CEDA's Top 10 Speeches
Energy policy 2007–17

A collection of speeches from the CEDA stage that highlight the shifting course of policy discussions in this space.

committee for economic development of australia

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About this publication

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About CEDA

CEDA – the Committee for Economic Development of Australia – is a national, independent, member-based organisation providing thought leadership and policy perspectives on the economic and social issues affecting Australia.

We achieve this through a rigorous and evidence-based research agenda, and forums and events that deliver lively debate and critical perspectives.

CEDA's membership includes more than 750 of Australia's leading businesses and organisations, and leaders from a wide cross-section of industries and academia. It allows us to reach major decision makers across the private and public sectors.

CEDA is an independent not-for-profit organisation, founded in 1960 by leading Australian economist Sir Douglas Copland. Our funding comes from membership fees, events and sponsorship.

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Introduction

Melinda Cilento

Chief Executive, CEDA

Few policy issues in Australia have provoked as much discussion, or been as contentious, as energy policy.

Over the past decade, the focus of energy policy has shifted constantly, from reducing the impact of climate change to reducing costs and ensuring supply. But one theme has remained constant – the need for a long-term focus and approach.

We have collated a set of speeches, delivered at CEDA energy events from 2007–17, that highlight the importance and focus of evolving energy policy.

The speeches in this volume represent a snapshot of CEDA's involvement in this facilitating discussion of this important issue. Between 2007 and 2017, CEDA hosted more than 230 events on energy, resources and mining. They were attended by over 15,000 delegates and supported by more than 75 CEDA members as sponsors. In addition, an energy policy discussion has been a regular feature at our annual State of the Nation conference.

CEDA has published seven research reports on this topic since 2007, starting with *Climate change – getting it right* in 2007 and *A taxing debate: Climate policy beyond Copenhagen* in 2009. CEDA's energy research series, *Australia's Energy Options*, started in 2011. This included three policy perspectives that covered nuclear energy, renewables and efficiency and unconventional energy options followed by a final report: *Australia's energy options: Policy choice not economic inevitability*. The final report provided key recommendations drawn from each policy perspective but also looked at the Australian electricity market and opportunities to improve its efficiency and effectiveness.

Further, CEDA's 2014 policy perspective, *The Economics of Climate Change*, examined the economic impact of climate change for Australia. The report explained how Australia's economy would be exposed without effective management of climate change risks.

During this time, Australian governments on both sides of politics have faced an energy policy conundrum; how do we address emissions reduction and the impact of climate change without increasing supply costs and risking reliability?

In 2007, against the backdrop of the resources and energy boom, fuelled by China's economic expansion, energy policy was viewed through a lens of export growth and earnings.

The landmark Garnaut Review prompted consideration of transitioning to a low-emissions economy. It charted a policy pathway to mitigate the impact of climate change. An emissions market was at its core.

For a time, nuclear energy was being raised by some as a possible solution to both reducing emissions and meeting increasing energy use. For example, in his speech to CEDA in 2009, Dr Ziggy Switkowski flagged an energy future for Australia with as much as 90 per cent of electricity derived from nuclear power. But discussions on nuclear energy, already a highly contentious political and ideological issue, stalled in the wake of the Fukushima disaster in 2011.

Most recently, the Finkel Review was tasked with securing reliability in our electricity market to ensure it stands up to the ever increasing demand for power.

Shifting energy policy has also been symptomatic of uncertainty and instability in Australian politics.

Successive governments, hampered by slender majorities and the necessity of alliances with minor parties and independents with differing reform priorities, have struggled to deliver their preferred policy agenda.

In recent years, the energy policy debate has shifted from prioritisation of environmental issues to focus squarely on cost and security of supply for both households and businesses in the face of rising energy prices.

The two constants have been the prominence of energy policy on the national policy agenda and the importance of affordable, reliable energy for our economy.

There is little doubt energy policy will remain a constant in policy discussion for some time and CEDA will keep contributing to this discussion through our events and publications.

In 2018, CEDA will continue to drive conversation on the energy sector, which has so shaped the Australian economy, examining supply and demand, policy and market developments as well as the impact of new technology and future opportunities for investment.

I hope you enjoy this collection and it provides an interesting reflection on how the energy policy debate has evolved in Australia.

Melinda Cilento
Chief Executive, CEDA

> STATE OF THE NATION ENERGY ADDRESS

> 14 JUNE 2007

> CANBERRA

Australia and China's growing resources and energy partnership

The Hon. Ian Macfarlane

Minister for Industry, Tourism and Resources (2001–07)

Addressing CEDA's State of the Nation event in 2007, the then Minister for Industry, Tourism and Resources, the Hon. Ian Macfarlane, outlined why bilateral economic relations with China was critical to the ongoing prosperity of Australia's economy.

The Minister also described the Howard Government's initiatives to tackle climate change through the creation of the office for greenhouse management and the establishment of the first mandatory renewable energy target. Finding a balance between the economic and environmental sides of the energy and resources boom would be a feature of energy policy discussion in the years to follow.

It is a great delight to be here and can I recognise Ivan Deveson AO, Chairman and President of CEDA and the many other business guests who I recognise.

It's always an interesting topic to talk about, the bilateral economic relationships that Australia holds and particularly, on this occasion, in regard to our resources and energy sector, our bilateral relationship with China.

China is, of course, the world's greatest growth market and one which Australia is exceptionally well placed and well suited to tap into. As it grows so too will our resources and energy boom continue. We have seen our total energy and mineral resource exports expand, bad weather permitting, from $54 billion in 2003–04 to $107 billion in 2006–07 and our mineral resource exports to China alone are worth some $11 billion in 2005–06 or 21 per cent of our total mineral export trade. It's no accident though that Australia is reaping the benefits of this boom and certainly we're blessed with resources, but then again, so too are many other countries.

We are where we are today through a concerted effort to build our relationship with China and the Asian region in general. We have built our credibility as a secure and reliable supplier and through our many economic reforms we have enhanced our own international competitiveness. Part of that hard work lies in the APEC framework and I have recently returned from attending and chairing one of the most critical APEC meetings of the year, the Energy Ministers Meeting in Darwin and apart from the weather being exceptionally warm, especially when you've thinned your blood out with 38 degree heat in Darwin to come back to this, the talks themselves were very, very, successful and they reinforced the importance and significance of the two-way relationship we have with a range of countries in APEC and in particular with China.

I thought today I'd talk a little about what Australia can offer beyond our endowment in resources and particularly in the areas of international competitiveness, our close relationship with China, our reputation, as I've already said, as a secure and reliable supplier and our leadership in developing and employing practical and realistic measures to minimise the impact that we have on our environment.

Our ability to develop our resources in an environmentally sustainable way is now, quite rightly, a very strong focus for Australia. When the Prime Minister addressed CEDA last year he spoke of the potential for Australia to become a world energy super power. I can only say that I agree with him wholeheartedly but for that economic potential of Australia to be fully realised, we need to act responsibly though to ensure that the environment that we live in has the footprint minimised from our expansion of energy and resources.

Contrary to Labor rhetoric, the Government has not just entered into the debate on the environment and how to combat climate change. In fact, the Howard Government started acting on this issue long before the debate was even mainstream. What is often overlooked is that while those who look for their soapbox opportunities to criticise our Government and mix with their metaphors a range of breathtaking inaccuracies and generalisations, we have in fact as a government taken action very early in our term of government and put in place a range of realistic and practical solutions to the challenge we face.

Our first action was in 1996 when Australia established the first dedicated office for greenhouse management in the world, the ground breaking Australian Greenhouse Office. In 2001 we set the world's first mandatory renewable energy target, the MRET as it is known, to increase the deployment of renewable energy, particularly in our electricity sector. This has led to great increases in renewable energy development and use in Australia and, in the case of wind, an 8000 per cent increase as a result of the MRET.

As mentioned in the introduction, in June 2004 our Government released its *Energy White Paper* outlining many key initiatives to reduce greenhouse gas emissions totalling over $700 million and including the $500 million low emission technology demonstration fund. And as a result of these initiatives we lead the world in the development of clean coal and carbon capture and storage. In a world first Australia is also establishing an international legal framework to allow the storage of carbon dioxide under the seabed, a critical step in promoting widespread uptake of this important technology.

Late last year the Prime Minister established a joint government business task group on emissions trading. This task group examined what form an emissions trading scheme might take both in Australia and globally as part of a broader climate change challenge. Ten days ago, the Prime Minister announced Australia would move to cap domestic emissions through an emissions trading scheme beginning no later than 2012. This scheme will be national in scope and meticulous and comprehensive in detail. It will be designed to take account of global developments and, importantly, to preserve the competitiveness of our trade exposed energy-intensive industries. Our Government's approach is one based on practical, realistic solutions, something that is evident in a similar way by our engagement with other countries, particularly China.

We are taking a leadership role in the Asia Pacific partnership on clean development and climate or AP6 as it is otherwise known, to deliver practical technology solutions to reduce greenhouse gas emissions. The AP6 initiative is crucial given that it includes India, China, Japan, South Korea, the US and Australia and it's the first time that the US, India and China have worked together on this issue. Collectively these countries in the AP6 account for 47.8 per cent of the world's emissions as of the year 2000 and it should be remembered in that total that Australia accounted for just 1.5 per cent. China, whose emissions were 14.7 per cent of the world's emissions in 2000, is expected to see its emissions increase to 22.9 per cent by 2050, overtaking the US as the biggest emitter of greenhouse gas. By comparison during this period Australia's emissions are expected to shrink to less than one per cent of the world's emissions by 2050.

The conundrum for countries like China and India though is how to grow their economies while keeping their emissions in check. Initiatives such as AP6, which aim to help China develop without massive increases in emissions, will be key to the world's efforts of combatting climate change in greenhouse gas emissions. Our $100 million investment in the AP6 is helping to focus efforts in government and industry to promote technology transfer and foster positive environmental outcomes. The active involvement of Australian industry in identifying ways in which AP6 outcomes can be implemented, particularly through projects in China and India has been very encouraging.

In recognition that international collaboration is critical to the success of clean coal technology, the Prime Minister and Premier Wen from China announced the establishment of the Australia China Joint Coordination Group (JCG) on clean coal technology earlier this year. This JCG was established to provide guidance to a range of cooperative clean coal activities and to identify opportunities for closer collaboration with China. Currently it is focused on joint projects in the area of coal gasification, carbon capture and storage, post combustion capture and education and training. All of these and other initiatives are and will have an impact on our resources and energy trade. I said earlier that China looks to Australia as a reliable source of quality energy and resources.

China is the largest market for Australia's export of mineral commodities. Just as Japan drove the investment boom in Australia in the 60s, China is now driving the investment boom in Australia today. The fact that China is such a huge market is also a driver of major investment here. Investing in Australian projects is a lot more than securing just the project and putting money into projects in some other parts of the world.

We have, here in Australia, the building and strengthening of the relationship between China and Australia and a relationship that has led to the establishment of negotiations on a bilateral Free Trade Agreement (FTA). As well as supporting free trading goods and services between Australia and China, the FTA is very much aimed at supporting two-way investment in each other's countries. China has invested to have easy access to the Australian resource sector through an open and transparent process and we now hope to open the Chinese resource sector to Australian investors. This will expand future resource opportunities for the value added exports of mining equipment and services and Australia will be in a position to better accommodate Chinese exports of mining equipment to meet our own needs.

The eighth round of the Australia-China FTA negotiations was held in late March of this year in Beijing and during these meetings discussions on trade and services continued and talks began on barriers to trade investment. Now I don't want to give you the impression that the FTA will happen tomorrow, because quite simply, it won't. Such agreements take a long time because of their complexity, but when it happens it will be a robust arrangement and one which will provide a huge opportunity for Australia here and in China.

Two-way investment between Australia and China is substantial and growing. The combined investment from the greater China region, which includes China, Hong Kong and Taiwan at the end of 2005 was $36 billion making the region the fourth largest investor in Australia. Through an agency of my department, Invest Australia, the Australian Government has been building on this strong performance and from April 2004 until the end of February 2007 Invest Australia played an important role in attracting 30 investment projects from China valued at almost a billion dollars with the potential to create more than 2000 Australian jobs and generate $639 million per annum in export value.

The Australian upstream petroleum industry is also another important element of our trade given its position as supplier of secure energy for our region. Given its importance, the Australian Government has provided significant funding support to underpin the expansion of upstream including the support for pre-competitive geoscientific data to aid exploration designated frontier petroleum resource rent tax relief and non-exclusive seismic policy changes.

The opportunities for investment by China in Australia's upstream petroleum industry are substantial. The Australian Government's offshore petroleum exploration acreage release, is another primary entry point for investment in off-shore exploration and to date Chinese investment in the Australian upstream industry has resulted in cautious strategic investments usually

through joint venture agreements. The Australian Government looks forward to the next stage of that relationship where Chinese explorers are prepared to submit stand-alone bids for exploration acreage.

If I turn for a moment to LNG and the Australian upstream industry is changing gear with a push for rapid development with big gas projects to meet the strong demand and growth in LNG markets. Such developments are tempered by labour and skill shortages, which could have a negative impact but, again, this is an area where the Government is addressing the issue to increase funding for education and training and through changes in workplace relations.

Demand for natural gas in the Asia Pacific region is growing strongly and Australia's reputation as a reliable, stable supplier makes our LNG very strongly sought after. While the recent decision by the Californian Government, a Governor rather, against BHP Billiton's proposed LNG terminal was disappointing, it was, after all, California's call. I note that Governor Schwarzenegger acknowledged California's need for LNG and remain hopeful that Australia can play a role in that supply. But there are many other opportunities for LNG in our region including alternative points in the North American market and rather than dwell on the disappointment of California, I can assure you that our marketers of LNG have simply moved on to the next option.

Australia is also the first country to supply LNG to China and the Guangdong LNG Contract signed in 2004 was a major milestone in Australia-China political and economic relationships. At the time this was Australia's largest single export contract ever negotiated worth some $25 billion. As well as its economic impact, Australian LNG's deal with China will have the effect of reducing China's emissions by seven million tonnes per year, a significant contribution to global greenhouse gas abatement.

Growing gas demand in China and India as well as strong demand in traditional markets such as Japan, Korea and Taiwan will ensure that Australian LNG projects have customers for a long time to come. To meet this, we expect Australia will quadruple our current LNG capacity to 60 million tonnes per annum within the next decade making us the world's third largest LNG supplier.

If we can turn for a moment to coal and the traditional source of energy. Coal highlights just how far bilateral trade between Australia and China has developed. Over the last decade our coal exports to China have grown from near negligible levels to a point where China is a very important customer. In 2006 we exported some 7.8 million tonnes of coal to China worth almost

$600 million. In 2001, for instance, coal exports to China were worth less than $70 million. Over the next five years don't be surprised to see multi-billion dollar deals on coal done between Australia and China.

Although China is a major coal producer itself as well as an exporter, it needs its own coal for its domestic uses and it needs more than it will produce. In September 2006, the Chinese Government abolished a 13 per cent value added tax refund that was paid for suppliers of export thermal coal reducing, therefore, the incentive for Chinese producers to target export markets. In November of the same year the Chinese Government also reduced the import duty on thermal coal from three per cent to one per cent, reducing the landed price of imported coal by about US$2 a tonne.

Reflecting these changes to trade policy, China's thermal coal imports are forecast to increase 17 per cent to 35 million tonnes per annum in 2007, while exports will decline by around three per cent to 56 million tonnes per annum. Australia, of course, will be well placed to service this market.

We are the world's largest coal exporter and black coal is Australia's largest single export earner with around $24.5 billion earned in 2005–06. In addition, much of the demand for coal in China is at coastal power stations located many thousands of kilometres from that country's coal mines. Australia is in pole position to supply these power stations both in terms of price and in terms of environmental and economic value our high-quality clean coal provides. The strong growth in demand for coal in recent years has placed some pressure on our coal infrastructure export terminals. However, the expansion plans for both rail and port infrastructure are well underway with new capacities coming on stream and with coal shipping capacity increasing by over 100 million tonnes by the year 2012.

We are seeing predictions, however, that that capacity will be well and truly needed with Australian coal exports expected to rise 70 per cent to almost 400 million tonnes per year and at current prices to be worth $40-50 billion a year in export income to Australia.

There are those who are not though supporting the expansion of Australia's coal industry and between (Shadow Minister for Climate Change, Environment and Heritage) Peter Garrett and (Leader of the Australian Greens) Bob Brown taking respective shots at the coal industry, some would be concerned if there was a change of government and those individuals had a major say in the coal industry's future. Let me say that apart from the dire economic consequences of taking such an action, it would have absolutely no impact on a global scale on world emissions and in fact may increase them. The world,

in fact, would be worse off without our cleaner, low sulphur coals and our Government remains strongly and firmly committed to the growth of Australia's coal industry.

The iron ore industry is, of course, another area of huge potential growth and the growth in Chinese steel production and consumption makes it a key market for Australia. China's steel production in 2006 was 419 million tonnes, which represented just over a third of the world's production. It's forecast to grow by eight per cent a year to reach 670 million tonnes by the year 2012. Of Australia's iron ore exports in 2006, just over half were destined for China representing, in fact, about 40 per cent of China's imports. As well as reflecting Australia's abundant supply of high grade iron ore, this huge trade is indicative of Australia's status as a proven reliable supplier of iron ore in our region, similar to coal, although China has its own iron ore reserves, China's iron ore production is well below its requirements. Consequently the Chinese imports of iron ore are projected to grow rapidly and that growth is to be sourced primarily from Australia.

Can I just say in conclusion that the importance of our relationship with China cannot be understated. The strong growth in China's demand for resources over the last four to five years has placed huge pressures on the international commodity markets. Any spare capacity in the system has been taken up and whether that be in mines, at ports, in ships or in skills, or even equipment such as explosives and tyres. We have seen this reflected in Australia and it's particularly noticeable in terms of coal. We have long queues of ships waiting off our coal ports.

Increased prices are providing the investment returns that are needed to support investment in new capacity and this investment is needed to provide the capacity to fully respond to the current world demand and to meet future growth. For this reason, it is important for customers like China to accept the market imperatives that dictate pricing. These imperatives ensure transparency, which in turn leads to investment, and the end result of that is supply. If customers try to blur that transparency, investment will simply dry up. The simple fact of that is, no one wins, and customers both large and small must recognise and accept that an operating market is the reality of a supplied future.

Incidentally, that's why I've been so critical of the Western Australian State Government's efforts to manipulate the gas market in that state by reserving a percentage of gas production for domestic use. It's very hard to reject Chinese pressure to interfere in market operation while state governments attempt such blatant efforts to skew the market in Western Australia for gas.

