ASIA PACIFIC ENERGY RESEARCH CENTRE

ENERGY SECURITY INITIATIVE: EMERGENCY OIL STOCKS AS AN OPTION TO RESPOND TO OIL SUPPLY DISRUPTIONS

APERC BACKGROUND REPORT

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FOREWORD

This report is prepared by the Asia Pacific Energy Research Centre to facilitate discussion on the *Energy Security Initiative: Emergency Oil Stocks as an Option to Respond to Oil Supply Disruptions* at Asia-Pacific Economic Cooperation Energy Working Group (EWG) meetings in particular, and more generally, as input for deliberations on energy security by governments, policy-makers, energy analysts and other energy market participants.

This document not only summarises and updates the earlier APERC report 'Emergency Oil Stocks and Energy Security in the APEC Region' of March 2000 but also takes into account more recent policy and market developments and other available studies on energy security.

While this report, like any other APERC publication, does not bind APEC member economy governments, it considers comments received from them and other experts on earlier drafts. Some issues raised will remain controversial. I hope this document may help to stimulate the thinking of policy-makers of APEC economies.

Tatsuo Masuda
President
Asia Pacific Energy Research Centre

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In particular, we would like to thank Keiichi Yokobori, past-president of APERC, for his contributions to earlier drafts of this report, and also Dr Sun Chun, US Dept of Energy and Chair of the APEC Experts' Group on Clean Fossil Energy, for his stewardship of the Energy Security Initiative.

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LIST OF ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APSA	ASEAN Petroleum Security Agreement
ASEAN	Association of Southeast Asian Nations
CNG	compressed natural gas
CO_2	carbon dioxide
EIA	Energy Information Administration (USA)
EWG	Energy Working Group (APEC)
ESI	Energy Security Initiative
FSU	former Soviet Union
GDP	gross domestic product
GTL	gas-to-liquids
IEA	International Energy Agency
IEP	International Energy Program
IMO	International Maritime Organisation
JNOC	Japan National Oil Company
KNOC	Korea National Oil Company
LNG	liquefied natural gas
LPG	liquefied petroleum gas
Mbbl	million barrels
Mbd	million barrels per day
NPV	net present value
OECD	Organisation for Economic Co-operation and Development
O & M	operations and maintenance
OLADE	Organización Latinoamericana de Energía
OPEC	Organisation of Petroleum Exporting Countries
SPR	Strategic Petroleum Reserve
USA	United States of America
VLCC	Very Large Crude Oil Carrier
WEO	World Energy Outlook

EXECUTIVE SUMMARY

This report reviews the growing energy import dependence of the Asia Pacific Economic Cooperation (APEC) economies and its implications for APEC energy security. As such, of the different energy types, the report focuses on oil with some discussion on gas.

Measures for mitigating oil supply disruptions, focused on oil stockpiling, are discussed. A rationale is presented for the advantages of a shared responsibility with regard to reducing the negative impacts of supply disruptions together with an evaluation of the costs and benefits of additional regional stockpiling in Asia.

The material presented here is partly based on APERC research conducted in 1999-2000 but updated and supplemented by more recent developments in oil and gas markets and new information from both APERC and other sources where this is available.

GLOBAL AND APEC OIL MARKET OVERVIEW

The last decade has seen significant shifts in global oil supply and demand demographics. Specifically, as far as the APEC region is concerned, there have been sharp declines in oil production and consumption in the former Soviet Union (FSU) economies, rapid increases in Asian oil demand, and an increasing import dependence of Asian APEC economies on OPEC.

The Asia Pacific Energy Research Centre's (APERC) APEC Energy Demand and Supply Outlook[1] and similar studies by other organisations indicate that Asian oil demand will grow substantially over the period to 2020, with a continued increasing dependence on Middle East OPEC to satisfy that demand. This increasing dependence has focused the attention of APEC governments and energy officials, as well as the producer economies, on the desire not only for secure supplies of oil, but also on the importance of stable and reasonable prices and the need for emergency measures should supplies or their delivery be disrupted.

OIL SUPPLY SECURITY AND RESPONSE MEASURES

Short–term oil supply disruptions can be responded to by a range of measures, including emergency oil stockdraw, demand restraint, fuel switching, standby production and information sharing. Among these measures, stockdraw from oil stockpiles by oil importing economies could be the most effective means for restoring and maintaining order in oil markets. Standby production, demand restraint and fuel switching can be expected to offset lost supply to some extent, but their effectiveness is likely to be limited among APEC economies.

The most recent example of large-scale emergency responses was during the 1990-91 Gulf War. The effectiveness of stockdraw and the contribution of Saudi Arabia in increasing production highlighted the value of oil stockpiles as well as the spare capacity held by producers. The contribution of other measures such as demand restraints, fuel switching and increased indigenous production were relatively minor.

POLICIES ON EMERGENCY OIL STOCKS IN THE APEC REGION

Six of the APEC member economies, namely the United States, Canada, Japan, Australia, New Zealand and Korea (since April 2001) are members of the International Energy Agency (IEA). These economies, except for Canada as a net exporter, are under the obligations of the Agreement of the International Energy Program (IEP) to hold stocks equivalent to at least 90 days of net

[1] APERC, 2002e.

imports. Among them, only the US, Japan and Korea currently hold government-owned emergency stockpiles.

Of the remaining 15 non-IEA member economies within APEC, seven are net oil exporters. The other eight are net oil importing economies. Among these, only Chinese Taipei maintains emergency oil stocks to some extent and has recently legislated to expand them. China is actively considering building oil stockpiles and plans to have significant stockpiles in place by the end of this decade. In the wake of 11 September, the Philippines and Hong Kong, China are actively reviewing and developing their energy emergency preparedness. Among net oil exporting economies, only Indonesia, as an archipelago, maintains oil stocks, mainly to ensure that there is no disruption of fuel availability to the islands. The ASEAN member economies are signatories to the ASEAN Petroleum Security Agreement (APSA) that established the ASEAN Emergency Petroleum Sharing Scheme for crude oil and petroleum products in times of both shortage and oversupply. In early 2002, ASEAN members began reviewing and updating the APSA.

