ENERGY SECURITY IN APEC: ASSESSING THE COST OF ENERGY SUPPLY DISRUPTIONS AND THE IMPACTS OF ALTERNATIVE ENERGY SUPPLY STRATEGIES - AN OVERVIEW

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Abstract

A recent report to the APEC Energy Working Group has highlighted that security of oil supply, as distinct from energy supply in general, is the most important energy security risk. This is due to the world's increasing dependence on the Middle East as a supply source. Given a continuation of current trends, the share of the Middle East in world oil production will increase from 30 per cent in 2003 to as high as 46 per cent in 2030.

A mix of response strategies is required by governments to energy security risks. An efficient, resilient and open global energy market is of fundamental importance. However, a key response strategy by all oil importing economies should be to expand oil exploration outside the Middle East.

This paper is an overview of a report of the same title presented to the APEC Energy Working Group in June 2005. The overview contains some slight modifications from the original report. The full report is available from www.abareconomics.com/research/energy/asiapacific.htm.

INDEX

1. Introduction

The Asia-Pacific Economic Cooperation (APEC) region accounts for over half of world output. [1] In recent years, global energy security has become a key political and economic issue within APEC and elsewhere. [2]

Energy security at its simplest means the security of energy supply. This necessarily infers that there must be a mismatch between centres of energy production and centres of demand, which is indeed the case in the world today.

In 2004, the Australian Bureau of Agricultural and Resource Economics (ABARE) and ResourcesLaw International were appointed by the APEC Energy Working Group to quantify the costs of energy supply disruptions to APEC economies and to analyse the costs and benefits of appropriate response strategies. Their report was presented in June 2005.[3]

2. Energy Supply Disruptions

Energy supply disruptions may occur at any point in the energy supply chain; they may originate at a range of geographical locations: they may affect one or more fuel types; they may occur in isolation or simultaneously; and they may be of either short or long term duration (although the longer the duration the less apt the term "disruption" becomes).

Energy supply disruptions may be caused by a range of factors:

- **war, civil unrest, acts of terrorism or piracy on key sea lanes** – these factors may disrupt energy exploration, production, processing or transportation activities and have the potential to cause a major impact on world energy markets;

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[1] There are 21 APEC member economies: Australia; Brunei Darussalam; Canada; Chile; People's Republic of China; Hong Kong, China; Indonesia; Japan; Republic of Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; The Republic of the Philippines; The Russian Federation; Singapore; Chinese Taipei; Thailand; United States and Viet Nam.

[2] In 2000, APEC commenced work on the APEC Energy Security Initiative described in section 4 of this paper. As G8 leaders recently acknowledged: *"Secure, reliable and affordable energy sources are fundamental to economic stability and development. Rising energy demand poses a challenge to energy security given increased reliance on global energy markets",* The Gleneagles Communiqué on Climate Change, Energy and Sustainable Development, Gleneagles, Scotland, 8 July 2005.

[3] Australian Bureau of Agricultural and Resource Economics (ABARE) and ResourcesLaw International, "Energy Security in APEC: Assessing the Costs of Energy Supply Disruptions and the Impacts of Alternative Energy Supply Strategies", Report to the APEC Energy Working Group, APEC Secretariat, Singapore, 2005 (hereafter **"the ABARE/ResourcesLaw Report"**). All data in this paper are sourced from this report. The full report is available from www.abareconomics.com/research/energy/asiapacific.htm.

- **natural events** – events such as earthquakes may cause major energy infrastructure damage, although the damage typically occurs at the local or regional level;

- **accidents or technical factors** – events such as plant breakdowns may disrupt energy supply;

- **market factors** – factors such as production volume limits or instability associated with major producer groups or cartels may have significant implications for the world energy market (the most notable example being the OPEC decisions in the 1970s); and

- **policy factors** – factors such as the unintended consequences associated with energy market reform may distort energy production and pricing outcomes (as occurred in recent years in California).

A comprehensive risk assessment of temporary energy supply disruptions in the APEC region would require information on the probability or likelihood of potential energy supply disruptions occurring and the damage or cost of each potential disruption. This would be a daunting and expensive task and its value would be doubtful. There will always be some ambiguity about what energy security really means. [4]

3. What Are The Main Causes of Vulnerability?

Despite any ambiguity about what "energy security" means, it is clear that there are three main causes of vulnerability of an individual country to energy supply disruptions. The first, and most important, is overdependence on either domestic production or imports of a single form of primary energy – this applies whether the primary energy form is oil, gas coal, uranium, hydro or any of the new forms of renewable energy.

