ENERGY SECURITY FOR AUSTRALIA – HAS IT ALREADY ESCAPED US?

Australia is drifting towards a situation where, in the event of a fuels emergency, there could be serious shortfalls in the supply of liquid fuels to the eastern seaboard and to critical sectors of the economy. The electricity sector is also in a 'state of risk' with challenges to supply coming from an excessive and poorly timed introduction of renewables coupled with aging electricity infrastructure.

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Authors' note: The original version of this paper, simply called Energy Security in Australia, was produced for inclusion in the recently published book, *Next Generation and Security Management* published by Australian Security Centre, Canberra, October 2012. In early November 2012 the Australian Government released the *Energy White Paper*, with its fourth chapter being entitled 'Energy Security'. The White Paper took a very market-orientated approach to the question of energy security, an approach that the authors of this paper strongly disagree with. More recently (June 2017) the Finkel Report has attempted to tackle the present insecurities in electricity supply following major outages in South Australia, but does Finkel offer workable solutions to electricity supply?

INTRODUCTION

Energy supply is the cornerstone of our developed civilisation. Energy is required for all facets of our lives, and without adequate energy our existence, in the way we have become accustomed, will be jeopardised.

Australia is very vulnerable to failures in the supply of energy, liquid fuels, electricity and natural gas. The loss of energy supply to a business is one of the major threats to the operation of that business and thus its continuity. The loss of energy supply to a community can move from an inconvenience to become a cause of political instability leading to challenges to government from a range of groups. For some businesses fuel/power can be a major component and thus a critical business requirement; for others, although fuel/power might be a minor expense, interruption of supply can cause serious disruption to business continuity. Furthermore, supply interruption of fuel/power may have consequences on basic life requirements such as food and potable water supply with a consequential impact on the continuity of government and national security.

There are new and serious threats to energy supply, and these include disorganisation from restructuring, the shift in emphasis from supply at any cost to improved corporate bottom lines, and the shift to more environmentally friendly feedstocks, and lastly terrorism. As the national energy supply continues to restructure, inherent risks to supply are compounded rather than mitigated.

ENERGY AND THE AUSTRALIAN ECONOMY

The Australian economy has been in a state of change since the 1950s, and now a strong trend towards de-industrialisation has become apparent. The importance of direct energy supply to heavy manufacturing has been reduced with energy being supplied to primary production (especially minerals and fuels) and commerce (inclusive of service industries) (Department of Foreign Affairs and Trade, 'Australia's top 25 exports, goods and services', 2011). Concomitant with this has been the inexorable rise in power supply to residential consumers paralleling the widespread introduction of energy-intensive appliances such as air-conditioning units and plasma televisions.

De-industrialisation has occurred through the reduction in tariffs, globalisation of production to low labour cost nations, and the difficulties experienced by middle-sized economies (such as Australia) to match the high level of technological innovation to ensure ongoing competitiveness. Significant lowering of energy intensity (as energy consumption per unit of gross domestic product) by around 18% occurred between 1990 and 2008/9; however the total energy consumption increased from about 5000 PJ to 5945 PJ between 1999–2000 and 2009/10, and since has plateaued at around 5920 PJ (Department of Resources, Energy and Tourism [DRET], *Energy in Australia, 2012*) Some of the reduction in energy intensity can be attributed to increased energy efficiency in production (such as cement) while other reductions can be attributed to de-industrialisation, for example the reduction in steel and motor vehicle production. The Australian economy has thus become a 'services based', commercial and raw product export centred economy, retaining some manufacturing where there are niche market opportunities servicing the export sectors, or are increasingly subsidised by central government.

Of major importance to the Australian economy is the export of energy. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) report *Energy in Australia 2011* stated that 'Since 1988–09, the value of Australia's energy exports (in 2009–10 Australian dollars) has increased at an average rate of 11 per cent a year', and goes on to state, 'the share of domestic consumption in Australian energy production decreased, from an average of 49 per cent in the 1980s to an average of 42 per cent in the 1990s, and has continued to decrease, to an average of 33 per cent over the past decade.' Note: *Energy in Australia 2016* has annual export growth softening to 4·6% for the financial year 2014/5; the most obvious reduction being in the export of Refined Petroleum Products, as would be expected following the closure of Australian refineries.

Trade statistics show that raw energy exports (excluding uranium) were around 12% of total exports in 2010 (ABARES Update, 2011) and have grown by an average 5·8% pa to the end of the FY 2015. The maintenance of energy exports is therefore an important factor in the Australian economy's health.

DISASTERS AFFECTING AUSTRALASIA

Disasters and major disruptions are easy to forget once the emergency is over. So it is worth recounting some of the major incidents that have affected Australasia in recent years:

1. The December 2010 flooding of Central Queensland coal mines and disruptions to the rail systems (*The Australian*, 12 January, 2011),
2. The flooding of Brisbane in January 2011 (*The Brisbane Times*, 14 January, 2011),
3. The September 1998 Longford gas explosion – 19 days' gas disruption to Victoria (*Esso Longford Gas Plant Accident Report of the Longford Royal Commission*, 1999),
4. The feeder failure into Auckland SKM in mid February, 1998 shut down power to the Auckland Central Business district (SKM Consulting, *Auckland CBD Power Failure*, 1998),
5. The Victorian bushfires of 2009 *(2009 Victorian Bushfires Royal Commission*, 2010), and
6. Major Outages in South Australia Feb. 2017.

