

# 能源消費與供給的澳洲觀點： 對國際政治經濟的意義

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## 中文摘要

今日能源產業面臨能源公平、能源安全與環境所共構的「三難困境」(trilemma)。對既是消費者又是全球能源商品供給者的澳洲而言遭遇諸多挑戰，亟待以確保克服其能源業界仍維持競爭力。各國在 2015 年聯合國氣候峰會(COP21)，即《聯合國氣候變化框架公約》第 21 次締約方會議上所做的承諾顯示有關再生能源與核能的能源消費將會增加，但石油、煤與天然氣仍會是世界能源組合的關鍵成分。然而能源市場近年來呈現越來越不確定高不確定性的特徵，主要是受到政策改變、不確定的經濟環境與不明確的投資訊息因素的影響。身為生產者的澳洲在此供應者日益增加的市場裡應不斷尋求方法來維持競爭力。

# Australian Perspective on Energy Use and Supply: implications for the international political economy

**Kate Penney**

5 May 2016, International conference on energy and international relations



1

Thank you to National Chengchi University for inviting me to address the International Conference on Energy and International Relations this morning.

It is an interesting time to be analysing energy markets given the rapidly changing dynamics of the sector. Over the past year alone, energy prices, particularly oil, have declined rapidly and new policy commitments were made in the lead-up to the Conference of Parties 21 (COP21)

that are likely to reshape energy consumption trends across many countries.

Today I have been asked to discuss the Australian perspective on energy use and supply and the implications for the political economy. I will begin by providing some context on Australia's role in world markets. I will then discuss some of the longer term trends emerging in energy markets and how these align with changes in Australia.

Given the themes of this conference and the importance of policy to the energy outlook, I will discuss the different aspects of the “energy trilemma”—energy equity, energy security and the environment—and what these mean to Australia both as a consumer and global supplier of energy commodities.

The changes in energy markets have also affected energy supply. As a major energy producer and exporter, there are a number of challenges that the Australian industry is facing and will need to overcome to ensure we remain competitive.

I will conclude with some observations on changes in world energy trade and what that may mean for international relations.

## **1.1 Australia's role in world energy markets**

Resources and reserves

## Australia has abundant energy resources and reserves



- World's largest uranium reserves
- 4<sup>th</sup> largest coal reserves
- 11<sup>th</sup> largest gas reserves
- 2013–14 energy production—18,715 PJ
  - Coal 66%
  - Uranium 14%
  - Natural gas 13%
  - Crude oil, condensate, LPG 5%
  - Renewables 2%

Source: Geoscience Australia and BREE (2014) Australian Energy Resource Assessment

2

[industry.gov.au/oc](http://industry.gov.au/oc)

Australia has an abundant and diverse range of high quality energy resources and reserves, which are distributed across the country.

Relative to the rest of the world, it has the largest uranium reserves, the fourth largest coal reserves and the eleventh largest gas reserves. Our resources of crude oil, condensate and liquefied petroleum gas are not as abundant and as a result Australia is increasingly reliant on imports. However, there remains significant potential for the discovery and development of petroleum resources both onshore and offshore.

Australia also has significant renewable energy resources. We possess some of the highest solar radiation levels per square kilometre of any continent in the world and have some of the world's best wind resources. Our geothermal, bioenergy, wave and tidal resources are also world class and hold considerable potential for producing energy.

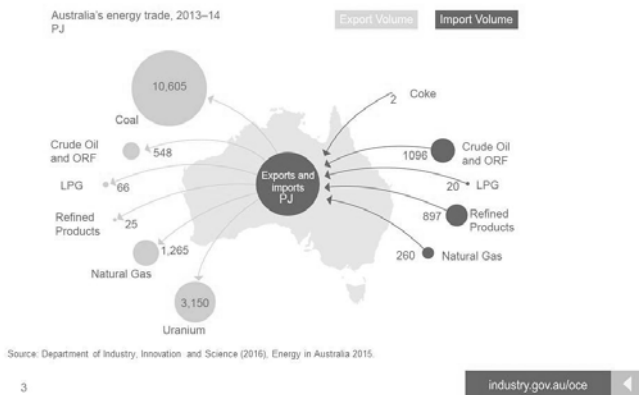
## Production and trade

In 2013, Australia was the world's eighth largest energy producer and sixth largest energy exporter.

Australia is currently the world's largest exporter of metallurgical coal, and the second largest for thermal coal.

In 2014, Australia accounted for 58 per cent of world metallurgical coal trade, and 27 per cent of total coal trade.

### A rich resource base supports Australia's position as a net energy exporter



In 2014, Australia was the world's third largest LNG exporter, behind Qatar and Malaysia, and accounted for 10 per cent of world LNG trade.

Australia is a net importer of crude oil and other refinery feedstock but a net exporter of LPG. Around 77 per cent of our crude oil and condensate production is exported, while

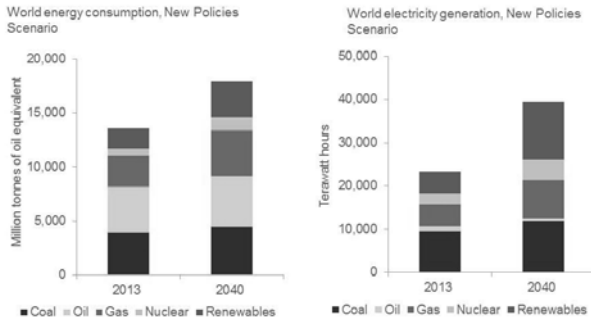
about 83 per cent of refinery feedstock for Australia is sourced from imports.