These are issues that come up in my discussions with China and the strength of the relationship we have with China is evident in the recognition they ultimately give to our market. Our energy and resources trade with China is healthy and promising but it can only continue to grow if government and industry work together to ensure that it does grow and work together to ensure its future.

I'm sure that, if we look at the long-term prospects for trade with China that this speech could have been shortened to one word and that is, bright.

> GARNAUT CLIMATE CHANGE REVIEW

> 3 OCTOBER 2008

> SYDNEY

Mitigating the impact of climate change

Professor Ross Garnaut

Chair, Garnaut Climate Change Review (2007–08 and 2010–11)

The Garnaut Review was a watershed moment in climate change policy thinking in Australia.

Just days after the release of the Review's Final Report, Professor Garnaut presented his Review's findings and outlined the key principles that would guide the development of an Australian emissions market.

In his speech Professor Garnaut insisted there was a way forward to Australia becoming a genuine low-emissions economy but, as the source of the highest emissions per head of any country in the developed world, we would need to change our ways. Central to his recommended policy agenda were an emissions trading scheme and carbon price.

It's good to be back with CEDA again, having now completed my presumptuous task. It's an urgent and large task before us. Delay is a luxury that Australia as part of the international community can no longer afford.

One of the key findings of the Review, which will change the tenor of the international negotiations before us, is that the world is rapidly approaching points at which high risks of dangerous climate change are no longer avoidable. It is making the approach rather more rapidly than was understood before our work. Mainly as a result of being realistic about the growth of emissions in the major developing countries, first of all China and then India, Indonesia and others as well, the world under business as usual without mitigation will be in a position in about 2030 that the IPCC and the Stern Review thought we'd be in about 2050.

This is a problem for the whole world. It is especially a problem for Australia. We're more vulnerable than other developed countries. Our location makes us already a hot and dry country. We live in a region of developing countries which are in a weaker position to adapt to climate change than wealthy countries, and their problems would become our problems. Analysis of the structure of our economy shows that our terms of trade will be damaged more by the effects of climate change than would the terms of trade of any other developed country. That means we should be right at the front of the developed country pack in wanting an effective global solution to this problem.

Not only are the problems of climate change especially severe for Australia, the challenges of mitigation are especially confronting for us. We have the highest emissions intensity of our economy, the highest emissions per head of any developed country. Our very strong dependence on coal is far greater than any other developed country, and greater than almost all other countries in the world. This has to change, and the change is not easy.

But we have some important assets in dealing with mitigation.These are very relevant to the story that I'm going to tell this morning. We have the human resource capabilities that are required to find a solution to the problem – the engineering, finance and project management resources that we've honed in our resources sector. These are exactly the human resources that are necessary to deal with the mitigation challenge.

We have large reserves of mineral resources, which will become increasingly valuable in international mitigation efforts, especially natural gas and uranium. We have other resources that will increase in value and other countries taking mitigation seriously. We have a very strong set of resources for low-emissions technologies. In per capita terms, we're probably richer in potential geothermal, wind, solar, wave and tidal power than any other country, certainly any other developed country. We have got some of the best opportunities in the world for the sequestering of emissions in biosequestration or geosequestration underground.

The main story I want to tell this morning is how Australia can make the adjustment to a low-emissions economy without eroding economic growth. The detailed work that we've done shows us there is a path through for Australia to being a low-emissions economy continuing strong growth in material living standards. It's not pie in the sky. You can point to the transitions, the economic costs that can get us there so that within about 40 years, we are a genuinely low-emissions economy with higher living standards than today.

The path will need to be supported by an appropriate set of policies. These include the carbon pricing that will come out of the emissions trading scheme. They include support for research development and commercialisation of low-emissions technologies. The report has discussed these at length. We have developed a package that meets the necessary and the sufficient policy conditions to support Australia through the transition.

If the world commits to an ambitious objective of stabilising emissions at 450 parts per million of carbon dioxide equivalent in the atmosphere, for us to do our full proportionate part in the global mitigation effort, that would require us to reduce emissions from 2000 levels by 25 per cent by 2020, and by 90 per cent by 2050. If the world commits to stabilisation of 550 parts per million, we will need to reduce emissions by 10 per cent by 2020 and 80 per cent by 2050. Now, some people think the second of those ambitions is a rather soft ambition, a soft target. I can assure you that it's not a soft target. It will take a very large effort in policy, plus a large effort within the private sector and through the community. But it can be done.

There's been quite a lot of discussion over the last few days, since the final report came out, about the important difference between the 450 and 550 ppm objectives on climate change impacts. The potential damages from climate change or the risks certainly would be greater with the 550 parts per million than for the 450 parts per million. For that reason, the Report has judged that the more ambitious global target is in Australia's national interest.

But there's a very much bigger difference between 550 parts per million and the absence of effective mitigation, and the risks go off the chart once you go much above 550 parts per million, if the world fails in early and effective mitigation.

The Review has undertaken a very large and sophisticated modelling exercise. The Report's transition path of the Australian economy to a low-emissions economy is anchored in this modelling exercise. We began the modelling when the Review was a state-based project. This early work had strong support from the modellers in the Queensland Treasury and some private sector modellers, especially at the Centre of Policy Studies at Monash University. When the Review became a joint Commonwealth-state exercise earlier this year, the Commonwealth Treasury joined the effort. I have with me here today two of the people who gave a lot of the strength to the technological work and the modelling work which I'll be reporting today, Ana Markulev and Tony Wood. The modelling allows us to present a very detailed base case. Then I'll discuss some of the risks to that. There are upside risks, there are chances of things being much better than the base case and there are downside risks.

The joint modelling with the Australian Treasury shows that, if we do it right, we can meet the 550 or 450 parts per million objectives. There are a lot of ways you can muck this up. I'll talk about some of them later. But successful mitigation and prosperity are mutually consistent if you get it right with continued strong growth in incomes in the Australian community. Average incomes of Australians at the end of the century are about three times as high as they are now under any of the scenarios.

Under a 550 or 450 parts per million scenario, comprehensive global emissions pricing will drive a fundamental restructuring of the economy. And what I'm presenting here today is Australia's effort in the context of an international agreement. The transition doesn't work if you don't have an international agreement.

If you don't have a carbon price driving structural change and innovation, reducing emissions everywhere in the world then we don't get good emissions outcomes. The only point of Australia doing anything in advance of the rest of the world is to put ourselves in good shape to take the big steps we're committing to once there is an international agreement. Part of this story is that we are one of the countries that committed ourselves at Rio De Janeiro in 1992 and Kyoto in 1997 that the developed countries would act first, and the developing countries act afterwards. But the solution has to come from a global effort within our global agreement with all major economies constraining emissions.

Emissions pricing will set up a long-term economy-wide marginal abatement curve that will drive the most economically efficient reductions in emissions. The private sector will find the most efficient ways of delivering on the emissions reduction target once we've got the framework in place. But large-scale fiscal support for research development and commercialisation of low-emissions technologies is an important part of the incentive structure that will make the cost of adjustment a manageable one.

A very important fact about the world, moving through this transition to a low-emissions economy is that it will be a genuinely global effort of innovation.

A tiny proportion of the genius of humanity was responsible for the first 150 years of modern economic development. With globalisation, incomes growth, the expansion of education through China, south Asia, south-east Asia and elsewhere, this innovation task will be shared by the whole world. The incentives of a rising carbon price and widespread support for innovations in the low-emission economy will stimulate generations of humanity that are more numerous, better educated, better informed, better connected and better equipped for productive innovation than any of their predecessors. One can expect innovation globally to proceed more quickly in the world that's emerging.

Global mitigation policies will provide incentives for humanity's expanded capacity and talent for innovation to be focused especially on the low-emissions technologies. Australia's emissions reduction effort will be the beneficiary of innovation everywhere, so our own approach to innovation has to have two parts. One is making sure that we are well equipped quickly to absorb and use the best innovations wherever they are happening. The other is making sure that we are contributing our own share of research, development and commercialisation. This is especially important in those areas where we have special strengths and interests. There are plenty of those in the low-emissions economy.

The work of the Review involved some of the most long-dated and complex modelling ever undertaken in Australia. We mapped structural change in the economy out to 2100. This is a longer time horizon than for any other detailed structural modelling of the Australian economy. We examined the Australian economy with and without climate change, and with different levels of ambition of mitigation. The results are presented in the Final Report.

I'll only be able to give you a bit of a taste for those results now. I hope that stimulates those of you that haven't already done so to dig in to the full Report, especially the four chapters that talk about the detail of structural adjustment in a big mitigation effort. These are chapters 20, 21, 22 and 23.

Venturing into timeframes and levels of mitigation not previously explored has had its challenges. You have to make assumptions about the level of innovation you can expect to see. This is the standard technology case, which is the first step in the modelling. We have used a set of reasonably cautious assumptions about the rates of improvement of technology. The base case assumes a steady rate of improvement in technologies where practical application is known.

We modelled two variations on the base technology theme. The standard technology assumes best estimate improvements to known technologies based on experience. The second case we modelled was an enhanced technology scenario, which assumed improvements on the standard scenario through greater energy efficiency gains, faster learning by doing for electricity and transport, and a general backstop technology in agriculture.

The third variation which we put in as an alternative to the second, was that at some time a general backstop technology would emerge which would, at some high cost, absorb emissions from the atmosphere and offset emissions elsewhere. We assumed that that backstop technology would come in at US$200 per tonne of carbon dioxide equivalent. That's about $250 Australian today. At that point on this third assumption we assumed that there would be a technological breakthrough that, at a substantial cost, would remove carbon dioxide from the air for sequestration.

There's lots of work being done in different places in the world on variations on that theme. For Australia, the best bet is probably improvements of some very old technology, some of which have quite a strong track record. One is the track record of algae, which converted a carbon-rich atmosphere in which no animal could survive into the oxygen-rich atmosphere that we have today. For algae you need lots of sunlight and a saline environment. There's quite a lot of that in parts of Australia.

Alternatively, perpetually growing trees, plantations, and then replanting once they've reached their final growing life could be a backstop technology. We don't go into that in a lot of detail. But we think that at some carbon price, like a couple of hundred dollars US a tonne things like this would start happening.

So, what trends are we likely to see in a world of effective mitigation in which Australia is playing its full proportionate part? Well, if we set up the policy structures right, we will see a rising carbon price that applies ever increasing pressure for a reduction in demand for emissions-intensive goods, and for substitution away from carbon-intensive ways of producing goods and services.

If the emissions permit markets are working well, the carbon price will rise steadily at the interest rate. Our recommendation is to start with a $20 price. All of our modelling, all of the numbers, are in 2005 prices, 2005 is the base year. So with inflation adjustments it might be $25 in 2010. If that's what it starts at, then smoothly working markets would price carbon at around $50 a tonne in 2030, $120 in 2050, and $600 in 2090, if a backstop technology hadn't emerged.

The whole forward price structure would rise with any disappointment about technologies. It would fall on any good surprises. But as the current price rose or fell, forward prices would remain in contango with an upward sloping forward price curve. I discuss in the Final Report the reasons why that's the economically efficient price path over time. The theory behind this has its origins in an area of resource economics first worked out by Hotelling 70-odd years ago.

Decarbonisation will occur earlier in some goods and services than in others, but there'll be strong pressure for it to occur right through the economy. After half a century, emissions will be confined to a small number of highly valuable goods and services which have no close substitutes in demand or supply. After the middle of the century, the increase in the cost of mitigation is determined by the resistance to substitution in supply and demand of a few goods and services that people continue to value highly, even when their prices have risen way beyond old relativities.

When our emissions are 80 per cent or 90 per cent below what they are now, the carbon price will be very high, by the starting standards. The only emissions-intensive goods and services that we will continue to consume are those to which we attach very high value, and which have no low-emissions substitutes, either in production or consumption. We can still eat our steaks and lamb chops if we're prepared to pay quite a lot in the way of a methane tax on them.

This will all be happening in a world much richer in purchasing power for goods and services than it is today. As I mentioned previously, average income is about three times as high at the end of the century as it is now in standard goods and services. We hope that our overall standard of living will be much higher than today, but that will depend on how good a job we've done of avoiding some of the environmentally bad outcomes that could seriously damage the overall standard of living.

As the process of decarbonisation proceeds, the products of newly competitive low-emissions processes can be expected to experience more rapid technological improvement than established high-emissions products and processes, so that their relative prices fall over time. At some point, part of the way through the decarbonisation process, falling economy-wide costs of newly competitive products and processes would outweigh the effects on costs through the economy as a whole of the rise in carbon pricing. I have a substantial discussion, especially in chapter 23, of the economic processes of decarbonisation.

The decarbonisation process won't come without a cost. The target for 2020 would shave about two tenths of a percentage point per annum from GNP growth, national income growth, between 2010 and 2020 under the 450 parts per million scenario, a bit less under the 550 parts per million scenario. By 2020, instead of Australians having a 17 per cent increase in after tax income per person, which would be the case if we didn't do mitigation, we'd have a 15 per cent increase in after tax incomes if we were mitigating. The modelling shows the difference in average after tax incomes. It won't be very different by 2020 whether we adopt the 450 and 550 scenario.

The difference in incomes would increase somewhat up until the middle of the century. By 2050, average income after tax will be 66 per cent higher than in 2006 if there were no mitigation, 57 per cent higher with 550 parts per million mitigation and 55 per cent higher with 450 mitigation. Then, after the middle of the century, in the second half of the century, we start to get back the small, early sacrifice in incomes growth.

The benefits of avoiding mitigation start to affect the standard economy from about 2050. The market-based economy, and so GNP growth rates are higher in later decades of this century if we mitigate than if we don't. By the end of the century, conventional incomes are a bit higher under the strong mitigation scenarios than in the absence of mitigation.

At the same time effective mitigation will have bought protection for society against increasing costs of climate change for all of time after the end of the century. It will have also bought the protection against loss of environmental and other values that we would otherwise experience from climate change. This protection will have been bought by the sacrifice of income in the first half of this century. We get the income back from then on, and in addition we get the non-economic benefits to which I have referred.

Substantial decarbonisation by 2050 to meet either the 450 or 550 commitments would move fastest in the electricity sector, then in transport. Agriculture is difficult, unless, as is possible, there are transformative developments in biosequestration.

Those of you who are interested by the detail that I'm starting to discuss now can go back to those chapters (chapters 20, 21, 22 and 23) in the Report. It's available on the web. Look at the detail there. I'll just briefly make a few points here. I won't pretend that I'll be able to explain them to you in the little bit of time we've got here today. You can go to the web and get the full explanations.

Let's examine first the path of emissions reductions by sector through to the end of the century on the standard technology assumptions, but with a backstop technology coming in when the price of carbon reaches about $250 Australian. These are physical emissions. The 80 per cent, the 90 per cent by the end of the century, are reductions in emissions entitlements which we can meet either by reducing our own emissions or by buying permits from other countries, which can reduce emissions more cheaply than we can. So, these are actual emissions, physical emissions, not entitlements. For a while we would be buying some permits from abroad.

The reduction in emissions is dominated by reductions in the electricity sector initially. Some of the hardest emissions to reduce are livestock and in the agricultural sector. It may be quite a long time before we make a lot of progress there, and so the share of livestock in total emissions will increase over time.

Under a 450 scenario, where we're having to reduce emissions entitlements by 90 per cent by the middle of the century, it all happens sooner. The world turns away from coal and gas more decisively, first of all coal and later gas. The turning away from coal happens at a relatively early stage if we're going for 450. The only coal that survives for long uses near zero emissions sequestration technology.

In the transport sector, mitigation happens in a different way in the 450 scenario than in 550. In both scenarios there is a bigger role for public transport and rail. But this happens less rapidly in the 450 scenario. The load is heavier in the 550 parts per million. But you can't reach the 450 scenario without decarbonising private transport at a relatively early date. That brings on the electric car more quickly than the 550 scenario, which slows down the shift to public transport.

Now let's look at transformations in some individual sectors. The energy sector will lead the mitigation task in Australia. A couple of points are worth

noting. The marginal abatement costs curve is driven by the ambition of the cap on emissions. In the early years of mitigation there are reductions in demand, energy efficiency and a bigger role for gas. A bit after that the focus shifts to an emphasis on renewables and carbon capture and storage. Then we get a period in which the main action is in transport, including electrification of transport.

Let me express a caution about all of this. This is dependent on assumptions that, while we worked them through carefully will not be mirrored at all in reality. In the real world ongoing innovation will change what turns out to be the best ways of reducing emissions.

With the 450 sequestration in forestry, plays a much bigger role in the first half of the century. We can't get to the 450 objectives without a lot more plantation forestry. The only forestry sequestration included in the modelling is the plantation forestry. I'll come back to other biosequestration in a moment.

In the electricity sector, the increasing value of mitigation across all sectors means that much depends on what turns out to be the economics of carbon capture and storage. The whole structure of change will be very different if carbon capture and storage works commercially than if it doesn't. If it does work commercially for a considerable period, that becomes the main source of decarbonisation in electricity. If carbon capture and storage turns out to be uneconomically expensive, decarbonisation of electricity will involve rapid replacement of coal by renewables.

The modelling says there will be rapid change in fuel use, at first from the emphasis on petrol, then with diesel playing a major role, followed by LPG. In the 2040s electricity becomes important in motor transport, then becomes much bigger and eventually dominates. Under a 450 standard technology scenario, the role of electricity and the electric car comes earlier and grows more rapidly.

I have mentioned that all of these mitigation scenarios are premised on the only opportunities for biosequestration being in plantation forestry. The opportunities in the real world outside the model are much larger than that. Chapter 22 discusses these. Some of them are potentially huge. While we haven't included these possibilities in the modelling, better use of our land has the potential to transform the mitigation task. Just take the restoration of the Mulga country. Some serious work has been done on the Mulga country in western New South Wales, western Victoria, south-west Queensland, stretching across South Australia into Western Australia. Australia has millions of hectares of that country. It is now applied to very low productivity grazing, many sheep, some cattle, a lot of rabbits, a few camels.

The bioscience tells us that restoring healthy vegetation in these areas could absorb about 250 million tonnes of carbon dioxide per annum. That could continue over 20 or 40 years. That's about half our mitigation task to the middle of the century. Similarly, sequestration in soils and the better management of existing eucalypt forests offer huge opportunities there. I hope that the work in chapter 22 leads to these issues being taken seriously in Australia. They're a big part of the story. We weren't able to get to the bottom of this big story, but handling this opportunity well could fundamentally change the Australian mitigation task.