The second cause of vulnerability is overdependence on any particular supply source of primary energy – whether it is the supply of oil from the Middle East, the supply of coal from Australia or the supply of LNG from Indonesia.

The third cause of vulnerability is overdependence on a single energy infrastructure facility – this could apply where the economy depends on a single oil or gas pipeline, a single oil or gas storage facility or a single electricity transmission grid.

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[4] As the Royal Dutch Shell Group has stated, *"Ambiguity will persist as to what the term "energy security" covers: physical supplies can be threatened by rising international insecurity as well as by depletion of supply sources. Insecurity can also result from the lack of investment in enhanced recovery of existing sources, in new energy sources and/or infrastructure",* "Global Scenarios", Press Release, 6 June 2005, London, UK.

4. The APEC Energy Security Initiative

In 2000, the APEC Energy Working Group commenced work on the APEC Energy Security Initiative. Since then, increased volatility in the world oil market, and heightened security concerns following the events of 11 September 2001, have resulted in its further articulation by the 21 APEC Energy Ministers and its ultimate endorsement by the 21 APEC Leaders in Chile in November 2004.

The APEC Energy Security Initiative now encompasses the following areas:

- **the Joint Oil Data Initiative** — the aim of the Joint Oil Data Initiative (JODI) is to improve the quality, timeliness and completeness of world oil market data available to market participants and hence improve market transparency;

- **sea-lane security** — oil and gas transport in the Asian region is almost exclusively by tanker; of particular concern in the APEC region is the fact that the Malacca Strait is very shallow and only 0.5 km wide at the narrowest point;

- **real-time emergency information sharing** — the aim of information sharing during oil supply disruptions and other energy emergencies is to enable APEC economies to accurately assess the nature of the emergency and develop appropriate responses;

- **emergency responses** — in the event of an energy supply emergency, there must be emergency preparedness plans and oil stockpiling arrangements within APEC to address short term needs; and

- **longer term responses** — longer term energy security responses include energy investment; natural gas trade; nuclear power; energy efficiency; renewable energy; hydrogen, fuel cells and alternative transport fuels; methane hydrates; clean fossil energy; and petroleum infrastructure and crude and refined products (the CAIRNS Initiative).

Energy security policies vary widely between APEC economies and are influenced by the specific circumstances of the economy including, most notably, income levels, access to domestic energy resources and participation in international agreements. Emergency fuel stockpiles within APEC are held primarily by high income economies that depend on imported oil, with Japan, the United States and Korea accounting for virtually all of the region's emergency stocks.

APEC's longer-term response strategies are not as well developed as its short-term strategies and it is one purpose of this paper to speculate how these strategies might in

future be further articulated. An appreciation of APEC's declining self-sufficiency in energy is first necessary.

5. APEC's Declining Self Sufficiency

In 2002, the APEC region accounted for 56 per cent of world output and 58 per cent of world total primary energy consumption (TPEC). Four APEC economies accounted for 45 per cent of world TPEC (United States, China, Russia and Japan).

The importance of specific fuel types in APEC energy consumption in 2002 may be summarised as follows:

- **APEC total primary energy consumption** — 90 per cent was sourced from non-renewable fuels including oil (35 per cent), coal (28 per cent), gas (21 per cent) and nuclear (7 per cent), and 10 per cent from renewable energy. Renewable energy includes combustible renewables and waste (7 per cent), hydro (1.9 per cent), geothermal energy (0.5 per cent) and solar, wind, tide and wave energy (0.1 per cent);

- **APEC electricity generation** — 85 per cent was sourced from non-renewable fuels including coal (46 per cent), gas (18 per cent), nuclear (16 per cent) and oil (6 per cent) with hydroelectricity the most important renewable energy source (13 per cent); and

- **APEC total final energy consumption** — this was mainly sourced from oil (petroleum products, 45 per cent), electricity (17 per cent), gas (15 per cent), coal (9 per cent) and renewables (9 per cent).