## 1.2 Trends in energy use

### World energy markets

Energy is the cornerstone of economic development and an essential component of modern lifestyles. The International Energy Agency (IEA) projects world energy

#### Renewables to play a greater role in meeting world energy needs



demand to increase by nearly one-third between 2013 and 2040. All of the growth in energy demand is expected to come from non-OECD countries, particularly in Asia, with the region projected to account for more than 40 per cent of the world's energy use by 2040. Over this period, the largest increase in energy use is expected in India, where consumption is projected to almost match that of the

United States. Conversely, energy demand in the OECD is expected to decline by 3 per cent.<sup>1</sup>

Overall, the rate of growth in energy usage is projected to decline over time because of an assumed deceleration in economic and population growth, structural change in key consuming countries, especially China, as well as policy measures that reduce the intensity of energy use.

Growth in energy demand will be supported by a rapid increase in electricity use as more of the population gains access to electricity and per person electricity use in non-OECD countries increases. Over the same period, the IEA projects electricity use to increase by 70 per cent by 2040.

Basic access to electricity allows for the introduction of mechanical power or replaces the need for manual labour, which is fundamental to the establishment of a low-cost manufacturing base that is globally competitive. It can also create opportunities for improving transportation and communication systems that enable the exchange of ideas and information.<sup>2</sup> As an economy develops, growth in electricity use typically slows as activity becomes structured around less energy-intensive sectors, such as services, and they can afford to invest in energy saving technologies.

The intensity of electricity usage per person in non-OECD countries remains well below that of advanced economies.

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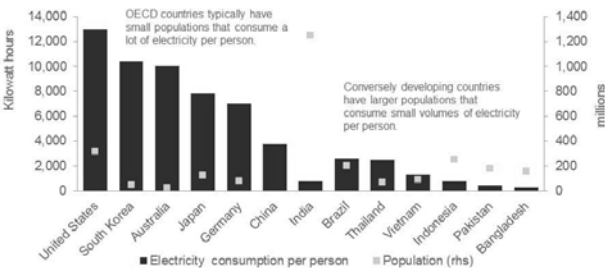
<sup>1</sup> IEA (2015) *World Energy Outlook*.

<sup>2</sup> Bryce, R. 2014, *Energy Innovation: Proving the Catastrophists Wrong*, remarks for the Sydney Institute, Gallipoli Club, 8 September.

In addition, the countries that currently have relatively low per person electricity usage have large populations. Around 82 per cent of the world's population resides in non-OECD countries, yet they only account for 53 per cent of world electricity consumption—this is roughly 1,900 kilowatt hours a person compared with 8,000 kilowatt hours a person in the OECD.<sup>3</sup> Given this, even small increases in per person usage in non-OECD countries, should translate into large increases in total consumption.

### Emerging economies to drive growth in energy use

Electricity intensity and population



Source: IEA (2015) *World Energy Balances*, indicators table

5

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Urbanisation trends will also influence energy use in non-OECD countries through changes in transportation and residential energy use. Households in urban areas typically have better access to energy services and consume more energy than in rural areas because of higher ownership of vehicles and appliances. The development of infrastructure to meet the needs of a

<sup>3</sup> IEA (2015) *World Energy Balances*.



growing urban population will also increase demand for energy-intensive construction materials such as steel and cement.

In non-OECD countries, particularly China, India, and countries in Southeast Asia and Africa, large numbers of people are migrating to cities in search of improved employment prospects and better access to health and education services. In 2015, just over half of the world population lived in urban areas. Over the next five years an estimated 455 million people, the equivalent of the current populations of the United States and Japan combined, are projected to migrate to cities.<sup>4</sup>

These broader trends mask some of the differences expected across these countries. For example, economic growth in China, the key driver of growth in energy demand over the past decade, is slowing as it transitions from investment-led growth to a model of consumption-led growth. China's economic transition will affect its patterns of commodity consumption and trade, shifting away from demand for resources and energy commodities towards consumer goods and food. In addition, stronger environmental and associated energy policies are driving a rapid change in its energy mix. Conversely, India is emerging as the key driver of energy demand over the period to 2040 as it tries to achieve its economic and social goals including expanding the manufacturing base and improving electricity access.

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<sup>4</sup> United Nations (2014) *World Urbanization Prospects: The 2014 Revision*, File 19 and 20.

The evolution of energy demand in OECD countries will be quite distinct from non-OECD. The IEA expects that OECD energy consumption will peak by 2020 and decline slowly thereafter because of energy efficiency improvements and the greater role of less energy-intensive sectors in these economies. As a result, the share of OECD in world energy consumption is projected to decline from 54 per cent in 2000 to 30 per cent by 2040. The global energy mix is projected to change substantially over the next 25 years. Rapid increases in renewable energy have already been occurring, with China leading investment in the region. Over half of the clean energy investment in the Asia-Pacific every year since 2011 has been in China.<sup>5</sup>

At the COP21 meeting in December 2015, the Intended Nationally Determined Contributions (INDCs) submitted by participating countries outlined their CO<sub>2</sub> reduction targets and plans. The implementation of these plans will be a key driver of energy consumption and the energy mix given that most of the plans signal an intention to increase the use of renewables and nuclear power. Oil, coal and gas are expected to remain the dominant source of energy supply but their share of the energy mix is projected to decline. The increasing role of renewables will be most evident in the electricity sector where they are expected to surpass coal as the largest source of electricity by 2030.

