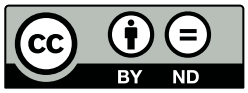
Australian Government

Department of Resources, Energy and Tourism

NATIONAL ENERGY SECURITY ASSESSMENT

2011

ISBN 978-1-921812-85-9 (paperback)
ISBN 978-1-921812-84-2 (online PDF)



The document should be attributed as
National Energy Security Assessment December 2011

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Produced by the Department of Resources, Energy and Tourism
Graphic design by Typeyard Graphic Design & Advertising

Minister's foreword

The 2011 National Energy Security Assessment (NESA) continues and updates a process commenced with the inaugural NESA in 2009.

Energy is fundamental to our modern economy and society. Adequate, reliable and competitive energy supply underpins economic activity, from powering our industries to lighting our houses. The secure supply of energy is essential to economic growth, jobs, and the prosperity and wellbeing of all Australians.

The 2009 NESA identified a range of challenges confronting our natural gas, electricity and liquid fuels sectors. Specifically it found that Australia's energy security assessment in these sectors was 'high to moderate', meaning our economic and social needs were being met, but that some emerging issues such as carbon pricing uncertainty, the global financial crisis and the drought were having negative influences on maintaining security.

Since 2009 we have seen a number of developments including the passage of legislation giving effect to a carbon pricing mechanism, large sections of Australia becoming drought free and significant development in the east coast coal seam gas to LNG industry.

The 2011 NESA finds that energy security in our natural gas, electricity and liquid fuels sectors has remained largely consistent with the assessment undertaken in 2009. Specifically, the NESA finds all three sectors have a 'moderate' or above energy security assessment over the short, medium and long term.

Importantly, the role of the NESA is to provide a reference point for policy makers and interested stakeholders, and in doing so the NESA is an important basis for the development of Australia's energy policy. As was the case in the 2009 NESA, this updated assessment provides a starting point for future energy security assessments and will inform the development of energy policy. The 2011 NESA has been an important input into the 2011 Draft Energy White Paper.

The Government presents the 2011 NESA, and associated 'shock' scenarios that sit behind the NESA, as an updated assessment of our energy security progress at this important time, and as an input to further assist the national policy development process in our energy sector.

The Hon Martin Ferguson AM MP
Minister for Resources and Energy
Minister for Tourism
December 2011

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Executive summary

Energy security remains a key priority for the Australian Government. Australia is a country well endowed with energy resources, but faces a period of unprecedented change as our liquid fuel, natural gas and electricity sectors invest to meet future energy demands and the transition to a lower-carbon energy sector.

Fundamentally, the ability to bring on adequate investment in future energy infrastructure in the decades ahead will largely determine our level of energy security. In this context, government policy has a role in creating the environment in which the private sector invests, and attracting global capital to Australia's energy sector.

Government policy is a particularly relevant consideration for investors in the electricity generation and gas sectors.

Our liquid fuel security – compared to electricity and natural gas – is more dependent on global supply chains and international outcomes than domestic policy decisions.

The Australian Government has updated the National Energy Security Assessment (NESA) to consider the key strategic energy security risks facing Australia currently and over the short, medium and long terms.

The NESA is an assessment rather than a prediction, and is not a policy document, but is an important input into the development of government policy through the Energy White Paper process. The NESA's analysis considers the main factors challenging the adequate, reliable and competitive delivery of energy in each of the liquid fuel, natural gas and electricity sectors.

In the Australian context, energy security is defined as the adequate, reliable and competitive supply of energy to support the functioning of the economy and social development. This assessment considers the key influences on energy security in Australia in the short, medium and long terms covering the period 2011 to 2035.

The 2011 NESA's key finding is that Australia's overall level of energy security has remained largely consistent with the assessment undertaken in 2009, and that Australia's energy security situation is meeting Australia's economic and social needs, albeit with some emerging market and policy uncertainties that could have implications for maintaining our current level of energy security.

While some of the significant economic factors that impacted the last assessment in 2009 (such as the drought) have largely passed the acute phase, a number of issues continue to present challenges in the energy market, including the implementation of a carbon pricing mechanism, uncertainties surrounding emerging gas market developments (particularly coal seam gas), unrest in global oil markets, continuing fall out from the global financial crisis, and upward pressures on energy prices, particularly for domestic electricity and global oil prices.

A common theme in the 2011 NESA – which was confirmed by stakeholder consultations – is that current market developments, existing clean energy policies such as the Renewable Energy Target, and carbon pricing policies are unlikely to reduce energy security adequacy or reliability in Australia. However, the impact of these climate change measures, together with increasing investment in energy networks, will create upward pressure on energy prices.

This energy security assessment examines:

- Australia's growing reliance on oil importation
- the gas sector's rapidly evolving unconventional gas resources and liquefied natural gas (LNG) markets on the east coast
- the investment environment in the electricity sector, particularly in the context of low-carbon and renewable energy policies.

The 2011 NESA reflects these important developments to give the following overall assessments for each energy sector.

Liquid fuels

Liquid fuel energy security remains largely unchanged from 2009 and is assessed as ***high trending to moderate*** in the long term, as Australia has continued access to highly adequate and reliable supplies of liquid fuels at price levels that are manageable within the broader economy. However, the moderate assessment in the long term recognises that the continued rise in Australia's imports of petroleum products will place greater reliance on international supply chains and the consequential need for investment in adequate import and storage infrastructure. The assessment also recognises a likely trend of high crude oil prices driven by increasing global demand and an increased reliance on more expensive sources of supply; the significant global investment challenge required to meet rising demand; and the continued risks of geopolitical uncertainty in key oil-producing countries.

Natural gas

Natural gas energy security overall remains ***moderate*** over the NESA period, reflecting a rapidly developing market with distinct regional differences and challenges.

Since the 2009 NESA, market reforms have progressed and investment in conventional and unconventional gas developments has continued to grow to meet the demand from domestic and LNG export markets. The considerable gas supplies that have been identified domestically and globally in recent years are expected to constrain the potential gas price increases that were flagged in the 2009 NESA, resulting in the long-term competitiveness rating moving from low in the 2009 NESA to moderate in the current assessment.

The overall moderate assessment recognises the mixed influences on gas security brought by the development of the coal seam gas and LNG export industry on the east coast, due to commence in 2014–15. The development of this industry was identified in the 2009 NESA, but has since progressed significantly. While this has increased the gas reserve levels in Australia, there is the potential to introduce competitive tension between the domestic and LNG export markets, and lead to increases in domestic gas prices.

The moderate assessment also reflects the evolving supply–demand balance in Western Australia. While increases in demand since the 2009 NESA have placed upward pressure on prices, the market is responding with increased supply from a greater diversity of sources planned to come on line in the short to medium term. Despite this, there is a risk that some downstream projects may be challenged in sourcing gas at prices that maintain their viability.

The longer term role of gas in the economy – especially in relation to electricity generation – is particularly important in the context of carbon pricing policy and the possible change to the generation mix that may occur in the future.

These elements are important drivers of the medium- and long-term assessment remaining moderate.

Electricity

Electricity energy security overall remains ***moderate*** over the 2011 NESA period, continuing the rating from 2009. A number of significant economic factors such as the drought and climate change policy uncertainty impacted the assessment in 2009. While these factors have moderated, the electricity sector faces significant challenges during the assessment period, most notably reliability and price pressures associated with the implementation of climate change and renewable energy policies, as well as significant investment needed in new and ageing infrastructure. The Australian Energy Market Operator's National Transmission Network Development Plan forecast that between $72 billion and $82 billion will be required for new generation and electricity transmission expenditure by 2030. However, market maturity, delivered through ongoing market reforms and assistance mechanisms associated with the Australian Government's Clean Energy Future package, should allow the market to respond appropriately and flexibly to such challenges.

The Australian electricity sector (principally the National Electricity Market and the South West Interconnected System) has historically responded in a timely manner to meet demand, building generation, and avoiding breaches of reliability standards. However, projected growth in electricity demand may present investment challenges in the short to medium term. For example, in the National Electricity Market at least 2500 megawatts of non-intermittent generation capacity is expected to be required to meet demand by the middle of this decade, and a potential further 2000 megawatts of highly

emissions intensive generation capacity could be removed from the market under the government's Contract for Closure program announced in the Clean Energy Future package.

Government-commissioned reports by Deloitte and the government-appointed Investment Reference Group into carbon pricing uncertainty also found in the short to medium term that carbon policy uncertainty prior to the government's announcement and legislation of the Clean Energy Future package had been affecting investor confidence, resulting in delayed investment. The energy security measures (see Box 4.2) as part of the government's Clean Energy Future package will be an important element in further mitigating any short term energy risks associated with carbon pricing implementation.

Electricity adequacy and reliability are expected to remain at a moderate level throughout the assessment period to meet projected demand. Price competitiveness of electricity is also assessed as moderate throughout the assessment period. Electricity prices are projected by the Australian Treasury to continue to rise in the short, medium and long terms as a result of continued investment in our electricity network, pricing of carbon in investment decisions, and embedded higher-cost generation imposed by renewable energy mandates, feed-in tariffs and, ultimately, the transformation in the economy to lower-emissions electricity generation technologies. Network infrastructure investment costs will make up the bulk of the cost increases in the short term, while renewable energy development and deployment and carbon pricing policies are likely to be the major contributors to cost increases in the medium to long term.

While electricity affordability was assessed as low in the 2009 NESA, the rating was largely based on the limited detail available at the time on the transition arrangements for the proposed Carbon Pollution Reduction Scheme and the cost impacts of the 20 per cent Renewable Energy Target. The 2011 assessment takes into consideration the Australian Government's Clean Energy Future assistance package that will provide low- and middle-income households and emissions-intensive, trade-exposed industries with assistance for the effects of electricity price increases which result from carbon pricing. There are also currently a range of activities underway to test regulatory outcomes with respect to network investment. Therefore, this 2011 assessment considers more confidently that cost impacts are manageable, and consistent with a ***moderate*** assessment rating for competitiveness.

Shock scenarios

The 2011 NESA also examined Australia's energy security resilience by modelling a set of physical infrastructure and supply chain 'shocks'.

The scenarios are hypothetical and were designed to test the response arrangements and resilience of the energy system. The scenarios seek to examine the impact on the adequacy, reliability and/or competitiveness of supply. They are not an assessment of a particular asset's resilience, reliability, or a prediction of the likelihood of the disruption event.

The modelling results indicate that, in general, Australia has resilient liquid fuel, gas and electricity supply arrangements. The results highlight the continuing importance of ensuring resilient infrastructure and the diversification of supply and transmission infrastructure to avoid and respond economically to supply disruption events.

Liquid fuels scenario

The 2009 NESA identified geopolitical risks and long global supply chains as two areas of risk to our liquid fuel security. The liquid fuels shock scenario considered disruptions to supply from our largest importing source for refined petroleum products – Singapore. The modelling demonstrated that the global market and international supply chain could provide Australia with adequate and reliable supplies, albeit at higher prices.

An immediate interruption to the Singaporean supply chain is estimated to increase global product prices by around 18 per cent on average in the first month, while prices decline somewhat from this spike in the second and third months. The main impact on Australia's energy security would be on competitiveness. Adequacy and reliability would be maintained through alternative supplies available due to excess regional and global refining capacity, access to stocks in Australia and those already on water, and the ability to acquire petroleum products from the Asia–Pacific that would normally be sold to other regions.

Gas scenario

The gas shock scenario looked at a major gas pipeline into south-east Queensland, with theoretical levels of increasing supply disruption. The modelling results showed how supply disruption would impact pipeline gas users (power generators and other consumers), and the importance of diversified supply in maintaining the energy security of both gas and electricity.

Realistically, any significant reduction in capacity on the pipeline will result in either voluntary or involuntary curtailment of gas load. Voluntary curtailment would be facilitated through the Short Term Trading Market for gas in Brisbane which commenced on 1 December 2011. This will provide an opportunity for voluntary gas curtailment by those gas users who can curtail gas at least cost. It is possible that gas-fired generators will offer to voluntarily curtail through the Short Term Trading Market, which would provide an opportunity to manage relatively significant reductions in capacity on the Roma to Brisbane pipeline without affecting most gas customers.

There are no issues for security of electricity supply caused by the curtailment of gas supplies on the pipeline, and the overall impact on electricity prices is relatively muted (with the exception of the peak demand day in summer).

Electricity scenario

The electricity shock scenario examined the impact of an unexpected and sudden withdrawal of a large baseload plant from the National Electricity Market (NEM). The modelling indicated that the NEM could be challenged by such an event. It would also place a greater reliance on the capacity of interconnectors to adjust supply and demand arrangements – and illustrates their importance in our energy security.

The outage of a major baseload power station results in significant high priced events and higher-cost generation being required to meet demand, particularly on the high demand peak days, and is likely to breach the reliability standard in Victoria, South Australia, and possibly New South Wales.

Also, a significant transmission outage occurring during the first two years after the unexpected and permanent exit of a large Victorian baseload power station (before investment can respond) may increase the likelihood of a reduction in reliability, and provides evidence for the importance of the energy security measures as part of the government's Clean Energy Future package associated with the introduction of the carbon price. Orderly and well-signalled plant retirements provide an important signal for new investment to ensure that electricity security is maintained during the carbon pricing transition.

The analysis also shows that there is likely to be sufficient capacity in gas infrastructure in the NEM region to manage the permanent exit or temporary outage of a large Victorian baseload power station – although there would be some short-term capacity constraints affecting particular gas infrastructure during peak gas demand periods in winter. However, this would not result in any significant reduction in security of supply, but would likely increase the cost of meeting electricity demand.

Cyber security case study

The broader security of our critical infrastructure in the energy sector was outside the scope of the 2009 NESA. However, emerging security threats also have the potential to affect our energy security in a similar manner to the shock scenarios.

The 2011 NESA includes a cyber security case study on the energy sector to build on the previous NESA examination of critical infrastructure resilience. While physical security forms an integral part of all Australian governments' critical infrastructure protection and resilience efforts within the energy sector, the rise of more interactive and technologically connected energy systems creates an emerging area of vulnerability.

Breaches in cyber security within the energy sector can adversely affect critical decision-making and the operational capacity of the sector to provide energy security.

Australia's electricity infrastructure utilises electronic systems generally known as Distribution Control, Process Control or Supervisory Control and Data Acquisition (SCADA) systems. The widespread use of these systems has heightened the energy sector's dependence on computer and information technology to monitor consumption and to drive production, transformation, transmission and distribution of supply.

While these systems have reduced operating costs, increased reliability and enhanced transparency, opportunities to exploit weaknesses have increased, particularly where systems are open networked and operate across the internet. Online electronic systems can be vulnerable to remote attacks, as physical proximity is no longer needed to inflict damage on infrastructure. Such attacks could pose significant risks to the reliability of our physical energy networks.

The reliability of our energy sector in the face of cyber security threats is difficult to assess, but a moderate assessment would be consistent with the Australian energy sector having been impacted by known cyber security incidents and a growing concern of further vulnerabilities and expected attacks. The Australian Government, through Australia's Computer Emergency Response Team (CERT), is working with industry to be better prepared for such attacks.

Conclusion

The NESA's findings continue to highlight that governments face a number of key challenges if Australia's energy security position is to be improved or at least maintained. Measures to address these challenges include:

- implementing a carbon pricing mechanism to address investment uncertainty among energy market participants
- continuing market (supply-side and demand-side) reforms to maximise appropriate investment and improve the flexibility and resilience of energy markets in the face of disruptions or structural change
- encouraging diversity of supply, infrastructure reliability and supply chain resilience
- regulatory and policy certainty to attract necessary investment, including foreign investment
- monitoring the competitiveness impacts and costs to consumers of increasing energy prices
- monitoring energy market developments and outcomes, and refine policy as necessary
- monitoring the level of investment needed to meet future energy demand, in light of the global demand for energy infrastructure capital, components and skilled labour
- promoting the importance of well-functioning international energy markets to our oil security, and energy security more broadly.

1 Introduction

Australia's natural resource endowment, our traditional access to international markets and the capacity of our economy to provide sufficient investment in the energy system all contribute to energy security and the overall operation of the Australian economy. Conversely, interruptions to energy supplies can cause significant disruptions to economic activity with consequent financial losses.

The assessment considers a variety of factors that drive energy security that are common to all regions in Australia. However, where possible, the assessment does distinguish between the differing local issues and markets. This accounts for the regional nature of our electricity and natural gas markets, and the differences between major energy demand centres on the south-eastern seaboard and those in northern and south-west Western Australia.

The NESA is divided into the three main energy sectors of:

- ***liquid fuels*** (including the range of refined liquid fuel products used in the domestic economy, and the feedstock, including crude oil, used in their production)
- ***natural gas*** (used domestically both as a direct energy source or feedstock and as an input fuel for electricity generation, and for export as liquefied natural gas)
- ***electricity.***

The NESA is based on information from a variety of sources, including domestic sources such as the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), the Bureau of Resources and Energy Economics (BREE), Geoscience Australia, the Australian Energy Market Commission (AEMC), the Australian Energy Market Operator (AEMO) and the Australian Energy Regulator (AER) as well as key international bodies such as the International Energy Agency (IEA). It was prepared by the Australian Government Department of Resources, Energy and Tourism in consultation with relevant Australian Government agencies including the Department of the Prime Minister and Cabinet, the Department of the Treasury and the Department of Climate Change and Energy Efficiency. Consultations were also held with jurisdiction and industry stakeholders in capital cities.

This assessment considers the key influences on the supply of energy in Australia in the short, medium and long terms covering the period 2011 to 2035. Assessment periods are in line with key publications produced by organisations such as the IEA, BREE, ABARES and the AEMO.

For the liquid fuels assessment, 'short term' means the period from the time the assessment was prepared out to the end of 2012 (in line with projections in the IEA's monthly *Oil market report*); 'medium term' is the period out to 2016 (in line with key reports such as ABARES' *Australian commodities: March quarter 2011* and the IEA's *Medium-term oil and gas markets 2011*); and 'long term' is the period out to 2035 (in line with key long-term outlooks such as the IEA's *World energy outlook*, the US Energy Information Administration's annual energy outlook and BREE's Australian energy projections).

For the electricity and gas assessments, 'short term' means the period from the time the assessment was prepared to 2015; 'medium term' is the period to 2020 (in line with the AEMO's Electricity Statement of Opportunities and Gas Statement of Opportunities); and 'long term' is the period out to 2035 in line with BREE's long-term energy projections and the results from Treasury modelling of a carbon price.

The different timeframes used for the short term reflect the faster evolution of issues faced by the liquid fuel sector, compared to the gas and electricity sectors, as well as the availability of credible data. However, it is important to note that the assessments are not a snapshot at the end of these time periods; they are an assessment of the trends over these periods.

The challenges identified from the assessments provide a key input to future energy policy, in particular the Energy White Paper. The Energy White Paper will consider national markets and national solutions across a consistent policy framework that will deliver adequate, reliable and competitive energy to Australia.

Definition of energy security

In the Australian context, energy security is defined as the adequate, reliable and competitive supply of energy to support the functioning of the economy and social development, where:

- **adequacy** is the provision of sufficient energy to support economic and social activity
- **reliability** is the provision of energy with minimal disruptions to supply
- **competitiveness**[1] is the provision of energy at an affordable price that does not adversely affect the competitiveness of the economy and that supports continued investment in the energy sector.

These three dimensions of energy security are interrelated and, to a large extent, mutually reinforcing. For example, in a situation where energy supplies are not adequate to meet the needs of the economy or community, the price of energy will need to rise or intervention in the market will be required to allocate scarce energy resources. Conversely, the interaction of these three dimensions can lead to trade-offs. For instance, ensuring or increasing reliability can require sustained or greater investments, which may place upward pressure on energy prices. Both situations could adversely affect the competitiveness of the economy.

Assessing Australia's energy security

The starting point for this assessment is the 2009 NESA, which used Australia's historical levels of energy security rather than that of other countries. This report builds on the 2009 NESA and provides an 'on-balance' assessment of energy security in the short, medium and long terms covering the period 2011 to 2035 for the liquid fuel, natural gas and electricity sectors. In each of the sectors, key issues that are expected to influence the adequacy, reliability and competitiveness of energy supplies are highlighted.

The interdependencies between energy sectors are becoming increasingly important to Australia's energy security position. These interrelationships mean that assessments of energy security, be it for a specific sector or Australia's overall position, should take into account the key issues affecting all three sectors. Additionally, within a sector there are issues that are dependent on each other.

The factors examined in the assessment include:

- supply-side factors, including drivers affecting the mix of energy sources
- demand-side factors that relate to the demand for energy by fuel source
- market and institutional arrangements that affect individual sectors or all sectors
- the investment environment, including incentives for investment in energy infrastructure in the various sectors, and interactions between the sectors that impact on investment outcomes
- technological change in the development of new, renewable and/or more efficient energy technologies
- publicly available information on climate change policies, including the carbon pricing mechanism and the Renewable Energy Target
- conditions in the domestic economy
- international factors, such as global financial crisis and Middle East unrest and vulnerabilities, that impact on the global oil market and domestic energy market.

1 The 2009 NESA used the term 'affordability'. For the 2011 NESA, this has been changed to 'competitiveness', with minimal definitional change, to be consistent with the Energy White Paper methodology, and reflecting the broader issue of international competitiveness that is not encapsulated in affordability alone.

Box 1.1: Global financial crisis

A major international factor in the 2009 assessment was the global financial crisis. The recovery in many developed countries has been fragile, which has slowed growth and weakened the demand for energy, particularly oil.

While overall Australia has weathered the crisis well, some related consequences such as reduced investment risk appetite, higher lending costs and difficulty in obtaining finance for large-scale energy investments due to financial institutions tightening their lending thresholds have continued across the Australian energy sector.

The debt recovery from the global financial crisis for many significant OECD economies continues to pose a serious international threat that has implications for domestic and global energy investment.

The overall assessment of energy security takes into account these factors, and is analysed within the context of the effectiveness of international and domestic markets in supplying energy. The level of energy security is expressed using classifications of low, moderate and high levels of energy security.

Low energy security is when the economic and social needs of Australia are not being, or might not be, met. A low rating means that the energy sector and/or energy users are significantly affected by major shocks to the energy system. In this assessment, the energy security rating is also tested through a number of hypothetical shocks on supply and/or infrastructure.

Moderate energy security is when the economic and social needs of Australia are being met. However, there could be a number of emerging issues that will need to be addressed to maintain this level of security. Further, a moderate rating might suggest that current risks to energy security are being, or have been, mitigated or that price movements are manageable within the broader economy, with minimal social and economic impacts. However, the mitigation strategies may take some time to resolve negative influences or uncertainties.

High energy security is when the economic and social needs of Australia are being met.

Policy assumptions

Australia's energy security is dependent on the supply and demand balance of fuels and electricity. The ability to meet energy demand is determined by a number of factors including the level of investment, efficient supply chain management and reliable access to energy sources. Energy investment tends to fall under one of four categories: production, transformation, transmission and distribution.

The findings of the assessments are based on the trends in energy market development, including relevant government policies, that were considered most likely to influence Australia's future energy security. Policy settings were assumed to be those in place across jurisdictions at the time of assessment and/or information on policy announced by government.

Building on the 2009 National Energy Security Assessment

The Australian Government's inaugural 2009 NESA identified the current strategic energy security issues in the liquid fuel, natural gas and electricity sectors, and those issues posing a potential risk in five years, 10 years and 15 years.

The 2009 NESA assessed that, although Australia's level of energy security had decreased in the face of mounting challenges, it was meeting the economic and social needs of Australians, albeit with some emerging issues that could impact on maintaining future energy security.

A key finding of the 2009 NESA was that Australia's energy security had decreased by historical standards because of a range of market and policy pressures:

- investment uncertainty and structural change
- tighter demand and supply balances
- increases in energy costs due to climate change policies and system investment and refurbishment
- increases in capital, skills and component costs
- reduced availability of global capital due to impacts from the global financial crisis.

For the 2011 update, many of these factors remain, and some additional factors have emerged. General assumptions in the 2009 NESA included the proposed Carbon Pollution Reduction Scheme, a 5 per cent emissions reduction target on 2000 levels by 2020 and a 20 per cent Renewable Energy Target being in place for the assessment period. Apart from the Carbon Pollution Reduction Scheme (now replaced by the Clean Energy Future package) these policy assumptions remain valid for the 2011 update.

The 2011 NESA revisits and updates the key influences identified in 2009 that were considered to affect energy security.

The five, 10- and 15-year snapshot assessment used in the 2009 assessment has been replaced by trend analysis across the short, medium and long terms to allow a more fluid assessment of the future energy security environment, based on available data.

The energy security ratings of ***low***, ***moderate*** and ***high*** have continued to be used. The 2009 assessment was assumed to stand, and existing ratings were examined for evidence that ratings were increasing, decreasing or unchanged against the 2009 assessment.

As with the 2009 NESA, there is no detailed comparative assessment with other countries, although domestic oil markets assessments and competitive energy prices are considered in a global context.

Shock scenarios

'Shock' scenarios have been included for each of the liquid fuel, natural gas and electricity sectors within each chapter. These scenarios are hypothetical physical or market-based disruptions to the energy market that provide insights into the vulnerabilities, risks, influences and impacts that such disruptions may have on Australia's energy security.

The purpose of the scenarios is to analyse energy security impacts under current market conditions and those publicly forecast for 2015–16. While the NESA itself provides an assessment, these scenarios add context to what may materially change the assessment should a disruption occur. As such, the scenarios seek to explore the impact on the adequacy, reliability and/or competitiveness of supply. They are not an assessment of a particular asset's resilience or a prediction of the likelihood of the disruption event.

ACIL Tasman (liquid fuels) and Frontier Economics (natural gas and electricity) were commissioned to undertake modelling for the three shock scenarios and these documents are available on the Department's website.

An overview of each scenario and the modelling framework is provided below.

Box 1.2: Shock scenarios – overview and modelling framework

Liquid fuels – a major interruption to Singapore's ability to trade petroleum products with Australia

This scenario was based on the temporary closure of shipping to and from Singapore and shutdown of Singapore's three major refineries. The interruption was modelled to last for about 30 days, and impacts were assessed under current conditions and then under the tighter global market conditions forecast for 2015–16.

Modelling of the shock scenario was done using an analysis of the response of the oil market to Hurricanes Katrina and Rita to estimate the impact on prices over three months of a 30-day shutdown in Singapore.

Hurricane Katrina resulted in an initial loss of around 2 million barrels per day (mb/d) in refinery capacity in the Gulf of Mexico and an average loss of refining capacity of 1.57 mb/d for the month immediately following. By comparison, a 30-day shutdown in Singapore would result in the loss of around 1.33 mb/d of refined petroleum products.

The availability of spare refining capacity in Asia was examined to help estimate demand and supply elasticities. In the short term, spare capacity is high. Spare capacity remains adequate over the medium term, but begins to decline slightly towards the end of the period.

Natural gas – a major reduction in the capacity of the Roma to Brisbane natural gas pipeline

This scenario involved a hypothetical reduction in the capacity of the Roma to Brisbane pipeline. The event was modelled to last for a period of 14 days and was assessed under current conditions and then under changed conditions for 2015–16 to determine:

- the impact on gas customers of the affected pipeline, including commercial and industrial customers, gas-fired generators and residential customers
- the impact on the broader gas markets in eastern Australia
- the impact on the electricity market and electricity prices.

Electricity – the sudden exit of the Loy Yang A power station from the National Electricity Market

This scenario examined the impact of an unexpected exit from the market by the largest electricity generator in Victoria. Two possibilities were examined: a 14-day temporary outage and a permanent exit. The modelling examined both non-peak and peak seasonal periods under current conditions and then under forecast conditions for 2015–16 to determine:

- the impact on the electricity (generation and transmission) and distribution networks in the National Electricity Market
- the impact on the market itself
- the effectiveness of market mechanisms in dealing with the reductions in electricity supply.

Cyber security case study

While the shock scenarios explore traditional energy security aspects, broader examination of the security of our critical infrastructure in the energy sector has been outside the scope of the NESA. Critical infrastructure protection and resilience has been a high-priority area for Australian governments and business since September 2001, with considerable efforts invested in protection and preparedness. However, cyber security threats have recently emerged that have the potential to increasingly impact energy infrastructure security.

For the 2011 NESA, a case study on cyber security in the energy sector has been included in Chapter 4 to build on the previous NESA examination of critical infrastructure resilience.

Energy security metrics

The 2009 NESA was a qualitative assessment of Australia's energy security. No metrics were used in that NESA to quantify Australia's energy security. The initial development of the methodology in the 2011 NESA included an evaluation of metrics. While this evaluation improved the understanding of the dynamics of energy security, none of the metrics were readily applied in this NESA. However, work is continuing to explore whether quantifiable measures of energy security can be developed for use in future assessments.

Box 1.3: Energy security metrics

The 2011 NESA has commenced a process of examining what metrics could be developed for Australian energy security assessments. Of notable interest is the internal work being undertaken by the International Energy Agency (IEA) to develop energy security metrics for primary energy sources in member countries.

The IEA metrics were explored as a starting point for NESA metrics, but were not aligned with the adequacy, reliability and competitiveness framework used in the NESA. However, the IEA's work provides useful insights into how to construct a comprehensive national metric system.

The Department of Resources, Energy and Tourism commissioned the Australian National University's HC Coombs Policy Forum to commence a process to explore development of energy security metrics for Australia – the National Energy Security Assessment Methods Advancement Project (NESAMAP) – and to review developments in metrics internationally.

The NESAMAP will provide:

- evidence of a commitment to the longer term development of energy security assessment measures via a partnership with stakeholders
- access to technical expertise worldwide on metrics and methodologies for possible adoption in future update of the NESA
- a mechanism for assessing the attractiveness and feasibility of adopting different methods by drawing together expertise from academia, government and business
- access to relevant insights from underpinning research, development and demonstration capability in different fields of energy
- access to policy expertise in relating technological and research policy issues to the use of risk-based assessment methods applied in the policy community
- an additional mechanism for constructive policy engagement on energy security with Australia's region.

A NESAMAP scoping workshop was held in May 2011 which invited experts, including the IEA, to explore energy security metrics.

The scoping workshop:

- considered current best international practices in conducting energy security assessments
- identified desirable attributes for energy security metrics
- undertook to develop a road map for future research, development and demonstration of energy security metrics for Australia.

NESAMAP will commence with a research project to allocate existing national data against energy security indicators that fit an Australian context.

Consultations

For the 2009 NESA, extensive consultations were conducted with other government departments to obtain data and information, develop assumptions and technical working papers, and analyse these various contributions. The 2009 NESA also benefited from the input of state and territory government agencies and industry stakeholders through targeted consultations that included a series of workshops.

This consultative approach was also used to develop the 2011 NESA. In addition to obtaining data, information and analysis from Australian Government agencies, consultations were also undertaken and submissions sought on the NESA.

The Department directly approached 90 organisations in the energy supply chain – from producers to consumers and various industry organisations— in a targeted consultation process. Industry representatives and state and territory government agencies were invited to attend workshops in major capital cities and/or provide written submissions.

Each consultation workshop was conducted over a day, with the morning session focused on liquid fuels and the afternoon session on natural gas and electricity, and an emphasis on what had materially changed since the 2009 NESA. Participants were welcome to attend either a single session or both as relevant to their organisations. More than 70 representatives from 44 organisations attended the following workshops.

- Perth – 16 May 2011
- Brisbane – 18 May 2011
- Sydney – 19 May 2011
- Melbourne – 23 May 2011
- Hobart – 6 June 2011
- Adelaide – 9 June 2011.

Direct bilateral discussions also occurred with key stakeholders who wished to raise specific issues or who were unable to attend the workshops.

The organisations that attended workshops and/or made non-confidential submissions to the 2011 NESA are listed in the appendix at the end of this report.

