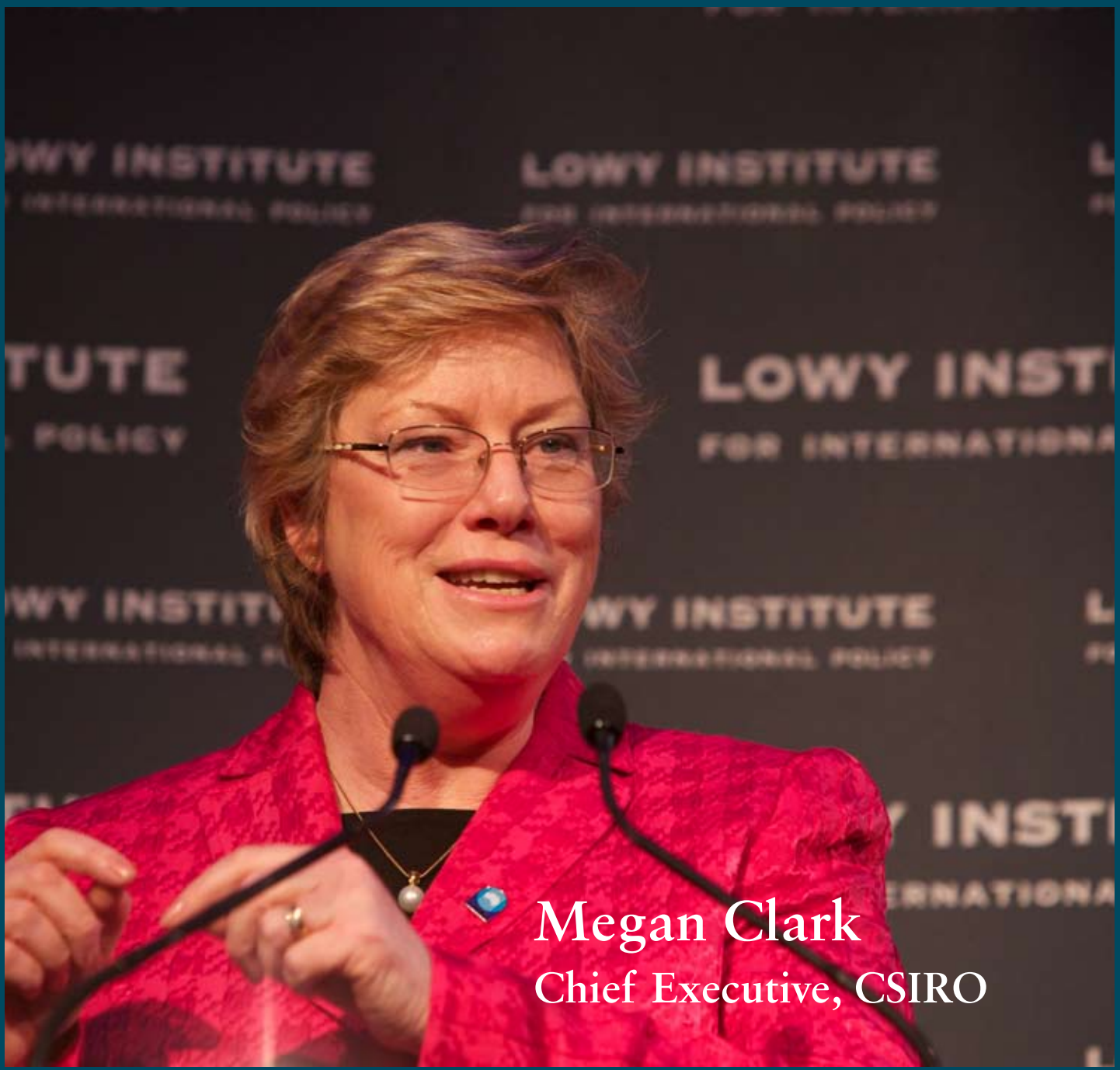
The 2010 Lowy Lecture on Australia in the World



Megan Clark

Chief Executive, CSIRO

LOWY INSTITUTE
FOR INTERNATIONAL POLICY

The Annual Lowy Lecture is the Lowy Institute's keynote event, providing a prominent thinker with the opportunity to reflect on Australia's role in the world, and the world's influence on Australia. This underpins the Institute's mission to analyse and stimulate debate on international affairs from an Australian perspective and to project Australian views into the global debate.