Oil, the key focus in energy security assessments, is mainly used in the transport and industry sectors. Transport is the most oil intensive sector in the APEC region with 94 per cent of energy sourced from oil in 2002. Agriculture is also highly reliant on oil with an oil share of 68 per cent, although this activity is a relatively small user of oil in absolute terms. Oil accounted for 27 per cent of energy consumption in the industry sector.

The supply side is rather different. In 2002, the APEC region accounted for 53 and 38 per cent of world energy and oil production, respectively.

APEC energy self sufficiency (energy production as a percentage of energy consumption) was 91 per cent in 2002, indicating the level of energy production was insufficient to cover the APEC region's total primary energy consumption in the same year. APEC energy self sufficiency declined from 96 per cent in 1992 to 91 per cent in 2002 and ABARE has projected that it will fall further to 79 per cent in 2030.

In the particular case of oil, APEC self-sufficiency was 67 per cent in 2002, which accounts for the energy shortfall within the APEC region. This compared with APEC coal self sufficiency of 105 per cent and APEC gas self sufficiency of 108 per cent.

APEC oil self sufficiency declined from 77 per cent in 1992 to 67 per cent in 2002 and ABARE has projected that it will fall to 38 per cent in 2030.

This increasing oil import dependence, or declining oil self sufficiency, is an important energy security risk for APEC, reflecting both demand side and supply side aspects of the oil market:

- **demand side aspects** — oil dependence is a feature of APEC economies, particularly in the transport sector where there are limited substitution possibilities over the short to medium term, but agriculture and energy intensive manufacturing activities are also highly reliant on oil inputs; and

- **supply side aspects** — oil and other major fuel types are non-renewable resources that need to be discovered before production may proceed, increasing uncertainty in any medium to longer term outlook assessment; in addition, world oil reserves and production are concentrated in relatively high risk regions with the prospect of increasing market concentration over the medium to longer term.[5]

Relative to current production levels, world coal resources are relatively more abundant than either oil or gas resources. At the end of 2003, the world reserves to production ratio was estimated to be around 41 years for oil, 67 years for gas and 192 years for coal. However, reflecting the impact of exploration activity on the level of proved reserves and despite higher world production levels, the reserves to production ratio for both oil and gas was higher in 2003 than in 1980 — the ratio was 29 years and 58 years, respectively, for oil and gas in 1980.

World proved reserves for oil and gas are concentrated in the relatively high risk regions of the Middle East and Africa. At the end of 2003:

- **oil reserves** – 72 per cent of the world's proved reserves for oil were located in the Middle East/Africa regions (63 per cent in the Middle East and 9 per cent in Africa);

[5] Proved reserves of oil, gas and coal may be interpreted as estimates of below ground stocks that are assessed to be economic to produce over time under current market conditions. Estimates of proved reserves will vary with economic conditions. For example, a sustained real price rise would result in currently uneconomic resources being reclassified as economic and, aggregate proved reserves for the resource would be revised upward. A sustained real price rise will also encourage exploration activity with any related resource discoveries potentially adding to proved reserves. Ongoing exploration activity is obviously crucial in gaining knowledge about new oil and gas fields.

- **gas reserves** – 49 per cent of the world's proved reserves for gas were located in the Middle East/Africa regions (41 per cent in the Middle East and 8 per cent in Africa); and

- **coal reserves** – 6 per cent of the world's proved reserves for coal were located in the Middle East/Africa regions (data for the separate regions are not available).

In 2003, the share of the Middle East and Africa in world production of oil, gas and coal was 41 per cent (30 per cent, 11 per cent), 15 per cent (10 per cent, 5 per cent) and 6 per cent respectively.

Assuming world oil consumption continues to rise over the medium to longer term, the global distribution of oil production will shift toward the distribution for proved reserves — that is, the share of the Middle East will rise. The timing of this shift will be influenced by new project developments associated with existing reserves, new discoveries made outside the Middle East, and a change in economic conditions that enables currently uneconomic reservoirs or deposits to be reclassified as economic. The development of non-conventional sources, such as tar sands and gas to liquids projects, will also contribute to future oil supply.