2 Liquid fuels

2011 summary of liquid fuel security

The overall assessment for liquid fuel security is largely unchanged since the release of the last NESA in 2009 and is assessed as ***high*** trending to ***moderate*** in the long term. There have been a number of notable events in the liquid fuel sector since that time, such as a return to high global oil prices, the political crisis in Libya, the Montara and Macondo oil spills, natural disasters such as the Queensland cyclones and floods, and the recent announcement of the conversion of Shell's Clyde refinery into an import terminal. However, while each of these events has been significant in its own right, none have had a material impact on Australia's liquid fuel security.

This is due to Australia's access to well-functioning markets for liquid fuels which have helped create robust and flexible supply chains with a significant degree of resilience. Access to such markets has also encouraged a high diversity of supply, which includes domestically produced crude oils, liquefied petroleum gas, biofuels and refined petroleum products, together with crude oil and refined products sourced from a wide variety of international sources. In addition, the overall strength of the Australian economy, and the recent rise in the Australian dollar, have allowed the increase in international oil prices to remain manageable within the broader economy.

Despite this, risks remain in the global market. Factors such as a major political crisis in a key production centre, higher than expected global demand growth, a weakening of the Australian or global economy or a shortfall in investment in new production capacity globally could all have a significant impact on global liquid fuel markets and prices, and would potentially lead to a change in the assessment of Australia's liquid fuel security.

Nevertheless, based on an on-balance assessment of foreseeable risks, in both the short and medium terms, overall Australia's liquid fuel security is assessed as high due to Australia having continued access to highly adequate and reliable supplies of liquid fuels at price levels that are manageable within the broader economy. A carbon price is expected to have a manageable impact on liquid fuels competitiveness over this period due to the transitional industry assistance and end-user compensation provided under the Australian Government's Clean Energy Future package.

Australia's imports of petroleum products will continue to rise with growth in demand, and crude oil prices are likely to remain high, driven by increasing global demand and political uncertainty in the Middle East. However, these issues are not expected to have a material impact on Australia's overall liquid fuel security in the short to medium term.

Over the long term, liquid fuel security is assessed as moderate due to increased global supply pressures driven by large-scale demand growth in emerging economies and a significant decrease in Australia's domestic production.

The consequent increase in import reliance, together with an expected decrease in non-OPEC and conventional oil supply, lead to a greater reliance on international supply chains and a greater level of supply reliance from geopolitically and geologically difficult locations. This risk could be mitigated to some extent by strong collective global climate change action, which may dampen global demand growth and reduce the pressure on supply.

Overall, liquid fuel security remains at a high level, although there is the potential to move to moderate or low if a major global oil supply shock occurs, with this particular vulnerability not changing since the last NESA.

Finally, growing Australian imports are placing compliance pressures on Australia's '90 day' stockholding obligation under the International Energy Agency (IEA) treaty (see Box 2.1). This assessment found no evidence that stockholding breaches are a reflection of an emerging domestic energy security problem. However, Australia's stockholding obligation is an important compliance issue under an international treaty intended as a credible response to a major global oil supply disruption.

Compared to electricity and gas security, Australia's liquid fuel security is more exposed to international developments and the international supply chains than to potential changes in Australian Government policy.

Table 2.1: Summary of liquid fuel security – 2011 NESA			
	Short term (to 2012)	**Medium term (to 2016)**	**Long term (to 2035)**
Adequacy	**HIGH**	**HIGH**	**MODERATE**
Comment	Open and well-functioning international and domestic markets continue to provide Australia with sufficient supplies of liquid fuels.	Increased global production is projected to adequately meet rising global demand. Growth in global and regional surplus refinery capacity provides highly adequate supplies of petroleum products.	Combined resources of conventional and unconventional oil are considered adequate to meet global demand. Significant global investment is needed to ensure that global supply meets rising demand.
Reliability	**HIGH**	**HIGH**	**MODERATE**
Comment	Access to well-functioning markets has helped create robust and flexible supply chains with a high degree of diversity of supply. Proactive supply chain management is able to mitigate the effects of short-term supply disruptions.	Continued access to flexible global supply chains and availability of alternative supplies due to surplus refinery capacity allow the petroleum industry to continue to provide liquid fuel supplies with minimal disruptions.	Australia becomes more dependent on more international supply chains, geopolitically risky and geologically difficult sources of supply. Australian refineries are likely to continue to face competitive pressures. Nevertheless, significant investment in regional refining is likely to continue to provide adequate supplies of refined products.
Competitiveness	**MODERATE**	**MODERATE**	**MODERATE**
Comment	High international crude oil prices remain manageable within the broader economy. The strong Australian dollar helps offset high crude oil prices.	Continued high global prices remain manageable within the broader economy. Commercial inventories, spare OPEC production capacity, and surplus global and regional refining capacity continue to provide a buffer against unexpected supply and demand shocks.	Strong demand growth in emerging economies and increased reliance on more expensive sources of supply are expected to cause global oil prices to continue to rise.
OVERALL	**HIGH**	**HIGH**	**MODERATE**

2009 liquid fuel security assessment

In the 2009 NESA, the level of security of liquid fuel supplies in Australia was assessed to remain relatively constant over the assessment period, with ***high*** levels of adequacy and reliability and moderate affordability in the short to medium term, and ratings of moderate for all three components of energy security in the long term.

Table 2.2: Summary of liquid fuel security – 2009 NESA

	Current (2009)	Short term (2013)	Medium term (2018)	Long term (2023)
Adequacy	HIGH	HIGH	HIGH	MODERATE
Reliability	HIGH	HIGH	HIGH	MODERATE
Affordability	MODERATE	MODERATE	MODERATE	MODERA TE
OVERALL	HIGH	HIGH	HIGH	MODERATE

Australia's participation in the global oil market means that domestic liquid fuel security is intrinsically linked to global oil market outcomes. This integration was viewed as having both positive and negative impacts on Australia's liquid fuel security.

Positive impacts included increased diversity of supply sources for both crude oil and refined petroleum products, resulting in more flexible supply chains. Access to refined products was expected to be improved by substantial investment in new refining capacity in Asia and the Middle East.

Negative impacts included the increasing concentration of production of crude oil in politically unstable regions leading to potential future price risks. Exposure to economic fundamentals affecting the global oil price, such as global demand growth driven by emerging economies, risks of insufficient investment in global production capacity, and increased production from regions with more geological and geopolitical difficulties were also viewed as potential negative impacts.

Adequacy

The 2009 NESA assessed current adequacy as ***high*** due to robust and flexible supply chains and diversity of supply, which included domestic refineries, as well as access to well-functioning international markets. Consistent with analysis by the IEA at the time, global supply was seen as adequately meeting global demand.

Adequacy remained ***high*** in 2013 and 2018 primarily due to Australia's continued access to global oil markets, supply diversity and an increase in regional refining capacity, tempered by the risk of a potential supply-side crunch if global investment did not keep pace with demand growth. The assessment decreased to ***moderate*** in 2023 largely due to ongoing demand growth and mature field declines leading to a tight global supply–demand balance.

Reliability

The 2009 NESA assessed current reliability as ***high***, with domestic refining disruptions being managed through effective supply chain management, and alternative supplies being sourced both domestically and internationally. Ongoing investment in import infrastructure and domestic refineries was seen as further improving reliability. Global investment in refining capacity, particularly in the Asia–Pacific region, had also improved the availability and reliability of imports.

Reliability continued to be ***high*** in 2013 and 2018 due to the continued resilience of domestic and global supply chains, effective supply chain management, improved storage capacity and stock management, and continued good access to regional refining capacity and well-functioning global oil markets.

The rating decreased to ***moderate*** in 2023 due to an increased reliance on long global supply chains sourcing crude oil from unstable regions, which offset continued effective supply chain management and access to significant regional refining. Regional refinery growth was considered a risk to domestic refining capacity as domestic demand growth was increasingly met by imports from these large mega-refiners.

Diversifying fuel types and sources was assessed as being increasingly important in improving Australia's liquid fuel security. However, taking into account the small contribution made by alternatives such as biofuels, and the technical and commercial challenges they faced over the assessment period, they were seen as likely to remain as niche products.

Affordability

The 2009 NESA assessed current affordability as ***moderate*** due to high international energy prices tempered by the resilience of the Australian economy, and a continuing decrease in its oil intensity, which enabled it to absorb the impact of the large price increases experienced up to mid-2008.

Affordability remained ***moderat***e in 2013, 2018 and 2023 due to Australia's continued exposure to international oil markets and global oil price movements. Prices were expected to be influenced by production capacity in more difficult geographic and geological regions and a tightening global supply–demand balance. Affordability was assessed as potentially moving to low if global investment did not keep pace with demand growth and field declines, stability in key production regions declined and/or supplier groups withheld significant supply capacity.

2011 liquid fuel security assessment

The liquid fuel sector (oil, refined petroleum products and gaseous transport fuels) is fundamentally different from the stationary energy sectors considered in the other chapters of this report. For one, the nature of liquid fuels makes them both storable and highly transportable. This provides a great deal of flexibility and resilience in supply chains when compared to the electricity and gas sectors.

But perhaps the greatest difference is the fact that liquid fuels are traded on a global market. Australia's lack of self-sufficiency in liquid fuels means that Australia, like many other advanced and developing countries, is intrinsically linked to the global market. Australia's liquid fuel security is, therefore, substantially dependent on global market outcomes and the global oil security situation.

As the 2009 NESA concluded, this lack of self-sufficiency and reliance on global markets do not necessarily mean that Australia has an energy security problem.

Global markets have both positive and negative impacts on liquid fuel security. A major benefit comes from the increased diversity of supply for both crude oil and refined petroleum products, with international sources supplementing Australia's domestic production. This is reflected in the diversity of Australia's import sources as outlined in the assessment below (Figure 2.1 shows the location of Australia's seven refineries and the range of import terminals around the country).

Figure 2.1: Key liquid fuel infrastructure in Australia

Source: Australian Institute of Petroleum, *Downstream Petroleum 2009*, AIP, Canberra, 2010.

Reliance on global markets also creates elements of risk absent from the stationary energy sectors. Such risks include the possibility of supply disruptions due to the high and increasing concentration of crude oil production in politically unstable regions; potential for delays in shipping that come from a reliance on long global supply chains; and the exposure of the economy and society as a whole to volatile oil prices.

Nevertheless, market mechanisms have historically proven an efficient and effective way of ensuring that Australian consumers have access to adequate and affordable supplies of liquid fuels. This has been true even during times of significant disruptions to world oil supplies such as has occurred during the recent political crisis in Libya and in the period after Hurricane Katrina.

In addition, Australia's liquid fuel security does not rest solely on market outcomes. As a member of the IEA, Australia also benefits from the IEA's emergency response mechanisms. These emergency response arrangements are designed to mitigate the impacts of sudden oil supply shortages by making additional oil available to the global market. This is achieved via coordinated measures by IEA member countries to increase supply and/or reduce demand.[1]

The IEA emergency response arrangements provide an additional element of insurance to the Australian liquid fuel sector in the event of a temporary large-scale global supply disruption.

A final component of our security in the face of a supply emergency is provided by the regulatory safety net powers contained in the *Liquid Fuel Emergency Act 1984*. This provides the Australian Government with wide-ranging emergency powers in the event of a national liquid fuel emergency.[2]

1 For an overview of the IEA's emergency response system, see IEA, *IEA response system for oil supply emergencies*, IEA, Paris, 2011, available at www.iea.org

2 For an overview of the Liquid Fuel Emergency Act and Australia's liquid fuel emergency arrangements, see www.ret.gov.au/energy/energy_security/emergency_response/liquid_fuel_emergency/Pages/lfe.aspx

The following assessment takes these factors into account when evaluating Australia's liquid fuel security over the short, medium and long terms.

This evaluation represents an on-balance assessment of the foreseeable risks and the extent to which these risks are likely to be mitigated. A critical aspect of this assessment is how these risks may be changing over time and whether these changes may represent an increased vulnerability.

Box 2.1: Australia's international emergency oil stockholding obligation

As a member of the International Energy Agency (IEA), Australia is a signatory to the 1974 Agreement on an International Energy Program.

This treaty requires IEA member countries to establish a common 'emergency reserve commitment' that includes self-sufficiency in oil supplies. Each country is required to hold oil stocks equivalent to at least 90 days of average daily net imports from the previous year to meet its emergency reserve commitment.

These stocks form the basis of the IEA's global emergency response system, which can be activated in the event of a major disruption to the global supply of oil.

Since joining the IEA in 1979, Australia has successfully relied solely on commercial industry stocks to meet its stockholding obligation.

In the past, these commercial stocks more than adequately covered our 90-day obligation due to Australia's relatively low levels of net imports. However, annual net imports have risen significantly over the last decade due to both an increase in imports of crude oil and petroleum products (largely driven by rising consumption), and a decrease in the exports of crude oil (driven by a decline in domestic oil production).

As a result of this, Australia has regularly been in breach of its 90-day stockholding obligation since December 2009.

The 2011 NESA does not find evidence that these breaches are an indication of a decline in Australia's domestic energy security.

Australia's national stockholdings have not declined in recent times, and evidence indicates that investment in new import infrastructure and storage is keeping pace with increasing consumption.

The IEA collective emergency response arrangements help provide added insurance against the effects of a temporary large-scale global supply disruption and are an important part of global energy security.

The Australian Government is currently considering possible options to respond to the issue of Australia's non-compliance with the IEA 90-day stockholding obligation.

Adequacy

Short term: Short-term adequacy is assessed as ***high***, as open and well-functioning international and domestic markets for both crude oil and refined petroleum products continue to provide Australia with sufficient supplies of liquid fuels to meet the needs of the economy. Industry consultations have also confirmed no recent or foreseeable difficulties in meeting Australian demand despite the supply uncertainty in the Middle East experienced since the beginning of 2011.

Recent analysis by the IEA sees the potential for an easing in the recent tightness in market fundamentals over the short term. Global demand growth is expected to average less than 1 per cent for the rest of this year, and growth for 2011 as a whole is expected to average 1.0 million barrels per day (mb/d) or 1.2 per cent (compared with 2.7 mb/d or 3.2 per cent in 2010). In 2012, demand is expected to increase by 1.4 mb/d or 1.6 per cent in line with expected higher global economic growth in 2012 compared with 2011.[3]

3 IEA, *Oil market report*, IEA, Paris, September 2011, p. 5.

This expected easing in demand growth is the result of concerns over the health of the global economy in the short term, combined with the impact of sustained high prices.

The IEA also sees further potential downside risks to demand growth in the short term due to the current wide range of threats to the global economy.[4]

This slowing in demand growth comes at a time when supply pressures have also eased in comparison to the outlook in the first half of 2011 following the loss of Libyan supply.

Global oil supply rose by 1.0 mb/d in August from July, with non-OPEC supply accounting for 80 per cent of this growth. When compared to a year ago, global production has increased by 1.2 mb/d, with 40 per cent coming from OPEC natural gas liquids and a further third coming from OPEC crude oil.[5]

The IEA sees non-OPEC supply continuing to grow in the short term, with overall growth in 2011 expected to total 190,000 barrels per day. The outlook for 2012 is even more optimistic, with expected growth of 1.0 mb/d.[6]

OPEC output levels have also increased in recent months. However, production levels were still expected to fall short of the necessary call on OPEC production in the third quarter of 2011. The IEA expects this call on OPEC production to ease back closer to current OPEC production levels over the following three quarters due to the slowing in demand growth outlined above.[7]

The heavy call on OPEC production has led to a drawdown in commercial inventories, with OECD commercial stocks falling below the five-year average for the first time since June 2008.

Overall, the heavy call on OPEC production, the current relatively low level of OPEC spare production capacity, and the continued loss of high-quality crude oil from Libya and other regions, are expected to continue to place pressure on global oil prices over the short term.[8]

Despite the tight supply–demand balance experienced in the first half of 2011, with this trend potentially continuing over the short term, consultations with Australian industry have indicated that the Australian market has continued to be well supplied and is expected to remain so over the short term.

Any shortfalls in global production in the short-term are likely to be reflected in price. It is generally recognised that high global oil prices can have an impact on economic activity and growth.[9]

However, as Australia is a net energy exporter, and still a relatively minor net importer of crude oil (Australia still exports significant amounts of oil), increased income from high commodity prices, as well as the recent high Australian dollar, have led to the Australian economy as a whole remaining well insulated against high oil prices.

This protection could be reduced if an oil price spike occurred at a time of low or flat commodity prices or when the Australian dollar was weak.

Medium term: Adequacy is assessed as ***high*** over the medium term. This is due to Australia's continued access to well-functioning global markets, which are expected to remain adequately supplied to meet rising global demand. Any tightness in the global supply and demand balance will be reflected in oil prices, although prices are expected to remain manageable within the broader Australian economy.

4 IEA, *Oil market report,* pp. 4–5.

5 IEA, *Oil market report*, p. 14.

6 IEA, *Oil market report*, p. 19.

7 IEA, *Oil market report*, p. 3.

8 See IEA, *Oil market report*, p. 36.

9 See, for example, IEA, *Analysis of the impact of high oil prices on the global economy*, IEA, Paris, 2004.

Recent medium-term projections by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) see global demand for oil rising in line with stronger global economic growth over the medium term, driven in particular by non-OECD demand associated with economic growth and industrialisation in emerging economies such as China, India and the Middle East. This trend is partially offset by a decline in OECD demand over the medium term.[10]

The IEA's *Medium-term oil and gas markets 2011* report also forecasts a similar trend. In the report's base case scenario, global demand is projected to grow from 88 mb/d in 2010 to 95.3 mb/d by 2016, an average of 1.2 mb/d annually (1.3 per cent). This is driven exclusively by non-OECD countries, with growth concentrated in Asia, the Middle East and Latin America.[11]

The transport sector (road, railway and airborne) continues to be the key sector driving global demand, accounting for around two-thirds of both absolute demand and growth.[12]

These demand projections are sensitive to changes in global economic conditions, technological change and efficiency measures. The IEA's base case scenario incorporates assumed efficiency gains of a reduction in oil use intensity of 3 per cent annually. A greater reduction based on more aggressive efficiency measures globally would lead to lower global demand.

While the IEA's medium-term projections are based on existing technologies and investment trends, the IEA also notes that investment in new, more energy efficient capital stock can play a critical part in moderating demand growth over the longer term.[13]

Domestically, Australian demand is also expected to continue to grow steadily over the medium term. ABARES' medium-term projections see consumption of petroleum products growing by 5320 megalitres (ML) from 2009–10 to 2015–16,[14] an average annual growth rate of around 1.5 per cent. This compares to the general decline in demand in the OECD as a whole, and is largely driven by forecast strong economic growth in Australia, including demand for petroleum products in our resources and energy sectors.

Medium-term forecasts have identified a range of new sources of oil supply which are expected to meet the projected increases in domestic and global demand discussed above, and the global market is expected to remain well supplied over the medium term.

The IEA, for example, forecasts global production capacity to rise from 93.8 mb/d in 2010 to 100.6 mb/d in 2016, with supply growth coming from non-OPEC, OPEC crude and OPEC natural gas liquids in roughly equal shares.[15]

Non-OPEC supply (including natural gas liquids) is forecast to grow from 52.7 mb/d in 2010 to 55.4 mb/d in 2016, with growth coming largely from US light tight oil (also known as shale oil), Canadian oil sands, Brazilian deepwater oil and Colombian crude oil.

This represents a more optimistic outlook than at the time of the 2009 NESA and to the IEA's 2010 report. A major driver of this more optimistic outlook is increased upstream investment as a result of higher oil prices. The IEA estimates that upstream investment is likely to increase by 10–20 per cent in 2011, and this comes on top of a 10 per cent increase in 2010.[16]

Other factors cited by the IEA include less pressure on cost, equipment and labour bottlenecks compared with 2005–08; a decrease in the occurrence of large-scale production shut-ins in comparison to 2005–08; and a slowing of observed

10 ABARES, *Australian commodities: March quarter 2011*, Commonwealth of Australia, Canberra, pp. 137–140.

11 IEA, *Medium-term oil and gas markets 2011*, IEA, Paris, pp. 36–37.

12 IEA, *Medium-term oil and gas markets 2011*, p. 40.

13 IEA, *Medium-term oil and gas markets 2011*, pp. 42–43.

14 ABARES, *Australian commodities: March quarter 2011*, p. 144.

15 IEA, *Medium-term oil and gas markets 2011*, p. 59.

16 IEA, *Medium-term oil and gas Markets 2011*, p. 63.

field decline rates due to international companies investing in boosting recovery rates at existing fields.[17] Changes in these factors, or another global economic downturn, would impact on this growth in supply.

In addition to the expected growth in non-OPEC supply, OPEC crude oil production capacity is projected to increase from 35.72 mb/d in 2010 to 37.85 mb/d in 2016, a net increase of 2.1 mb/d. OPEC's production of natural gas liquids is also expected to increase, from 5.3 mb/d in 2010 to 7.2 mb/d in 2016.[18]

Increased production from Iraq is considered to be a significant new source of supply over the medium term.

The IEA's forecast production capacity for OPEC includes a rise in Iraqi production capacity of 1.5 mb/d to 4.1 mb/d by 2016.[19] Official Iraqi government targets are 6.5 mb/d in 2014 and 12 mb/d in 2017; if reached, this would provide substantial new supply to the global market over the medium term and into the longer term. However, these ambitious targets are faced with a range of political and technical constraints and the IEA expects a more gradual increase in production.[20]

Industry analysis also takes a cautionary approach to Iraqi production. Shell notes that Iraqi government targets of 10–12 mb/d would require annual growth of 10–15 per cent for at least a decade, which is an achievement unseen in recent times.[21]

There is also a great deal of uncertainty as to how OPEC would treat increased Iraqi production under its quota system and how Iraq would choose to balance increased production so as not to oversupply the market and cause a crash in prices.

Eastern Russian crude, supplied via the East Siberia – Pacific Ocean pipeline, provides another significant source of supply into the Asia–Pacific market over the medium term. While targeted at China and Japan, East Siberian crude will still assist in meeting rising regional demand.

Despite a generally optimistic outlook for the medium term, the IEA acknowledges a number of downside risks to its supply projections, including:

- the possibility of sustained high oil prices leading to global demand destruction and a subsequent re-evaluation of (and reduction in) current investment plans
- the possibility of further political unrest affecting production in the Middle East and North Africa
- proposals to increase production taxes in a number of key countries in response to high oil prices
- the possibility of project delays due to requirements for local sourcing of infrastructure, equipment and labour in some countries
- higher than expected production shut-ins due to high storm activity
- risks to supply growth in Canada and the United States if key infrastructure projects are delayed
- the possibility of increased upstream costs and labour shortages in key markets.[22]

Such delays to production could lead to a tighter than expected supply and demand balance, with subsequent impacts on oil prices.

A shortfall in global investment over the medium or long term poses another risk to supply. The importance of continued upstream investment is highlighted by the IEA's *Deferred Investment Case* in the *World energy outlook* 2011 which analyses the impact of a shortfall in investment in the Middle East and North Africa (MENA).

17 IEA, *Medium-term oil and gas markets 2011*, pp. 59–63.

18 IEA, *Medium-term oil and gas markets 2011*, p. 59.

19 IEA, *Medium-term oil and gas markets 2011*, p. 81.

20 IEA, *Medium-term oil and gas markets 2011 – 'Iraq Production on a Solid Upward Trend,'* pp. 81–82.

21 Shell International, *Shell energy scenarios to 2050: signals and signposts*, Shell International, The Hague, February 2011, p. 26.

22 IEA, *Medium-term oil and gas markets 2011*, pp. 64–65.

This leads to a significant reduction in oil production in MENA and a substantial rise in global oil prices. Nevertheless, global markets are able to balance through increased investment in other regions induced by higher oil prices, and a reduction in demand in price responsive markets.[23]

For Australia, domestic production of crude oil and condensate is forecast to increase over the next few years, growing from 26 950 ML in 2008–09 to around 30 221 ML in 2012–13. Beyond this, Australia's oil production is expected to decline gradually to around 26 923 ML in 2015–16.[24] In general, this represents the beginning of a steady decline over the longer term absent any major new discoveries, although it is expected that, for a short period beyond 2016, condensate production from some recently committed and proposed liquefied natural gas projects (Prelude and Ithchys developments in the offshore Browse Basin) will slow, or reverse, the long-term decline in liquids production.

Despite the possible short-term increase in domestic production over the next few years, and in the period after 2016, most of this oil and condensate will be exported from production locations in waters off north-western Australia to Asian markets. Therefore, the forecast rise in domestic consumption of petroleum products is expected to be met by increasing imports of refined product.

Australia's imports of refined products will increase further following the conversion of Shell's Clyde refinery into an import terminal to service the New South Wales market, which is due to commence in mid-2013.[25]

Increased reliance on imports does not automatically mean a decline in Australia's energy security. Australia is already well integrated into the global market for liquid fuels and pays global prices for oil. Australia is therefore subject to the price risks associated with this global market irrespective of our level of imports. Those risks are considered to be manageable over the medium term and do not adversely impact on Australia's overall liquid fuel security.

Australia's vulnerability to an interruption to the international supply of petroleum products is assessed as part of the 'shock' scenario discussed at the end of this chapter (Box 2.2).

Alternative transport fuels are another potential source of future liquid fuel supply. In general, it is expected that the supply of alternative fuels will increase to the extent that they become commercially competitive. Over the medium term, there is not expected to be a significant change in the fuel mix, as the advanced technologies and infrastructure required for alternative transport fuels are unlikely to be readily available at competitive prices. However, advanced alternative fuel and technology options, including electric vehicles, are emerging and are likely to have an increasing role over the long term.

One area where there could be a change in the medium term is in the demand for biofuels, driven by state government policy. The NSW Government biofuels mandate, and to a lesser extent government policy direction in Queensland, have led to an increase in the consumption of biofuel blended fuels in those states. The Australian Government's Ethanol Production Grants for domestic producers of ethanol has indirectly supported these policies, as the program has allowed E10 ethanol blends to be sold at a competitive price compared with regular petrol. However, there are concerns within the fuel industry as to whether the limited number of domestic producers will be able to meet the potential increase in demand, and this may impact on reliability of supply over the medium term.

In a submission to this assessment, one industry participant suggested that there is potential for growth in fuels such as liquid petroleum gas (LPG), liquefied natural gas (LNG) and coal-to-liquids but would require significant investment in infrastructure. Work conducted for the Department of Resources, Energy and Tourism indicates that there are a number of barriers to uptake for these fuels including infrastructure and technology challenges and switching costs.

This work also indicates that LPG sales will be subject to increased competition from more efficient petrol vehicles, including hybrids, which will reduce the operational cost advantage of LPG vehicles. However, this outcome is dependent on a range of price, cost, technology and public acceptance assumptions which may vary.

23 IEA, *World energy outlook 2011*, IEA, Paris, 2011, pp. 145–147.

24 ABARES, *Australian commodities: March quarter 2011*, p. 143.

25 See Shell Australia, 'Shell to cease refining at Clyde', media release, 27 July 2011, available at www.shell.com.au/home/content/aus/aboutshell/media_centre/news_and_media_releases/2011/clyde_cease_refining_27072011.html

While increased domestic production of alternative fuels may partially offset Australia's rising imports, they are expected to remain niche products over the medium term and are unlikely to have a significant impact on the level of imports in this time period.

Work being conducted on the uptake of alternative transport fuels by the Department of Resources, Energy and Tourism aims to assist with the further commercial development of alternative transport fuels by identifying and suggesting action by industry, government and other stakeholders to address identified regulatory, market and other barriers to their uptake in Australia in the medium to long term. However, their development will remain dependent on their long-term relative cost compared to conventional liquid fuels.

In regard to the supply of refined product, the IEA expects global surplus refinery capacity to grow over the medium term, with additions to capacity largely exceeding forecast demand growth. Total global crude distillation capacity is expected to increase to 102.7 mb/d from 2010 to 2016, an increase of 9.6 mb/d.[26]

Growth is heavily concentrated in Asia, with substantial capacity expansions expected in China and other parts of Asia, which includes significant growth in India.[27] The export focus of the Indian industry in particular will assist in meeting regional growth in demand for petroleum products. India's refinery capacity has already seen substantial growth, increasing by 0.8 mb/d over the 2009–10 period, reaching a total of 4.0 mb/d by early 2011, with further expansions expected out to 2016.[28]

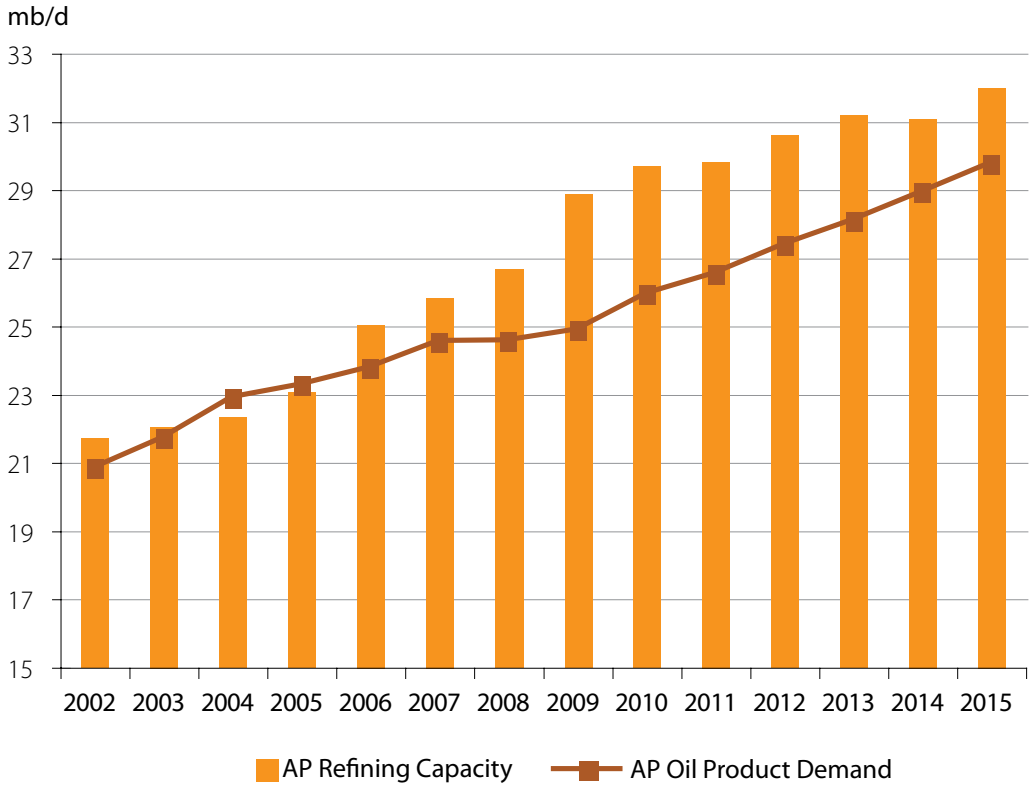
The significant surplus regional refining capacity expected over the medium term can be seen in Figure 2.2. This excess refining capacity helps provide a buffer against unexpected demand or supply shocks.

26 IEA, *Medium-term oil and gas markets 2011*, pp. 106–107.

27 IEA, *Medium-term oil and gas markets 2011*, pp. 106–107.

28 IEA, *Medium-term oil and gas markets 2011*, p. 122.

Figure 2.2: Asia–Pacific oil product demand (mb/d) versus refining capacity



Source: Liutong Zhang, 'Asian Refining Industry – New Paradigm', *Hydrocarbon Asia*, vol. 21, no. 1, 2011, p.11.

When compared to the highs of 2009 and 2010, surplus Asian refining capacity declines slightly towards the end of medium term. However, significant expansions are also expected in the Middle East, with an additional 2.3 mb/d of crude distillation capacity likely to be added by 2016 – and this will help provide additional supply alternatives if required. The investment outlook in Saudi Arabia in particular looks positive over the medium term, with major projects expected to be commissioned in 2013 and 2014, and the possibility of a third by 2016. The United Arab Emirates also has a major project planned for start-up in 2014.[29] All of these projects have the potential to provide valuable additional supply of refined products into the Asian market.

