

The (default) strategy determining the security of Australia's energy supply

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Abstract

The matter of Australia's energy supply security has been totally eclipsed by the current debate on climate change. Should we be concerned? What is energy security and how is it determined? What impact will climate change policies have on energy security? Does Australia need a national strategy? This paper seeks to answer these questions by first examining the concept of 'security of energy supply' which has quietly slipped into the energy lexicon and assumed a relatively prominent position without any meaningful discourse about its meaning or assumptions. It is contended that the concept is inherently slippery because of its polysemic nature having multiple dimensions and taking on different specificities depending on the country (or continent), timeframe or energy source to which it is applied. A four-dimensional grid of availability, adequacy of capacity, affordability and sustainability is proposed to assess energy supply security over the short and long term. The paper argues that, in the absence of a national strategy, the short and long term security of Australia's energy supply is being determined by default, by the conjunction of a vast range of existing policies, all of which have been specifically implemented to address other objectives. The impact of existing and potential 'non-energy-security' policies on Australia's supply security is shown by applying the aforementioned four dimensional-grid. A final section discusses the policy antagonisms within Australia's default strategy and concludes that the strongest threat, in the short and long term, to Australia's energy security is to adequacy of capacity.

1 Introduction

Australia is well endowed with energy resources and produces around three times more primary energy than it consumes domestically. It is the world's largest coal exporter, one of the largest exporters of uranium and liquefied natural gas but is a net importer of liquid fuels. Coal (41%) and oil (36%) dominate primary energy consumption with oil consumption growing most rapidly in recent years. Total energy consumption has more than doubled in the last thirty years and is currently increasing by a little less than 2.5% each year. Australia's three largest energy users are electricity generation, transport and manufacturing. Since the early 1990s total electricity consumption has increased by more than 50% and is forecast to grow by more than 60% from 2006 to 2030. Electricity is an input to every Australian good and service produced and consumed. More than 90% of Australian electricity is generated by fossil fuels (76% coal, 2% oil and 15% gas) and

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contributes nearly 40% to Australia's greenhouse gas emissions (ABARE 2008a, 2008b; DRET 2008c; Energy Futures Forum 2006, Syed *et al* 2007). Energy, in some form, is involved in most household activities and virtually all activities of Australian firms.

These energy 'mix' dimensions raise a number of fundamental yet significant issues for Australia's future growth prospects, and the general health and well-being of the population. What will *ensure* there is sufficient capacity to meet forecast energy demand levels? What will *ensure* energy being available when and where, and in the form, it is needed? Should affordability be a consideration to the supply of energy? What consideration should be given to the longer term sustainability of using fossils fuels to generate energy given the relationship to greenhouse gas emissions and climate change mitigation? These questions are germane to energy security.

As the debate has intensified about Australia's response to climate change, discussion has been seemingly transfixed on renewable targets, energy efficiency, adaptation measures and more recently, on a proposed emissions trading scheme (ETS). There is "no comparable crescendo of public concern about energy security" (Gault 2007: 1). The matter of Australia's energy supply security has been eclipsed by the focus on climate change. Should we be concerned about Australia's energy supply in the short or long term? What are the determinants of energy security? What impact will climate change policies have on energy security? Does Australia need a national strategy?

The paper seeks to answer these questions by first examining the concept of 'security of energy supply' through different definitions, inferred and explicitly stated, which have been increasingly used in recent decades. A four-dimensional grid of availability, adequacy of capacity, affordability and sustainability is proposed to assess energy supply security over the short and long term.^{1 2} This is followed by a discussion of the policy rhetoric and actions of the previous and current Federal Government. In the absence of a national strategy, it is argued that the short and long term security of Australia's energy supply is being determined by default. It is being determined by the conjunction of a vast range of existing policies, all of which have been specifically implemented to address objectives other than security of energy supply, albeit often within the energy sector. The proposed ETS and Mandatory Renewable Energy Target (MRET) will also have direct impacts. The impact of existing and potential 'non-energy-security' policies on Australia's energy supply security is shown by applying the four dimensional-grid presented earlier. A final section of the paper discusses the policy antagonisms evident within Australia's default strategy and the implications for the development of a national energy security strategy. It is concluded that the strongest threat, in the short and long term, to Australia's energy security is adequacy of capacity.

2 What does 'security of energy supply' mean?

The expression 'energy security' has become ubiquitous to contemporary discussion about energy issues. But what does this concept mean? How is it defined?

The common context for this concept is discussion framed around a handful of notions which denote:

¹ Short term is defined as the immediate future up to five years and long term as beyond five years.

² The conceptualisation of each dimension is contested particularly sustainability (Pearce and Walrath 2000). The term sustainability, in the context of energy security, is used in this paper to mean moving to a higher reliance on renewable energy sources. See Section 4.

- unimpeded access, or no planned interruptions, to fuel sources;
- not relying on a limited number of fuel sources or being tied to a particular geographic region for fuel sources;
- abundant energy resources;
- an energy supply which can withstand external shocks; and/or
- some form of energy self-sufficiency.

The concept's blithe appearance throughout a wide range of reports and documents issued by government and supranational organisations, and academic discourse, has been rarely accompanied by discussion or explanation of the notions which underpin its meaning. The concept has quietly slipped into the energy lexicon and assumed a relatively prominent position without any meaningful discourse about its meaning or assumptions. Yet governments around the world have expended considerable time and resources framing strategies and policies to deliver energy security (e.g. the European Union, Japan, the United Kingdom).

Of the limited definitional discussion that has ensued, it has been more peripheral than centre stage and often, the meaning attributed to the concept is more implicit than clearly stated. Those definitions that can be deduced, or are readily apparent, fall broadly into one of two categories. The first category has a far narrower focus around market supply and energy availability at market price. The second category is far broader taking into account a number of dimensions. This definitional dichotomy, and the changing nature over time, is evident if first we consider the context in which the expression 'energy security' has appeared and then 'unpack' the available definitions or their apparitions.