The share of the Middle East in world oil production is projected by ABARE to increase from 30 per cent in 2003 to 46 per cent in 2030. However, the share of the Middle East in world gas production is projected to be 10 per cent in 2030, unchanged from 2003 — this outlook reflects the assessment that there are likely to be substantial gas resources outside the Middle East that will be economic to develop over the outlook period. The prospects for acceleration of gas trade have been the subject of two further studies in 2004.[6]

Given the level of historical price volatility of oil sourced from the Middle East, the concentration of proved reserves and production in this region for oil and, to a lesser extent, gas, market dependence on the Middle East represents an important energy security risk to the APEC region. Future oil exploration outside the Middle East is therefore important to discover new reserves as well as to diversify fuel sources to reduce market dependence.

A further important consideration in world energy markets is the role of OPEC. Compared with a peak of 54 per cent in 1973, OPEC's share of world oil production varied within a relatively narrow band of 38 per cent to 42 per cent range between 1990

[6] (i) ResourcesLaw International, "Great Expectations: Cross-Border Natural Gas Trade in APEC Economies", Report to the APEC Energy Working Group, APEC Secretariat, Singapore, November 2004;

(ii) ABARE, "The Asia Pacific LNG Market: Issues and Outlook", Research Report for the Australian Government Department of Industry, Tourism and Resources, November 2004.

and 2003, but is now projected by ABARE to increase to 61 per cent in 2030. Future oil investment and production decisions by OPEC member economies will have important implications for world oil market outcomes. From an energy security perspective, some consideration needs to be given to the risk of some combination of short term oil supply disruptions associated with political instability in the Middle East and an unexpected change to OPEC oil production targets over a more sustained time period.

6. Quantifying The Economic Effects of Temporary Energy Supply Disruptions in APEC

For the purposes of the ABARE / ResourcesLaw Report, ABARE used its global trade and environment model, GTEM, to quantify the impacts of possible energy supply disruptions on APEC economies. GTEM requires a reference case or a 'business as usual' scenario against which the impacts of the energy supply disruptions can be measured. The reference case represented the likely outlook for economic activity and energy demand and supply in APEC and across the world over the period to 2030 in the absence of changes to key energy, environmental or economic policies.

As a result of slow growth in oil production, the share of APEC in world oil production declines considerably over the projection period from 37 per cent in 2002 to 22 per cent in 2030. Conversely, oil production grows strongly in the Middle East. By 2030, the Middle East produces 46 per cent of world oil supplies, up from 29 per cent in 2002.

Three energy supply disruption scenarios occurring in each of 2005 and 2020 were modelled in to represent the variety of possible threats to APEC energy supplies:

- **oil disruption scenarios** — in each oil simulation, it is assumed that oil production in the Middle East is disrupted for around three months, resulting in a fall in world oil production by around 8 per cent relative to the reference case;

- **LNG disruption scenarios** — in each LNG simulation, it is assumed that LNG production in the Middle East region is disrupted for about six months, resulting in a fall in world LNG production by around 10 per cent relative to the reference case; and

- **sea lane disruption scenarios** — in each sea lane simulation, it is assumed that shipping through the Malacca Strait is stopped for 5 weeks.

In the ABARE analysis, supply disruptions in 2005 were compared with disruptions of a similar magnitude in 2020 in order to depict the implications of projected significant changes within the APEC region, particularly increasing oil import dependence and expanding LNG trade.

7. The First Scenario: Disruptions to Middle East Oil Supply

A three month disruption to the supply of oil from the Middle East and the associated increase in world energy prices, would have significant impacts on APEC economies.[7]

In both the 2005 scenario and the 2020 scenario, the three month disruption to world oil supplies leads to a contraction in APEC gross national product (GNP) of 0.2 per cent relative to the reference case in the year of the disruption. To put these numbers into perspective, the contraction in the 2005 scenario is $US43 billion (in 2002 prices) and is roughly similar to the current size of each of the economies of New Zealand, Peru or Viet Nam. In the 2020 scenario, the contraction in the APEC economy is $US82 billion (in 2002 prices) and is similar to the current size of each of the economies of Malaysia, the Philippines or Singapore.

Aggregate income impacts vary considerably between APEC economies and over time. High income economies experience the greatest losses in APEC as they typically depend heavily on net oil imports. However the GNP impact in the high income economies relative to the reference case declines from 0.28 per cent in the 2005 scenario to 0.25 per cent in the 2020 scenario because of a substantial decline in the importance of oil for generating output.

