Delivering energy price security in an age of uncertainty

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A portfolio approach to electricity system development in Australia

This paper provides preliminary evidence of a possible threat to Australia’s electricity price security. International linking of Australia’s gas market may expose domestic gas prices to significant uncertainty and volatility in international markets. If Australia has invested heavily in gas generation for bulk energy production, this could pass through to electricity prices.

This may constitute an economic driver for supporting the development of a diverse generation portfolio including significant renewable energy to manage fuel price risk. This paper outlines the potential materiality of these issues, and highlights the need for further quantitative analysis to ensure an affordable electricity future for Australian consumers.

Executive Summary

While energy security has historically been thought of in the context of threat of abrupt supply disruptions, it can also apply where there is the potential for sudden, unexpected high prices over which there is little domestic control or ability to respond. This is consistent with the International Energy Agency (IEA) definition that energy supply is "secure" if it is adequate, affordable and reliable [1].

Energy price security has not typically been an issue for electricity production in Australia, given our abundant domestic fossil fuel resources. However, by the IEA definition, the current combination of circumstances (outlined below) has the potential to threaten Australia's electricity price security. This arises because of two distinct developments that could link our electricity prices to international gas prices:

1. Domestic gas price linking to international gas price – East coast domestic gas markets are likely to become linked to international gas markets in the near future via the development of a large Liquid Natural Gas (LNG) export industry. This creates a growing degree of domestic gas market exposure to the uncertainty and volatility inherent in international markets. This has translated into material uncertainty over future domestic gas prices, as illustrated in Figure 1.

2. Domestic gas price linking to electricity price – There is expected to be a strong trend towards investment in gas fired generation. If investment is in plant designed for bulk energy production from gas (combined cycle gas turbines, rather than gas peaking plant), electricity prices are likely to become increasingly linked to domestic gas prices, passing through gas fuel costs to consumers.

These two factors mean that Australian electricity prices could become exposed to the possibility of sudden, unexpected high international prices over which we have little domestic control or short term ability to mitigate. Electricity markets are composed of long lived assets with long development timeframes. This means that they respond to fuel price volatility by passing through higher electricity costs to consumers for extended periods of time before new generation assets that are more competitive under the prevailing pricing regime can be installed.

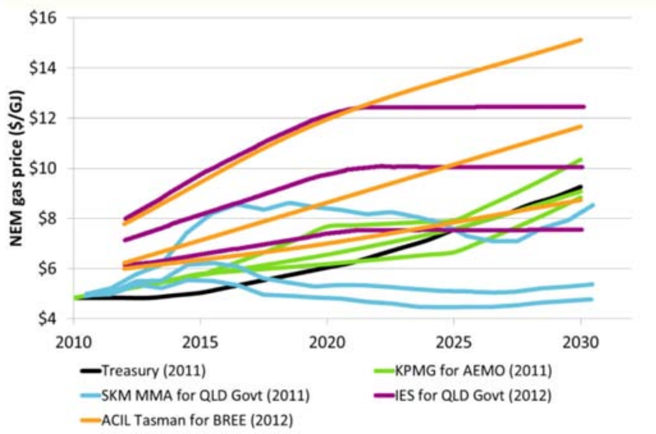

Figure 1 – Recent domestic gas price forecasts from a range of sources [2, 3, 4, 5, 6, 7], in real 2012 Australian dollars. A significant range is apparent, even in the near term, indicative of the high level of uncertainty over future domestic gas prices.

The potential rise in electricity price volatility and uncertainty can be addressed by the development of a diverse generation portfolio. Renewable generation, in particular, has been recognised internationally for its value in mitigating fuel price volatility in electricity markets [8, 9, 10, 11, 12, 13, 14]. Continued investment in renewable generation in Australia allows bulk energy production from renewables rather than gas. Although the least expensive renewable technologies are generally variable in nature, with increasing quantities of energy being supplied by renewable sources, a larger proportion of new gas-fired plant can fulfil a peaking role (rather than bulk energy supply) [15]. This has the potential to de couple electricity prices from gas prices, increasing energy price security.

Australia has the opportunity to learn from the experiences of other nations, and move pre-emptively to prevent these issues from arising in our market [16, 17, 14]. It is apparent that the Renewable Energy Target (RET) is an existing initiative that helps achieve this goal. By contrast, the evidence outlined here suggests that removal of the RET scheme could result in significantly higher costs to consumers when fuel price risk is taken into account.

This preliminary analysis suggests that the materiality of these issues is significant, and warrants further quantitative analysis to determine optimal policies, and ensure we reach the ideal outcome for Australia.