As well as these local incidents there have been several major incidents which have had worldwide impacts, of which BP's Deepwater Horizon blowout (Macondo Well, 2011), the Japan tsunami and subsequent Fukushima nuclear meltdown (BBC News, 11 March, 2011) and the Lusi mud volcano (BBC News, 25 February, 2011) are incidents which are still having an impact. The above disasters are mostly from human error and/or plant malfunction and do not include deliberate disruption or terrorist acts. Human error and plant malfunction (or lack of planning) compounding a natural hazard (for example Fukushima where an earthquake was followed by tsunamis) are perhaps the most dangerous disasters in the above list.

Open conflicts in, East Asia between North Korea and its neighbours and United Nations members, China and S. E. Asian countries and their allies over the South China Sea, India and China over the borders of Sikkim and Bhutan, and in the Middle East are potentially catastrophic and likely will be very damaging to the world petroleum trade; lower levels of political tension will lead to nations topping-up their strategic fuels stockpiles causing petroleum supply distress, as suppliers use 'force majeure' clauses to delay or cancel contracted petroleum shipments. Open conflict that disrupts Australia's crude petroleum imports, coal, LNG

and condensate exports, and imports of plant no longer manufactured in Australia would be an extreme disaster.

The 'depth' of 'energy' disasters

The disasters listed above all have very serious physical and economic implications. They also have serious political and social ramifications. Security in part means peace of mind to energy users and those that may be affected by existing or future energy-related developments. The Sandman definition of risk (P. Sandman, commercial presentation, http://www.psandman.com/) is:

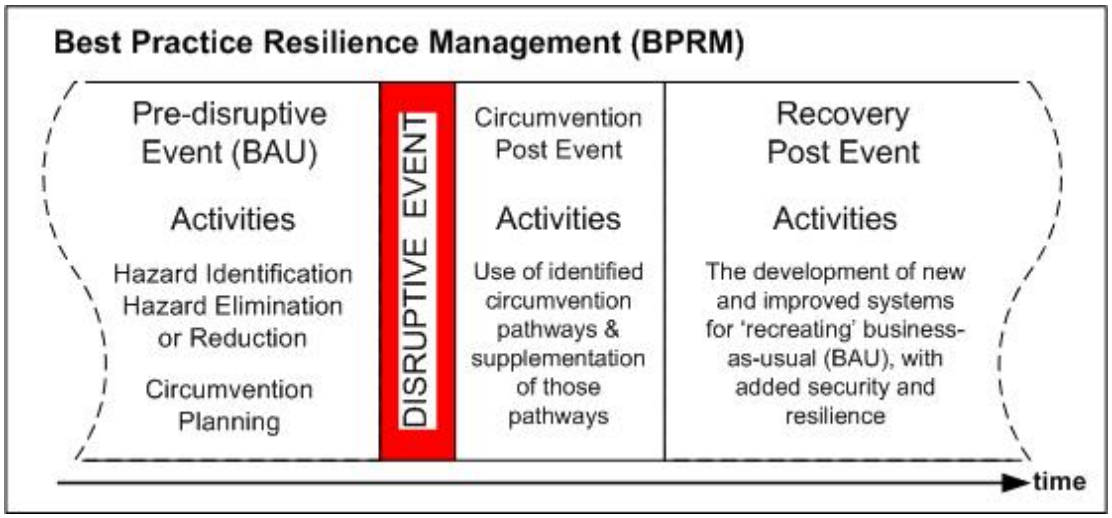
Risk = Hazard + Outrage

Disruptions of the supply of energy are an excellent reason for the creation of outrage. Disasters play into the hands of community members who promote the 'precautionary principle' to the point that energy projects become impossible as the 'what if' analyses become totally consuming. Such members of the community also help create outrage, but more divisively, help maintain outrage such that logical management strategies are not possible.

In the Fukushima aftermath all Japanese power reactors were shut down, and Japan has been forced to use expensive fossil fuel alternatives to maintain electricity supply. If the outrage from Fukushima could be abated, and selected power reactors allowed to restart (after thorough safety reviews), then a more rational and sustainable approach could be created for national energy supply over the long-term. This now appears to be occurring.