In contrast to high income economies, strong gains are experienced relative to the reference case in the oil exporting economies of Indonesia, Malaysia and Russia, and to a lesser extent Mexico. These economies benefit from income transfers associated with higher world oil prices. However the gains from an oil supply disruption are lower for each of these economies in 2020 than in 2005, reflecting the substantial decline in net oil exports projected for each of these economies over that period.

The negative impact on APEC of the disruption to oil supplies is concentrated in those industries that rely intensively on petroleum inputs, specifically the transport industry and the chemicals, rubber and plastics industry. The higher cost of oil leads to higher prices and lower demand for these oil intensive commodities relative to the reference case.

The aggregate and sectoral output impacts of the oil supply disruptions lead to a substantial decline in APEC oil consumption and imports relative to the reference case in both scenarios. Total APEC oil consumption contracts by 7.3 per cent in 2005 under the 2005 scenario relative to the reference case or by 148 Mt. In the 2020 scenario, APEC's crude oil imports decline relative to the reference case by 9 per cent in 2020, or by 243 Mt.

[7] The extent of these impacts will vary between APEC economies depending on each economy's net oil import position and on an economy's reliance on oil. Net oil exporting economies are likely to gain from income transfers associated with higher world oil prices, whereas net oil importing economies stand to lose.

8. The Second Scenario: Disruptions to Middle East LNG Supply

The impacts of the disruption in LNG supplies on APEC as a whole are insignificant, reflecting that LNG supply is only important for a small number of APEC member economies.

Even in those economies that do import LNG from the Middle East, the economy-wide impacts of a disruption to LNG supplies are marginal. Under the 2005 LNG disruption scenario, for example, aggregate output in 2005 contracts by less than 0.1 per cent in Japan and Korea relative to the reference case. Similarly in the 2020 LNG disruption scenario, the contractions in aggregate output in 2020 among all LNG importing economies are less than 0.1 per cent.

The contraction in LNG consumption and in LNG imports relative to the reference case varies between economies according to the degree of dependence on Middle East LNG, and on the opportunities for low cost substitution away from gas.

The fact that it is cheaper for some importers to reduce LNG imports by a given proportion than it is for others reveals there are opportunities for economies engaged in LNG trade to gain from cooperation, and more generally from enhancing market flexibility.

9. The Third Scenario: Sea-Lane Blockages in the Malacca Strait

Trade underpins the strength of APEC economies, and most maritime trade with non-APEC regions flows through the Malacca Strait. Obstruction of the Malacca Strait, APEC's principal maritime trade route with non-APEC economies, raises freight costs for all traded commodities and thereby leads to a contraction in world and APEC trade volumes relative to the reference case. The reduction in demand for traded commodities across the world undermines production and income in the world and in APEC economies.

Again, the impacts on APEC are marginal, particularly when compared with the impacts of the oil supply disruption. For APEC as a whole, the 5 week blockage costs US$1.7 billion (in 2002 dollars) in GNP in the 2005 scenario, and US$2.8 billion (in 2002 dollars) in the 2020 scenario. In percentage terms, this is less than 0.1 per cent of annual APEC GNP.

The cost would be greater if the blockage were simulated for a longer period. However 5 weeks is not an unreasonably short period of time given the experience and state of readiness of the workforces that manage the Strait, particularly in the narrowest length of the channel alongside Singapore. If anything, 5 weeks may overstate the length of time

of any potential blockage. Nonetheless the 5 week blockage assumed in the APEC study is sufficient to indicate the nature and extent of impacts of a major blockage.

10. The Economic Rationale for Government Intervention in Energy Security

Energy security may be considered within the context of energy policy whereby energy policymakers aim to ensure the provision of energy at least cost over time, given energy technologies and resource availability, and taking into account environmental impacts and economic and other risks in the outlook. The economic rationale for government intervention is based on the presence of market failure (that is, the failure of markets to efficiently provide some goods and services) and the capacity of the government, first, to identify and assess policy options that address the market failure and, second, to implement the policy option judged to result in the highest net economic benefits over time.