There's a lot of interest in the future of minerals and metals processing in Australia. Within a global mitigation there will be some boost to the competitiveness of these industries in Australia. International transport will become more expensive. That will make it more economic to process minerals close to where they are. Here in Australia where the minerals and energy resources are found. But the biggest determinant of the location of minerals processing will be the cost of energy. We are a relatively low-cost energy producer based on coal now. Will we stay one? Well, if we can use our advantages in low-carbon energy production, we will definitely still be a low-cost energy producer. We will remain a good place for processing minerals into metals.

There is likely to be a period with strong global mitigation in which most of the action in new investment, for example in the aluminium sector in energy intensive metals processing is going to be in developing countries with stranded potential for low-cost renewable energy production. BHP is currently conducting a feasibility study on a huge smelting investment up the Congo, which will be based on hydro with zero emissions. There's a lot of that potential in Papua New Guinea, other parts of Africa, Latin America. But it's finite in quantity. So, we may get a period in which the new action, the new aluminium smelters go to those sorts of sites, but then the good sites will be exhausted, and we'll get back to a period where the new investment goes to what is the lowest cost source of other sources of energy. It's us if carbon capture and storage works at relatively low cost. If it doesn't, we may still be a relatively low-cost energy supplier, because of our advantages in a wide range of renewables.

Chapter 23 emphasises the importance of investment in education and skills if we're to make a good fist of this period of rapid technological change. A lot of the skills that are necessary are precisely those that are important in the resources sector, so it's a matter of expanding investment in education and skills in which we are already strong.

I will conclude by mentioning some risks, upside and downside to a low-emissions transformation. I see three main downside risks. The first is that there may not be an early comprehensive global agreement, and mitigation doesn't work without that. Chapters 8, 9 and 10 set out in detail an international approach that I think can work. I don't think it will be easy. It will be very hard. There are lots of barriers to overcome. But there is actually a way through. It will take some high-quality diplomacy, and we'll have to play a big role in that. Obviously, it doesn't work without a big effort in leadership from the United States. Obviously, it doesn't work without a willingness to participate fully from China. But I think there is a way through and the numbers that I set out in those chapters show the way through.

They're not the only numbers that will be put on the table over the next year or so. It's the first set of numbers in the world that have been put forward that actually add up to a solution. I notice the German Environment Minister came out with a call for such numbers yesterday. If he's got another set of numbers that add up that would be great. We can start to have a discussion about the best among alternative sets of numbers. I hope I've started a discussion in which what we have is a number of competing proposals which add up to a solution, not a lot of pie in the sky general statements that aren't backed up by numbers.

The second risk is that the climate change science contains a lot of uncertainty. And even under 550 or 450 there's a risk that climate change outcomes will be a good deal worse than anticipated. We're not talking about certain reduction of an amount of climate change of 550 or 450. We're talking about reduction of risks. When that's the reality, then there's always a chance that a long-odds or an intermediate-odds nag will come through and win. The relatively benign transition scenario under 450 and 550 mitigation that I've sketched could be upset by climate change turning out to be worse than the middle of the expectations from what the mainstream science now describes.

The third risk relates to unexpectedly high costs of mitigation. There's a little bit of a technological risk. I don't think much. I think on technology, the main risks are on the upside. The bigger risk is things turn out to be much better as a result of unleashing a new period of innovation.

For me, the biggest risks come from botching the emissions trading scheme. We could botch it by having a lot of uncertainty, so that business cannot develop stable expectations around the parameters of the scheme. This could be continued with argy bargy about permits so that the game of mitigation becomes a continuing negotiation, with business putting its efforts into getting government preferment rather than applying the low-emissions technologies.

There's quite a lot of risk of that. Those risks are discussed in some detail in the Report.

So, I hope today that I've sketched the path along which Australia could travel to a low-emissions economy. I know that I haven't been able to present all the detail here that would convince you that there is such a path. I hope that I've encouraged you to go back to the detail in the Final Report. There's a lot there that can take you a lot further than I've gone today. There are large changes ahead, but Australia is well equipped to handle these changes. Our established market economy and economic dynamism, the skills and capacities of our people honed in being the world's leader in the technologies and management of the resources industries and our very wide range of potential for low-emissions production of goods and services are all big assets.

The Review has recommended a necessary and sufficient mitigation policy package that will facilitate the efficient and equitable transformation of Australia to a low-emissions economy. There is a path to Australia being a low-emissions economy within 40 years, consistently with continuing strong growth in material living standards. If the subsequent policy debate follows the approach laid out by the Review, we will improve the prospects of Australian and other governments taking good decisions in the years ahead. We will improve the prospects of governments taking these decisions with the widespread community support that's going to be necessary for policy continuity over the long periods over which the policy will need to be applied. Thank you.

> URANIUM MINING AND NUCLEAR POWER

> 8 SEPTEMBER 2009

> MELBOURNE

Nuclear scenarios for Australia

Dr Ziggy Switkowski AO

Chairman, ANSTO (2007–10)

Speaking at a 2009 CEDA forum on uranium mining and nuclear power, then ANSTO chairman Dr Ziggy Switkowski issued a call to action for Australian policy makers and the community to embrace nuclear power.

Nuclear power, he argued, must be in the mix in tackling the challenges of global warming and could provide most of the solution.

Dr Switkowski predicted an energy future in which Australia would produce up to 90 per cent of its electricity needs from nuclear power. He called for the commissioning of our first nuclear reactors in the 2020s to be backed up by a fleet of 25 reactors by the middle of the century.

Good afternoon ladies and gentlemen and thank you for your interest in this very relevant, current topic around energy strategy, climate change, uranium mining and nuclear power.

I'm going to talk primarily to policy issues around nuclear energy and also try to update your understanding as to what's happening around the world in this field and why is it that there is increased interest in the deployment of nuclear power in many countries around the world, and why in Australia we are taking a different position.

So, the context. The global demand for energy, and specifically electricity, continues to grow by about one to two per cent per year. And, economic growth, prosperity and rising standards of living almost always drive a nation's energy intensity. Notwithstanding the popular rhetoric of energy conservation and productivity, the economic and social goals of all countries, *all* countries, require use of more energy not less. I believe that will be the case for decades to come.

This implies a doubling in our global capacity for electricity generation by about 2030 and probably a doubling for all forms of energy, transport, etc, by 2050. Whether I'm exactly right doesn't matter; the fact is we're on an increasing demand curve. And Australia will follow a similar trajectory, in my opinion, of demand growth. Now, there is little difficulty in meeting such demand growth; power generation technologies are well established and fossil fuels are widely available. But the challenge is to produce more clean energy, which is environmentally benign, and, as well, to follow a path which improves the country's energy security while reducing dependence upon geo-politically volatile sources of supply for fuels like oil and gas.

So, in this context there has been a revival of interest in nuclear power globally. Let me give you an example. The best case study of the deployment of nuclear energy is, of course, France. But let me take you to Italy. Beginning in 1946, straight after the war, Italy had been a pioneer in civilian nuclear power. But a year after the tragic disaster in Chernobyl, in 1986, a referendum in Italy determined the phasing-out of all of their nuclear energy. And that was also the time when, globally, all new construction of nuclear reactors was halted. And that situation prevailed for about 20 years.

By 2008, last year, Italy had become the world's largest net importer of electricity with prices 30 per cent higher than the EU average and 60 per cent higher than in France from which it imported nuclear-generated electricity. In May of last year the Italian government confirmed it would commence building new nuclear power plants within five years to reduce the country's dependence upon oil, gas and imported power. The phasing-out of nuclear power has been described as, I quote, "A terrible mistake" by the Italian Minister of Economic Development.

Italy, which is the world's seventh largest economy, now has a new vision, to be the European energy hub via a diversified strategy including a network of gas pipelines, liquid natural gas and nuclear power. And the government has plans to achieve an electricity mix in 2030 which is 50 per cent fossil fuels, 25 per cent renewables and 25 per cent nuclear. Remember they have zero nuclear today in terms of domestic generation. By then they plan to have eight to 10 large reactors in operation. A new nuclear authority will be set up by this year-end. Locations for the new plants are expected to be identified within six months, not 10 years, and construction is due to start by 2013, in only four years' time.

Motivated by hardcore economics plus the desire for more energy independence and the requirement for a cleaner energy mix from a standing start, Italy will be producing 13 Gigawatts of electricity in the 2020s from nuclear power; that's about a third of Australia's total energy capacity today. A public opinion poll in July of 2008, just over a year ago, found 54 per cent of Italians supported nuclear power and 36 per cent opposed it compared to 82 per cent which opposed it the previous year. And such shifts in positive public attitudes to nuclear power have now become familiar, including in Australia.

So, let's turn to what's going to happen in the Copenhagen global conference in December this year. What will Australia's energy and climate change representatives be reminded of when they arrive in Copenhagen in December? Fifteen per cent of the world's electricity is produced from nuclear power; 440 reactors in 31 countries. Two-thirds of the world's population gets some of their electricity from nuclear reactors and the other third would love to have that opportunity. Countries which had paused in their deployment of nuclear power: Sweden, the UK, Italy and the USA, are reactivating their programs while others such as Spain and Germany have reopened debate.

Neighbouring countries most affected by the fall-out from the Chernobyl reactor explosion and fire: the Ukraine, Russia, Finland, are increasing their nuclear networks, and others like Poland and Belarus are about to start down

this path. The UK, a beacon of climate change leadership, is committed to accelerating its nuclear build program replacing its current fleet of 19 reactors. Its Chief Energy Advisor forecasts 35 to 40 per cent share of electricity generation in the 2030s by nuclear, roughly double today's levels. The UK has established a new and sophisticated regulatory environment to support this program. The US delegation will echo President Obama's view that the US cannot meet its climate change goals without more nuclear power, and also in Copenhagen, the Chairman of the Inter-Governmental Panel on Climate Change will extend that comment to the world in general.

The countries with the most ambitious nuclear outlooks are China, India, Brazil and Russia. The most dynamic developer of uranium resources is now Kazakhstan, and some of these countries present quite interesting geopolitical challenges and opportunities for Australia. With the exception of Italy, which can purchase nuclear power, and does so, no economy of Australia's size or larger is without nuclear power; that's 14 countries. Indeed, Australia now stands alone among the world's top 25 economies in excluding consideration of nuclear power in our long-term energy and climate change strategy.

Most countries confronting the challenge of adding new and clean energy capacity have concluded that nuclear power must be in the mix for the following reasons: The technology is well-established; it's available off the shelf today and it's not dependent upon heroic assumptions of cost or technology breakthroughs in the future. Nuclear energy is truly baseload; it's optimised for 24/7 operation and couples into the national electricity grids just as coal or gas-fired power does. In terms of the whole-of-life emissions, that is, from uranium mining to reactor decommissioning and long-term storage of spent fuel assemblies, greenhouse gas emissions are low and similar to that, roughly equal to that, from solar and wind. Generating costs are comparable to coal and gas in most parts of the world, including here, when moderate carbon costs are included; such as $15 to $40 Australian per tonne of carbon dioxide per year. And the nuclear power industry fully funds its lifecycle costs including decommissioning and waste management in most countries.

Australia's energy and climate change strategy is based upon the following: expected contributions from energy conservation and productivity; accelerated deployment of renewable energy; a substitution of coal by gas; and the presumed success of clean coal technologies including carbon capture and storage. There can be no question as to the merit of pursuing each element in this approach. Probably the least problematic of these is the proposed increased use of gas. Yet because of the cost differential between coal and

gas its increased use is dependent upon a substantial carbon price for which there is not yet sufficient appetite. Of course, being a fossil fuel, its combustion continues the build-up of greenhouse gases albeit at a slower rate.

So, in Australia what we have is household demand for energy increasing – we are using more energy but talking about using less – renewables contributing two per cent to our current energy-generation capacity – only two per cent – and carbon capture and storage yet to be demonstrated as a scalable cost-effective and safe process. We may be the only country whose total energy strategy is dependent upon such fragile assumptions.

Much has been made in Australia about the fact that we are blessed with abundant sunshine and wind as if this might be a source of comparative advantage. But the opposite may, in fact, be the case. Sunshine and wind are more democratically distributed than fuel resources such as oil, gas and coal and uranium. Most countries already have plenty of sunshine and wind. That we appear to have proportionately more is a statement of our low population density, something that translates into a small economy and fewer intellectual and commercial resources to exploit those technologies.

So, as we transition to a low-carbon economy our traditional sources of competitive advantage, namely, abundant and inexpensive fossil fuels, will be overtaken by new generation technologies such as nuclear power where we have no presence, and our competitive advantage will disappear. In allowing coal to be demonised as a dirty fuel and barring any consideration of nuclear energy as an option, our policy-makers may be shaping an energy future disproportionately dependent upon technologies which may compromise the reliability, the productivity and low cost of our current electricity system.

Viewed from afar, our energy strategy seems to be more about nuclear avoidance rather than embracing solutions that seem obvious and sensible to others. And this is very frustrating. We may be pursuing a complex, high-risk, speculative path when international experience points to a simpler road forward; that is, augmenting our proven coal and gas-fired facilities with equally proven nuclear power initially to meet growth in energy demand and eventually displacing fossil fuel infrastructure at the end of its working life. This should be the plan for the next 50 years.

The study that George Dracoulis and I and our colleagues conducted in 2006 described a scenario where Australia installed its first reactor in the 2020s, in 15 years' time, and thereafter built a fleet of 25 reactors by 2050, and that could then provide a third of our electricity needs. This outlook is now too

conservative. With nuclear and environmental regulators around the world striving for consistent, simplified rules, and reactor vendors introducing more standardised, efficient and safer designs, an estimate of 15 years to commission Australia's first reactor is needlessly cautious.

For example, the plan in Italy anticipates less than 10 years. Even Egypt, new to the nuclear field, has just signed a contract with Australia's Worley Parsons organisation to project manage the construction of its first 1.2 Gigawatt electricity reactor for the generation of electricity in 2017, eight years hence. Australia could and should plan for its first nuclear reactors by 2020 aiming for a fleet size of 50 large reactors producing 75 Gigawatts of electricity by 2050. Forecasts suggest there will be about a thousand such reactors in the world by mid-century.

With a moderate additional amount from hydroelectricity, renewable and residual coal and gas this will meet all of Australia's electricity needs reliably, safely, cleanly and cost-effectively. It solves our greenhouse gas challenge in the electricity sector completely. It ensures an industrial strength energy infrastructure with baseload integrity. It provides for energy security and independence given Australia's extensive uranium reserves. It creates a modern industry of high technology with sophisticated jobs. It establishes the energy platform which can charge your electric cars and produce hydrogen gas dependably and cleanly as will be required in the latter part of the century. Indeed, the recharging of electric vehicles will drive off-peak demand and pressure on baseload generation will grow proportionately faster than, and double the rate of growth in overall demand.

And with the arrival of small 20 to 200 Megawatt gas-cooled reactors around 2015 these modular units, reactors small enough to be shipped in one shipping container, could contemporaneously be deployed to meet the needs of towns that are not reached by the main grids, industrial sites such as mines and smelters, and our growing number of desalination plants.

Now, in a room like this there'll be people who will have obvious questions. The two to come up earliest will be "What about locations for reactors?" "What about waste management?" The criteria for siting reactors include proximity to the main electricity grid, availability of water, which can be sea water, and access to consumer and industrial markets. In larger networks reactors are typically built in configurations of two to four operating units, so, 50 reactors would require 13 to 25 sites, usually these would be co-located with existing power stations which automatically satisfy the criteria above.

Let me give you some additional information. Our two most energy-intensive states are New South Wales and Victoria. New South Wales is about 800,000 square kilometres, Victoria is 238,000 square kilometres. So, Victoria is the size of the UK, which has 19 reactors in that space. France is in between Victoria and New South Wales and it has 59 reactors. Japan is a bit bigger than Victoria. It has 55 reactors. And South Korea, which is a third of our land size, has 20 reactors. Italy, which is about the same size as we are, a bit bigger, proposes to have eight to 10 reactors in the next 20 years.

All these countries have population densities much greater than any found in Australia, and in the cases of Japan, South Korea and Italy, have much more difficult and less stable geologies, yet all have identified satisfactory locations for their reactors in numbers much greater than can be contemplated in Australian states. The task of finding suitable locations in Australia is simple even if the political and social challenges may be difficult for the first step.

In terms of waste management, the US Nuclear Regulatory Commission has determined that used nuclear fuel can be stored safely and with no environmental impact indefinitely and certainly for at least 30 years beyond the licensed operating period of a nuclear power plant. Accordingly, most spent fuel is kept onsite either in pools of water, which cool and shield the fuel rods, or in dry storage ventilated concrete casks about six metres high alongside the plant. They stay there for the life of the reactor, typically 40 to 60 years, and then are transported by road or rail to national repositories for long-term storage.

The civilian industry is now 54 years old globally, so some reactors are now approaching the end of their useful lives, and decisions for the disposal of spent fuel and decommissioning of reactors will need to be addressed in the decades ahead. Criteria for selection of a repository site include a deep geological disposal site where there is low seismic activity, no nearby water flows and reasonable distances from population centres. That's 95 per cent of our continent.

If you believe and accept that global warming is a serious issue then given the choice of managing a legacy of nuclear waste produced at 1000 or even 5000 well-engineered and carefully controlled reactor locations globally versus managing the consequences of runaway climate change at the end of this century, in my view the choice is obvious. So, what should we do?

Our current national debate about greenhouse gases and an emissions trading scheme is the first step of a larger agenda. The main game, in my opinion, is to design an evolutionary path along which the Australian economy progressively moves and reduces its dependence on fossil fuels while enhancing its productivity and competitiveness. Assembling a range of novel, niche, alternative energy technologies may be interesting and intellectually satisfying but is inefficient, especially when industrial-grade solutions are available. Nuclear power must be in the mix and, in fact, we should be prepared for it to be most of the answer within a few decades. After all, France achieved this state in the 1980s with almost 80 per cent of its electricity being nuclear generated.

Here are the conclusions of a UK Government White Paper that was published last year. The UK Government "believes new nuclear power stations should have a role to play in this country's future, and if you mix it alongside other low-carbon sources that it would be in the public interest to allow energy companies the option of investing in new nuclear power stations and that the government should take active steps to facilitate this. It will be for the energy companies to fund, develop and build new nuclear power stations in the UK including meeting the full cost of decommissioning and their full share of waste management costs." To me, this seems like a very sensible starting position for Australia to emulate.

Clearly, we must have – I'm down in my conclusions here – bipartisan agreement on the legitimacy of nuclear power in our planning. No corporate, no utility will make a 10, 15 or 20-year investment, or put another way, an investment that will cover five to 10 electoral cycles unless they were confident that the policy enjoyed bipartisan support.