INTERNATIONAL EMERGENCY RESPONSE COOPERATION

The risk of oil supply disruptions is intrinsic to oil supply systems. Among other reasons, disruptions may be due to damage to supply facilities, pipelines or tankers caused by accidents, terrorism or wars, blockage of chokepoints or political instability. Oil emergency preparedness strategies such as emergency stockholding take account of the risk of severe economic damage. Having the oil price reflect the cost of maintaining oil supply emergency response measures such as oil stocks is one way of internalising the external cost of oil security. Failure to include these external costs in oil prices could distort competition and result in an inefficient allocation of resources.

Oil emergency response measures have the characteristics of international public goods. This means that those without measures may still share the benefits with those who have gone to the expense of putting in place emergency measures. However, a pattern over the last 15 years of declining oil stocks held by IEA economies and declining spare capacity held by OPEC producers indicate that the possibility of 'free-riding' could be diminishing and, therefore, all concerned economies would need to share the responsibility for emergency response measures such as oil stockpiling.

Enhanced cooperation between producers and consumers is also beneficial as producers rely on stable oil revenues for their economies.

The modality of stockholding is also important. For example, mixing commercial and emergency stocks masks the true availability of emergency oil supplies and may frustrate the oil industry's efforts to minimise stockholding costs. Therefore, it would be more transparent and economically justifiable to have emergency stocks held by a separate stockholding entity and the costs of stockpiling fairly shared by all consumers.

ECONOMIC ANALYSIS OF EMERGENCY OIL STOCK SIZE IN THE APEC REGION

The analysis of costs and benefits of expanding oil emergency stocks in the APEC region presented in this report supports expanding reserves by several hundred Mbbl for the APEC region. More specifically, for the smaller Asian oil importing economies, a stockpile of around 30 days coverage of net imports is shown to be optimal in terms of costs versus benefits. For an economy the size of Thailand's, this implies a stockpile of around 27 Mbbl by 2010. Further, the analysis indicates that the smaller importing economies of the Asia APEC region would benefit from a joint stockpiling scheme sharing a common large-scale facility. Given the large costs of stockpile development, the leasing of existing surplus storage capacity, if this is available in stockpiling economies' facilities or in commercial facilities, is a cheaper option.

GAS

Global demand for gas, for both direct use and for electricity generation, is predicted to be the fastest growing of all the conventional energy types. For gas importing economies, the broad supply and security issues are similar to those for oil. If anything, the delivery of gas from often distant and/or remote supply sources to points of demand presents greater challenges than for oil, for which supply methods and modes are well established. On the plus side, supply sources for gas are more diversified than for oil.

While the desire for gas storage for both demand management and emergency purposes has been acknowledged, ways of storing gas are comparatively difficult and under-developed. Additionally, storage costs for gas are known to be considerably higher than for oil on an energy equivalent basis.

CHAPTER 1

INTRODUCTION

Oil security and oil market volatility have increasingly commanded the attention of governments and energy analysts in recent years. The availability of oil is clearly vital to the performance of all economies, and the price volatility of recent years has been disruptive to this and of orderly market operations for both suppliers and users.

Oil security has been considered of particular concern to oil-importing economies and especially so for economies with a high oil dependency in their energy mix. A number of the APEC economies fit into this category. However, oil market stability is a common concern of both exporters and importers.

In light of the expected increase in oil demand as shown, for example, in the "APEC Energy Demand and Supply Outlook", APERC carried out research and in March 2000 produced the report Emergency Oil Stocks and Energy Security in the APEC Region.

Recently, there have been a number of APEC deliberations on energy security at the levels of officials and ministers, resulting in the adoption of the APEC Energy Security Initiative (ESI). Activities in this regard can be chronicled as follows:

The APEC Energy Ministers Declaration, San Diego, California, May 2000 reads in part:

"Over the past few years we have endorsed energy policy and regulatory initiatives that provide … increasing energy security by creating conditions for providing adequate supplies at reasonable prices." (Paragraph 2)

"We believe that the time is right to focus on how to implement our initiatives because (1) … (2) rising demand and resulting dependence on oil supplies from outside the region have made energy security a major concern in many of our economies." (Paragraph 4)

The 20th Meeting of the APEC Energy Working Group (EWG), Cuzco, October 2000, endorsed a proposal 'Energy Security Initiative: Petroleum Stocks as an Option to Respond to Oil Supply Disruptions'.

Energy security concerns were reaffirmed in the APEC Economic Leaders Declaration, Brunei Darussalam, in November 2000.

Following a planning meeting for implementing this Initiative in Seoul, in March 2001, and EWG-21, in Kuala Lumpur, in May 2001, APERC agreed to produce a report with a view to assisting the APEC EWG develop and progress the Initiative especially at the workshop on this matter held in Bangkok on 14-15 September 2001.

A set of recommendations from the Bangkok meeting was put to EWG-22, in Port Moresby on 26-28 September 2001. The EWG-reviewed recommendations were submitted as an APEC Energy Initiative to the APEC Leaders' Meeting, in Shanghai on 18-20 October 2001, and adopted by them.

APERC held a Sea-Lane Disruption Simulation Exercise in Tokyo on 18-19 April 2002 involving participants from almost all of the APEC economies.

The key findings of this exercise and other energy security issues were deliberated on at an APEC Energy Security Initiative Workshop in Chinese Taipei on 23-24 April 2002.

This report summarises the earlier APERC report: 'Emergency Oil Stocks and Energy Security'[2] of March 2000, and updates it by incorporating some more recent information. Oil and gas market developments, especially as they pertain to energy security in the APEC region, are also discussed.

[2] APERC, 2000a.

