



Securing our energy future

Energy Group

Now, more than ever, energy is a topic of unprecedented community, government and industry activity globally.

Australia's growth and way of life is underpinned by access to affordable and sustainable energy sources for electricity and transport.

To secure our energy future, it is imperative that we move quickly to address the significant challenges of reducing our greenhouse gas emissions and developing scientific solutions that will ensure Australia's long term economic, environmental and social well being.

There is no single solution that will solve the energy puzzle. To meet future energy demand and protect our environment we will need a mix of existing and new technologies, and will require significant shifts in the way we live and work.

Working in collaboration with industry, research organisations and government, CSIRO is committed to developing cost-competitive energy technologies and helping mark out a pathway to a clean, viable and secure energy future.

Our \$140 million per annum energy research program is aimed at:

- reducing greenhouse gas emissions
- ensuring energy security; and
- creating wealth from energy.

The program brings nearly 500 energy scientists and engineers together with CSIRO's multi-disciplinary breadth in information technologies, materials and biosciences to focus on:

- Providing government and industry with the tools, data and modelling capability to inform policy assessment and investment decision making.
- Demonstrating and deploying technologies at scale to maximise the wealth from our resources and advance Australia's move to a low-carbon economy.
- Improving the reliability, efficiency and affordability of renewable

energy technologies – including solar, geothermal and wind – enabling them to become a major energy source in Australia.

- Improving building design and energy efficiency to reduce our energy consumption and carbon dioxide emissions from commercial buildings and homes.
- Developing alternative routes to fuel production and transportation power that could lead the way to a sustainable future for road, rail, air and water transport.
- Developing new technologies to improve efficiency in the resources sector and maximise the benefits of Australia's abundant coal, uranium, gas and oil resources.

For more information about our energy research please visit www.csiro.au/science/Energy.html



Understanding and planning our energy future

If Australia is to address the enormous challenge of climate change, we need the collective action of individuals, communities, companies and government.

CSIRO is working at each of these levels to reduce greenhouse gas emissions and help develop technologies, change behaviours and map the pathway to a clean, viable and secure energy future.

There is no silver bullet solution. In the future we will need to provide cleaner energy to a larger, energy-hungry population. We will need to improve the current technologies we use and find new ones. And we will need to change the way we operate in business, government, as communities and at home.

CSIRO is modelling the options for achieving this goal and giving industry and individuals the knowledge and tools they need to make a difference.

> Research snapshot: Planning a sustainable future in energy

Access to low cost energy underpins Australia's economy and our way of life. Our energy infrastructure requires substantial ongoing investment and each new investment brings with it implications that last for decades.

At the same time, if we are to limit climate change we must consider whether the fuels and technologies Australians currently use will continue to be appropriate for our future. But which portfolio of choices do we choose and on what basis?

CSIRO has an extensive program of integrated modelling and consultation work that is undertaken by a team of analysts and scientists to examine the implications of pursuing particular technology paths.

For example, CSIRO and its partners recently set up the Future Fuels Forum. Against the backdrop of high fuel pump prices, peak oil concerns, fuel security and climate change, the Forum worked to identify scenarios that could shape a new fuel mix for Australia to 2050. Some of these scenarios were subsequently included in the Garnaut Review and will be used to inform policy as the country moves towards a cleaner transport fuel industry.

Our energy modelling provides a foundation for research into energy technologies and behaviours, and helps to give Australia a clearer picture of what it needs to do to address the energy challenge.



Renewable energy

Renewable energy is an essential part of Australia's energy mix and will play an increasingly important role as we move to reduce greenhouse gas emissions and simultaneously secure future energy supply.

Wind, solar, biomass and geothermal energy provide sustainable options to deliver our energy and transport needs.

CSIRO has marshalled the talents of hundreds of scientists to develop the next generation technologies for energy production from renewables. We are also focused on finding new ways to integrate this type of energy into existing electricity grids or for use immediately in the home.

As well as searching for new ways to mitigate climate change through reduced emissions from energy generation and use, CSIRO is also working to better understand the climate, as well as adapt to the climate changes we know are inevitable.