Surplus capacity does, however, place competitive pressures on refineries globally, and there will remain a risk of further rationalisation in the Australian refining industry as Australia's relatively small refineries continue to struggle to compete against mega-refineries in Asia. This was a risk identified in the 2009 NESA, and Shell has subsequently announced the closure of its Clyde refinery.

Despite the general surplus in refining capacity, the IEA also sees a potential tightening of supply of middle distillates, including diesel, other gasoils and kerosene, towards 2016. This is driven by strong global demand growth for these products, with the share of middle distillates in total demand growth at 52 per cent[30] versus their current share of 36 per cent of global demand. This may continue to place pressure on the price of diesel – a product of increasing importance in Australia due to its use in the mining and transportation sectors.

Long term: Adequacy is assessed as ***moderate*** over the long term. Combined resources of conventional and unconventional oil are considered adequate to meet global, and therefore Australian, demand in the long term. The prime risk to adequate supply over this period is underinvestment in the global oil supply chain, rather than a lack of resources to meet growing demand.

29 IEA, *Medium-term oil and gas markets 2011*, pp. 124–125.

30 IEA, *Medium-term oil and gas markets 2011*, pp. 111–112.

The outlook for global oil demand over the long term also depends greatly on the capacity of governments globally to stem growing consumption and carbon emissions. Nevertheless, in the absence of a strong global commitment on climate change, growth trends seen over the medium term are expected to continue, with global demand growing steadily driven by emerging economies.

In the IEA's *World energy outlook 2011* (WEO 2011), OECD primary oil demand is projected to fall in the period to 2035, while non-OECD demand grows to around 60 per cent of global demand from around 47 per cent in 2010. China is projected to become the largest single consumer of oil by 2035, and India and the Middle East region are also expected to show rapid demand growth.[31]

On the supply side, the global share of conventional crude oil production declines to 2035 in the WEO 2011, with production of natural gas liquids, biofuels and unconventional oil rising to meet demand growth. Despite this trend, conventional crude oil is still projected to account for the majority of world liquid fuels supply by 2035.[32]

Under the WEO 2011's central New Policies Scenario,[33] total global oil production does not peak before 2035. In contrast, under the 450 Scenario,[34] production peaks before 2020, as a result of a peak in demand rather than supply constraints, driven by the implementation of ambitious global greenhouse gas reductions, which would encourage the more efficient use of oil and the development of alternatives.[35]

This implies that uncertainty and risk over time can be partially mitigated by moderating demand – whether driven by climate change mitigation policy, sustainable planning, incentives for increased use of public transport, or improvements in efficiency stemming from government policy and commercial and technological innovation.

However, meeting the projected trends in the WEO 2011 requires significant global investment in oil supply infrastructure. The IEA expects upstream spending will need to continue to increase over the long term due to: rising global demand; rising production costs resulting from both cost inflation and the need to develop more difficult resources; and the need to combat rising decline rates at existing fields.[36]

While the required investment levels are significant, they are not unachievable and to-date the market has been able to deliver adequate investment. The IEA notes global upstream investment is set to continue to grow strongly in 2011, reaching a new record. In the period between 2000 and 2011, upstream investment has quadrupled in nominal terms, and in real terms has increased by 120 per cent.[37]

Nevertheless, there is considerable uncertainty around long-term investment and maintaining an open and efficient investment environment remains critical to ensure that there is adequate investment in new production capacity over time. Even under a scenario where long-term investment needs are met, it is likely that there will be short periods of underinvestment with implications for prices.

Similar views are shared by both BP and Shell in their long-term outlooks, which see an uncertain near-term outlook for global economic growth as a major contributing factor to uncertainty about the path of investment over the medium to long term.[38]

31 IEA, *World energy outlook 2011*, IEA, Paris, 2011, pp. 105–107.

32 IEA, *World energy outlook 2011*, p. 122.

33 The WEO 2011's New Policies Scenario assumes the cautious implementation of the broad policy commitments and plans that have been announced by national governments.

34 The WEO 2011's 450 Scenario is based on an energy pathway consistent with limiting the concentration of greenhouse gases to 450 parts per million of CO2 equivalent.

35 IEA, *World energy outlook 2011*, pp. 104, 122.

36 IEA, *World energy outlook 2011*, p. 144.

37 IEA, *World energy outlook 2011*, pp. 143–144.

38 See: Shell, *Shell energy scenarios to 2050: signals and signposts,* February 2011, pp. 10–11; BP, *Energy outlook 2030*, BP, London, 2011, pp. 63–65.

Compounding the general uncertainty about economic growth is uncertainty about the extent, timing and nature of global climate change policies, which has the potential to stall investment decisions.[39]

Under the WEO 2011 New Policies Scenario, the OECD share of global oil production declines from around 22 per cent in 2010 to around 18 per cent in 2035, while OPEC's production share is expected to increase from around 42 per cent to just over 50 per cent over the same period.[40] This may have impacts on reliability over the long term due to increased geopolitical risks to global supply.

Contributing to that trend, Australia's domestic oil and natural gas liquids production from 2008–09 to 2034–35 is projected to decline by an average of 2.9 per cent per year. Production of naturally-occurring LPG is projected to increase at an average annual rate of 1 per cent over the same period; however the volumes are not significant enough to offset the decline in oil production.[41]

Declining domestic production, combined with increasing domestic demand, leads to an increase in net imports over time, with growth of 3.3 per cent per year projected from 2008–09 to 2034–35.[42]

Over the long term, alternative transport fuels have the potential to play an increasing role in Australia's liquid fuel market as infrastructure costs decrease and carbon pricing influences demand. In a report produced by the CSIRO in 2011, four sources were viewed as realistic long-term supplements to conventional transport fuels in Australia – biofuels, liquefied natural gas, compressed natural gas and electricity.[43]

Modelling released by the Treasury in support of the Australian Government's carbon pricing mechanism demonstrates that activity in the transport sector is expected to continue to grow over the long term. However, the introduction of a carbon price is expected to drive changes in the fuel mix over the long term, including greater adoption of alternative transport fuels.[44]

Under the assumptions used in the modelling, the greatest change in the fuel mix over the long term comes from the adoption of biodiesel blends. By 2030, biodiesel blends become the dominant fuel used in heavy vehicles, while also having an increased share of the light vehicle mix.[45]

However, it is important to note that these are biodiesel blends such as B20, and therefore conventional diesel supply will still remain a critical part of the fuel mix over the long term.

The modelling also forecasts a minor increase in the uptake of electric vehicles in the light vehicle segment, and in rigid trucks and buses. There is also increased uptake of synthetic diesels, primarily in the heavy vehicle segment. However, they remain a small part of the overall fuel mix over the long term of this assessment.[46]

In addition to the a bove sources, Australia is estimated to have about 1.3 per cent of the world's resources of recoverable shale oil.[47] However, development of shale oil production is still in the early stages and is faced with environmental challenges in a move to a lower-emissions economy.

39 See Shell, *Signals and signposts*, pp. 10–11; BP, *Energy outlook 2030*, pp. 64–67.

40 IEA, *World energy outlook 2011*, pp. 122, 126.

41 BREE, *Australian energy projections to 2034–35*, BREE report, prepared for the Department of Resources, Energy and Tourism, Canberra, 2011, pp. 54–55.

42 BREE, *Australian energy projections* to 2034–35, p. 51.

43 CSIRO, *Climate change: science and solutions for Australia*, 2011, p. 123.

44 Treasury, *Strong growth, low pollution: modelling a carbon price*, Commonwealth of Australia, Canberra, 2011.

45 Treasury, *Strong growth, low pollution*, pp. 131–132.

46 Treasury, *Strong growth, low pollution*, p. 132.

47 Geoscience Australia & ABARE, *Australian energy resources assessment*, report commissioned by the Department of Resources, Energy and Tourism, 2010, p. 57.

Despite the potential changes in the fuel mix discussed above, overall, the clear message from the Treasury modelling is that, even with a carbon price, conventional fuels are likely to retain a dominant share of the transport fuel mix in Australia over the long term, either as conventional petrol or as the major component of petrol or biodiesel blends.

Reliability

Short term: Australia's short-term reliability for liquid fuels is assessed as ***high***.

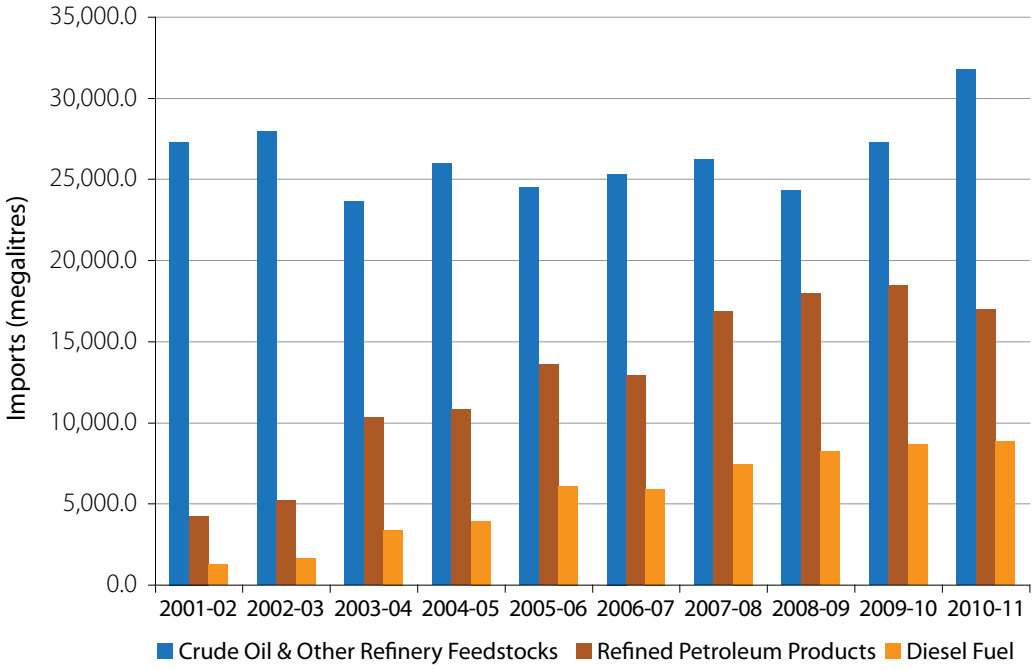
The liquid fuel industry has consistently performed well in meeting consumer demand with minimal disruptions to supply. This is due to continued access to well-functioning markets which have helped create robust and flexible supply chains with a high degree of diversity of supply – a key component of risk management.

Domestically produced crude oil, LPG, biofuels and refined products supplied by Australian refineries are well integrated with crude oil and refined products sourced from a wide variety of international suppliers.

Highly diversified supply has combined with pro-active supply chain management to mitigate the effects on reliability of short-term events such as refinery outages, shipping delays or unexpected spikes in demand.

Australia's total petroleum imports (crude oil and refined products) have increased significantly in the last decade, rising by nearly 55 per cent from 31 576.5 ML in 2001–02 to 48 798.5 ML in 2010–11. As shown in the Figure 2.3, this growth has largely been driven by growth in refined products, in particular diesel, although imports of crude oil have also risen steadily in recent years.[48]

Figure 2.3: Australian oil imports, 2001–02 to 2010–11



Source: Department of Resources, Energy and Tourism, *Australian petroleum statistics*, Commonwealth of Australia, Canberra, June 2004 - June 2011.

Overall, this increase in imports is not assessed as having an impact on the reliability of supply in the short term, due to the highly diversified nature of these imports and the ability to source alternative supplies from a growing number of suppliers when required.

48 Department of Resources, Energy and Tourism, *Australian petroleum statistics*, Commonwealth of Australia, Canberra, June 2004 – June 2011.

Consultations with industry and analysis conducted by the Australian Competition and Consumer Commission (ACCC) have indicated that the availability of Australian-specification unleaded petrol and diesel from regional refiners has increased in recent years.[49] This is an improvement since the last assessment and adds to the resilience of Australia's liquid fuel supply chains.

In 2010–11, Australia's total refinery input was 39 880 ML and imports of crude oil and other refinery feedstocks were 31 768 ML (around 80 per cent of refinery input). These imports were sourced from around 20 different countries, with no heavy reliance on one particular country or region.[50]

Key sources of crude oil included Malaysia (5929 ML or 14.8 per cent of total refinery input), Indonesia (4802 ML or 12 per cent), United Arab Emirates (4684 ML or 11.7 per cent), New Zealand (2565 ML or 6.4 per cent), Vietnam (2554 ML or 6.4 per cent), Nigeria (2050 ML or 5.1 per cent), Brunei (1830 ML or 4.5 per cent) and Papua New Guinea (1612.6 ML or 4 per cent). Only 5917 ML or 14.8 per cent of Australia's refinery input was sourced from the Middle East.[51]

While regional supply has provided for a large proportion of Australian oil import needs, industry consultations for this assessment indicated a recent trend to go further afield for a small proportion of crude supplies in 2010–11. This was thought to be due to increased competition for crude oil from regional suppliers, and is an indication of supply chains growing longer earlier than had been expected in the previous assessment. This is not assessed as having an impact on reliability in the short term.

Longer supply chains lead to a greater potential for delays in shipping; however, such delays are a common occurrence and are routinely managed by industry through regular commercial operations. This highlights the importance of continued investment in import infrastructure. Available evidence, discussed below, suggests that adequate investment in this area is occurring.

In regard to the supply of refined petroleum products, a significant proportion of Australia's consumption (measured in terms of annual sales) is still produced domestically. In 2010–11, Australian refineries produced 38 395 ML of petroleum products (around 74 per cent of Australia's total annual sales of 52 095 ML).[52]

At the same time, Australia imported 17 030 ML (32.6 per cent of total annual sales) of refined products. This was sourced from over 20 different countries, with key suppliers including Singapore (9470 ML or 18 per cent of total annual sales), South Korea (2078 ML or 3.9 per cent) and Japan (1873 ML or 3.6 per cent).[53] While there is a good level of diversification of supply sources for refined products, a number of countries are only very minor suppliers and Australia does have a significant reliance on Singapore as a regional refining hub.

In 2010–11, Australia imported 9470 ML of refined product from Singapore. This is over 50 per cent of Australia's imports of refined products; however, it is only 18 per cent of Australia's total sales for that year.[54] The extent to which increased import dependency may represent a vulnerability over the short, medium and long terms is tested in the 'shock' scenario outlined at the end of this chapter (Box 2.2).

Rising imports of liquid fuels require increased investment in domestic storage and terminal capacity. An audit of Australia's import infrastructure prepared for the Australian Government and released in August 2009 examined the capacity of Australia's existing infrastructure to meet forecast petroleum import requirements. The report found that existing infrastructure and planned investments will result in spare capacity emerging in all jurisdictions except the

49 See ACCC, *Monitoring of the Australian petroleum industry: report of the ACCC into the prices, costs and profits of unleaded petrol in Australia 2010*, ACCC, Canberra, 2010, p. 66.

50 Department of Resources, Energy and Tourism, *Australian petroleum statistics*, issue no. 179, June 2011.

51 Department of Resources, Energy and Tourism, *Australian petroleum statistics*, issue no. 179.

52 Department of Resources, Energy and Tourism, *Australian petroleum statistics*, issue no. 179.

53 Department of Resources, Energy and Tourism, *Australian petroleum statistics*, issue no. 179.

54 Department of Resources, Energy and Tourism, *Australian petroleum statistics,* issue no. 179.

Northern Territory over the two years from December 2008.[55] During consultations for this assessment, industry provided evidence of additional plans for expansion made since the 2009 audit was released, indicating that investment in infrastructure has continued to meet growing demand.

Infrastructure resilience is another important factor in liquid fuel security, as it is in the energy sector more broadly. However, the considerable flexibility in liquid fuel supply chains and transportation systems, proactive supply chain management and well-diversified sources of supply have successfully mitigated reliability issues in the past and are highly likely to continue to do so over the short term.

One area in which infrastructure resilience has had an impact on reliability of supply recently is in biofuels production.

Natural disasters in Queensland in early 2011 and the reduced availability of feedstocks had a temporary negative impact on domestic biofuels production, which led to shortages in the supply of ethanol blended petrol to retail consumers in Queensland in particular.

Consultations with industry indicated that the existing excise arrangements, where only domestic ethanol is eligible for an Ethanol Production Grant, contributes to alternative supplies from the international market being uneconomical. In May 2011, the Australian Government announced a 10-year extension to the excise arrangements for biofuels, and therefore reliability of supply for biofuels is likely to continue to be an issue over the short and medium terms.

While domestic and imported biodiesel are both effectively excise free, the international market is subject to production and blending subsidies from overseas governments, which have in the past been successfully challenged by Australian producers. This, together with limited and expensive feedstocks, and concerns over some sourcing (such as from palm oil), means the reliability of the supply of biodiesel is likely to remain problematic for the short to medium term.

Medium term: Reliability of liquid fuel supplies is also assessed as ***high*** in the medium term.

Access to adequate supplies of crude oil and petroleum products through well-functioning domestic and global markets will allow the petroleum industry to continue to provide liquid fuel supplies with minimal disruptions. Any risks from increased dependence on refined product imports is expected to be mitigated by access to flexible global supply chains and continued pro-active supply chain management.

While the domestic refining industry is expected to continue to be an important component of a well-diversified domestic supply chain in the medium term, increased competition from large-scale Asian refineries will continue to pose a risk of further rationalisation in the domestic refinery sector. However, access to regional markets for refined products is expected to provide ample supply to meet any domestic refinery shortfall.

The Australian Government's carbon pricing mechanism is expected to have a minimal impact on domestic refining over the medium term. Under the Jobs and Competitiveness Program announced as part of the government's Clean Energy Future package, the Australian refining industry will qualify for the highest rate of assistance for trade-exposed industries. This assistance will reduce stress on Australian refining associated with the introduction of a domestic carbon price over the medium term.

Consultation with industry has highlighted significant current and planned investment in storage capacity to meet the forecast growth in demand for imports of refined products. Adequate and sufficient investment in terminal infrastructure will be an important contributor to reliability over the medium term.

Long term: Reliability is assessed as ***moderate*** over the long term due to a decline in global conventional oil production and oil production in OECD countries, and a greater reliance on OPEC sources.

Australia is projected to become more dependent on oil imported from distant regions, and global oil markets will rely increasingly on unconventional sources of supply.

55 ACIL Tasman, *Petroleum import infrastructure in Australia: executive summary*, report prepared for the Department of Resources, Energy and Tourism, 2009, p. 33.

Australian domestic consumption of petroleum products is forecast to grow by 1.2 per cent a year between 2008–09 and 2034–35.[56] Australia's refining capacity is not expected to increase over the same period due to competitive pressures from large regional refineries, and therefore consumption growth will need to be met by increased imports of petroleum products. In addition, domestic production of crude oil and natural gas liquids is expected to decline sharply over the period from 2015–16 to 2034–35.[57] While a large amount of Australia's domestically produced crude oil and condensate is already exported, the forecast decline in production may require an even greater proportion of refinery feedstocks to be imported.

Therefore, over the long term, Australia is likely to have a greater reliance on imported oil and long global supply chains, a decrease in diversity of supply (due to the decline in domestic production of crude oil) and increased exposure to international factors such as geopolitical tensions and events, and the investment decisions of international and state-owned oil companies.

In the WEO 2011, OPEC's share of global oil production is projected to exceed 50 per cent by 2035.[58] Industry analysis suggests similar trends. For example, BP's *Energy outlook 2030* projects OPEC's share of global oil production to rise to 46 per cent by 2030.[59]

Similarly, Exxon Mobil projects non-OPEC crude oil and condensate production to essentially remain flat to 2030, with growth in demand for liquid fuels met through increased production in OPEC countries, as well as biofuels, natural gas liquids, coal- and gas-to-liquids, and refinery processing gains.[60]

Importantly for OPEC production outlooks, industry publications view Iraq's ability to make future production targets and the reintegration of Iraqi production into the OPEC quota system as a major source of uncertainty, in addition to broader uncertainty over geopolitical developments.[61]

Unconventional oil production is projected to increase significantly in the long term, enabling it to meet about 10 per cent of world demand by 2035 in all scenarios in the WEO 2011. Canadian oil sands and Venezuelan extra-heavy oil (the main sources of current unconventional oil production) continue to provide the majority of unconventional oil out to 2035, with other unconventional sources only beginning to play a role towards the end of the projection period.[62]

While unconventional oil resources are considered to be several times larger than conventional oil resources, the development of these resources faces a number of challenges. These include high development costs compared with conventional oil resources, capital-intensive production with long payback periods, high carbon emissions intensity of extraction, and water and land use constraints on some new developments due to their location in environmentally sensitive areas.[63]

Nevertheless, the IEA expects production of unconventional resources to continue to be economical over the long term, and does not see unconventional resources as being a constraint on global production out to 2035, or for many decades beyond that.[64]

56 BREE, *Australian energy projections 2034–35*, p. 43.

57 BREE, *Australian energy projections 2034–35*, pp. 54–55.

58 IEA, *World energy outlook 2011*, p. 122.

59 BP, *Energy outlook 2030*, p. 37.

60 Exxon Mobil, *The outlook for energy: a view to 2030*, Exxon Mobil, Irving, Texas, 2010, p. 42.

61 Shell, *Signals and signposts*, pp. 11, 33; BP, *Energy outlook 2030*, pp. 2, 36–39.

62 IEA, *World energy outlook 2011*, pp. 122–124, 126, 134. The WEO 2011 defines unconventional oil as bitumen and extra-heavy oil from Canadian oil sands; extra-heavy oil from the Venezuelan Orinoco belt; oil obtained from kerogen contained in oil shales; oil obtained from coal through coal-to-liquids technology; and oil obtained from natural gas through gas-to-liquids technologies, as well as refinery additives and gasoline blending additives originating primarily from gas or coal.

63 IEA, *World energy outlook 2010*, pp. 143–144.

64 IEA, *World energy outlook 2010*, p. 143.

While Australian crude oil supply chains are expected to lengthen, under the WEO 2011 New Policies Scenario, the majority of cumulative investment in refining capacity from 2010 to 2035 is projected to be made in Asia, particularly in China and India.[65] This would mean that a greater proportion of global refining capacity would be based in the Asia–Pacific in the long term, with the potential to help maintain reliability of supply of Australian imports.

Increased competition from new refineries in the Asia–Pacific, however, increases the risk of further rationalisation of Australian refining capacity over the long term, leading to a greater reliance on imports of refined petroleum products and a further decrease in the diversity of supply. Nevertheless, substantial investment in regional refining is likely to continue to provide access to reliable supplies of refined petroleum products.

Competitiveness

Short term: Competitiveness of liquid fuels in the short-term is assessed as ***moderate*** due to the current high international prices for oil and oil products, which are expected to continue over the coming months.

However, despite prices being relatively high in historical terms, current and expected short-term price levels are manageable within the broader economy, and the economic and social need for liquid fuel supplies in Australia continues to be met.

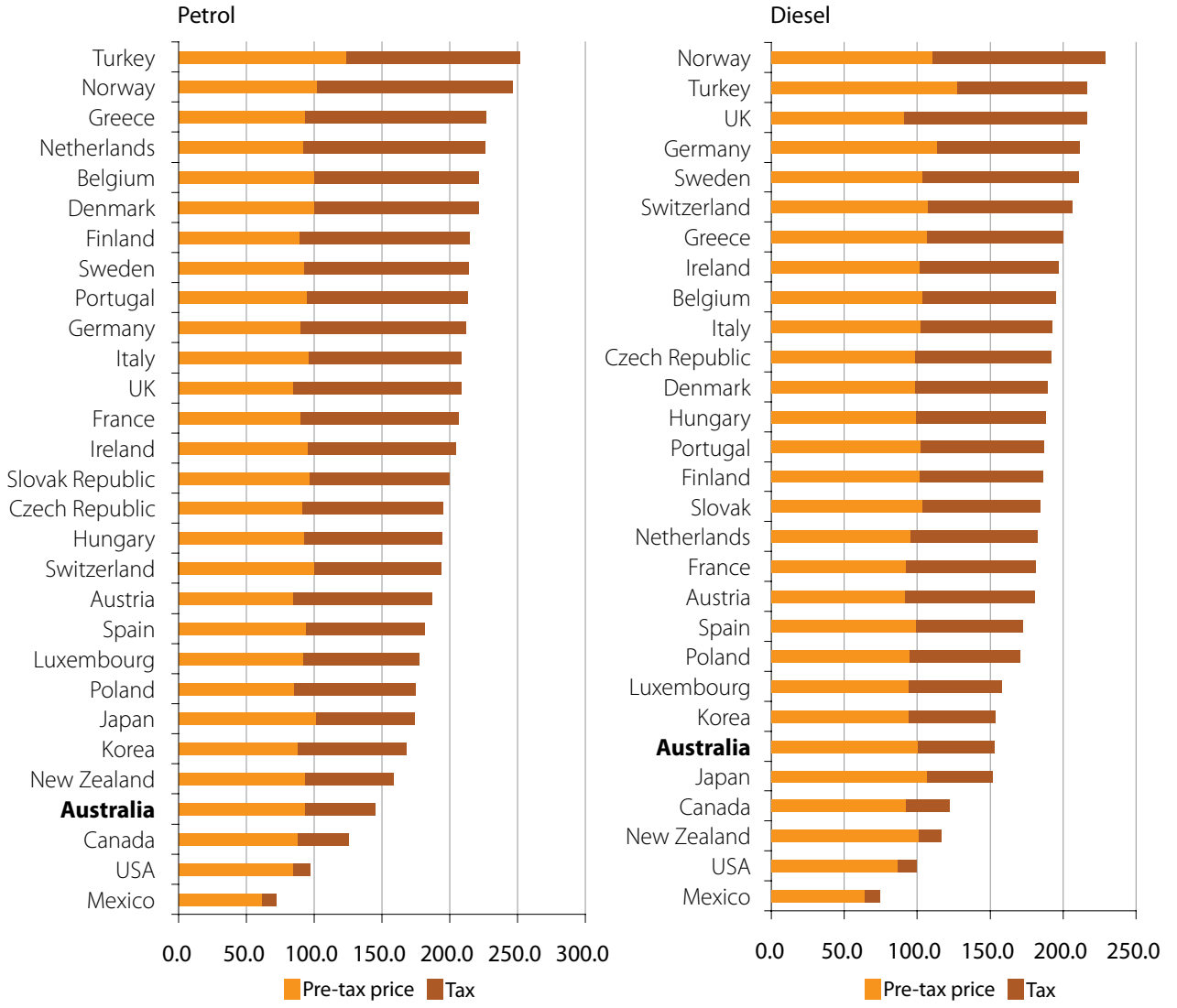
Many sectors of the Australian economy, and a significant proportion of Australian households, have benefited from growth in real incomes over recent years and are therefore less affected by increases in fuel prices.

However, sectors of the economy and community that have not benefited as greatly from economic growth can still be affected by higher real fuel prices. Therefore, on balance, an overall assessment rating of moderate is appropriate as it signals that the liquid fuel needs of some sectors and groups remain vulnerable to significant increases in crude oil prices.

Nevertheless, as shown in Figure 2.4, both the pre-tax and overall price for petrol and diesel in Australia continue to be among the lowest in the OECD.

65 IEA, *World energy outlook 2011*, p. 144.

Figure 2.4: OECD petrol (left panel) and diesel (right panel), June quarter 2011 (in Australian cents per litre)



Source: Department of Resources, Energy and Tourism, *Australian petroleum statistics*, issue no. 182, September 2011

The ACCC's regular monitoring and analysis of the liquid fuels sector has shown that the major determinants of retail petrol prices have been:

- the international price of refined petrol (the benchmark for Australia is the price of Singapore Mogas 95 unleaded), which is in turn largely determined by the international price of crude oil
- the exchange rate of the Australian dollar against the US dollar
- weekly retail price cycles that operate in capital cities and affect day-to-day prices of petrol.[66]

International prices have risen since the 2009 assessment was released and in real terms have reached levels that can be considered historically high, although they have not yet reached the price levels experienced in mid-2008.

66 ACCC, *Monitoring of the Australian petroleum industry*, p. xix.

However, the impact of higher crude oil prices on current retail prices has been partially offset by the strong Australian dollar. The size of this effect can be seen from analysis conducted by the ACCC in 2010.

This analysis showed that if the Australian dollar had remained constant at US 89 cents (its value at 20 August 2010) over the period 1 September to 31 October 2010, Australian consumers would have been paying an average of 130 cents per litre at the end of October 2010 instead of an actual average of 123 cents per litre.[67]

In the absence of the rise in the Australian dollar exchange rate, the rise in the price of petrol in Australia during the recovery of the world economy following the global financial crisis would have been much steeper.

The ACCC has also tracked movements in average retail fuel costs in comparison to a range of household products and services. The analysis shows that the total increase in automotive fuel costs from 1980 to June 2010 has been higher than changes in the consumer price index. However, it has been lower than price increases for other products and services such as electricity, bread, health services and urban transport fares.[68]

In addition, a number of key sectors of the Australian economy, including large fuel users like the mining, agriculture, forestry, fishing and industrial sectors, qualify for full or partial excise relief through 'fuel tax credits' to off-road business use of all fuels and fuel used in heavy on-road vehicles under the Australian Government's Energy Grants (Cleaner Fuels) Scheme.

Medium term: Competitiveness is assessed as ***moderate*** in the medium term.

Prices for crude oil and refined products are likely to remain relatively high over the medium term, driven by increasing global demand. Nevertheless, prices are expected to remain manageable within the broader economy, without undue social or economic impacts.

The flexibility of global markets for liquid fuels will also help ease potential price pressures from unexpected events. The availability of commercial inventories, spare OPEC production capacity, and the expected surplus in global and regional refining capacity outlined above will continue to provide a buffer against unexpected supply and demand shocks and help to mitigate price rises over the medium term.

As part of the Australian Government's Clean Energy Future package, it was announced that households, on-road business use of light vehicles and the agriculture, forestry and fishery industries will not face a carbon price on the fuel they use for transport.

Some other businesses outside of these sectors that currently effectively pay no excise on the fuel they use off-road will be faced with an effective carbon price due to a reduction in their fuel tax credit entitlements.

The government also intends to apply a carbon price on heavy on-road vehicles from 1 July 2014; however, the government has noted that this measure was not agreed to by all members of the Multi-Party Climate Change Committee.

Aviation, marine and rail transport will be subject to a carbon price via changes to the current fuel excise and fuel tax credit schemes.[69]

These arrangements will have an impact on the price of liquid fuels for certain sectors of the economy; however, the impact is not expected to be large. This, together with the large range of exemptions, means that the Australian Government's carbon pricing mechanism will only have a minor impact on competitiveness or consumer affordability and is not expected to be significant enough to affect the overall assessment.

67 ACCC, *Monitoring of the Australian petroleum industry*, pp. xxiv.

68 ACCC, *Monitoring of the Australian petroleum industry*, p. 157.

69 For further details, see *Clean energy future fact sheet: transport fuels*, available at www.cleanenergyfuture.gov.au/transport-fuels

Long term: Competitiveness is assessed as ***moderate*** in the long term. Strong demand growth in emerging economies and increased reliance on more expensive sources of supply are expected to cause global oil prices to rise over the long term.