CHAPTER 2

OIL DEMAND AND SUPPLY: RECENT TRENDS AND PROSPECTS IN THE APEC REGION

WORLD OIL SUPPLY: RECENT TRENDS

In the last decade, the structure of world oil supply has changed significantly. The principal phenomena since 1990 have been the sharp decline in oil production and consumption in the former Soviet Union (FSU) economies, and the rapid increase in demand in other areas, particularly Asia. FSU production declined by 3.5 million barrels per day (Mbd) between 1990 and 2000, falling from 17.6 percent of world supply to 10.8 percent (Table 1). Over the same period, total world production increased by 8.8 Mbd. Therefore, between 1990 and 2000 world oil production without the FSU increased by 12.3 Mbd (22.7 percent). OPEC and non-OPEC producers each contributed roughly equally to satisfying the 12.3 Mbd gap between lost FSU production and increased world demand. The OPEC share has increased, rising from 37 percent in 1990 to 41.4 percent in 2000. At the same time, non-OPEC oil production (excluding the FSU) has also increased substantially, accounting for 51.6 percent of the total increase (6.4 Mbd).

The IEA's World Energy Outlook 2000 (WEO2000)[3] projects that FSU production will be around the 2000 level until 2020. Non-OPEC production is projected to peak around 2010 and decline slowly thereafter. Notably, of the 33.4 Mbd (45 percent) projected increase in world demand between 2000 and 2020, the WEO projects OPEC will supply 93 percent of the increase, with non-OPEC producers and the FSU supplying the balance. In this scenario, OPEC production is projected to double between 2000 and 2020.

Table 1 World Oil Production (1,000 bpd)

	1990	2000	Increase over 1990	2010	Increase over 2000	2020	Increase over 2010
OPEC	24,865	30,825	5,960	44,100	13,275	61,800	17,700
Non-OPEC	29,285	35,640	6,355	39,800	4,160	38,200	-1,600
Former Soviet Union	11,570	8,035	-3,535	7,100	-935	7,900	800
World Total	65,720	74,500	8,780	91,000	16,500	107,900	16,900

Source: bp Statistical Review of World Energy (2001) - historical; International Energy Agency, World Energy Outlook 2000 - projections.

World oil consumption increased by 10.9 Mbd between 1990 and 2000, from 65.4 Mbd to 76.3 Mbd. During this period FSU economies' consumption fell by 4.8 Mbd. The fastest rate of demand growth by far was in the Asia Pacific region (including some non-APEC economies such as India and Pakistan), where demand increased by 51.4 percent or 7.1 Mbd, from 13.8 to 20.9 Mbd[4]. This region consumed 27.4 percent of total world oil supply in 2000. Thus, the world oil demand increase in the last decade has been supported overwhelmingly by the rapid economic growth of the Asia Pacific region, or more precisely, by that of Asian economies. However, from late 1997, Asian economies experienced economic difficulties, and consequently, their oil demand

[3] International Energy Agency, 2000, World Energy Outlook 2000, OECD, Paris.

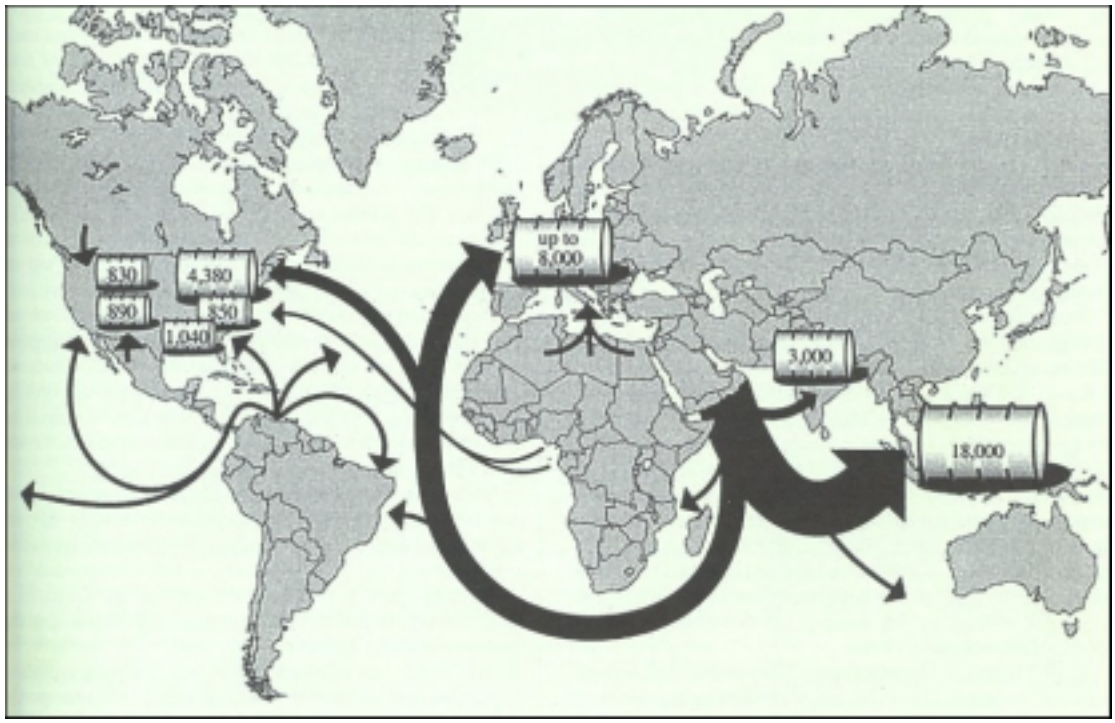
[4] Petroleum Argus Fundamentals, Vol XIII, No 11. November 2001

fell by 2.2 percent in 1998. As Asian economies began recovering in 1999, consumption grew overall by 3.2 percent that year and then 4.4 percent in 2000, excluding Bangladesh, India and Pakistan, low by recent standards. While China, Korea and Chinese Taipei increased consumption by 5.1, 7.6 and 7.2 percent, respectively, in 1999, the consumption (growth) in other Asia Pacific economies remained weak. In 2000, China is estimated to have accounted for 75 percent of the approximately 0.4 Mbd increase in Asian demand.