Key aspects of market adjustment to major temporary energy supply disruptions were quantified in ABARE's GTEM analysis and include demand restraint, surge production and fuel switching. It should be noted, however, that private investment in energy supply reliability is not included explicitly in GTEM. Private companies invest in supply reliability provided there is an economic incentive to do so (ignoring any policy requirements). Private companies may adopt a range of risk sharing and reducing measures designed to offset, at least to some extent, the negative impact of temporary energy supply disruptions on profitability. For example, private companies may manage risks by investing in energy stocks, energy exploration activity, research and development into or adoption of energy conservation and switching technologies, and diversification strategies (such as participation in joint ventures).

Energy markets tend to underinvest in energy supply reliability. This is a result of the public good nature of investment in energy supply reliability (others benefit from private investment in energy supply reliability, resulting in free riding), the possible external costs of energy supply disruptions (if the energy sector does not incur the full costs of energy supply disruptions, the economic incentive to invest in energy supply reliability is lower than would otherwise be the case) and the inclusion of a risk premium in private investment decisionmaking.

The observation that private investment in energy supply reliability tends to be below the optimal level provides the economic justification for considering government intervention in energy security, either directly through public provision or indirectly to increase private investment in energy supply reliability.

11. Stockpiling as a Short Term Response

Investment in energy stocks is the major approach for smoothing short term fluctuations in both supply and demand where it is feasible to store the fuel type (particularly important for commodities such as oil and LNG). The availability of stocks during a temporary energy supply disruption reduces the costs of the disruption by providing an alternative supply source.

The policy response to the problem of underinvestment in energy stocks in the private sector is to supplement private storage (for example, through subsidies or tax concessions) or invest in public storage. A major issue with public investment in energy storage is that it reduces the economic incentives for private investment — that is, public storage results in some crowding out of private storage. Public storage reduces the net economic benefits of private storage by moderating price increases during temporary energy supply disruptions. In addition, compared with private sector behaviour, there may be greater uncertainty about the nature of public intervention in energy markets through stock drawdown during periods of supply disruption, increasing perceived risks in private investment in stocks and placing further downward pressure on private investment.

There has been some recent analysis of the potential for joint investment by a number of smaller net oil importing APEC economies in an oil stockpiling facility. For these economies, the economies of scale in a joint facility would reduce the costs that would otherwise be incurred in storing similar quantities of oil in separate facilities in each economy. The costs associated with a range of options for such a joint facility have been examined by the Tokyo-based Asia-Pacific Energy Research Center (APERC). The benefits of additional oil stocks are the reduced costs of any temporary oil supply disruptions. While APERC has provided some indicative estimates of the costs of oil supply disruptions, the ABARE modelling analysis provides more comprehensive estimates of the economic impacts of a major global oil supply disruption.

12. Other Short Term Responses

(i) Price Rationing in Energy Markets

Energy prices have a key role in signalling variations in supply and demand conditions. During an energy supply disruption, higher energy prices are part of the process that allows energy to be rationed to users who place the highest value on the energy source. That is, price rationing is an important part of the normal operation of energy markets and is the market response to volatility. Price rises encourage demand restraint, fuel switching and surge production in the short term.

(ii) Quantity Rationing by Market Intervention

Various forms of non-price rationing mechanisms are adopted by governments during an emergency, mainly to ensure access to energy by high priority users, such as emergency services, and in response to equity concerns about large energy price rises. Quantity rationing may be achieved through direct allocation (the government allocates energy supplies directly to energy users), demand suppression (the flexibility of energy purchases and consumption is restricted) and queuing (energy supplies are allocated on a first come first served basis). In practice, some combination of these options is used with direct allocation to emergency uses, and demand suppression and queuing mechanisms applied to other energy consumers. To complement quantity rationing, information programs by governments encouraging energy users to adopt more energy conservationist practices, at least for the duration of the shortage, may further restrain demand.

(iii) International Cooperation

International cooperation is an important aspect of the policy response to a major global energy supply disruption. Governments need information on the nature of the shock, first, to identify and assess policy options to reduce the magnitude and duration of the energy supply disruption (that is, reduce the disruption costs by addressing the source of the shock directly) and, second, to plan and implement the appropriate emergency policy response. The importance of international cooperation and information sharing is recognised by the APEC Energy Security Initiative.

13. Longer Term Policy Responses

Since the probability of a major energy supply disruption occurring is positive, governments need to maintain an emergency response capability. However, there is a need for longer term policy responses that can reduce the costs of disruptions in the future by reducing the probability of major energy supply disruptions occurring and by reducing the costs when such disruptions actually occur.