Post World War 2 many countries, particularly those comprising the OECD, became strongly reliant on Middle East oil as an energy source. Oil was relatively abundant and cheap until the oil price shocks of the 1970s. This led to a view of energy security as synonymous with the need to reduce dependence on oil consumption (UNDP 2000). The global economic crisis of the 1970s led to strident criticism of government intervention and regulation. By the 1980s the need for greater competition and less government involvement was strongly advocated for network sectors (especially electricity, gas and telecommunications) which had been traditionally dominated by government monopolies. Considerable restructuring of energy markets around the world has subsequently occurred and, in electricity's case, at an astonishing pace (Chester 2007: 16-26). Competition has been injected through the breaking up of vertically integrated monopolies, pricing and access regulation of monopoly networks, and the creation of new trading markets. This restructuring has not only been promoted by individual country governments but actively encouraged by the OECD, the World Bank, the International Monetary Fund, and international trading agreements such as the General Agreement on Tariffs and Trade (GATT) and the subsequent General Agreement on Trade in Services (GATS). More recently, global oil and gas prices have escalated and remained high, compared to their low levels of the 1990s, and political instability in supplier countries (e.g. Europe's supply of gas from Russia; oil supplies from Iraq) has heightened the possibility of serious energy supply interruptions given the levels of energy import dependence around the world.

Bohi and Toman (1993: 1094) state that "energy security can be defined in various ways" although their focus is limited to "economic issues related to the behaviour of markets". Subsequently they define energy insecurity "as the loss of economic welfare that may occur as a result of a change in the price or availability of energy" (Bohi and Toman 1996: 1). Some years earlier, the International Energy Agency (IEA) defined energy security

as an “adequate supply of energy at a reasonable cost” (1985: 29) and later posited that “energy security is simply another way of avoiding market distortions” (1995: 23).

This IEA definition of energy security in market terms has been consistently restated and most recently expressed as “energy security always consists of both a physical unavailability component and a price component, [but] the relative importance of these depends on market structure (IEA 2007: 32)”. A similar approach is mirrored by Stern (2007), the UK Government (DBERR 2007a; DTI 2006, 2007) and Bielecki (2002: 237) who suggests that the concept is centred on notions of supply ‘reliability’ and ‘adequacy’ at ‘reasonable’ market-determined prices.

The logic which underpins these ‘market-centric’ definitions goes something like this: as a consequence of the ‘liberalisation’ of energy markets, energy security [and insecurity] is a market outcome, determined by the operation of the market and thus can only be defined in market terms – particularly supply (physical availability) and price. Continuity of physical supply – often described in terms of availability, reliability, relative shortage or complete disruption – across the total supply chain assumes a singular, unparalleled importance within this definition of the concept.

A security of supply risk refers to a shortage in energy supply, either a relative shortage, i.e. a mismatch in supply and demand inducing price increases, or a partial or complete disruption of energy supplies (Scheepers *et al* 2006: 13).

Therefore the purpose of energy security strategies is to overcome “situations when energy markets do not function properly ... [and] should be mostly aimed at ‘making markets work’” (Noël 2008). Competitive markets and ‘independent’ regulation are considered the “most effective way of delivering secure and reliable energy supplies” (DBERR 2007a: 8). A corollary of this view comes strongly to the fore in the UK Government’s energy approach. The ‘right’ level of security [i.e. continuity of supply] “depends on the balance between the costs and the benefits of increasing security ... [and] is left to the market as suppliers are better placed than Government or the Regulator to understand the value that their different customers place on security of supply” (DBERR 2007a: 17).

A further corollary of this market-centric conceptualisation of energy security has been successive endeavours at its ‘operationalisation’. The first step was the ‘translation’ of the market-centric definition into short-term (operational) and long-term (adequacy) threats to supply disruptions based on sources of energy supplies, and subsequent transit, storage and delivery (IEA 1995; Stern 2002). The second step was quantification of these risks. “To be analytically helpful, a measure of supply security needs to be quantifiable” (DBERR 2007b: 2), “can be used as a measure to indicate a desired state” (Scheepers *et al* 2006: 13) and can “measure risks and policy effectiveness” (Tönjes and de Jong 2007). Quantitative measurement of ‘market-centric’ energy security risks has been proceeding since the early part of this decade. Since 2002 the UK Government has published security-of-supply indicators which range across three categories of supply and demand forecasts, market signals (e.g. forward prices for gas and electricity) and market response (planned major new investments). The Clingendael International Energy Programme has developed, in relation to the European Union, a Crisis Capability Index (for short-term supply interruption) and a Supply/Demand Index (Scheepers *et al* 2006, 2007). The IEA (2007) has also proposed two energy security measurement ‘tools’ of market power (the price component) and pipe-based import dependence (physical availability). Another example of this quest for quantification has been an extension of the Shannon-Wiener index which is more commonly used to measure biological diversity (Neumann 2007).

Broader definitions of energy security are observable which embrace dimensions other than market supply and market price. For example, the European Commission's (EC) Green Paper *Towards a European strategy for the security of energy supply* stated:

energy supply security must be geared to ensuring, for the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical *availability* of energy products on the *market*, at a price which is *affordable* for all consumers (private and industrial), while respecting environmental concerns and looking towards *sustainable* development ... Security of supply does not seek to maximise energy self-sufficiency or to minimise dependence, but aims to reduce the risks linked to such dependence (2000: 1-2, emphasis added).

The hazards posed to each of these dimensions of energy security are identified, by the Green Paper, as physical, economic, social and environmental risks. Moreover, it is recognised that these risks will not be ameliorated or prevented without government intervention - through policy and/or regulatory action – given the complex institutional arrangements which guarantee the existence and functioning of contemporary energy markets.

A similar view is expressed in the European Parliament's response to this Green Paper which highlights notions of adequate capacity to meet demand, and availability through source diversification and many suppliers. The Parliament's response stresses Europe's high oil import dependence, proposes a reduction in transport's demand for oil but contends that dependence on imports of energy fuels "is neither necessarily a bad thing nor economically inefficient provided the sources are diverse, no one supplier is dominant and we can produce sufficient goods and services to pay for them" (European Parliament 2001: 17).

The dimensions of availability, affordability, adequate capacity and sustainability are echoed by the Asia Pacific Energy Research Centre (APERC 2007) and annual issues of the *World Energy Assessment* which defines energy security as "the availability of energy at all times in various forms, in *sufficient quantities* and at *affordable* prices without unacceptable or irreversible impact on the environment" (UNDP: 2004: 42, emphasis added). These latter assessments distinguish between short and long term energy supply interruptions, and stress the need for diversification of local and imported energy sources to keep pace with expected growth in demand (For example: UNDP 2000: 113). The APERC's energy security definition of:

the ability of an economy to guarantee the availability of energy resource supply in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy (2007: 6)

places the concept firmly within the context of the broader economy. It also clearly infers the desirability for government action should economic performance be jeopardised by insufficient, unsustainable and unaffordable market provision of energy.