The rise of gas

The current generation portfolio in the National Electricity Market (NEM), the interconnected electricity network on the Australian eastern seaboard, is dominated by coal-fired plant. However, existing capacity aside, the majority of investment in generation in the NEM over the past decade has been in gas-fired technologies (combined cycle turbines and peaking generation) and wind generation, as illustrated in Figure 2.

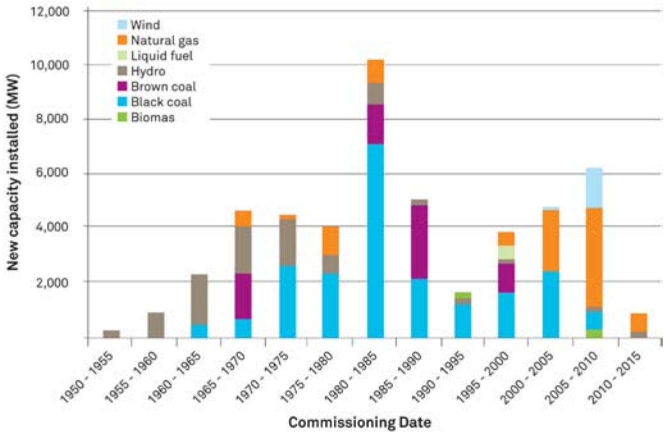

Figure 2 – The trend to gas is already happening (data from AEMO 2010 NTNDP [18])

In deciding which technologies to develop, investors in the competitive market seek profit maximising solutions within the constraints imposed. In the NEM at present this means investing in gas-fired generation (either peaking or combined cycle turbines) or wind generation (supported by the Renewable Energy Target (RET)). Other generation types are considered unlikely for wide-scale deployment in the NEM during the next decade for the following reasons:

– Although the majority of existing coal-fired assets are likely to remain viable for some time, installing new conventional coal-fired technology is considered to have a high investment capital risk due to the certainty of emissions reduction incentives (regardless of whether the present carbon pricing scheme continues). There remains a possibility that the government will choose to 'de-risk' investment in new coal-fired plant and support their development in the market. However, given the political controversy around the issue, and the growing pressure to meet emissions reduction commitments, this is considered unlikely.

– Nuclear development is highly politically sensitive, and is likely to remain so for the foreseeable future.

– Hydro and biomass technologies may offer some opportunities for further deployment, but due to resource limitations this is not likely to be widespread.

– Geothermal, tidal, wave, carbon capture and sequestration and other emerging technologies are not likely to be commercially viable until beyond 2030 [18].

– While solar thermal technologies can be considered technically demonstrated, these remain extremely high cost and require substantial additional subsidies.

This means that under present policy, it is likely that the majority of new generation developed in the NEM will be gas-fired (either peaking or combined cycle turbines), combined with variable renewable generation supported by the RET (predominantly wind, with a possible contribution from solar photovoltaics if cost reductions continue). This view is supported by the list of projects proposed for development in the NEM at present, illustrated in Figure 3.

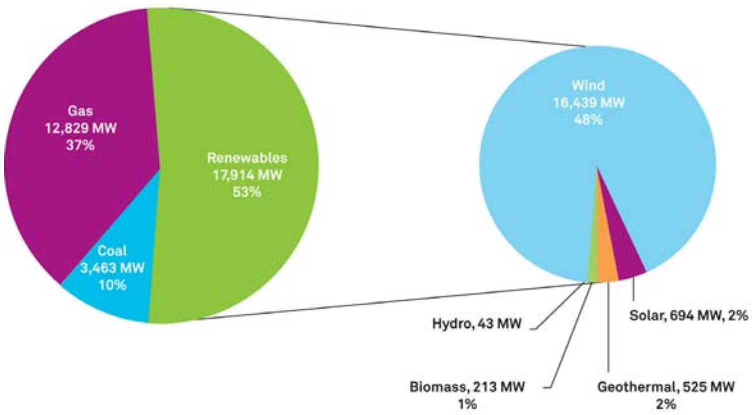

Figure 3 – Proposed new capacity in the NEM (data from AEMO ESOO 2011 [19])

The RET scheme is widely acknowledged to be essential for continued deployment of renewable technologies in Australia over the next decade. Even with the introduction of a carbon price, it is likely that prices in the range \$50-\$70/tCO2-e would be required to support renewable development in the absence of the RET. Prices at these levels are not anticipated prior to 2030 [2].