(i) Diversification in Energy Markets

Diversification of fuel types and fuel sources is one of the most important components of the longer term policy response to energy security risks. Key aspects of diversification in energy markets include:

- **diversification in energy production** — that is, reduce the dependence of economies on higher risk sources of energy by diversifying the geographic location of fuel sources; and

- **diversification in energy consumption** — reduce the dependence of economies on higher risk forms of energy by diversifying the fuel types in energy consumption.

If there is assessed to be an equal probability of disruption across locations and fuel types, diversification would reduce the expected costs of future supply disruptions by spreading the risks across different locations and fuel types. If certain locations and fuel types are assessed to be relatively high risk, private companies and governments need to assess the net economic benefits of diversifying the energy market to reduce dependence in these higher risk areas.

In particular, any economic assessment of the appropriate level of diversification (and other longer term responses) needs to take into account the net economic benefits over time from utilising relatively abundant energy resources, particularly in low risk geographic locations in the world economy. Coal is the most abundant resource that is mainly located in relatively low risk geographic regions, while oil is the least abundant resource that is mainly located in higher risk geographic regions — gas falls between coal and oil in terms of abundance and location risk.

(ii) R&D and Technology Adoption in Energy Markets

Another important component of the longer term policy response is research and development (R&D) into, and adoption of, energy technologies that may reduce the risk and/or cost of disruptions in the future. While energy security may represent only part of the benefits of R&D activity in energy markets, government support for R&D is a key mechanism to achieve a level of energy security that is closer to society's optimal level.

R&D and technology adoption may have major implications for both the supply side and demand side of energy markets:

- new technologies facilitate energy exploration and production for both conventional and non-conventional sources;

- alternative processing technologies (such as gas to liquids plants) increase the flexibility of markets to adapt fuel types to different end uses;

- new technologies may aim to reduce energy consumption in the economy (or increase the efficiency of energy use); and

- new technologies may increase the flexibility of energy markets to adjust to supply disruptions (energy substitution or switching technologies).

R&D activity, and associated adoption of new technologies, is a key mechanism to increase the level of diversification in energy production and consumption. The high level of dependence on oil in transport use in all APEC economies is an area where there has been limited progress in technology adoption to date. Introduction of new technologies to increase the diversity of the fuel mix in transport would significantly reduce energy security risks in this area.

New environmental technologies are important for the upstream industry by allowing energy exploration and production activity to be undertaken in new areas while managing environmental impacts. In addition, the introduction of more advanced coal technologies would enable relatively abundant coal resources to be utilised more effectively over time. R&D is clearly important for the further development of renewable energy sources.

(iii) Removal of Market Impediments

Other aspects of the longer term policy response may include removal of market impediments in order to increase the efficiency of the energy market to respond to supply disruptions, the provision of energy market information and international policy cooperation. It should be noted that other policies may have significant implications for energy security (for example, environmental policies tend to reduce energy consumption).

(iv) Market Efficiency Measures

The energy policy setting in each economy may have important implications for the economic incentives of the private sector, including investment in energy supply reliability. Policy reform to increase the efficiency of energy markets, including their capacity to respond to supply disruptions, is a significant component of the longer term energy security policy response. For example, an important issue is that economic regulation of natural gas and electricity markets typically limits the extent to which prices may rise in response to an energy supply disruption, increasing the burden of adjustment on other parts of the energy market. This has been one of the issues addressed through the process of energy market reform in many economies in recent years.

(v) Market Information

Government support for the collection, dissemination and analysis of relevant energy market information is justified, at least to some extent, on energy security and broader economic efficiency grounds.

(vi) International Cooperation

Aspects of international cooperation that are important include, for example, ongoing dialogue between the major oil producers and consumers, progress to ensure reasonable levels of sea lane security, and joint R&D and information projects such as JODI. The APEC Energy Security Initiative, described in section 4 above, is an important example of international cooperation that should significantly enhance energy security in the region.

14. Prioritising Emergency and Longer Term Policies

The energy security policy response in each APEC economy will include a mix of emergency and longer term measures. It was beyond the scope of the ABARE / ResourcesLaw Report to examine in detail the energy security risks and policies of individual APEC economies. The objective was to present relevant information that may contribute to energy security risk and policy assessments that will be undertaken by individual APEC economies and that may further contribute to joint assessments within the APEC forum.