A number of fundamental aspects about the expression 'energy security' are discernible from the discussion thus far. First, an inherent feature of energy security is about the management of risk – the risk of interrupted, unavailable energy supplies; the risk of insufficient capacity to meet demand; the risk of unaffordable energy prices; the risk of reliance on unsustainable sources of energy.

A second point concerns the extent to which the definition of energy security may be framed to reflect a country's (or continent's) energy use 'mix', the abundance of local resources and reliance on imports. This is illustrated by the EC's 2006 Green Paper *A European strategy for sustainable, competitive and secure energy*. The document places a far stronger emphasis on the physical security of supply (network infrastructure, stock,

diversification of supplies) than the Green Paper of six years earlier. The objective of supply security, now separated from sustainability, is targeted at “tackling the EU’s rising dependence on imported energy” (European Commission 2006: 18) which is projected to rise to around 70% of energy requirements in the next 20 to 30 years. This dependence is to be ‘tackled’ by a number of policy measures such as reducing demand, diversification of the energy mix and supply sources, stimulating investment in adequate capacity, emergency preparedness, and improved energy access for business and citizens. The clear priority of ‘energy security’ is to minimise the EU’s import vulnerability, supply shortfalls and potential supply uncertainty given the dependence on one single gas supplier (European Commission 2007).

Third, the expression ‘energy security’ clearly reflects a concept and has some form of strategic intent. This view is exemplified by the following definition developed by the Centre for European Policy Studies: “security of supply consists of a variety of *approaches* aimed at insuring against supply risks. Security of supply becomes a cost-effective risk-management strategy of governments, firms and consumers” (Egenhofer and Legge 2001: 3, emphasis added). The latter point about responsibility or carriage of the strategy is contestable and goes beyond the purposes of the current discussion. The salient point is that energy security is a concept with strategic intent. Energy security is not policy. Specific policy measures are implemented by governments to achieve the objective of energy security, however defined, and these policy measures have increasingly included reliance on competitive markets, the creation of new regulatory regimes to support those markets, and ‘geopolitical approaches’ (Youngs 2007).

Fourth, the concept of energy security has a temporal dimension. The risks or threats to physical supply differ across short and long term horizons. Short-term risks include extreme weather conditions, accidents, terrorism attacks, or technical failure. The main issue of concern is the *reliability* and *continuity* of available technological and commercial mechanisms which convert primary energy sources for end-use by consumers. Long-term risks concern the adequacy of supply to meet demand and the adequacy of infrastructure to deliver supply to markets which will, in turn, depend on levels of investment and contracting, the development of technology and the availability of primary energy sources (Egenhofer *et al* 2004). Therefore the meaning attributed to energy security will differ across time because the probability, likelihood and consequences of different risks or threats to supply will vary over time.

A further aspect concerns the differences between energy markets. There are significant differences between the oil, gas, nuclear and electricity energy markets such as the rigidity of transport infrastructure, the difficulties of storage, and the regional nature of markets (IEA 1995). Consequently, to apply the concept of energy security to the gas market will result in a different meaning than if applied to the oil market or the electricity market. These security-of-supply differences across energy markets were recognised by the IEA’s 1995 gas study. They also are affirmed by the UK Government’s decision to develop separate sets of security-of-supply indicators for each energy market.

A final aspect about energy security is possibly the most significant given the implications for the policy role and actions of governments. As we have seen, a definition of energy security may contain both absolute and relative notions. Availability and adequacy of capacity are capable of absolute measurement. Affordability, or the ‘reasonableness’ of prices, are relative notions with meanings subject to considerable variation. Supra-national organisations, governments, policy advisers and commentators generally favour a definition of energy security narrowly centred on the absolute notions of market supply and market price. Broader definitions, such as those used by the European Commission, encompass

absolute and relative notions. All definitions envisage the market playing a central role in ensuring, enhancing or attaining energy security. However, what is the market paradigm underpinning these definitions?

Two competing market paradigms are evident within contemporary economic thought: the pure Walrasian market which optimally allocates products in a perfectly informed, atomistic world; or the market which is a social, political and historical construct (Chang 2002; Coriat and Weinstein 2005). Each paradigm defines the interrelationship between market and state, and thus the role to be played by policy to deal with matters such as 'energy security'.

The narrower market-centric definition of energy security clearly is based on the pure Walrasian market with its self-equilibrating properties. Markets are assumed to clear automatically via price adjustments i.e. prices respond to changes in demand or supply, finding equilibrium at the price at which the quantity supplied equals the quantity demanded. These oscillations, according to this paradigm, underpin a systemic stability across markets for all goods and services and ensure an optimal allocation of resources between competing needs. Yet this self-equilibrating nature of the market rests on numerous assumptions such as identical consumers behaving rationally because they are perfectly informed about all the available alternatives, zero transaction costs, no trading at disequilibrium prices, and infinitely rapid velocities of prices and quantities (Blaug 2002: 40-41).

Notwithstanding any perceived incompatibility of these assumptions with economic reality, this paradigm maintains that the market should be left 'unfettered' from state interventions – left pure – to ensure its 'efficient' workings are allowed to determine output and price. The market-centric definition of energy security is couched in these market terms of output (supply) and price and "energy security policies should be mostly aimed at 'making markets work' and letting them work when they do" (Noël 2008). This approach strongly advocates a limited role for governments and policy. Energy markets should be allowed to operate 'freely'. Competitively determined output and prices should be the energy security objectives of governments. Adequacy of capacity, affordability and sustainability will be by-products of an 'unfettered' market but the sacrosanct objectives of competitive output and prices will be jeopardised if governments intervene in the pursuit of lower-order objectives.

Not surprisingly, a different view is held by the alternative market paradigm which situates the market as one of a multiplicity of formal and informal institutions comprising capitalism. "All institutions, including the market ... are defined in relation to the structure of the rights and obligations of the relevant actors" (Chang 2007: 7) which in the case of the market includes the institutional arrangements that determine and/or regulate market participants, and the objects and process of market exchange. As these 'rights and obligations' are deemed to be the result of politics, the market – like all institutions – is considered to be a political construct. Property rights, and the entitlements bestowed on market participants are not free of politics, nor are the determination of interest rates and wages which impact on every sector of the economy, along with numerous state actions to 'protect' market participants. Far from being 'natural', "markets are the fruit of complex social and historical developments" (Coriat and Weinstein 2005: 1) with politics, and thus the state, being integral to their creation and functioning.