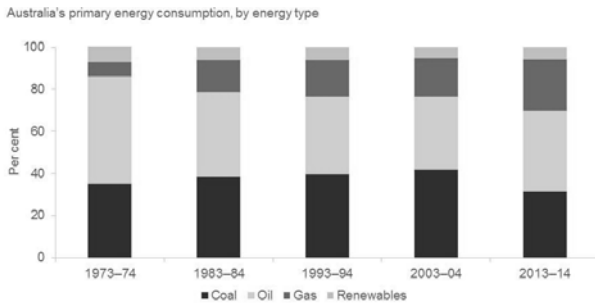
## Trends in Australia

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<sup>5</sup> Bloomberg New Energy Finance (2016).

Compared with its position as an energy producer and exporter, Australia is a relatively small energy consumer. In 2013 Australia was the world's twentieth largest energy consumer. Like most OECD countries, Australia's energy consumption has been declining, with energy use falling since 2011–12. In 2013–14, Australia's energy consumption was roughly the same as it was five years ago.

### Australia's energy use and mix are changing



Energy use for power generation accounts for more than one-quarter of Australia's total energy use. As a result, trends in electricity demand play a big role in this overall story. Electricity use in the National Electricity Market (NEM), which covers the east coast of Australia, has been declining over the past few years. This is largely the result of slowing economic growth, changes in consumer behaviour because of relatively high electricity prices,

energy efficiency measures and increased off-grid solar PV generation.

The Australian energy mix is also changing. The share of oil has been increasing at the expense of coal and accounted for around 38 per cent of energy use in 2013–14. The share of coal was 32 per cent, which is the lowest level since the early 1970s when we first started recording this information. Australia's coal use has been declining because of lower domestic iron and steel production and the closure of old coal-fired electricity generation capacity. Gas and renewables accounted for 24 per cent and 6 per cent of Australia's energy mix, respectively.<sup>6</sup>

The change in the energy mix is even more pronounced in the electricity generation sector. Although coal remains the major fuel source for electricity generation in Australia, it only accounted for 61 per cent of the generation mix in 2013–14, down from 79 per cent a decade ago. Renewable energy now accounts for 15 per cent of electricity generation, with the share of gas also growing. These changes have been driven by policies to support renewables, declining technology costs that have improved their competitiveness and a reduced share of baseload power.

### **Policy implications: energy trilemma**

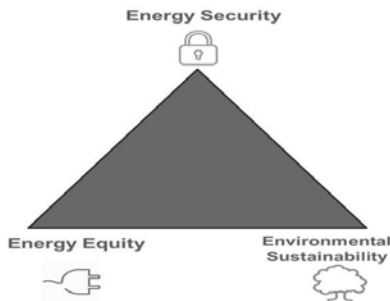
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<sup>6</sup> Department of Industry, Innovation and Science (2015) *Australian Energy Statistics 2015*.

Government policies will play a key role in determining developments in the energy sector. As a major energy supplier, it is important for Australia to monitor policy developments in importing countries.

How much each country satisfies increases in its energy demand will depend on policy settings with respect to objectives regarding energy equity and cost (ensuring access and affordability), energy security and environmental sustainability. The energy trilemma. No single energy option can meet each of these objectives equally; oil, gas, coal, nuclear and renewables can all

Policy challenge: the energy trilemma—no single solution



have drawbacks. As a result, there are complex trade-offs that will need to be made, which will have a bearing on each country's energy mix, particularly in a carbon constrained world. The relative weight attached to each objective will differ between countries and vary over time. Consequently, a change in policy may significantly alter a country's demand for particular energy sources.

## Energy equity

Given how essential energy is to our day-to-day lives, energy equity is an important policy issue. The first aspect of energy equity relates to accessibility. The IEA estimates that 1.2 billion people, or around 17 per cent of the global population, did not have access to electricity in 2013. Many of those that do have access, experience regular supply disruptions. The majority of those without electricity are in sub-Saharan Africa and developing Asia, and are in rural areas.

The second aspect of energy equity is affordability. Defining a reasonable price for energy can be difficult as there is no universally accepted standard.

### ***Electricity prices in Australia***

Australia has universal electricity access and Australians have enjoyed low electricity prices for much of our past. However, from 2008 until 2014, national average prices increased by about 90 per cent.<sup>7</sup> The biggest driver of the increase was the costs to maintain and upgrade the electricity network. Prices have since remained relatively flat, which equates to a decrease in real terms.<sup>8</sup> This moderation was largely because of a reduction in the price networks can charge for distributing electricity and the repeal of the carbon tax from July 2014. These reductions

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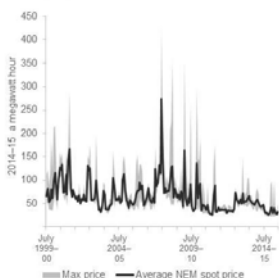
<sup>7</sup> Australian Bureau of Statistics, Consumer Price Index 6401.0.

<sup>8</sup> Australian Energy Market Commission, 2015 Residential Electricity Price Trends report.

were partially offset by increases in competitive market costs (wholesale and retail electricity costs).