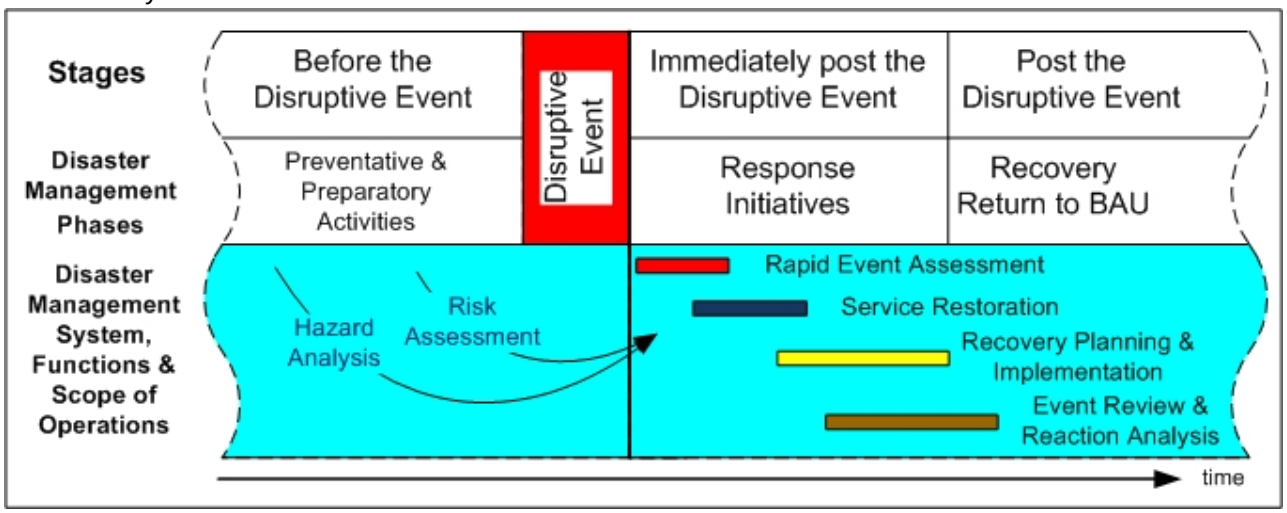
SCENARIOS/STRATEGIES FOR MAINTAINING FUEL AND POWER SUPPLIES

Barriers, buffers and resilience are tools to maintain energy supply. Barriers will help prevent incidents by keeping the hazard at a distance, where its effect will be lessened if not totally negated. Buffers on the other hand, such as secure raw energy stocks, will help maintain energy flow during an incident and will help lessen the immediate impact. Resilience Management is a crucial sub-set of risk management and therefore any post-event risk management assessment includes a review of the resilience in the system. For energy systems the creation of resilience that maintains energy flows is crucial. The development of best practice resilience management will allow for a rapid return to 'business-as-usual' (BAU).



Circumvention is the key to maintaining supply and service. It will often require use of buffer stocks, alternative pathways for supply and most of all ingenuity. It will be a major component of rapid event assessment that will lead to service restoration. It will draw upon existing hazard analyses and risk assessments, to understand what systems are fully or partially functioning and what systems need to be replaced or mended. Resilience in terms petroleum would be greatly enhanced by having the 90 days of

petroleum reserves that can be utilised (excluding condensate that cannot be readily refined in Australia) as mandated by the IEA.



Source: K Moule, *Situation Awareness for Disaster Management* - modified figure

HYPOTHETICAL DISRUPTIONS TO SUPPLY OF LIQUID FUELS, NATURAL GAS AND ELECTRICITY

Hypothetical disaster scenarios which could occur in Australia are outlined below with comments on how government can assist in avoiding or minimising disruptions to fuel supply, while at the same time not unnecessarily putting impediments into fuel exports.

Background

As world communications and logistics systems continue to speed up, the world inexorably moves towards becoming a global village, which can have profound consequences for national security and planning of energy supply. Just as in the village, rather than everyone making butter one household provides butter for the village, so it is with the world's economy in that some countries become specialists in supplying world needs and others look to this supply on a sustainable basis. For Australia it is clearly on one hand providing basic quarried products and LNG, while on the other hand moving away from value-added, energy-intensive industries and manufacturing.

To date this movement appears not only to work well but also, from the global standpoint, moves the supply of goods to those regions which are most efficient in producing it with consequential economic (cheaper) and environmental (lower unit energy use) benefits. In the finality of the global village there is no room for 'strategic' industries, for such industries have to be supported against the globalisation trend. Significantly, the move to globalisation of the economy and the energy sector is not a centrally planned event; rather it is a consequence of the accumulation of many investment decisions over time by companies, suppliers and users. In capitalist or near capitalist economies this arrow of time inevitably leads to investment in the most profitable and efficient regions, starving less efficient regions of capital. Also, all of the players have absolute faith in the transport logistics system and since these are generally in private hands, minimal capital will be expended on security of supply, rather a just-in-time system of minimising working capital (stocks) will hold for both liquid fuels and gas supply.

The move to globalisation can have profound consequences for national security and planning of energy supply, particularly in relation to the supply of liquid transport fuels and natural gas to domestic users. Note: The move by government to designate some gas resources for exclusive delivery to the domestic market is a sign that there is acknowledgement of political risk coming from power outages caused by gas shortages and including consequent industrial losses. The question is; does government have the will and the constitutional power to enact and act on legislation for mandatory partial embargoes on natural gas export?
Perhaps the next political cycle will herald a new era of cross-party co-operation to avert disasters from the disruption of liquid fuel and natural gas energy supplies, and ensure that electricity generation from natural gas (or condensate) is available where and when needed.