Consequently, the 'institutionalist' paradigm assigns a far more active role to the state in relation to the market. Market outcomes result from a myriad of institutional arrangements and processes all of which are influenced by the state and politics. Consequently, a view of market outcomes solely in terms of output and price provides a

partial and thus inaccurate view, of reality. The corollary of this paradigm is that energy markets need to be considered through a multi-dimensional lens which goes beyond the absolute market notions of output and price to include notions such as adequacy of capacity to meet demand, affordability and sustainability. This approach is more consistent with the European definitions of energy security.

What does this mean for 'energy security' and more particularly, Australian energy security? The discussion has shown multiple meanings can be attributed (and have been) to the term 'energy security'. Its meaning may be used to convey absolute and relative notions denoting dimensions of availability, adequacy of capacity, affordability and/or sustainability. Those favouring a narrow market-centric definition place an almost exclusive priority on the absolute dimension of availability i.e. physical supply (although notions around 'adequate capacity' may be mentioned) and affordability is eschewed, not only due to its inherent relativity but because it is generally assumed that market price reflects energy availability and thus the cost of security of supply (Behrens and Egengofer 2008). Possibly the narrowest market-centric definition of energy security is that posited by Noël (2008) as energy availability "to those willing to pay the market price".

The adoption by government of a narrow market-based or broader multi-dimensional definition of energy security is an unequivocal signal of its intended role in the pursuit of energy security objectives. Energy market outcomes are either viewed purely in absolute market terms or more broadly. If the latter, governments may wish to intervene to 'adjust' the market outcome.

The discussion has also shown that energy security is a concept and policies may be directed at implementing its strategic intent which often is framed in terms of: (1) the management of perceived risk(s) – to avoid supply disruption, insufficient capacity, unaffordability, and reliance on unsustainable energy sources, and/or (2) a country's energy use mix and reliance on local resources or imports. The time horizon adds a further layer of complexity to the meaning of energy security because whatever dimensions are used to define the term, the risks or threats to those dimensions will differ in the short term from the long term. Finally, the heterogeneity between energy markets means that the application of the concept will result in different meanings for different energy sources.

These findings lead to the contention that the concept of 'energy security' is inherently slippery because it is polysemic in nature. The concept has many possible meanings. Energy security may be delineated through multiple dimensions and takes on different specificities depending on the country (or continent), timeframe or energy source to which it is applied.³ Given this polysemic layering in which energy security is swathed, the concept is akin to a 'wicked' problem which is not amenable to traditional linear, analytical approaches (Rittel and Webber 1973).⁴

Brennan (2007: 3), recognising energy security's polysemy in the context of electricity, suggests "rather than adopt one at the risk of excluding others, it is useful to have as a reference point as many of these different meanings as is reasonable". This approach would reduce the possibility of energy security strategies being partial and only

³ Bohi and Tolman (1996) also found time and country specificities but in relation to energy security externalities.

⁴ Wicked problems have multiple characteristics which may include being difficult to define, having many interdependencies, being multi-causal, leading to unforeseen consequences, evolving as steps are being taken to address it, having no clear solution, being socially complex, being the responsibility of more than one institution, involve changing behaviour and/or being seemingly intractable (Australian Public Service Commission 2007).

dealing with some aspects that determine the security of energy supply at any point in time.

A possible approach, encompassing Brennan's notion of a 'multiple meaning reference point', is to assess a country's (or continent's) energy supply security, over the short and long term, using a four-dimensional grid of availability, adequacy of capacity, affordability and sustainability fully cognisant that the level of disaggregation would need to be at the level of each energy source to provide a realistic picture. This approach conceptualises the issue of energy security broadly yet explicitly recognises the temporal aspect and energy market heterogeneity. Such an approach does not presuppose that one dimension is – or should be – the sole or primary determinant of energy security. Such an approach does, however, infer that all four dimensions contribute – to some degree – to energy security, the implications of which for governments and policymakers would not be discernible unless all dimensions are considered. This is the approach adopted by this paper to shed light on the current drivers of Australia's energy security given the policy approach adopted by the Federal Government in recent years which is discussed in the next section.⁵

3 Does Australia have a national energy security strategy?

In 2004 the former Federal Government released *Securing Australia's energy future*, a White Paper which outlined the "policies and principles that will guide the production and use of energy in Australia well into the 21st century" (Howard 2004). The Federal Government's 'energy objectives' were stated as:

- prosperity - the value of energy resources is optimised,
- security - reliable access to competitively priced energy, and
- sustainability – environmental issues are well managed (Australian Government 2004: 2).

The document devotes considerable space to cataloguing Federal Government 'achievements' and explaining 'progress' possibly because its release was some four months prior to the 2004 Federal election.

One chapter is entitled energy security which is rated as 'high' for Australia because of abundant resources, extensive infrastructure and access to world markets.⁶ Australia's long-term energy security challenge is defined as "timely large-scale investment in sustainable supply systems" [i.e. adequate capacity]. In the more immediate future, the strongest threat to security of supply is seen as disruptions to energy production and distribution for which the Federal Government was "fast-tracking work ... to develop a cross-jurisdictional mechanism for handling major gas disruptions" (Australian Government 2004: 115). These latter efforts obviously fell short given the June 2008 loss to Western Australia of around 30% of its domestic gas supply.⁷

The 2004 White Paper also made an undertaking to conduct a bi-annual review of Australia's energy security outlook. The first review, of seven and half pages in length, was released in July 2006 with discussion of Australia's energy security limited to a few lines.

⁵ I am not aware of any other empirical analysis using these four-dimensional grid.

⁶ This chapter comprises fifteen pages of a 193-page report.

⁷ In June 2008 a pipeline failure at the Varanus Island gas processing plant resulted in a total loss of supply from this source. This represents around 30% of Western Australia's total gas supply.

Emergency and counter-terrorism measures were the sole focus for this particular discussion of Australia's energy 'security'.

During the November 2007 Federal election campaign, the Australian Labor Party (ALP) released a policy document entitled *Securing a sustainable energy supply for Australia's future*. The focus of this document is the development of renewable energy, alternative fuels and clean coal technologies although it does commit to:

Regularly release a National Energy Security Assessment that compiles the best available information to develop detailed projections of our energy supply and demand – five, ten and 15 years into the future – to better inform industry and the energy sector (Australian Labor Party 2007: 7).

This policy document contains no discussion per se of the concept of 'energy security' which is not unexpected given its purpose. It does, however, place particular emphasis on the long-term sustainability of energy resources. The document is also notable for its statement that "households have a right to access reliable and affordable energy ... to ensure their standard of living" (ibid: 1).