With continued development of wind and other renewable generation under the RET, it is anticipated that new gas-fired generation will be predominantly peaking plant, providing new capacity to meet growing peak demand and supported by revenue in rare high priced periods. With renewable generation providing significant quantities of energy to the market, average wholesale prices are likely to remain low and insufficient to support the development of significant combined cycle or other higher capacity factor gas-fired plant. In this case, gas prices could be expected to remain a relatively less significant driver of electricity prices, since the bulk of energy remains provided by other sources[1].

In the absence of the RET it could be anticipated that a larger proportion of investment would be in combined cycle gas turbines, or other gas-fired plant intended to operate at high capacity factors [15]. Without the deployment of significant renewable energy, average electricity prices are likely to rise sufficiently to support new combined cycle plant. In this case, gas prices could be expected to become a significant driver of electricity prices.

International linking of domestic gas market

With the exploitation of large coal seam gas resources on the east coast, a range of companies are seeking to rapidly develop a LNG export industry. Projects that are well progressed are listed in Table 1.

Table 1 – LNG projects sanctioned or proposed for development on the east coast of Australia [5]

Project name	Owner	Two train project size (tonnes of LNG pa)	Announced commissioning
Queensland Curtis LNG (QC-LNG)	QQC (part of BG Group)	8.5 million	2014
Gladstone LNG G-LNG)	Santos/ Petronas/Total/ Kogas	7.8 million	2015
Australia Pacific LNG (APLNG)	Origin Energy/ ConocoPhilips/ Sinopec	9 million	2016
Arrow LNG	Arrow Energy – Shell/PetroChina	8 million	2017

The size of anticipated LNG exports is compared to the domestic gas market on the east coast in Figure 4. Only the sanctioned or close to development trains have been included. However, each of the proponents have indicated the possible eventual development of three to four trains per project, which would expand the LNG industry further [5].

1. It is important that appropriate market signals remain for investment in sufficient capacity to meet the reliability standard (ensuring system adequacy). However, the Renewable Energy Target is not considered likely to pose a threat to energy security or system adequacy.

Given the vast scale of the proposed LNG industry, it is clear that outcomes in the eastern Australian gas market will be strongly affected by future developments in the LNG market.

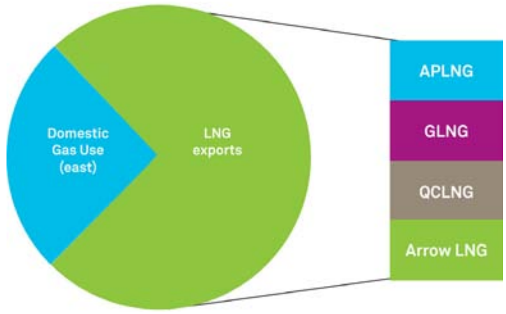

Figure 4 – Size of anticipated LNG exports compared to the domestic east coast gas market [5]

In the absence of market intervention, which is the government's preferred course of action at present [20], it is generally agreed that these developments mean that domestic gas prices will become linked to international prices. With domestic gas producers having established access to international markets, domestic gas consumers will need to compete with international LNG buyers for gas contracts. As stated in the recent Energy White Paper [20]:

"There is little doubt that Australia's east and west coast gas markets are increasingly linked to international markets."

Further, from the Bureau of Resources and Energy Economics in its recent Gas Market Report [7]:

"Eastern market wholesale gas prices are projected to rise sharply over the short to medium term as prices converge towards LNG netback prices in anticipation [of] gas exports beginning in 2014."

Gas price uncertainty

There is significant uncertainty as to how global energy markets will evolve. We are entering a decade where countries such as China and the emerging Asian economies are growing in their influence over global energy security. Global markets will be impacted by their degree of economic growth and corresponding growing demand for energy, their energy technology policies and their impact on the supply chain in general as 'factories of the world' [21]. Furthermore, we can expect policy changes in nations around the world in response to changing economic conditions and growing pressures for increased climate change mitigation. Unexpected regulatory impacts and technology development could also have unanticipated consequences for fuel markets. As stated by The Executive Vice President of BP [22]:

"we are settling into an 'age of uncertainty"

With particular relevance to the impacts of these factors on gas markets, the IEA states that [23]:

"Natural gas is subject to greater uncertainty than many other fuels because it is the back-up fuel in many sectors, so demand for it can be disproportionately affected by policy changes or price disparities."