Currently, more than 90 percent of the Philippines' oil imports come from the Middle East. Japan relies on the Middle East for over 80 percent of its oil imports. The import dependence on the Middle East for Korea, Singapore and Thailand was around 70 percent in 1998, while Chinese Taipei had a 60 percent dependence on imports from the Middle East. In turn, the Asia region is also increasingly important from the perspective of Middle East oil exporters. Asia accounted for 58 percent (11.1 Mbd) of total oil exports from the Middle East in 2000, slightly higher than 53 percent (7.6 Mbd) in 1990[5].

Concerning future import trends, the current APERC Outlook projects in its Reference scenario an increase of 131 percent of oil imports into APEC as a whole between 1999 and 2020[6] and a similar increase, 129 percent, for APEC Asia, which is already very import dependent as described above. In most APEC economies, net imports are expected to increase and net exports are expected to decline during this period. Figure 1 illustrates the magnitude of the flow that could occur from the Middle East to Asia in 2010.

Figure 1 Flow of Gulf Oil Supplies – 2010 (Mbd)



Source: Kemp and Harkavy (1997)

As illustrated in Figure 2 and Table 3, the import requirements of APEC Asia will increase, with oil import dependency remaining between 90 and 100 percent for a number of economies. Notably, China's rapidly expanding economy has a concomitant rapid increase in oil demand,

[5] bp Statistical Review of World Energy 2001. bp plc, London, June 2001

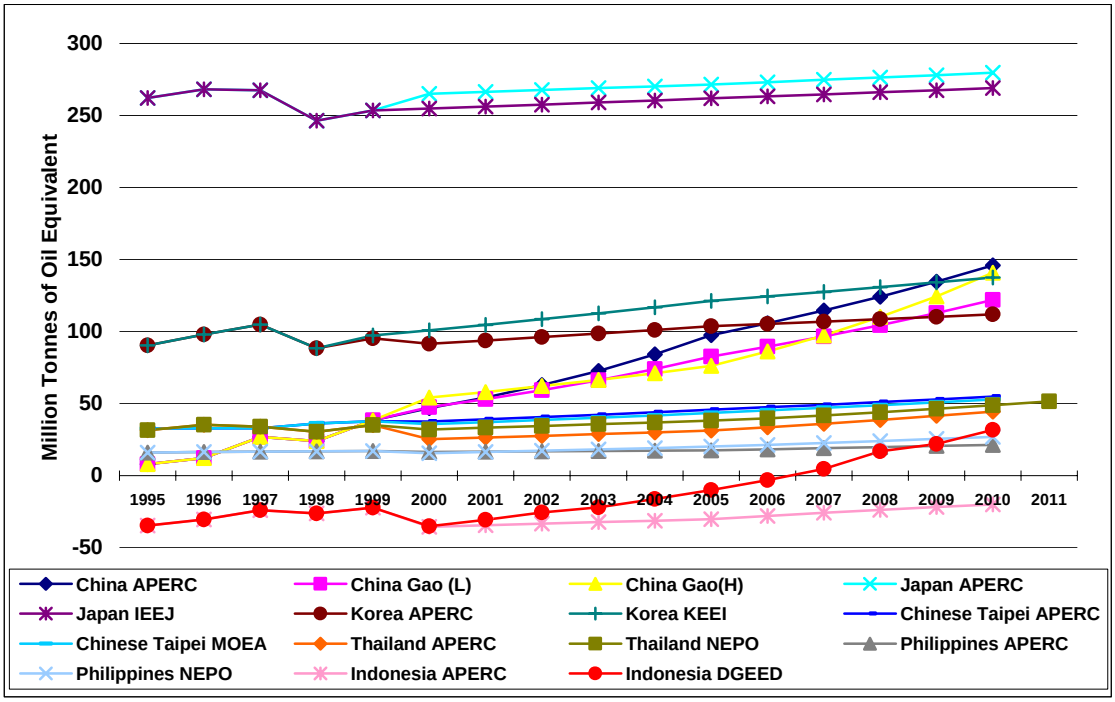
[6] APERC, 2002e.

projected to be supplied almost entirely from additional imports, resulting in an import dependency that rises from around 20 percent now to around 70 percent by 2020.

Overall, APERC projections[7] see oil demand in the APEC region increasing at a rate of 2.1 percent per year between 1999 and 2020, rising from 40.6 mbd in 1999 to a projected 62.4 mbd in 2020. China's growth rate of 4.3 percent per annum is exceeded only by those of Viet Nam, Chile and Brunei Darussalam. Its increase in demand of 5.88 mbd between 1999 and 2020 is exceeded only by that of the USA at 6.96 mbd.

Net imports into APEC Asia are projected to grow at around 4.0 percent per annum between 1999 and 2020, twice the rate of the demand increase, as the region's own production is projected to decline slightly (6.5 percent) in the two decades. The region currently has an import dependency of around 60 percent and could see this gradually increase to around 80 percent in 2020.

Figure 2 Oil Imports – APERC and Other Projections



Source: APERC and Member Economy Sources

Note: 1995-1999 Actual based on APERC and BP Statistics (2000); Projections and interpolations beyond 1999.