Since its election in late 2007, the Federal Government has injected considerable energy into developing Australia's response to climate change. The Kyoto Protocol was ratified not long after office was assumed, a Minister for Climate Change was appointed, the May 2008 Federal Budget included \$2.3 billion for programs to address climate change, a 516-page Green Paper for a *Carbon pollution reduction scheme* (Australian Government 2008c) was released in July 2008 followed in September by the 634-page final report of *The Garnaut climate change review* (Garnaut 2008), and the subsequent release of a 292-page report of the potential impacts of an ETS (Australian Government 2008d) accompanied by its own 'low pollution' website pending the December 2008 release of the proposed ETS.

Less overt activity by the Federal Government with regard to the security of Australia's energy supply is evident. The report on the achievements of its first 100 days in office makes no mention of any strategy, or policies, to ensure the security of Australia's energy supply (Australian Government 2008a). The final report on the Federal Government's 2020 summit is similarly silent (Australian Government 2008b). The Prime Minister has made some passing references to the 'security challenge of energy' but usually nothing more than a mention of the phrase within the context of Australia's role in the Asian-Pacific region (For example, see Rudd 2008b). The Minister for Resources and Energy has mentioned, on a number of occasions, the preparation by his Department of a National Energy Security Assessment (NESA) which is consistent with the earlier mentioned 2007 election commitment (For example, see Ferguson 2008a, 2008b, 2008c, 2008d). The Department of Resources and Energy's website has stated throughout 2008 that preparation of this Assessment is underway and it will identify "key strategic energy security issues in the liquid fuels, natural gas and electricity sectors currently and those likely to influence the level of energy security in 5 years (2013), 10 years (2018) and 15 years (2023)" (DRET 2008a).

More significantly, the Minister stated in April 2008 that the NESA would provide the basis for 'a new energy White Paper' (Ferguson 2008d).⁸ This particular speech by the

⁸ Material on the Department's website was amended on 24 October to state that the "development of a White Paper on energy issues was agreed to by the Government in September 2008". Previously the website referred to the Minister's April 2008 announcement of the White Paper and by the Prime Minister at the 28 May 2008 annual dinner of the Minerals Council of Australia. There is no publicly available record of this announcement by the Prime Minister. Policy papers are traditionally referred to as 'White' papers. These are papers or reports which embody a statement of government

Minister has been the most forthright statement by the current Federal Government of its intentions and views about the security of Australia's energy supply. The Minister clearly acknowledges that Australia "does not have an energy security strategy ... [but] we need one – and one which embraces all the alternative energy options for the future" (*ibid*: 4) and the 'new energy White Paper' will "put in place the policies necessary for Australia's long-term energy security" (*ibid*: 6). This demonstrates explicit Federal Government recognition of the need for Australia to have a national energy security strategy and that the strategy will be delivered through a suite of policies.

The Federal Minister for Resources and Energy also made a number of other very pertinent comments about energy security in this particular speech in April 2008 to the Committee for the Economic Development of Australia's State of the Nation Conference. He signals the Federal Government's favouring of market-based policies to drive Australia's strategy.

The Australian Government is committed to achieving energy security through open and transparent global markets for energy trade and investment ... Only open markets can send the right signals to industry and consumers (*ibid*: 4)

Secondly, broader regional implications of Australia's energy security strategy are foreshadowed.

Australia is one of the world's energy superpowers – a very sobering reality that comes with enormous responsibility, not only for our own energy security but for the energy security of the region ... It is ... my intention to reinvigorate the energy security agenda – for Australia and the region – through the APEC Energy Working Group and the East Asian Summit's Energy Cooperation Task Force ... with my colleagues, the Ministers for Foreign Affairs and Trade, I will pursue regional cooperation to achieve greater deregulation of global energy markets (*ibid*: 3-4).

Finally, the concept of supply security is presented in terms of control over access to energy resources, particularly the supply of oil and its recent price volatility.

The overall tenor of this somewhat seminal statement about the Federal Government's attitude to energy security indicates a leaning more towards a market-centric definition than a broader conceptualisation. This is reinforced by the information recently added to the website of the Minister's Department which states, *inter alia*,

In an Australian context, energy security is defined as the **adequate, reliable** and **affordable** supply of energy where:

adequacy is the provision of sufficient energy to support economic and social activity

reliability is the provision of energy with minimal disruptions

affordability is the provision of energy at a price which does not adversely impact on the competitiveness of the economy and supports continued investment in the energy sector (DRET 2008b, original emphasis)

Note the above statement's shift in emphasis from the rights of households to affordable energy, in the earlier cited 2007 ALP election policy document, to the notion of energy prices not impacting on the economy's competitiveness.

Australia has no national energy security strategy. Ministerial comments have flagged the need for a national strategy and intimated the conceptual basis which may

policy and have been agreed by Cabinet. 'Green' papers are discussion papers, prepared for the purpose of public discussion and comment and do not commit the government to the views expressed. Green papers are often used as a step in the process of preparing a White paper. At the time of writing, no details about the scope of the proposed White paper on energy security, or the process for its development, had been announced by the Federal Government.

underpin a strategy. The responsible Minister has announced the Federal Government's intention to prepare a White Paper on energy, a statement of government policy, which 'will put in place long-term energy security policies'. The drafting, and Cabinet endorsement, of a White Paper will take time. The Federal Government's response to recent turmoil in global financial markets and the current state of economic conditions, along with the intended late 2008 release of details of the Federal Government's proposed ETS (Wong 2008) will occupy public debate for some time.

Until the Federal Government develops a national strategy, what in the meantime is determining the security of Australia's energy supply? Security of supply, as proposed earlier, reflects four fundamental dimensions which can assume different specificities across time, countries and energy sources. What is currently determining these dimensions for Australia given its energy use 'mix'? In the absence of a national strategy, it is contended that the short and long term security of Australia's energy supply is being determined by default. It is being determined by the conjunction of a vast range of existing policies, all of which have been specifically implemented to address objectives other than the security of energy supply, albeit often within the energy sector. The proposed ETS and mandatory renewable energy target will also have direct impacts. This contention is supported if one assesses the relationship of existing (and proposed) public policies to each energy security dimension – on adequacy of capacity, on availability, on affordability, and on sustainability. Such an assessment is presented in the next section. The purpose of the assessment is not to debate the particular merits or otherwise of 'non-energy-security' policies. The purpose is to elucidate the impact of these policies on the security of Australia's energy supply over the short and long term.