Consequence for liquid fuels

For transport fuels globalisation has led to the growth of large regional refining centres such as Singapore which has been inimical to the growth of oil refining investment in Australia. Australia faces the prospect that, should globalisation of the hydrocarbon processing industry continue, then there will be no crude oil refinery operations on the eastern seaboard of Australia, with the concomitant closure of downstream hydrocarbon processing industries reliant on them. From a global perspective, this may bring efficiency gains by using larger-scale operations overseas. It may also help achieve domestic political goals by removing large emitters of carbon dioxide from the economy.

But there are also serious downsides. Closure of refineries will have the effect of turning refinery sites into import terminals for fully finished (Australian specification) products imported from overseas operations, in particular Singapore [this is now the openly stated policy of Caltex Australia]. One immediate outcome of this will be that Australia will not have the ability to upgrade any indigenous crude oil, should for whatever reason Australia become isolated. Continuance of supply in a stressed economy will be from the stocks kept in the system until the transport logistics system is restored. This is in contrast with today's situation where in the event of isolation, Australian refineries could produce some fuels (within limits) from the remaining indigenous oil production in the Bass Strait and oil from the small fields off Western Australia. Furthermore, in the non-refinery scenario, the stocks have to provide for three fuels – petrol, jet fuel and motor distillate – with only minimal flexibility to switch, whereas a refinery would have the opportunity (again within limits, but broader limits) to change the relative availability of the three important fuel types.

Another feature of the non-refinery scenario is that disaster management is affected. In the refinery case, supply of fuels is provided by the ability to obtain crude oil, with stock control and supply in few hands. By contrast in the import terminal case, the import terminal may hold a limited quantity of stock compared to the general market requirement. For example many of us have experienced unplanned refinery shutdowns and noted the rapid movement of petrol stocks from petrol station forecourts to private vehicle tanks. In the terminal scenario, this may be exacerbated by not just petrol but also jet and diesel seeing a similar rapid change in location of stocks. Not only would authorities have to initiate petrol rationing, rationing of jet and diesel fuel would be necessary.

Energy White Paper

Australia's response to international disruption in the oil market is set out in the *Energy White Paper* (DRET, 2012). This follows a draft version (DRET, *Draft Energy White Paper*, 2011) which gives some further background on energy security including some argument for the positions expressed in the 2012 white paper. The white paper states that in the event of an emergency the government's response would be by the International Energy Agency's (IEA) collective emergency response mechanism and the Liquid Fuels Emergency Act of 1984. In the case of the IEA, it is not clear if the collective measures would ensure the supply of finished product as opposed to crude oil from various sources. Furthermore, one of the conclusions is a view that Australia's compliance with the IEA measures (by not having a 90-day crude oil stock position – see later discussion) may be in doubt, if not today, then in the near future as energy demand rises.

The draft white paper is rather dismissive of energy security stating, 'For a major global energy exporter like Australia, pursuing a goal of national energy self-sufficiency is counterintuitive.' However, this rather naive view ignores the fact that Australia's energy resources are in domestically unusable forms – coal and LNG – rather than the required forms of liquid transport fuels, natural gas and electricity. Historical parallels could be drawn with the Irish famine of the 1840s. At that time Ireland was a net exporter of foodstuffs (mainly meat and wheat); it was just not available at an affordable price for the starving population of the western part of the country.

For gas supply across Australia, alternate resources are possible for meeting the demand of LNG producers, electricity generation, other industry and domestic demand. This will addressed later as part of the discussion on natural gas supply continuity.

The Finkel Report June 2017

The title of the Finkel report "Independent review into the Future Security of the National Electricity Market" takes as its standpoint the current political consensus that the nation needs to embrace its Paris Climate Change goals and commitments by 2030 and sets out a methodology to achieve them in the energy generation sector whilst minimising price rises for the consumer. The issues for this sector are perceived to be poor reliability of renewable generators and poor electricity market performance by poor regulation and administration. Interestingly at no point is the potential for significant investment in base-load nuclear power considered, rather the political consensus that Australia does not need nuclear power is taken as a given.

Our reading of this report indicates that the first problem to solve is the occasional unintended failure of the system for short periods, for instance because of a single generator failure or interconnector. This is solved by batteries (largely unproven technology) or short-term open-cycle gas generators. These are fired, if necessary by government edict, interrupting contacted supplies by LNG export companies. At no stage is a major collapse in the system considered. For instance by a stationary high pressure weather system across eastern Australia shutting down wind generators across several states for several days or possibly weeks or the loss through accidents of several base-load generators at the same time.

Major disruptions which are not addressed by Finkel should be considered. Security from major disruptions would require a significant level of overcapacity in the provision of base-load power; this has been energy industry practice for many decades. It is also puzzling why nuclear power was not considered seriously by this report, since it supplies steady base-load at a low fuel cost, i.e. running a nuclear power station at 100% maximum continuous rating (MCR) costs little more than running the same plant at 80% MCR.