### Australian energy prices

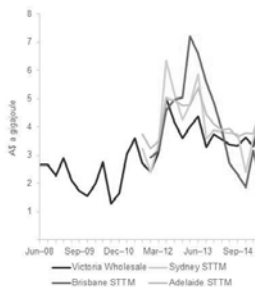
Spread of monthly average real spot prices across states in the NEM region compared to the average NEM spot price



Notes: The electricity price excludes the wholesale prices reported for the Snowy Scheme as well as the price spike in 2005 which may be associated with high prices in Tasmania at the time that state joined the NEM.  
Source: Global Room, AEMO

8

Quarterly domestic gas spot prices



industry.gov.au/occe

The Australian Energy Market Commission estimates that in 2014–15, an average customer paid around \$1,507 a year for electricity, of which 6 per cent goes towards environmental policies to reduce greenhouse gas emissions, encourage investment, support employment and make energy efficiency measures more affordable, 47 per cent goes to regulated network costs and a further 47 per cent goes to competitive market costs.

Australia's energy markets are progressively moving toward full retail contestability. Competition provides more choice for consumers. Consumers in most jurisdictions can take advantage of more competitive offers which can save them \$52–\$289 compared with standing offer tariffs.<sup>9</sup>

<sup>9</sup> Ibid.

Average electricity costs as a proportion of household disposable income were lower in 2014–15 than in the previous two years in all jurisdictions except Queensland. For a benchmark low income household receiving energy bill concessions, electricity costs accounted for about 4.6 per cent of disposable income in 2014–15, down from 5 per cent in 2012–13.<sup>10</sup>

Nationally, residential electricity prices are expected to increase by an average of 1.1 per cent over the next three years to 2017–18.<sup>11</sup>

The Energy White Paper, released in April 2015, committed the Australian Government to maintain downward pressure on electricity prices by repealing the carbon tax (achieved in July 2014), increasing competition and supporting further energy market reforms.

Electricity prices are ultimately the responsibility of state and territory governments. However, all Australian governments are working together to increase competition and customer choice.

National energy consumer protections were implemented in 2012 to empower customers to engage in competitive energy markets with confidence. As part of these measures, the Australian Government developed a price and offer comparator service, Energy Made Easy, and electricity retailers are required to develop and maintain

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<sup>10</sup> Australian Energy Regulator, *State of the Energy Market 2015*, page 136.

<sup>11</sup> Australian Energy Market Commission, *2015 Residential Electricity Price Trends report*, p.81.



approved customer hardship policies which assist customers experiencing difficulty paying their energy bills.

### ***Gas prices in Australia***

Natural gas has assumed an increasingly important role in the energy industry in eastern Australia since production first commenced 45 years ago from Bass Strait in Victoria, the Cooper Basin in South Australia, and the Surat Basin in Queensland. The relatively low cost supplies from these basins led to the rapid penetration of gas into the residential, commercial and industrial markets. More recently, gas consumption has expanded into the power generation market with the growth of both peaking and base load generation capacity.

The development of new liquefied natural gas (LNG) capacity on the east coast of Australia has given rise to concerns about gas prices in the eastern market as a result of the sheer scale of LNG production compared to the size of the domestic market. Once the projects reach maximum production, LNG demand in the eastern market is expected to be almost three times greater than domestic demand.

There was strong pressure on domestic reserves while these LNG plants were being constructed as supply portfolios were being developed, with some domestic gas diverted to the LNG projects. This pressure was heightened by uncertainty about the number of LNG plants likely to be constructed.

Over this period, it was thought that the linking of the eastern domestic gas market to the LNG market would cause domestic gas prices to rise to the long-run LNG netback price in each state. This is on the basis that the LNG producers would be willing to pay up to LNG netback for third-party gas supplies. A typical long-run netback at Wallumbilla in Queensland two years ago was about \$8.40 a gigajoule, more than twice the rate of domestic legacy contracts.

Gas prices for new domestic contracts have indeed risen. A study for the Department found that although new contract prices had increased significantly, average prices had not increased much because of legacy contracts at lower prices.

Now that the east coast gas market is connected to the global LNG market, movements in global prices will translate through to the domestic market. The Department's analysis suggests domestic gas prices will be determined in part by the short-run netback price. While the interaction between LNG spot prices and the domestic market will be important, and will contribute to volatility in domestic prices, the most critical determinant of prices will be gas production capacity, which in turn depends on the level of investment.

There are many factors which influence the adequacy of production capacity, including the physical capability of the fields, the costs of supply, and the incentives to invest in new supply. The supply and demand situation in eastern Australia, is best understood as two distinct markets—the

north and the south. The current production capacity is adequate to supply both markets in the short term, but modelling conducted by the Department suggests that in the medium to long term the physical production of gas in the south will decline, which in the absence of new supply may expose the market to shortfalls and put upward pressure on prices beyond 2020.

### Energy security

Given the importance of energy to all economic activity, there has been an increasing focus on energy security in response to price variability and fears of supply disruptions. Concerns about energy security emerged after the first oil shock in the 1970s. The IEA was founded in response to these shocks to help co-ordinate a collective response to major disruptions in the supply of oil.

There are numerous approaches to defining energy security. In fact, one paper released during 2015 identified 83 definitions.<sup>12</sup> Most definitions of energy security include either the reliable, adequate or affordable supply of energy. The reliable and adequate supply of energy does not necessarily apply to just external sources. Domestic supply can also become an issue in many countries.

The term can also capture geopolitical, military, technical and economic dimensions. The increased use of IT networks in the operation of critical energy infrastructure

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<sup>12</sup> Ang B. W. et al, Renewable and Sustainable Energy Reviews.

has also resulted in cyber security becoming closely associated with energy security.