The 2010 Lowy Lecture examines the central role science and technology have played in shaping the evolution of our world and the primordial role they will play in shaping it over the next hundred years to deliver more, from fewer resources, to more people.

Australia became globally networked through technological change and has made significant contributions to innovation in agriculture, resources and medicine. That is why we asked Dr Megan Clark, the Chief Executive of CSIRO, Australia's leading scientific and technological research organisation, to deliver the 2010 Lowy Lecture.

In her lecture Dr Clark analyses why Australia needs to change the way it conducts scientific research and invest aggressively in science and innovation to keep pace in an increasingly competitive world, with new players such as India and China driving a new wave of reverse innovation of high-quality products with much lower price models.

Dr Clark advocates for a multidisciplinary, integrated model for scientific research. Plant and animal science, critical to establishing Australia's agricultural sector, will again underpin our global competitiveness, but we need to be good at other things too. Dr Clark has a vision of smart Australian cities which integrate design, water, energy usage, health and well-being and communication.

Dr Clark began her career as a mine geologist, and worked in mineral exploration, mine geology, research and development management, venture capital and technical strategy for Western Mining Corporation. More recently she was Vice President for Health, Safety, Environment, Community and Sustainability for BHP Billiton and served on the Expert Panel for the Review of the National Innovation System.

In her lecture Dr Clark persuasively argues that a more collaborative research model coupled with critical strategic investments in Australia's science and technological infrastructure are needed to continue to deliver prosperity and security to Australians and to give us the opportunity to play our part in meeting the global, interconnected challenges of food, water and energy security.

Michael Wesley
Executive Director

Science and Australia's Place in the World

Megan Clark
Chief Executive, CSIRO

18 November 2010

Good evening, ladies and gentlemen. I'd like to thank Frank Lowy and the Lowy Institute for inviting me tonight and acknowledge the important work of the Institute in stimulating discussion around Australia's role in the world.

It is an honour to be here representing CSIRO, where we exist to ensure science is *used* – to create profound impact for the economy and industry, to improve the health and well-being of all Australians and to create a sustainable environment.

Tonight I wanted to explore three questions. What are the major challenges facing the nation that will require science and innovation? What new opportunities are emerging for Australia that will be driven by science and innovation? How is science changing and what will we have to do differently to remain globally relevant?

Introduction

To set the scene I want to share with you some work we have been doing to look at the pressures and trends that will affect the way we live in the future and how science is already changing in response to these trends.

Global pressures, trends, shocks and risks

Steven Chu, the US Secretary of Energy, observed when he was talking about climate change: 'For the first time in history, science is making predictions on how our actions will affect how we live 50-100 years from now.'[1]

In this future we are all connected. Globally we face the challenges of securing our food, water and energy needs in a world of finite resources.

These challenges are coming from the significant pressures on global systems such as population growth and rapid urbanisation. The global challenges of food, water and energy security are connected. They cannot be dealt with in isolation.[2]

Individuals, communities, industries and nations are seeking to understand

these connections and the inevitable trade-offs necessary to achieve a sustainable future.

At CSIRO, we already allocate about one third of our investment to working on complex connected questions. And now this means tightening our focus on the top challenges and opportunities that face the nation and building national pictures of the systems that connect them. It means an even deeper commitment by our scientists and partners to working together in mission-based teams across and between all disciplines.

Megatrends and emerging market opportunities

In defining the future challenges and opportunities for the nation, 50 of our leading scientists and 120 leaders in industry, government, community, media and academia have looked at the top five global megatrends of the future.[3] We and others have concluded that the most significant trend will be to deliver more, from fewer resources, to more people.[4]

Depleting natural resources and increasing demand for those resources will see a global focus on resource use and efficiency.

As a nation that exports energy, minerals and food commodities like wheat and meat, we understand very well how this trend has helped position Australia. But we also see powerful new markets will emerge that will drive a shift to resource efficiency and clean technology. Waste will be a source of opportunity and nature a source of inspiration.[5]

We will place measurable value on things we have previously taken for granted such as water and biodiversity.