OIL SUPPLY DISRUPTIONS

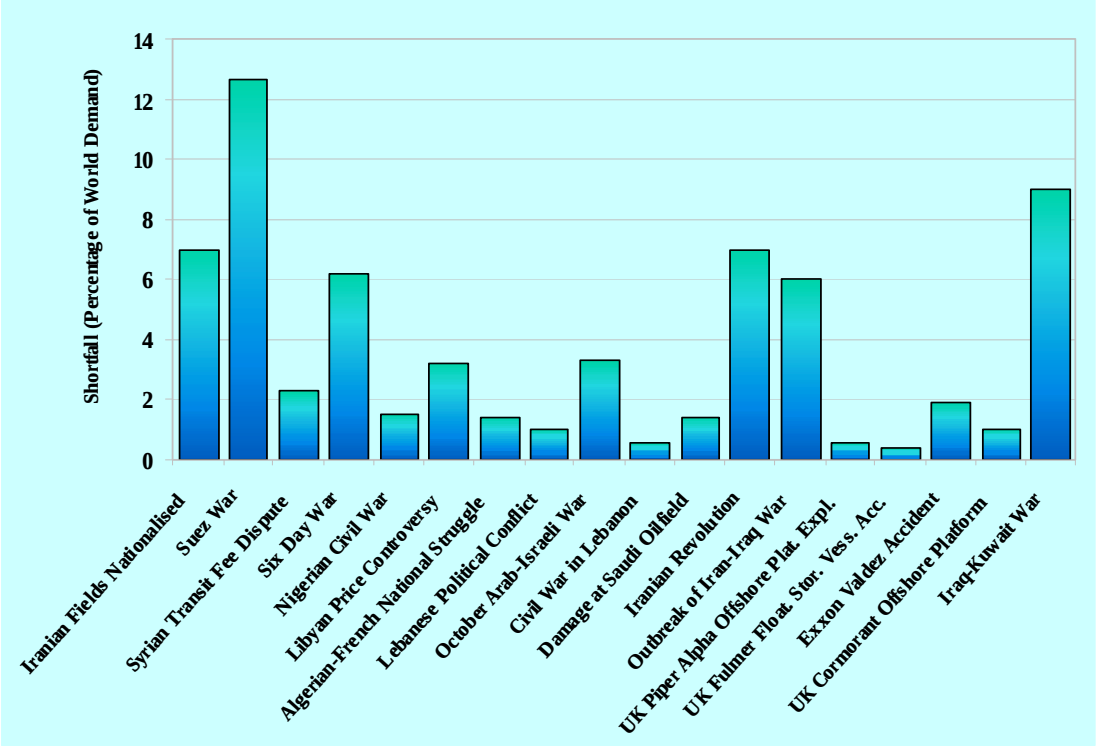
There have been 18 cases of oil supply disruptions since 1951 (Figure 3 and Table 2). However, they have not always caused significant oil market instability. Generally, severe market impacts were felt when supply disruptions occurred at a time of tight market conditions. As will be discussed later, the sharp price fluctuations of the last few years could discourage stable exploration and development activities and constrain the stable supply of capacity expansion. This could further result in tight market conditions in the future.

[7] APERC, 2002. APEC Energy Demand and Supply Outlook, Asia Pacific Energy Research Centre. Tokyo. June 2002.

As can be deduced from Figure 3, supply disruptions have not only resulted from intentional acts but also from unintentional or unforeseen events.

While political instability in the Middle East has raised concerns as a cause of oil supply disruptions, the issue of sea-borne oil transport has recently attracted the attention of many oil security experts. For example, the IEA Millennium Conference (Paris, March 2001) discussed the issue of tanker security passing through narrow waterways[8] and, more specifically, Stares discusses its relevance to East Asia[9].

Figure 3 Significant Crude Oil Supply Shock Events since 1951



Source: U.S. DOE (1990) updated by Leiby and Jones.

Table 2 Average Durations and Percent Shortfalls by Disruption Category

	Number of Events	Length (Months)	Shortfall (%)
All	18	8.1 (6.1*)	3.7
Accidents	5	5.2	1.1
Internal Struggles	5	6.5	2.3
Wars/Embargoes/Disputes	8	11.0 (6.1*)	6.2

Source: Hoffman, 2001.

* Excluding 44 month Iranian oil field nationalisation in 1951

[8] Khanna, P. 2001, World Oil Choke Points, presentation to IEA Millennium Conference, OECD, Paris, 21-22 March 2001.

[9] Stares, P.B. (Editor) 2000, Rethinking Energy Security in East Asia, Japan Center for International Exchange, Tokyo.

The tanker security issue is more acute for the Asia Pacific region, in particular Asia. First, because of the lack of transborder pipelines in the region, tankers are virtually the exclusive means of oil and gas transport. Second, tankers transporting oil from the Middle East to Southeast Asia and East Asia pass through the Straits of Malacca and Lombok. At present, more than half of the merchant fleet tonnage and more than half of oil transported by tanker pass through the Straits of Malacca, Sunda and Lombok[10]. Table 3 gives some indication of the volume of traffic travelling through the Straits of Malacca and the rate at which it is growing.

Table 3 Volume of Traffic Through the Straits of Malacca

Ship Type	1999	2000	2001
VLCC/Deep Draft Vessel	2,027	3,163	3,303
Tanker Vessel	11,474	13,343	1,427
LNG/LPG Carrier	2,473	2,962	3,086
Cargo Vessel	5,674	6,603	6,476
Container Vessel	14,521	18,283	20,101
Bulk Carrier	3,438	4,708	5,370
RORO/Car Carrier	1,229	1,761	1,764
Passanger Vessel	1,919	3,301	3,151
Other	1,210	1,833	1,787
Total	43,965	55,957	59,314

Source: Marine Department of the Federation of Malaysia.