### Australia's approach to energy security

The Australian Government has an ongoing role in assessing Australia's energy security and examining potential threats to Australia's energy systems to ensure all Australians can access an adequate, reliable and competitively priced supply of energy

The Australian Government assesses Australia's energy security through National Energy Security Assessments (NESAs) and monitors global and domestic settings to inform the development of energy policy and broader government policies

NESA is an economic assessment of the effectiveness and anticipated resilience of Australia's electricity, natural gas and liquid fuel systems in continuing to meet the long term requirements of domestic energy users



### ***Energy security in Australia***

Australia defines energy security as the “Adequate, reliable and competitively priced supply of energy to support economic and social development”.

While some international definitions are narrowly focussed on oil, and more specifically oil self-sufficiency, Australia's definition is broader. It encompasses the total energy supply system— liquid fuel, electricity and gas and all parts of the supply chain—both international and domestic—from production through to final consumption.

The government's approach to energy security is to minimise risk and manage issues that occur rather than

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seeking to eliminate risk entirely. Achieving agreement on the appropriate level of energy security and the level of risk attached requires a trade-off between reliability and price. Some consumers are willing to pay more to ensure greater reliability. For example, emergency services, such as hospitals, require a much higher level of reliability than the general public. These types of facilities often take responsibility for their own energy security by installing back-up electricity generators and additional fuel storage.

A large focus of Australia's energy security is concentrated around oil. Australia has large coal and gas resources and is a major exporter of these commodities, but we are short on oil.

Our liquid fuel markets are linked to the global market through the open movement of crude oil and petroleum products between Australia and a number of other countries. Around three-quarters of the crude oil consumed by Australian refineries is imported. Malaysia is the single largest supplier, followed by the United Arab Emirates and Indonesia. Similarly, around half of the refined petroleum products—such as petrol and diesel—consumed in Australia are imported. This is largely sourced from Singapore, South Korea and other Asian producers such as China, Taiwan, India, Malaysia, and Indonesia.

Australia's state and territory governments have a role in establishing market rules and monitoring markets to ensure that they operate efficiently and effectively to benefit consumers. In addition, governments have put in

place response measures in the event that markets are unable to cope with supply disruptions. For example, if the Liquid Fuel Emergency Act 1984 is invoked, the government can control the drawdown, transfer and sale of industry stocks of crude oil and liquid fuels; the range of products produced by Australian refineries; and bulk and retail sales of fuel across Australia. This Act has not been invoked to date.

The Government undertakes regular assessments of the status of Australia's energy security. This is primarily achieved through the National Energy Security Assessment (NESA), which is a forward-looking whole-of-government energy security assessment of Australia's liquid fuels, gas and electricity sectors. NESAs were conducted in 2009 and 2011 and a third NESA is currently being prepared.

With each successive NESA, we have built on past experience. The 2009 and 2011 NESAs focussed on market fundamentals of supply, delivery and price competitiveness for the liquid fuel, gas and electricity sectors. For the next edition of the NESA, the scope of the assessment will be expanded to look at system resilience and national security issues related to infrastructure and supply across the entire chain, both domestic and international.

The Government also monitors and assesses Australia's energy security situation by commissioning external studies on specific issues, and undertaking internal analysis across government agencies. This ensures that

we have an up-to-date awareness of changes in global and domestic energy markets.

Australia participates in domestic and international critical energy infrastructure groups to promote international collaboration and mutual assistance on issues related to electricity infrastructure assurance among countries with common infrastructure assurance challenges. The International Electricity Infrastructure Assurance Forum was established in 2004 and consists of representatives from the five participating countries of Australia, Canada, New Zealand, United Kingdom and the United States.

### ***Global governance mechanisms***

Australia actively participates in multiple international energy organisations, including on collaboration between organisations, to ensure global energy governance architecture is as coherent and streamlined as possible.

As a member of the IEA, Australia is strongly supportive of IEA Executive Director Dr Fatih Birol's vision for IEA modernisation, including enhancing engagement with non-OECD economies, particularly in the Asia-Pacific.

Australia is also a founding member of APEC, working closely with member countries on a range of issues including key energy security initiatives. As part of this engagement, Australia has recently proposed to investigate how modern approaches to risk management could be applied to energy security in the APEC region.

Energy security is inherently about managing risks across the supply chain, which has become increasingly complex over recent decades. Global and regional energy markets share common features with other large scale systems such as global financial markets, and large events such as pandemics and natural disasters in that all are highly complex, involve multiple participants, trade-offs in objectives, and competing interests including sovereign, commercial and regional. Markets and global systems are also highly diverse, interconnected and interdependent. As a result, they are vulnerable to shocks in demand, supply and price, which can create contagion effects both between participants and between different systems.

The nature of recent global shocks, such as the global financial crisis, has highlighted the deficiencies in traditional approaches to managing risk in complex systems. As a result of the lessons learned from these events, risk management has shifted increasingly towards more systemic approaches that look at risk at the level of the whole system, including the interconnections and interactions between different system components. These risks can and do look very different from those that are apparent when you look only at one part of a system.

Australia's view is that similar systemic approaches can be of value in the energy security space. The application of modern risk principles could enhance energy security objectives by providing capacity to identify risks arising from supply chain interdependencies, as well as a clear approach to assessing the costs and benefits of different mitigations responses. This is the basis on which Australia



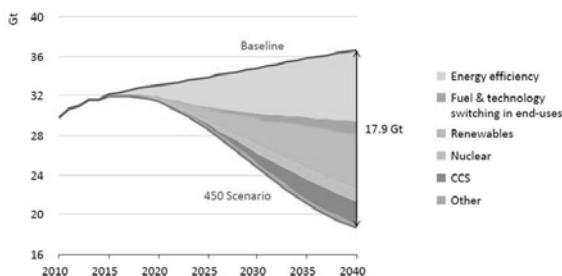
is seeking APEC project funding to further investigate how modern risk management approaches could apply to energy security in the APEC region. The project is seeking to undertake the preliminary work on what a risk framework would look like and how it might work, working with APEC member economies and energy governance organisations to develop a framework that can guide regional energy security policy and decision making.