Another major failure of the report is to make heroic assumptions on the cost of electricity generation from renewable sources. The report would appear to accept at face value costs provided by technology suppliers. For instance wind power costs are quoted from a source which concerns as yet to be completed wind-farm (planning permission granted in May 2017 with completion expected in 2019) and involves a substantial up-front cash receipt by the power purchaser of $A110 million. It is not clear if any of this upfront payment was for any tangible assets and clearly would have a material impact on the power purchase price by the purchaser receiving a discount to account for this up-front payment.

Commitments to the International Energy Agency (IEA)

A feature of the IEA commitment is that member countries (like Australia) hold 90-day stock supply. But in the non-refinery scenario, it is not clear if Australia would hold 90 days' stock of finished products – petrol, jet and diesel (indeed, industry sources indicate that the stock level of finished product is generally less than 20 days). As noted above, in the event of a crisis a large quantum of the stock could move from larger controllable centres (tank farms and distribution centres) to privately controlled storage out of the control of the government agencies charged with managing a crisis. The 90-day stock requirement could fall dramatically before government powers could be marshalled.

Latent nationalism merging into potential conflict in East and South Asia, and the increasing Instability in the Middle East

One of the principal assumptions of the global village is that goods and services flow to the highest value sector, because price is the yardstick by which efficiency of distribution is judged. Thus in the case of a disruption, flow would be to the user who could pay the highest price. A key component of this assumption is that national interests play no part in resource allocation. But as has been demonstrated in the recent past, and is now becoming increasing evident in Europe, in time of crisis there is a re-emergence of nationalism which undermines this basic assumption

An example is that regular disputes in the contracted gas supply between Russia, the principal gas supplier to the EU, and several of the countries of Eastern Europe results in limited supply of contracted gas to the western part of Europe. In the UK, in the far west, it was assumed that price signals from UK industry (rising

prices) would assure continued supply. However, the gas flow is controlled by state and quasi-state controlled utilities which are often pressured by the national governments to ensure local domestic supplies irrespective of price signals from the UK. The resulting shortfall of gas supply in the UK has from time to time forced the closure of gas-intensive industries and prompted increase supply from Norway and the expansion of LNG import terminals, ultimately paid for by consumers.

For Australia the lesson from this development concerns the provision of liquid fuels to Australia, namely: Can Australia rely on price signals alone or will our suppliers, in the event of a serious international emergency, be pressured by nationalist interest to divert supply to others. For example would Singapore be pressured to supply Malaysia, Japan or China rather than Australia? From Australia's perspective this could both exacerbate and extend a supply disruption crisis.

Gas Supply Continuity; taking the gamble out of supply

There is a major risk to continuous and affordable gas supply to the east Australian domestic gas market; the risk is that insufficient gas will be available for delivery to the gas-fired generators and industry that relies on gas for manufacturing and commercial services. On the Australian eastern seaboard, gas is supplied from three geographic areas. In the south, the Gippsland and Otway basins provide gas to Victoria; central Australian reserves supply mainly Adelaide and Sydney; and the developing coal seam gas reserves supply Brisbane and the export LNG terminals at Gladstone.

Following a fire at the main Victorian gas plant at Longford in 1998 and the consequential shut-down of supply to Victorian industry, there has been integration of the pipeline network to ensure supply in the event of an emergency. One consequence, probably unintended, of this integration is that price for the entire eastern seaboard is determined by the highest price in the system which is the price determined by the export LNG industry based in Queensland, which in turn is linked to the international oil price.

Furthermore, although rising prices and carbon taxes could be expected to reduce industrial demand, there is a constantly rising demand for gas for power generation. This is driven by increasing use of unreliable renewable power generation which requires gas-turbine facilities as "dispatchable" power back-up, and by government fiat favouring new gas-based rather than coal-based base-load generation. We thus have a situation where in the future a major disruption of gas supply could severely interrupt the supply of electricity.

Should a major disruption occur, say by the simultaneous disruption of supplies from the major Victorian facilities at Longford and the central Australian facilities at Moomba, in theory gas could flow via various interconnectors from the coal seam gas (CSG) operations in Queensland. However, most of this gas is likely to be committed to the export liquefied natural gas (LNG) business and it is a moot point to ask could export LNG be disrupted quickly enough to support the domestic supply. In other words, does the government have the necessary power, or political will, to place contracted export gas at risk in order to support domestic supply of gas and power? At this time, as noted in the *Energy White Paper*, and as previously stated, the government has no mandatory power concerning the distribution of gas, rather acting as a co-ordinator and leaving it up to market forces (price) to efficiently distribute gas in the system.

As noted above, in the event of a gas shortfall in the Australian domestic market, the government is proposing to limit the flow of gas to LNG operations in favour of compulsory diversion into the East Australian Grid. At the time of writing the appropriate regulations to give effect to this are not in place.

Australia does not possess the large gas storage facilities of other countries with large gas supply industries. Gas storage is by means of the stock within the pipeline system and in small gas fields primarily designed to even out local supply at times of a local peak demand. There are no national large-scale storage facilities.

It is important to note that in recent years several state governments (NT, NSW and Victoria) have moved to restrict or ban gas exploration and development. It is obvious that this is inimical to future gas supplies but it also affects gas storage because the measures effectively restrict the development of small gas fields which after depletion can be used for storage.