The work of our 2006 Task Force should be updated, perhaps by the Productivity Commission, as issues of relative costs and economics are becoming more important, and there is clearly much more data and more experience available today.

We must authorise and resource our nuclear regulators to design appropriate protocols and regimes in anticipation of a fast-growing nuclear industry. We must re-establish the tertiary-level education and training capabilities that such an industry would demand, and explore international partners that stand ready to collaborate with us.

We should start the identification of prospective sites for the first reactors, even though it's easy to run a scare campaign about "Where would you put reactors?" Let me remind you, the Italians expect to make this decision in six months. Our goal should be to have nuclear electricity supplying our grid from the first reactor in 2020. We should then have 10 Gigawatt-scale reactors by 2030. That would deliver about a quarter of our electricity needs. That would position us alongside most other countries in the world in 2030.

By 2050 we could have 50 reactors producing 90 per cent of our electricity needs. And the role for government throughout all of this? The nation needs to be clear about what our energy strategy and our goals are; what is actually driving the proposed changes to the rules? We need to work fast. The government needs to lead in achieving bipartisan support for nuclear reactor deployment, and then we have to establish a world-class nuclear regulatory authority to oversee this industry. The rest will be up to us.

Thank you.

> ASSESSING THE POTENTIAL OF NUCLEAR POWER IN AUSTRALIA

> 19 APRIL 2010

> PERTH

Understanding the formation of attitudes to nuclear power

Professor Daniela Stehlik

Lead author, National Academies Forum (2009)

In a time of increased focus on climate change and global warming leading up to the Copenhagen Climate Change Conference, the potential of new energy technologies – including nuclear energy – was in the spotlight.

The National Academies Forum conducted a 2009 study into community attitudes towards nuclear power in Australia. At a CEDA event in April 2010, the report's lead author, Professor Daniela Stehlik, provided an overview of the report's findings. The report examined how attitudes towards nuclear energy are shaped and concluded that, in Australia, attitudes towards nuclear power were polarised and essentially political. Nuclear power was more of a cultural and political issue than a technological, economic or resource issue.

Thank you all for being here today. It's a great pleasure for me to have this opportunity to talk to you all and I begin by acknowledging CEDA, the National Academies Forum, ATSE (the Australian Academy of Technology and Engineering) and Curtin University. And just a word of thanks to both Dr (Vaughan) Beck (ATSE Executive Director, Technical and Project Manager) and the Expert Reference Group for seeing me through what was a very interesting time. My presentation today attempts to encapsulate the whole project with enough detail to get you interested so that you'll actually read the report.

I'd like to begin by outlining the structure of what I'm going to be talking about. So first, an introduction to the conceptual framework. In order to understand how we came to the conclusions the report makes, it's important to see the window through which we looked at the issues, some key questions, the method we used, the findings and then some brief recommendations.

So first, our conceptual framework. As we now know, the project timing coincided with an increased attention on climate change, global warming and the challenges associated with new energy technologies leading up to what was perceived as a major global milestone in Copenhagen. As we tracked the debate over the nine months or so of the project, it was fascinating to see how our hypothesis – that attitude formation, is linked to social networking and the influence of opinion leaders – was being publicly enacted.

Common sense tells us that attitudes to new technologies don't leap fully formed into our collective consciousness. They have a past and they are continually shaped and reshaped by the present. The research, therefore, approached the key questions from the perspective of considering our attitudes as having both an historical and cultural base. While Australia, as a nation, has a reputation for quick uptake of new technologies, nevertheless, history teaches us that such an embrace of new ideas is not without its challenges. Decision making is therefore affected by perceived risks, whether real or imagined.

Our research was guided by a social construction understanding of the adoption of such new technologies. In this regard, the classic "diffusion of innovations" model can assist in conceptualising change as a wave passing through society. As society's approach to the technology in question matures the wave continues, beginning with innovators and early adopters through to the majority and finally, the so-called laggards. The now classic example of the adoption of the internet is an illustrative case.

Our research took this one step further and considered the role of opinion leaders and what has been termed the epistemic community in this diffusion model. By epistemic community, we mean those formed around particular ideas but also have some characteristics they share. They share a set of normative and principled beliefs, they share causal beliefs, they have a shared notion of validity and a shared common policy enterprise.

Individuals who share such characteristics adjust their opinions on the basis of the perceived quality of information they're exposed to as a result of their involvement in such a community. The sharing of information and the role of opinion leaders within such communities therefore became an important focus for the study. This project was primarily conceived of as a desktop analysis that would act as a ground clearing exercise about the debate thus far to enable foundation for a further, more mature discussion.

As a result, the project has developed a very large dataset of national and international literature, scholarly articles, books, media reporting, statistical analysis etc, which is now publicly available, to any future research or proposed dialogue. The research also interviewed key opinion leaders, conducted some focus discussions and delivered and analysed an e-survey using social networks within epistemic communities to consider a snapshot of attitudes held and perceived issues around energy technologies into the future.

Two case studies were developed and focused on two key periods: the first, in 2006–07, the period of uranium mining processing and nuclear energy reviews, sometimes called the Switkowski Review, and the release of the report and the subsequent fallout from that report. The second, last year, which was timed perfectly – so thank you very much Al Gore – timed around the visit to Australia by previous US Vice-President Al Gore and the lead up to the debates around climate change in Copenhagen. And if you want a pathway into the report I suggest you start by reading the two case studies, they are very interesting reading.

The research identified six pathways to attitude formation to nuclear power. These are: historical, cultural, political, news media, international and educational. The report examines, in detail, how the debate has been framed, the influences associated with these pathways and the subsequent impact of these. The following offers a brief overview. Key events have come to be used as symbols in the debate as well as helping shape current attitudes.

Such historical examples include, nationally, the testing of weapons at Maralinga, Emu Field in the 1950s and the Ranger Uranium Inquiry of the 1970s. And internationally, the Three Mile Island and Chernobyl accidents. In the cultural pathway it was very clear, doing the study, the emergence of

the fact that, as a society, we're completely submerged in cultural symbols ranging from books and films, television and now the internet media. We now only need to see one image and a whole range of associated factors are delivered to us without having to be stated or detailed.

Public acceptance of new technology is, therefore, based more often on agreed cultural and political values rather than on the potential offered by science and technology. Building on national and international evidence and drawing on the social constitution of nuclear power, the study has determined that nuclear power in Australia can best be understood as a political rather than as a technological, economic or resource issue.

Our national cultural values are shaped by media and this offers a platform for the expression of attitudes and opinions. In this drama, the language of the actors is very important and can often escalate the debate by drawing on powerful cultural symbols.

The global climate change debate which was consuming the media during the project timeline was analysed in detail on how Australians draw on international science and media examples to further their argument nationally. The study also undertook a review of research into opinions and attitudes internationally and how such research is then drawn into public debates here.

On an education pathway, the future teaching of essential science, the use of education as contributing to a lay understanding of the issues and the place that science communication, through a CSIRO example which is an attachment to the report, were detailed. The research also highlighted two key issues: first, the relationship between skills development associated with science, engineering and technology and a national understanding of the place of energy in society and, second, the knowledge about history and education about the future impacts for demands for new technology. Now, both of these aspects cross the expertise of the National Academies Forum.

Let me now turn to the key questions that shaped the research. The key questions included: What has been in the debates regarding nuclear power in Australia in recent times and what can we learn from the historical and contemporary formations of attitudes to nuclear power from international comparisons? What influences are brought to bear locally and nationally and how are such debates likely to be shaped in the future?

In brief, the method undertook a national and international review of the literature, we conducted some in-depth interviews of key informants and ran some focus discussions and we conducted an e-survey, electronic survey, did a detailed content analysis of media and undertook two case studies.

Ethical clearance for the project was granted by Curtin University in January 2009 and for the survey in July 2009 and one of the important aspects of the project was that we gave and kept confidentiality, the report does not identify individual respondents.

On the interviews, the opinion leaders, as key informants, were chosen to represent a cross section of leadership in the issues and across the sectors. And we covered as broad a range of the sectors as we could in the calling for volunteers to come forward as key informants. The electronic survey had questions shaped around their networks, the environment, energy futures, information sources, sources of advice and their own characteristics. We disseminated this through various e-networks between 25 August and 23 September (2009). Some of you in the room may have been one of the 300 respondents.

The report details both the questions, the analysis of the survey and the networks approached. So, what were some of our key findings? Well, on attitudes we found that any measurement of them remains essentially problematic. But an attitude or a behaviour is different to an opinion which is a verbal expression. It's really important that we make it very clear that when we're talking about attitudes we're actually talking about behaviour change. When we talk about opinions, that (the opinion) is something we think at that moment.

Now, attitudes are very highly dependent on salience and this is a critical finding from the report. Australians tend not to think of nuclear power as necessarily salient, that is, relevant to the way that they're thinking about the future of energy technology. We found that formation of attitudes is a long and complex process, has both gender and intergenerational differences. This is a challenge because the generations do think differently and younger people have different views than perhaps those who are currently in leadership positions.

Attitude formation also draws on individual belief systems. It operates very much in moral and political domains and so that explains why nuclear power continues to provide an example of essentially polarised attitudes. On the diffusion of new technologies, the report found that they are integrated, adapted or rejected within a social change political agenda and that we need to understand the roles of societal groups, their networks and their relationships within institutional infrastructures to really get a handle on how we can manage any adaptive change process.

On communication, the report found that it was very important to understand people's values about science and science institutions if we are to understand their particular positions on new technology and that, by simply making more information available – "let's just overwhelm people with information" – doesn't actually lead to any greater understanding or, indeed, acceptance. In fact, it can have the opposite impact.

And we also found that there's huge potential in deliberative democracy processes which offer opportunities to consider such complex technological issues within group processes and within a safe environment, in other words, within an environment that isn't politically charged. ATSE commissioned CSIRO to produce a summary of work that they conducted over the past couple of years which is an attachment to the report.

On opinion leaders, we found that they tend to have high social rank, that they're connected through socio-demographic structures by association, that they draw on collective action in framing their argument according to their audience and that they themselves are influenced by an increasingly small number of individuals.

From the opinion leaders, within the Australian context, we found that the debate in Australia is essentially a political one. There was pretty much agreement across the board. But it's important to understand the historical interrelationship between uranium mining and nuclear power and that the nation needs a bipartisan consensus if there's going to be any shift in the current status quo.

From the e-survey our respondents expressed concern about the future of water security, energy demands and global warming. They tended to favour nuclear and solar power as well as gas, hydroelectric, geothermal and favoured an increase in nuclear, solar and geothermal into the future. They did believe that nuclear power would be an important contributor to the current debate on global warming and they stated that the global climate change debate had positively influenced their own views about nuclear power.

One of the report's recommendations is associated with the fact that in Australia we tend to be guided by opinion polls rather than by a scientific basis of regular community, national attitudinal surveys. The studies found that in Europe there is an instrument called the Eurobarometer which, on behalf of the nation states, does regular polling over longitudinal periods. That has been going for many years now. The Eurobarometer is used to track attitudinal change.

Australia has nothing like that. We tend to rely on media polling and media polling usually happens at the moment of a heightened spike in interest. As a result, we have no longitudinal sense of attitudinal change. We just have media polling. So, one of the recommendations in the report is that we establish what the report calls an Ozbarometer.

Other recommendations include the establishment – the Ozbarometer is it – of a rigorous national-based instrument to measure changes in community attitudes, the development of an education and communication strategy to counter the lack of salience.

In other words, we do need to make the issue salient through education and communication and the facilitation of a multidisciplinary dialogue focusing on the future of national energy technology. Thank you very much.

> AUSTRALIA'S ENERGY FUTURE

> 13 DECEMBER 2011

> MELBOURNE

Strengthening the foundations for Australia's energy future

The Hon. Martin Ferguson AM

Minister for Resources and Energy and Minister for Tourism (2007–13)

How do we deliver secure, reliable, clean and competitively-priced energy to consumers? That was the challenge facing the Gillard Government in 2011 when many households and businesses were feeling the squeeze from rising energy prices.

Just weeks after the Government's carbon price legislation passed parliament, Minister for Resources and Energy the Hon. Martin Ferguson used a CEDA forum to release three key Government energy publications, including the draft *Energy White Paper*.

He outlined the Government's long-term strategic framework aimed at providing a sense of direction and confidence in our energy future for investors, consumers and planners, which, he said, would require a balance between government regulation and market forces.

I firstly express my appreciation to CEDA today for hosting what is a very important event for my department. I spoke at a CEDA event in Sydney on the fourth of May this year and laid out the work of the Government, especially my department in particular, was undertaking on the *Energy White Paper*. In that speech, I discussed some of the challenges facing our energy sector and reiterated my intention to release a draft *Energy White Paper* prior to the end of this year, with a view to providing policy direction to help address these challenges. I am pleased to be here this morning to deliver on that commitment.

Today I am releasing a draft *Energy White Paper* for public consultation. I'm also releasing the 2011 *National Energy Security Assessment* and the *Strategic Framework for Alternative Transport Fuels*. These three publications represent a tremendous amount of work. I would like to take this opportunity to thank my department for their contribution to these major publications. I also express my appreciation to industry for their input, which I hope will continue as we go about finalising the *White Paper*.

In my CEDA address in May I flagged that the *White Paper* would not spawn a raft of new spending, to the satisfaction of my colleague the Treasurer. The draft *White Paper* is consistent with my undertaking in May. Ladies and gentlemen, that's because the *White Paper* is about a major policy discussion in Australia.

I said in May that we are working to provide a long-term strategic framework intended to give investors, consumers and planners a clear sense of direction and confidence in our energy future. The proposed Commonwealth Government priorities in the draft *White Paper* deliver that in a way that will be affordable, reliable and environmentally sustainable.

This in turn takes us to the important issue of maintaining Australia's competitiveness. The development of the draft *Energy White Paper* has been framed around the need to maintain Australia's competiveness, which is about attracting investment and providing jobs and prosperity for the whole Australian community. Competiveness relies on three elements, three key elements, including flexibility in industrial relations, capital markets and product markets.

I am here today to talk about how the *Energy White Paper* can help the overall competiveness of our economy through sound energy policy settings. Energy is fundamental to our economy and national prosperity. The *White Paper* is seeking to support economic development by reaffirming the important role of markets to optimise outcomes from our energy sector. Markets deliver more

competitive outcomes than central planning and the draft *Energy White Paper* continues the policy work of governments since the 1980s in driving open energy markets in Australia.

This does not diminish the important role governments have in setting policy and creating an institutional and regulatory framework within which the market economy operates. The *White Paper*, in my opinion, strikes the right balance in recognising the role for government and the role for industry in delivering our shared energy future. Recognising that our energy security is critical to Australia's prosperity, the proposed priorities in the *White Paper* provide a platform for further micro-economic reform to help maintain Australia's international competiveness and attractiveness as an investment destination. The scale of investment required in our energy sector, not only to maintain and replace current infrastructure but also to meet future increases in demand, makes this platform vital to ensuring our continued prosperity.

Why the need for an *Energy White Paper*? Ladies and gentlemen, unprecedented change has occurred in the energy sector in the seven years since the last *Energy White Paper* was delivered by my predecessor Ian Macfarlane. Australia's energy exports have risen from $24 billion per annum to around $69 billion and are still rising. Global oil prices have tripled. We have seen investment in our export energy sector at an unprecedented scale in the last seven years, with over $140 billion committed to LNG projects alone since 2007. We have also seen huge changes in east coast gas markets with investments of $45 billion committed to support free coal seam methane gas to LNG projects in Queensland, bringing benefits to domestic gas competition and infrastructure as well. The growth of our LNG sector will see Australia rival Qatar to be the world's largest LNG exporter in the years ahead, in addition to our role as the world's largest coal exporter and a top three uranium producer.

On the domestic front, we have seen a significant increase in investment in electricity networks in recent years to maintain reliability and replace ageing assets. This has obviously flowed through into rising electricity prices. The Government's carbon price legislation passed the parliament last month and will drive significant investment in lower-emissions energy technologies in the years ahead. All this has occurred at the same time as significant industrialisation and economic development within our regional trading partners.

As I mentioned at the outset, there are a range of challenges facing our energy sector. This is the case not only in Australia but internationally - a point highlighted again only yesterday by the International Energy Agency Chief Economist Dr Fatih Birol in his presentation at Parliament House on the IEA's 2011 *World Energy Outlook*. These challenges are not insignificant. And I would like to take a moment now to touch on them in the Australian context.

Over the next two decades Australia will need investment of around $240 billion in our electricity and gas generation distribution and transmitting infrastructure. We need sound regulatory frameworks and covenants from investors to ensure that this necessary investment is delivered. Confidence is particularly important when talking about long-lived assets and when we are looking to private sector and, in many cases, foreign capital to invest in Australia. This therefore must be supported by further market reform to address non-market risks and improve investment attractiveness. A degree of bipartisanship is important, particularly in this capital-intensive sector.

I said in March last year that this current term of parliament would need to resolve the question of a price on carbon. The parliament has just done that with legislation now in place to implement a carbon price from first of July next year. For the energy sector, I do not believe the Coalition's repeal proposal is feasible. This sector needs certainty not policy that changes with the electoral cycle. We must now seek to implement the carbon price in a manner that allows us to continue to maintain reliability in our electricity system and continue to attract investment. This in turn brings me to the all-important question of energy security.

You and I appreciate that energy security will remain a fundamental challenge. I have touched on our investment requirements and if we can pull through investment I am confident that we can reliably meet future energy demand requirements. In the electricity and gas sectors our energy security will largely require domestic investment and prices may increase in response to the investment task. In the liquid fuel sector, we are part of a global supply chain. In this sector, to a much greater extent than electricity or gas, our energy security is also reliant on these international supply chains. This global supply chain helps provide our energy security but can also create pressures and our refineries face stiff competitive pressure from our regional mega refineries.

The 2011 *National Energy Security Assessment* that I'm releasing today shows that overall our energy security remains strong – rated at moderate or above over the short, medium and long term for electricity, for gas and for liquid fuels.

As I touched on earlier, the community has experienced a period of rising energy costs, for instance, 40 per cent in the case of residential electricity prices over the last three years. This largely reflects significant investment in electricity networks to maintain reliability, replace ageing assets and upgrade networks to meet growing peak demand.