The IEA's analysis in the WEO 2011 assumes that prices rise steadily in both the Current Policies Scenario and the New Policies Scenario. In the New Policies Scenario, the average IEA crude oil import price increases from just over US$78 per barrel in 2010 to nearly US$109 per barrel in 2020 and US$120 per barrel in 2035 (in 2010 dollars). In nominal terms, in this scenario, prices essentially double to US$212 per barrel in 2035.[70]

Under the Current Policies Scenario, significantly higher prices are needed to balance supply due to faster growth in demand. In this case, the average crude oil price rises to US$118 per barrel in 2020 and US$140 per barrel in 2035 (in 2010 dollars).[71]

The US Energy Information Administration has forecast a similar trend towards higher prices. The reference case of its *International energy outlook 2011* assumes a global oil price (based on light sweet crude) of US$125 per barrel in 2035 (in 2009 dollars).[72]

For the Australian Government's carbon pricing mechanism, the Treasury's oil price forecast was drawn from oil and gas projections from the IEA. Prices in real terms are constant from around 2035.

However, there are a number of risks to prices over the long term and the rating for competitiveness could change to ***low*** if global investment in production capacity does not keep pace with demand growth and field declines; stability in key production regions declines; and/or supplier groups withhold significant supply capacity.

On the other hand, price rises can also be eased if strong global action is taken to stem rising demand. Under the IEA's 450 Scenario, for example, prices level off at around US$97 per barrel by 2015 due to a persistent decline in demand. In this scenario, declining demand outweighs rising costs of production and higher carbon prices contribute to lower demand and therefore lower international oil prices.[73]

Actual prices will naturally vary significantly due to the uncertainties for oil markets over the long term, and price volatility will continue to be a feature of global oil markets. Nevertheless, there is a general consensus that in the long term oil prices are likely to continue to rise in comparison to recent average prices, although this will affect all countries that participate in the global fuel market in a similar way.

70 IEA, *World energy outlook 2011*, pp. 61–62, 64.

71 IEA, *World energy outlook 2011*, pp. 61–62, 64.

72 US Energy Information Administration, *International energy outlook 2011*, US Department of Energy, Washington, DC, 2011, pp. 28.

73 IEA, *World energy outlook 2011,* pp. 64, 105.

Box 2.2: Liquid fuel shock scenario

The hypothetical shock scenario analysed for the liquid fuel sector was a temporary interruption to the supply of oil products from a major regional oil trading and refining hub. Specifically, the scenario involved interruption of shipping of oil to, and oil products from, Singapore for about 30 days.

After allowing for the time it takes to ship crude oil to Singapore, refine crude oil, store and blend sufficient oil products, break up cargos, and ship crude oil and refined products to Australia, the interruption of supply from Singapore to Australia could last for 45 to 60 days.

Logistical implications of a 30-day closure

The greatest impact of a 30-day shutdown of Singapore's role in liquid petroleum markets is likely to be in the supply of refined petroleum products to Australia and other customers. Not only does Singapore have a large refining capacity of its own, but it is also an important market hub for refined petroleum products. Products from Singapore's refineries and refineries in other countries are blended in Singapore. Products from refineries elsewhere are also transferred from large tankers to medium-range tankers suited to Australian ports.

The most immediate impact would be on products imported into Darwin and north-western Australia that are usually supplied from Singapore. Industry consultations, undertaken in developing this shock scenario, indicated that the sailing time from Singapore to Darwin is around seven days, which means that stocks on the water and in import terminals are likely to be sufficient for about two weeks on average.

Sailing times from Singapore to import terminals further south on the east and west coasts of Australia are around 14 days. Importers supplying these areas would have up to two weeks' supply of product on the water and potentially another one to two weeks' supply in import terminals.

Most Australian cargos are locked into the Australian market well before tankers sail, which would ensure supply in the first two weeks of the disruption. This, along with storage at import terminals, would provide a buffer period of between two and four weeks while importers sourced alternative product from other sources to make up for the loss of product normally shipped from Singapore.

Alternative supplies for Australia would be sourced from the spot market in the first instance. This would include diverting cargoes that would otherwise have been exported from the Asia–Pacific region. Refineries in the Asia–Pacific region routinely export surplus production to other regions, notably the Americas and Europe.

Diesel that meets Australian specifications is a fairly fungible grade in Asia and industry consultations suggested that sourcing additional diesel from Asia would not be difficult.

Australian-specification unleaded petrol is less fungible. However, Japanese and Korean refineries can supply petrol to Australian specifications, as can newer refineries in India and refineries in the Middle East. Supplies from Japan and South Korea can take up to four to six weeks from contracting supply to delivery at Australian ports. Sailing time from India and the Middle East is around six weeks. Industry advised that importers would take early action to secure additional supplies from these sources to ensure that the Australian market was supplied in the subsequent weeks.

Modelling assumptions

Modelling of the shock scenario was done using an analysis of the response of the oil market to Hurricanes Katrina and Rita to estimate the impact on prices over three months of a 30-day shutdown in Singapore.

Hurricane Katrina resulted in an initial loss of around 2 million barrels per day (mb/d) in refinery throughput in the Gulf of Mexico, and an average loss of 1.57 mb/d for the month immediately following. By comparison, a 30-day shutdown in Singapore would result in the loss of around 1.33 mb/d of refined petroleum products.

The availability of spare refining capacity in the Asian region was examined to help estimate demand and supply elasticities. In the short term spare capacity is high. Spare capacity remains adequate over the medium term, but begins to decline towards the end of this period.

The price shocks in the short term are based on large spare capacity being available in Asian refineries. Prices increase 12.3 per cent initially, with a further 5.71 per cent rise due to precautionary buying.

The estimate of the impact of precautionary buying is based on estimates drawn from the Hurricane Katrina example. The total price increase in the first month is 18 per cent.

In the second month, the total price increase reduces to 10.6 per cent due to the additional supply response from spare refining capacity induced over the first month.

Table 2.3: Percentage price change for the short term

	Month 1	Month 2	Month 3
Elasticity of demand	–0.10	–0.15	na
Elasticity of supply	0.04	0.10	na
Change in quantity	–1.72	–1.72	0.00
Percentage change in price	12.3	6.9	0.0
Assumed impact of precautionary demand	5.7	3.7	2.0
Percentage change in price	18.00	10.6	2.0

Source: ACIL Tasman, *Liquid fuels vulnerability assessment*, October 2011, p. 87.

The price shocks for the medium term are based on comparatively less spare capacity being available in Asian refineries. Prices are estimated to increase 14.3 per cent initially, with a further 6.7 per cent impact estimated for precautionary buying.

The estimate of precautionary buying is based on estimates drawn from the Hurricane Katrina example. The total increase is 21 per cent. In the second month the supply response reduces the total increase to 14 per cent.

Table 2.4: Percentage price change for the medium term

	Month 1	Month 2	Month 3
Elasticity of demand	–0.10	–0.15	na
Elasticity of supply	0.02	0.05	na
Change in quantity	–1.72	–1.72	0.00
Percentage change in price	14.3	8.6	0.0
Assumed impact of precautionary demand	6.7	5.4	3.5
Percentage change in price	21.0	14.0	3.5

Source: ACIL Tasman, *Liquid fuels vulnerability assessment*, October 2011, p. 87.

Results of the modelling

Short term

The interruption is estimated to increase product prices by around 18 per cent on average in the first month, while prices decline in the second and third months.

The total loss in real GDP (in 2010 dollars) is estimated to be $1382 million over four months and the loss in real income is estimated to be $2146 million over four months (see Table 2.5).

To place these numbers in perspective, the loss in real GDP is roughly equal to 0.1 per cent of total (i.e. annual) GDP in 2011, while the loss in real income is equivalent to an average of around $96 for each Australian.

Table 2.5: Projected economic impacts in 2011 (in 2010 terms)

	Units	Month 1	Month 2	Month 3	Month 4	Total
Increase in price of petroleum products	%	18	10.6	2	0	
Loss in real GDP	A$ million	–791	–479	–102	–10	**–1382**
Loss in real income	A$ million	–1,227	–749	–160	–10	**–2146**

Source: ACIL Tasman, *Liquid fuels vulnerability assessment*, October 2011, p. 92.

The transport and manufacturing sectors of the economy are less affected than are the agriculture and mining sectors, which have fewer options for substitution and reducing consumption in the short term.

Medium term

The interruption is estimated to increase product prices by around 21 per cent on average in the first month, while prices decline in the second and third months.

The total loss in real GDP (in 2010 dollars) is estimated to be $2211 million over four months and the loss in real income is estimated to be $3704 million over four months (see Table 2.6).

Table 2.6: Projected economic impacts in 2015 (in 2010 terms)

	Units	Month 1	Month 2	Month 3	Month 4	Total
Increase in price of petroleum products	%	21	14	3.5	0	
Loss in real GDP	A$ million	–1,169	–805	–221	–16	–2,211
Loss in real income	A$ million	–1,954	–1,359	–374	–17	–3,704

Source: ACIL Tasman, *Liquid fuels vulnerability assessment*, October 2011, p. 92.

To place these numbers in perspective, the loss in real GDP is roughly equal to 0.15 per cent of total (i.e. annual) GDP in 2015, while the loss in real income is equivalent to an average of around $164 for each Australian. The same relative impacts occur in the economy, with transport and manufacturing faring better than agriculture and mining.

Analysis

The analysis of a shutdown in Singapore for a period of 30 days indicates that while there would be a short-term rise in petroleum product prices, there would nevertheless be sufficient availability of petroleum products to support economic activity.

- In the short term, product supply would be maintained with product from substantial surplus capacity in other Asian refineries and from product that would normally be arbitraged out of the region.
- In the medium term, there would be more delays in redirecting supplies because of the comparatively smaller surplus in Asian refining capacity expected in 2014.

- In the longer term, new investment expected in the Asian refineries would again reduce the time for redirecting supplies.
- There would be differential impacts on industry sectors in the economy caused mainly as a result of rising prices.
- The price rises in the immediate term would be more modest than in the medium term. The reason for this is the proximity of surplus capacity in the Asian region that currently exists but which is expected to be slightly reduced by 2014, mainly as a result of demand growth.
- Nevertheless, replacement products could also be sourced from refineries in the Middle East and even Europe, where there is also expected to be surplus capacity over the medium term.
- Price rises in the longer term are likely to be reduced as new surplus capacity is brought on stream.
- The impact on affordability will be more significant for some sectors of the economy than others. For example, sectors that are heavily dependent on road transport in particular are likely to be relatively worse off.
- Wages in Australia have been increasing at a faster rate than petroleum product prices and in this respect affordability of liquid fuels has improved. In most cases the impact of price spikes during a major disruption such as the hypothetical Singapore shock would not raise affordability concerns as consumers have some scope to adapt their fuel consumption in the short term.
- However, some consumers could be more seriously affected – notably those for whom alternatives to private road transport are not available. This impact is likely to be more evident in the medium term – around 2014 – for the reasons explained above.
- Growing dependence on imports of petroleum products is not in itself a cause for greater risk of a supply disruption, provided the industry invests in import infrastructure. There is evidence that this is occurring as demand grows.
- The potential closure of refinery capacity in Australia reduces the diversity of supply options for the Australian market. This will be offset in the short term by increasing diversity of supply from Asian refineries

Source: ACIL Tasman, *Liquid fuels vulnerability assessment*, October 2011

3 Natural gas

2011 summary of natural gas security

The 2011 NESA has found that Australia has maintained its level of natural gas security at ***moderate*** since the assessment in 2009, reflecting a rapidly developing market with distinct regional differences and challenges.

In the short term, the gas assessment continues to reflect a rapidly evolving gas market. Tightness in the supply–demand balance, driven largely by demand growth in the resources and electricity generation sectors, persists, although this issue is being addressed through additional investment in exploration and infrastructure.

In particular, steps are being taken to address the energy security issues identified for the western market in the 2009 NESA. Market reform is in the process of being implemented and facilities to deliver more gas and diversify supply options for the western market are currently under construction. Gas security will continue to improve as the western market matures and develops.

In the medium term, the demand for gas-fired electricity generation in the eastern market is expected to increase as part of the transition to less carbon-intensive fuels. However, the uncertainty identified in the 2009 NESA about the extent of this growth has continued into the current assessment period and this could have implications for energy security if investment does not keep up with demand growth. Uncertainty about future gas prices is also affecting the demand for gas and investment in associated electricity generation capacity.

Gas prices in Australia are projected to increase due to higher gas production costs and the impact of the liquefied natural gas (LNG) export market on the domestic market. This change may be more evident in the eastern market due to the rapid growth of the coal seam gas industry in Queensland that has occurred sooner than was expected in the 2009 NESA. Although the expected trend for gas prices is still upwards, the significant levels of global gas supplies that have emerged since the 2009 NESA will introduce greater competition in the LNG industry and constrain price increases. As witnessed in the United States, market dynamics can be difficult to predict.

Competitiveness in the medium and long terms has risen to ***moderate*** from the low rating in the 2009 NESA, primarily due to an expected increase in global gas supply leading to price moderation. Long-term reliability moves to ***high***, reflecting market maturity.

Overall, the ***moderate*** rating reflects the progression of market reforms and investment in conventional and unconventional gas as reserves and associated infrastructure continue to grow in support of domestic and LNG export markets. However, the longer term role for gas, particularly in electricity generation, will be dependent on the interplay between carbon pricing policy, technological developments and costs for other electricity generation technologies, and –importantly – gas prices. The moderate rating also reflects the environmental challenges currently faced by the coal seam gas sector that could restrict future production. These are risks that could materialise as negative influences on the assessment and shift the level of gas security to ***low***.

Further initiatives to improve transparency in Australia's gas markets could help ensure security in the years ahead, and facilitate a monitoring role for the Australian Government to ensure that it has ready access to information on which to base policy decisions.

Table 3.1: Summary of natural gas security – 2011 NESA			
	Short term (to 2015)	**Medium term (to 2020)**	**Long term (to 2035)**
Adequacy	**MODERATE**	**MODERATE**	**MODERATE**
Comment	Gas reserves are able to meet demand in all domestic markets, with a significant increase in coal seam gas reserves in the eastern market. While the western domestic market has sufficient reserves, it is facing the risk of a supply shortfall before planned increases to production capacity become available.	LNG exports from the east coast introduce competitive tension between the supply of gas for domestic use and for export. Tightness of supply in the western market is eased by additional capacity coming online. Timely development of reserves could be impacted by uncertainty about gas prices in the eastern market.	Conventional and unconventional gas resources are expected to be developed to meet demand. Market mechanisms are expected to provide timely signals for investment to occur in response to rising demand.
Reliability	**MODERATE**	**MODERATE**	**HIGH**
Comment	Tight supply chain conditions put pressure on reliability. Recent market reforms in the eastern market are a positive influence that will alleviate pressure over time. The eastern market has a diversity of supply sources. The western market is reliant on a small number of supply sources.	Eastern market reliability is enhanced by a maturing market. Uncertainty regarding future gas demand in the eastern market could discourage investment. Additional supply sources are available in the western market. Western market gas reform begins to have a positive impact on reliability.	Gas market developments further enhance reliability. Uncertainty in gas demand is resolved, with investment responding to demand. Western market reliability is improved by identification and resolution of critical supply chain points.
Competitiveness	**MODERATE**	**MODERATE**	**MODERATE**
Comment	Long-term contracts in eastern market underpinning new developments. New contracts in western market at significantly higher prices than previous contracts is introducing a risk that some downstream projects may be challenged in sourcing gas at prices that maintain their viability	New contracts in the eastern market at higher prices. Prices rise under the influence of LNG export prices, but rises will be constrained by additional supply. Market mechanisms will lead to greater price stability while encouraging investment.	LNG export industry continues to influence domestic prices. Greater competition that has emerged since the 2009 NESA from international gas supplies will constrain price rises.
OVERALL	**MODERATE**	**MODERATE**	**MODERATE**

2009 natural gas security assessment

The 2009 NESA assessed the level of security for gas in Australia as ***moderate*** over the assessment period. Positive factors in this assessment were the anticipated investment in new production and transmission and growing market maturity. The tightness of the supply–demand balance was identified as a dominant driver affecting gas security, as gas is increasingly used as a transition fuel for electricity generation while renewable energy and low-emissions technologies develop.

Table 3.2: Summary of natural gas security – 2009 NESA				
	Current (2009)	Short term (2013)	Medium term (2018)	Long term (2023)
Adequacy	MODERATE	MODERATE	MODERATE	MODERATE
Reliability	MODERATE	MODERATE	MODERATE	HIGH
Affordability	HIGH	MODERATE	LOW	LOW
OVERALL	MODERATE	MODERATE	MODERATE	MODERATE

For the eastern market, the increasing use of gas for electricity generation was identified as a cause of pressure on gas security, especially due to the decrease in hydroelectricity generation under the drought conditions that prevailed when the 2009 NESA was undertaken.

The development of the coal seam gas industry was identified as a key influence on increasing gas security. The development of coal seam gas deposits was expected to add significantly to Australia's gas reserves and improve the diversity of gas supply in the east.

The 2009 NESA acknowledged natural gas reserves offshore of Western Australia as a positive influence on gas security. However, the 2009 NESA identified the combination of the immaturity of market arrangements, large geographic distances, high capital costs of gas supply infrastructure, and a relatively small domestic market as challenges to gas security in Western Australia.

Adequacy

The adequacy of gas supplies across Australia in 2009 was assessed as ***moderate***, with the Western Australian market assessed as ***low***. The slowing domestic economic growth at the time had not eased the tight supply–demand balance, and investment in supply-side infrastructure was considered overdue.

The 2009 NESA assessed adequacy as remaining at ***moderate*** to 2023. Significant reserves were expected in all gas markets. Production and transmission capacity were expected to remain tight, with easing to occur late in the assessment period as investment was expected to outstrip demand growth.

Reliability

The 2009 NESA assessed the reliability of gas supplies across Australia as ***moderate*** due to tight supply chain conditions in the east and west. Investment in production and transmission infrastructure occurring at the time was a positive factor in the assessment. However, the potential for a significant increase in gas demand before the additional infrastructure was commissioned was identified as a risk that could shift the rating from moderate to ***low***.

The 2009 NESA assessed reliability as remaining at ***moderate*** in 2013 and 2018. The 2009 NESA anticipated that the market would respond to the tightening supply–demand balance with investment in infrastructure. The rating increased to ***high*** in 2023, due to an expected easing of the supply–demand balance, improved supply infrastructure, and the development of a mature national gas market.

Affordability

The affordability of gas was rated as ***high*** leading into the 2009 NESA. Even though there was volatility in spot prices, the majority of Australia's demand was being met by long-term contracts with moderate prices.

The affordability rating was expected to decrease to ***moderate*** by 2013 (short term), and ***low*** in 2018 and 2023 due to tighter supply conditions, and competition between domestic gas and international LNG markets leading to price rises.

Adequacy

Short term: Short term adequacy is assessed as ***moderate***, with gas reserves in all markets sufficient to meet demand. The significant development of coal seam gas has had a positive effect on gas security, but challenges in gas extraction and tightness in the supply–demand balance contribute to a moderate rating.

Australia has significant conventional and unconventional gas resources. Most (around 92 per cent) of conventional gas is located off the north-west coast of Australia, while significant coal seam gas resources exist in the major coal basins of eastern Australia.[1] These coal seam gas reserves have increased by more than four times 2008 levels, reflecting the rapid growth of the industry since the 2009 NESA.[2]

Gas production is currently meeting demand in the eastern domestic market. The market's gas production capacity has increased in recent years, mostly due to the production of coal seam gas. In the short term, gas production rates in the eastern market are expected to remain stable, with a decrease in conventional gas production compensated for by an increase in coal seam gas production.[3] Over the next few years, it is expected that ramp gas[4] will continue to be produced in the lead up to the start of LNG production from coal seam gas. Some of this gas will be available to the domestic market, maintaining or improving adequacy in the short term.

The western domestic market faces the risk of supply shortfalls due to ongoing production capacity constraints. This situation has been exacerbated by market participants being unable to agree on commercial terms for gas contracts. In response to higher prices, a number of gas projects focused on the domestic market are coming on line in the short term. For example, the Devil Creek domestic gas plant which sources gas from the Reindeer Field commenced production in December 2011. Importantly, Devil Creek will provide a third injection point into the WA gas market. The Macedon project is also expected to provide additional capacity in the short term.

In the northern domestic market, adequacy of supply has been enhanced following the commencement of gas production from the Blacktip gas field in September 2009. This has allowed the gas market to meet the full demand of gas users that were previously forced to use alternative fuels due to gas supply constraints.[5] It is expected that supply will meet demand in the short term.

Demand for gas is expected to continue to increase in the eastern domestic market. The growth is expected to be driven by an increase in gas-fired electricity generation. However, the demand for gas-fired electricity generation is dependent on the actual observed impact of the Australian Government's carbon pricing mechanism, future gas prices and the development of other electricity generation technologies.

Demand for gas for residential and commercial use is currently expected to remain fairly flat over the short term. If the demand for gas-fired electricity generation grows rapidly in the short term, the supply–demand balance will be tight during periods of peak demand.

In the western domestic market, significant demand growth is evident largely due to the resources sector. While any supply shortages are not likely to be caused by a lack of accessible reserves,[6] departmental analysis has suggested that due to strong demand growth in the mining sector there may be difficulty in meeting demand at current prices in the short term before all of the supply that has been sanctioned (as a market response to higher prices and domestic gas supply obligations from LNG projects) comes online.

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1 Geoscience Australia, ABARES, *Australian energy resource assessment*, Commonwealth of Australia, Canberra, 2010, p. 83.

2 EnergyQuest, E*nergyQuarterly May 2011 report*, EnergyQuest, Adelaide, 2011, p. 31; and, EnergyQuest, E*nergyQuarterly May 2008 report*, EnergyQuest, Adelaide, 2011, p. 28.

3 AEMO, *2011 Gas Statement of Opportunities for Eastern and South Eastern Australia*, AEMO, Melbourne, November 2011.

4 Ramp gas is the unavoidable gas produced by LNG project coal seam gas wells before LNG plant start-up, owing to the difficulty of shutting in coal seam gas production.

5 Australian Energy Regulator, *Draft Decision: N.T. Gas access arrangement proposal for the Amadeus Gas Pipeline*, Australian Energy Regulator, Commonwealth of Australia, Canberra, 2011, p. 144.

6 Parliament of Western Australia, *Inquiry into domestic gas prices*, Economics and Industry Standing Committee, Legislative Assembly, Parliament of Western Australia, Perth, 2011, p. 35.

The adequacy of gas in the western domestic market is expected to be improved by market mechanisms to increase the level of gas market information and transparency. The WA Government recently announced plans to implement a Gas Statement of Opportunities and Gas Bulletin Board similar to those in the eastern market. This would facilitate a more competitive and efficient market, and provide a positive influence on adequacy.

Currently in the northern domestic market, gas is predominantly used for electricity generation, and this is not expected to change. Demand growth is expected due to growth in electricity demand, although the growth rate is expected to be slower than historical rates following the installation of electricity generation units with improved efficiencies.[7]

The eastern market faces some broader and significant challenges associated with extracting sufficient gas to meet demand. These challenges include gaining access to the required equipment and recruiting skilled labour to develop the infrastructure in time. The environmental impact of coal seam gas extraction and tensions with land users continue to be sensitive issues. The Australian Government has recently announced the introduction of a new framework, which includes an Independent Expert Scientific Committee, with the view to providing greater confidence that coal seam gas projects will be subject to rigorous and objective scientific assessment.

Coal seam gas is already an important part of the eastern market's gas supply, and it is expected to play a greater role in the future. If measures are implemented that restrict the development of the industry or the areas in which coal seam gas resources can be exploited, this would reduce the availability of gas resources and have a negative effect on adequacy.

Extreme weather events could also impact on the ability to extract gas. This was witnessed during the flooding of the Cooper Basin in 2010, and during the Queensland floods in 2011, when production was affected.

There is a risk that gas adequacy in the short term will become ***low*** if these challenges are not overcome.

Medium term: Medium term adequacy is assessed as ***moderate***.

While the eastern domestic market will face competition for gas from LNG export customers, it is expected that there will continue to be adequate reserves to support both domestic and international markets, although challenges to achieving the required gas extraction levels faced in the short term will remain in the medium term. Equally, higher demand in the western market is expected to be met by new projects.

In the medium term, Australia's gas reserves are expected to be sufficient to support projected increases in domestic and export demand. Gas reserves overall in the eastern market are expected to increase due to projected increases in coal seam gas reserves in Queensland and New South Wales, driven by LNG export and demand for gas-fired electricity generation. This is despite an eventual decline in reserves in Victoria and South Australia.[8] In the western and northern markets, reserves will continue to be dominated by conventional gas.[9]

As in the short term, there are risks to maintaining the required gas production levels due to potential issues relating to skills shortages, accessing required equipment, and environmental impact.

It is expected that LNG export from the east coast will commence in the medium term. The LNG export demand will be met by new facilities dedicated to LNG production. This could introduce competitive tension between the supply of gas for domestic use and for export.

In recognition of this, the Queensland Government has introduced an annual review of the gas market in Queensland, and put in place arrangements to implement the Prospective Gas Production Land Reserve policy if gas security issues are identified. This policy, if implemented, would allow for gas production from future exploration tenure releases in Queensland to be sold into the domestic market only.

7 Australian Energy Regulator, *Draft Decision: N.T. Gas access arrangement proposal for the Amadeus Gas Pipeline*, 2011, p. 135.

8 AEMO, *2011 Gas Statement of Opportunities for Eastern and South Eastern Australia*, November 2011.

9 Geoscience Australia, ABARES, *Australian energy resource assessment*, 2010, p. 120.

Domestically, it is expected that the demand for gas-fired electricity generation will continue to increase in the eastern market. This is in response to the introduction of a carbon price and the associated replacement of coal-fired electricity generation with gas-fired electricity generation, including through the Contract for Closure announced as part of the Clean Energy Future package. However, uncertainty surrounding gas prices in the medium term will have a direct influence on the demand for gas and associated generation in the electricity sector.

Based on existing and currently committed infrastructure, it is expected that in the medium term the supply–demand balance in the domestic market will tighten further.[10] With the demand growth of gas-fired electricity generation being uncertain, there is a risk that additional supply may not be sufficient to meet forecast demand. This could impede or delay new developments requiring a significant supply of gas until additional gas supply is confirmed, and the adequacy rating for the eastern market could become ***low*** if this were to eventuate.

Gas to the domestic market has traditionally been sold under long-term contracts, but many existing contracts in the eastern market are due to expire in the medium term.

Industry consultations revealed that negotiations currently underway for new domestic gas contracts have been difficult, with both gas producers and customers uncertain about future gas demand and prices. If there is a delay in the successful negotiation of future domestic gas contracts, this could impact the timely development of reserves and infrastructure and influence the future supply–demand balance. A shift away from the traditional long-term gas contracts could introduce investment uncertainty for both gas producers and customers, and be a negative influence on gas security.

While supply remains tight in the western market, it is expected that increases in production will lead to an improvement on the short-term situation. These committed increases in domestic supply are in a response to higher prices and obligations of LNG exporters to provide a proportion of gas to the domestic market under a state agreement or Western Australia's domestic gas reservation policy of 15 per cent of total production. Under its state agreement, the Gorgon LNG project will provide 150 terajoules (TJ) per day of domestic gas from 2015 (a contract has recently been signed between Chevron and Verve Energy for the supply of 125 TJ per day over a 20 year period), expected to increase to 300 TJ per day from 2021. In addition, the recently sanctioned Wheatstone LNG project will provide gas to the western domestic market – current reports estimate the quantity at 200 TJ per day from around 2016.

Other prospective sources of domestic gas from LNG projects include Pluto and Scarborough. If these projects progress, additional domestic supply could be available in the medium term.

Where demand is sufficient and commercial terms can be agreed, the western market supply situation could also be improved further if small to medium-sized gas fields held under retention leases are developed.[11]

In the northern market, domestic demand will continue to be primarily from the electricity generation sector, with demand met by gas produced from the Blacktip gas field.

Long term: Long term adequacy is assessed as ***moderate*** as reserves continue to be developed, and investment in gas production and transmission infrastructure occurs to meet demand.

Australia has significant levels of both conventional and unconventional gas resources. While some of these resources, in particular shale gas and tight gas, are not currently considered to be commercially recoverable due to a greater degree of difficulty to access, it is expected that future market conditions and technological advances will be favourable for the exploitation of these resources.

Unconventional gas is likely to have an increased role in the gas market. However, successful development of these resources will depend on Australia's ability to access the professional skills, materials, equipment and technology required, and to resolve any environmental sensitivities arising from these developments.

10 AEMO, *2011 Gas Statement of Opportunities for Eastern and South Eastern Australia*, November 2011.

11 WA Office of Energy, *NESA a Regional Perspective*, Government of WA, Perth, 2009, p. 5, accessed at http://www.energy.wa.gov.au/cproot/1584/2/GSEMC%20Response%20to%20NESA.pdf

Currently there is a high level of exploration activity occurring in conventional gas, coal seam gas and shale gas across all Australian gas markets. Although some of this exploration activity is still in the early stages, it is expected to lead to a significant increase in reserves in the long term.[12]

Australian gas production is projected to grow significantly in the long term driven by LNG exports, which could potentially account for around 70 per cent of total production by 2035.[13]

Domestic gas consumption is projected to continue rising. In the eastern and northern markets, demand growth for gas for the electricity generation sector is expected to continue through to the long term,[14] although the extent of the growth will depend on the price of gas and alternative electricity generation technology choices.

While the continued growth in gas consumption for electricity generation also applies to Western Australia, the large share of mining in the state's economy and relatively high global demand for Australia's resources exports will be the important drivers of increases in its gas consumption.

Recent analysis of committed and existing production facilities in Western Australia suggests that beyond 2020, production from a number of known gas fields begins to decline, and the ability to meet future gas demand will depend on the rate at which new gas fields are discovered and developed.[15]

Nationwide, gas supply will need to continue to meet both domestic and export demand. If market reforms in the eastern and western markets are successful, it is expected that investment will occur in response to the rising demand from both the domestic and international markets.

However, if investment is unable to keep pace with eventual demand growth, there is a risk that supply will not be adequate to meet demand in the long term. If this risk materialises, the rating for adequacy could fall to ***low***.

Reliability

Short term: The reliability of the gas sector is assessed as ***moderate***, given that tight supply chain conditions in the eastern and western markets continue to put pressure on reliability.

Reliability in the eastern market is enhanced by the diversity of gas supplies available; however, the western market is heavily reliant on a small number of supply sources, although the situation is expected to improve within the short term.

The eastern gas market is supplied by multiple gas fields and gas production plants that are integrated with a transmission pipeline network. The network provides extensive interconnection of major demand centres in the eastern market, and most major markets are supplied by more than one pipeline. This mitigates against short-term reliability issues caused by a loss of a supply source or issues on the transmission network.

Since 2008, there have been a number of projects for new gas transmission pipelines, or looping and capacity increases to existing transmission pipelines. Most notable is the QSN (Queensland – South Australia – New South Wales) Link that was commissioned in May 2009, creating a link between Queensland and the south-eastern states. This has improved the reliability of the gas sector. However, Tasmania remains vulnerable to gas supply issues since it is served by a single gas pipeline.

In the short term, the anticipated growth in demand for gas for electricity generation in the eastern market is expected to put pressure on gas processing and transmission pipeline infrastructure during periods of peak demand.

12 Geoscience Australia, ABARES, *Australian energy resource assessment*, 2010, pp. 83–130.

13 BREE, *Australian energy projections to 2034-35*, BREE, Canberra, December 2011, pp. 52–53.

14 BREE, *Australian energy projections to 2034-35*, December 2011, p. 34.

15 WA Office of Energy, *Strategic Energy Initiative Directions Paper*, Government of WA, Perth, 2011, p. 21.

There are currently plans for pipeline expansion projects (such as expansion of the South West Queensland Pipeline and Moomba to Sydney Pipeline), and for additional interconnection between Queensland and New South Wales with the Queensland–Hunter Gas Pipeline.[16]

However, a delay in the implementation of these projects could result in demand not being met, and the assessment for reliability in the short term could become ***low***.