Another variation on this scenario is a major disruption to the CSG operations which would place the contracted export of LNG at risk. Would the government countenance limiting domestic supply in order to maintain output from the Gladstone export facilities?

Gas and Liquid Transport Fuel for Metropolitan Centres

The general disaster scenarios considered above and in the Energy White Paper take little account of the demographics of Australia, where it is important to note that most of the population is clustered in large metropolitan centres. Clearly there is a difference between managing an energy disaster scenario between relatively remote towns and communities and the major metropolitan centres. On the face of it the distributed centres would be better able to cope with an energy supply disaster since, being remote, they tend to carry a proportionally higher volume of stock, though this needs to be verified.

The situation could be quite different for metropolitan centres where it is likely that stocks are relatively lower and there is critical demand for fuel supply for maintaining life's necessities. For example, most supermarket chains appear to operate on a one-week stock cycle and require significant volumes of diesel fuel to maintain adequate stocks and supply of fresh food. A national liquids fuel supply strategy in times of crisis would be required to ensure adequate distribution of fuel to food retailers. A further complication is that the urban areas are very large so that it would be critically important from a political standpoint to maintain a homogeneous supply across the region and not appear to favour one electorate relative to another.

A similar but probably less severe situation would occur in the event of a natural gas/electricity crisis. Power disruption to supermarkets could result in the destruction of fresh food, frozen and dairy products which would require rapid replacement or alternative delivery methods introduced. Again this is likely to exacerbate political considerations of managing the crisis.

The political decision would appear to be one of balancing the political stink of shutting down domestic supply in order to fulfil contracted obligations to foreigners versus offending powerful trading partners (China) in order not to suffer on the domestic political front. On present information it is not clear which way the government would choose and the decision could be dependent on a random event such as an upcoming by-election or an increasingly unfriendly Senate.

Western Australia and Northern Territory

This discussion has concerned the energy supply on the eastern seaboard. Western Australia and the Northern Territory are isolated from the eastern supply chains in terms of liquid fuels and gas and should be considered separately. At the time of writing the refinery in WA is likely to remain operational and so the scenarios outlined in the Energy White Paper would be applicable. The Northern Territory has no refinery and is unlikely to attract such in the near future. The supply of fuels is by importing finished fuels and this is likely to persist. If local stocks are considered adequate (90-day minimum) then the issues raised in this paper are likely not to affect the Territory.

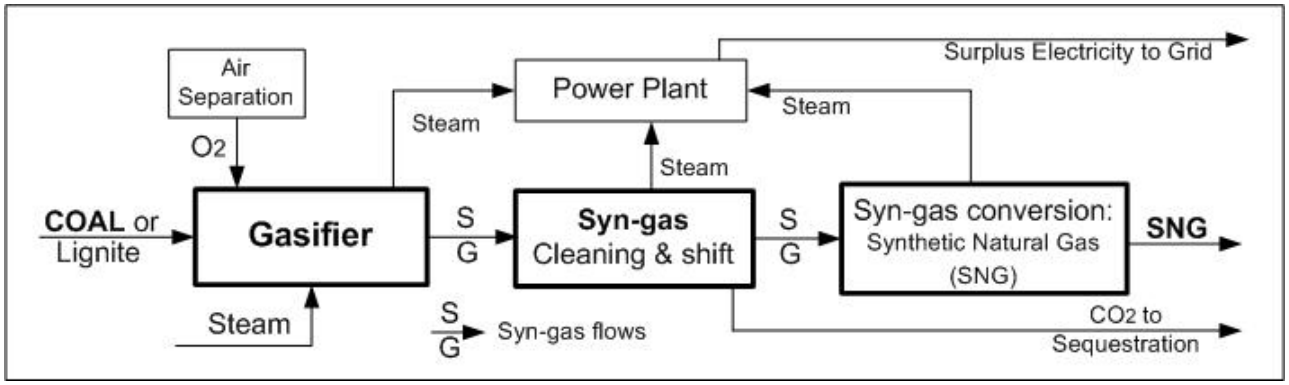
Overcoming and Avoiding the Energy Disaster Scenarios - Gas

In the original version of this paper (Clarke & Seddon 2012) consideration of installing floating LNG receival terminals at Newcastle or Wollongong and in southern Victoria was recommended as a means of overcoming short-term acute disruptions to gas supply. Very recently AGL has suggested LNG receival terminals in NSW, Victoria and SA (June 15, 2017, Ref Matt Chambers, The Australian) as a way managing chronic shortages. Recent events with respect to there being insufficient gas in the Eastern Australian Grid has greatly strengthened the argument for LNG receival terminals. Note: The present glut of LNG in the Pacific Basin has caused LNG spot prices to be significantly lower than domestic gas prices.

Returning to the political ramifications of not having sufficient domestic gas, the state governments of New South Wales and Victoria could remove their moratoriums that block gas exploration, production and logistics, and open up their onshore confirmed and potential gas resources. The Northern Territory

government could suspend its moratorium on fraccing onshore non-conventional gas prospects and allow discovered gas to be monetised by either selling into the new NEGI pipeline or be sent to the original LNG train where the gas can be used to supplement the diminishing offshore Bayu Undan gas reserves. Note: LNG from Darwin could be contracted to receival LNG terminals in southern Australia.