There is great uncertainty at present over the development of an LNG export industry in the United States and Canada. Large reserves of shale rock gas have been recently exploited in the US and Canada, and have flooded their domestic market, with US gas prices falling by almost 80% over the past four years [24]. This has ignited serious interest in the development of an LNG export industry in the USA, to access significantly higher priced gas markets in the growing Asian economies. The development of this industry has become the topic of extensive political debate in the USA, with concerns over the impact upon job creation, trade and the local price of gas [24]. How this debate plays out will have significant consequences for the global market; if a large export industry is developed global prices could be significantly reduced. If international LNG prices fall far enough, the further development of an LNG industry in Australia may become unsustainable [7].

At present, many LNG contracts (particularly with Japan, Korea and Taiwan) are indexed against the international oil price [25, 26, 27, 28]. Indexing against oil was originally introduced to help ensure gas price competitiveness against alternative fuels, and to help integrate market changes without renegotiating long term contracts. Although the substitutability of oil and gas for bulk electricity production has decreased over time, there do remain a number of drivers for maintaining oil-linked pricing [7]. Demand-side competition between oil and gas does remain in some areas, namely in the heating sector (such as in Germany), and in peak electricity generation. Gas is also expected to become a more important transport fuel over time. Furthermore, there is supply-side competition between the resources used for the exploration and production of gas and oil. Also, at present, oil prices are seen to be less volatile, more transparent and less subject to manipulation than gas prices. Finally, no suitable alternative mechanism on which to base prices has yet been demonstrated in the Asian market [7].

For these reasons, oil-linked pricing is expected to remain dominant for long term LNG contract pricing in the Asia Pacific region for the foreseeable future [7]. However, emerging buyers of LNG, such as China and India, are resisting the explicit link to oil prices, arguing the decreasing relevance of this historical framework. If this trend continues, it is possible that a global and independent market for LNG as a separate commodity could emerge [24]. Alternatively, if the USA becomes a significant LNG exporter, Asian prices could eventually become linked to Henry Hub prices in the USA.

These various outcomes would have material consequences for pricing in Australia. With continued oil-linked pricing, at oil prices of USD100 a barrel, Australian LNG netback prices of around $7/GJ are predicted[2]. However, with linking to Henry Hub prices, LNG netback prices might be as low as $3.50-4.50/GJ [7]. There remains significant uncertainty over how this will evolve in the LNG marketplace.

In addition to uncertainty around the development of international gas markets, there is uncertainty in how the international linking of Australia's gas markets will evolve. This involves complex interactions between a range of different markets around the world, with the pricing interaction relying upon a complex and changing set of influences. As stated in the Energy White Paper [20]:

"The changing dynamics in gas (and electricity) markets have yet to mature and are not yet fully understood...While it is generally expected that [gas] prices will rise over the period, the speed and scale of these increases are far from clear."

Thus, while there is strong agreement over the international linking of the east coast domestic gas markets, there remains significant uncertainty over how this will play out in future domestic gas prices. To illustrate this, consider the wide range of recent gas price projections, several of which are illustrated in Figure 5. Many projections show prices rising significantly, while some scenarios in modelling performed for the Queensland Government by SKM MMA suggest the possibility that prices may remain relatively constant, or fall below present levels.

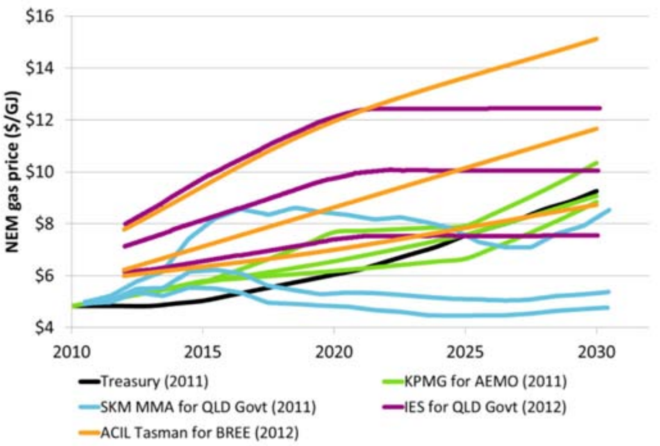

Figure 5 – Projected domestic gas prices from a range of sources [2, 3, 4, 5, 6, 7] in real 2012 Australian dollars. A significant range is apparent, even in the near term, indicative of the high level of uncertainty over future domestic gas prices.