The supply chain is also tight in the western market, with very little spare capacity on regulated pipelines despite significant investment and upgrades.[17] This makes the western market more vulnerable to supply failures, particularly at times of peak demand.

Systems with a small number of injection points, such as the Dampier to Bunbury Natural Gas Pipeline, are more susceptible to single-point failures, particularly where demand centres become increasingly dependent on gas supply via a primary transmission pipeline.

Significant investment in looping and capacity increases has recently occurred with regard to the Dampier to Bunbury pipeline, which has resulted in improvements to the Western Australian gas transmission system's reliability.

Since the 2009 NESA, the recent stage 5B construction on the pipeline has boosted capacity to 900 TJ per day and stage 5C will add a further 100 TJ per day. In addition, it is also noted that new connections to the pipeline such as Devil Creek will improve supply-point diversity.

While these new investments are having a positive impact on short-term reliability, the western gas market remains vulnerable to potentially severe disruption if there is a failure in any link in the supply chain.

In the northern market, while more than 90 per cent of the domestic gas supply is provided by Blacktip, reliability is provided by a backup gas supply available by pipeline from the Darwin LNG plant.

The eastern and western markets have a number of gas storage sites that can assist in the management of supply disruptions, adding to the overall reliability of gas, but the capacity of gas storage available and total gas withdrawal rates have not changed significantly since 2008.[18]

In the eastern market, there are plans to develop additional underground gas storage facilities to assist in the management of ramp gas for LNG production from coal seam gas, and to meet gas demand during peak periods. There are also plans for a new LNG storage facility in Newcastle.[19] In the western market, there are plans to expand the Mondarra underground gas storage facility by five times its current level to 15 PJ (petajoules), which will contribute to system resilience as a whole[20] The development of these facilities within the short term would provide a positive influence on gas security.

Reforms in the eastern gas market led to the introduction of a Short Term Trading Market and associated contingency gas mechanism in 2010. However, it is still too early to assess the impact this has had on reliability. While the availability of the contingency gas mechanism provides the market with an alternative to involuntary curtailment of gas usage, it is still untested in the market.

Medium term: The reliability of the gas sector is assessed as continuing to be ***moderate*** in the medium term.

Reliability of gas supply in the eastern market will be enhanced by the maturing of the gas market arrangements. However, the effects of the uncertainty regarding the future demand for gas for electricity generation could be observed to flow through to the medium term if investment in the interim does not keep pace with demand growth.

16 ABARES, *ABARES Minerals and energy: major development projects – April 2011 listing*, Commonwealth of Australia, Canberra, 2011, p. 13.

17 Parliament of Western Australia, *Inquiry into domestic gas prices*, 2011, p. 130.

18 EnergyQuest, E*nergyQuarterly (editions from February 2008 to May 2011),* Adelaide, 2008-2011.

19 Core Energy Group, *2011 Energy Outlook - Part 3, The eastern Australian Gas Market,* Core Energy Group, Adelaide, 2011, p. 53 and Attachment 1.

20 WA Office of Energy, *NESA Submission*, Government of WA, Perth, June 2011.

In the western market, investment in infrastructure made in the short term will continue to be a positive influence on reliability in the medium term, although the supply situation is expected to remain tight.[21]

Following the national gas market reforms implemented in recent years, the eastern gas market arrangements will be more mature and established in the medium term. Market participants will have increased confidence in the market arrangements and have gained the experience required to better respond to and manage possible supply issues with minimal disruptions to customers.

The availability of market information will have created better signals for the daily trading of gas to meet demand, and for the market to deliver the timely investment required to meet demand.

Further development of new gas pipeline transmission infrastructure to deliver coal seam gas sources from Queensland and New South Wales to the domestic gas market are expected to improve reliability. Proposed developments include a pipeline from New South Wales to south-east Queensland,[22] which would provide Brisbane with an alternative gas supply.

The current implications of a single gas supply arrangement into Brisbane are examined in the shock scenario at the end of this chapter (see Box 3.3).

In addition, it is expected that infrastructure to deliver gas to the proposed east coast LNG facilities will become available in the medium term. Although these pipelines will primarily be used to supply the LNG facilities, the existence of such infrastructure still provides a positive influence on domestic reliability.

Even though it is expected that demand for gas for electricity generation will grow, there is uncertainty regarding how this demand will develop in the medium term as the sector responds to the implementation of a carbon price, future gas prices and the availability of other electricity generation technologies.

This, combined with ageing gas production and transmission infrastructure, means that pressures on system reliability will remain. The moderate rating for reliability for the gas sector is dependent on investment in gas infrastructure keeping pace with demand.

In the western market, investment in new connection points, supply sources, and gas storage facilities made earlier in the decade will have improved reliability. Despite these improvements, the supply situation will remain tight – for example, the Dampier to Bunbury Natural Gas Pipeline is fully contracted to 2019.[23]

As identified in the 2009 NESA, timely investment in new capacity in response to transparent market signals will be a crucial determinant in the outlook for the supply–demand balance for Western Australia.

The Western Australian Government has taken steps to implement reforms already seen in eastern Australia, and is considering adopting further market reforms, including the implementation of a Short Term Trading Market.[24]

The successful implementation in the medium term of market reforms that improve the transparency of market signals and promote sufficient integration of gas transmission into an effective market arrangement will assist pipeline users to efficiently contract for gas and transmission capacity. This will help mitigate the risk of the assessment for reliability falling to ***low***. A shift away from traditional long-term gas contracts could introduce investment uncertainty, and be a negative influence on reliability.

21 Parliament of Western Australia, *Inquiry into domestic gas prices*, p. 35.

22 ABARES, *ABARES Minerals and energy: major development projects – April 2011 listing*, p. 10.

23 Parliament of Western Australia, *Inquiry into domestic gas prices*, Perth, 2011, pp. 89, 131.

24 WA Office of Energy, *Strategic Energy Initiative Directions Paper*, 2011, p. 36, 54.

Long term: Reliability in the long term is assessed as ***high***.

Future improvements in gas market development and investment in infrastructure that have been signalled to occur nationally are expected to improve reliability in the long term.

The demand uncertainty faced by the eastern market in the short and medium terms in relation to carbon policy transition, coal seam gas development and east coast LNG market development is expected to ease in the long term, and the market will have had the opportunity to respond to any increase in demand with new investment. It is expected that timely investment will be assisted by further maturity of the gas market, and the pricing signals provided by market fundamentals.

Gas market reforms being implemented over the short and medium terms in the western market will have improved the transparency of short-term price signals, so that capacity to manage short-term supply constraints associated with infrastructure disruption will be sufficiently developed. However, infrastructure resilience will continue to be influenced by relatively low supply point diversity and a continued reliance on key pipeline and processing facilities.

The WA Government has plans to examine this issue in a study of the comparative costs of alternative supply points for the long-term delivery of gas into the south-west of the state from local, national and international sources.[25] Undertaking such a study indicates government intent to secure long-term energy and improve long-term reliability.

Overall, the high rating is dependent to a degree on investment to adequately maintain existing gas infrastructure. If there is insufficient investment and issues with ageing infrastructure emerge, the rating could become ***moderate***.

Competitiveness

Short term: There are differences in price trends in the eastern and western markets, but overall the assessment for competitiveness is ***moderate***.

Competitiveness in the short term in terms of accessing gas at a price that does not disadvantage the economy has been assessed as ***high*** in the eastern market as prices are fixed in long-term contracts. Competitiveness in the western market has been assessed as ***moderate***, as gas prices in new contracts have increased significantly since the 2009 NESA when affordability was assessed as high.

It is difficult to establish current gas prices with certainty due to the confidential nature of gas contracts. Evidence suggests that since 2008, domestic gas prices in the eastern market have been relatively stable at around $2 per gigajoule (GJ) to $4 per GJ.[26] This price stability is due to the majority of gas in the eastern market currently being sold under long-term wholesale contracts to gas retailers and major gas users, with limited opportunity for price increases.

This trend is expected to continue in the short term. While there have been reports of new long-term contracts in excess of $5 per GJ in the eastern market[27], the majority of gas contracts are in place until 2015. The long-term gas contracts currently in place in the eastern market have been a positive influence on competitiveness because they have provided gas producers with the certainty to invest in new gas developments and bring supply to the market.

The availability of moderate volumes LNG-related ramp gas over the next few years is likely to make some cheaper gas available to the eastern market over the short term. However, this is not expected to have a long-term effect on competitiveness.

In the western market, prices have increased since the 2009 NESA. There have been indications that the average price of all wholesale domestic gas contracts in 2009–10 was around $3.70 per GJ, while prices for new wholesale domestic gas contracts are in the range of $5.55 to $9.25 per GJ.[28]

25 WA Office of Energy, *Strategic Energy Initiative Directions Paper*, 2011, p. 36.

26 EnergyQuest, E*nergyQuarterly (editions from February 2008 to November 2011),* Adelaide, 2008-2011.

27 EnergyQuest, E*nergyQuarterly November 2011,* 2011.

28 Wood Mackenzie, The cost of supplying Western Australia's domestic gas market, *Upstream Insight – Asia Pacific*, December 2010, p. 1 (cited in Parliament of Western Australia, *Inquiry into domestic gas prices*, 2011, p. 51).

Western Australia's market conditions also continue to play a part – including the need for project economies of scale leading to lumpy investment, market structure (which is less liquid, transparent and competitive than in the eastern markets) and the gas reservation and retention lease policies.

The WA Inquiry into domestic gas prices noted that for several decades there appears to have been an oversupply of gas in the western domestic market. This is attributed to the agreement underpinning the original development of the North West Shelf gas project, whereby the joint venture was to supply more than 5000 PJ to the local market over a minimum 20-year period. In return, the government-owned State Energy Commission of Western Australia purchased a substantial proportion of this gas. Local buyers are now confronted with higher prices as contracts from this legacy period approach maturity at a time when demand, driven by unprecedented growth from the resources sector, is extremely strong.[29]

As shown in Table 3.3, gas prices in the eastern market are currently low by international standards, which assists in maintaining the competitiveness of the Australian economy. However, in the western market the higher gas price under new contracts has introduced a risk that some downstream projects may be challenged in sourcing gas at prices that maintain their viability.

Table 3.3: International and Australian gas prices, September quarter 2011

Region	Price ($A/GJ)
Eastern Australia, domestic gas price	2.98 to 3.85
Eastern Australia, domestic gas price (new contracts)	5.00+
Western Australia, domestic gas price	1.42 to 3.87
Western Australia, domestic gas price (new contracts)	7.00 to 8.00+
United States, Henry Hub spot price	3.71
China, average landed import price	8.56
Russian Federation, average gas export price	8.35
United Kingdom, average landed import price	7.60
United Kingdom, system average price	7.81
Australia, LNG exports free-on-board	11.37
Taiwan, average landed import price	12.76
South Korea, average landed import price	12.37
Japan, average landed import price	14.79

Source: EnergyQuest, *EnergyQuarterly*, November 2011.

The western market is responding to higher prices with new supply scheduled to come on-stream, such as Macedon. As mentioned earlier in this chapter, the committed Gorgon LNG and Wheatstone LNG projects have a requirement to provide 15 per cent of production to the domestic market that is expected to commence in the medium term. Other prospective sources of LNG include Pluto and Scarborough.

In addition, considerable new exploration activity is occurring for unconventional supply sources such as shale gas and tight gas. If these activities are successful, the increased supply of gas may limit future increases in gas prices. Nonetheless, the lack of transparency and relatively small number of participants in the wholesale gas market in Western Australia is an impediment to competitiveness.

The gas spot price in the eastern market is not considered to be a significant influence on competitiveness in the short term. While there is some price volatility in the gas traded on the Victorian spot market and the Short Term Trading

29 Parliament of Western Australia, *Inquiry into domestic gas prices*, 2011, p. xvii.

Market hubs in Sydney and Adelaide, spot prices are generally below the price of gas traded under long-term contracts.[30] Furthermore, the volumes traded are small compared with gas traded under long-term contracts.

The implementation of a price on carbon in the short term is likely to increase domestic gas production costs, with these cost increases passed through to gas users. This could reduce the competitiveness of the Australian LNG sector in some markets where competitors are from other gas-producing countries that do not apply a price on carbon. The Australian Government has indicated it will provide support for the Australian LNG sector through its Jobs and Competitiveness Program.

Medium term: Competitiveness is assessed as ***moderate*** in the medium term, with the eastern and western markets continuing to exhibit different upward price trends.

Upward pressures on prices are expected to emerge in the eastern market. In the western market, new supply sources in response to higher gas prices will ease the pressure on prices.

In the eastern market, a number of factors putting upward pressure on domestic gas prices are expected to emerge in the medium term. An important influence is the beginning of export of LNG from the east coast. Australian LNG export prices historically have been linked to oil prices, making the LNG netback price – the equivalent Australian gas price received by gas producers after adjusting for costs of liquefaction and freight – significantly higher than domestic gas prices.[31]

With the emergence of the east coast LNG export industry, it is expected that gas producers will seek to monetise their gas at the higher prices that can be achieved in the LNG export industry. While it is not expected that domestic gas prices will reach parity with LNG export prices within the medium term, domestic gas prices are projected to trend higher.

In the western market where the LNG export market is already established, linkages between LNG export and domestic supply infrastructure are expected to increase as economies of scale are needed to maintain competitive gas production prices. This could strengthen the relationship between domestic and LNG netback prices, resulting in continued upward pressure on domestic gas prices.

In the wake of the incident at Japan's Fukushima nuclear power plant in 2011, there may be a greater global trend towards gas-fired electricity generation over nuclear emerging in the medium term. This could increase the demand for global LNG and Australian exports, and support the development of additional LNG projects. However, this may put further upward pressure on domestic gas prices.

A significant number of long-term domestic gas contracts in the eastern market are due to expire in the medium term.[32] There has been anecdotal evidence through stakeholder consultations that gas producers are seeking to link gas prices with oil prices in new domestic contracts. This is another factor that will act to increase domestic gas prices in the medium term.

The implementation of a carbon price is likely to put additional upward pressure on domestic gas prices as a reflection of higher gas production costs and greater demand for gas as the electricity generation sector transitions from coal to gas as a fuel for baseload generation.

Future gas supplies are likely to come from sources that are more difficult and therefore costlier to extract and produce.[33] This, combined with rising labour, equipment and raw material costs, is also likely to result in higher gas prices in all markets.

30 Core Energy Group, *2011 Energy Outlook - Part 3, The eastern Australian Gas Market,* Core Energy Group, Adelaide, 2011.

31 EnergyQuest, *Australia's natural gas markets: connecting with the world*, EnergyQuest, Adelaide, 2009.

32 Core Energy Group, *2011 Energy Outlook - Part 3, The eastern Australian Gas Market,* 2011.

33 Core Energy Group, *2011 Energy Outlook - Part 3, The eastern Australian Gas Market,* 2011, p. 58.

In the eastern market, price increases will be moderated by the diversity of gas supply options and the level of competition in the eastern market. It is also expected that producers of coal seam gas supplying LNG producers will maintain excess production capacity to ensure reliability of supply to their customers.

Although not a guaranteed supply source, it is likely that the excess gas will be available on the spot market, increasing trading options for producers and consumers. This additional trading activity will provide greater pricing and market transparency, which will help drive the maturity of the domestic gas market and support further investment. It is expected that market reforms currently in progress will have provided the market with sufficient capability to facilitate the increased trading activity.

In the western market, price increases will be moderated by the new domestic production capacity that is expected to come on-stream in the medium term as a part of a supply-side response to higher prices.

In addition, significant supply will become available from LNG projects that will also supply gas to the domestic market under a WA Government state agreement or its reservation policy. For example, 150 TJ per day of gas from the Gorgon LNG project is expected to become available to the domestic market from 2015 (a contract has recently been signed between Chevron and Verve Energy for the supply of 125 TJ per day over a 20 year period).

Another issue that will impact on the medium-term competitiveness of gas in Western Australia will be the extent to which the market has matured. The WA Government has recently confirmed its commitment to implementing market reforms aimed at providing greater transparency of relevant gas market information. These include a Gas Statement of Opportunities and Gas Market Bulletin Board for the western market.[34] If implemented successfully, these reforms would facilitate efficiently timed and sized investment in the gas sector and curb price increases.

In addition, the establishment of a western short term trading market is currently under consideration. This would likely provide the short term price signals associated with peak demand. Such signals facilitate demand response and may provide consideration of commercial storage facilities that will prevent future price spikes.

Long term: Competitiveness is assessed as ***moderate*** in the long term, influenced primarily by the LNG export industry. However, it is expected that international price increases will be constrained through greater competition from international gas suppliers.

In the long term, domestic gas prices in the eastern market are expected to be higher than historical levels. The east coast LNG export industry will continue to influence domestic gas prices, and the extraction of gas from higher-cost developments (including unconventional gas sources) will cause prices to remain on an upward trend.

However, increases in global supply on the international market from non-traditional exporters are anticipated to put downward pressure on gas prices. China, currently a major customer for Australian LNG producers, has signalled its intention to develop unconventional gas resources within China.[35] This is expected to decrease China's LNG import dependency and impact the gas market in the long term.

Production of shale gas from the United States is expected to grow over the long term, adding further gas supplies to the market and softening prices. This development is a part of changing market dynamics outlined in Box 3.2 below. LNG export projects have been proposed in the United States, although currently it is not certain that they will proceed.[36]

In addition, if exploration ventures for further conventional and unconventional gas sources within Australia are successful, the potential increase in supply would also moderate future price increases.

If the gas market reforms outlined in the medium term are implemented effectively, investment timing and size will more accurately reflect demand conditions in the long term and volatility in gas prices will be reduced. However, if global gas supply does not develop as expected, price rises could be higher and the rating for competitiveness could become ***low***.

34 P Collier, *State Government announces key projects to boost energy security*, WA Liberal, 2011, accessed at: http://www.wa.liberal.org.au/item/5785

35 F.Biro et al, *Are we entering a golden age of gas? World energy outlook 2011 special report* International Energy Agency, Paris, 2011.

36 U.S. Energy Information Administration, *Annual energy outlook 2011 with projections to 2035*, Office of Integrated and International Energy Analysis, Washington DC, 2011.

Box 3.2: Changing market dynamics in the United States

In the United States, gas prices at the Henry Hub have fluctuated significantly over the past decade. In 2011, monthly prices have ranged from US$3.76 to US$4.25 per GJ. This compares with prices that in 2008 climbed to US$12.03 per GJ and in 2009 reached a low of US$2.85 per GJ. The recent price movements can be attributed to both low US economic growth reducing demand and to the major increase in supply from the successful production of unconventional gas from shale. This development has completely changed the dynamics of the gas market and has potentially moved the United States from an LNG importer to exporter. Evidence of this shift is seen in the US Department of Energy's recent authorisation for Cheniere Energy to export LNG from its Sabine Pass terminal and the observation that all planned LNG facilities in the United States are now two-way in design.

Box 3.3: Natural gas shock scenario

The natural gas shock scenario is a hypothetical reduction in the capacity of the Roma to Brisbane Pipeline (RBP), which transports gas from the Wallumbilla gas hub in Queensland to gas users in south-east Queensland, including Toowoomba and Brisbane.

It is important to note that the RBP has features that were designed to prevent and mitigate against loss of pipeline capacity. These features make it unlikely that the RBP will experience a significant reduction in capacity. Historically, pipeline incidents in Australia are rare, and have not been the cause of any major gas supply incidents in Australia to date. This scenario therefore is designed to outline the dynamics of an energy system under stress, not to assess the vulnerability of an element of that system. However, hypothetical reductions in capacity have been modelled to test the broader impacts on the gas and electricity markets, and the system's ability to respond to a range of disruptions, including extreme events.

While a specific piece of infrastructure, in this case the RBP, was used to provide 'real world' information, it is neither a reflection on the infrastructure's redundancy and/or mitigation plans that exist to prevent a loss of capacity, nor a reflection on the reliability of the infrastructure or current and future Australian Government energy policies.

This shock scenario is defined to result in a temporary outage of the RBP of 14 days' duration. The temporary outage includes three cases:

- a 10 per cent reduction in transport capacity on the RBP
- a 50 per cent reduction in transport capacity on the RBP
- a complete loss of transport capacity on the RBP.

For each of the three cases the outage is defined to occur at a number of different periods:

- a peak period in 2011–12 and a shoulder period in 2011–12
- a peak period in 2015–16 and a shoulder period in 2015–16.

Each of these interruptions is assumed to be an immediate reduction in capacity in keeping with the intention of modelling a 'shock' to the gas sector and is assumed to affect the entire pipeline equally.

For a temporary interruption to the RBP, no investment response would be expected. The key question is the extent to which existing gas producers and pipelines can respond to the interruption to the RBP, and the impact that the interruption has on gas market outcomes in south-east Queensland.

Due to the presence of gas-powered generation in south-east Queensland, interruptions to the gas supply to south-east Queensland are also likely to have implications for the electricity market.

Modelling framework

In examining outcomes from the natural gas shock scenario, Frontier Economics adopted a three-stage modelling approach, which made use of three interrelated electricity and gas market models: WHIRLYGIG, SPARK and WHIRLYGAS.

Both WHIRLYGIG and SPARK incorporate a representation of the physical infrastructure in the National Electricity Market (NEM) that includes all existing generation plant in the NEM (including technical and cost information for the existing plant), all existing interregional interconnectors in the NEM, demand forecasts for each region in the NEM and options for new generation plant.

WHIRLYGAS incorporates a representation of the physical gas infrastructure in the eastern states that includes all existing production plant, all existing transmission pipelines, demand forecasts for each region and options for new plant and pipelines.

Modelling assumptions

Peak demand days on the RBP are driven primarily by demand from gas-powered generation. Gas demand forecasts from the 2010 Gas Statement of Opportunities indicate that this will become more evident over the next decade, with peak demand days driven primarily by gas demand from gas-powered generation.

The implication of this is that peak daily demand on the RBP is driven by, and will coincide with, peak daily electricity demand. As such, the peak gas and electricity interruptions were assumed to occur for the same two weeks. This assumption was also adopted for the shoulder months of the year.

Analysis

Broadly speaking, irrespective of the timing of the interruption (peak or shoulder) or the year of the interruption (2011–2012 or 2015–16), the analysis indicates that the following outcomes are likely to occur on the RBP:

- A 10 per cent loss of RBP capacity will result in relatively modest curtailment of some gas-fired electricity generators that draw gas from the RBP. Other customers will be largely unaffected.
- A 50 per cent loss of RBP capacity will result in complete curtailment of all gas-fired generators that draw gas from the RBP as well as significant curtailment of other large customers. Smaller business and residential customers on the Allgas and Envestra distribution networks are not likely to be affected.
- A complete loss of transport capacity on the RBP will impact all customers drawing gas from the pipeline, but there are unlikely to be significant impacts on the broader eastern Australian gas and electricity markets. There are no issues for security of electricity supply caused by the curtailment of gas supplies on the RBP, and the overall impact on electricity prices is relatively muted (with the exception of the peak demand day in summer).

Since Brisbane is supplied with gas only through the RBP there are few options available to manage the effects of a supply interruption on the RBP.

Realistically, any significant reduction in capacity on the RBP will result in either voluntary or involuntary curtailment of gas load.

Voluntary curtailment will be facilitated through the recently established Short Term Trading Market in Brisbane. This will provide an opportunity for voluntary gas curtailment by those gas users who can curtail gas at least cost.

It is possible that gas-fired generators will offer to voluntarily curtail through the Short Term Trading Market, which would provide an opportunity to manage relatively significant reductions in capacity on the RBP without affecting most gas customers.

In the longer term, security of gas supply to gas users along the RBP will only be significantly improved through further investment in infrastructure: either gas storage or a second gas pipeline.

There is at least one proposal for a second gas pipeline to supply gas users in and around Brisbane – from gas fields in northern New South Wales – but so far no investment decision has been made.

While the consequences of a supply interruption to the RBP will be significant for customers drawing gas from the RBP, the analysis indicates that there are unlikely to be any significant consequences for other markets.

This is not to suggest, however, that all individual gas production facilities in the Bowen and Surat basins are equally able to manage an interruption to the RBP.

In particular, coal seam gas production plants that do not have direct pipeline connections to the Wallumbilla hub – including Berwyndale South, Daandine, Kogan North, Peat, Scotia, Talinga and Tipton West – will not have the same ability to continue supplying gas through the Queensland Gas Pipeline and the South-West Queensland Pipeline that are available to other coal seam gas production plant.

The analysis also indicates that even a complete curtailment of gas supplies on the RBP would be unlikely to have substantial impacts on electricity markets.

Source: Frontier Economics, *NESA gas shock scenario* A Final Report prepared for the Department of Resources, Energy & Tourism, November 2011.

4 Electricity

2011 summary of electricity security

Electricity energy security overall remains ***moderate*** over the 2011 NESA period (2011 to 2035), continuing the rating from the 2009 NESA. A number of significant economic factors, such as the drought and uncertainty about climate change policy, affected the 2009 assessment. While these factors have largely passed the acute phase, the electricity sector will face significant challenges during the assessment period, most notably reliability and price pressures associated with the implementation of climate change and renewable energy policies, as well as the upgrading and refurbishment of ageing network infrastructure in the face of rising demand. However, ongoing market maturity, established by market reforms and mechanisms associated with the Australian Government's Clean Energy Future package will assist in facilitating a flexible market response to such challenges.

Adequacy is expected to remain at a ***moderate*** level throughout the assessment period. Australia has access to substantial primary energy resources for electricity generation and these resources are adequate to meet current demand and future growth in demand.

However, moving to a lower-carbon economy will shift Australia towards a greater reliance on low-carbon fuels. As outlined in Chapter 3, this will place a greater demand on natural gas for baseload generation and peaking plants to back up growing intermittency from the specific types of renewable energy generation (such as wind and solar) expected from the implementation of the carbon price, the Renewable Energy Target, feed-in tariffs and peak load durations.

Over the long term, there is potential for gas supply issues to affect the electricity sector. If investment is unable to keep pace with eventual demand growth, there is a risk that supply will not be adequate to meet demand. If this occurs, the adequacy rating could move to ***low***. However, at this time it is considered that the adequacy rating for electricity will remain ***moderate*** over the long term.

Reliability is expected to remain ***moderate*** throughout the assessment period. To a large extent, the moderate rating reflects the transition pathway that the electricity sector will need to follow in order to lower its emissions profile.

Electricity demand is expected to continue to grow over the assessment period, consistent with projected Australian economic growth. However, this demand growth will be lower than it would otherwise have been without a carbon price. The first new capacity in the National Electricity Market (NEM) regions is expected to be required from 2013–14.[1]

The market has historically responded in a timely manner to forecast shortfalls, building generation capacity to meet demand and avoiding breaches of reliability standards. However, the uncertainty about carbon policies over the last decade has affected investor confidence and has resulted in delayed and/or suboptimal investment in generation capacity.

Significant amounts of new capacity will also potentially be needed over the medium to long term, as more emissions-intensive coal plants are retired from service to help achieve emissions reduction targets.

The Australian Government's Clean Energy Future package, which includes measures for strongly affected electricity generators, will promote a smooth transition that maintains energy security, and improves investor certainty.

However, during the implementation phase of the carbon pricing mechanism some uncertainties and perceived risks remain concerning the orderly retirement and replacement of emissions-intensive generators.

Improved reliability for electricity supply is expected as current new infrastructure investments replace ageing network infrastructure.

Competitiveness is assessed as ***moderate*** throughout the assessment period.

1 AEMO, *2011 Electricity statement of opportunities*, AEMO, Australia, 2011, p. 212.

Since the 2009 NESA, there have been significant increases in the real price of electricity. This trend is likely to continue over the assessment period, with the major contributing factors to these price increases changing over time. In the short term, investment in new and ageing electricity network infrastructure will make up the bulk of the cost increases. There are currently a range of activities underway to test regulatory outcomes with respect to network investment.

Renewable energy development and deployment and carbon pricing policies are more likely to be the major contributors to cost increases in the medium to long term. However, the Australian Government will provide assistance to low- and middle-income households and emissions-intensive, trade-exposed industries for the effects of electricity price increases arising from the introduction of carbon pricing. This will help to maintain both household affordability for electricity and the international competitiveness of Australian industry.

While competitiveness was assessed as ***low*** in the 2009 NESA, that rating was largely based on a lack of detail on the transition arrangements for the proposed Carbon Pollution Reduction Scheme and the cost impacts of the 20 per cent Renewable Energy Target. The 2011 assessment takes into consideration the detailed transition mechanisms provided in the carbon pricing announcement and the extensive modelling by Treasury of the cost impacts. Therefore, this assessment considers more confidently that the cost impacts are manageable, and consistent with a ***moderate*** assessment rating for competitiveness.

The Australian Government is also establishing an Energy Security Council to further assure energy security, and governments collectively need to ensure that investment signals bring on appropriate investment to meet demand requirements. The NEM, in particular, will be required to bring on significant investment in the years ahead – investment on a scale not seen since the establishment of the NEM.

Table 4.1: Summary of electricity security – 2011 NESA			
	Short term (to 2015)	Medium term (to 2020)	Long term (to 2035)
Adequacy	**MODERATE**	**MODERATE**	**MODERATE**
Comment	Reserves of energy resources for electricity generation are substantial. Generation capacity is sufficient to meet current electricity needs, but new capacity required towards the end of the short term. Policy uncertainty has stalled and/or resulted in sub-optimal generation investment over the past 12 months.	Reserves of energy resources continue to be substantial, and the move to cleaner energy sources begins. Strong growth in peak demand and tighter supply and demand balance are emerging. Improved carbon policy certainty and transition measures for the sector provide increased confidence for investment.	Energy market has access to a variety of energy resources, with a shift towards cleaner energy. The supply profile for electricity is expected to change towards cleaner generation technologies. New investment in generation is required, but improved policy certainty and mature market arrangements provide a stable investment environment.
Reliability	**MODERATE**	**MODERATE**	**MODERATE**
Comment	Investment constraints from previous policy uncertainty place pressure on reserve margins. Market arrangements are mature enough to maintain reliability standards. Generation investment continues to be focused on peak demand.	Transition to lower-emissions energy infrastructure accelerates. Improved certainty arising from the Australian Government's Clean Energy Future package. Risks remain to system reliability if emissions-intensive plants retire without adequate planning. Improved reliability as new investment replaces ageing network infrastructure.	Transition to lower-emissions energy infrastructure continues. Growing electricity market confidence in lower-emissions transition improves reliability. Risks still exist in transition, especially with greater integration of intermittent renewable energy and if emissions-intensive plants retire without adequate planning.
Competitiveness	**MODERATE**	**MODERATE**	**MODERATE**
Comment	Electricity prices are likely to continue to rise, primarily as a result of significant investment in electricity network infrastructure. Nevertheless, Australia continues to have some of the lowest electricity prices in the OECD.	Electricity prices are likely to continue to rise both as a result of network costs and due to climate change policy measures. Assistance in the carbon price transition will be provided for low and middle-income households and emissions-intensive, trade-exposed industries.	Electricity prices are likely to continue to rise as a result of climate change policy measures. Assistance will continue to be provided for low and middle-income households and emissions-intensive, trade-exposed industries.
OVERALL	**MODERATE**	**MODERATE**	**MODERATE**

2009 electricity security assessment

In the 2009 NESA, the level of electricity security in Australia was expected to remain relatively constant over the assessment period, with ***moderate*** levels of adequacy and reliability and ***low*** levels of affordability. The overall assessment of electricity security was ***moderate*** (see Table 4.2)**.**

Table 4.2: Summary of electricity security – 2009 NESA

	Current (2009)	Short term (2013)	Medium term (2018)	Long term (2023)
Adequacy	HIGH	MODERATE	MODERATE	MODERATE
Reliability	MODERATE	MODERATE	MODERATE	MODERATE
Affordability	MODERATE	LOW	LOW	LOW
OVERALL	MODERATE	MODERATE	MODERATE	MODERATE

The primary factors affecting electricity security in the 2009 NESA were the level of electricity demand, climate change policy uncertainty, gas supply issues, the global financial crisis and impacts of the drought.