> The CSIRO National Solar Energy Centre, in Newcastle, NSW, is the only solar thermal research facility of its type in Australia and is home to the largest high concentration solar array in the southern hemisphere.

> Research snapshot: Harnessing the sun for green power

The CSIRO National Solar Energy Centre is home to the largest solar array tower in the Southern Hemisphere. At this pilot site, scientists are using mirrors to collect the sun's energy and transform solar power into a gas called SolarGas that can be stored and transported.

SolarGas embodies about 25 per cent solar energy in the chemical bonds of the gas and can be used to reduce emissions in the electricity, transport fuels and chemicals industries.

Researchers recently completed a \$7 million facility upgrade and will soon establish a new solar thermal array on-site as part of the Australian Solar Institute. The new facility will allow CSIRO to help make solar thermal power competitive in the future low-emission energy mix.

As well as researching solar thermal technologies, CSIRO is investigating

organic photovoltaic solar cells.

Most of today's commercially available solar cells are made from silicon, which makes them expensive and less competitive with other sources of energy such as coal.

The next generation of solar cells will be light, flexible, attractive and most importantly, cheap, because they will be made from organic (plastic) materials.

CSIRO researchers are collaborating with national and international groups to improve the efficiency and durability of solar cells based on these new materials and to advance the uptake of solar technology in Australia and around the world.

By working with government, industry and other research institutes, CSIRO is playing a key role in advancing solar energy technologies for the world.



> CSIRO is involved in four operational PCC pilot plants in Australia and overseas with more scheduled to be commissioned.

Energy from coal

Coal is Australia's largest export and a major contributor to the national economy. It is the primary fuel for power generation worldwide and provides more than 80 per cent of Australia's electricity supply.

Coal is however a major contributor to the world's greenhouse gas emissions. Current coal-based power technologies account for more than one third of Australia's emissions alone.

CSIRO's coal technology research is focused on maintaining the benefits that Australia's coal resources bring to the nation and world while minimising the adverse environmental impacts of coal mining and coal-fired power generation.

Working with industry, research organisations and government, CSIRO's \$50 million per annum coal technology research program uniquely covers the entire coal value chain - from mining and beneficiation to gasification and CO₂ capture and storage technologies.

> Research snapshot: Carbon capture and storage

Carbon capture and storage (CCS) technologies have the potential to make deep cuts to Australia's greenhouse gas emissions and CSIRO is working to reduce the cost and improve the efficiency of CCS to make it a viable option for our energy future.

By rallying the skills and experience of a team of more than 200 scientists and engineers, CSIRO has made important steps to advance this key technology.

The organisation has broad capabilities in the science that underpins CCS technology and a strong track record of working with government, industry and research organisations on demonstration projects.

Post-combustion capture (PCC) technology, which works to capture CO₂ from power station flue gases, has the potential to reduce CO₂ emissions from coal-fired power stations by more than 85 per cent.

CSIRO has partnered with industry and government in the development, commissioning and operation of four PCC pilot plants – three in Australia and one in China. This program is supported by extensive laboratory research aimed at developing more cost-effective

capture technologies that are applicable in Australia.

CSIRO's CO₂ storage research is finding ways to safely and economically store CO₂ underground. CSIRO has committed significant resources and research to find suitable storage sites, minimise the risks of storing large volumes of CO₂ and provide cost-efficient monitoring technologies for storage systems.

CSIRO is involved in Australia's largest underground CO₂ storage project, The Cooperative Research Centre for Greenhouse Gas Technologies (CO₂CRC) Otway Project, located in south-west Victoria.

The project boasts one of the world's most comprehensive monitoring and verification programs for CO₂ storage and is demonstrating that CO₂ can be safely transported, stored and monitored in the deep subsurface under Australian conditions.

Over 60 000 tonnes of CO₂ has been injected two kilometres below the earth's surface and scientists have demonstrated that the CO₂ has been successfully contained.



Smart energy systems

Using energy more efficiently is often more cost effective than generating more energy.

Generating power close to where it is needed, or managing when and how energy is delivered and used, can improve energy efficiency, minimise energy consumption, reduce peak demand on the electricity grid and save money.

Decentralising power supply by switching to local energy sources can also reduce transmission and distribution losses and in turn reduce carbon emissions.