4 The public policies driving Australia's energy security ⁹

The range of public policies examined is not definitive nor is it intended to be. The purpose is to illustrate the potential relationship between existing (and proposed) policies given the absence of a specifically formulated national strategy. The policies considered include: market reliance on investment in capacity; nuclear energy prohibition; subsidies to energy and transport; promotion of energy renewables; new technology development (e.g. clean coal and biofuels); energy efficiency; smart meters; solar rebates and feed-in-tariffs; the proposed mandatory renewable energy target and ETS; the offshore petroleum exploration program; the WA domestic gas reservation policy; the governance and operation of electricity and gas markets; reliability standards; regulation of monopoly network infrastructure; water resource management; end-use price regulation; as well as assistance to those on low incomes.

Table 1 presents a list of current and proposed public policies and indicates if there is any potential impact on each of the four energy security dimensions. [Appendix A provides descriptions of the policies and their potential impacts.] The table should be read with the following points in mind.

This table provides a broad indication of the pattern of impact. For example: is there an even spread of impact by an array of public policies across each of the four dimensions or is there a concentration of impact in one dimension. Secondly, the table indicates if there is a relationship impact between a public policy and an energy security dimension i.e. if the policy has a potential impact. The table does not illuminate the nature

⁹ This section reflects preliminary findings of a continuing research project.

of that policy impact which may support or detract from an energy security dimension. For example, a particular taxation policy may promote behaviour which is contrary to improving adequacy of energy capacity. Therefore it detracts from energy security but this is not evident from the table. Third, the table is not disaggregated by energy source nor does it differentiate between the short and longer term. These aspects are subject to further research.

The energy dimensions against which potential policy impacts were assessed are defined as follows:

- *Adequacy of capacity:* Adequacy of capacity refers to the net outcome of demand for energy and the capacity available to provide energy in response to that demand.

Table 1: Dimensions of Australian energy security impacted by current and proposed public policies

Common name of public policy or primary policy area	Energy security dimensions			
	Adequacy of Capacity	Availability	Affordability	Sustainability
Market reliance for new capacity investment	*	*		
MRET and State Government GG schemes	*	*		
Proposed Emissions Trading Scheme	*		*	*
Regulation of transmission and distribution networks	*	*		
Tax – current review, condensate tax, frontier exploration tax, FBT	*			
Nuclear energy prohibition	*			
Subsidies for fossil fuel use	*			*
State govt energy concessions/end-user electricity pricing	*		*	
Programs to develop renewable energy sources	*	*	*	*
New technology development (e.g. clean coal, biofuels)	*		*	*
Energy efficiency	*			*
Smart meters	*			*
Solar rebates and feed-in-tariffs	*			*
Offshore petroleum exploration acreage release program	*			*
WA domestic gas reservation policy	*			
Cap on electricity generation capacity	*	*		
Gas retail price cap for small use customers			*	
Energy market operation (e.g. NEMMCO, IMO, Gas Bulletin Board)		*		
Reliability standards		*		
Water resource management		*		*
<i>Trade Practices Act</i>			*	
Built environment (especially housing and transport policies)	*			*

- *Availability*: Availability is about continuity and reliability of the energy supply. There is a strong relationship with the previous dimension of adequacy of capacity. The capacity to provide energy may exist but it needs to be available when demanded. Electricity's unique nature means that demand and supply need to be matched instantaneously.
- *Affordability*: Affordability refers to the capacity to pay based on income. Housing affordability refers to the capacity to meet housing costs by reference to the proportion of income allocated to housing. Energy affordability refers to the amount of income allocated to meet energy costs. This is not equivalent to energy being 'competitively priced'. Residential energy affordability shows considerable variation by household type and income level. Low income single-person households spend about 15% of income on energy, high income households about 5%, and around 9% on average for all Australian households (Hatfield-Dodds and Dennis 2008).
- *Sustainability*: The condition of sustainability is generally used to mean that non-renewable sources should only be used within the rate of substitution by alternatives and renewable resources should be used no faster than they are able to be renewed. For the purposes of this broad assessment, the meaning has been taken less literally and has been used in the sense of moving to a higher reliance on renewable energy sources.

This broad assessment illustrates a number of aspects about the array of policies impacting individually and collectively, by default, on Australia's energy supply security.

First, the most frequent *potential* impact by 'non-security-energy' policies is on the dimension of adequacy of capacity. This could be purely some form of implicit bias which occurred in the choice of public policies included in the assessment. These policies, however, all fall squarely within the gamut of the energy sector so their impact on adequacy warrants notice. More significantly, subsequent assessment [see Appendix A] indicates there is a very high preponderance of policies 'detracting' rather than 'supporting' adequacy of capacity. This indicates the most serious immediate and longer threat to Australia's energy security lies in the capacity available to provide energy in response to demand. The most significant of these 'detractive' policies rely on the market – market reliance for new capacity investment in the production, transmission, storage and distribution of all energy sources; new technology development such as clean coal and biofuels; offshore petroleum exploration; and the proposed ETS to name a few.

Secondly, there is evidence of policy 'push-pull' i.e. some policies are 'pushing' in a supportive direction for an energy security dimension but other policies are diluting, or counteracting, this impact by 'pulling' in a contrary direction.

There is also evidence that a policy can impact on more than one energy security dimension but the direction of that impact may not always be the same. For example, policies to develop renewable energy sources (such as solar and biofuels) may be supportive of adequate capacity but detract from affordability and sustainability; policies to develop new technology may be supportive of adequate capacity but not for sustainability; and, water resource management policies may impact negatively on availability and sustainability.

5 Conclusion

An examination of the concept of 'energy security' found it to be inherently slippery, being able to assume a range of meanings. All definitions envisage the market playing a central role in ensuring, enhancing or attaining security. However, the market paradigm underpinning the definition adopted will determine the role of government and policy.

Given the polysemic nature of energy security, it is contended that a four-dimensional grid of availability, adequacy of capacity, affordability and sustainability provides a framework to realistically assess energy security which does not ignore the temporal or energy market heterogeneity aspects. A country may have continuously available energy, but if there is insufficient capacity to meet energy demand, if energy is not generally affordable nor its ongoing provision sustainable, it would be disingenuous to conclude that a country is 'energy secure'.

A review of the policy action and rhetoric of recent and current Federal Governments found no national strategy for the security of Australia's energy supply, an announced intention to formulate a strategy and a clear favouring of a narrow market-centric definition. In the meantime, the short and long term security of Australia's energy supply is being determined by default, by the conjunction of a labyrinth of existing and proposed public policies, all of which have been specifically implemented to address objectives other than the security of energy supply, albeit often within the energy sector.