This degree of uncertainty is material. Figure 6 shows the combinations of carbon and gas prices at which the long run marginal cost (LRMC) of combined cycle gas and wind generation are equivalent. At higher carbon and gas prices (above the line), wind is anticipated to be less expensive than combined cycle gas for bulk energy production, and vice versa. The magenta points indicate gas prices forecast by the Bureau of Resources and Energy Economics [6, 7] with carbon prices forecast by the Federal Treasury [2], and remain below the line until after 2020 (indicating that combined cycle gas is the lower cost generation option in this scenario). However, this is only one possible economic outcome, and as shown in Figure 5, the high degree of uncertainty over gas prices at present means that gas price projections vary widely. The range of gas price projections forecast in each year is illustrated by the magenta “uncertainty bars”. It is clear that the degree of uncertainty is material, compared with the relative costs of the two technologies. Carbon price uncertainty is not illustrated, but is similarly large.

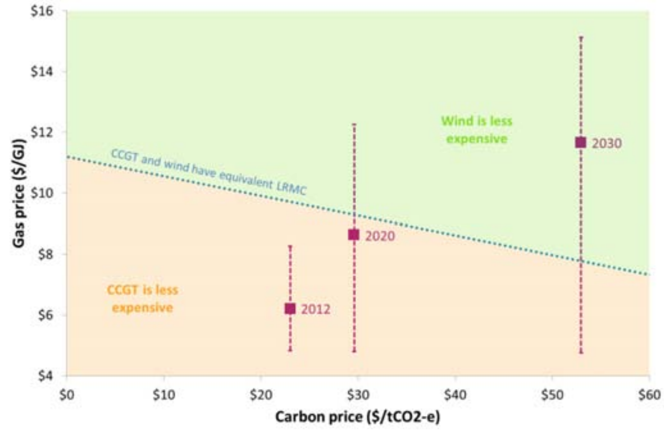

Figure 6 – A comparison of the long run marginal cost (LRMC) of wind and combined cycle gas turbines (CCGT), indicating the combination of carbon and gas price at which they are equal. The points in magenta illustrate carbon prices from the Treasury modelling [2] and the most recent available ‘medium scenario’ gas price projections from the Bureau of Resources and Energy Economics [6, 7], Uncertainty bars indicate the range of the highest and lowest gas price projections forecast for that year from the selection of recent gas price projections listed in Figure 5. The CCGT is assumed to operate at a capacity factor of 80%; other technology costs for LRMC calculation are from reference [18].

Gas price volatility

As well as increasing the degree of uncertainty over future domestic gas prices, the international linking of the Australian gas market is also likely to expose domestic gas prices to international market volatility. Ultimately, the presence of fuel price volatility could have far more significant consequences for the electricity sector than the potential pass-through of high prices.

If indexing of LNG prices against oil prices continues to be common practice, oil price volatility could translate directly to gas price volatility. Key drivers of oil price volatility include the availability of oil refineries, information release on depleting oil underground reserves worldwide and geopolitical events [29]. Significant geopolitical events affecting the global price of oil have included the Arab oil embargo in 1972, the Iranian revolution in 1978 and Saddam Hussein’s invasion of Kuwait in 1990 [30]. More recently, the conflict in Libya reduced exports of Libyan oil and gas, increasing the price of oil and gas worldwide [25].

It is also apparent that perception of the potential for imminent scarcity (rather than scarcity itself) may be a key driver of oil market volatility. As eloquently stated by The Economist [30]:

2. All price are in Australian dollars unless otherwise specified

"Two factors determine the price of a barrel of oil: the fundamental laws of supply and demand, and naked fear."

Even if the practice of indexing against oil prices ceases, the potential for significant volatility in future gas markets is recognised. For example, the International Energy Agency (IEA) states in commentary on their "Golden age of Gas" report [31]:

"Forget about straight line forecasts for natural gas demand and supply. The patterns can suddenly diverge from the conventional view in the most unexpected way."

Extreme weather events (such as hurricanes, heatwaves and bushfires) are already one of the most significant factors affecting large infrastructure involved in the extraction, processing and delivery of natural gas. For example [21]:

"In the summer of 2005, Hurricane Katrina shut off what amounted to around 19% of US refining capacity, damaged 457 pipelines and destroyed 113 platforms. Oil and gas production dropped by more than half; causing a global spike in oil prices. Much of the infrastructure destroyed in 2005 was rebuilt in the same location, leaving it vulnerable to similar weather events in the future."

Similarly in the Australian context [5]:

"For the second year in succession, extreme wet weather conditions impacted the Bowen and Surat Basins...severe rainfall and floods in summer 2011-12 again hampered access to gas wells. The adverse weather conditions had a major impact on the appraisal and development activities underway to prove up CSG reserves."

This suggests that as climate change progresses and the intensity and frequency of extreme weather events increases, it is reasonable to expect the possibility of more frequent supply disruptions, increasing volatility in international oil and gas markets [32].

