MARTIN GREEN

Breaking world records with solar cells

Martin is internationally recognised for his work on silicon solar cells. Billions of the solar cells he has invented have been manufactured in factories around the world.

Solar cells turn sunlight into electricity. Martin Green and his fellow scientists at the University of New South Wales are famous for inventing new types of solar cells made from silicon, the most commonly used material for making solar cells. For more than 20 years, Martin and his team have held the world record for the amount of energy in sunlight that a silicon solar cell can turn into electricity.

fact file

Born: 20 July 1948

Schooling: (Queensland) Coorparoo State School, Brisbane State High School

Selected achievements:

Australian Museum Eureka Prizes, 1991, 2010

Australia Prize (shared), 1999

Right Livelihood Award, 2002

World Technology Award for Energy, 2004

Switched on to electricity

Martin Andrew Green was born in Brisbane. As a young boy, he always did well at school, but especially liked playing Rugby League football. At secondary school, he took study more seriously. A **physics** teacher, who conducted experiments about electricity, particularly inspired him. In his final year exams, Martin was awarded the Lilley Medal for gaining the highest marks in Queensland.

Studying semiconductors

Martin began studying electrical **engineering** at the University of Queensland in 1966. He most enjoyed his hardest subject – the physics of materials such as silicon, which are called **semiconductors**.

Specialising in microelectronics

After completing his engineering degree, Martin travelled to Canada to study for a **PhD**. On his first day at McMaster University, in 1971, he was shown experiments using the semiconductor silicon.

Martin was struck with curiosity about how the silicon in these experiments could turn sunlight into electricity, but at first he concentrated on other aspects of semiconductors. By the time he had finished his PhD, he was a specialist in microelectronics, a branch of physics which concentrates on the tiny electrical parts inside appliances, such as radios, telephones and computers. These parts are often made with semiconductors.

Science jargon

semiconductors materials that sometimes allow electricity to pass through them, and sometimes stop electricity from flowing

the science behind it

SILICON

Some materials, including many metals and water, allow electricity to pass through them easily, but others, such as plastic, rubber or glass, do not allow electricity to pass through easily. Materials that allow electricity to pass through easily are called conductors, while those that don't are called insulators.

Materials in between conductors and insulators are called semiconductors. They are widely used for making electrical appliances because scientists can treat them in certain ways to control how well electricity passes through them. Some semiconductors are useful for making solar cells because they strongly absorb light.

Silicon is a hard, dark grey, shiny material. It does not occur in a pure form in nature, but must be extracted from other substances and processed in a factory.

Starting in solar research

In 1973, an **oil crisis** caused petrol shortages in many countries of the world. The Australian Government began looking for alternative ways to generate energy. It started supporting research into **renewable** forms of energy, such as **solar energy**, which created new jobs for scientists. Martin began research into solar energy at the University of New South Wales (UNSW) in 1974.