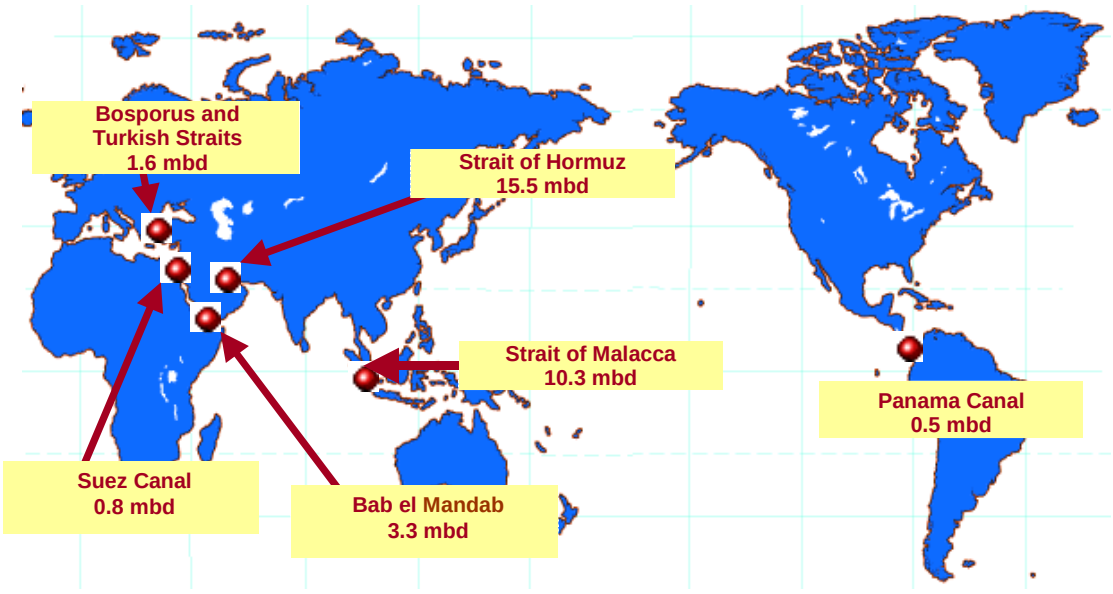
Third, the volume of oil transported through the Straits of Malacca is expected to increase in proportion to the increase in oil imports by the relevant Asian economies such as China, Japan, Korea, Chinese Taipei and the Philippines. This volume is projected by APERC to increase by around 127 percent (four percent per annum) between 1999 and 2020[11].

Among major sea-lane chokepoints in the world, the Malacca/Singapore Straits region is the second-largest after the Strait of Hormuz in terms of oil flow (Figure 4 and Table 4). The Straits of Malacca is both shallow and narrow for the transit of oil tankers.

[10] US EIA, Feb 2001.

[11] APERC, 2002e.

Figure 4 Global Sea-Lane Chokepoints



Source: APERC

Thus, the increased tanker traffic alone could increase the risk of oil supply disruptions caused by ship accidents.

Table 4 Global Sea-Lane Chokepoints

Chokepoint	Oil Flow (mbd)	Unique Characteristics
Strait of Hormuz	15.5	Deep, at least 9.8 km wide, 5mbd pipeline backup (Petroline, Saudi Arabia)
Straits of Malacca	10.3	Very shallow, only 0.5 km wide at narrowest point, longer alternative routes (Sunda, Lombok)
Bab el-Mandab	3.3	Pipeline backup (SuMed, Egypt) Suez Canal for smaller ships
Bosporus/Turkish Straits	1.6	About only 1 km wide at narrowest point, heavy ship traffic
Suez Canal	0.8	No VLCCs, plans for size increase

Source: APERC

Due to the importance of the Malacca and Singapore Straits region to the shipping of oil and gas, APERC held a Sea-Lane Disruption Simulation Exercise in Tokyo on 18-19 April 2002. Delegates from almost all of the APEC economies were formed into small groups to 'brainstorm' the consequences of and solutions to a number of possible disruption scenarios of varying severity to the shipping of oil and gas through this 'chokepoint' region. The following summarises the outcomes of the Workshop.

Scenario 1 – If Serious Accident:
Key Perspectives (Summary/Recommendations by the Participants):

1. Serious choke point – one tanker at a time; no passing
2. Increasing traffic balanced by enhanced electronic controls
3. Established systems for response are in place and improving
4. Tripartite decision-making is the basis of controlling the straits
5. If collision and spill, market will spike and adjust quickly

Scenario 2 – If Strait (say, Strait of Singapore) Closed:
Key Perspectives:

1. Difficult to clear VLCCs already in the Strait
2. Product demand shock east of Singapore (hoarding) will disrupt market; product stocks, and foreign ownership, worthy of study
3. Severe public safety, economic and clean-up problem for Singapore
4. Strait closure under Tripartite decision-making; three party decision-making under stress difficult; an obvious lever for affected states to request indemnification for economic or environmental loss
5. Alternate routes of Lombok and Sunda untested at Malacca/Singapore traffic density; their navigational aids need upgrading
6. Need for governments to share real-time emergency information including location of stockpiles
7. IEA stock release triggers not applicable to this situation
8. Need for regional coordination of trigger mechanisms for stock draws (different from IEA's)
9. Mechanisms and exercised procedures not in evidence for addressing an energy emergency of this size and type

Scenario 3 – If Serious Act of Terrorism:
Key Perspectives:

1. VLCCs easy to seize (has already happened)
2. Singapore Strait with VLCC is economic/environmental equivalent of WTC with airplanes; enormous impact
3. No apparent wider intra-regional and international process for mitigating energy/macroeconomic consequences
4. If it happened today, stock releases, international naval activism maybe under UN; IMO, APEC/ASEAN for security; sharp price increase, then decrease due to economic slowdown, regional sourcing where possible, many trade routes shut down, incentive for national self-sufficiency and alternative energy forms
5. What to do? Establish multilateral procedures for exchanging energy emergency-related information & dissemination of appropriate information, identify what states should do to establish appropriate response, APEC identify energy product emergency mitigation measures

IMPACTS OF OIL SUPPLY DISRUPTIONS

The occurrence of oil supply disruptions could adversely affect the economies of not only oil consumers but also of oil producers. The findings of the APERC (2000) report can be summarised as follows:

(a) Because of the low short-term price elasticity of oil demand, oil supply shortfalls would induce disproportionately higher price increases. For example, the GDP-weighted figure derived for selected Asia-APEC economies was -0.065.[13] The almost exclusive dependence of the transport sector on oil and the high demand growth generally predicted for this sector is particularly pertinent in this regard. Thus the effect of an oil supply disruption would be to increase oil input costs and damage the overall performance of the economy.