Other natural disasters also affect energy markets in sudden and unpredictable ways. For example, the 2011 incidents at Fukushima have had a significant and immediate impact upon global gas markets by increasing Japan's LNG consumption [25]. Over the longer term, Germany's announced move away from nuclear power towards alternative energy sources (likely to include gas) provides a clear example of how such events can suddenly and unpredictably affect gas markets around the world [25, 33].

Exposure to volatility

In the past, the majority of gas in the Australian domestic market has been traded via long term contracts. This has been favoured by gas producers and consumers alike, since it provides long term certainty to underwrite large investments (whether they be in gas field development, or in combined cycle gas turbines). In the past, these gas contracts were generally based upon the cost of gas production plus an annual price escalator such as the consumer price index [7].

A significant proportion of long-term gas contracts in the Eastern market have expired within the last five years, and more are due to expire in the next five years [7]. The current market uncertainty is driving new domestic contracts to be much shorter term (five years). Also, many gas agreements are known to include "reset" or "re opener" clauses, which allow the price to be re negotiated on shorter intervals, or based upon certain pre designated triggers (such as high oil prices, for example). These factors could undermine the past trends in long term contracting and allow gas price volatility to translate into the electricity sector.

Electricity generation assets are long lived and have long development timeframes. This means that when fuel price volatility occurs, higher electricity costs are passed through to consumers for extended periods of time before new generation assets that are more competitive under the prevailing pricing regime can be installed.

Historical examples serve to illustrate this concept. Consider the case of a 250MW oil-fired steam turbine installed at Nordkraft in Denmark in 1967 [34]. It was commissioned in August 1973, only a few months before the first oil crisis began. It continued operation (on oil) through the two oil crises. In response to continued high oil prices, in the early 1980s it was decided to convert the power unit into a coal-fired unit, requiring substantial extra investment (rebuilding and expansion of the boiler, and the addition of coal storage and harbour facilities). The conversion was completed in the mid-1980s, at which time oil prices dropped again. The unit was then operated on coal until around the turn of the century. The unit was demolished a few years before oil prices rose again. The costs associated with operating this plant on high cost fuels was passed through to consumers over the life of the unit.

The impact of international fuel volatility on consumers has been observed in the UK, where the price of gas is identified to be the main driver of household electricity bills. Following the Fukushima incident and conflict in Libya, international gas prices rose significantly. Despite the remoteness of these events to the UK, they directly acted to significantly increase consumer electricity bills [25].

Similarly, more local drivers of fuel volatility can affect entire economies. As one example, consider the impacts of the Varanus Island gas explosion in Western Australia on 3rd June, 2008. The gas explosion at a processing plant on Varanus Island cut Western Australia's domestic gas supply by 30%. With the absence of alternative low cost generation this triggered a micro energy crisis. The WA Chamber of Commerce and Industry estimates that the event cost the state $6.7 billion.

Year-on-year electricity price volatility (caused by international fuel market fluctuations) carries a significant cost. As stated by Awerbuch [35]:

"An extensive body of research indicates that fossil volatility significantly disrupts the economies of consuming nations, potentially exacting hundreds of billions of dollars from the US and EU economies alone."

Coal markets

Questions have also been raised about an increased link between Australia's thermal coal market and international markets, potentially increasing competition for coal for domestic electricity production. Although this is not explicitly dealt with in detail in this paper, similar arguments could apply, and it has the potential to exacerbate the issues discussed.

An energy price security risk

Given our abundant fossil-fuel resources suitable for energy conversion, Australia has had relatively little exposure to energy price security issues related to electricity production. However, as outlined, this could change in the near future. While energy security has historically been thought of in the context of threat of abrupt supply disruptions, it can also apply where there is the potential for sudden, unexpected high prices over which there is little domestic control or ability to respond. This is consistent with the IEA definition that energy supply is "secure" if it is adequate, affordable and reliable [1].

Gas reservation policies

Concern over these issues and the general expectation of higher gas prices has prompted discussion on domestic gas reservation policies on the east coast. A 15% gas reservation policy has applied for some time in Western Australia, and the NSW Parliamentary Committee recommended in May 2012 that NSW implement a domestic gas reservation policy modelled on the Western Australian design [36]. The Queensland Government is also under pressure to consider similar policies [5].

However, gas reservation policies are likely to produce a sub-optimal response. While they may reduce prices in the short term, they can have the opposite effect over the longer term. Lower gas prices reduce market returns to gas producers and lower their incentive for future investments, reducing supply. Similarly, lower prices can increase domestic consumption, supporting the development of gas-intensive industries that may not be sustainable in the absence of the reservation policy.