Another source of East Coast gas could be synthetic natural gas (SNG) which is methane produced from black coal or lignite. Coal to SNG is well known and is commercially practiced. A typical coal to gas plant would use about 2 million tonnes/year of dry coal to produce about 30PJ/a gas. The plant would produce electricity as a by-product. Fulfilling the entire gas shortfall would require six such plants, offering business opportunities for players with suitable coal reserves down the east coast. The process is schematically described in the following figure.



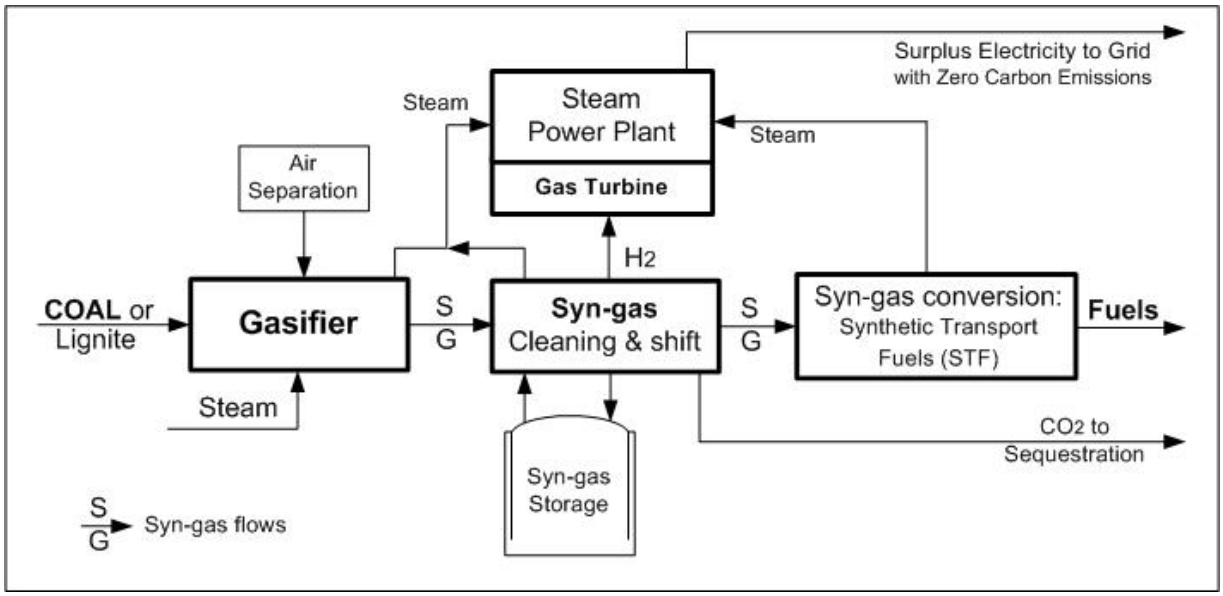
Although the cost of producing natural gas from conventional onshore petroleum resources is lower than SNG production costs, SNG projects are economically feasible when compared to many unconventional NG plays. Where uncertainties such as sovereign risk from international conflict and/or civil strife and sovereign risk from moratoriums and outright banning of fraccing, the certainty of having very extensive, delineated, mineable and convertible coal resources is a major positive for future SNG production.

Overcoming and Avoiding the Energy Disaster Scenarios - Liquid Transport Fuels

Australia has a significant production of condensate from its gas and oilfields. This raw product has limited use as a transport fuel but can be refined into 'finished' transport fuels such as jet fuel, gasoline and diesel in Singapore and S. Korea. The remaining Australian oil refineries are not suited to refining condensate. Non-conventional potential new oil reserves are likely to be shale-oil/gas plays, which will produce very light crudes similar to condensate, these new resources will again need to be refined off-shore. If new conventional oil finds are found they will also likely have an API gravity of >55˚ and be condensate/naphtha. The answer to making better use of present and Australian natural oil production is to build a new condensate friendly refinery in eastern Australia with a minimum capacity of 200,000 bbl/day product.

An alternative and/or supplementary way of avoiding Australia's transport fuel crisis is to build Coal-to-Liquids (CTL) plants on the eastern seaboard. The CTL plants would also be coupled with major power generating plant that would provide over 200MWe each into the East Australian Power Grid. The total coal/dried lignite requirement per combined plant would depend on the split between power to grid and syn-fuels production and the performance of the gasifiers.

The CTL process is schematically described in the following figure, and is similar to the SNG schematic above, however the catalysts required for either process are specific to the process, the ratios of hydrogen to carbon monoxide are different for each process, and the syn-gas reactor operating conditions are process specific.