An important issue for individual economies is that energy security policy options need to be prioritised within the framework of the national budget — this includes the total budget available to policymakers as well as the full range of competing priorities in the economy. In middle and low income APEC economies, for example, addressing theft of energy and ensuring physical protection of the workforce and infrastructure may have a higher priority than investment in energy stocks.

It is important not to lose sight of the fact that, despite a doubling of global energy demand over the past 25 years, increased competition in global and domestic energy markets in the same period has counterbalanced the supply vulnerabilities of energy importing economies, and most of the world has continued to prosper from available and affordable energy supplies. The continued promotion of an open global energy market should therefore be one of the overarching policy responses.

Table 1 below sets out a list of energy risks and a choice of risk reduction strategies that are open to any economy.

Table 1: Main Energy Security Risks and Basic Reduction Strategies	
Security risk	**Risk reduction strategies**
1. Heavy dependence on oil	• Diversity the energy mix (increase share of natural gas, coal and 'old' and 'new' renewables • Utilise fuel switching systems
2. Heavy dependence on natural gas	• Diversify the energy mix (increase share of oil, coal, nuclear and 'old' and 'new' renewables) • Utilise new conversion technologies such as gas to liquids (GTL), if viable • Utilise fuel switching systems
3. Heavy dependence on coal	• Diversify the energy mix (increase share of oil, natural gas, nuclear and 'old' and 'new' renewables) • Utilise liquefaction and gasification technologies, if viable • Utilise fuel switching systems
4. Heavy dependence on hydro-electricity	• Diversity energy mix (increase share of oil, natural gas, coal, nuclear and 'new' renewables) • Utilise fuel switching systems
5, Heavy dependence on imports	• Diversify external sources of supply • Increase domestic oil and gas exploration • Build stockpiling capacity • Strengthen alliances with reliable suppliers
6. Inadequate stockpiling capacity	• Participate in regional and international oil stockpiling schemes for the common good • Increase domestic oil stockpiling capacity • Increase domestic gas storage above and below ground • Increase domestic coal stockpiling
7. Inadequate transport capacity	• Increase cross border and domestic pipeline capacity • Build and expand LNG receiving terminals
8. Poor utilisation of primary energy	• Utilise new vehicle technologies • Utilise new and more efficient generation technologies • Maintain high reserve generating plant margins • Increase fuel switching capacity
9. Poor efficiency of gas and electricity industries	• Maintain high system security • Utilise private capital and competitive markets • Reduce energy intensity • Utilise demand management systems • Compel demand restraint • Ration supplies if unavoidable
10. Poor utilisation of electricity transmission and distribution networks	• Decentralise generation • Upgrade and augment networks • Interconnect with other power systems by cross border transmission • Extend grid service to unserviced areas

15. Conclusion

For all oil importing economies, the key response strategy should encompass both supply side and demand side aspects – importantly, on the supply side, increased oil exploration and production outside the Middle East and, on the demand side, reduced oil dependence.

For a particular economy, what might be the 'best' response strategy will depend on the combination of particular energy security risks that it faces. Emergency stockpiling systems have a pivotal balancing role to play as a temporary response to shortages but there are four main longer-term response strategies:

- **adoption of a diversified portfolio of interchangeable energy forms and energy supply sources** – this will entail, for example, increased investment in domestic exploration for oil and other energy forms, investment in fuel switching systems and, in many economies, increased utilisation of natural gas.

- **interconnection of energy systems** – interconnection reduces vulnerability to system failure.

- **timely investment in energy production, transport and storage facilities** – these facilities will include pipelines, other transport facilities, power stations and electricity transmission and distribution networks.

- **investment in more efficient energy technologies** – these technologies will reduce the energy intensity of economies by, for example, reducing fuel use in transport.

In summary, in addition to the overarching policy of continuing to promote the need for a more open global energy market, the reduction of energy supply vulnerability requires a diversified portfolio approach to energy policy and planning. Policy makers in all current and prospective net oil importing economies in the APEC region must consider a complementary mix of short term and longer term response strategies, including increased oil exploration outside the Middle East.

Each economy must of course analyse its particular circumstances and decide for itself what are its most appropriate, cost effective and affordable response strategies.

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