And this is not in the distant future. Science and markets are already interacting more closely than ever before.[6]

The second megatrend we see is divergent demographics. OECD countries are ageing, with lifestyle and diet-related health problems. At the same time poorer countries have higher fertility rates and not enough food for millions.

On one hand this will drive an increased investment in preventative and personalised health care and on the other an increase in global trade in basic commodities of carbohydrates, protein and fat mostly as cereals, meat and milk products.

Around the world, as a species, we are on the move – moving from rural to urban cities. We are changing jobs, careers and houses more and commuting further to work than ever before. Even through the Global Financial Crisis we saw over 8 per cent year-on-year growth in airline travel and China plans to build 97 new airports.

Our future world will be connected and virtual – an 'iWorld'. Computing power and memory storage are still improving rapidly.

This has already had a deep effect on the way we do science, underpinning advances in genetics, information and communication and modelling complex systems such as climate and exploring the frontiers of space.

As more devices connect to the Internet we see its power increase. New networks are arising. Smart electricity grids will offer the same sort of opportunities for our power grid that the Internet provided to communications. We will see opportunities in energy storage, integration of renewable energy into our grids and increased energy efficiency.

The key to unlocking these challenges and opportunities will be working across the connections and not thinking of them in isolation.

These challenges, risks and opportunities are also changing the very way we do science.

The way we do science is changing

To respond to these major challenges that are so connected we will need to be good at two things: a deep understanding of the fundamental mechanisms of the world around us – that requirement has always been the case – and a deep understanding of how things are connected.

'we urgently need, as a nation, a picture of the interplay of our carbon, water and land use.'

'A personal touch' is a trend for innovation aimed at tailoring and targeting services and is exemplified by the rapid take-up of the personalised smartphones, iPads and social media.

These trends are visible, but Australia must also be prepared for shocks such as another health threat like H1N1. Science will need to help the nation prepare for the increasing threat of plant and animal diseases coming from overseas.

These fundamental mechanisms include understanding genes and how genes in all living things change over time in response to the world around them. It includes understanding the currents, temperatures, acidity of our oceans, wind patterns and rainfall and it includes understanding the nature of materials and molecular structures.

We have always been taught to break down problems so we can see things

simply, but understanding how things are connected requires us to model and comprehend complex systems. For example, we urgently need, as a nation, a picture of the interplay of our carbon, water and land use.

The insights of this new future will be fuelled by the power of our networks and computers. Our science future will be data-intensive and collaborative and globally connected.

We are currently building the next generation Australian SKA Pathfinder radio telescope in Western Australia. In its first week of operation, ASKAP will generate more data than currently exists on the entire Internet. And 160 institutions from 27 countries have already booked to use it.

The very best science has always been grounded in observation. In this new future increasingly our science will be grounded in national and global observational networks and collaborations. An example is the Argo float network, over 3000 robotic floats in the oceans around the world providing real-time data for oceans, climate and fisheries research with collaboration by 50 research agencies from over 26 countries.

What are the major challenges for Australia that will require science and innovation?

There are some things we simply must be good at, such as taking action on climate, managing our water and preventing chronic disease. This innovation will not be driven by business and will require public investment.

Australia is one of the most vulnerable of the developed nations to changes in climate because of our highly variable climate and the fact that 85 per cent of our people live near the coast.[7]

This vulnerability has driven a history of innovation in our agriculture. We have consistently developed drought-tolerant and disease-resistant crop varieties, at the same time increasing our productivity.[8] Our new cotton varieties use half the water to produce a bale of cotton compared with the varieties from the '70s.[9] Australia's cotton varieties are now used in 60 per cent of plantings in Texas.[10]

We also invested in world's best climate observation and short-range forecasting capability together with the Bureau of Meteorology and because of this we know our climate has already changed.[11]

We have seen warming in every state in every season. We have seen the maximums of each decade break the records of the decades before and we have seen fewer

really cold days with each new decade. Our farmers already know that we have seen the greatest warming in spring.