## Environment

Climate change and increased concerns about the environment have created challenges for energy systems. It is crucial that energy and environmental policy is well integrated to avoid unintended outcomes that risk either energy or emission reduction objectives. To achieve environmental outcomes, most countries are targeting the increased adoption of low-carbon technologies or finding ways to reduce energy use through efficiency measures.

### Low-carbon energy and energy efficiency key to reducing emissions

Source of emission reductions between IEA baseline and 450 Scenarios



Source: IEA (2015) World Energy Outlook presentation to the Institute of Energy Economics, Japan

The IEA's 450 Scenario models a set of policies that produce an emissions trajectory that is consistent with the international goal to limit the increase in global temperature to 2 degrees Celsius. According to their projections, renewable energy and energy efficiency will be the key technologies required to achieve the goal.

### ***Reducing emissions from Australia's electricity sector***

Electricity currently contributes around one third of Australia's total greenhouse gas emissions. Australia has abundant coal resources and, as a result, coal-fired power dominates the generation mix at around 61 percent of the generation mix. This fleet is largely based on relatively old technologies, with around half of the installed capacity more than 30 years old.

By global standards, the Australian grid has a very high emissions intensity. In 2013–14, the emission intensity of the grid was 0.72 tonnes of carbon per megawatt hour of electricity. This was approximately 60 per cent higher than in the United States.

If Australia is to reduce emissions to meet the targets set at COP21, the electricity sector will need to play a major role. This will require the replacement of high-emissions generation capacity. As a result, there will need to be significant investment in both low-emissions baseload capacity and solutions to intermittency issues.

To encourage the development of low-emissions capacity, these plants will need to be profitable and have a sufficiently clear long-term price signal. Stable policy

settings across a range of areas will play a key role in facilitating investment in new generation and network assets and ensure the economic and efficient operation of the NEM. Without efficient investment signals, unprofitable generation supply may not be closed, which can have the effect of deterring investment in new, more efficient and lower emissions plants.

Renewable energy now makes up all of the new investment and accounts for 15 percent of electricity generation.

The extensive deployment of renewables also brings with it the technical challenge of integrating higher levels of renewables in the electricity generation mix. The power system can operate reliably with a high percentage of renewable energy and respond to challenges posed by intermittency of renewable energy sources and integrating distributed energy sources. However, these challenges are likely to become more frequent and significant as conventional generators continue to be displaced by renewable energy.

### Australia's electricity infrastructure and power plants



Source: Geoscience Australia (2014).

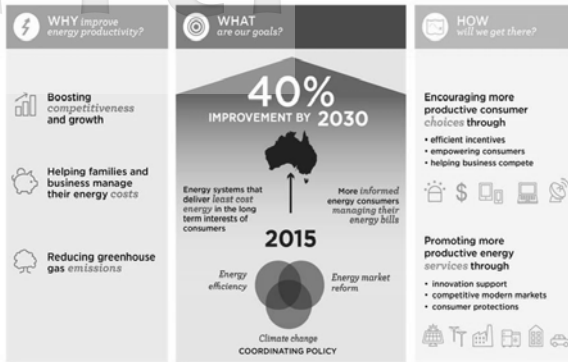
South Australia provides a good example of some of the broader trends happening in the NEM. South Australia generates the largest share of wind electricity in Australia, accounting for 40 per cent of Australia's total wind generation. The penetration of wind in South Australia is also relatively high by global standards, with wind accounting for more than 30 per cent of South Australia's total electricity generation. In addition, over a quarter of South Australian households have solar panels. This could result in 100 per cent of demand being met by rooftop PV at some times in the day.

The high penetration of renewables has introduced the challenges of a demand profile that requires additional peak generation capacity, particularly in summer, and adequate frequency control. Frequency and voltage control services have typically been provided by conventional baseload generators. Unlike wind and solar PV, these conventional baseload generators resist and dampen changes in the frequency of electricity in the grid. Given the closure of coal and gas-fired capacity in South Australia, an increasing penetration of wind and solar PV generation in the generation mix can create issues for frequency control.

### ***Energy productivity***

Improving energy productivity will help Australia adjust to rapid change that is occurring in the energy market. Australia is focused on improving its energy productivity so that we can obtain more value from the energy we consume and assist in achieving environmental objectives.

## National Energy Productivity Plan



11

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A focus on productivity instead of energy efficiency ensures a better balance between demand-side consumer choices and supply-side energy services. Energy productivity is a common international measure that will make it easy to compare our progress with other countries.

Improving energy productivity requires more efficient investment across both the supply and demand side of energy markets, including: primary energy sources (such as coal, gas, oil, solar and wind); energy supply assets (generation and networks); assets related to energy use (such as more efficient equipment, buildings and vehicles); and avoided energy use.

As part of its emission reduction target announced in August 2015, the government made a commitment to improve Australia's energy productivity by 40 per cent between 2015 and 2030. The National Energy Productivity Plan (NEPP) is expected to contribute more than a quarter of the savings required to meet Australia's 2030 greenhouse gas emissions reduction target.