Fuel and gas prices are also rising, reflecting increased demand and rising production costs. The Government is very aware of the pressures this is placing on many households and businesses. Unfortunately – it is time to be honest – there is no easy fix to this issue if we want to maintain reliable supplies of energy into the future. However, it is incumbent on governments at all levels to ensure that energy policy frameworks are efficient and do not impose unnecessary costs.

We must also ensure that our social policies are looking after the most vulnerable in society. That is why the Australian Government has increased pensions, cut tax rates, increased the childcare rebate, introduced the education tax rebate and programs like the Teen Dental Plan and paid parental leave. These are all measures that go a considerable way towards easing the cost of living pressures on the most vulnerable families in the Australian community.

Let us now turn to the all-important question of resource development. Australia is currently experiencing historically high terms of trade and significant activity in the development of our energy resources. This activity is obviously creating strains and is drawing labour and capital away from other sectors such as the tourism sector for which I also have national responsibility. Responsiveness in the economy as a whole is important to manage these pressures. Furthermore, in recent years we have seen significant growth in coal seam gas extraction, particularly in Queensland. This will affect the east coast gas market particularly from around the middle of the decade when exports are scheduled to begin from Gladstone.

It's important that resource development occurs in a manner that minimises disruption to both other industries and the environment and involves appropriate engagement with land holders. There are no quick fixes to any of these challenges. But a strong foundation for energy policy gives us the means to plan, invest, innovate and, above all, evolve. I therefore go to the *Energy White Paper*.

To address these challenges, the draft *Energy White Paper* has four policy priorities. The first is strength in the reliance of Australia's energy policy framework. Energy policy is never complete or finished, it will always evolve. In many ways, the pace of that evolution has accelerated in recent times – an acceleration that will likely continue in coming years. Therefore, in this draft *White Paper* it is proposed the Government undertake a regular four-year review on national energy policy to ensure that the framework remains appropriate, relevant and responsive to circumstances.

We will also continue to deliver the *Australian Energy Technology Assessment* every two years to build a more transparent information base on energy resources, technologies and fuels, including their comparative costs and commercial maturity. And finally, we'll commit to an assessment of energy security for the *National Energy Security Assessment* every two years.

The second priority is to reinvigorate the energy market reform agenda. The draft *Energy White Paper* appropriately reaffirms the Government's belief in a market-based approach to energy policy. Well-functioning and appropriately regulated energy markets are essential to the delivery of reliable and secure energy. Energy market reforms over the past decade and a half have served Australia well. It has also meant bipartisan support at a Commonwealth and state level. But with rising cost pressures and a large investment challenge looming, all governments need to set a clearer path for better functioning energy markets.

Improving the competiveness and efficiency of our energy sector is important to delivering the best outcome for consumers – both industrial and household. This is about further privatisation of energy assets and the removal of retail price regulation to do away with distortions that deter investment and are harmful to consumers' needs and interests. Furthermore, the period ahead must entail increased consumer engagement so that energy customers better understand investment and price drivers and have greater information to empower them to make informed decisions to help manage their energy use and associated costs.

Peak demand is a particular issue requiring further detailed work. At the moment, we are seeing significant deployment of air conditioners, which place strain on our electricity network, often at peak times. For instance, a $1500 air conditioner when used at peak times can impose a cost of $7000 on the electricity system. These system costs are then cross subsidised by all other consumers. Hence it is important that we undertake further work to examine whether there are energy efficiency measures on demand side measures that can economically reduce peak demand and ultimately reduce costs to consumers.

We must also work to remove or harmonise the range of distortions that deliver different levels of government in terms of their activities, with respect to those initiatives, have imposed on energy markets such as feeding tariffs. In this context, I'm also today announcing that the Commonwealth will no longer proceed with the introduction of emission standards on all CCS ready requirements for new coal-fired power stations. With the passage of legislation last

month to introduce a carbon price we need to let the market determine the most efficient investment outcomes within the energy market carbon price and renewable energy framework.

In terms of different fuel sources, the *White Paper* identifies the key role that gas is likely to play as a transition fuel in our downstream energy market. In this respect, the Government will enhance its monitoring role to better understand market developments to help inform policy development. These energy market reforms are challenging and require cooperation across all levels of government. In this respect the record to date of the Ministerial Council on Energy, now the Standing Council on Energy Resources that met in Melbourne last Friday for the first occasion, shows our governments can deliver reforms that benefit consumers.

Moving now to our upstream industries, the third priority area is the need to continue to develop Australia's energy resources, particularly gas. Largely reflecting economic development of our region, global energy demand is predicted to rise by 40 per cent over the next 20 years with around 90 per cent of this growth coming from non-OECD counties. Ladies and gentlemen, Australia is extremely well placed to meet this demand due to our abundance of energy resources including fossil fuels, uranium and renewables. And let's not forget the strategic importance of Australia's position as one of only three net energy exporters in the OECD.

With this abundant and diverse resource base, we must continue to develop a pipeline of competitive projects to maintain our enviable position as a reliable, high-quality energy supplier to our region and a world-class innovator and developer of new technologies. The development of Australia's gas reserves over the last decade will be critical, not just for export but also for our domestic objectives. As a lower-emissions fuel it stands to play an important role in the development of our electricity sector as a fuel or feed stock for downstream industries.

In my CEDA speech in May I said that the Government would seek to ensure the development of our gas resources occurs in a manner that optimises economic growth, revenue and infrastructure as well as supporting community and regional development priorities. In this respect, the Australian Government will pursue an active approach to the development of its offshore gas resources. This includes updating retention lease arrangements to help ensure offshore projects are developed in a manner that best meets the objectives I articulated in May.

In terms of calls for the introduction of a domestic gas reservation policy, the Commonwealth policy position reflected in the draft *White Paper* is that policy intervention to force domestic gas outcomes is unwarranted. However, there is a need to monitor market dynamics to assess whether policy settings are delivering optimal outcomes given the growing domestic use of gas. This monitoring will occur and duly inform government decision-making.

The *White Paper* articulates a policy position whereby the Commonwealth will have regard to the potential for projects to supply the domestic gas market when considering granting a production licence. In developing our gas resources, the safety of workers and the environment will always be our foremost consideration. And that is why the government has established a new national offshore petroleum regulator to commence operations from 1 January next year.

The same considerations apply equally to developments onshore although in this sector states and territories not the Commonwealth are the prime regulators. More specifically with respect to the CSG sector, the initiatives for the Standing Council on Energy Resources announced last Friday are important in seeking to harmonise state-based regulations in the CSG sector. The Commonwealth has also announced its intention to establish a new independent expert scientific committee to give advice on approvals where they have significant impacts on water.

The fourth priority is accelerating cleaner energy outcomes. The scale of transformation proposed as we move to clean energy technologies is unprecedented. Investment of $200 billion in all forms of electricity generation is forecast to be required between now and 2050. The Australian Government has a comprehensive package of measures with carbon prices and the expanded renewable energy target prominent amongst them designed to accelerate clean energy technology outcomes.

As a government, I remind you we have committed up to $17 billion to support clean energy knowledge and drive down costs. We are targeting government support at those technologies with the greatest potential benefits. Government support for R&D demonstration and commercialisation of clean energy technologies is about learning lessons to help further commercial deployment and drive down costs. With respect to costs we must also be honest when discussing clean energy technologies. They are expensive. For instance, just about all clean energy technologies as they currently stand require some form of government assistance or cross subsidy to operate in a commercial environment and the community as a whole are paying for this.

Given these current cost challenges we cannot afford to limit our options. We need technological breakthroughs wherever they may come from whether that is in solar, ocean, geothermal or carbon capture and storage. Technological breakthroughs are important because if they are not achieved, future governments could face difficult decisions when balancing the need to maintain reliability with competitiveness. The *Energy White Paper* is about putting in place a framework to help deliver good policy to best equip markets in the context of the range of government support for R&D and deployment to determine technology outcomes.

Can I say in conclusion as with any kind of a structure the foundations of Australia's energy sector need to be strong. I thank the *Energy White Paper* Reference Group, many of whom are in attendance, in particular for their expertise and feedback through the draft *Energy White Paper* process. Today we begin a process of extensive consultation. My department will conduct information sessions in every state and territory capital early next year and written submissions are invited until mid-March. I hope to release the final *Energy White Paper* around the middle of next year. But as you and I appreciate, energy policy is never complete. It must and it will continue to evolve.

The draft *Energy White Paper* articulates the changes, priorities and challenges facing Australia's energy sector. I commend it to you and in doing so express my appreciation to my department represented by secretary Drew Clarke today, the *Energy White Paper* team led by Bruce Wilson and my own personal staff for the wonderful work they have done under intense pressure over the last month. I encourage you to consider the *Energy White Paper*, to participate in a consultation process and, in doing so, assist government in strengthening the foundations of the energy future of Australia and, in doing so, guaranteeing our economic prosperity.

I thank you for the opportunity to address you today.

> ENERGY FUTURES SERIES

> 13 NOVEMBER 2012

> PERTH

Renewable energy financing models

Jillian Broadbent AO

Chair, Clean Energy Finance Corporation Expert Review (2012–17)

A shift towards cleaner energy is critical for Australia to face the challenges of climate change. This poses both economic challenges and opportunities for the country. As part of a fundamental push towards renewables, the Gillard Government announced the Clean Energy Finance Corporation (CEFC), a $10 billion fund dedicated to investing in clean energy, in October 2011.

At a CEDA event in Perth, Chair of the CEFC Expert Review panel, Jillian Broadbent, outlined a raft of potential economic benefits for Australia's economy if we positioned ourselves to take advantage of the coming growth in clean energy. She argued the substantial benefits warranted significant government investment in the emerging clean energy sectors.

Thank you. It is a pleasure to be here at a CEDA function. I've participated a lot on the east coast but I haven't been over here with CEDA. I was on the board of Woodside for 10 years so I'm very familiar with the east-west trip and I am very happy to be back here in a different capacity.

I'm not an energy expert. I'm an economist and a financier. My interest in the Clean Energy Finance Corporation is the role and contribution it can make to the diversity, vibrancy and resilience of the Australian economy.

Despite the differences in policy approaches of the Government and Opposition, there is a bipartisan agreement that the world is becoming carbon constrained and that Australia requires a renewable energy target and an emissions reduction target to position it for this environment. A shift towards cleaner energy is critical. This requires continued responsiveness in public policy and a substantial investment in energy efficiency and the deployment of new generation capacity. Mobility in both our labour and capital resources is vital if we ask to prosper through the global drive to reduce carbon emissions.

Australia has shown itself to be very adaptive through several decades of significant changes in the global economy. While economic performance in many countries is patchy and volatile we have sustained our economic growth and our low inflation over a 21-year period without a major downturn. Our Gross Domestic Product has doubled over that time. Our unemployment has fallen from 10 per cent to stay around five per cent.

These economic outcomes don't just happen. They are a consequence of appropriate public policy, businesses and households and the workforce adjusting to structural change, both global and domestic. It is worth considering Australia's economic performance over the last two decades and the changing forces at work as it is encouraging for our capacity to adjust to a carbon constrained world and to expand and strengthen our clean energy sector to achieve this.

One of the external forces at work is the shift in the source of global growth. The much-used Asian Century is the recognition that world growth is being driven by Asian developing countries, like China and India, rather than the developed world, which dominated world growth in the previous centuries. Contributing to this shift is the transfer in manufacturing to the lower-wage structure of the emerging economies. The jobs created there and the consequence of urbanisation it drives is further supporting their economic growth and feeding back into the demand for, and the price of, Australia's mining exports.

Consistent with the long-term global trend, manufacturing in Australia is becoming a smaller sector of our economy and the service sector has expanded to provide employment for our growing workforce. This shift in the share of economic activity to developing countries, not just Asia but more broadly, has accelerated since 2008. As challenges to the banking system and fiscal imbalances in Europe, the UK and the US in particular have slowed the recoveries in those economies, the share of the emerging economies in global growth has increased from 30 per cent 20 years ago to a current level of 75 per cent. And since the Global Financial Crisis 75 per cent of world growth has come from the emerging nations.

The divergence in economic growth rates between the developed and developing countries has some parallels for us on the national level and at an industry level. The changing global dynamics are feeding into the Australian economy and, in turn, into our individual states. Growth now is favouring the resource-rich states. You're lucky to be one of them. For the first time since federation, Western Australia is making a contribution to the Federal fiscal budget.

We are experiencing very different growth rates paths in the mining related and non-mining related parts of our economy. For the first 15 years of our 21 years of consecutive growth, household demand was the prominent factor driving growth. The key driver now is mining investment. Importantly we have been able to keep unemployment low through this transition. We are now building our capacity to meet the Asian demand for iron ore, coal and gas. We are undertaking one of the biggest resource investment upswings in our history. The consequent high Australian dollar is a heavy burden on our manufacturing, tourism and education exports. These changes require significant adjustments.

Despite substantially slower growth in retail sales and housing construction, in the non-mining parts of the economy we have maintained trend growth at a national level. Our continued growth and low unemployment is in sharp contrast to the experience of other developed countries where the transition to lower household leverage and consumption expenditure has been far more painful. The adaptation required in shifting our labour and capital resources from servicing household demand to mining investment is not without its pain. It carries losses in jobs and losses in capital.

A parallel challenge for Australia is our transition to a lower-emissions economy. Federal and state governments have designed policies to support this transition. The flexibility and adaptability that has sustained Australia's growth through these global dynamics over the last 20 years needs to be

directed into energy production and consumption. Adjustments can be slow and disruptive as companies decline and others emerge but our track record in making them is a good one.

Traditional finance is slow to move to new areas and financing any transition is critical. As governments globally implemented stimulus packages in response to the negative growth of 2008 with the GFC many were directed to the clean energy sector. There is currently a tightening of funds into the renewable energy sector as the European countries address their budget deficits. But there was certainly a boost to renewable energy when – I think it was the end of 2008 – all the finance ministers met and came away saying "we've all got to spend on something to stop the world going into a decline". The renewable energy sector was a real beneficiary of those initiatives.

In the US, the package resulted in a doubling of renewable energy power, generation and unprecedented investment in energy efficiency, advanced bio-fuels and green manufacturing. China also was one of the largest investors in renewable energy. With these global investments, there has been a fall in the component costs of wind and solar energy projects.

There are both defensive and opportunistic reasons why the clean energy sector warrants business attention and government support. It is not just a means for fulfilling our country's commitment to reducing carbon emissions but an opportunity to position Australia in an important growing global industry sector – that of clean energy, energy efficiency and lower emissions. It can support the development of businesses, jobs and export opportunities around this sector and play a critical role in maintaining a buoyant economy in a changing global environment.

Substantial investment is required in the shift to cleaner energy. The early stage of our clean energy industry and the market barriers encountered during the industry's development exacerbate the challenge of mobilising these investment funds.

In October last year, I was asked by the Government to chair the review to develop an implementation plan for the establishment of the Clean Energy Finance Corporation. A focus of that review was to examine the presence of financial barriers, consider ways of addressing those barriers and whether the positive externalities justify doing so. We completed that review. We had consultations with about 80 different industry participants and received submissions from 175. We absorbed that information and the review was completed in April this year (2012). The Government accepted all our recommendations and the legislation for the establishment of CEFC was passed in July (2012).

A partial board has been operating since August and we have selected our CEO. I'm waiting for the Government so that I can announce this. The board – the partial board – has been meeting weekly. We've been working on our investment mandate, our solar strategies and our industry relationships. The five directors have rolled up their sleeves and are off on tasks. We're trying to move very quickly to be positioned for when the government appropriations are available in July 2013.

The CEFC is a fund set up to invest its own funds and to capitalise private sector funds into renewable energy, low emissions and energy efficiency. It is designed as a $10 billion investment fund off-budget. A key principle of its operating framework is to take a commercial approach. The commercial approach requires investments to be developed beyond research and development stage and have a positive expected rate of return and a capacity to repay capital. This approach is critical to financial self-sustainability at the CEFC and its intention to operate with minimal budgetary assistance.

Its broad objective is to apply capital through a commercial filter to facilitate and increase the flow of funds into the clean energy sector thus preparing and positioning the Australian economy and industry for a cleaner energy future. With commerciality being the primary filter for investments in the initial stages of the CEFC, the support of a co-financier is expected to be a prerequisite for CEFC funds. There are two distinct but related goals for requiring this co-financier – firstly to increase the total amount of funds available and secondly to enhance the expertise and capacity of the financial sector to fund clean energy investments going forward.

We will be focused particularly on identifying financial barriers in clean energy financing which the CEFC might impact. The common financial barriers we identified in the review were availability, tenor and cost of finance. The impact of these barriers is specific to each project and will not apply evenly across the sector. Ultimately barriers affect the risk return assessment of potential financiers and their consequent willingness to invest. The individuality of each project necessitates a case by case approach, with each project potentially receiving different terms. Consistent with other green investment banks globally, the principle will be that the terms of investment would be the least generous required for the project to go ahead.

As participants in the clean energy sector can attest, the appetite for investment in clean energy has fallen sharply from its pre-2008 level. European banks who are very active in this sector have retreated back home. There has been a reduction in the risk appetite across all financiers. With less capacity to raise long-term liabilities, and pressure to match their assets and

liabilities, banks have been shortening the terms of their lending. They have also reduced the size of their teams dedicated to renewable energy and clean energy generally.

As an economist, I believe in the market being the preferred mechanism for the optimal allocation of capital and resources. In areas of national importance and long lead times on investments, however, government can play a critical and supportive role. Their challenge is to find the right balance between encouraging a sector's development and using the market to support success and allow failure. The CEFC is intended to support the clean energy sector in its transition towards greater efficiency. It is a policy mechanism to mobilise private sector disciplines and skills for a public policy outcome. It has the capacity and flexibility to provide financial support to clean energy projects and technologies.

As a corporation independent of government, and with what we hope will be a broad investment mandate – we're meeting this Thursday to go through the fine wording of that – it can adjust quickly to market changes and needs. While each investment will individually support the sector, it is the cumulative impact of the positive externalities of expanding the sector experience, lowering the first mover barrier costs, moving down the cost curves and creating third party benefits which are essential to positioning Australia for a cleaner energy future. The CEFC board has been progressing arrangements with other related government programs as the CEFC has the capacity to enhance the impact of these programs.

Low Carbon Australia was a fund set up under the Rudd Government with about $85 million of investments in energy efficiency. It's the intention that Low Carbon Australia's activities get merged into the Clean Energy Finance Corporation. The two organisations are currently working on how to make this happen. Low Carbon Australia has done a great job establishing pilot programs and we're expecting to build on them. They're active with major financial institutions to intermediate and aggregate smaller transactions and provide supportive funds to progress them.