(b) In many oil-exporting economies, the oil-producing sector does not necessarily constitute a dominant proportion of the overall economy. Therefore, the gains in an oil-producing economy would be more than offset by the non-oil sectors' losses.

(c) The oil consuming economies' decline in economic activities would eventually affect demand for oil that, in turn, would adversely affect the oil producing economies.

(d) In the longer term, high oil prices would discourage demand for oil by encouraging conservation or substitution away from oil, both of which were evidenced as responses to the oil crises of the 1970s.

EMERGENCY RESPONSE MEASURES

BRIEF REVIEW OF MEASURES

The risks of oil supply disruptions could be reduced by long-term energy policy efforts including diversification of oil import sources, improvements in the efficiency of oil use, enhancing fuel flexibility, investment in alternative energy sources and technologies, removal of market impediments, and promotion of dialogue between oil producers and consumers. But these measures could not eliminate the possibility of oil supply disruptions and rectify the damage once a disruption occurred. The short-term or emergency response measures that could be implemented to alleviate imbalances in oil supply and demand include information sharing, demand restraint, fuel switching, standby oil production and emergency oil stock drawdowns. Among these, except for information sharing, which would be essential, oil emergency stock drawdown would be the most useful because of its certainty and transparency and the limited scope of some of the other measures in many economies.

INFORMATION SHARING

Uncertainty in the oil market can cause speculative, uninformed or irrational behavior by both oil consumers and suppliers to hoard oil and bid up oil prices, exacerbating oil market turmoil. Sharing reliable information on the oil market situation among oil consuming economies as well as

[13] APERC, 2000a, Table 7.

between oil consuming and producing economies would calm the market and remove the pressures of rising oil prices. The ongoing international meetings on improving oil data availability and transparency, involving the IEA, APEC, OPEC, OLADE and other regional and international organisations and forums is expected to contribute to more comprehensive and reliable oil market information.

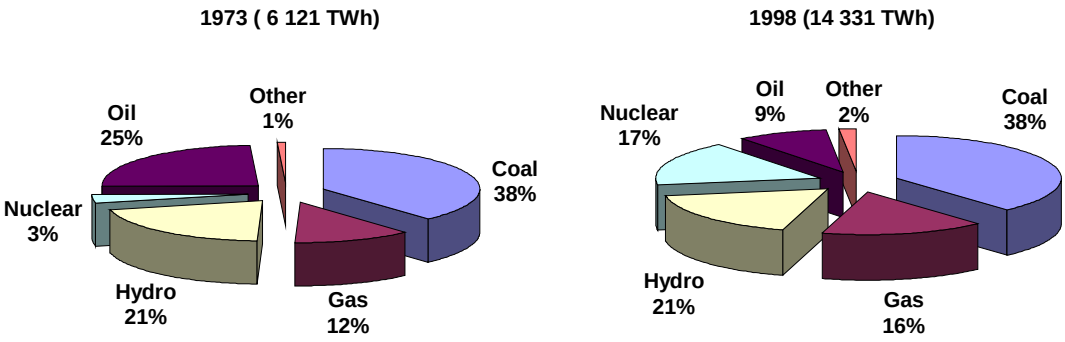
DEMAND RESTRAINT

During an oil emergency, when oil prices increase rapidly, consumers will naturally react by cutting back on oil consumption. Demand can be brought down through a combination of the price effect, persuasion and mandatory measures. Demand restraint measures could take various forms, ranging from voluntary energy use reduction and responding to the persuasion of government, to a temporary ban on the use of some energy using equipment such as vehicles, to tightening or reducing speed limits and to rationing of supplies. Some market-oriented approaches such as the auctioning of coupons could be used in implementing these measures. While demand restraint measures' costs and benefits may vary depending on their modality, there are views that these measures tend to be more costly than oil stockdraw and thus result in resource misallocation.[14]

FUEL SWITCHING

Another way of reducing oil consumption during an emergency is to switch out of oil-using equipment to another fuel. However, there are some constraints that limit the scope of fuel substitution potential as an emergency measure, including limited switching capability, especially in the transportation sector. Further, it is generally the case that since the oil crises of the 1970s and the rise of gas as a fuel, economies have become less oil-intensive, especially through reduced use in the industrial and power generation sectors (for example, see Figure 5), and as a consequence the potential for further fuel switching is much diminished. Thus the scope in this regard is limited.

Figure 5 Fuel Shares of Electricity Generation



Source: IEA, 2000, Key World Energy Statistics

STANDBY OIL PRODUCTION AND SPARE CAPACITY

During an emergency non-affected producers, if they have spare production capacity, can increase oil production. This 'standby' production would help supplement oil supply shortfall and stabilise the oil market. The majority of APEC economies are not well-endowed with indigenous resources, and so the scope for standby production in the region is limited. The availability of standby production is critically dependent on spare production capacity. Today, only some OPEC producers, led by Saudi Arabia, have meaningful spare capacity. Industry wisdom suggests that spare capacity should be at a level not less than 2.5 percent of demand. Recently, Saudi Arabia,

[14] Paik, I. 1987, Economic Cost of Demand Restraint, U.S. DOE Report, April 1987, Washington D.C.

Asia's largest supplier of oil, expressed a desire to maintain stable international oil markets, with a cornerstone of this being the maintenance of reasonable spare capacity.[15]

EMERGENCY OIL STOCKS

Oil stock drawdowns generally have some advantages over other alternative response measures. First, compared with fuel switching or standby production, stockholding is more openly available to many oil-consuming economies and is more certain. Second, compared with demand restraint, oil stocks are more visible and transparent and would affect market perceptions more effectively. Also, oil emergency stocks' transparency could serve as a deterrent to politically or economically motivated supply disruptions. Third, while demand restraint could cause adverse economic impacts through misallocation of resources, oil stocks could be free of such adverse economic impacts. Fourth, the IEA experience shows that its members' emergency reserve commitments are exclusively met by holding stocks, although the International Energy Program, its founding treaty, provides for using standby production capacity and fuel switching potential as alternatives to stock-holding.