To return to a question posed earlier in this paper, we should be concerned for a number of reasons. First, the security of Australia's energy supply is being impacted currently by default, by a labyrinth of non-energy-security public policies in the absence of a national strategy. Secondly, a number of these 'default' policies have the potential to severely jeopardise the provision of adequate capacity. Many of these policies strongly rely on the 'market' such as new capacity investment in the production, transmission, storage and distribution of all energy sources, new technology development, offshore petroleum exploration, and the proposed ETS. Third, there is a strong likelihood of a narrow market-centric definition framing the Federal Government's intended energy security strategy.

The Prime Minister stated in early 2008 that:

For too long Australian policymaking had been focused on short-term outcomes dictated by the electoral cycle. If Australia is to effectively confront the challenges of the future, we need to develop an agreed national direction that looks at the next ten years and beyond (Rudd 2008a: 1).

These sentiments need to imbue the development of a national strategy for Australia's energy security. In addition, energy security needs to be seen as a concept of multiple dimensions which assumes different specificities depending on the country (or continent), timeframe or energy source to which it is applied. These are the basic reasons for its 'slipperiness'. It is capable of different meanings but it should not thwart the development of a national strategy nor overcoming the weaknesses inherent in Australia's current default strategy.

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Appendix A: Details of policy impacts on policy dimensions

Adequacy of capacity:

- Reliance on the market to provide investment in new capacity (electricity, gas, oil and renewables) - Reliance by all Australian governments on the market for new capacity investment in electricity generation, transmission and distribution has only occurred since the sector's restructuring accelerated from the mid 1990s. The oil and gas sectors have, on the other hand, been dominated by private sector ownership and operations. The most recent assessment of electricity supply capacity expects no shortfall during the imminent 2008-09 summer but has flagged that reserve shortfalls in Victoria and South Australia require investment in new generation in the immediate future (NEMMCO 2008). Investment in recent years has been skewed towards peak capacity, wholesale prices have not provided the stimulus expected by policy makers to electricity generation and policy uncertainty about greenhouse gas emissions has stymied investment in new capacity (Chester 2008);
- MRET, State Government greenhouse gas schemes and proposed ETS – The Federal Government has set a target of 20% electricity to be generated from renewable sources (solar, wind, geothermal etc) by 2020. Across Australia there is a patchwork of State Government greenhouse gas schemes and renewable energy targets. The Federal Government has committed to release details of the 2020 MRET scheme, which is intended to consolidate all State schemes, by the end of 2008. The Federal Government has announced its intention to introduce an ETS from 2010 although precise details (including the legislation) will not be known until late 2008 (Wong 2008). This scheme will impact particularly on coal-fired electricity generators. The Green Paper proposes different treatment of gas and coal-fired generation (Australian Government 2008c). Until the new MRET policy is released, and decisions made about the extent of ETS transition assistance, it is highly unlikely that decisions to invest in new electricity generation capacity (including augmentation) will occur;
- Regulation of transmission and distribution networks – Monopoly networks are subject to pricing and third party access regulation. Only marginal additions to network capacity have occurred in the electricity sector (Chester 2008). The current regulatory regime does not reward the use of distributed (decentralised) electricity generation i.e. from renewable energy sources. There are also further investment barriers including connecting renewable energy to existing grids, and the increasingly prohibitive costs of transmission with greater decentralisation of energy sources (like wind);
- Taxation system – The current Federal tax system review has added to policy uncertainty which is not conducive to new capacity investment decisions. The recent imposition of the condensate tax will also affect future capacity investment decisions in the gas sector;
- Prohibition on nuclear energy – This Federal prohibition limits diversification of energy sources which may compound future capacity constraints depending upon the impact of the impending MRET, ETS and possible tax changes;
- Subsidies for fossil fuel use (including State government energy concessions and end-user electricity pricing) – It has been estimated that the energy and transport sectors receive around \$10 billion each year in subsidies from all Australian governments through paying less for coal than the export price, subsidised electricity costs for

aluminum smelters, energy concessions to low income users, and end-user electricity pricing being less than the full cost of supply (Reidy 2007). Any 'subsidy' which keeps the cost of fossil fuels artificially low, makes it harder for renewable energy sources to compete and also means there is no incentive for a behavioural shift to reduce the growth in demand for energy. Thus, by default, these 'subsidies' place pressure on the need for additional capacity to meet growing demand;

- Programs to develop renewable energy sources – The 2008 Federal Budget included programs to promote the development of renewable energy. The ability of these programs to add new capacity is limited. For example, funding for the \$500 million 7-year Renewable Energy Fund – designed to expand and accelerate the commercialisation and deployment of renewables - does not start until 2009-10 and is forecast to have spent barely half its allocation by 2012.¹⁰ The Green Car Innovation Fund does not commence until 2011-12;
- New technology development – The Federal Government has placed priority on the development of clean coal technology with funding of \$500 million over 5 years. According to the UN Climate Change Panel, it is possible to capture 80-90% of carbon dioxide from a coal-fired electricity plant but this will require additional energy (11-40% more coal than that used to generate electricity by the plant). In the case of retrofitting existing plants, the amount of coal needed is much greater than for new plants (Greenpeace International 2008). The development of clean coal technology is not discouraging fossil fuel use nor adding to electricity generation capacity. It is maintaining a dependence on coal and will contribute to higher electricity costs (and thus, impact on affordability);
- Energy efficiency and smart meters – All Australian governments are placing a high reliance on the policy instrument of information – which carries no obligation - to effect a significant behavioural shift leading to much slower growth in energy demand and thus reduce the pressure for additional capacity (MCE 2004). Household energy consumption is projected to rise with electricity and gas expected to increase their proportional shares (DEWHA 2008). All Australian governments have agreed to the progressive roll-out of electricity smart meters which are intended to reduce total demand as well as for higher-cost peak electricity (MCE 2008). The meters will provide data about energy use, cost and emissions for consumers to choose when to run 'energy-hungry' appliances. The critical assumption about smart meters changing the total demand of electricity (and thus the demand for sufficient capacity) has been questioned by a major report to the Ministerial Council on Energy (NERA 2008);
- Solar rebates and feed-in-tariffs – A range of government schemes provide rebates to households to install solar energy. The rebate is heavily means tested and the current cost of installing solar remains prohibitive for most households. Some State governments offer a solar installation incentive through payment of a feed-in-tariff. Households are paid for each kilowatt-hour of electricity exported to the grid. Although the tariff is usually higher than the retail price, current Australian schemes only pay a tariff for that electricity exported to the grid after what is consumed. Given the current cost of installation, it is questionable if net tariff payments are providing sufficient incentive for changeover;

¹⁰ The Federal Government announced mid-December 2008, as part of a series of stimulatory measures in response to the 2008 financial market turmoil, that this expenditure would be brought forward with \$100 million to be spent in 2008-09 and \$400 million in 2009-10 "subject to the availability of suitable demonstration projects" (Rudd 2008c).