CONCLUSIONS

Australia has significant threats to both electricity and liquid transport fuels supply. Government has commissioned reports on the potential crises of energy supply interruption but has not dealt with the possibility of major and extended disruptions across the whole system, including disruptions affecting both the supply of liquid fuels and electricity. The *Finkel Report* makes heroic assumptions on the cost of electricity generation from renewable sources and the reliability and adequacy of future energy storage facilities. The report would appear to accept at face value costs provided by technology suppliers for systems that are still on the drawing-board – e.g. very large batteries with storage capacities in the GWh range; units that as now have NEVER been built.

Australia is drifting towards a situation where, in the event of a fuels emergency, there could be serious shortfalls in the supply of liquid fuels to the eastern seaboard and to critical sectors of the economy. This situation is exacerbated by the move away from crude oil refining in Australia and an increasing reliance of imported finished fuels. Crisis management methods as set out in the *Energy White Paper* are considered inadequate to deal with such a scenario as they primarily assume a 90 day stock of crude oil and the ability to refine it. International agreements are unlikely to help as they, on the face of it, concern crude oil supply, and without new refining capacity there is no means of producing finished fuels.

To date crisis management assumes suppliers will respond to price signals in the market. In the event of a crisis, latent nationalism in supplier countries may exacerbate the situation from Australia's standpoint, preventing timely supply of products. In the *2012 Energy Security* paper the external threat was described as 'nationalism', however recent events would warrant the use 'conflict' in place of 'nationalism'.

Crisis management measures in place appear inadequate to deal with this situation and would require extensive revision in order to ensure adequate and timely supply of petrol, diesel and jet fuel to the eastern markets. Note: LNG can be used as a fuel in modified diesel engines; given the wide distribution of NG resources across the nation, alternate or dual fuelling of road (and rail) transport should be expanded. The construction of additional small LNG plants (say 30 – 100 tpd) should be considered; such plants would be welcome by the gas resource owners, since presently stranded gas resources would become economic.

Australia is increasing its reliance on gas for domestic electricity production and is planning to increase this reliance further by installing base-load gas power generation and converting coal-fired generators to gas. A crisis in the supply of gas to the eastern seaboard could have a dramatic impact on the continuous availability of electricity to metropolitan centres with consequential impacts on the supply of fresh food. There seem to be inadequate national measures to ameliorate this situation; for instance the mooted mandating of the use of export gas to supplement domestic supply in such an emergency is not in place yet.

WHAT IS TO BE DONE?

Liquid fuels

On the face of it, following refinery closures, the current national response to a potential energy crisis involving the supply of liquid fuels would be inadequate. A national response would have to address the following issues:

- The adequacy of present storage capacity for refined fuels, the distribution of this capacity and the logistics for effective distribution of the fuels according to national needs,
- If a significant increase in storage of refined fuels is required then not only will this require additional tanks but the funds for the cost of this storage will have to be found. This is unlikely to be readily available from industry participants without the ability to pass this cost on to the consumer. For example, if an additional 70 days' stock is necessary this could have a value in excess of $3,000 million at current prices. Furthermore, the requirement to considerably increase holding times may result in product deterioration – for example, petrol oxidation and gum formation, bio-infestation of jet-fuel and diesel,
- Having logistics for sourcing additional supplies from outside the region. This would go beyond the relatively small refinery operations of New Zealand (which is also likely to be affected in a regional supply crisis) and would probably consider supplies from across the Pacific from major refineries in California which are not reliant on oil supplies from the Middle East or the Far East. In passing we note that exports of finished fuels from the US are subject to restrictions,
- Re-examine Coal-to-Liquids (CTL) technologies for their abilities to remove both the liquid fuels and electricity supply threats; with the new plants being 'Carbon Capture and Sequestration (CCS) Ready', and
- Increase the utilisation of LNG in heavy transport.

Gas

For natural gas supply issues it would be necessary to have a formal response mechanism rather than a "leaving it to the market" approach. This should not necessarily require a "strategic reserve" approach towards gas supply or any interference with price-setting arrangements, but should set out the methodology of government control in the event of a national crisis. This may be extended to provision (by government investment) of strategic gas storage at appropriate points in the gas pipeline network.

Incentives to long-haul road transport groups to switch to dual (LNG and diesel) vehicles and for the main national railways to also be dual fired, are wise steps with good risk reduction and positive environmental ramifications.

Electricity

Follow PM Turnbull's advice to install new coal-fired, high efficiency, low emission (HELE) generation technology, to stabilise the power supply and meet base-load and some intermediate-load demand; this technology could be CTL and would be an excellent means of achieving a high level Energy Security.

Reconsidering nuclear energy in the form of small to medium Generation IV (200 – 300 MWe) reactors. Note: Nuclear resources are discussed in *Australian Energy Resource Assessment*, *BREE, Nov. 2014*.

Although Australia's flat geography plus hot and dry climate are not well suited for pumped storage (PS) electricity, PS is viable in certain areas with the Snowy Scheme 2 being a good possibility for storing electricity from new Victorian HELE coal plants and Victorian and Southern New South Wales renewables generation. Realistic opportunities for pumped storage may exist in the eastern border region of Queensland and NSW, Tasmania, and south-west Western Australia. Battery storage for grid back-up is a distant hope.

Final Note: May Australia have a secure energy future.

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