Measuring and understanding our own changing climate is also contributing to global understanding. Our research in the Southern Ocean seeks to understand changes to the westerly winds, ocean temperatures, and climate. We are looking at how layers in the ocean mix, because mixing of deep colder water with warmer surface water can influence not just climate systems but the richness of marine life in our oceans.[12]

As I mentioned, we are gathering this information from networks of sensors. Our scientists use the robotic Argo floats. These floats drift with the currents and sink down to 2 kilometres every 10 days before coming to the surface to relay their information.

Why is this important? The Southern Ocean has the deepest and largest ocean currents in the world and so its role in storing and moving heat in its currents will affect how the globe responds to warming. Our oceans absorb around a quarter of the CO_2 that human activity produces and the Southern Ocean takes up a third of that. If we were paying $10 to reduce a tonne of carbon, that represents an annual service of around $5 billion.

Another important reason to understand our climate in detail is that Australia's coastal regions are vulnerable to storm surges and sea-level rises. Over 35,000 residences in south-east Queensland are exposed to a two and a half metre storm surge, risking damage of over a billion dollars.[13] Understanding the frequency and intensity of storms and the variation in sea-level rise across our coasts will be important in planning how we adapt.

'… innovation will not be driven by business … [it] will require public investment.'

Our climate drives our rainfall. And in this wide brown land, access to fresh water has governed where and how we live in Australia. Water will be no less important for our future. Our cities will need designs that allow secure water services and wastewater and stormwater to be used.

Managing our water resources to maximise the benefit to our economy, our communities and to create sustainable healthy water systems will need fundamental studies of our rainfall, river systems and groundwater systems and

integrated pictures of carbon, water and land use.

Our emerging water market will need to be informed by science as well as economics. Water is traded in every state; in 2008 financial year, around 2,515 gigalitres of it. That's about five times the volume of Sydney Harbour. In the peak summer months, many hundreds of transactions occurred in a single day.[14]

Although there is incomplete trading and price information around Australia, the total value of the transactions in the 2007-08 financial year was about A$1.68 billion and grew to A$3.6 billion in 2008-09.[15]

Valuing water increases efficiency. In Australia, over the period that water rights were introduced there has been a 50 per cent decrease in water usage per hectare. This increase in efficiency far exceeds that in other countries that are arid, such as Spain, Mexico and the US.

One example of how we are increasing our efficiency by 10-30 per cent is a service our famers in the Murrumbidgee really appreciate: an SMS to their phones that tells them how long to turn on the irrigation, based on current data from satellites, weather, soil moisture and previous usage.[16]

We still have a long way to go to manage our water sustainably, but we simply must be the best in the world at this.

As a developed nation, a drive to a more personalised health care system and increased investment in our health services will be required. Chronic diseases like heart disease, diabetes, Alzheimer's and obesity will both stretch our health resources and drive innovation. Already there is work being done on diagnostics and treatment using high-speed broadband, which will accelerate with the rollout of the National Broadband Network.

'Chronic diseases like heart disease, diabetes, Alzheimer's and obesity will both stretch our health resources and drive innovation.'

We have a strong capability in human life sciences in areas such as immunology, biomedical devices and childhood disease. We can build off this springboard to deepen our understanding of our inherited genes and the changes to our genes in response to the world around us.

Increasingly the importance of food, nutrition and personalised health will provide radical changes to our approach to the health system.

What are the national opportunities that come from our unique strengths and capabilities?

In a resource-constrained world, basic resources like food, water, energy, marine life and mineral resources will show shifts in supply and demand and shifts in market prices.

We all understand the importance of the minerals and energy sector to the nation. Australia has 75 advanced minerals and energy projects with planned capital investment of $109.6 billion.[17] This investment is driving increasing efficiency across the whole supply chain and new innovation such as one of the world's largest CO_2 storage projects at Gorgon.

Food production demand is likely to increase by 50-80 per cent between now and 2050. We won't meet that demand without new science and innovation.

Food security is an issue for many countries. For Australia as a net exporter of food it is a potential opportunity if supply and demand changes can drive real price increases.

Australia produces just over 1 per cent of the world's total food and about 3 per cent of global food trade. In 2009-10 food exports were $24 billion and total imports were $10 billion.[18]

Terms of trade for Australian farmers have declined over the last 30-40 years, with some levelling off of the decline in the last 10 years. Farmers have been able to stay in business only by improving productivity by a similar amount to stay competitive.[19]

So we will need consistent, real price increases before we see significant volume shift and value to the farmers.