The 2009 assessment found that, while electricity markets in Australia were well developed, significant challenges existed in terms of exposure to supply-side shocks, which were being observed in the market at the time. The relationship between generators, transmission/distribution, retailers and end users (market architecture) and increasing market concentration were seen to be limiting the capacity of the market to absorb these shocks.

In the medium term, these market arrangements were expected to have a continuing impact, although the extent of the impact varied depending on the factor in play. These factors included the market's overall efficiency, the implications of the proposed Carbon Pollution Reduction Scheme and the Renewable Energy Target, and related tight conditions in the gas market.

Overall, the assessment found that electricity security would be improved if market reforms provided outcomes that allowed the market to respond more flexibly to changing policy and operating environments.

Adequacy

In 2009, adequacy of electricity was assessed as ***high*** leading into the assessment. Despite some uncertainty about the implementation of the proposed Carbon Pollution Reduction Scheme and the Renewable Energy Target, sufficient investment in renewable and gas peaking plant was occurring and available to meet increases in demand.

The adequacy rating was expected to decrease to ***moderate*** over the assessment period. This was attributable to tight market conditions and possible inadequate investment. Over the medium and long terms, investment was seen to ease supply–demand pressures. However, if the investment climate was constrained by a lack of progress in the reform agenda or a lack of capital, the rating could fall from moderate to ***low*** in both the medium and long terms.

Reliability

In 2009, reliability of electricity was assessed as ***moderate*** due to the ongoing implications of energy input constraints from the drought. These impacts were somewhat offset by improvements to system arrangements and reduced demand resulting from the economic slowdown brought on by the global financial crisis.

Reliability remained at a ***moderate*** level throughout the assessment period. In the short and medium terms, the tight supply–demand balance, impacts of the proposed Carbon Pollution Reduction Scheme and the expanded Renewable Energy Target, and limited gas infrastructure to meet increasing gas-fired generation demand were all expected to place pressures on reliability.

By the medium term, continued gas market reforms were likely to result in an easing of gas supply issues. However, if adequate electricity and gas investment did not occur, electricity reliability could be reduced to a ***low*** rating.

In the long term, reliability was expected to remain ***moderate*** if market reforms delivered the correct signals and the market was able to deliver reliable electricity. However, if investment and progression of market reforms did not occur, the rating could fall to ***low***.

Affordability

The 2009 rating for affordability was ***moderate***, as markets were expected to continue to experience historically high electricity prices through 2009, mainly as a result of greater reliance on gas for electricity generation.

Affordability moved to a ***low*** rating over the assessment period due to higher costs emerging through the impact of greater gas utilisation and gas price pass-through, inefficient market operation and investment, and pass-through of a carbon price.

In the medium term, there was expected to be a slight improvement; however, gas issues were expected to have a continued impact on the cost of electricity. In the long term, carbon pricing was likely to continue to influence affordability as more cost-effective low-emissions generation technologies became available.

At the time of the 2009 NESA, affordability was assessed as low as it was envisaged that there would be significant and ongoing electricity price increases arising from the introduction of the proposed Carbon Pollution Reduction Scheme. Details had yet to emerge of assistance arrangements for low and middle-income households and emissions-intensive, trade-exposed industries.

2011 electricity security assessment

The Australian electricity market comprises three major electricity networks: the National Electricity Market (NEM), connecting Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania; the South West Interconnected System (SWIS), servicing the greater Perth region; and the North West Interconnected System (NWIS), primarily servicing the mining areas in the north west of Western Australia.

The Northern Territory's electricity industry is small and consists of three regulated systems: the Alice Springs regulated system, the Darwin–Katherine regulated system and the Tennant Creek regulated system.

Figures 4.1 and 4.2 show the eastern Australian electricity transmission and northern and western Australian electricity transmission markets.

Australia has historically enjoyed secure and reliable supplies of electricity. Australia has a high-quality electricity system, with access to substantial primary energy resources for electricity generation and an energy market that has delivered timely investment in new generation capacity to meet growth in demand.

Since the introduction of the NEM, Australia has seen private sector investment in generation capacity. The market has historically responded in a timely manner to forecast shortfalls, building generation to meet demand and avoid breaches of reliability standards.

The Australian electricity sector faces a number of challenges, due primarily to the need for policies on climate change and renewable energy that address the risks to our environment and our economy, and the need to continue to invest in new, and upgrade ageing, electricity infrastructure to meet rising demand and maintain the reliability and security of supply. While Australia enjoys access to an abundant range of energy resources for electricity generation, the electricity sector is facing unprecedented investment challenges to make this transition.

Box 4.1: Differences between the eastern and western electricity markets

There are a number of significant differences between the electricity market arrangements in the east of Australia and those that operate in the west. This is due to geographic and load profile differences between the two regions.

The eastern market (the National Electricity Market) operates as a wholesale spot market where generators and retailers trade electricity through a gross pool managed by the Australian Energy Market Operator (AEMO). Wholesale prices are formed continuously at five-minute intervals at a state region level in the National Electricity Market. The use of the common trading pool allows the AEMO to identify which generators are dispatched at any one time and the amount market customers are consuming. The AEMO produces an annual National Transmission Network Development Plan to provide an independent and strategic view of the transmission network for the forthcoming 20 years.

In the western market, the South West Interconnected System operates as a capacity payment wholesale trading market, known as the Wholesale Electricity Market. Energy in the Wholesale Electricity Market is traded mainly through bilateral contracts outside the energy pool. These contracts may be entered into years, weeks or days before supply. Before the trading day, generators must inform the Independent Market Operator of the quantity of energy to be sold under bilateral contracts, and to whom it will be sold, to enable the operator to schedule that supply. Due to its smaller size, the North West Interconnected System does not have a wholesale electricity market.

Figure 4.1: Eastern Australian electricity transmission system

Figure 4.2: Northern and Western Australian electricity transmission systems

Adequacy

Short term: Short term adequacy is assessed as ***moderate***.

Consistent with recent and projected economic growth, energy demand will continue to grow over the short term. However, Treasury modelling suggests that after a carbon price is introduced the rate of growth in electricity demand will be slower than without a carbon price.[2]

Australia has sufficient electricity generation capacity to meet our current electricity needs. According to the Independent Market Operator, existing and committed capacity in the SWIS is expected to be sufficient to satisfy the reserve capacity requirement for 2013–14 and 2014–15.[3] Under the medium economic growth scenario in the AEMO's 2011 Electricity Statement of Opportunities, Queensland, Victoria and South Australia are identified as regions in the NEM that are likely to require new capacity to meet demand towards the end of the short term.[4] While there is evidence that recent policy uncertainty has stalled investment across the NEM in the past 12 months,[5] the Clean Energy Future package should remove much of this uncertainty.

Energy sources

Australia has large black and brown coal resources, significant resources of gas and large renewable energy resources to meet future demand.

As one of the lowest-cost fuels, coal has historically contributed most of the NEM's baseload generation. In 2008–09, coal-fired electricity generation accounted for 74 per cent of total electricity generation.[6]

Australia also has significant resources of gas. Over the past decade, there has been a noticeable increase in the use of gas as a source of electricity generation. Australian gas consumption has grown by 4 per cent per year over the past decade. [7]

The last decade of climate policy uncertainty, together with increases in peaking demand and the technical need to balance the variability of increased wind generation through open-cycle gas turbines in the grid, has contributed to greater investment in gas-fired generation to meet the growth in demand for electricity.

This trend was expected to continue over the short term had uncertainty in climate change policy continued, resulting in further increases in demand for open-cycle gas turbine plant to minimise capital cost risks.

The introduction of a carbon price will initiate a transformation of the electricity sector in the NEM by influencing fuel switching from coal to gas-fired and renewable generation. However, the timing and size of this switch will be strongly influenced by domestic gas prices, the carbon price, and the cost of gas and renewable technologies.

Eastern Australia's production of gas is expected to meet the gas demand for electricity generation planned over the short term. However, as outlined in Chapter 3, the demand for gas-fired electricity generation is dependent on future carbon prices, future gas prices, and the commercial availability of competing electricity generation technologies. Chapter 3 also noted tightness of gas supply in Western Australia in the short term which could affect the adequacy of gas supply for electricity generation in the SWIS, leading to a requirement to use other fuels.

2 Treasury, *Strong growth, low pollution: modelling a carbon price*, Commonwealth of Australia, Treasury, Canberra, 2011, p. 114

3 Independent Market Operator, *2011 Statement of opportunities,* Independent Market Operator, 2011, p. 5.

4 AEMO, *2011 Electricity statement of opportunities*, p. 212.

5 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy,* Department of Resources, Energy and Tourism, Canberra, April 2011, p. 27 available at: http://www.ret.gov.au/energy/energy_security/irg/Pages/irg.aspx

6 BREE, *Australian energy projections to 2034-35*, BREE, Canberra, December 2011, p. 9.

7 Geoscience Australia, ABARES, *Australian energy resource assessment*, commissioned by the Department of Resources, Energy and Tourism, Canberra, 2010, p. 85.

In the short term, renewable energy supply will continue to grow. This is primarily driven through the mandated Renewable Energy Target (RET), which began on 1 January 2010. This will increase the contribution of renewable energy generation from around 7 per cent of Australian electricity in 2008-09[8] to 20 per cent by 2020.

As of 1 January 2011, the RET was split into the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES).[9]

The majority of the generation capacity under the LRET is expected to be built over the short term as large-scale projects attempt to capture the maximum value out of the RET period. Wind is expected to be the main generation technology to be implemented in the short term[10] and has been largely responsible for recent incremental demand growth being met.

Supply–demand balance

Energy is an essential input into economic activity, and growth in the economy is one of the main drivers of increases in energy demand. According to Treasury modelling, GDP growth in Australia is expected to average 3.1 per cent a year over the short term.[11] However, there may be some moderating of this economic growth as a result of the uncertain international economic climate.

Recent large-scale natural disasters, such as the Queensland floods, have caused significant disruptions to regional economic activity, but the situation is expected to improve as rebuilding gathers momentum over the short term.[12]

According to the Energy Supply Association of Australia (ESAA) in 2009-10, Western Australia recorded high growth in consumption (an increase of 9.7 per cent), Northern Territory increased by 3.3 per cent, South Australia and Queensland each experienced a marginal increase (0.1 per cent), and Tasmania, Victoria and New South Wales recorded a decline in electricity consumption.[13]

Comments from stakeholders in the 2011 NESA consultations, as well findings from a survey and report undertaken by the Independent Pricing and Regulation Tribunal of NSW, indicate a decline in electricity consumption in the residential sector in New South Wales. The exact cause of this decline remains unclear, but the survey identified higher utility prices, the introduction of additional energy (and water) saving schemes by the NSW and Australian governments and greater awareness of environmental issues to be possible contributing factors.[14]

Nationally, the ESAA reported that electricity consumption increased by a marginal 0.01 per cent in 2009–10, which is lower than the 1.4 per cent growth rate observed in 2008–09.[15]

The Treasury modelling on the introduction of a carbon price indicates that increasing electricity prices will drive changes in electricity consumption through substitution by households and firms to more efficient consumption choices and production processes, and through restructuring of the economy towards less electricity-intensive industries.[16]

Investment

In the past five years, policy uncertainty, particularly about whether and when a price would be set for carbon, has been affecting the appetite of investors to finance some forms of new generation capacity to meet the expected increase in demand. This uncertainty is likely to ease over the short term now that the Australian Government's carbon pricing mechanism has been legislated.

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8 Department of Resources Energy and Tourism and ABARES, *Energy in Australia 2011*, ABARES, Canberra, 2011, p. 31.

9 Department Of Climate Change and Energy Efficiency, *Enhanced renewable energy targe*t Fact Sheet, DCCEE, Canberra, July 2010

10 AEMO, *National transmission network development plan*, AEMO, Australia, 2010, p. 10.

11 Treasury, *Strong growth, low pollution- modelling a carbon price*

12 ABARES, *Australian commodities, march quarter 2011*, ABARES, Canberra, 2011, p. 17.

13 ESAA, *Electricity gas Australia*, ESAA, Melbourne, 2011, p. 13.

14 Independent Pricing and Regulatory Tribunal of New South Wales, *Residential energy and water use in Sydney, the Blue Mountains and Illawarra- results from the 2010 household survey- electricity gas and water research report*, IPART, Australia, 2010.

15 ESAA, *Electricity gas Australia*, pp. 12–13.

16 Treasury, *Strong growth, low pollution: modelling a carbon price*, p. 114.

Australia has sufficient electricity generation capacity to meet current electricity needs. Two wind-powered electricity generation projects were completed in the year to October 2011, adding 179 megawatts (MW) of capacity to the Australian electricity grid at a capital cost of around $488 million, according to the *Major electricity generation projects, November 2011* report by the Bureau of Resources and Energy Economics (BREE).[17]

At the end of October 2011, 19 projects were at an advanced stage of development (defined as 'committed' or 'under construction') with an estimated generation capacity of 2668 MW and a capital cost of $4.8 billion. There were ten advanced renewable energy projects, including seven wind projects; two hydro upgrade projects and one solar thermal project. These renewable projects have a combined capacity of 1233 MW, or around 46 per cent of the capacity of projects at an advanced stage of development.[18]

According to the Australian Energy Market Operator (AEMO), Queensland, South Australia and Victoria will reach their low reserve condition (LRC) point within the short term. With medium economic growth:

- Queensland will reach its LRC point in 2013–14, requiring at least 341 MW of new generation or demand-side investment to delay the shortfall until the following year.
- South Australia will reach its LRC point in 2014–15, requiring at least 46 MW of new generation or demand-side investment to delay the shortfall until the following year.
- Victoria will reach its LRC point in 2014–15, requiring at least 96 MW of new generation or demand-side investment to delay the shortfall until the following year.[19]

Medium term: Adequacy is assessed as ***moderate*** over the medium term.

Australia's vast reserves of energy resources continue to be available to meet growth in electricity demand over the medium term, with peak demand expected to grow faster than average demand.

New South Wales will require new generation capacity to avoid the LRC point in this period.

The NEM's historical performance is expected to continue by meeting forecast shortfalls in a timely manner, but will be influenced by the transition pathway set by climate change policies and the degree of certainty in which investment decisions can be made by the electricity generation industry.

While the carbon pricing mechanism and associated transitionary measures will provide the sector with a more conducive environment for making long term investment decisions, the NEM will potentially be faced with an unprecedented period during which large coal-fired capacity is being retired.

Energy sources

Australia's vast reserves of energy resources over the medium term will continue to be available for electricity generation.

Following the introduction of a carbon price, Australia could begin to see a significant substitution away from coal-fired generation to gas-fired generation over the medium term. However – as noted in Chapter 3 – the extent of the transition to gas-fired generation will be heavily dependent on domestic gas prices in eastern Australia and the extent of the linkage to global liquefied natural gas (LNG) markets.

The relative share of renewables in electricity generation is also expected to continue to increase steadily over the medium term through annual LRET targets to reach 41 000 gigawatt hours (GWh) by 2020 (see Table 4.3), with a further 4000 GWh resulting from the SRES.

17 BREE, *Major electricity generation projects November 2011*, BREE, Canberra, 2011.

18 BREE, *Major electricity generation projects November 2011*, 2011.

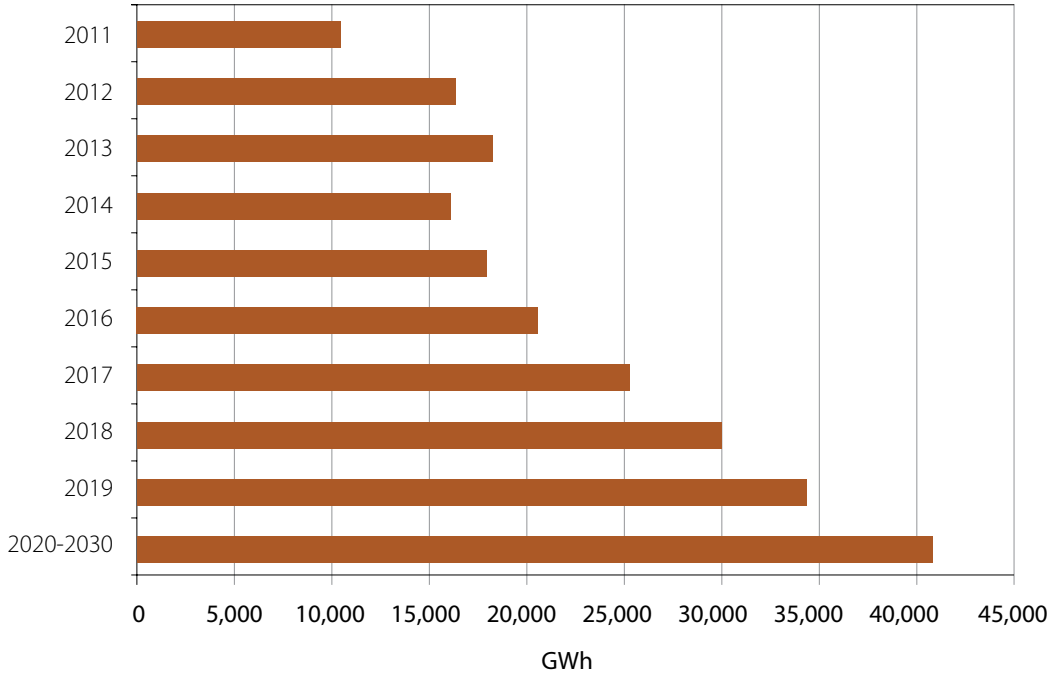
19 AEMO, *2011 Electricity statement of opportunities*, p. 212.

The LRET creates a financial incentive for the establishment and growth of renewable energy power stations, such as wind and solar farms, or hydro-electric power stations. It does this by legislating demand for Large-scale Generation Certificates.[20]

The SRES creates a financial incentive for owners to install eligible small-scale installations such as solar water heaters, heat pumps, solar photovoltaic systems, small-scale wind systems, or small-scale hydro systems. It does this by legislating demand for Small-scale Technology Certificates. [21]

The LRET will be the main driver of renewable generation over the medium term. However, the carbon pricing mechanism will also be a contributing factor to investment in renewables within this timeframe.

Figure 4.3: Expanded LRET Targets



Source: Office of the Renewable Energy Regulator

Supply-demand balance

According to Treasury modelling, GDP growth in Australia is expected to average 2.8 per cent a year over the medium term.[22]

Consistent with this economic growth, electricity demand is expected to continue to grow over the medium term, with faster growth in peak electricity demand compared to average demand.[23] Electricity growth rates are expected to also reflect regional differences in local economic activity.

20 Australian Government Office of the Renewable Energy Regulator, *Increasing Australia's renewable electricity generation- The Large-scale Renewable Energy Target and The Small-scale Renewable Energy scheme,* ORER, Australia, 2011, p. 4 available at: http://www.orer.gov.au/publications/pubs/ORER_booklet.pdf

21 ORER, *Increasing Australia's renewable electricity generation-The Large-scale Renewable Energy Target and The Small-scale Renewable Energy Scheme*, p. 8.

22 Treasury, *Strong growth, low pollution- modelling a carbon price.*

23 AEMC, *Strategic priorities for energy market development*, AEMC, Australia October 2011, p. 22.

While the forecasts indicate that energy and peak demand will continue to rise steadily, changing market circumstances make accurate demand forecasting increasingly difficult, in particular due to greater energy efficiency measures and structural changes in the economy.

Over the medium term, the pattern of electricity demand is also expected to change based on recent trends. According to the AEMO, since 2005–06 the summer maximum demand in the NEM has grown at a rate of 1.8 per cent a year, and the winter maximum demand has grown at a rate of 0.3 per cent a year. Over the medium term, the AEMO, under its medium growth scenario, forecasts growth of 2.6 per cent for summer maximum demand and 2.4 per cent for winter maximum demand.[24] According to the Independent Market Operator, maximum demand in the SWIS will increase at an annual compound growth rate of 3.7 per cent to 2021–22, and winter peak demand is forecast to grow at an average rate of 2.9 per cent to 2021.[25]

Electricity demand will also be strongly influenced by the Australian Government's carbon pricing mechanism. The reduction in demand growth expected in the short term will continue as a trend over the medium term as carbon prices increase and consumers respond.

Investment

The supply and demand balance is projected to become tighter over the medium term. New South Wales will reach its LRC point in 2018–19, requiring at least 190 MW of new generation or demand-side investment to delay the shortfall until the following year.[26] In the SWIS, 36 MW of new capacity will be required in 2015–16 in order to satisfy the requirement for that year.[27]

The medium term will be a key period of transition for the electricity sector under the Australian Government's carbon pricing mechanism. Decisions on investment and implementation will most likely occur over this period, as will decisions on possible plant retirements. These decisions will be extremely important for maintaining Australia's electricity security.

According to the government-appointed Investment Reference Group, such investment decisions will require sufficient investor confidence to be created at the outset. At least 10 to 15 years of forward clarity will be needed to develop new generation capacity and to have confidence in future revenue streams for assets with a 40-year life.[28]

There are also standard time periods for generation deployment (although each individual project will be different) and investment lags will be an important factor in new capacity being effectively deployed.[29] For the four main generation technologies used in Australia, the period from project conception to operation is typically three to five years for open cycle gas turbines and wind, four to six years for combined-cycle gas turbines, and more than five years for coal.

Under emergency conditions, the timing for bringing on new generation capacity could be reduced. This is illustrated in the electricity shock scenario report at the end of this chapter (see Box 4.4). For example, it may be possible to establish new capacity on existing power plant sites and avoid the time delays associated with planning approvals and grid connection.

Where generation is located remotely from the existing network, there may also be issues associated with investment in electricity networks to deliver new generation capacity. Electricity networks require significant approval processes, including a test to demonstrate economic efficiency and environmental assessments. This can add significantly to the amount of time it takes for generation capacity to be deployed.

24 AEMO, *2011 Electricity statement of opportunities*, pp. 69–70.

25 Independent Market Operator, *2011 Statement of opportunities*, pp. 36–38.

26 AEMO, *2011 Electricity statement of opportunities*, p. 217.

27 Independent Market Operator, *2011 Statement of opportunities*, p. 45.

28 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy,* p. 26.

29 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy*, p. 26.

The Australian Government's Clean Energy Future package, combined with adequate energy security measures, will assist in creating a regulatory environment that is more conducive to investor confidence than the previous situation of ongoing policy uncertainty.[30]

In particular, the energy security measures as part of the government's Clean Energy Future package (see Box 4.2) will assist in establishing a framework to ensure a smooth transition for plant retirements and new investment to maintain energy security. The package incorporates a Contract for Closure program, which provides for payments for the closure of up to 2000 MW of very highly emissions-intensive coal-fired generation capacity by 2020.

The Contract for Closure program will provide better information to the market about when new capacity is required and will allow new investors to plan with greater confidence and less risk. With these considerations, the government will ensure that the timeframes for closure are realistic and provide enough time for replacement capacity to be built and reliability standards to be met. The AEMO will be asked to advise on any proposed closure timetable to ensure that it is consistent with maintaining secure energy supplies.[31]

Long term: Adequacy is assessed as ***moderate*** over the long term.

Energy sources

Conventional coal-fired electricity generation (from both black and brown coal) is projected to decrease gradually to 2029–30, driven by carbon pricing, but will still play a role in the electricity fuel mix.[32]

The role of coal over the longer term is heavily dependent on the development of carbon capture and storage technologies. However, the timing for the deployment of these technologies depends on their economic viability.[33]

A large part of the decline in coal-based electricity generation is likely to be taken up by gas-fired generation until other lower-emissions technologies become more technically and economically viable. However, as noted in Chapter 3, the penetration of gas-fired generation in the electricity mix is heavily dependent on gas prices.

Australia has abundant and widespread renewable energy resources; continued growth in the use of these resources will be driven by carbon pricing in the longer term. The extent of this growth will depend on the speed of innovation, the associated reduction in the cost of renewable energy generation technologies and their cost competitiveness with other low-emissions technologies (such as carbon capture and storage).

As indicated in Figure 4.4, according to Treasury modelling under the 'Government Policy Scenario' a carbon price drives significant changes in the mix of technologies and fuels in the electricity sector.

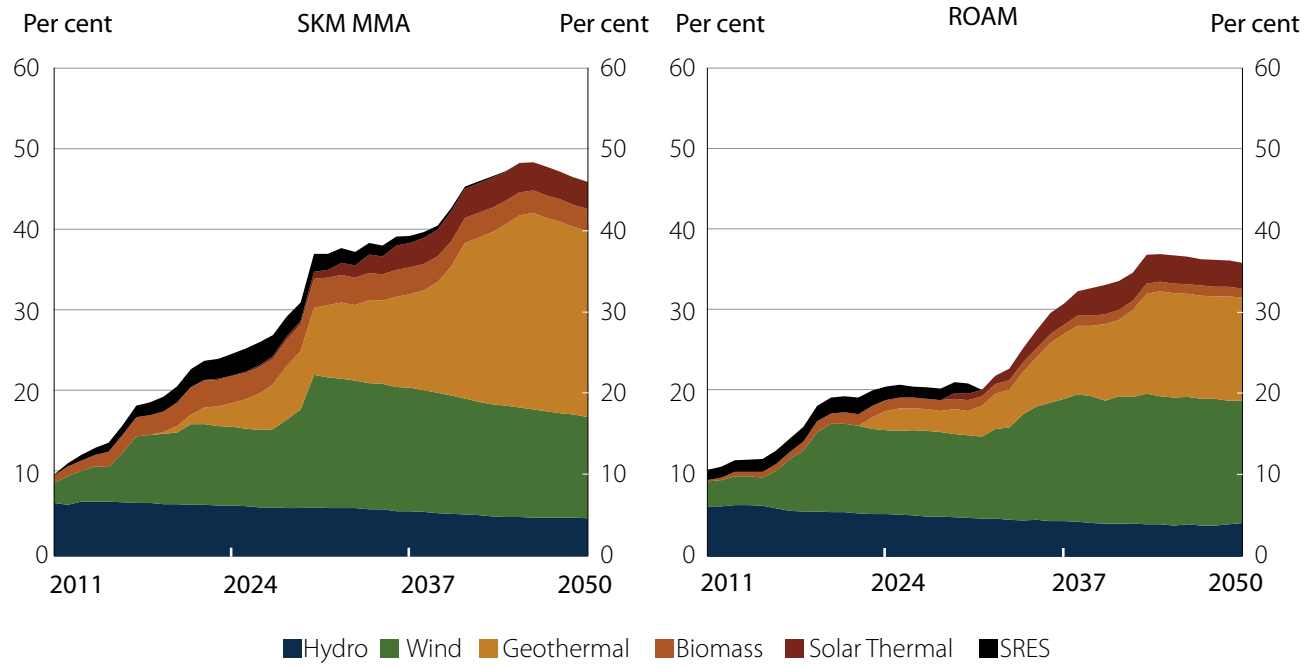
30 AEMO, *Carbon price energy security measures*, Letter to Mr Blair Comley Secretary, Department of Climate Change and Energy Efficiency and Mr Drew Clarke, Secretary, Department of Resources, Energy and Tourism, 5 July 2011, available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

31 Department of Climate Change and Energy Efficiency, *Securing a clean energy future, The Australian Government's climate change plan*, DCCEE, Canberra, 2011, p. 75.

32 Treasury, *Strong growth, low pollution: modelling a carbon price*, p. 116.

33 BREE, *Australian energy projections to 2034-35,* p. 38.

Figure 4.4: Renewables by technology – share of total generation – Government Policy Scenario



Note: Treasury commissioned modelling of the effects of a carbon price from two organisations: ROAM Consulting and SKM MMA (part of the Sinclair Knight Merz Group).

Source: Treasury, *Strong growth, low pollution: modelling a carbon price- charts 5.20 updated: Government policy scenario renewables by technology- share of total generation*, Commonwealth of Australia, Canberra, 2011.

Government Policy Scenario: Assumes a world with a 550 parts per million stabilisation target and an Australian emission target of a 5 per cent cut on 2000 levels by 2020 and an 80 per cent cut by 2050. Assumes a nominal domestic starting price of A$23/t CO_2-e in 2012-13, rising 2.5 per cent per year, plus inflation, before moving to a flexible world price in 2015-16, projected to be around A$29/t CO_2-e.

In this context, the Australian Government has in place a range of 'push–pull' technology policies to drive investment in renewable energy in the long term. The Australian Renewable Energy Agency will assist in demonstrating promising technologies, while the Renewable Energy Target, the Clean Energy Finance Corporation and carbon pricing will create incentives to deploy commercially available technologies.

The uptake of renewable energy will also be influenced by timely and adequate investment in infrastructure development, including transmission and distribution.[34]

Supply–demand balance

According to Treasury modelling, GDP growth in Australia is expected to average around 2.5 per cent a year over the long term.[35]

The structure of the Australian economy will continue to shift away from agriculture and industry toward the services sector. This shift will continue to dampen the expected growth in energy demand over the long term.[36]

34 Geoscience Australia and ABARE, *Australian energy resource assessment,* p. 39.

35 Treasury, *strong growth, low pollution- modelling a carbon price.*

36 Geoscience Australia and ABARE , *Australian energy resource assessment*, p. 26.

Over the period to 2034-35, Australia's aggregate energy intensity is projected to decline by around 1.7 per cent a year. This indicates a considerable shift in Australia's economic structure over this period. Improved efficiency through technological development and fuel switching will also contribute to this trend. [37]

The demand profile for electricity is also expected to change over the long term, driven by changing consumption patterns such as increased energy efficiency, greater demand-side participation and price discovery through smart meters and smart grids – all of which may change consumer demand and behaviour over the long term.

In addition, the increased adoption of electric vehicles may create different consumption patterns.

The nature of the supply and demand balance over the long term will be profoundly influenced by the government's carbon pricing mechanism.

As is the case in the short and medium terms, Treasury modelling indicates that, with the introduction of a carbon price, growth in electricity demand continues to fall over the long term relative to growth without a carbon price.[38]

The AEMO's electricity planning forecasts some customer response and reduction in consumption through energy efficiency initiatives and growth in embedded generation. Despite this, peak demand is forecast to continue to grow within the economy.[39]

The AEMO considers that the market is aware of the need for investment and parties have been developing a range of projects in response. Publicly announced projects are adequate in number and size to fill the gap left by potential plant closures, but the AEMO remains concerned that relatively few of these announced projects have been making the transition towards commitment.[40]

The AEMO considers that the transition of projects from announcement to commitment is critically dependent upon investor confidence and the ongoing financial stability of the existing market because of the capital-intensive nature and significant expenditure required for generation projects.

Clarity on carbon pricing now that the Australian Government's carbon pricing mechanism has been legislated, combined with adequate energy security measures, will assist in creating a regulatory environment that is more conducive to investor confidence than the previous situation of ongoing policy uncertainty.[41]

Reliability

Short term: Reliability is assessed as ***moderate.***

The Australian electricity generation sector has a good track record in reliably meeting electricity demand. The average duration of outages per customer in the NEM has generally been 200 to 250 minutes per year.

The generation sector has defined what customer reliability should be in the form of a standard. Reliability or continuity of electricity supply to customers in the NEM is set as a reliability standard, unserved energy, for the NEM by the Australian Energy Market Commission (AEMC) Reliability Panel. Reliability standards provide a measurement against which to assess supply and demand conditions. The standard is the expected amount of energy at risk of not being delivered to customers due to a lack of available capacity.

The AEMO, determines the necessary spare capacity to meet the reliability standard that must be available for each region (including via transmission interconnectors) to provide a buffer against unexpected demand spikes and generation failure.