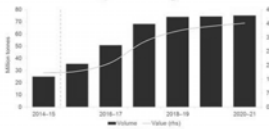
The NEPP provides a framework and work plan of 34 measures designed to accelerate improvement in energy productivity over the next 15 years. It seeks to address emerging market risks by better coordinating policy and planning across energy efficiency, energy markets and climate policy.

The NEPP is also designed to improve Australia's international competitiveness. Australia's energy productivity has improved, growing at around 1.8 per cent a year in the last decade. Despite this we are still lagging behind many countries, such as Japan, Germany, and the United Kingdom, and without action this gap will get wider. Improvements to the way we use energy can significantly reduce costs, which is particularly important if we are to remain competitive against other economies. Many countries such as the United States, the European Union and China have their own energy productivity or energy efficiency targets.

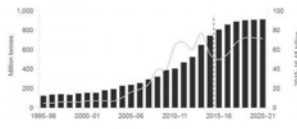
## Trends in energy supply

### Exports of Australia's bulk resources and energy commodities

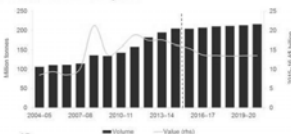
LNG will be the key driver of growth in Australia's export earnings



Increased volumes to drive iron ore earnings



Well-supplied markets will limit growth in thermal coal exports



Source: ABS (2016) International Trade, Australia, cat. no. 5465.0, Department of Industry, Innovation and Science

**Australian producers will need to remain highly competitive to maintain market share**

The decade-long increase in commodity prices contributed to a large and sustained increase in investment in global energy projects. As these projects are completed and new output materialises, supply of energy commodities has increased rapidly.

Over the longer term, new projects will need to be developed to meet the projected increase in energy demand. However, these investments will need to be made in an environment of relatively low prices and greater uncertainty. Low energy prices, and the expectation that they will prevail for some time, and limited access to finance have reduced the interest in developing new energy projects. Instead, companies are selling assets to generate cash rather than operate or buy assets or develop them. This pullback in investment will have varied effects on world energy markets. In the oil and gas sector, where projects have long lead times and high capital costs, ongoing investment is required to maintain production levels. A likely consequence of this not occurring is an increased dependence on OPEC and Russia for oil supply.

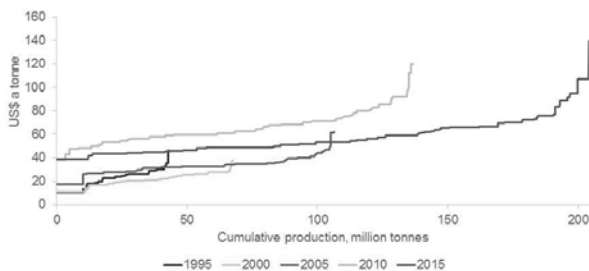
Australia is expected to be a key contributor to the increase in world energy supply over the period to 2040. Australia is expected to be the only OECD country to have a substantial increase in coal production as new mines are developed to meet export demand. Our gas production is projected to increase rapidly over the period to 2020 to feed into seven new LNG projects that have been developed over the past several years. Investment cutbacks in response to lower prices and tighter access to

finance will limit the growth in production over the longer term. Nonetheless, Australia is expected to dominate trade in these two commodities at least over the near term.

It is very clear that operating conditions are becoming more challenging for producers. The sustained period of low prices has reduced the viability of many operations and increased the financial pressure on companies. As a result, many operations have scaled back production or been placed on care and maintenance. As financial losses continue to accumulate, there is an increasing possibility that further closures will occur or more companies will fail.

The Australian sector has been able to adjust to changing market conditions

Australia's thermal coal cost



Source: AME Group (2016)

However, the industry has been very successful at rapidly reducing costs as low prices have encouraged a series of cost cutting exercises targeting exploration, capital expenditure and employment. If we take the Australian thermal coal industry as an example, some operations



have been able to achieve large cost reductions over the course of a few years.

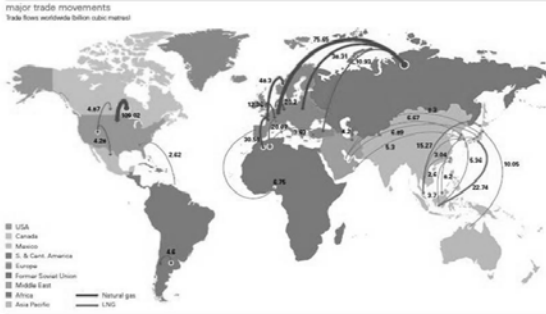
Competitive conditions in Australia's major energy export markets have not remained static. If we take LNG markets as an example, the number of buyers and suppliers almost doubled from 25 in 2000 to 48 in 2014. LNG buyers, who previously had only a limited number of options for sourcing LNG, now have access to a growing range of suppliers across many regions. As the market continues to grow and mature, there has been an increase in the diversification of LNG supply in consuming countries, although the extent of this diversification varies. For example, Japan, South Korea and China have achieved a low to moderate concentration of LNG supply in recent years, but India remains heavily reliant on Qatar.

The concentration of suppliers into both Japan and China is expected to increase in the medium term, given the increasing share of Australian LNG from projects recently completed or under construction. As such, medium to long term growth in LNG exports from Australia is more likely to be from emerging importers, such as India, rather than these foundation buyers.

This highlights the trade-off between security, access and environmental sustainability that I discussed earlier. The energy trilemma is dynamic and it depends not just on the price, quality and sustainability of Australia's energy exports, but also those of our competitors.