- Offshore petroleum exploration acreage release program – In April 2008, the Federal Government released 35 new exploration areas of which 7 are eligible for the frontier exploration tax incentive of 150% uplift for exploration expenditure. Around the same time the Western Australian State government released 10 more petroleum acreage areas;
- WA domestic gas reservation policy – The Western Australian State government requires that 15% of LNG production from export gas projects be reserved for domestic use as a condition of access to WA land for the location of processing facilities. The target of 15% is based on estimated gas demand, reserves and forecast LNG production; and
- Caps on electricity generation capacity - In the case of the WA government-owned generator, Verve Energy, a cap has been placed on its generation capacity to 3000 Megawatts (MW) “to promote competition and encourage increased private sector investment in the new electricity market” (OoE 2008). The loss of energy arising from the mid-2008 WA gas crisis led the State Government to request Verve Energy to recommission 240 MW of coal-fired capacity which had been retired to meet the Government’s earlier directive to limit generation capacity.

Availability:

- Market operation – The National Electricity Market is managed by a market operator, NEMMCO.¹¹ The WA wholesale electricity market is managed by the Independent Market Operator (IMO). These market operators operate within the guidelines agreed by government to ensure continuous supply. The National Gas Bulletin Board operates in a similar manner. Apart from the mid-2008 WA gas crisis, there have no been no significant losses of any energy supply since these market operators commenced;
- Reliability standards – Reliability measures a system’s capability to continue to supply sufficient energy to satisfy demand. Australian energy markets are required to comply with reliability standards set by regulation. If reliability standards are improperly defined or applied, the availability of energy will be impacted e.g. transmission networks are not able to deliver an energy source;
- Water resource management – Prolonged drought conditions across Australia has led to all governments adopting new water management policies as well as placing pressure on water resources available for both hydro and coal-fired electricity generation capacity; and
- Renewables – Government policies to develop renewable energy sources include those that are not available continuously (e.g. wind, solar). The ability to connect renewable energy sources to the existing grid, to ensure availability, also raises another availability issue.

Affordability:

¹¹ Western Australia and the Northern Territory are not part of the National Electricity Market. The West Australian Government established the Independent Market Operator to manage the WA wholesale electricity market.

- Trade Practices Act (TPA) – This legislation is intended to promote competition, fair trading and consumer protection across all industry sectors. A small number of companies dominate each of the Australian energy sectors. The TPA has not prevented increasing ownership concentration or re-integration in the electricity or gas sectors which reduce the number of competitors, and introduce barriers to entry and to effective competition. Moreover, it has been found that the electricity generation companies are able to ‘game’ the market, causing excessive wholesale price spikes at levels well below maximum demand (Chester 2006; 2007: 240-46);
- End-use price regulation – Residential electricity prices remain regulated for the majority of Australian households although the levels charged in each State and Territory have increased substantially in recent years. All Australian governments have agreed to phase out this form of price regulation from 2010 onwards subject to evidence of effective competition (Council of Australian Governments 2006). With this abolition, the prices paid by households will be set by their electricity supplier. Overseas evidence of unregulated electricity prices shows households experiencing increases of up to 60%, and increasing proportions of disposable income needed to pay electricity bills with considerable hardship being incurred by low-income consumers (Showalter 2007; Thomas 2006). Similar price caps exist on gas prices charged to small consumers;
- Proposed ETS – The Federal Government’s proposal for an ETS will result in increased prices for emission-intensive products such as electricity, gas and oil. ‘Average’ household electricity prices have been forecast to increase by \$4-5 per week and gas by \$2 per week (Australian Government 2008d). The Green Paper discusses assistance for households and business, and commits the Federal Government to increase income support payments and “other assistance to meet the overall increase in the cost of living flowing from the scheme” (Australian Government 2008c: 25) as well as provide carbon pollution permits at less than the market price to assist business ‘transit to a cleaner economy’. The amount, the recipients and the timeframe over which any assistance is provided is critical to the dimension of affordability. It also should be acknowledged that monetary assistance is not guaranteed to encourage a behavioural change to reduce the growth in energy consumption (which will reduce the pressure on the adequacy of capacity);
- Renewables, new technology – The development of new renewable energy sources, and new technologies (such as clean coal), used to generate electricity will result in higher end-use electricity prices in the foreseeable future as renewable energy becomes available. This will impact on affordability.
- Low income assistance – Currently each State and Territory government provides energy concessions to low income users, and the Federal Government provides a utilities allowance to the majority of income support recipients. The extent of ‘affordability assistance’ which these measures continue to provide to one group of energy users will depend on the level of price increases and the nature of ETS ‘compensation’.

Sustainability:

- New technologies – The Federal Government’s promotion of clean coal technology is inconsistent with a low-emissions strategy or diversification of energy sources. A very strong role for non-renewable fossil fuels is retained. The development of biofuels

based on feedstocks raises issues about competition for finite food supplies. First generation biofuels have been based on sorghum, sugarcane and tallow. Second generation biofuels are based on microalgae;

- Water resource management – Irrigating corn, soybeans and sugarcane to process ethanol or biodiesel can take as much as 1000 times more water than ordinary oil refining. Desalination requires considerable electricity plus five times as much energy as the treatment of traditional water supplies;
- Smart meters – Household use of smart meters may alter the pattern of consumption and spread more into off-peak use (when it is intended that renewable energy will be the primary source if sufficient capacity is available) but, as mentioned earlier, total consumption may not be reduced. Hence the pattern of energy demand may be altered without any change in efficiency and possibly only marginal change in emissions;
- Oil exploration and development – The release, and subsequent exploration, of new areas with considerable tax advantages does not lead to a greater diversification, or improve the sustainability, of energy sources; and
- Built environment (especially transport and housing) – The built environment reflects a multiplicity of Federal, State and Local Government policies. Australian cities are dominated by the car which “also significantly informs much of the content of lifestyles more generally” (Healy and Kuch 2008: 5). Energy sustainability will be directly impacted by these policies which will also impact on energy demand and thus, the adequacy of energy capacity.