AURORA Vehicle Association Inc

The Aurora Vehicle Association Inc is a non profit body dedicated to developing highly efficient vehicles. It has a twenty year history of achievement and is presently focused on being the world's best in solar powered electric cars.

Aurora 101 is spurred on through competition, it has been Australia's most successful entry in the World Solar Challenge events held since 1987 and was the winner of the Citipower Sunrace ?8.

Aurora 101 encourages technical collaboration with many of Australia's leading scientific research establishments and universities and attracts highly capable young people interested in developing the future.

Aurora website sponsored by

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Technical collaborators

RMIT University · Chisholm Institute · CSIRO

Foundation Supporters

Ford · Whirlpool · 101 Collins · Sumitomo Corporation (Sumitomo Wiring Systems Ltd) · Strategic Industry Research Foundation · R J Pound Services

1999 World solar challenge
Darwin to Adelaide

The World Solar Challenge is the pre-eminent solar race in the world and was inaugurated by Hans Tholstrup in 1987. It takes place every 3 years and has attracted an international field of entries including factory teams from the major car companies. The event winners have been General Motors, Biel and Honda (both in 1993 and 1996). The race is from Darwin to Adelaide, just over 3000 kilometres.

Aurora 101 has been in every World Solar Challenge event and has been the top Australian team.

The 1999 World Solar Challenge, which starts on the 17th October, has over 40 entries from 11 countries with strong groups from Japan, USA and Australia.

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Major Supporters

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20 Years Of Aurora History

1980	First competed in Shell Mileage Marathon	2nd Place
1983	Won Shell Mileage Marathon 2,948 mpg	World Record
1984	Won Shell Mileage Marathon 3,133 mpg	World Record
1985	Won Shell Mileage Marathon 5,107 mpg	World Record
1987	First Australian in World Solar Challenge	2nd place (45 km/h)
1990	First Australian in World Solar Challenge	6th place (50 km/h) 1st in lead acid class
1992	Competed in Suzuka, Japan	3rd in class
1993	First Australian in World Solar Challenge Team Patron: John Button	5th place (70 km/h)
1994	Perth to Sydney Solar Car Crossing	8 days, World Record
1996	Fastest Australian qualifier in World Solar Challenge. Team Patron: Dick Smith	95 km/h (DNF)
1998	Citipower Sunrace '98 Melbourne to Sydney	1st Place
1998	World Record* speed on commercial solar cells and lead-acid batteries over one hour, Hay to Balranald	100.9 km/h
1999	Competed in World Solar Challenge	1st Place!

* Pending Ratification

See also our Technology Advancement page.

Aurora - A Decade of Solar Car Technology Advancement

Development work in solar energy applications is most visible in speed and endurance races. Major events take place all around the world each year. The toughest and most demanding race has been held in Australia for the past 10 years. The World Solar Challenge runs from Darwin to Adelaide - a distance of 3,010 km.

Picture of 1987 car here

Aurora has entered every World Solar Challenge since the event's inauguration in 1987 and has been the most successful Australian competitor.

Since 1987 the technology improvement in every area important to solar cars has been immense. The World Solar Challenge has provided a strong incentive for this technology advance. Major car companies have entered the WSC with leading edge electric vehicle technology as a way of emphasising their advanced technology objectives.

Aurora finished second to GM in the 1987 WSC but it was only in the 1996 WSC that the Aurora entry matched the technology needed to be competitive against "works" entries. The decade of Aurora improvement is outlined below.

	1987 WSC	**1996 WSC**	**% Improvement**
Aerodynamics CD	0.27	0.095	150%
Solar cell efficiency	11%	22 - 23%	100%
Motor efficiency	85%	98%	15%
Solar panel output	800 watts	1,700 watts	100%
Vehicle weight	250 kg	195 kg	22%
Average race speed	44.5 km/h	90 km/h*	100%
Race time	67.5 hours	33.3 hours*	100%
	* projected, Aurora DNF		

Solar Vehicle Technology

The solar vehicles that compete in the WSC are of course very different from conventional vehicles. The energy available from sunlight at usual radiation intensites (about 1000 watt/square metre) is far too low to power a conventional motor vehicle. Solar powered vehicles make the most of the energy that is available by using highly efficient solar cells, light-weight batteries, super-efficient traction systems and motors, and aerodynamic bodies with ultra-low drag coefficients.

More information

- How solar cells work
- Aurora's solar cells
- Aurora's motor
- Electric vehicles

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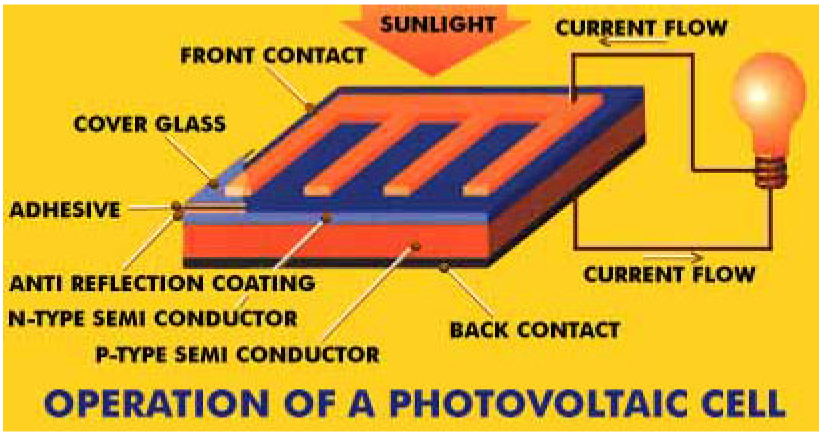
/ | \
How solar cells work - Electric vehicles

Last updated 15-Sep-1999

Solar Cell Technology

How a Photovoltaic Cell works

A solar cell is made up of a number of layers. The critical two layers of the cell are the middle two, one of which is known as n-type semi-conductor and the other as p-type semiconductor. It is at the junction of these two layers that the cell generates electricity.