Population pressures and coastal urban growth and supply constraints are likely to drive a rise in the fundamental seaborne trade commodities of carbohydrate, protein and fat. The recent 60 per cent increase in wheat prices and 12-15 per cent in meat prices in response to supply issues in Russia and regulation changes in Indonesia respectively indicate shifts in demand and supply can have real price impacts. However, we will need to see sustained increases and less volatility.

The plant and animal science that was so critical to establishing our agricultural sector will again underpin our global competitiveness. Australian science leads the world in the understanding of the wheat genome and was a leading contributor to the recent completion of the bovine genome.

Space collaboration

I'd like now to stretch your minds a little more; to an area of science we will never know enough about, and where Australia's remoteness and vast distances provide new opportunities – space.

When I look to the future of communication, data handling and even how we do science, I talk to our astronomers.

Space is the ultimate wireless frontier. Just look at the little Voyager 1 spacecraft now about 17 billion kilometres from the Sun – about twice as far away as Pluto – and operating on less than 20 watts of power, similar to the light in a fridge. At NASA's Deep Space Communication Complex in Tidbinbilla our people still communicate with Voyager 1.

As our astronomers and deep-space communicators listen to these faint signals they are defining the future of wireless communication on earth.

Who would have known that the efforts in the 1970s of our astronomers to listen to the whispers of black holes would have led to the chip technology that permitted the development of the now ubiquitous wireless LAN.

It is used in over 1 billion devices, soon to be over 4.5 billion devices worldwide.

And our vision is expanding.

Almost 20 years ago, scientists had a vision of a telescope so large and so powerful that it could answer some of the most fundamental questions in astronomy and physics.[20]

That vision was the beginning of the Square Kilometre Array (SKA) project.

The SKA will be the world's most impressive telescope, linking several thousand antennas together, up to 5000 kilometres apart, to act as one giant telescope. It will be capable of looking back to the dawn of time to observe the first stars and the most distant galaxies.

'When I look to the future of communication, data handling and even how we do science, I talk to our astronomers.'

Australia's proposed core site for the SKA in Murchison, Western Australia, is in one of the most sparsely populated, radio-quiet regions on the planet.

In an exciting development in May, radio telescopes in Parkes, Narrabri, Hobart, Ceduna and Warkworth in New Zealand and the ASKAP antenna at the Murchison Radio Astronomy Observatory

linked up to act as one giant telescope.

This was the first time in Australasia that telescopes had been linked over such a distance. This new 5500-kilometre east-west baseline capability has 10 times the resolution of the Hubble telescope and our astronomers have already looked into the heart of a galaxy called Centaurus A.[21] Lurking in this galaxy is a black hole that shoots out jets of radio-emitting particles at close to the speed of light.

The galaxy is more than 14 million light-years distant from us, and making the new image was like photographing the head of a pin from 20 kilometres away.

And if our astronomers are pushing the boundaries of communication they are also pushing computing and data handling.

What are the new market opportunities where we have to be focused and smart to win in global markets?

The trends I described earlier are bringing opportunities for new markets and development but unlike the previous examples where Australia has unique characteristics or advantages, the opportunities I wanted to discuss now are open to global competition.

There will be market opportunities in green technologies that decrease energy, reduce environmental impact and increase efficiency and in service industries where opportunities will be unlocked by the power of networks such as smart grids, water and environmental services.

'Large, low-income markets in India and China are driving a new wave of 'reverse innovation' developing high-quality products with new price models such as Tata's $2000 car.'

The multidisciplinary team working on this project will be bringing data never before seen from the sky, at a volume never before managed, to the biggest super computer in the world, using the latest energy technology.

Australia has no free ride here and we will have to be smart, with globally competitive intellectual property, focused and ruthless in our prioritisation. Why? Because these market opportunities will be open to one of the greatest shifts in innovation we have seen in our history in manufacturing and services.

Large, low-income markets in India and China are driving a new wave of 'reverse innovation' developing high-quality products with new price models such as Tata's $2000 car and new service models such as Care Hospital in Hyderabad which has US-trained doctors and can perform open heart surgery for $6,000 compared to $100,000 in the United States.[22]

This will put game-changing price and performance pressure on manufacturing industries from the developing nations.