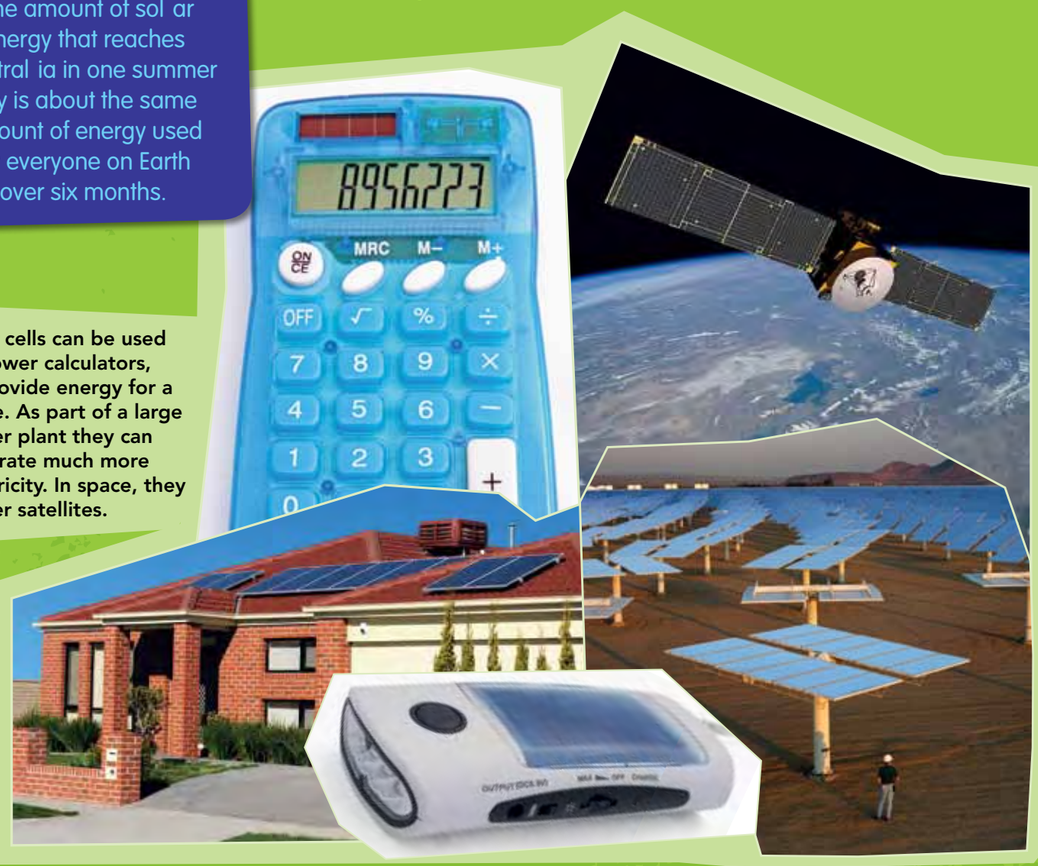
A new theory on solar cells

The first main use of silicon **solar cells**, in the 1950s, was to power spacecraft. Then, in the 1960s and 1970s, companies began to manufacture silicon solar cells for use on Earth. At the time when Martin started at UNSW, scientists believed 20 per cent of the Sun's energy was the most a cell could ever change into electricity. According to the laws of **physics**, the remaining energy would have to be reflected, or lost as heat.

An early achievement of Martin's was to work out that if a particular loss of energy in the cell was avoided, it might eventually be possible, in theory, to make a cell that changed 30 per cent of the Sun's energy into electricity.

Did you know?

The amount of solar energy that reaches Australia in one summer day is about the same amount of energy used by everyone on Earth over six months.



Solar cells can be used to power calculators, or provide energy for a home. As part of a large power plant they can generate much more electricity. In space, they power satellites.

Inventing the 'buried contact solar cell'

In 1983, Martin started working with Stuart Wenham, who had previously been working as a scientist for a business making silicon solar cells. Martin and Stuart invented a new type of cell, called the 'buried contact solar cell'. Like earlier cells, it is made by slicing a block of solid silicon into 'wafers', but in this cell the wafer has metal contacts 'buried' into it, rather than sitting on top of it. This increases the amount of electricity the cell produces.