For these reasons, the Federal Government's current position is that policy intervention to force domestic gas outcomes is "unwarranted". They state [20]:

"efficient domestic gas markets supported by robust regulatory frameworks are critical to delivering the required investment to meet gas demand growth. In this context, the Australian Government believes that it is essential to allow domestic gas markets to adjust to new dynamics rather than trying to constrain domestic prices through intervention."

Despite this recognition, there is a risk of increasing pressure on governments to implement intervention of some kind, as gas prices rise and the impacts of uncertainty and volatility become apparent. However, as discussed in the following section, it may be possible to alleviate exposure in the electricity sector by the application of a portfolio approach to the development of our electricity system. This may be sufficient to ensure electricity price security without the need for gas reservation policies.

The importance of a portfolio for energy price security

Energy price security can be addressed through the adoption of a portfolio approach to manage risk [35, 37, 38, 39, 40]. This approach recognises that "least cost" system development does not appropriately deal with uncertainty and the potential for market volatility. Given that this analysis suggests that these could be key characteristics anticipated in the energy sector in Australia over the coming decades, the adoption of a portfolio approach optimised under a range of possible economic outcomes would appear prudent.

Renewable energy, in particular, has been identified as having particular value in reducing the sensitivity of electricity systems to fluctuations in fuel prices [8, 9, 10, 11, 12, 13, 14]. Continued investment in renewable generation in Australia allows bulk energy production from renewables rather than gas. Although the least expensive renewable technologies are generally variable (non-firm) in nature, with increasing quantities of energy being supplied by renewable sources, a larger proportion of new gas-fired plant can fulfil a peaking role (rather than bulk energy supply) [15]. This has the potential to de couple electricity prices from gas prices.

The concept of a portfolio approach to generation system development is illustrated in Figure 7. Calculating system prices under only a single projection of external drivers (such as gas price) does not adequately take risk into account. When risk is not included, system prices appear to increase when renewables are added into the mix. However, when the system is conceptually adjusted back to the original level of risk (to allow fair comparison with the original fossil portfolio) system prices typically reduce with the inclusion of renewables [35].

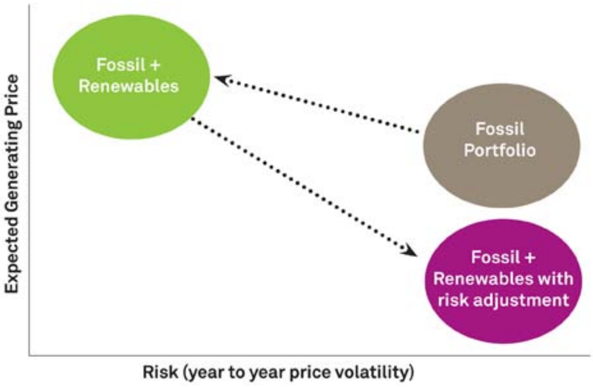

Figure 7 – The price of a generating portfolio must be considered over a range of economic scenarios, including consideration of potential risk. When renewables are added to the mix, portfolio prices rise and the overall risk profile of generation falls. Following inclusion of renewables we can optimise the mix to conceptually raise risk back to the original level (allowing comparison on an equivalent basis), at a lower generating price. Thus, when the cost of risk is included, the addition of renewables can reduce the expected price of the mix. Figure adapted from [35].

The use of portfolios for risk mitigation and reduction of exposure to volatility is standard in the finance sector. Investing entirely in a single option with projected maximum returns and 'putting all the eggs in one basket' would be considered high risk. Instead, investors typically seek to maximise portfolio performance under a variety of unpredictable economic outcomes.

Many retailers do vertically integrate and utilise generation portfolios to manage electricity market risk. However, if the majority of retailers consistently invest in gas-fired technologies for large-scale energy production, in the absence of differentiated competitors they will be able to effectively pass through gas price uncertainty and volatility to their retail customers. Thus, with effective hedging and vertical integration retailers could be expected to remain relatively indifferent to gas price uncertainty and volatility, but their customers would be exposed for extended periods of time before lower cost forms of generation can be brought to the market.

The value of a portfolio approach is being increasingly recognised and addressed by regulators and utilities. Twelve western American utilities have integrated renewable energy in their resource plans despite the fact that the majority had no renewable energy target or other external drivers; renewable energy was included only on the basis of its value in portfolio diversification [41]. In California, "promoting stable electricity prices by hedging against volatile natural gas prices" was identified as one of the primary reasons for introducing an ambitious 33% by 2020 renewable energy target [16]. The UK Government has similarly adopted a 15% renewable energy target by 2020, stating that [42]:

"[Renewables] will be crucial to help protect consumers from fossil fuel price fluctuations, help contribute to our long-term energy security, and drive investment in new jobs and businesses."