CSIRO is developing smart energy systems to improve energy efficiency and management in buildings, offices and homes, and to manage energy more intelligently in electricity networks.



> The zero emission house produces all the clean, renewable energy it requires on-site.

> Research snapshot: Zero emission housing

Energy use in buildings is responsible for 26 per cent of Australia's greenhouse gas emissions and is the primary cause of peak energy demand on the electricity network.

CSIRO is working with industry and government partners, through the Australian Zero Emission House (AusZEH) project, to assess how significant cuts in greenhouse gas emissions can be achieved in residential housing.

The first AusZEH demonstration house has been built in Victoria. This eight-star energy efficiency rated house has been designed specifically for the high volume housing market by meeting the design

requirements and budget of a typical middle income Australian family.

The house showcases renewable energy generation and energy management technologies, and demonstrates an integrated approach to sustainable building design. The energy generated from solar panels mounted on the roof produce enough zero emission, clean, renewable energy to supply all the operating energy needs of the household.

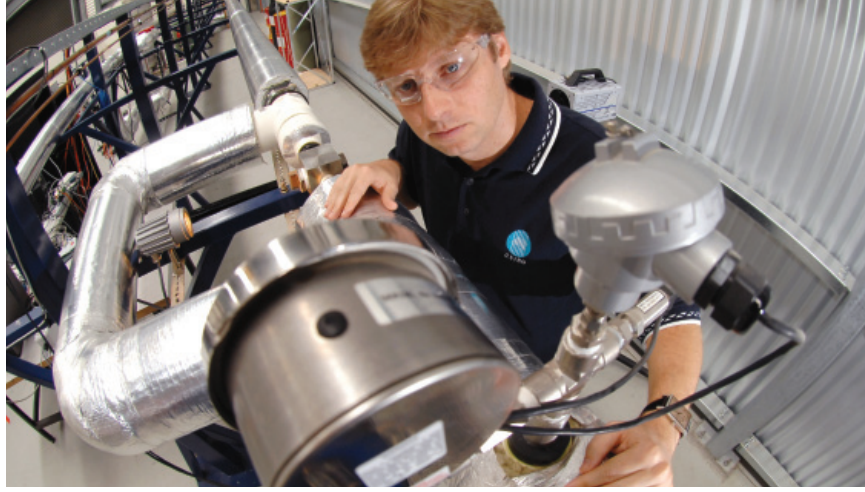
Through a combination of energy efficiency measures and the application of a computerised home energy management system, which is able to balance energy supply with demand and storage, the house will consume

around 70 per cent less energy than a traditional home supporting the same household.

AusZEH features:

- 6 kW solar panel array mounted on the roof for on-site electricity generation
- optimised building envelope design specific for the Victorian climate
- high efficiency appliances
- smart meters and an integrated energy management and monitoring system
- high efficiency reverse cycle heating and cooling system
- high efficiency solar hot water system.

> CSIRO has Australia's only gas-dominant hydrates flow loop, allowing researchers to investigate methods to prevent flow disruptions in subsea pipelines, particularly blockages from gas hydrate crystals which form at high pressure and low temperature.



Energy from oil and gas

There are few resources with the same impact on the world economy as oil and gas. Petroleum products have widespread and important uses – from transport and power generation to consumer goods. As such, Australia's economic wealth and growth relies heavily on our petroleum endowment.

In terms of costs and benefits, petroleum is superior to other energy sources. It is also likely to remain a significant primary source of energy well into the future. It is therefore imperative to maximise the precious crude oil resources we have and recover the massive supplies of gas located off North West Australia and along our Eastern seaboard.

New technologies are making it possible to meet the challenges faced in reaching and recovering oil and gas further offshore and from reservoirs that were previously inaccessible because they were uneconomical or too difficult to produce.

Research and development is vital for the continuous creation, improvement and adoption of these technologies, helping the nation fully utilise its hydrocarbon resources.

With a team of 300 geoscientists, multi-disciplinary breadth and key collaborations like the WA Energy Research Alliance (WA:ERA), CSIRO is providing solutions through the integration of complementary capabilities and technologies, large scale research focus and strong national and international partnerships with industry and government.