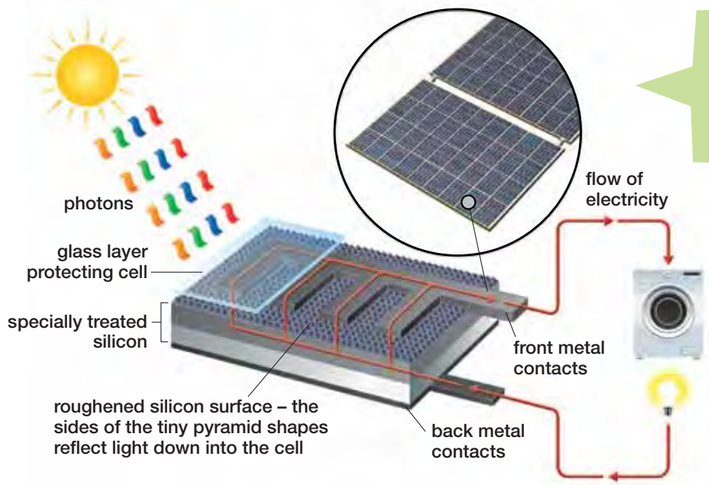
the science behind it

SILICON SOLAR CELLS

In a silicon solar cell, sunlight is turned into electricity. The famous scientist Albert Einstein solved the mystery of how this occurred when he showed that light is made up of packets of energy, now called photons.

In a silicon solar cell, the energy of photons is absorbed and turned into electricity inside a layer of silicon. The silicon has been specially treated to make it easier for electricity to flow. When the cell is connected by metal wires to an electrical device, such as a lightbulb or washing machine, the electricity flows out of it through metal contacts.

Solar cells can be connected to each other to provide more electricity. Large groupings of thousands of cells can be used to make a power plant. Smaller groupings, called solar panels, are often found on rooftops. Strips of just a few cells are used to power household objects such as toys, calculators or radios.



In a silicon solar cell, sunlight changes into electricity inside a layer of specially treated silicon. Cells can be connected to each other to provide more electricity.

Sales success and world records

In 1984, through the University of New South Wales (UNSW), Martin and Stuart lodged a **patent** for the buried contact **solar cell**. Companies around the world began manufacturing it.

Meanwhile, Martin's team was breaking world records for silicon solar cells. In 1983, they had become the first in the world to make a silicon solar cell that changed 18 per cent of the Sun's energy into electricity, and they went on to break many further records.

Developing silicon-on-glass cells

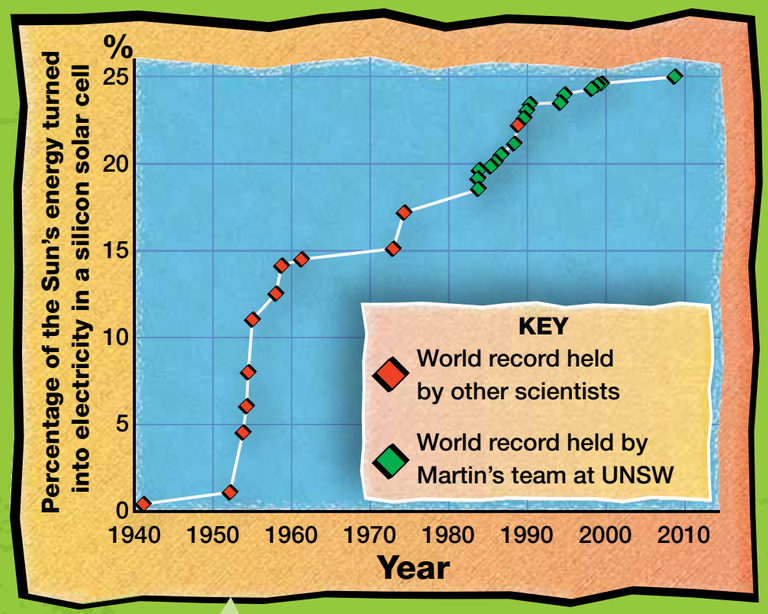
Martin's team started to develop a new type of solar cell in 1988. Instead of being made by cutting up solid silicon, this cell is made by coating a glass sheet with an extremely thin layer of silicon, in the form of a **vapour**. The vapour is made solid by heating in a furnace.

These 'silicon-on-glass' cells use less than one hundredth the amount of silicon that wafer cells use, but they produce more than half the energy. They may become more common in the future, because producing silicon for solar cells is expensive.

more about...

