations including the Samford Ecological Research Facility (SERF), at Central Queensland University (CQU) in Rockhampton, and in Brisbane city.

The Solar Powered Nano-sensors project is supported by the Queensland State Government's National and International Research Alliances Program (NIRAP), and includes Brescia and Roma Tor Vergata Universities, CQU, QUT and Dyesol as partners.

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#### "GREEN IT" TRANSFORMATIONS

Researchers at Queensland University of Technology (QUT) are studying the role of "Green IT" in global organizations becoming sustainable, green enterprises.

The team from QUT and University of Liechtenstein spent the last 2.5 years following global business management software leader, SAP and their 20,000 employees in their efforts to develop green work practices and providing sustainability technology solutions to their clients.

QUT's Associate Professor Jan Recker said the team started with reviewing how green information technologies were governed through organizational mandates and policies, and how these technologies enable the processes of change. These technologies included as Cloud Computing, eco-Printer servers, and energy-efficient data storage.

It was observed that using green technologies kick-starts a cycle of

innovation and eco-awareness, which in turn breeds green working behaviours and translate into other areas of the business.

The team is now looking to collaborate with Australian organizations partaking in the Green movement to help further this research in the Pacific-Asian sector.

For other related research papers, [visit QUT's eprints archive](#).

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### **BLUEBOX AWARDS PROOF-OF-CONCEPT FUNDING TO IMPROVE EFFICIENCY OF CLEAN ENERGY TECHNOLOGY**

qutbluebox, the knowledge transfer and commercialisation company for the Queensland University of Technology (QUT), has awarded Professor Graeme Millar \$100,000 of Proof-of-Concept (POC) funding for the optimisation of an innovative plasma gasification process.

The funding is to extend earlier work undertaken by emerging technology company Syn Dynamics, who are supplying equipment for the project.

The POC funding will assist the commission of a 10kW pilot plant and support a range of process and equipment improvements with the aim of increasing energy efficiency.

The plasma gasification process is conducted in a controlled fluid reactor vessel and converts organic matter (eg. biomass, municipal solid waste, etc.) to a gaseous fuel known as synthetic gas, or syngas. This in turn can be used for energy generation.

The primary application of plasma gasification is in waste-to-energy applications, particularly those for which the net energy loss of the process is less than the cost of removing the waste. Existing technologies are provided by Westinghouse, AlterNRG, GE and Shell.

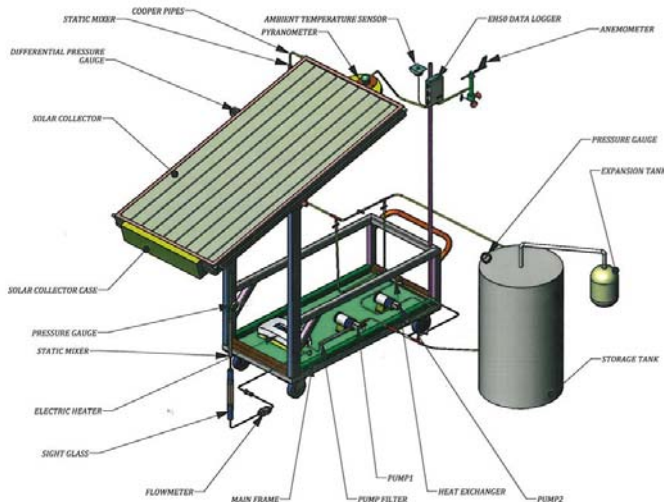
However, further improvements in energy efficiency may enable this form of energy generation to ultimately be competitive with base load sources, including traditional coal fired power stations and other emerging classes of renewable energy technologies.

The bluebox POC funding may not only assist in the development and demonstration of QUT energy efficiency measures for plasma gasification generally, but also provide a platform for the equipment to be progressed to a larger scale.

bluebox established the POC fund to enable the development of QUT intellectual property to a Proof-of-Concept stage and to enhance the ability to achieve QUT's commercial goals. Each investment has specific, targeted technical and commercial milestones. For further information on bluebox please visit [www.qutbluebox.com.au](http://www.qutbluebox.com.au).

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### **HIGH TEMPERATURE SOLAR THERMAL STORAGE RESEARCH**



Queensland is one of the highest solar energy recipient areas in the world and therefore has great potential to be first state with 100% renewable

energy usage. Current solar energy systems lack the proper storage technology to operate without support from traditional energy sources, particularly at night and during cloudy days. A QUT research project is investigating this problem by developing efficient and cost effective thermal storage technology for medium and high temperature applications. This innovative storage methodology will ensure continuous green energy supply without the need for backup from fossil energy sources.

Water due to its high specific heat and benign character, is an attractive storage medium in thermal storage applications. However, for high temperature applications like solar thermal power generation, other heat transfer fluids (HTF) (e.g. oil and molten salt) need to be used. As very little research has been done on high temperature thermal storage most solar thermal power plants do not have appropriate storage systems. A solution to this problem is the use of stratified storage systems which store hot and cold HTF in the same tank. The heat transfer fluids in the tank and separated by natural stratification due to their density difference. This difference creates a region of vertical temperature gradient, called 'thermocline', that lies between the two HTF masses allowing for more efficient storage.

In this project, a complete solar thermal storage method has been developed. High heat capacity and low cost HTF and low cost solid filler materials have been developed for high temperature storage. Detailed design guidelines and optimum operating conditions for different environmental conditions will be developed.

To investigate the thermal stratification in a single tank a naturally stratified cool thermal storage system tank and a new type of octagonal diffuser was designed, constructed and tested. The project uses flow visualization tests to observe the flow patterns in the tanks in order to understand the influence of different operating variables upon the formation of the thermocline and its subsequent behaviour. The image below shows the flow visualization results. In this test, coloured (red) cold water was passed to the tank which was filled with clear warm water. From the image, stratification of chilled water in this temperature range was evidenced.



Overall results indicated that stratified storage tank consistently stratified well without any physical barrier. Investigation also showed that storage efficiency decreased with increasing flow rates due to the increased mixing of warm and cold water. The diffuser design and layout primarily affected the mixing near the inlet diffuser and the extent of this mixing had primary influence on the shape of the thermocline. The heat conduction through the tank walls and through the thermocline caused widening of mixed volume. The thermal efficiency of the stratified storage tanks was as high as 90 percent, which indicates that stratified tanks can effectively be used as a load management technique.

In the second stage of the project, low and medium temperature solar thermal water storage will be studied. A solar thermal storage test set up has been designed with its fabrication now underway. In this system water will be used as storage medium for low and medium temperature applications (up to 100°C).

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