37 BREE, *Australian energy projections to 2034-35*, p. 29

38 Treasury, *Strong growth, low pollution: modelling a carbon price*, 2011, p. 114.

39 AEMO, *Carbon price energy security measures*, Letter, available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

40 AEMO, *Carbon price energy security measures*, Letter, available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

41 AEMO *'Carbon price energy security measures,'* Letter, available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

A reserve margin of generation in the system is then made available above the amount required to meet forecast demand. Reserve margins are generally calculated to provide sufficient spare generation capacity to meet projected maximum demand under a level of system stress (for example, the outage of the biggest generating unit in a region).

A breach of reserve levels does not automatically mean blackouts or load shedding of customers, but that spare capacity is reduced. This breach may increase the risk of blackouts should additional generator outages occur. Load that is not met is classified as unserved energy.

The current level of unserved energy set for the NEM is that no more than 0.002 per cent of customer demand in each NEM region should be unserved by generation capacity in the region, allowing for demand-side capacity and import capacity from interconnectors.[42]

Reliability issues generally emerge as a result of a combination of concurrent factors such as tight reserve margins and running infrastructure at close to capacity limits. These factors can increase risks to reliability by reducing the flexibility, or resilience, of the supply chain. Ageing infrastructure and natural disasters are also contributing factors or causes of reliability incidents.

The Australian Energy Regulator (AER) has identified a number of underlying causes of reliability problems that can usually be attributed to one or a combination of the quality and capacity of infrastructure. These include ageing infrastructure; operating infrastructure close to capacity limits; inadequate maintenance; monitoring and/or operating procedures; and extreme events that are not provided for in contingency planning.[43]

Infrastructure reliability covers the performance of generation, transmission and distribution.

Generator performance

The AEMC Reliability Panel reports annually on the performance of the generation sector against the reliability standard and minimum reserve levels set by the AEMO.[44] The panel's *Annual market performance review 2010* states that there was no unserved energy due to reliability events in 2009–10.[45]

All regions of the NEM have consistently met the 0.002 per cent unserved energy standard based on a measured 10-year moving average.

Historically, reserve levels have rarely been breached, and generator capacity across all regions of the market has been sufficient to meet peak demand and allow for an acceptable reserve margin.

Transmission network reliability

The quality of transmission network services relates principally to networking reliability and network congestion issues.

Standards for the design and operation of the transmission system play a central role in ensuring the reliable and secure delivery of power to customers. These performance standards are critical because the interconnected nature of the network and the physics of power flows mean that the loss of a single element (such as a transmission line, generator or transformer) can instantaneously result in changes in power flows through all other elements of the network. Under the existing arrangements in the NEM, there is some degree of national consistency in transmission standards.

Transmission congestion issues can arise from factors within the control of a service provider – for example, the provider's scheduling of outages, its maintenance and operating procedures and its standards for network capability such as thermal, voltage and stability limits. They can also be caused by circumstances that are beyond a service provider's

42 AER, *State of the energy market 2010*, AER, Australia, 2010, p. 41.

43 AER, *State of the energy market 2007*, AER, Australia, 2007, p. 39.

44 AER, *State of the energy market 2010*, p. 41.

45 AEMC, *Final report - annual market performance review*, December 2010 Australia, p. 1, available at: http://www.aemc.gov.au/Market-Reviews/Completed/Annual-Market-Performance-Review-2010.html

control, such as extreme weather. Hot weather, for example, can result in high air-conditioning loads that push a network towards its predetermined capacity limits.

Historically, NEM jurisdictions have generally achieved high rates of transmission reliability due to a range of factors, including the broad regulatory regime, the investment and operational decisions by transmission operators, and the existence of the AER national service target performance scheme. This scheme sets targets based on transmission circuit availability and the average duration of transmission outages and the frequency of 'off supply' events.

The major networks in eastern and southern Australia have generally outperformed their targets.

Historically, the electricity system was designed around large coal-fired baseload plant built on fuel sources and connected to major loads via long-distance transmission lines. Recently, there has been a trend towards more intermittent generation sources and potentially more diverse generation types. These policy-driven changes to move Australia towards a lower-carbon economy could pose growing challenges to reliability, in the face of growing demand that is also likely to be peakier.

Distribution network reliability

The trade-offs between improved reliability and cost mean that the standards for distribution networks are less stringent than those for generation and transmission. These less stringent standards also reflect the fact that the impact of a distribution outage tends to be localised to part of the network, compared with the potentially widespread geographic impact of a generation or transmission outage. The capital-intensive nature of distribution networks makes it expensive to build in high levels of redundancy (spare capacity) to improve reliability. These factors help to explain why distribution outages account for such a high proportion of electricity outages in Australia.

Currently, state and territory governments are responsible for setting the expected level of reliability for their distribution networks. The AEMC has been tasked with considering whether there is merit in developing a national approach to delivering distribution reliability outcomes.

Through government policies, there has been a move towards more active management of consumption of electricity by consumers, such as through investment in solar panels or smart meters. This could pose growing challenges to the operation and reliability of distribution networks.

Renewable Energy Target

As noted earlier, the Renewable Energy Target is composed of the Small-scale Renewable Energy Scheme and the Large-scale Renewable Energy Target. Depending on the nature of renewable generation brought on by the target, the grid can expect an increasing amount of intermittent generation to occur in the future.

Increasing reliance on sources of intermittent energy could pose challenges for energy security and reliability. The RET has already delivered significant amounts of wind energy. However as wind power is likely to represent the lowest-cost option for meeting the LRET, wind power is likely to expand substantially over the period to 2020.

In 2009, the AEMC published a review of energy market frameworks in light of climate change policies to consider this issue[46]. The review also took into consideration power system voltage, frequency and inertia related to system reliability.

The review concluded that existing energy market frameworks are sufficiently resilient to enable the system operator to maintain a secure system following the large anticipated increases in renewable electricity generation as a result of the introduction of a carbon price and an expanded RET.

The review noted that there have been a range of recent reforms to the NEM that enhance the ability of the market to accommodate intermittent generators.

46 AEMC,, *Review of energy market frameworks in light of climate change policies*, AEMC, Sydney, September 2009 , available at: http://www.aemc.gov.au/Market-Reviews/Completed/Review-of-Energy-Market-Frameworks-in-light-of-Climate-Change-Policies.html

In addition, in 2008, a requirement was introduced as part of the NEM Rules under which intermittent generators with a capacity of greater than 30 MW are classified as semi-dispatch generators and are controlled by the NEM dispatch process, similar to other large generators that bid into the NEM.

This semi-dispatch rule, together with the use of the Australian Wind Energy Forecasting System, has improved the AEMO's ability to manage the power system with large increases in intermittent generation capacity and substantial changes in dispatch patterns.

Climate change policy

The operation of the NEM and the Australian electricity supply industry relies on clear price signals to ensure that there is adequate investment to maintain the security and reliability of the electricity system, and ensure that demand is appropriately met by supply.

While there is always a degree of investment uncertainty in areas such as future demand, fuel prices and capital costs, the policy uncertainty surrounding the carbon price debate has been much harder to manage.

Investors and market participants are faced with a wide range of potential alternative technologies and there are vastly different cost implications under different carbon policy scenarios. The Australian Government commissioned both Deloitte and the Investment Reference Group to examine how the policy uncertainty was affecting investment and system reliability.[47]

These reports identified broad impacts that were emerging from observed trends in the market, including delayed and/or sub-optimal investment and reduced maintenance spends. All have reliability impacts in the longer term.

In advance of a carbon price, and specific knowledge of transitional assistance, generators in recent years have been limiting available capital for ongoing maintenance directed towards ensuring plant reliability, which increased the chances of possible unplanned outages.

Importantly, such generators were most likely to be brown and black coal baseload generators that have a significant supply reliability role in the operation of the NEM and the SWIS.

Further, a carbon price without transitionary assistance could lead to some existing generation facilities becoming financially distressed, making them unviable to the extent impairment on these existing facilities required them to withdraw from the market unexpectedly.

To address these policy uncertainty risks, the Australian Government's Clean Energy Future package includes energy security measures (see Box 4.2). These measures are designed to support market stability in the sector and ensure electricity reliability during the transition to a lower-carbon economy.

47 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy* and Deloitte, *Electricity generation investment analysis*, Department of Resources, Energy and Tourism, Canberra, April 2011, available at: http://www.ret.gov.au/energy/energy_security/irg/Pages/irg.aspx

Box 4.2: Australian Government energy security measures

Energy Security Fund

The Energy Security Fund will provide $5.55 billion in transitional assistance through to 2016–17 to foster market stability and energy security through targeted support for emissions-intensive generators as a carbon price is introduced.

Assistance will be provided to generators with an emissions intensity above 1.0 tonne of carbon dioxide equivalent per megawatt hour (t CO_2-e/MWh) on an 'as generated' basis.

Contract for Closure

Through the Energy Security Fund, the Australian Government is pursuing contracts for closure, seeking to support the closure of around 2000 MW of highly emissions-intensive generation capacity by 2020.

An expression of interest process will be open to generators with an emissions intensity above 1.2 t CO_2-e/MWh on an 'as generated' basis, to deliver closure before 2020.

Both Energy Security Fund measures require that energy security and market stability outcomes be delivered before any capacity can be withdrawn, and structural adjustment impacts will be carefully managed in the contract for closure process.

The transitional assistance also requires generators to prepare and annually lodge an updated Clean Energy Investment Plan with the Minister for Resources and Energy.

The plans will be published annually and require generators to identify investment in new capacity, investment to reduce the emissions intensity of existing plant and investment in research and development, as well as highlighting outcomes identified in Energy Efficiency Opportunities program[a] assessments.

Loan support

Loans will be available, on the advice of the Energy Security Council, to generators with an emissions intensity greater than 0.8 t CO_2-e/MWh on an 'as generated' basis to support the refinancing of existing debt if commercial loans are unavailable on reasonable terms.

Loans and loan terms will be subject to the approval of the Treasurer. Loan terms will be designed to encourage generators to seek private finance in the first instance.

Energy Security Council

The Australian Government will establish the Energy Security Council to advise it on possible support measures to address energy security risks.

The Council will include the heads of the Australian Energy Market Commission, the Australian Energy Regulator and the Australian Securities and Investments Commission and experts in the fields of business, public finance, insolvency and the energy market, and will consult with the managing director of the Australian Energy Market Operator.

Source: Department of Resources, Energy and Tourism and the Department of Climate Change and Energy Efficiency, *Transforming Australia's Electricity Generation Sector Fact Sheet*, July 2011

a The Energy Efficiency Opportunities (EEO) program encourages large energy-using businesses to improve their energy efficiency by identifying, evaluating, and reporting publicly on cost effective energy savings opportunities.

Medium and long term: Reliability of electricity over both the medium and long terms will remain at a ***moderate*** level.

The NEM framework has to date delivered reliable electricity services to customers and the market has historically responded to forecast shortfalls, building new capacity to meet reliability standards.

The supply–demand outlook published in the AEMO's annual Electricity Statement of Opportunities is expected to continue providing market participants and other interested parties with information about the timing and magnitude of the additional investment required in the long term to maintain the reliability standard, and importantly should provide signals for new investment in the market under the transition to a lower-carbon sector.

While historically the NEM market participants have generally invested in sufficient time to enable the NEM to meet reserve plant requirements,[48] in recent years the investment climate has been far more uncertain. The Australian Government's Clean Energy Future package will reduce this uncertainty. The energy security measures in the package will be crucial in reducing implementation risks to the electricity sector.

Carbon pricing

While the government's Clean Energy Future package will address carbon price–related risks to reliability, the market bodies overseeing the NEM still consider that some residual implementation risk may exist with this transition.

According to the AEMC, 2500 MW of non-intermittent capacity will be required to meet expected demand by the middle of this decade.[49] Gas-fired generation appears well placed to provide this capacity, although this will be dependent on gas prices. In the event that this capacity is not provided by gas-fired generation, there are a range of other potential options.

However, the AEMC considers investment risks still remain if significant amounts of emissions intensive generation were to close without substantial notice.

In addition, if operational management of the generators and ongoing investment in their maintenance is affected by financial insecurity, a risk emerges that there might be an inappropriately low focus on plant condition, leading in turn to a reduction in system reliability.[50]

As part of its Clean Energy Future package, the government will pursue the Contract for Closure over the medium term, seeking to support the orderly closure of potentially up to 2000 MW of highly emissions-intensive generation capacity by 2020.

The importance of an orderly transition in the retirement of large plant is highlighted in the shock scenario at the end of this chapter, which examines the reliability implications of the unexpected departure of a large power station from the NEM (see Box 4.4).

The retirement of any significant coal-fired baseload capacity will require timely investment in replacement capacity. This will need to be facilitated by a managed closure regime, providing investors with upfront certainty and the confidence to invest early.

The AEMC emphasises that any contracted closure implementation will need to be carefully managed so as not to distort market incentives for investment, and to provide the certainty that potential investors will be seeking to mitigate the risks created by the disrupted market environment.[51]

48 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy,* p. 27.

49 AEMC, *Carbon price energy security measures*, Letter to the Hon Martin Ferguson AM MP and the Hon Greg Combet AM MP, 7 July 2011, available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

50 AEMO, *'Carbon price energy security measures,'* Letter, available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

51 AEMC, *Carbon price energy security measures*, Letter available at: http://www.ret.gov.au/energy/energy_security/fund/Pages/fund.aspx

As part of the Australian Government's Energy Security Fund, support will be provided to highly emissions-intensive coal-fired power stations in Australia to assist with the transition under a carbon price. Importantly, this assistance will be conditional on generators ensuring security of supply and their development of Clean Energy Investment Plans.

Over the longer term, participant's exposure to the carbon price mechanism and improved certainty will result in transitional issues being mitigated by participant responses to build and deploy cleaner generation technologies.

Transmission and distribution network reliability

As a result of current planned investment and continuing new investment replacing ageing network infrastructure, reliability is expected to continue improving.

Future augmentation of transmission networks will be essential to meet future load growth and security of supply. In particular, meeting the targets under the expanded RET scheme will require substantial quantities of wind and other renewable generation and additional gas-fired generators to be connected to the network.[52]

The Investment Reference Group considers that network risks exist in the simultaneous transition to greater reliance on intermittent renewable energy and the potential retirement of significant baseload plant as it nears the end of its asset life or through contracted closure.[53]

Over the medium and long terms, distribution network investment will continue, including the integration of smart grid technologies. Smart grids may pose new reliability challenges associated with internet or online vulnerabilities being imported to the network. This risk is explored in more detail in the case study on cyber security (see Box 4.3).

Renewable Energy Target

As noted in the short-term reliability section, in 2009 the AEMC published a review of energy market frameworks in light of climate change policies. While the review considered that wind power would not have an adverse impact on the operational reliability of the NEM, it noted that a particular challenge for energy market frameworks is whether the market signals are supporting investment in generation that is technically able to complement the intermittent output of wind.[54]

The AEMC review noted that the primary signal for complementary peaking generation is through expected prices in the spot market and concluded that this signalling mechanism does not appear to be compromised by the introduction of an expanded RET. However, the review assumed that wind capacity would increase to 6000 MW by 2020.[55] This assumption appears conservative, given the size of the LRET and the limited ability of other renewable electricity technologies to compete with wind power within this timeframe.

More recently, the AEMC has noted that the expected increase in wind power is likely to increase price volatility, and may lead to more periods of both high spot prices and negative spot prices.[56] These effects will become more evident if 'clustering' of wind power occurs in specific regions, as has already been experienced in South Australia.

There is also a risk that the LRET may lead to difficulties in meeting the target for unserved energy in the NEM. This situation could arise because the LRET depresses wholesale electricity prices, which reduces the primary source of revenues for non-renewable generators. Consequential reductions in operating hours for baseload and peaking gas-fired generation, combined with projected higher gas prices, mean that it may not be economical for sufficient new gas-fired generation to develop to meet the unserved energy target.

52 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy*, p. 6.

53 Investment Reference Group, *A report to the Commonwealth Minister for Resources and Energy.*

54 AEMC, *Review of energy market frameworks in light of climate change policies.*

55 AEMC, *Review of energy market frameworks in light of climate change policies.*

56 AEMC, *Strategic priorities for energy market development discussion paper,* p. 31.

Price volatility and depressed wholesale electricity prices will increase the importance for retailers and generators of hedging effectively in the contract market to avoid exposure to high and volatile spot prices. They also increase the importance of understanding potential systemic risks in markets like energy with financial contract products.[57]

A 2011 report by Deloitte into electricity generation investment in the face of carbon policy uncertainty also noted that the extent of new and proposed investment in intermittent generation, mainly wind, has raised concerns about system security and reliability.

Although the Deloitte report did not reveal any cause for alarm, it concluded that the potential lack of baseload investment, coupled with large-scale entry of intermittent generation, is an area of concern that will need to be closely monitored.

The AEMO is currently investigating how a significant increase in wind power can be efficiently and securely integrated into the NEM. A series of studies will include modelling of the characteristics of wind and network congestion, and a survey of international experience and best practice.[58]

57 AEMC, *Strategic priorities for energy market development, discussion paper*, p. 31.

58 AEMO, *Revised 2011 NTNDP scope and consultation report*, AEMO, Australia, July 2011.

Box 4.3: Case study – cyber security and the energy sector

The Australian Government released its Critical Infrastructure Resilience Strategy on 30 June 2010. The strategy aims to ensure the continued operation of critical infrastructure in the face of all hazards, in support of Australia's national security and our economic prosperity and social wellbeing.

A key imperative of the strategy is to have an effective business–government partnership with critical infrastructure owners and operators. The Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience is one important avenue for this partnership.

The Australian Government's Cyber Security Strategy was launched on 23 November 2009, and aims to maintain a secure, resilient and trusted electronic operating environment that supports Australia's national security and maximises the benefits of the digital economy.

Critical infrastructure protection has been a high priority area for Australian governments and businesses since September 2001, with considerable efforts on protection and preparedness in place. However, cyber security threats have recently emerged that have the potential to increasingly affect our physical energy security.

While physical security forms an integral part of all Australian governments' critical infrastructure protection and resilience efforts within the energy sector, the rise of more interactive and technology-connected energy systems creates an emerging area of vulnerability through cyber security threats.

Cyber security is a global issue and was acknowledged as a national security issue in the 2008 *National security statement*. The statement considered the sophistication of Australia's modern community to be a source of vulnerability in itself given that 'we are highly dependent on computer and information technology to drive critical industries such as aviation; electricity and water supply; banking and finance; and telecommunications networks. This dependency on information technology makes us potentially vulnerable to cyber attacks that may disrupt the information that increasingly lubricates our economy and system of government'.[a]

The Australian Government's Cyber Security Strategy notes that:

> Australia is vulnerable to the loss of economic competitiveness through the continued exploitation of ICT networks and the compromise of intellectual property and other sensitive commercial data. This has the potential to undermine confidence of Australians in the digital economy. Cyber security is therefore not just an issue of national security but also one of economic security.[b]

a Rudd, K, National security statement, 2008, available at: http://pmrudd.archive.dpmc.gov.au/node/5423

b Australian Government, Cyber security strategy, Commonwealth of Australia, 2009, p. 4, available at www.ag.gov.au/cybersecurity

Key issues for the energy sector

Breaches in cyber security within the energy sector can adversely impact critical decision making and the operational capacity of the sector to provide energy security.

In Australia, electricity control systems in energy infrastructure include corporate networks, automated industrial control systems such as Supervisory Control and Data Acquisition (SCADA) systems, distributed management systems and the development of smart grids.

The types of cyber security attacks and the disruptions that may occur following a successful attack will vary across the energy sector. For example, a compromise of certain control systems could lead to the physical destruction of hardware and major supply disruptions. The consequent economic losses will be felt by those industries, businesses and communities that depend on a reliable energy supply.

For example, an attack on a billing system of a retail electricity supply company could lead to the short-term loss of revenue or the disclosure of customers' personal information.

A less noticeable, but potentially more long-lasting, impact on energy security may occur from the loss of economic competitiveness through the exploitation of compromised intellectual property and other sensitive commercial data.

In 2010, MacAfee, a major internet security provider, reported on the covert, systematic and coordinated cyber attacks that it called 'Night Dragon'. These attacks were aimed at global oil, energy and petrochemical companies to collect sensitive competitive proprietary operations and project-financing information regarding oil and gas field bids and operations.

Vulnerabilities associated with information security and the loss of highly sensitive commercial information have the potential to be economically harmful and undermine commercial decisions that may impact on energy security in the medium to long term.

The widespread use of industrial control systems such as SCADA across the sector has heightened the energy sector's dependence on computer and information technology to drive production, transformation, transmission. While these systems offer relatively low operating costs, increased reliability and enhanced transparency, opportunities to exploit them have increased, particularly where systems are open-networked and operate across the internet.

Online systems can be vulnerable to remote attacks, as physical proximity is no longer needed to inflict significant damage on infrastructure, as is evidenced by the recent issues with Stuxnet.

What is Stuxnet?

Open source media sources note that Stuxnet is a computer worm that targets industrial software and equipment. The worm initially spreads indiscriminately, but includes a highly specialised component designed to target a specific manufacturer's SCADA systems used in Iran's nuclear program. Known examples of Stuxnet have affected SCADA systems and caused the centrifuges to malfunction. The damage caused is believed to have significantly set back the Iranian nuclear program.

The 2011 McAfee report *In the dark: crucial industries confront cyberattacks* found that the emergence of Stuxnet points to an overriding need for critical infrastructure companies that depend heavily on industrial control systems to acknowledge the changes in the cyber threat landscape and focus attention not only on denial-of-service attacks, but also on more sophisticated threats, like infiltration from state-sponsored actors or cyber extortionists.

Smart grids

A smart grid is an 'intelligent' electricity network – a system of systems – that overlays digital technology to deliver electricity from suppliers to consumers and includes two-way communications between the grid and consumers.

It is composed of remotely operated digitised devices and the industrial facilities in the energy sector that such devices help operate: electrical plants, electrical substations, utility towers, relays, transformers, gas pipelines and oil refineries.[c]

Smart grids are expected to be a positive influence on energy security.

The International Energy Agency's *Smart grids road map* (2010) notes that 'smart grids are expected to increase electricity system information and transparency, improving the ability to make system investment decisions to address ageing infrastructure and demand growth while enabling the sharing of costs and benefits with all stakeholders'.[d]

Interoperability of standards both nationally and internationally for the smart grid will play a critical enabling role in expanding product markets and promoting vendor competition as well as preventing premature obsolescence and facilitating future upgrades of equipment and technologies to meet the ever-increasing challenges of security and privacy concerns.

With the development of smart grids and smart meters, there are also security issues to consider in addition to the immediate energy security concerns mentioned above.

These concerns come from the increasing number of actors involved in the market and increasing connectivity to the internet.

These issues, which are also applicable for the energy sector as a whole, include:

- information security
- increasing reliance on external service providers (such as communications infrastructure)
- data protection
- interoperability and standards development
- privacy concerns.

Mitigation of risks

The Australian Government is actively working with key businesses in the energy sector to understand cyber-based vulnerabilities and is assisting industry to take steps to address and mitigate these risks.

This work is being facilitated though the Critical Infrastructure Resilience Strategy and the Cyber Security Strategy. For cyber security issues, industry's first point of contact is CERT Australia.

Established in early 2010, and located within the Attorney-General's Department, CERT Australia is the national coordination body for the provision of cyber security information to the Australian community.

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c Logical Security, Smart grid security overview, December 2010, available at: http://cissp.logicalsecurity.com/network-security/cissp/smart-grid-security-overview.

d International Energy Agency, Smart grids roadmap, 2010 available at: www.iea.org/Papers/2010/SmartGrids_Roadmap_Foldout.pdf

CERT Australia places a special emphasis on assisting the owners and operators of critical infrastructure and systems of national interest – systems that if compromised, could result in significant impacts on Australia's economic prosperity, international competitiveness, public safety, social wellbeing or national defence and security.

As part of this role, CERT Australia provides information on cyber-based threats and vulnerabilities to the owners and operators of these systems and is responsible for technical coordination and incident response with the private sector during a cyber incident.

Through this cooperation, businesses can work to reduce system vulnerabilities.

Assessment

Breaches in cyber security in the energy sector can adversely impact critical decision-making and the operational capacity of the sector to ensure energy security. Although these are significant and legitimate issues, the Australian energy sector has largely been resilient in the face of this mounting threat.

The energy sector will continue to be of interest to a broad range of malicious actors who exploit cyber security vulnerabilities, including:

- industry competitors seeking to manipulate the market
- financially motivated criminals seeking to extort large sums of money
- issues-motivated groups.

Forty per cent of respondents in the global McAfee public survey reported Stuxnet incidents, and those respondents were very concerned about this type of vulnerability, including Australian energy sector respondents.

Globally, smart grid investments will exceed $45 billion by 2015, indicating a growing vulnerability for the reliability of electricity supplies if appropriate safeguards or standards are not included in their development. Customer and consumer groups have raised concerns in relation to the impact of smart grids and their (or any lack of) safeguards on energy prices and privacy.

While cyber attacks could potentially pose significant risks to the reliability of our physical energy networks, there has been a considerable focus by government on developing critical infrastructure protection and resilience in Australian industries to address such threats.

Overall, the reliability of our energy sector in the face of cyber security threats is moderate over the assessment period. This is consistent with the Australian energy sector having been affected by known cyber security incidents and government working with industry to be better prepared for such attacks.

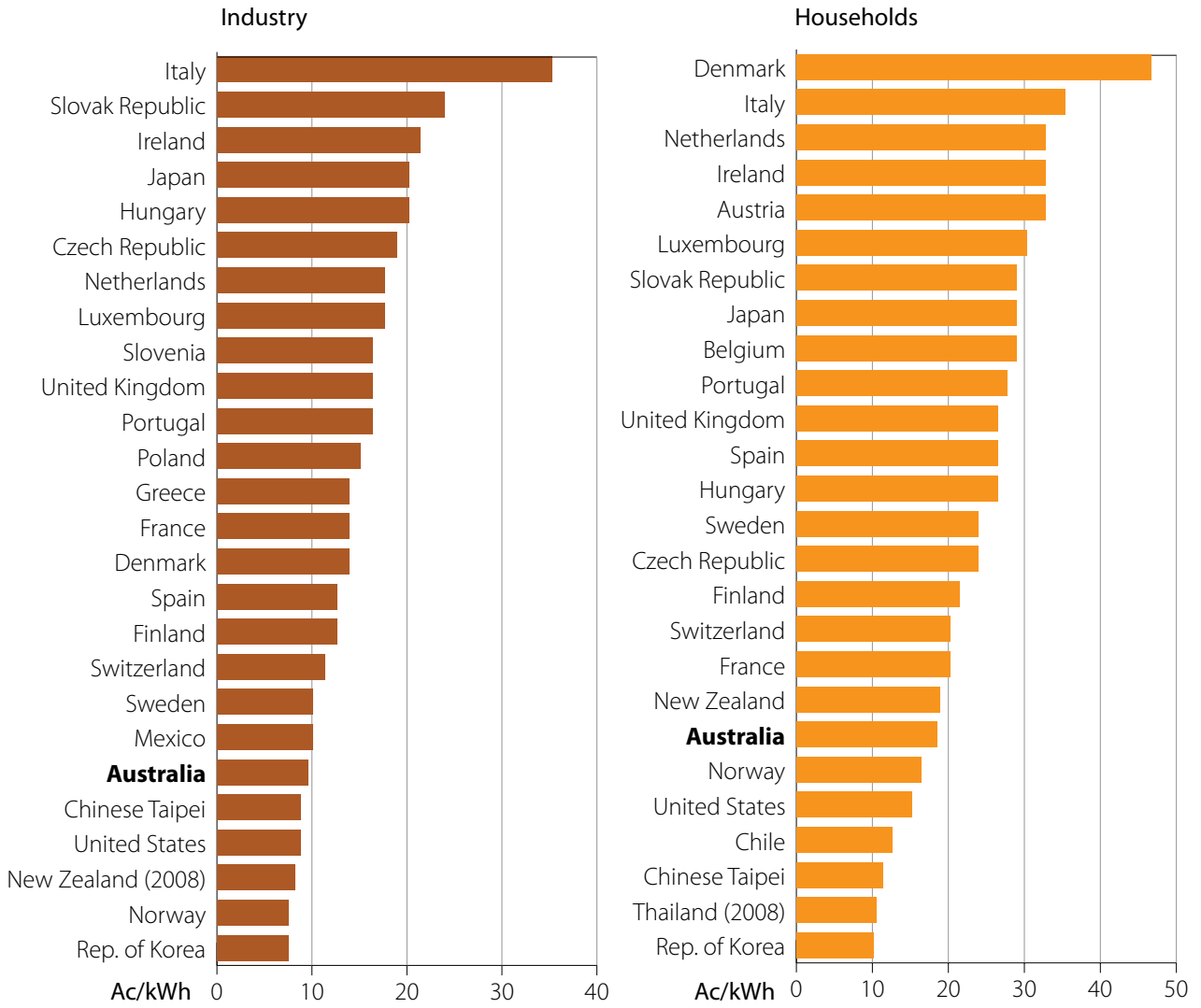
The Australian Government's Cyber Security Strategy, released in 2009, articulates Australia's cyber security policy. One of the strategy's objectives is that: 'Australian businesses operate secure and resilient information and communications technologies to protect the integrity of their own operations and the identity and privacy of their customers.' It is a strategic priority of the strategy to improve the detection, analysis, mitigation and response to sophisticated cyber threats, including a focus on critical infrastructure and other systems of national interest.

Competitiveness

Short term: The assessment is ***moderate*** for competitiveness over the short term.

As shown in Figure 4.5, Australia continues to have some of the lowest electricity prices in the OECD.

Figure 4.5: World electricity prices, selected countries, 2009



Source: ABARES, Energy in Australia 2011.

A 2010 AEMC report concluded that between 2009–10 and 2012–13 most Australian states and territories face nominal increases of 20–40 per cent in residential electricity prices (this does not factor in a carbon price impact).[59] This represents an average increase of 19 per cent in real terms.

The New South Wales Independent Pricing and Regulatory Tribunal (IPART) determined increases in average regulated household electricity prices in New South Wales of around 17 per cent from 1 July 2011.[60]

59 AEMC, *Future possible retail electricity price movements: 1 July 2010 to 30 June 2013*, December 2010, p. I, available at: http://www.aemc.gov.au/Market-Reviews/Completed/Future-Possible-Retail-Electricity-Price-Movements-1-July-2010-to-30-June-2013.html

60 IPART, *Consumer summary- changes in regulated prices from 1 July 2011*, IPART, June 2011, p. 2.

Drivers of price increases

The primary driver of price increases is the need for increasing network investment expenditure. Other factors contributing to price increases include rising wholesale electricity costs, and government schemes to reduce greenhouse gas emissions. The relative proportions of these drivers differ significantly across jurisdictions.

For example, as a result of changes to the RET scheme from 2011, IPART has determined an increase in electricity prices by a further 6 per cent from 1 July 2011, over and above its original estimated price rises of 10 to 13 per cent. [61]

Network charges: Nationwide, approximately 41 per cent of the estimated increase in residential electricity prices over the period 2009–10 to 2012–13 is due to increasing costs of electricity distribution services.

The increases in network costs have arisen from a number of factors, including the need for new assets and replacement of ageing assets, increases in peak demand, enhanced reliability requirements and higher costs of debt financing.

The contribution of network investment drivers is illustrated through the AER's April 2009 determination for New South Wales distributors.

It shows that of the $14 billion of approved capital expenditure over five years across the three distributors, asset replacement accounts for around 31 per cent and growth in electricity demand represents around 42 per cent. The remainder covers reliability and quality of service enhancements (9 per cent) and costs associated with environmental, safety, statutory obligations and other system and non-system assets such as information technology and business support (18 per cent).[62]

Ageing assets: With most of the existing electricity networks constructed in the 1960s and 1970s, significant investment is now required to replace and upgrade these older assets, which have reached the end of their service life.