A critical partnership for the CEFC is with ARENA, the Australian Renewable Energy Agency. As the CEFC seeks to promote technology along the innovation chain, the projects funded by ARENA provide a potential pipeline of projects for us. I'm pleased to report that ARENA and CEFC are already in discussions about ensuring a collaborative approach and a clear interface with the market. The key difference between ARENA and the CEFC is primarily that ARENA is a grant maker and the CEFC is a loan maker and expects repayment. This however does not prevent a project proponent receiving contributions from both organisations.

Greg Bourne the chairman of ARENA describes our relationship as a hurdle relay; he's running across the hurdles to the first person passing me the baton. And while I'm supportive of that analogy, I'd say if you haven't got to the commerciality stage I might not be able to reach that baton. I hope I won't drop it but we'll be trying to work together to see if our assessment of whether the project can be financed by us is achieved.

The electricity industry's future will ultimately be transformed by widespread adoption of renewable power, electric cars and smart meters. Green energy is expensive but it is getting cheaper. Black energy is getting more expensive. Early action towards the transformation to increase renewable energy alternatives minimises the ultimate cost of disruption to the economy. No action leaves us very vulnerable. Australia is an energy exporter. We have been accustomed, not so recently but historically, to a low cost of energy. The recent increases in energy and transmission prices both in the eastern states and in the west, and tougher economic conditions in the non-mining sectors together with government support, have stimulated investment in energy efficiency and lower emissions.

Despite our economic growth, electricity consumption has slowed. The development of Australia's clean energy capacities is essential to industry's preparedness for a carbon constrained world. Our geography, our renewable energy resources and our adaptive engineering skills are well suited to Australia playing a significant role in the clean energy sector. Our strong infrastructure servicing skills can certainly add value in the application of clean energy technologies and their modifications.

As Asia's investment in clean energy grows so can Australia's prosperity as we build the technology, design, construction and operating skills to service the sector. These skills can be applied domestically and in the export of services. Finance is critical to this development and the CEFC is a catalyst to mobilise this finance. The first tasks of the board and the CEO are to determine the initial area of focus of our investments, to communicate to the market what they are and to establish processes for attracting, managing and accessing the investment proposal.

Thank you.

> GLOBAL ENERGY FUTURES: INTERNATIONAL SPEAKER

> 13 NOVEMBER 2013

> BRISBANE

Energy technology and the equation for a sustainable energy future

Dr Michael Weinhold

Chief Technology Officer, Siemens Energy

Australia is a country rich in solar, wind and hydro resources yet our take-up of renewable power sources has been problematic, while countries in Europe have firmly embraced it. CEDA gained an international perspective on sustainable energy from Siemens Energy Chief Technology Officer Dr Michael Weinhold, when he visited Australia in 2013 and spoke at two CEDA events.

In this forum on Global Energy futures held in Brisbane, Dr Weinhold drew on the European experience to make the case that the answer to how we achieve a sustainable energy future isn't in reducing electrical energy consumption. Rather, he stressed, we need a holistic approach to supply electrical energy.

Hello everybody, good afternoon. In Germany it's a little bit after midnight, we have unfortunately 14 hours' time difference, but I'm wide awake, and I'm looking very much forward to exchanging thoughts with you. In order to kick off that discussion, I would like to present our view on what's going on in the energy system, what are the key levers to pull more efficiency in our infrastructure, and how that will move on. I'll give you my perspective on that.

Now first to understand how we tick at Siemens. We are aiming to be the trendsetting company in the market segments that we serve. So, we're not a follower, we are a trendsetter. That means also we are investing heavily in R&D, and we are filing 30 patents each day on average. And part of my task is making sure that we protect our portfolio by our proper representation, not only patents, but also in sanitisation regulation bodies.

In the energy sector, we are covering a wide range of applications of the conversion chain, starting in subsea oil and gas technologies. That's the start, where many fossil fuels get into the system in oil and gas exploration, and moving on to power plant technologies, fossil power plant technologies, renewables. We are number three globally overall in wind power technologies, number one in offshore technologies. And then we have the grid technologies. I will talk later of that. It's a very wide span, moving not only electrons that are competent but also moving molecules. But the core of Siemens is moving electrons from the generator via the grid to the end usage. And these are exciting times these days, as energy efficiency increase is heavily linked to increased electrical energy usage.

So many, many studies that analyse how to raise energy efficiency in infrastructures point out more application of electrical energy. Therefore, I also cannot understand, for example, targets of governments when they say, "We want to lower the electrical energy consumption overall". That's a disconnect. We have to take a holistic approach, looking at infrastructures, and that means applying more electrical energy, of course wisely, in buildings, in industry.

We spend an enormous amount of effort in tweaking out fraction of percentage points in our power plant technologies. That's a major, major focus of our work. And therefore, on the other end of the conversion chain, at the end usage, it hurts me a lot if energy is just wasted. For example, in lighting, still using incandescent lights which are actually heating equipment. And there was in Europe a company that was claiming they were selling heating equipment, because there was that ban on 100-watt light bulbs, and now I think it's also the 60-watt light bulb is banned, and that company was saying "Hey, let's sustain the market by not selling light bulbs, but selling heating equipment, the

heat bulb, and the light emission is just the parasitic event we cannot prevent from happening". Unbelievable. Heat bulbs.

No, that's not our business. We are striving for efficiencies. Not only efficiency alone in each component of the conversion chain, but also looking overall at systemic efficiency and I will come later to that. It means crossing over into other infrastructures, into the heating and cooling sector, also there will be in the future increased crossovers into the chemical sector. I'll come to that later.

Now, as I pointed out, efficiency in end usage is a key lever for many industries, for the cement industry, for example, you see other industries in steel, we are also providing our customers with steel mill domain with technologies that really raise their efficiencies substantially, or paper mills, just thinking about that, also a lot of energy being utilised. And that's what we are serving, that's what our cause is about, raising the efficiency in those infrastructures. Also in building, we have a building technology branch that does state-of-the-art climatisation and so on, technologies to raise the efficiency of buildings since buildings and industrial usage are the main load in our infrastructures.

When we look at the front end where electricity is being generated, we have to consider that each region of this world ticks a little bit differently. That's depending on where you are in the set-up of your energy system, in the set-up of your electricity system. It's also dependent on what resources you have at hand.

Well, here in Australia you have everything. But in Germany for example we are not that rich in natural resources. We have almost used up all of our hydro power plant potential, not much left, and concerning biomass – Germany is heavily populated, so the biomass only contributes a small amount to the electricity sector, for example. And, by the way, biomass has that inherent disadvantage that the photosynthesis in nature works with less than one per cent efficiency, and then coming back to the solar panels, they work with 16 per cent or even more percentage of efficiency.

Looking at utilising land for generating renewable power, it's best to utilise wind power and then comes photovoltaic, or you do both, and have a hybrid set-up. So, biomass only plays a significant role in those countries which have very few people and a lot of countryside and forest, like in Finland for example or in Brazil, in parts of Brazil, where they have a huge potential utilising the bagasse of their sugar cane fields. I was there two years ago and we discussed that if they would use those left overs completely for power generation, they would be able to produce something like 10 gigawatts of electricity in the Sao Paulo region. That's already coming pretty close to the load of that region. So, each region ticks differently.

But what they have in common, they are moving more and more towards electrical energy, that's the overriding theme. And the innovations that are being worked on globally, they are exchanged right away. So, there is no closed innovation taking place anymore. We are a global community, and the internet is the key enabler for this collaborative movement, for this, I call it swarm intelligence, that we have globally. And we at Siemens we tap into that swam intelligence quite heavily, that's also part of why I am here. I want to listen first hand to the creativity of the people living here, working at research institutes, and I want to listen to your swarm intelligence here in the room to get new ideas.

Last week I was in Norway and they are very rich in hydro power. They have in their electricity sector 99 per cent of electricity covered by hydro power. We would have an excellent synergy with Germany if we would build transmission lines between northern Germany and Norway so we could have synergies between our immense wind power plant fleet in northern Germany, and the hydro power plants in Norway. So, I hope that we will see those lines. There's no technological barrier, we can build that, no problem. We also discussed a couple of years ago with an investor a connection between Iceland and Germany. That's 2000 kilometres – no problem, we can build that.

If you think about bridging distances on land, going DC, there is no limitation anywhere. We discussed with investors already 4000 kilometres of DC transmission, not here in another continent, but it's also no problem. We have moved now to ultra-high voltage DC. Ultra-high voltage means the further you're up with the voltage, the transmission voltage, the less losses you have. They go down with the square of the voltage you use. We have that technology. So, you see each region ticks differently concerning the usage of the mix, but each region is going more and more into electricity.

Now, just to show you a little bit of what we have ahead as a global community. The whole continent of Africa has less installed power generation equipment than Germany, but there are 10 times more people living in Africa than in Germany. And they are so rich in natural resources. So, a lot lies ahead of that. And they were also part of the talks I had in Norway.

So where does Australia fit in here? Where are you going? I will be listening very closely later on. For sure Australia is rich, for example in conventional and unconventional gas resources. It's one of the richest countries also concerning coal, uranium, solar, wind, hydro. You have everything here. And only 23 million or 22 million people living here. What a country. What a rich country. I am so impressed.

Now, look at "sunshine state" Germany. What we did in the last, basically the last five years, we built the biggest power plant we have so far in Germany, that's the PV fleet, looking at it as a virtual power plant, combining all the panels. We ended up with 35.1 gigawatt at the end of September. We are building at the moment with a pace of around about 300 megawatts per month PV panels, or installing them, most of them come from outside Germany, from China and Taiwan.

With a house, 30 per cent inclination towards the sun is the best inclination you can have. And so, a couple of years ago, you saw a lot of tracking systems, even a house that turned. For sure, if you do the numbers, the PV power plant pays for itself and for the house underneath it, because the German feed-in tariffs were really very generous. That's in combination with the low interest rate scenario that is a hidden secret behind the success of photovoltaics in Germany – 35.1 gigawatts of photovoltaics.

Our wind power plant fleet has around about 32 gigawatts, so we have more photovoltaics in Germany than wind power. I live in Bavaria, in the state of Bavaria, where the peak power in the electricity system is 12 gigawatts, and we have installed more than 10 gigawatts of photovoltaics. So, our installed fleet is close to the peak power demand. And a typical figure is that on a very sunny day you'll see around about 70 per cent of the PV fleet feeding in with around about 70 per cent of the installed power at noon, it's a figure of experience. So, we do have on sunny days, we have the reversal of power flows in our grid, that's where smart grid technologies kick in, and that's where there's a lot of discussion what should be the redesign of the electricity market, and of the regulation.

In January, when the panels are covered with snow, or there is extensive cloud coverage, of course there's not much solar in-feed, but we typically have very good wind conditions in winter time, and if you do the calculation, you will see that 14 per cent of electrical energy in Germany was covered by wind power in January, and in July, it was really a super July, almost all days were blue skies, we had 14 per cent of electrical energy covered by photovoltaics in Germany. To put it in perspective, Germany has the same latitude as south Alaska, and in the state of Bavaria with more PV, than the whole of the United States.

This is a tremendous development that we underwent in the last basically five years in Germany. And what did not take place, by far not, was the grid enforcement. It's a big topic now, how to harden the grid so we will see within the next years HVDC lines, DC lines that will take the wind power in the north, and eject them at dedicated grid nodes in the southern part of Germany. We

did not need those DC lines before, because we used to build our power plants very close to the load centres. This is a really dramatic change.

What you also see is very extended times when there is no wind and solar in-feed. So even if you build offshore wind parks, there are times when there is only a very low wind power output, unfortunately. That's the reason why we will need also in the future a conventional power plant fleet. They will change their role from providing baseload power supply to providing back-up power supply in the future. There have been studies, if this development of installation of wind and solar continues, we will have in the future substantial negative, so called residual load.

So where to go with all that surplus electricity in the future? That's a big question. And therefore, the German Government is now incentivising several demo projects in the field of energy storage. It's a whole variety of storage technologies that we are looking at. And what's happening in Germany is also very important for the neighbouring countries, because Germany is around about one-sixth of Europe concerning energy.

Denmark probably has an even more intermittent energy mix. Denmark has the target to push that further and to have, by 2020, 50 per cent of energy, not only electrical energy, of energy, covered by renewables, and that will be wind power. Denmark is a rather small country also concerning energy consumption. It's only a fraction of Germany. It's a peak power of five gigawatts. We have 80 gigawatts of peak power in Germany. They are lucky that they have good grid connections to neighbouring countries, and when there are strong wind conditions, they send the wind power to Germany, or part of it.

And since we are neighbours, we also have good wind conditions during those times, so we send that wind power to Poland, which causes turmoil in the Polish grid, because they are heavily coal based and not expecting us to give them this gift, so they are considering installing blocking transformers to block that electricity, because otherwise, and what happens today is that it causes a major re-dispatching of their conventional power plant fleet. That power continues then travelling southwards to the Czech Republic and re-enters Germany. You see that our grids are not prepared for such a fleet, which came not overnight but over the last five years.

Those are dramatic developments that we have seen in Europe. And there is now a new breed of specialists, that's around meteorology, weather forecasting, and that's the energy forecasting. We used to need that for our barbecues, and now we need that for our energy market. And when I want to know exactly how the weather will be like in the next days, I go to those

forecasting companies, and look what the solar and wind power feed-in will be in the next days, and then I know precisely how the weather will turn out, because they are using forecasting and using their intelligence to actually derive the numbers.

Now, levelised cost of electricity or the cost of electricity of photovoltaics in different countries. The source is the World Energy Council, so it's a very established and well-known source. Those LCOEs differ quite substantially depending on which country you are in. The reason is also the value chain behind it. Probably Germany is the country where you have the lowest cost for the photovoltaic system, because that value chain is so well in place already, and probably, I would assume, that the cost of a PV system in Australia is more expensive than in Germany, and of course pushing up the LCOE.

One of the questions that I deal with is how will that further develop, especially since we at Siemens, we are going out of solar, but that doesn't mean that we don't watch it. The solar technologies, especially photovoltaic, has a quite disturbing characteristic, because you can do it anywhere, anywhere where the sun is shining, and it's shining anywhere on this planet at least part of the year or part of the day. And it's the most simple power plant. And on the other hand, it cannot work as a standalone power plant, it needs a complementary power generation or a storage element. But it's the most disturbing because it's the most simple, anybody can put it up, you hold a panel to the sun and off you go with production.

What do we have to do in order to cleverly integrate those intermittencies, those intermittent power sources, that will be wind and that will be photovoltaics? Those are the two. Well, these are the fields of innovation that we focus on. And they actually apply globally, they are good on a global perspective, driving up efficiencies and infrastructures and in power plants that's needed anywhere. Operational flexibility is also needed more and more. Also flexibility on the load side, that's still not really utilised, so there the regulator and legislator in Germany for example also has to come up with new laws in order to tap into the flexibility that we do have at the receiving end of the electricity system. And it's grids.

In all the studies I know, guiding electricity through grids to the load centre, that's the most cost-efficient means, and especially when you have intermittent power generation in areas where there's not enough load, it's better to expand the grid, or to upgrade a transmission grid than to install storage equipment.

That is because all the storage equipment first of all needs substantial capital expenditure, and then has inherent losses. For example, lithium ion batteries, they are at 80, 90 per cent round trip efficiencies. Now there is an ultra-high voltage transmission scheme spanning 1300 kilometres in China and that has an efficiency of more than 93 per cent. That's why in Germany you will see those new lines going north-south. But we will run into scenarios where that will still not be sufficient and that's where energy storage kicks in. But we have to think about storage in a wider scope. It's not only going back into electricity, but also into other infrastructures.

Now I want to discuss quickly some products and solutions to what we have. We are in the oil and gas industry phase with various onshore and offshore technologies, and just last week I visited our subsea development centre in Trondheim in Norway. We also equip ships and drilling rigs with equipment. We do micro-grids on ships, quite exciting technologies, as for example the drive systems have changed substantially on those ships, and looking at those huge floating LNG vessels that are being built now, these will require quite substantial power generation equipment as they are going about 500 megawatts of electricity needed.

We have a vision of a subsea exploration site. We are in the industrial turbine business, and we are on the other end at the moment, commercialising electrolyser technology and, in parallel, we are developing hydrogen burners for our gas turbines, so that also goes hand-in-hand. On the one side, using surplus electricity producing hydrogen, and then you have the option, for example, to burn that hydrogen in gas turbines again for re-electrification, or utilise it in the chemical industry, or utilise it for a hydrogen-based car fleet. Such demo projects are being started in Germany.

Talking about wind power, here are the dimensions. I landed here in an Airbus A380, and that fits nicely underneath the blades that we are now building in the six megawatt class. Such a six megawatt wind turbine produces in one week more energy than the 30 kilowatt wind turbine produces in 33 years. That's evolution. That's efficiency. That's why we are pushing up the power rating of those wind turbines. As the blades get longer, you can also have very good efficiencies in low wind conditions.

We are doing cost-out, that's one of the key topics in the wind power business, cost-out by utilising direct drive technologies, for example, getting out complexity of wind turbines, doing the aerodynamics of the blades better. One project is called Quantum Blade. And of course, also looking at the overall lifetime and service life of a wind turbine.

Talking about grids, the design comes from gas pipeline design. They have conductors which allow the transfer of power equal to transmission lines, so-called gas insulated lines. And that's what these power electronic animals look like. If you come to Germany, give me a call and we will go to a factory and we'll see them being designed. It's dramatic evolution that the power electronic domain has undertaken in the last years and, in parallel, it was also the computer architecture domain and signal processing domain, so we are now able to control very complex silicon structures.

In general, those schemes require very sophisticated control, and this is possible now. This data or digitisation trend also relates of course to the overall integration of this very complex energy system. The lines that we will see in Germany that I talked about, four lines going north-south, being built within the next years. And there is also that indication already that this will result in a so-called super grid that is a gateway to France. We will most probably see a super grid developing in Europe spanning the continent, and pushing power from the most promising renewable sites to the load centres.

The storage domain I already talked about. We are looking at the full-blown picture of energy storage. It's not only about batteries, it's not only about chemicals, it's also about the heating and cooling sector and that is being now tapped into extensively in Europe. For example, the city I live in, they are building a 70-metre tall hot water tank for the district heating network.

With that I would like to end. What do we need now? We have to look at the energy system in a holistic fashion. We built interconnected systems, we built grids to pull synergies and to allow reliability, higher reliability, and cost efficiency. I see many doubts, and I see that there are tendencies of grids or loads disintegrating from the grids. We have to remember in the first place we built them for cost efficiency reasons.