Semi-conductors are special electronic materials that are used in computers and other electronic devices. They are called semi-conductors because they conduct poorly when compared to metals, but they conduct very well when compared to insulators. They fall somewhere in the middle.

Semi-conductors have two special properties that are essential to the solar cell's ability to make electricity:

1. When light is absorbed within a semi-conductor, electrons are freed by the semi-conductor.
2. When dissimilar semi conductors are joined at a common boundary, a fixed electric field is usually induced across the boundary.

So how does the cell generate electricity? When light enters the solar cell and is absorbed in the semi-conductor sandwich an electron is freed. If this electron is close enough to the boundary of the two semi-conductors, it is swept across the boundary by the fixed electric field. The movement of the electron across the boundary causes a charge imbalance in the semi-conductors. The semi conductors naturally want to get rid of this charge imbalance. However, the electric field prevents the electron from recrossing the boundary, so if it is to return, it must travel via an external circuit - thus we have electricity! (because electric current is the flow of electrons through a wire)

The outermost layer of the cell is a cover glass. This is designed to protect the rest of the structure from the environment. It is attached to the rest of the cell with a transparent adhesive.

When sunlight passes through the glass and the adhesive, it encounters an anti-reflection (AR) coating. This coating is also transparent. It is designed to reduced the amount of sunlight reflected by the cell. Without the AR coating, the solar cell acts like a mirror, reflecting up to 30% of the light hitting the cell. The AR coating minimizes this reflection off the cell, reducing reflection losses to less that 5%, so that as much sunlight as possible is available for the cell to use to make electricity.

For the solar cell to be useful, there must be some way for the electricity it produces be passed to the outside world. This is the purpose of the front and back contacts. Their function is to carry the electrical current produced by the cell.

The current generated by the light hitting the solar cell flows from all parts of its surfaces, so it is important that the contacts reach everywhere on the cell. Ideally, to reduce losses caused by the current having to travel any distance across the surface of the cell, we would like to cover the whole of the top and bottom surfaces of the cell with the contacts. However, if we did this, the top contact would block the sunlight and the cell wouldn't work. As a compromise, the top contact is usually made of thin fingers of metal that reach most of the cell and only block a small portion of the light. The bottom contact is not in the way of the light, so it can be a sheet of metal.

As long as light shines on the cell, we get electricity. Light comes into the cell and gets absorbed. Electrons are freed and pushed across the boundary by the electric field. They pass through an external circuit and return to their starting point.

This happens as long as light shines on the cell, so how come the cell never wears out? Because the sunlight provides the energy input. Just like sunlight provides the energy for plants to grow, it also provides the energy for solar cells to produce electricity.

Aurora Home Page

Last Updated 16-Sep-1999

Aurora - The Solar Cells

Aurora's solar array is equipped with some of the highest efficiency solar cells in the world (similar to those used on 1996 winning entrants "Honda Dream" and "sCHooler"). Cells of this type, developed here in Australia at the UNSW Photovoltaics Special Research Centre under the direction of Professor Martin Green, hold the world records for efficiency.

These "Green" cells are known as PERL (Passivated Emitter, Rear Locally-diffused) cells and were manufactured especially for the World Solar Challenge. They have a top surface which is indented in the shape of a grid of inverted pyramids, and a double layer of anti-reflection coating, to enhance light collection. The metal contacts are kept narrow so they block as little of the light as possible. Other steps are taken to reduce losses within the cell.

For general information, see Technology: How a Solar Cell Works.

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Last updated 19-Dec-1997

Aurora - The Motor

Aurora approached CSIRO to co-develop an in-wheel electric motor for use in solar car racing. The main features of the resulting motor are:

1. Three-phase brushless
2. Halbach magnet assembly
3. Air gap winding
4. Direct drive to eliminate drive train losses
5. No larger than wheel hub to eliminate wind resistance
6. Light weight to allow more aerodynamic single front wheel design

Rating	*Value*	*Condition*
Continuous torque	29 Nm	60蚓 temperature rise
Overload torque	51 Nm	120 s for additional 35蚓 temperature rise
Starting torque	51 Nm	Limited by controller
Rated speed	1060 rpm	100 km/h
Maximum Speed	1270 rpm	120 km/h, limited by controller
Outside radius	180 mm	
Axial length	39 mm	
Mass	7 kg	6 kg of magnet material and copper
Efficiency	97.6%	1.8 kW output at 100 km/h
Total loss	48.7 W	Including 0.75 W/kg weight penalty

Motor Performance, contrasted with:

- an induction motor (typical electric motor)
- with an internal combustion motor and drivetrain (typical for motor vehicle)

Motor type	*Torque/Weight ratio*	*Torque/Volume ratio*	*Efficiency*	*Losses*
CSIRO motor	4.6 Nm/kg	8160 N/m^2	97.6%	2.4%
Typical Induction motor Ratio CSIRO : Induction	0.79 Nm/kg 5.8 : 1	1530 N/m^2 5.3 : 1	82% 1.2 : 1	18% 1 : 7.5
Internal Combustion motor Ratio CSIRO : Combustion	1.5 Nm/kg 3 : 1	1969 N/m^2 4.1 : 1	25% 3.9 : 1	75% 1 : 31

For more information, see these CSIRO pages:

- General motor information
- Technical paper

Last updated 1-Jul-1998