> Research snapshot: Oil and gas take a smooth ride to shore

Much of Australia's gas resources exist in deep, remote, offshore areas. Our ability to realise their full potential relies on the development of economically viable solutions to access and transport them over long distances to onshore processing facilities.

In collaboration with a number of universities, CSIRO is designing subsea infrastructure and pipelines that enhance gas flow and withstand the challenging terrain and conditions of deep water gas fields.

New technologies to repair subsea infrastructure will save industry large economic losses by reducing downtime resulting from oil and gas pipelines succumbing to corrosion and other damaging processes in the marine environment.

To optimise gas production, CSIRO is developing remote control robots and subsea sensor networks that can monitor well conditions and provide real time data. The information gleaned by these robots will be used to better manage gas flow and production in reservoirs and wells.

A significant industry challenge is reducing the water produced during oil and gas recovery. Water trapped underground is brought to the surface along with the oil or gas, bringing contaminants with it and producing economical and environmental issues.

CSIRO is engineering methods to reduce the amount of water produced and is developing water management solutions, for example, technologies which reinject water directly back into the reservoir.

The presence of water can also form ice-like crystals, called gas hydrates, in gas pipelines under deep subsea conditions which can cause blockages in the pipelines. CSIRO is developing solutions to predict and control the formation and transportation of gas hydrates.

CSIRO is working closely with global industry partners to develop and deploy these technologies, providing economical and efficient access to our huge resources of deep water gas lying far offshore and at great depths.

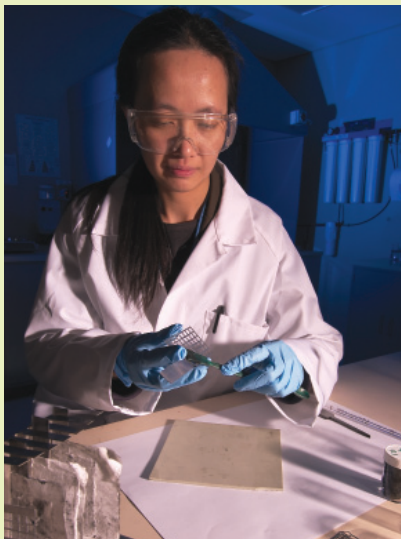
Powering transport

Transport is essential to the strength of Australia's economy and way of life, however domestic and international oil supplies are becoming increasingly constrained. At the same time, Australia has large natural gas resources with the potential to provide a cleaner source of fuel.

> Research snapshot: Battery to reduce global transport emissions

Driving to work and home in today's standard petrol vehicles contributes significantly to Australia's carbon dioxide emissions.

To help reduce emissions from transport, CSIRO researchers have developed the UltraBattery to improve hybrid electric vehicle cost and performance.



> Researcher Rosalie Louey prepares components for the UltraBattery: a technology aimed at reducing emissions from transport.

The UltraBattery is an energy storage device that integrates a supercapacitor with a lead acid battery in one unit. It is 70 per cent cheaper than conventional car batteries and provides 50 per cent more power than its lead acid battery counterparts.

The technology is set to have a global impact on greenhouse gas emissions thanks to an international commercialisation agreement with Japanese manufacturers Furukawa.

The agreement will see the production and distribution of the UltraBattery in Japan and, through sublicensing to US manufacturer East Penn, in Mexico, Canada and North America. In fact, the US Department of Energy awarded \$US32.5 million to East Penn to increase production of the battery for micro to mild hybrid applications.

Integrating a standard car engine with a battery-powered electric motor means hybrid electric vehicle technology achieves the dual environmental benefit of reducing both greenhouse gas emissions and fossil fuel consumption from transport.

As fuel prices rise, so too are the environmental impacts of powering our transport. The transport sector is the third largest emitter of greenhouse gases in Australia behind energy generation and agriculture.

To ensure long term security for our nation's fuel supply, CSIRO is researching a number of complementary technologies for alternative routes to fuel production and powering transport that could lead the way to a sustainable future for road, rail, air and water transport.

Contact Us

Phone: 1300 363 400

+61 3 9545 2176

Email: enquiries@csiro.au

Web: www.csiro.au

Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.