Thinking positively, I see that we will span, energy carriers will be able to span, infrastructures more and more in the future, and having electrical energy in the middle of the action. And that I am very glad about, because as a small boy I always wanted to become an electrical engineer, I did that, and now it's all about electrical energy.

Thank you very much.

> GLOBAL ENERGY OUTLOOK: OIL AND GAS

> 9 OCTOBER 2014

> ADELAIDE

The shale technology revolution

Professor Paul Stevens

Distinguished Fellow, Chatham House London, Visiting Professor, University College London (Australia) (2014)

At an energy outlook event in Adelaide in 2014, Chatham House Distinguished Fellow and University College London (Australia) Visiting Professor, Paul Stevens provided an outline of developments in the shale technology revolution and its potential impact on the global oil market.

According to Professor Stevens, in terms of its impact on future supply, the application of shale technology could hold interesting surprises. It could, for example, improve extraction of previously untapped oil supplies.

He highlighted that this technological revolution was already having a direct impact on global oil markets, with possible global economic and geopolitical ramifications.

Today I want to talk about the global oil and gas scene and to do that I want to hang it on a peg and the peg is the shale technology revolution.

One of the great things about this industry is over a very long career you spend a lot of time studying it in great depth and thinking about it, and you reach a point where you think I really now understand the industry, I really understand what's going on and what's going to happen. Then you get up in the morning and something's happened that blows it all right out of the window and to some extent the shale technology revolution is part of that story.

I want to just say a few bits about the characteristics of the technology revolution, I then want to say a few words about what the impact on the United States (US) has been which is quite significant and which has had indirect implications for global energy. Finally, I want to look a little bit to the future and ask what might the direct impacts be on global oil markets.

So as I'm looking at the characteristics of the shale technology revolution, the first point to make is that this is not new technology and most of it's been around for a long time.

Horizontal drilling was developed in the 1930s and the first well was fracked in the US in 1947. There are a few other bits and pieces of technology as well but it's been around for quite some time.

The second important point to make, and I make this because it's very little known in the industry, is that the US shale gas revolution kicked off in large part because of a very large amount of R&D money put up by the US government to investigate basic scientific research into low permeability operations.

Now this is the sort of basic scientific research that private companies wouldn't and shouldn't do. No private company is going to fund Isaac Newton to sit under his apple tree and discover gravity because it has no commercial value. You can't patent the laws of gravity once you've found them. So that was a very important part of the story: US government funding basic scientific research, making the results of that available to the industry, who then picked it up and basically ran with it.

The final point to make about the revolution is that it has been a trial of technology and it has been a trial because it's been going through a process of improving and learning by doing.

But, and again I think this a very important point, to do that you need to do an awful lot of drilling and an awful lot of fracking. You have to get a very large critical mass of experience and the reason for this is because shale operations are very different. Different places, different wells are very different so you do need to build up a very large amount of information and share it.

A good example of this is the Marcellus Shale Coalition which has a large number of members that regularly meet and exchange information.

So what has been the impact on the US? Well 2012 is the last data that is available for shale gas production in the US and part of the reason for that is because the whole experience in the US has come from a large number of small to medium size companies and it takes quite a long time to get that data together.

However, the data shows that if you go back to 2008 less than 10 per cent of US domestic gas came from shale. In 2012 it was about 33 per cent. Now it's above 40 per cent, the estimates suggest.

Now the main impact this has had has been on domestic gas prices. In April 2008 they hit $11, by the time you get to April 2012 it had gone below $2. It's now back up to around the $4 mark. But there are other impacts that have more global relevancy.

The first one I want to talk a little bit about is US energy independence which has been part of the US political DNA since Nixon made his statement in 1974.

Of the five scenarios coming out of the EIA (Energy Information Administration), two show that by the time we get to around the sort of 2035, 2038 mark, the US is no longer dependent on imported liquid and indeed, it actually becomes a net exporter.

This has interesting implications globally. The first implication is half of the US current account deficit is energy. So, if you stop importing a lot of oil you've halved your current account deficit.

Now that is clearly going to have an impact on the dollar. What the impact will be, answers on a postcard please to the Federal Reserve. I don't know, I gave up macro-economics a long time ago but it will have an impact on the value of the dollar.

Secondly there will be geopolitical consequences. The sort of things we're being told is that because the US won't be importing oil it'll lose interest in policing sea lanes and it will lose all interest in having any influence in the Middle East.

I think both views are seriously mistaken. Super powers police sea lanes, it's what super powers do. And at the risk of starting an argument, US policy in the Middle East, apart from a few occasions, have had very little to do with oil.

Also, the oil market is one big pool, so if nasty events in the Middle East means the price of oil in rest of the world reach $200 a barrel, it's $200 a barrel give or take in Houston.

In other words, the threat switches from a sort of physical security of supply concern to the macro-economic consequences of very volatile oil prices.

Other impacts have been an increase in the export of coal. As the gas price in the US has gone down, coal is being pushed out from under the boiler and a lot of that coal is now being exported particularly into Europe, particularly into Germany.

Germany's just given up nuclear because of the environmental concerns and they're now importing huge quantities of US coal. If somebody can explain that to me I'd be very grateful.

The other implication of course is that the US petrochemical industry which everybody was writing off seven or eight years ago now has had a boom and you're getting a lot of foreign direct investments in there.

In terms of the impact on the LNG market, if you go back to 2006, that's only eight years ago, the expectation for LNG imports into the US was that the US would increase LNG imports by about 640 Tcf.

Now to put that into manageable numbers that is equal to six Trinidad and Tobagos and four Indonesias. It's a lot of LNG.

That of course has now disappeared, so a lot of the LNG projects that were being built in anticipation of this boom of exports to the US has now disappeared and of course the US itself is starting to get into a position of being a major LNG exporter, although I think there are serious question marks about that.

First of all, there are question marks about the continuation of the shale gas revolution in the US, not least because the whole thing was built on a mountain of debt. When the interest rates go up a lot of these small and medium size operators are going to be bankrupt.

Also, there are pressures in Washington to limit gas exports. Much the same sort of arguments that you have here in Australia about reservation policy. 'You know if we export it, it's going to increase the domestic price, we shouldn't be doing that and I thought the whole objective was to be energy independent anyway, so why are we exporting it?'

Let me finish by looking a little bit at global oil markets and here I want to introduce you to a concept that I've been banging on about now for about two and a half years, longer, called OPEC's (Organization of the Petroleum Exporting Countries) dilemma.

OPEC's dilemma is very simple. As a result of the Arab uprisings which kicked off at the beginning of 2011 the Arab oil producers need higher prices. They need higher prices to keep the kids off the streets.

In 2008 Saudi Arabia probably needed about $50 a barrel to manage the budget. Today estimates suggest it's around $100, although that is a debatable number.

The problem is that high prices create market feedback loops and high prices lead to demand disruption.

You've all heard of the BRICS (Brazil, Russia, India, China and South Africa) and those of you following the Eurozone crisis will have heard of the PIIGS (Portugal, Ireland, Italy, Greece and Spain). Meet the MEICs. The MEICs are Middle East, India, China and they are expected to account for a very large increase in the amount of non-OECD demand for oil between now and 2035.

The problem is that all three have had a long history of highly subsidised oil price, that's to their domestic consumers. That process began to change in India in 2002, in China in 2009, in the Middle East they're talking about it. It's not a good time now to talk about increasing energy prices in the Middle East but there are discussions about it.

As those prices increase, markets work. So the sort of projections you're seeing with ever-increasing oil demands coming out of MEICs and Asia I think are grossly overstated.

Another side of the story is higher prices are also going to lead to more supply and this brings me back again to the impact of the shale technology revolution. If I'd have said five years ago that the US would be dramatically increasing domestic oil production, two men in white coats would be walking over gently to me to lead me away to put me in a dark room for three days. It was just inconceivable and yet in 2011 the joke amongst the oil analysts would be the next member of OPEC will be North Dakota, and in fact at the end of 2011 North Dakota was producing more liquids than Ecuador.

So OPEC's dilemma is they need a high price to survive politically but this is going to lead to a market reaction, demand destruction and increased supply.

The whole situation is unsustainable and for those of you with a strong sense of history it's a re-run, in part, of the period between 1981 to 1986 and we all know where that ended up, it ended up with the oil price collapse of 1986.

If you think that's unrealistic today just remember 3 July 2008 when the WTI (West Texas Intermediate) hit $147 a barrel on NYMEX (New York Mercantile Exchange). At the beginning of December that year it was about $32 a barrel. So an oil price collapse is not actually impossible.

The shale technology revolution has already had a direct impact on global oil and it effectively saved us from a major oil price spike.

Between December 2010 and March 2014, the world oil market lost 3.2 million barrels a day as a result of political outages dominated by Libya and Iran but also a number of smaller producers.

Now again if you'd had said five years you're going to lose 3.2 million barrels a day what will that do to oil prices? Everybody would be pointing towards $200 a barrel. It hasn't happened, the price has been remarkably stable and indeed in the last month and a half or so it's been falling.

Why is that? Simple, because in exactly the same period the US increased its production by exactly the same amount, 3.2. That's purely incidental. Somebody up there has a sense of humour I think to balance the two numbers.

One of the other impacts is that it's changed perceptions in the market. A few years ago, everybody was talking about peak oil, which I always took the view was a very very flawed concept – how you can talk about supply without mentioning price and costs remains a mystery to me – but peak oil now thank god is dead.

The danger is of course people are now going in the other direction and starting to talk about oil abundance. However, in terms of the future impact on supply, the shale technology revolution could hold interesting surprises.

It's worth reminding you that on average, in terms of the recovery factor on oil fields, the global average is about a third, which means two-thirds of the oil remains under the ground.

With the application of this technology that two-thirds is going to reduce significantly, so it could have very interesting implications for the future of oil supply but we have a long way to go before we get there.

> ENERGY SERIES: FINKEL REVIEW AND THE FUTURE MARKET

> 26 JUNE 2017

> ADELAIDE

Reflections on the Finkel Review

Tony Wood

Energy Program Director, Grattan Institute

In late 2016, the Federal Government invited the nation's Chief Scientist, Dr Alan Finkel to chair an independent review into the future security of the National Electricity Market. The resulting report, the *Blueprint for the Future*, widely known as the Finkel Report, was handed down in June 2017.

Just days after the report's 50 recommendations were delivered, Grattan Institute Energy Program Director, Tony Wood, provided a CEDA Energy series forum in Adelaide with his take on the review and identified a number of challenges ahead in implementing its recommendations.

Climate change remains a topic that keeps people who work on policy well and truly occupied.

What I want to do for about 10 or 15 minutes is to comment a little on some of the aspects of the Finkel Report that have got less publicity than the Clean Energy Target, because they are all important and there are 49 other recommendations apart from the Clean Energy Target in Dr Finkel's blueprint.

My suspicion is that it's really only about half a dozen of those that actually will make a real difference, and there will be some of them which will be tricky for implementation. Tricky means there will be winners and losers and the losers won't like it very much. They will make it very difficult for whoever has to implement these things to go through.

And, of course, the fact that the Federal Government has supported 49 of them partly just means that they don't give a damn because most of them [recommendations] don't have anything to do with the Federal Government anyway. The people who have to do it are the states and territories, and that's where some of the more interesting challenges I think will emerge. The COAG Energy Council is due to meet in early July and it will be just as interesting to see what emerges from there as what's been emerging from the discussions of the Coalition party room.

I guess at its core what Alan Finkel has tried to do is look at the task he was given, which was to say, "Look, we've had an energy market that was set afloat in the mid-1990s, formally launched the NEM in 1998 and pretty well stayed on course for most of that time. But it's gone adrift just slightly and needs to be brought back on-track". And so, what he has tried to do, rather than throw it away and start with a new craft, is rehabilitate the existing one as a fit-for-purpose model for the next 20 years.

The trick of not having the 50th of 50 recommendations is, I think, a bit like fitting out the ship and forgetting to have a navigator on-board. Without the Clean Energy Target, a lot of the rest of it just ends up not making a whole lot of sense. Without it you may as well just keep digging the stuff out of the ground and burning it. So, how that's dealt with – and I'll come back to that briefly in a few minutes – is important.

In terms of reliability, the issues that Finkel was asked to look at were broadly reliability and security of the market. Now, there are interpretations or definitions of reliability and security that most of the people in this room and, I suspect most people who watch television and read papers would use, and there are those that are used precisely by the energy wonks. And the definitions of "security" and "reliability" then become particularly interesting and important because they don't necessarily mean the things that most of you,

I suspect, think they mean. And so, as you pore over claims people make about the integrity or otherwise of the Finkel Report and whether or not it actually addresses security and reliability, you need to remember that the report does not use the words "reliability" and "security" in the same way that you may do in your everyday life.

In that context, a number of the security issues that Finkel has recommended are pretty straightforward and relate fundamentally to technical issues associated with frequency and voltage stability and all those sorts of issues, which of course, were an issue, as you would know, in South Australia a few months ago. The more tricky ones are associated with what's broadly in the "reliability" basket, and that is how do you ensure that the system can deal with the various changes in supply and demand that we're now looking at given that we used to have to deal with a lot of variation in demand, now we all have to deal with a lot of variation in supply? And so how do you deal with that?

Some of the things that Alan (Finkel) has recommended include a three-year notice of closure period. It sounds straightforward. It will not be so when you have to come to work out how you actually require someone to give three-years' notice of closure. It is not a straightforward issue and it will be tricky. The thing called the "Generator reliability obligation," will be probably the one that will get a lot of contentious debate; a lot of people in the renewable energy sector are very unhappy with that particular recommendation because they see it imposing an unrealistic obligation on renewable energy and particularly wind and solar. So, it will be interesting to see how that plays out, because Alan has not been all that prescriptive as to how that should actually be done.

There is a lot of flexibility left in the way the recommendations have been positioned that give very significant authority and power to the Australian Energy Market Operator (AEMO). Now, I'm not saying it's a good or a bad thing; it's certainly better than giving it to the politicians because you saw what they did when they had the renewable energy target.

Ensuring that we have a reserve bank of the energy sector where people can understand specifically that there will be changes, and the way in which AEMO or whoever it is will make those changes, will be absolutely critical if you're going to get a situation where you don't spook investors. And you only had to see what happened when the Prime Minister talked last week about asking AEMO to have a look at the issue of "Do we have enough continuous dispatchable electricity in the market?" He, himself, even confused "continuous dispatchability" and "baseload" in the one sentence. You only have to look at the way that was interpreted, not just by people in the anti-coal lobby but people in the industry who said, "Oh, my goodness. This means we're

going to have a re-nationalised market" to understand how tricky this issue is going to be.

Making sure that you have clarity around the rules by which AEMO will make these decisions will be critical and making sure that those rules are robust, and that AEMO is able to do its job without political interference on a month-to-month basis will be challenging.

The introduction of some changes in governance, I think, will be another of the challenges. It appears that most of the state governments and territory governments have been able to support the appointment of an Energy Security Board. This Board will do something that the COAG Energy Council has been demonstrably incapable of doing and that is actually making decisions on a constant, persistent basis and running the market properly. Maybe this will help do that. The implementation of the Finkel recommendations and the Energy Plan that goes with that will be central to the role of the Energy Security Board. It will not be welcomed, I think, by some of the people from the bodies, not necessarily individuals, who make up that board. AEMO, the AMC and the AER themselves thought they had a better idea of how to do this within the three of them, and Finkel's made a recommendation of creating something that in some ways could go over the top of them, in some ways could work with them. In addition to that, the Energy Security Board has been recommended as a way to address the concerns that many people raise, and Finkel gave words to this in his report about the propensity for state and territory governments to talk nationally and then behave parochially. He's recommended that we have a new Australian Energy Market Agreement to which the states and territories commit; a national approach. In addition to that, the Energy Security Board will review initiatives by state and territory governments that may impact on the reliability and security of the market. That's code for "state-based renewable energy targets".

Now, how that plays that out, whether or not the states and territories will accept that role and what happens the first time the Energy Security Board needs to review the impact of one of the state or territory renewable energy targets will be more than interesting, quite important, and at least vaguely entertaining for people who do the sort of thing that I do.

The issue around gas is tricky. Finkel stayed away from a lot of issues to do with gas. He did comment that having a situation in which we have inconsistent regulatory arrangements around the country on gas development should be avoided. He didn't go to the point of saying, "Well, why don't we do something to fix it?" But he did adopt the language of the ACCC which refers to the concept of reviewing regulatory approval for gas development projects on a case-by-case basis rather than what we have in some territories and states

today – and in the mind of some opposition parties today – some form of moratorium or restriction on a blanket basis. Now, again, that will be a red rag to a number of state and territory governments.

As one of the most disturbing things I saw come out in the week leading up to the Finkel Report, like three days before, the Queensland Government announced what they called the "Powering Queensland plan". One of the announcements in that was that they would form an implementation task group to implement those recommendations, yet to be published, of the Finkel Review with which they agreed, with which *they* agreed. Now, if that's a recipe for a consistent national energy agreement then I would be very surprised. So, we'll see.

There are lots of rocky shoals ahead but so far things are going okay and I think the achievement of the Federal Government in supporting the 49 recommendations is not insignificant. I think both Malcom Turnbull and Josh Frydenberg have done a pretty impressive job in getting it that far. They have some challenges ahead but so far that has to be classified as success.

For example, they are supporting the recommendation that by 2020 Australia will have a whole-of-economy emissions reduction strategy for 2050. Now, that is not something that we've heard from this current Coalition Government before. It is, of course, at the heart of one of the criticisms that people have made of the Finkel Review, that is, it was only specific to electricity, and yet that particular very broad commitment or recommendation has been supported by the Federal Coalition Government.

Turning finally to the issue of the Clean Energy Target, it's not first best policy if you define that as being the lowest-cost way of reducing greenhouse gas emissions. But when you look at how much time we've wasted since 2007–08 when we actually had an opportunity for a while there when the windows of policy and political opportunity were aligned, and how much has happened since then, you'd have to say, "Well, just pick one of these policies and get on with it".

There are at least half a dozen different variations of climate reduction policies that would work just perfectly fine with the energy market; a lot better than what we've had and might actually provide some direction and some credible forward momentum. And so, my view would be "Look, just pick one. Just pick one. Don't care almost". Because any of these policies can be engineered and designed in a way that would meet the fundamental needs that we have of the energy market.