One example that just might make it is our next generation printable electronics and photovoltaics. We led the world in polymer banknotes and we are leading the world in printable electronics that can turn light into electricity and electricity into light.[23]

As a nation we have shown we can compete in services. We have demonstrated the global strength of our financial services sector with its credit stability and good regulation. Our banks are capitalised and profitable.

Our teams at CSIRO are already exploring how we can develop new environmental services industries based on global observation networks.

Major shifts are required in how we do science and how we invest nationally if we are to remain globally relevent

In Australia we fund science mostly on the basis of individual investigator excellence. Solving the interconnectedness of big issues requires funding mission-directed multidisciplinary teams. In Australia we've done this over the past 15-20 years, but it's a relatively small sector of total funding and really only the necessary first steps.

Global investment in R&D is growing faster than global GDP. In 2008 the US (35.4 per cent), Japan (13.2 per cent), China (9.1 per cent) and Germany (6.4 per cent) accounted for 60 per cent of global gross domestic expenditure on R&D, with Australia having 1.3 per cent.[24]

But we are smart. In 2009 we were the tenth-ranked country for new patent filings. Japan and the US were clear leaders in patent success, filing more than double any other country. Large emerging economies also performed strongly in terms of patent filings with China, Korea and Russia ranking in the global top 10.[25]

If we are to have the science quality that will give us relevance we must build on our strengths and commit to national precincts of global critical mass of more than 10,000 researchers and students,

combined annual investment of over $1 billion by all players in the precinct and appropriate computing infrastructure and collaboration.

We believe Australia can build on its existing strengths and build five such precincts in environmental science and ecology in Brisbane, human life sciences in Melbourne, resource geosciences and space in Perth, plant and ecosystems science in Canberra and material science at Clayton in Melbourne. Sydney has an opportunity to build a globally significant information communications precinct and Adelaide is emerging as a centre for preventative health and nutrition.

Conclusion

Science and innovation in Australia will take an increasing role in Australia's understanding and taking action on the most significant issues facing the nation. It will underpin the development of new opportunities, for example in food and services and space. Major shifts in how we do science and how we invest nationally are required if we are to remain globally relevant and attract the brightest and best to Australia.

Science will be central to addressing our future energy options, understanding and adapting to climate change and water usage nationally. In these areas Australia has a major contribution to make globally.

Science will also underpin new opportunities.

The world is shifting from an abundance of basic resources like food, water, energy, marine life and mineral resources to a world that is resource-constrained.

Population pressures are likely to drive real price increases in global seaborne trade in cereals, meat and milk. The plant and animal science that was so critical to establishing our agricultural sector will again underpin our global competitiveness.

Our manufacturing sector will be under pressure from new price and services models from India and China.

We will need to be very smart to compete. We will need to build smart cities with integration of design, water, energy usage, health and well-being and communication.

There will be new opportunities in our services sector such as for water, waste, environmental services and climate services to our region.

As we address the inherited genes and the changes to our genes in response to the world around us, food, nutrition and personalised health become increasingly important. This will stimulate radical changes to our approach to the health system to provide whole-of-life personalised care, not just treating disease.

Major shifts in how we do science and how we invest nationally in our innovation system are needed to meet these challenges and opportunities and to remain globally relevant.

We face highly complex problems for which we will need to develop a capacity to model complex systems from all angles. This will be supported by the multidisciplinary science we are driving in the CSIRO Flagships and University Institutes. More than that, we need to undertake entirely new innovation at the interface of these areas and build our capacity in complex systems modelling.

As global investment in R&D outstrips GDP growth, we will need global-scale precincts, powered by computing and linked to global and national networks that bring together the best teams from our universities, research and science institutes to create powerhouses of innovation.

Science will have increasing importance in Australia's taking its place in the world. It will be key to understanding and gaining insight into unique opportunities and challenges for Australia and globally.

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31 Bligh Street Sydney NSW 2000
Tel: +61 2 8238 9000 Fax: +61 2 8238 9005
PO Box H-159 Australia Square NSW 1215
ABN 40 102 792 174
www.lowyinstitute.org

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FOR INTERNATIONAL POLICY