A total of $33.3 billion in capital expenditure is forecast to be spent on distribution networks in the NEM and in Western Australia over the current regulatory determination, which is an increase of 54 per cent compared to the previous regulatory determination.[63]

This investment is critical to ensure that the continued reliability of supply is not compromised.

Increase in peak demand: The need to replace ageing assets is compounded by the need for networks to cope with growing energy loads as demand continues to rise. In particular, growth in appliances such as air conditioners, have significantly increased demand during peak periods, placing additional pressures on network infrastructure that requires augmentation. The use of air conditioners in Australian households has doubled over the past decade, and this upward trend is projected to continue.

Household growth: Population growth, particularly in some regions such as southeast Queensland, requires connection of expanding residential areas to the network.

Rising customer connections are highlighted in the AER's determination for New South Wales distributors in 2009. This revealed that, in the previous regulatory period, around 32 900 new customer connections occurred per year across the three distributors. The distributors forecast that the number of new connections would be 36 200 in 2009–10 and 42 200 in 2013–14.

This growth in residential demand comes from both population growth and a long-running and steady reduction in household occupancy levels. The Australian Bureau of Statistics forecasts that average household size in Australia will continue to decrease from 2.6 people per household in 2006 to between 2.4 and 2.5 people per household in 2031.[64]

61 IPART, *Consumer summary - changes in regulated prices from 1 July 2011*, p. 2.

62 AER, *Final decision – New South Wales distribution determination 2009-10 to 2013-14*, AER, Australia, April 2009.

63 AEMC, *Future possible retail electricity price movements: 1 July 2010 to 30 June 2013*, p. ii.

64 Australian Bureau of Statistics, *Australian social trends*, ABS, Australia, December 2010, p. 6 available at: http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/82A5CEFA5963E139CA2577F80010E013/$File/41020_astdec2010.pdf

Increasing reliability: To date, consumers have enjoyed stable or improving reliability of supply outcomes – the average duration of outages per customer in the NEM is 200 to 250 minutes per year. However, any improvement to the level of supply reliability will have costs.

Jurisdictions monitor and assess the reliability of distribution networks against performance standards, which account for the trade-off between improved reliability and cost. For example:

- In New South Wales, licensing requirements relating to network design, reliability and performance have been gradually enhanced, requiring greater expenditure by network businesses to ensure compliance.
- In Queensland, the state government acted to improve reliability through the introduction of performance requirements.

Higher costs of debt financing: In its determination for New South Wales distributors in 2009, the AER noted the higher costs of debt financing and the increased risk businesses faced in recovering the costs of debt as a result of the global financial crisis.[65]

The global financial crisis is therefore a contributing factor to higher network charges and this trend is expected to continue, as higher costs for debt financing for new generation, network investment and business operation will flow through in the investment needed to meet growing electricity demand.

The AEMC has also noted that rates of return on investor capital in the current regulatory period are in absolute terms generally more than 1 per cent higher compared to the previous regulatory period, following the increase in debt premiums from 1 per cent to 3 per cent in the wake of the global financial crisis.[66]

Wholesale electricity prices

At a national level, wholesale electricity cost increases are estimated to comprise 19 per cent of the total increase in residential electricity prices over the period 2009–10 to 2012–13.[67]

There are a number of factors behind higher wholesale cost allowances, including changes in the generation mix, higher capital costs for generators, increasing gas prices, and financing risks associated with uncertainty about carbon pricing implementation. These estimated cost increases do not include the impact of a carbon price.

Movements in the prices of natural gas and thermal coal could also have a significant impact on wholesale electricity prices, as will future carbon prices.

While it is difficult to predict the interaction of these elements on competitiveness, the risk is generally for a collective upside movement in fuel and electricity prices over the assessment period.

Natural gas: Australia has access to competitively priced gas, supported by mature long-term contracts predominately out of the Cooper and Gippsland basins and the North West Shelf fields.

Long-term contracts have also historically provided price stability, with base prices periodically adjusted to reflect changes in the consumer price index, but often capped by the price of coal.

It is difficult to establish current gas prices with certainty due to the confidential nature of gas contracts. Evidence suggests that since 2008, domestic gas prices in the eastern market have been stable at around A$2 per gigajoule (GJ) to A$4 per GJ.[68] While there have been reports of new long-term contracts in excess of $5 in the eastern market[69], the majority of gas contracts are in place until 2015.

65 AER, *Final decision – New South Wales distribution determination 2009-10 to 2013-14,* April 2009.

66 AEMC, *Future possible retail electricity price movements: 1 July 2010 to 30 June 2013.* November 2010, p. ii.

67 AEMC, *Future possible retail electricity price movements: 1 July 2010 to 30 June 2013,* p. ii.

68 EnergyQuest , *Energy Quarterly*, February 2008 to November 2011, Energy Quest, Australia.

69 EnergyQuest, E*nergyQuarterly November 2011,* Adelaide, 2011.

In the western market, prices have increased since the 2009 NESA. There have been indications that the average price of all wholesale domestic gas contracts in 2009–10 was around $3.70 per GJ, while prices for new wholesale domestic gas contracts are in the range of $5.55 to $9.25 per GJ.[70]

Coal: Coal is currently the cheapest fuel source in the NEM, ranging from below $0.50 per GJ for brown coal in Victoria to between $1.00 and $2.00 per GJ in New South Wales, Queensland, South Australia and Western Australia.

Strong international demand for coal over the past five years has resulted in substantial increases in export coal prices. From 1998 to 2003, thermal coal contract prices, in real terms (2008–09 US dollars), were between US$32 and US$52 per tonne.

Exports of thermal coal are sold both under long-term contracts (approximately 70 per cent) and on a spot basis (approximately 30 per cent). The spot price for export ex-Newcastle averaged US$124 per tonne or approximately A$4.20 per GJ in the first half of 2011.[71]

International and domestic coal prices are not directly comparable as they are of differing qualities (e.g. energy content) and export prices incorporate rail freight and coal washing costs. Furthermore, coal fired generators have generally been tied to long-term pricing contracts, which have locked these competitive fuel prices, and avoided links to international prices. This situation is likely to prevail in the short term.

Carbon pricing: A carbon price will directly affect wholesale electricity prices through the inclusion of the price in fossil-fuelled generators' bids for wholesale electricity dispatch.

The extent of cost pass-through to consumers will depend on regional market factors and the merit order that generators dispatch to the NEM. Coal-fired generators may experience limited capacity for full cost pass-through when gas-fired generators set the clearing price in the market.

Modelling conducted by Treasury on the government's Clean Energy Future package estimates that the carbon price will increase wholesale electricity costs by an average of $18 per MWh over the next five years.[72] To moderate impacts on electricity affordability for consumers and competitiveness for industry, low- and middle-income households and emissions-intensive, trade-exposed industries will be compensated for the effects of electricity price increases arising from the introduction of carbon pricing.

It also needs to be recognised that cost increases associated with the introduction of a carbon price will be partially offset by the removal of cost increases arising from reduced carbon policy uncertainty.

The 2011 study undertaken by Deloitte for the Australian Government noted that the longer the period of uncertainty, the greater the cost. If policy uncertainty had continued and only been resolved by 2017, the annual cost would have been around $1 billion per year, corresponding to an increase in wholesale electricity costs of around $5 per MWh. If resolution had been delayed until 2025, the annual cost could have escalated to almost $5 billion.[73]

Economic efficiency

Networks: Ensuring that electricity networks operate to their full economic potential is a particular challenge where networks are natural monopolies and charges are determined via regulatory determinations.

Concerns have been expressed by several bodies and experts, including the Garnaut Review, IPART and the Energy Users Association of Australia, that the current regulatory framework has led to overinvestment in networks and unnecessarily high electricity prices for consumers.

70 Parliament of Western Australia, *inquiry into domestic gas prices* Economics and Industry Standing Committee, Legislative Assembly, Parliament of Western Australia, 24 March 2011.

71 BREE, *Resources and energy quarterly,* vol 1, number 1, September quarter 2011, p29 available at: http://www.bree.gov.au/documents/publications/resources/ResEng_Quart_Sept11.pdf

72 Treasury, *Strong growth, low pollution: modelling a carbon price*, p. 122.

73 Deloitte, *Electricity generation investment analysis*, p. 7.

Given the impact of network expenditure on consumers' energy prices, it is important to ensure that energy network frameworks are providing a balance between necessary investment and efficient outcomes for consumers. Network companies need to have sufficient incentive to maintain and operate networks and invest in their upgrade to replace ageing infrastructure and meet increasing demand. However, network investment needs to be carried out in a cost-effective manner. It is important that the costs that consumers face reflect efficient investment outcomes based on expectations of the reliability of supply.

The AER has undertaken an internal review of the rules it is required to apply when considering investment proposals from network businesses. As a result of the review, the AER has proposed changes to rules to ensure that they better reflect the legislated objective of promoting efficient investment, operation, and use of energy services for the long-term interests of energy consumers.[74]

The AER considers that the current rules are highly prescriptive in regard to process and limit the ability of the regulator to exercise proper discretion in assessing key inputs to its decisions. The AER has prepared a rule change proposal which was submitted to the AEMC in September 2011.[75]

There are also opportunities to use demand-side participation to reduce the price pressures arising from the growth in peak demand. The Ministerial Council on Energy (now the Standing Council on Energy and Resources) agreed on the terms of reference for stage 3 of the AEMC's review of demand-side participation. This will enable the AEMC to extend and broaden its work to identify further cost-effective opportunities for demand-side participation.

Downward pressure on network costs can also arise from reductions in electricity losses in the transmission and distribution networks. Australia has a geographically extensive electricity grid and reducing losses could be of significant benefit economically and environmentally.

Under the Australian Government's carbon pricing package, networks will be included in the *Energy Efficiency Opportunities Act 2006*. The networks will be required to identify measures to reduce losses in the networks, where the benefits to the market of doing so clearly outweigh the costs.

Wholesale electricity market: While a market exists for the provision of wholesale electricity, it is important to ensure that the market is administered efficiently.

In June 2011, the AEMC decided to make a rule change regarding reliability settings from 1 July 2012. The rule establishes a process of indexation to preserve the real values of the market price cap and the cumulative price threshold over time.

The market price cap and the cumulative price threshold are key parameters governing the price envelope within which energy supply and demand are balanced in the NEM.

The market price cap is a cap on spot market prices in each half-hour trading interval and is currently set at $12 500 per MWh. This cap is reached occasionally, when generation or interconnection is at capacity and demand is high due to a temporary event such as a heat wave.

The cumulative price threshold governs the introduction of a lower administered price cap and is triggered if the sum of spot market prices over a consecutive seven-day period exceeds a certain level. The threshold is currently set at $187 500 to provide some financial protection to market participants from events driving extended high spot prices.

Concerns have also been raised by several organisations about the potential for electricity generators to exercise market power in the NEM and the resultant impact on electricity prices. In its *State of the energy market 2009* report, the AER raised concerns that generators were exercising market power in some regions. While the NEM has been designed to minimise the risk of market power, through an interconnected transmission grid that allows competition between generators, there are circumstances in which baseload generators can price capacity at around the market cap and be certain of at least partial dispatch. This behaviour is often more evident at times of peak demand, typically on days of extreme temperatures.

74 Reeves, *Find the balance – the rules, prices and network investment*, EUAA Seminar, 20 June 2011.

75 AER, *Promoting efficient investment – protecting consumers from paying more than necessary*, AER Executive Briefing, September 2011.

Transitory market power and price spikes are a feature of the energy-only market design of the NEM. The Energy Supply Association of Australia does not consider that there is evidence of the NEM failing to deliver sound outcomes or evidence of generators having sustained market power.[76]

In April 2011, the AEMC commenced public consultation on a rule change request in relation to the potential exercise of market power by generators in the NEM. The AEMC considers that regulatory intervention is only potentially justified if there is evidence that a generator has exercised, or is likely to exercise, substantial market power. This would involve conduct that sustains pricing above a level that would prevail in a workably competitive market.[77] Following public consultation, the AEMC is scheduled to issue a draft determination on the rule change request by April 2012.

Other climate change policy measures: A number of government policies to promote renewable energy–based electricity generation are funded from the prices paid by consumers for electricity.

These policies contribute directly to higher retail electricity prices, and depending on the level of uptake, have the potential to place further upward pressure on prices.

In 2010, the Australian Government split the RET into the LRET and the SRES. Under this arrangement, the level of assistance that was provided for eligible small-scale generators, such as those for household photovoltaic systems, was initially five times higher than the assistance to large-scale generators. This level of assistance was scheduled to be gradually phased down to the same level as large generators over the period 1 January 2011 to July 2015.

Feed-in tariff schemes are based on the market or, in some instances, governments paying owners of small-scale photovoltaic generation a premium rate.

In the case of market-based feed-in schemes and the RET, the costs of these premium rates are typically spread across all electricity consumers. In the case of photovoltaics, the combined impact of the SRES and feed-in tariff schemes has placed significant upward pressure on electricity prices.

As a result, in New South Wales in June 2011, the IPART approved increasing electricity retail prices by 6 per cent to accommodate the additional cost impost on electricity retailers.

The New South Wales and Australian governments subsequently reduced the level of incentives they provide for photovoltaic systems, and the New South Wales Government also suspended its feed-in tariff measure (Solar Bonus Scheme) to new participants.

The Australian Government plans to bring forward its planned phase-down of the level of assistance under the SRES to the same level as large-scale generators by 1 July 2013.

Water reform: The National Water Initiative, signed by all Australian jurisdictions, establishes the blueprint for a market-based approach to sustainably managing Australia's water resources.

Once the initiative is fully implemented, thermal electricity generators will have the option of acquiring water from markets rather than being faced with the prospect of water restrictions as has previously occurred during drought conditions. Drought was a key issue in the 2009 NESA assessment.

The National Water Initiative could improve electricity supply reliability and place downward pressure on any price rises arising from reduced water availability in the future. Many generators have also taken subsequent steps to drought-proof their generation activities.

Medium and long term: The assessment continues to be ***moderate*** for competitiveness over the medium and long terms.

76 ESAA, *Submission to the AEMC – National electricity amendment (potential market power in the NEM) Rule 2011:* Consultation Paper 14 June 2011.

77 AEMC, *Directions paper, National electricity amendment (potential generator market power in the NEM) Rule 2011*, 22 September 2011, pp i-ii.

It is likely that the real increases in electricity prices that are currently being experienced will continue into the medium and long terms.

The relative role of many of the underlying drivers is likely to change. Many of the factors underpinning major increases in network charge are a one-off, such as higher costs of finance, or are cyclical nature, such as asset replacement, and unlikely to be as significant in five years as they are today.

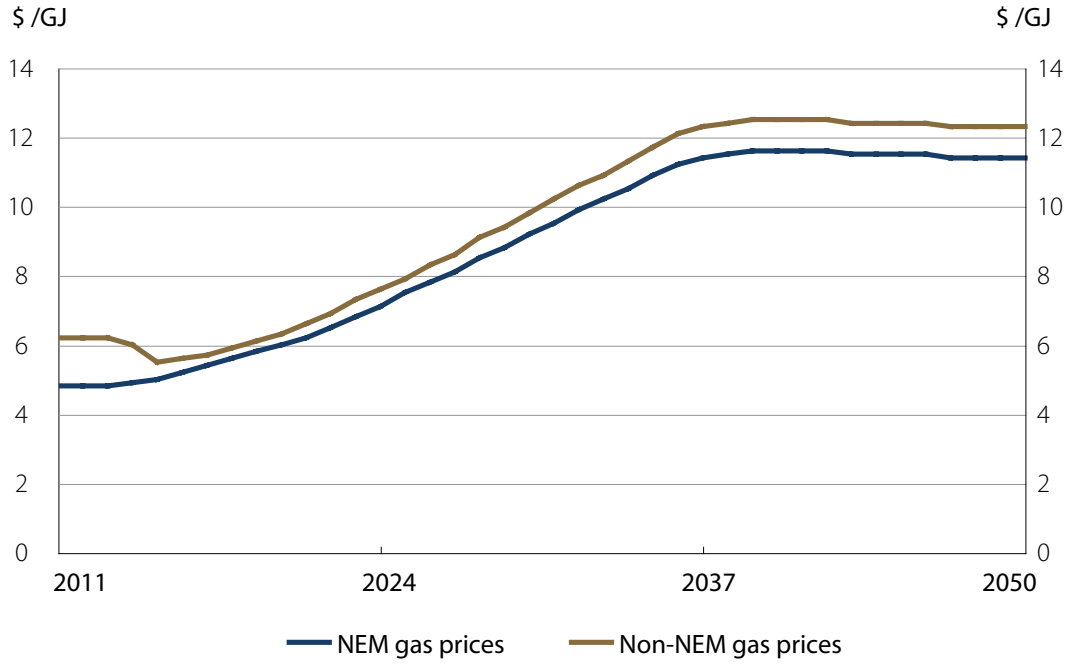
Climate change measures are likely to place upward pressure on electricity prices as the carbon intensity of the Australian economy progressively declines in accordance with Australia's international commitments.[78]

The extent to which climate change measures place upward pressure on electricity prices will depend upon a number of factors, including:

- the level of global ambition and any subsequent agreement to limit greenhouse gas emissions
- the level of the Australian contribution to global action on reducing greenhouse gas emissions
- the cost of low-emissions electricity generation technologies
- the efficiency and effectiveness of action by various levels of government in Australia
- the price of gas and the relativities between the prices of coal and gas.

Treasury has assumed that domestic gas prices follow a similar path to international prices given the influence of LNG projects in Western Australia and Queensland. Figure 4.6 shows the projected domestic gas prices for the NEM and non-NEM markets.[79]

Figure 4.6: Domestic Australian gas prices – medium global action scenario



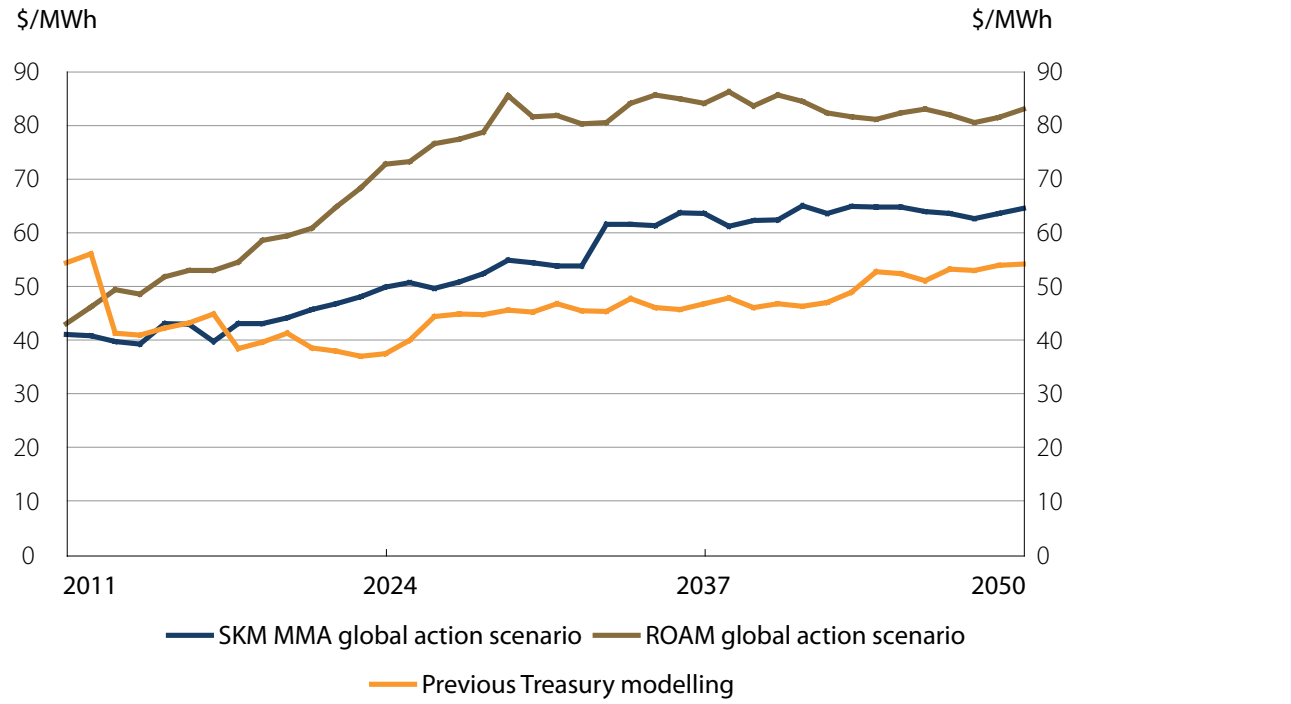
Source: Treasury, *strong growth, low pollution: modelling a carbon price*, Commonwealth of Australia., Canberra 2011.
Note: prices in 2010 dollars.

78 Australia has committed unconditionally to reduce its emissions by five per cent from 2000 levels by 2020.

79 Treasury, *Strong growth, low pollution: modelling a carbon price*, p. 73.

The Treasury modelling of the carbon pricing scheme includes electricity price forecasts over the assessment period. Treasury confirms (see Figure 4.7[80]) that even in the absence of a carbon price, wholesale electricity prices grow significantly over the next 10 years, partly driven by higher gas prices and increased costs of new generation capacity. The modelling also reveals that over the next five years, household electricity prices are projected to increase by a further 16 per cent[81] in the absence of a carbon price.

Figure: 4.7: Wholesale electricity prices



Source: Treasury, *strong growth, low pollution: modelling a carbon price*, Commonwealth of Australia, Canberra 2011. Average of medium and ambitious global action scenarios.
Note: Prices in 2010 dollars.

Under its carbon price scenarios, Treasury estimates that, in the medium and long terms, average wholesale electricity prices roughly double (see Tables 4.3 and 4.4).

Average household electricity prices also rise, but to a lesser extent, reflecting the fact that wholesale prices only make up about half of the contribution to retail price increases.

As previously noted, the Australian Government will provide low- and middle-income households and emissions-intensive trade-exposed industries with assistance for the effects of electricity price increases arising from the introduction of carbon pricing. This will provide significant support in protecting the competitiveness of these industries from risks of carbon leakage. These are important factors in the assessment rating for competitiveness remaining at ***moderate*** in the medium to long term.

It is also important to recognise that competitive electricity prices are one of a number of factors that will determine whether future investment will occur in energy-intensive industries.

80 Treasury, *Strong growth, low pollution: modelling a carbon price*, p. 167.

81 Treasury, *Strong growth, low pollution: modelling a carbon price*, p. 74.

Historically low-cost energy resources, such as coal and gas, were a key factor in attracting resource processing activities, such as aluminium smelting, to Australia, outweighing competitiveness disadvantages such as geographic isolation from major markets and high labour costs compared to non-OECD countries.

However, this competitive advantage is likely to diminish as increasing global demand for Australia's energy resources is likely to lead to domestic energy prices trending towards international parity and as developing countries increasingly compete for projects based on their lower costs for labour and resources and improving political stability.

Table 4.3: Average wholesale electricity price increases – arising from the introduction of carbon pricing (%)

	2013–2017	2018–2022	2046–2050
NSW	39	35	122
VIC	46	39	84
QLD	49	43	122
WA	33	37	101
SA	41	35	68
TAS	42	43	80
National average	**43**	**38**	**107**

Note: Prices in 2010 dollars.
Source: Treasury, Strong growth, low pollution: modelling a carbon price, Commonwealth of Australia, Canberra, 2011. Table 5.14 - updated

Table 4.4: Average household electricity price increases – arising from the introduction of carbon pricing (%)

	2013–2017	2018–2022	2046–2050
NSW	10	8	35
VIC	11	8	31
QLD	11	8	34
WA	10	10	38
SA	9	7	23
TAS	9	9	28
NT	9	6	23
National average	**10**	**8**	**32**

Note: Prices in 2010 dollars.

Source: Treasury, *Strong growth, low pollution: modelling a carbon price - update*, Commonwealth of Australia, Canberra, 2011, Table 5.15- updated.

Box 4.4: Electricity shock scenario

Frontier Economics modelling

Description

The electricity shock scenario involved modelling the effects of the sudden exit or failure of the Loy Yang A power station in Victoria. Loy Yang A is the largest generator in the Victorian region of the NEM, with winter maximum capacity of 2270 megawatts.

The electricity shock scenario was defined to include two different kinds of events affecting Loy Yang A power station:

- A full power station forced outage of 14 days duration during
  - a peak period in 2011–12 and 2015–16
  - a shoulder period in 2011–12 and 2015–16.
- The permanent exit of the power station from the National Electricity Market (NEM), commencing at the beginning of 2012–13. The permanent exit was assumed to result from an unexpected event, such that there was no advance notice of the exit of the power station.

While a specific piece of infrastructure, in this case the Loy Yang A power station, was used to provide 'real world' information, it is neither a reflection on the infrastructure's redundancy and/or mitigation plans that exist to prevent a loss of capacity, nor a reflection on the reliability of the infrastructure or current and future Australian Government energy policies.

Modelling framework

In examining outcomes from the electricity shock scenario, Frontier Economics adopted a three-staged modelling approach, which made use of three interrelated electricity and gas market models: WHIRLYGIG, SPARK and WHIRLYGAS.

Both WHIRLYGIG and SPARK incorporate a representation of the physical infrastructure in the NEM that includes all existing generation plant in the NEM (including technical and cost information for the existing plant), all existing interregional interconnectors in the NEM, demand forecasts for each region in the NEM and options for new generation plant.

WHIRLYGAS incorporates a representation of the physical gas infrastructure in the eastern states that includes all existing production plant, all existing transmission pipelines, demand forecasts for each region and options for new plant and pipelines.

Modelling assumptions

Where possible, Frontier Economics adopted input assumptions developed by the Australian Energy Market Operator (AEMO). The major sources were:

- AEMO, *Electricity Statement of Opportunities for the National Electricity Market*, 2010. This was the source for system demand forecasts.
- AEMO, *National Transmission Network Development Plan*, 2010. The plan's modelling assumptions (supplied by ACIL Tasman and the Electric Power Research Institute) and input tables, both released with the plan, were the source for most of the input assumptions for existing and potential new generation plant.

The modelling also assumed that existing climate change policies, such as the Renewable Energy Target, would be in place together with a carbon price starting at $20 per tonne of carbon dioxide beginning in July 2012 and increasing by 4 per cent per annum in real terms. It should be noted that this price was an assumption only for the purposes of modelling the shock scenario and did not attempt to model the final price and trajectory of the Australian Government's carbon pricing mechanism (details of the government's scheme had not been announced when the modelling was carried out).

AEMO additional modelling

At the request of the Department of Resources, Energy and Tourism, the Australian Energy Market Operator (AEMO) was also asked to undertake 'monte carlo' modelling of the Loy Yang A permanent exit scenario. The base modelling used by AEMO was the same as that used for AEMO's Energy Adequacy Assessment Projection reports and the Power System Adequacy report.

The modelling incorporated all interregional and intraregional network constraints and incorporated two demand forecasts based on a combination of studies performed using 10 per cent and 50 per cent probability of exceedence demand traces, which are consistent with the 2011 peak demand forecasts provided by the jurisdictional planning bodies and published in the 2011 Electricity Statement of Opportunities.

Given this, the AEMO's modelling reflects a range of potential outcomes, including some outcomes in which outages at other power stations coincide with high levels of demand (including demand from the medium growth, 10 per cent probability of exceedence forecast).

Analysis

Frontier Economics' modelling showed that the permanent exit of a Victorian baseload power station was not likely to result in a significant and ongoing reduction in reliability in the electricity market.

The analysis by the AEMO indicated that, with no investment response, there would likely be unserved energy in excess of the reliability standard in Victoria, New South Wales and Queensland. However, Frontier Economics' modelling indicated that there would be significant investment in open-cycle gas turbine plant one year after the permanent exit of the power station and significant investment in combined-cycle gas turbines plant two years after the permanent exit. That investment would mitigate any increase in unserved energy.

The permanent exit of the power station would result in substantial increases in the cost of meeting demand, particularly in the two years before an investment response from combined-cycle gas plant. Even following the investment response, prices would remain higher as a result of the permanent exit of a lower-cost baseload power station.

The price increases caused by the permanent exit would ultimately result in higher retail electricity prices, with residential electricity tariffs likely to increase by around 24 per cent in 2012–13 and 18 per cent in 2013–14. To the extent that electricity retailers had not fully hedged their retail load (through contracting or vertical integration) and were unable to pass on those additional costs to end users immediately, the electricity price increases would also result in substantial financial losses to those retailers.

In the gas market, the analysis also showed that there was likely to be sufficient capacity in gas infrastructure in the NEM region to manage the permanent exit of the power station, although there could be short-term capacity constraints affecting particular gas infrastructure. However, Frontier Economics considered that the flexibility in the electricity market and the gas market would mean that even short-term capacity constraints would not result in a significant reduction in reliability. Any short-term capacity constraints to gas infrastructure would likely increase the cost of meeting electricity demand.

It should be noted that Frontier Economics modelled 'system normal' [a] conditions for the electricity transmission system. A significant transmission outage occurring during the first two years after the permanent exit of the power station (before investment responded) might increase the likelihood of a reduction in reliability. In Victoria, the majority of transmission constraints were expected to occur on the section of the grid between the Melbourne node (where most load is located) and the La Trobe Valley (where most supply is located, including Loy Yang A power station). As such, the permanent outage of Loy Yang A would in all likelihood lead to less transmission constraints in Victoria by freeing up capacity.

Orderly retirement

It should be noted that orderly retirement of generation capacity in a manner that signals to the market to bring on replacement capacity is quite different to a shock scenario where capacity leaves the market unexpectedly.

Source: Frontier Economics, *NESA- electricity shock scenario*, A Final Report prepared for the Department of Resources, Energy and Tourism, November 2011.

a System normal is a configuration of the power system in which all major transmission elements are in service.

Appendix

NESA consultation stakeholders

The following organisations attended workshops and/or made non-confidential submissions to the 2011 NESA.

7-Eleven	Exxon Mobil
AGL	Horizon Power
Alcoa	Hydro Tasmania
Australian Institute of Petroleum	International Power
APA Group	Loy Yang Power
Apache Energy	LPG Australia
Australian Pipeline Industry Association	Neumann Petroleum
Aurora Energy	NT Chief Minister's Department
Australian Energy Market Commission	Primary Industries and Resources SA
Australian Energy Market Operator	Qantas
Australian Petroleum Production and Exploration Association	Queensland Department of Employment, Economic Development and Innovation
Beach Energy	Retail Energy Market Company
Biofuels Association of Australia	Rio Tinto
BHP Billiton	Shell Australia
BP Australia Pty Ltd	Synergy
Caltex	Tarong Energy
Dampier to Bunbury Pipeline	Tasmanian Department of Infrastructure, Energy and Resources
Delta Electricity	Transend
DomGas Alliance	Verve Energy
Electranet	Wesfarmers
Energy Retailers Association of Australia	Woodside Energy
Ergon Energy	WA Gas Network
ERM Power	WA Department of Transport
Energy Supply Association Australia	WA Office of Energy

Abbreviations and acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BREE	Bureau of Resources and Energy Economics
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ESAA	Energy Supply Association of Australia
ESOO	Electricity Statement of Opportunities
GDP	gross domestic product
GSOO	Gas Statement of Opportunities
IEA	International Energy Agency
IPART	Independent Pricing and Regulatory Tribunal
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LRC	low reserve condition
LRET	Large-scale Renewable Energy Target
NEM	National Electricity Market
NWIS	North West Interconnected System
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
RET	Renewable Energy Target
SCADA	supervisory control and data acquisition
SRES	Small-scale Renewable Energy Scheme
SWIS	South West Interconnected System
WEO 2011	World energy outlook 2011

Units

GJ	gigajoule
GWh	gigawatt hour
kW	kilowatt
mb/d	million barrels per day
ML	megalitre
MW	megawatt
MWh	megawatt hour
PJ	petajoule
TJ	terajoule