There is enormous confusion, some of it deliberate, some unintentional, around the words "cost" and "price". Now, to many people they're sort of

the same thing. In fact, one of the major newspapers, said, “Well, this is the cheapest”. Does “cheapest” mean lowest price or lowest cost? People would say, “Does it matter?” Yes, it does matter because when you look at the actual words inside the Finkel Report the Clean Energy Target is the most expensive on a cost basis, of the three assessed alternatives, that is, an emissions intensity scheme or business as usual. And, of course, business as usual itself requires an incredible amount of definition to “What the hell do you mean by that?” So, the Clean Energy Target is the most expensive on a cost basis but it’s the lowest on a price basis. And people say, “Well, how does that work?” And if any of you read Henry Ergas’ piece in *The Australian* today [26 June, 2017] you will see he’s raised exactly that point that unfortunately the report was very unclear on how those two can be different. They can be different and it’s not very difficult; it’s a distributional challenge. If the cost is higher but consumer prices are lower that means that guess what? The suppliers are paying some of the cost, that’s all. But that often gets confused.

The modelling was always going to be tricky. There is going to be an argument here which is basically “My model is better than your model”. And you’ve only to see what happened in the last couple of weeks to know how that’s going to intensify. Ergas has talked about it. There was a report commissioned by the Minerals Council of Australia. It is not exactly surprising that a report commissioned by the Minerals Council of Australia concluded that the Finkel report was biased against coal. The first time we see a report which comes to a conclusion that’s against the interests of those who commissioned the report will be the first time I think you might actually take it seriously. Now, that’s not to say that Brian Fisher’s work in this space is not absolutely robust, and as Henry Ergas says, he is one of the more respected energy and climate economists in the country. But you start with your answer and you pick your economist. It’s not the other way around if you want to get the answer you want. That’s the way this world works. And so, I think there are some challenges that have been created by the fact that the Finkel Review did put a lot of work into modelling.

Industry, I think, needs to be far more vocal in supporting strong and sensible positions, and I think, for me, the comment that Innes Willox, [Chief Executive] from the Australian Industry Group made last week was probably one of the more useful when he said, and I quote, “We need to offer not just criticism but a credible and superior alternative”.

It is very easy to find things in those 49 recommendations and 100 and whatever pages of a report with which you disagree, but why not come up with something that you think might improve the report rather than try and kill it. One of the intentions or one of the very successful strategies of those who

have knocked over policy in this space before is damning with faint praise. "Of course climate change is important, of course we need to have a carbon price, but not this one." And then you proceed to basically kill the whole thing by starting with just opening up the door to some possible criticisms.

I think there's a challenge ahead in relation to how far we move between the dimension, which, on the one hand is markets and the other is regulation. By nature, Alan Finkel is a planner and you can see that in the report; "Why not have a plan?" It's hard to argue with. But if we go to the point where people are becoming concerned about government intervention and government building it all, we're going back to re-nationalisation. Now, if that's what we want to do, fine, but let's do it consciously rather than subconsciously and find in 10 years' time we say, "How the hell did we get here?" Because the worst position would be to be stuck in the middle where we have another bugger's muddle of ownership by state governments and private sector people which ends up in the worst possible outcome of higher prices, less security and emissions not even going down.

I think, as I said, we won't see the end of the debate around modelling. In a piece I wrote a couple of weeks ago I said, "Look, all this does is prove that Galbraith was right when he said that 'Economic modelling was developed to make astrology look good'." This particular work I think demonstrates it very strongly although I'm not criticising the modelling; I'm criticising the whole way in which modelling gets interpreted.

At the same time, we've got people who want to go back to the past. "Why don't we just go back to the time when electricity was cheap, prices were stable?" It sounds like a song from Les Miserable; you know, "I Dreamed a Dream" almost. "Let's go back to the days when things were different, when it didn't matter if the lights went out in the middle of the night because we had candles and most of the rest of our lives weren't affected by it". But those days have gone. As people in this room know more than anybody, electricity now is such a fundamental part of our society that even the concept of quantifying reliability is way beyond the capacity of what our market people can even think about. It's only when the lights go out that you start to realise the consequences.

So, I think in summary, there are many things we have to deal with as we move forward and many uncertainties, but one thing I am very sure of is that neither nostalgia nor astrology is a good way to make decisions.

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> ENERGY MARKETS:
FUTURE OPTIONS FOR A CET

> 11 OCTOBER 2017

> MELBOURNE

Future options for a Clean Energy Target

Chloe Munro

Panel Member, Independent Review into the Future Security of the National Energy Market (2016–17)

A statewide black out in South Australia in late 2016 called into question the reliability of renewable energy sources in providing a secure electricity supply to eastern states, particularly during the peak demands of summer. The crisis prompted the Federal Government to commission the Finkel Review – an independent review into the future security of the National Electricity Market. The resulting report provided 50 recommendations aimed at providing a blueprint for the market's future.

Speaking in Melbourne in late 2017, Finkel Review panel member Chloe Munro outlined how the Finkel Review concluded that a Clean Energy Target was the preferred mechanism to guide emissions reductions and stressed there is no going back from a renewable energy future.

Well, good afternoon everybody. I have to say also thank you to CEDA for the invitation to speak here today. I'm really delighted to have the opportunity to address such a distinguished audience, and it's particularly good to see so many friends in the room.

I'd especially like to acknowledge that there are some members here today of AEMO's expert panel, which I now Chair. But I would just like to point out that I'm speaking today very much in a personal capacity as one of the members of the Finkel Review Panel, and I'm not here to represent the views of AEMO's expert panel, or indeed of the Australian Energy Market Operator itself.

So, what I plan to do in today's address is to start with an overview of the purpose of the Finkel Report to provide the context in which we arrived at our conclusions, of which the Clean Energy Target is just one recommendation. I'll explain at a high level our thinking, and I'll close with a few personal observations that draw on my experience as the Chair of the Clean Energy Regulator, which was established under my leadership to administer a range of climate change policies, including the renewable energy target, with which you'd all be familiar, the now abolished carbon pricing mechanism, and the emissions reduction fund which replaced it.

So just starting with a context. The formal title of the review led by the Chief Scientist, Dr Alan Finkel, is *The Independent Review into the Future Security of the National Electricity Market*, affectionately known as the NEM. The NEM looks rather like a vascular system, delivering energy throughout the eastern states of Australia. It's a very complex physical and engineering network, coupled with a sophisticated financial market and regulatory framework, to keep our electricity supply and demand in fine balance at every instant. And while the terms of reference and the recommendations of the Finkel Review are confined to the NEM itself, by and large they could also apply to the electricity systems in Western Australia and the Northern Territory.

Now, as I'm sure you will all recall, the review was commissioned in the wake of the events in South Australia in September last year when storm damage brought down a large section of transmission infrastructure. The system was unable to cope with the resulting instability. More and more components disconnected to protect themselves from voltage fluctuations and overload, and ultimately the whole state was blacked out. Hence the first priority of our review, as reflected in its title, was system security.

But only a few days after we started our work, the market was rocked by an announcement that Hazelwood would close in just five months' time. Now, it was no surprise that this rapidly ageing power station was to shut, but the timing was a shock. It threw into stark relief the question of reliability, that adequate resources would be available to meet demand at all times, and particularly in the summer peaks. The price of forward contracts shot up, reinforcing concerns about rising energy costs to consumers, both households and businesses.

So, what was required of the Finkel Review was a blueprint for the future NEM that would deliver secure and reliable energy services to consumers at the lowest cost. As the Australian Energy Regulator puts it, consumers should pay no more than they need for the services they want. Finally, electricity production and consumption contribute around a third of Australia's greenhouse gas emissions. If Australia is to meet its international commitments to reduce emissions, the NEM must play its part.

As the review gathered information and consulted widely here and overseas, it became evident to the panel that the energy system is undergoing a profound transformation. There's no going back. The four outcomes are often discussed in terms of trade-offs. But what we saw was that they are in fact intimately connected. You can't have security without reliability, and you can't have either without investment in the system.

Investment is also required to take us along the path to lower emissions. And ultimately, it's the nature of these investments and the terms on which they are made that will drive costs to consumers. So, our challenge was to provide a blueprint for the future NEM that would take advantage of the transformation to optimise across all four outcomes to deliver security, reliability and low emissions at the lowest feasible cost.

Famously, the Finkel report delivered to the Council of Australian Governments in June 2017 contained 50 recommendations. The COAG Energy Council, which is chaired by the Federal Energy Minister Josh Frydenberg, and includes the five NEM states and the ACT, agreed to 49 of the 50 on 9 July. And good progress is already being made to put them into effect.

The 50 recommendations form an integrated package as you'd expect of a blueprint. Some of them go directly to the four outcomes. For example, we recommended new energy security obligations should be placed on transmission networks for service providers and that connection standards for generators be reviewed in their entirety. Similarly, we made a number of recommendations under the heading "Rewarding Consumers" that go to cost.

It's worth emphasising that these recommendations are all about the outcomes, we weren't focused on inputs. The Panel was truly technology agnostic. We were indifferent as to whether emissions reduction was achieved by an increase in renewables, more efficient thermal plant, or energy efficiency. These options stand and fall according to their own economics in a competitive market, and according to the results they deliver.

Similarly, better consumer outcomes in terms of price and reliability might be achieved by network investments, by storage, or demand side measures as we heard announced about today.[1] The digital revolution has opened up a world of new business models for consumer participation, and we think they can be facilitated by improved access to data as we also recommend. However, we weren't at all deterministic about which solutions will win out.

Alongside those recommendations on the four outcomes, a further set addressed what we describe as the three pillars. These are overarching recommendations that support the performance of the system as a whole: an orderly transition, system planning, and stronger governance. Recommendation 3.2, "An Orderly transition", is the single one not yet agreed.

As I've already observed, a profound and irreversible transformation of the energy system is underway. One of the benefits of this transformation is that it is pulling through technological change and new patterns of consumer participation that can lead to a lower emissions future. However, it's not without risk. We've already seen how speed bumps along the way can stall investments and increase costs. Unacceptable risks to security and reliability, and unsettling volatility in the market can result.

To mitigate these risks and create an environment where there is greater confidence to invest, we recommended three measures under that single heading, "An Orderly Transition". The first and in many ways the most significant of the three is that the Australian and state and territory governments together agree to an emissions reduction trajectory for the national electricity market itself, and this is the one that we modelled.

We recommended this in the context of our previous recommendation, 3.1, that by 2020 the Australian Government should develop a whole-of-economy emissions reduction strategy for 2050. The strategy needs to be long term both for the economy as a whole, and for the energy sector, because that was consistent with the expected life of many infrastructure assets so that investors know the context in which they're building their business cases. Once industry knows what's expected of it in the long term, a better assessment can be made of the returns, risk premia should fall, and more coherent planning can take place.

So, once a trajectory is agreed, the natural question for investors is "how will governments ensure that the trajectory is achieved?" Mere aspiration or borrow and hope is simply not good enough. Relying on the forces of technological change still leaves too much to uncertainty. This is why, even as the cost of new build renewables continues to fall relative to thermal technologies, we recommended a mechanism to guide the system down the emissions reduction trajectory. I'll discuss our preferred mechanism, our Clean Energy Target, in a moment.

While the mechanism provides an economic incentive for additions to the stock of infrastructure, the timing of such investment can be improved if there is a good signal about when the new capacity will be well utilised. And hence the third element of an orderly transition, is that withdrawals of old capacity are signalled well in advance. So, we recommend a three years' notice of closure to give enough time.

Finally, I should add that the mechanism would work in tandem with our recommended mechanisms for security and reliability: the energy security obligations and generator reliability obligations respectively. We see reliability and emissions reduction as going hand-in-hand. Our reasoning is covered in detail in chapter three of the report. So, having set the scene, I'll explain briefly why we landed on the Clean Energy Target as our preferred mechanism, and first I'll take a minute to explain how it would work.

The Clean Energy Target works like any other market mechanism on the principles of supply and demand. On the supply side, electricity generators receive certificates in proportion to the output that they deliver to the market. A threshold emissions intensity would be set and any power station that operated below the threshold would be eligible for certificates. A zero-emissions power station, such as a solar farm, would receive one certificate for each megawatt hour of energy that it sent out. A power station that operated say at half the threshold would receive half a certificate per megawatt hour.

Now there's considerable flexibility as to how the threshold is set. A higher threshold would allow a wider range of technologies and fuel sources to be eligible, but it wouldn't change the merit order. A power station with lower emissions would still receive more certificates than a power station with higher emissions for the same output.

On the demand side, electricity retailers are required to surrender certificates in proportion to the electricity they acquire for sale to their customers. The proportion is set according to a statutory formula. It would increase over time in a predictable way, so that overall emissions for the electricity sector fall in line with the agreed trajectory.

Retailers would get their certificates either by purchasing them in the spot market, or by writing long-term contracts with low-emissions generators. New investment underwritten by such contracts will generally face a lower cost of capital than the more speculative investment built to service the spot market, and the result is lower cost all round.

The Clean Energy Target was just one of several options we considered, including a business as usual scenario with no new policy beyond the existing renewable energy target. We also examined whether simply applying a lifetime limit to old power stations would be enough to pull through the necessary investment. We modelled an Emissions Intensity Scheme, and this and the Clean Energy Target in combination with the lifetime limit. On balance we decided that the Clean Energy Target was the superior mechanism.

I'll quote our conclusions: "Both a Clean Energy Target and an Emissions Intensity Scheme are credible emissions reduction mechanisms, because they minimise cost for consumers, are flexible and adaptable, and satisfy security and reliability criteria. Both mechanisms are shown to deliver better price outcomes than business as usual. With the additional context that a Clean Energy Target can be implemented within an already well understood and functioning framework, which is the renewable energy target, and has better price outcomes, the Panel recommends a Clean Energy Target be adopted".

As I mentioned, the Panel commissioned modelling to support these conclusions. Jacobs compared the business as usual scenario, that is no new policy beyond the current renewable energy target, with a range of policies to achieve a long-term emissions reduction trajectory. Our terms of reference do not specify how much effort should be expected from the electricity sector, so we adopted the vanilla option, based on Australia's Paris commitments, and extrapolated to reach zero emissions around 2070.

We did hear arguments that the electricity sector either could or should contribute a higher proportion of the national target for the economy as a whole. However, we also heard that a 28 per cent reduction on 2005 emissions by 2030 would be a significant challenge. On balance, it seemed a fair basis for our analysis.

To varying extents in all scenarios, the proportion of renewable energy in the mix increases over time. This can add operational complexity, particularly with respect to frequency control, which is central to maintaining security. So, we asked the Melbourne Energy Institute to review the modelling outputs of Jacobs to confirm that the level of variable renewable energy in the system

reached by 2020 and 2050 would not put system security at risk. Their conclusions were reassuring. In an orderly transition, with all the other elements of the blueprint in place, security and reliability can be maintained in the NEM on this trajectory. If a more ambitious trajectory were to be set, it would be prudent of course to revisit the modelling to reassess this result.

The modelling results show that either an Emissions Intensity Scheme or a Clean Energy Target would deliver lower prices to industry than continuing with business as usual. Household tariffs show a similar picture. On our assumptions, which were based on known costs for technologies in use today, the Clean Energy Target gave the better result. The modelling reinforced our reasons to favour a Clean Energy Target over the other options we examined.

But there is a lot of flexibility in how a Clean Energy Target could be designed. Many variations on the theme could deliver acceptable outcomes. The certainty introduced by a clear and enduring policy framework will allow better investment decisions to be made, and enable the market to take greater advantage of the falling costs of cleaner technologies.

The Panel considered that the precise design of the mechanism is less important than its durability. And we said in the Panel's view, the single most important characteristic of any emissions reduction mechanism to be adopted by governments is that it is agreed expeditiously, and with sufficient broad base support that investors can be confident it will endure through many electoral cycles.

So finally, I'd just like to add some personal observations, drawn especially from my experience as Chair of the Clean Energy Regulator. And I must say it was an immense privilege to be part of the Finkel Review Panel. I don't think the Government could have assembled a better equipped group of people to tackle this multifaceted question. The Chief Scientist's leadership was exemplary, and it was wonderful to see up close such a fine mind at work.

Most significantly for me it was an opportunity to revisit in depth, and with the benefit of over 20 years' hindsight, everything I had thought about the design of the NEM when I led Victoria's energy reform program in the late 1990s. Much of it has held up well, but some of it has proven to be quite mistaken. Over time I've become much more pragmatic, and less convinced by the tenets of neoclassical market economics and general equilibrium modelling. What is theoretically the most efficient and effective policy scheme doesn't always hold up in practice.

And this is partly because the community is not tolerant of shocks. The costs of adjustment are too high. As a result, pure policy is inevitably diluted: for example, with protection for emissions intensive trade exposed businesses, or with price controls. The policy framework becomes more and more complex to mitigate every foreseeable adverse impact, and ultimately it risks losing traction on its core objective.

The pursuit of a perfect policy in an imperfect world is a recipe for indecision. A better approach is to agree that good enough is good enough, and put more onus on our institutions. And this takes me to one of the other pillars of our recommendations: stronger governance. The National Electricity Market needs to be resilient to forces that are outside the electricity system itself, forces that are well beyond the control of the NEM rules. It can't be entirely pre-cooked. This applies equally to emissions reduction policies such as the Clean Energy Target. Adjustments will need to be made over time as the operating environment changes in ways that cannot be fully foreseen.

This is why I prefer principles-based regulation that can embrace changing technologies and business models, why I prefer those principles-based regulations over highly prescriptive rules that often turn into barriers to innovation. It requires the stewardship of strong institutions who behave predictably according to well understood principles. They need to be empowered, capable, and held accountable, not just for good process, but for good outcomes. The COAG Energy Council has an important role to play in the oversight of the performance of the NEM as a whole and of its institutions.

Finally, as I said it was a privilege to be part of the Finkel Review. I have never experienced a policy process that has enjoyed such unequivocal and broad-based support: before during and after. Consumer groups, industry associations, energy businesses and their customers almost without exception welcomed the review, and endorsed the blueprint. The help that we were offered from all quarters was incredible. If our conclusions are inadequate, it's certainly not for lack of input from knowledgeable and concerned people, both here in Australia and overseas. It was quite extraordinary.

This is not a report that has disappeared to gather dust on a shelf. A lot of progress has been made to put it into action. But one element, the orderly transition, including the Clean Energy Target is still missing. And we look to the Australian Government to complete the picture as they have said they will. I'm an optimist by nature, and I genuinely believe a resolution can be achieved.

Thank you for your attention.

Endnote

1 On the day of Ms Munro's speech, the Turnbull Government announced it would, through the Australian Renewable Energy Agency (ARENA), provide $28.6 million funding for a new trial with the Australian Energy Market Operator (AEMO) to deliver 200 MW of capacity to help secure the electricity grid during times of peak demand.

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