SILICON

Silicon is easy to find in nature, occurring in sand, soil and nearly all rocks, but it is never in a pure form. Instead, it is always combined with oxygen as part of substances called silica and silicate. To obtain the pure silicon used in solar cells, silica must be heated to a high temperature and undergo careful processing.



Martin and scientists at UNSW have held the world record for silicon solar cell efficiency almost continuously since 1983.

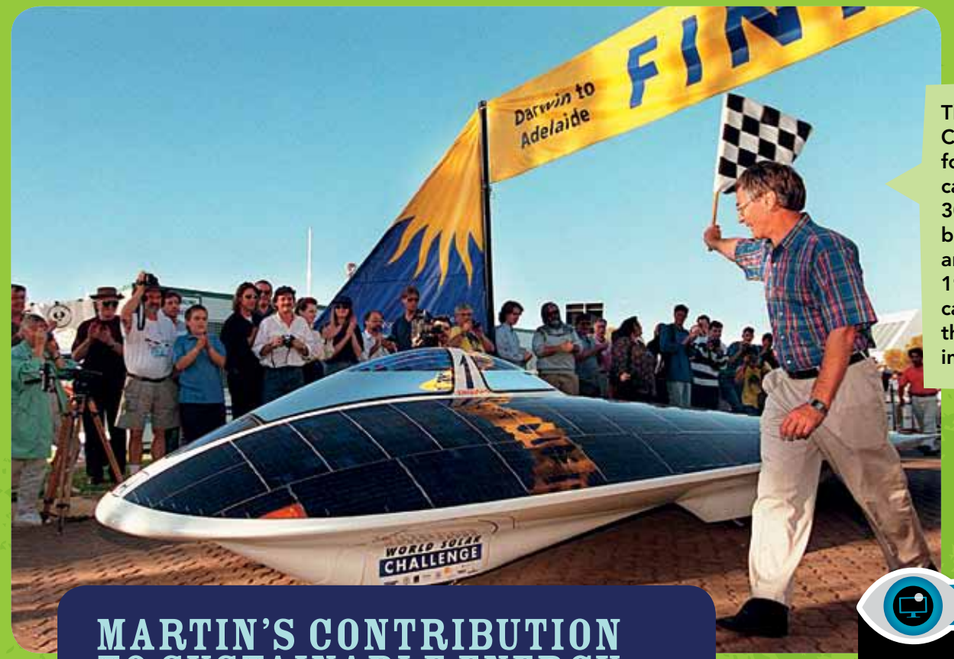
Continuing to improve solar cells

At UNSW, Martin helped Stuart establish the world's first university course focused entirely on solar energy engineering. Today, scientists come from around the world to study this course and work with Martin. His team is using **nanotechnology** to continue to improve solar cells. Martin now believes that one day it may be possible to make solar cells that turn 74 per cent of the energy in sunlight into electricity.

An influential teacher

Many scientists who have trained with Martin have gone on to make important contributions to the solar power industry. Some have invented new types of solar cells. Others have used their expertise to start manufacturing businesses. One scientist, Shi Zhengrong, became a billionaire by founding Suntech Power, the world's biggest manufacturer of silicon solar cells.

> *The hope is that one day we will develop a solar cell that can be rolled out like Gladwrap.*
>
> – Martin Green, 'Solar photovoltaics: Power source for the future?', talk given at the Australian Academy of Science, 7 October 2008



The World Solar Challenge is a race for solar-powered cars, run over 3021 kilometres between Darwin and Adelaide. From 1990 to 1999, every car but one that won the race used a cell invented at UNSW.

MARTIN'S CONTRIBUTION TO SUSTAINABLE ENERGY

Martin Green is internationally recognised for his work on silicon solar cells. His team at UNSW has developed some of the best silicon solar cells in the world. They continue to develop even better cells to make it cheaper and easier to harness **renewable** energy from the Sun.

web watch

Watch Martin talk about his work in this video clip made by the New South Wales Office for Science and Medical Research: ww3.business.nsw.gov.au/media/osmr/video.htm