Similar drivers have been recognised by the European Union [43]:

"By increasing the amount of energy generated domestically from renewable sources, the EU should be able to reduce its dependency on fuel imports and improve the security of its energy supply."

It is recognised that there is an additional cost premium associated with portfolio diversification, since by definition it requires investment in technologies that are not the lowest cost. This paper proposes that the additional cost of diversification can be thought of as a type of 'insurance premium', since diversification towards a protective portfolio insures our electricity market against volatile fossil fuel prices. The insurance premium that we should pay in order to develop this protective portfolio will be dependent upon the likelihood of adverse events, and their consequences. In this case there is evidence that volatility is likely and could have severe consequences, suggesting that a high insurance premium could be justified.

Given the anticipated increase in gas prices over the coming decades, the premium required is likely to be small, as suggested by Figure 6. At gas prices of $11-$12/GJ, wind generation becomes competitive with a combined cycle gas turbine (CCGT), even in the absence of a carbon price and RET support. With a carbon price of $23/tCO2-e, wind competes at only $9-10/GJ [18], as illustrated in Figure 8. This indicates that the additional premium required to develop significant quantities of wind generation over the next decades could be small, and likely to be justified by the reduction in risk and exposure to volatility. Similarly, recent and continued cost reductions in solar photovoltaics put this technology at only a small additional cost.

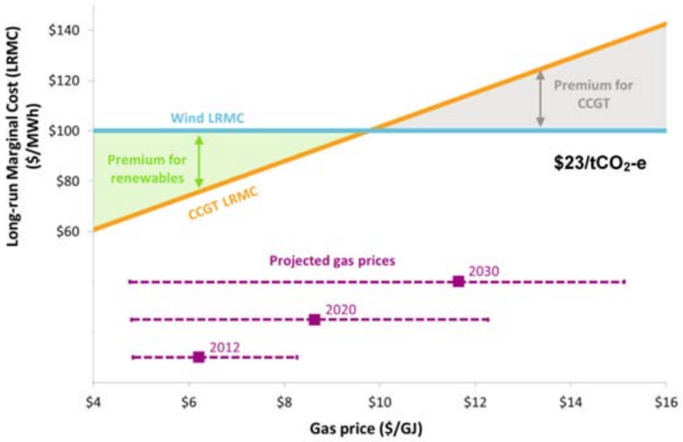

Figure 8 – A comparison of the long run marginal cost (LRMC) of wind and combined cycle gas turbines (CCGT), depending upon gas price. The additional premium required for renewables (wind) is illustrated in green. The gas prices illustrated in magenta are from the Bureau of Resources and Energy Economics [6, 7], with uncertainty bars indicating the range of the highest and lowest gas price projections forecast for that year from Figure 5. A carbon price of $23/tCO2-e has been applied, and CCGT is assumed to operate at a capacity factor of 80%. Other costs used for LRMC calculation are from reference [18].

In summary

With the development of an extensive LNG export industry, Australia faces a new potential threat to energy price security in our electricity supply. Domestic gas prices are likely to become exposed to potentially significant international price uncertainty and volatility. If Australia has invested heavily in gas-fired assets for bulk energy production, this uncertainty and volatility could translate into electricity prices This would potentially expose consumers to high prices for extended periods of time before new generation assets that are more competitive under the new pricing regime can be installed. This can be addressed by supporting the development of a diverse generation portfolio, particularly including renewable technologies (which are not vulnerable to fuel price volatility or uncertainty). While the development of an optimised portfolio involves an increase in cost under the 'most likely' economic scenario, over the full range of possible economic scenarios it reduces expected cost via a reduction in risk. This risk dimension must be taken into account for a valid comparison between alternative portfolios.

We are faced with an opportunity to recognise a potential threat to Australia's energy price security and learn from international experiences [14]. This analysis suggests that at moderate additional expense our electricity prices can be made more resilient against international market volatility, protecting the future of Australian businesses. For these reasons, the continuation of the RET scheme is likely to be of high value for maintaining a diverse generation portfolio and protecting Australia's economy.

Next Steps

This short paper provides only a preliminary overview of a range of extremely complex issues. Rather than providing all the answers, this paper aims to explore whether there may be important questions that warrant further analysis. This preliminary study does indicate that the issues involved could be highly material, and more detailed quantification specifically in the Australian east coast context is warranted.

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