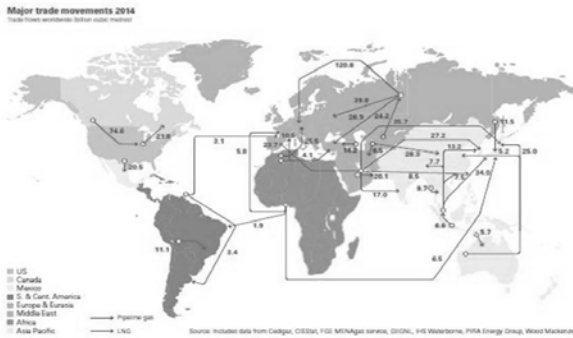
# Implications for the international political economy

## The world gas market has changed since 2001



Source: BP Statistical Review of World Energy 2002

## There were more participants in 2014



Source: BP Statistical Review of World Energy 2015

Energy policy is vital to a country's economic, defence, industrial, cultural and diplomacy objectives. It is a source of government revenue, ensures energy security, facilitates the development and sharing of industrial knowledge, the exchange of ideas and its trade requires negotiation and compromise with other countries. As a result, energy policies can be highly politicised, and political imperatives can have a greater influence on energy market outcomes than market or technological drivers.

Energy markets have changed markedly over the last decade. In particular, the shift in the centres of production and consumption of energy has contributed to increased global trade in energy commodities. Energy markets are now more interconnected than they were in the past, which will have varied implications for energy equity, energy security and the environment.

The shift in energy geography has also created the need for new trade relationships to be developed. Australia's role as a major energy exporter, particularly in the Asia-Pacific, will be reinforced by the conclusion of bilateral trade agreements with three of our largest trading partners.

- The China-Australia Free Trade Agreement will allow more than 85 per cent of Australia's goods exported to China to enter duty free when the agreement enters into force, rising to 95 per cent once fully implemented. This locks in zero tariffs on Australia's major resource exports, including LNG.

- The Japan-Australia Economic Partnership Agreement, which entered into force in 2015, provides duty-free entry for almost all of Australia's resources, energy and manufacturing exports to Japan. Once fully implemented, the agreement will allow more than 97 per cent of Australia's merchandise exports to receive preferential access or to enter Japan duty-free.
- The Korea–Australia Free Trade Agreement, which entered into force in 2014, provides duty-free entry for 88 per cent of Australia's exported resources, energy and manufacturing products into Korea. Under this agreement, all remaining tariffs on these goods, including a 3 per cent tariff on LNG, will be eliminated by 2023.

In addition, Australia has successfully concluded negotiations on the Trans-Pacific Partnership (TPP). The TPP includes 12 countries that represent around 40 per cent of global GDP and 25 per cent of world trade, including Japan, Malaysia, Singapore and Vietnam. It aims to create seamless trade and investment and eliminate 98 per cent of all tariffs across a range of agricultural, manufacturing, and resource goods. Key Australian minerals, petroleum and LNG exports will have zero tariffs into TPP countries.

Australia is currently negotiating several other free trade agreements, including the India–Australia Comprehensive Economic Cooperation Agreement and the Regional Comprehensive Economic Partnership Agreement that

includes the Association of South East Asian Nations (ASEAN), India, China, Korea, Japan and New Zealand.

## Conclusion

### Key messages

- 1 Energy markets are dynamic—consumption trends and the energy mix are changing rapidly
- 2 Markets are increasingly characterised by increased uncertainty, particularly around policy
- 3 Australia is implementing policies to deliver competitively priced, reliable and secure energy for households and businesses
- 4 Supply is projected to increase to meet world demand but Australia will need to find ways to remain competitive
- 5 Increased interconnectivity of international energy markets will increase the importance of trade relationships

The markets for energy commodities are changing and growth in consumption is moderating, primarily reflecting the pace of China's structural transition, and the increased implementation of energy-related policies, such as energy efficiency measures. Overall, world energy consumption is projected to increase by almost one-third over the period to 2040, underpinned by an increase in non-OECD demand as they improve energy access and urbanise.

Energy policies aimed at meeting environmental and energy security objectives are facilitating the increased diversification of the global energy mix. Commitments made at COP21 indicate that growth in energy use will increasingly be met by renewable energy and nuclear

power. Nonetheless, oil, coal and gas will still remain key components of the world energy mix.

Despite these expectations, energy markets are increasingly characterised by greater uncertainty driven by policy change, uncertain economic conditions and unclear investment signals. Any major policy changes in response to the energy trilemma could encourage more rapid changes in the consumption profiles and energy mix than expected.

Australia has implemented a number of measures to promote a competitive and innovative energy sector that delivers competitively priced, reliable and secure energy for households and businesses. The government is also an active participant in international fora to promote collaboration and trade.

World energy supply is expected to continue to meet growing energy requirements. In the near term, operating conditions for producers will remain challenging because of low energy prices and poor profitability. Australia is expected to maintain its position as a major energy producer and exporter over the longer term, supported by an increase in export demand. However, producers will need to continue to find ways to remain competitive in a market with a growing number of suppliers.

The increased interconnectivity of international energy markets will increase the importance of trade relationships. Australia has continued to reinforce our existing trade relationships and develop new connections as growth in

energy consumption in other countries in the Asia-Pacific increases.

## Conclusion

If you are interested in seeing more analysis of the Australia's energy markets I encourage you all to visit our website and keep up to date on new releases through our twitter account.



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