MEDIUM- AND LONG-TERM RESPONSE OPTIONS

There are several medium- and long-term options available to reduce the risk of oil supply disruptions. They include, inter alia:

- Construction of pipelines to reduce the high tanker dependence of oil and gas transport, especially in the greater Asia region. This would at least diversify, perhaps even assuage, the risk of 'chokepoint' disruptions as well as the vulnerability of tankers to terrorist attack. Although the construction of pipelines should meet commercial criteria, and indeed pipelines are subject to their own vulnerabilities, some risk premiums may be justified in some cases. APERC has published reports on potential natural gas pipelines and power grid inter-connections in the APEC region, which could also contribute to increased energy security and lessen oil dependence in APEC member economies[16,17,18].
- Fuel diversification: Replacing oil with other fuels. Natural gas, coal and nuclear power have contributed to lowering oil use in power generation. In the industrial, household and commercial sectors, oil use could be replaced by natural gas and electricity for heating, cooking and other purposes. In the transport sector, where oil is still dominant, diversification of the vehicle fleet into compressed natural gas (CNG) and liquefied petroleum gas (LPG) usage is already economic under certain conditions. Such conditions include the availability of gas at competitive prices or the need for air quality improvements in polluted urban environments. Additionally, CNG, in particular, has lower CO_2 emissions compared to liquid fuels. Gas-powered vehicles, possibly dual-fuel, are particularly attractive for high mileage fleet operations where the cost of conversion can be recovered within a short time and refuelling can be achieved at base installations. In the longer term, gas-to-liquids (GTL) technologies, coal liquefaction and fuel and solar cell technologies used in stand-alone or hybrid form may reduce dependence on oil. Most of these technologies are not yet economic or are marginally so under persistently high oil price conditions. These issues are currently being pursued in various APEC EWG groups, particularly those on renewable energy (New and Renewable Energy Technologies Working Group) and clean fossil fuels (Clean Fossil Energy Working Group).

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[15] Al-Muhanna, I. *East Asia, West Asia and the World Oil Market*, paper presented at the 2nd Seminar on Energy Security in Asia, Tokyo, March 2001.

[16] APERC, 2000b.

[17] APERC, 2000c.

[18] APERC, 2000d.

- Source Diversification: Among APEC member economies, Asian economies are characterised by their higher dependence on the Middle East for oil supplies, despite the existence of some oil exporting economies in the region. While this might result from market conditions, the exploration of alternative supply potential inside the region as well as from adjacent regions such as Central Asia and Russia should be and is being pursued.
- Energy Efficiency: The scope for further improved energy use efficiency, particularly oil, remains under-exploited. The Expert Group on Energy Efficiency and Conservation and APERC have investigated this issue and produced reports. The issue needs to be further examined, perhaps by these groups.
- The issue of energy supply security also concerns other energy forms and sources. Although similar considerations could also apply to them, there are some more specific factors associated with each fuel. For example, electricity cannot be economically stored with current available technologies. Instead the maintenance of reserve generation capacity is necessary for security (of supply) purposes. Issues of electricity and gas supply security merit further analysis in their own right.

EXPERIENCE IN OIL SUPPLY DISRUPTIONS IN 1990 AND 1991

The most recent oil supply disruption took place when Iraq invaded Kuwait in July 1990, which caused the loss of 4.3 Mbd of production. The crude price doubled in a few months. This was high but more moderate than the previous oil supply disruptions of 1973 and 1979-80. This loss was soon offset by increased oil production by other producers, notably Saudi Arabia, to the tune of 3.7 Mbd increased production. The crude oil price declined gradually from November 1990.

With the outbreak of 'Desert Storm' operations on 17 January 1991, the IEA activated its oil contingency plan, which was claimed to match the lost supply of 2.5 Mbd. Around 2.09 Mbd (83 percent) of this amount was made by stockdraw; 0.33 Mbd (13.2 percent) by demand restraints, and 0.07 Mbd by fuel switching, with only 0.02 Mbd coming from increased indigenous production[19].This experience illustrates the importance of emergency response options, notably oil stockdraws by importers and production increases by producers.

[19] International Energy Agency, 2001, *Oil Supply Security – The Emergency Response Potential of IEA Countries in 2000*. OECD, Paris, p364-365.

CHAPTER 3

APEC EMERGENCY RESPONSE AND INTERNATIONAL COOPERATION

OIL EMERGENCY RESPONSE MEASURES AS AN INTERNATIONAL PUBLIC GOOD

When spare production capacity, oil stocks, fuel switching capabilities or demand restraint measures are maintained for the specific purpose of mitigating the adverse effects of interrupted oil supplies, they have the characteristics of being a public good. That is, the benefits of reduced economic losses are available to all whether they pay for it or not. They are an international public good in the sense that an oil supply disruption anywhere in the world would affect oil markets everywhere, and actions taken by any oil consuming as well as producing economy to mitigate the adverse effects of the supply disruption, including oil stockdraw, would affect all oil markets. Since the benefits conferred by these actions during oil supply emergencies spill across national borders, they have the attributes of being an international public good.

Since non-providers can freely access some benefits of such a public good (free riding), it follows that there will be failure of the market to provide adequate supply.

INTERNATIONAL COOPERATION ON EMERGENCY RESPONSES

The inherent fragility of an international public good suggests the need for an international framework of burden sharing. The IEA provides a model that legally binds its members by the Agreement of the International Energy Program. The recent development of discussions on another international public good, the system to deal with the climate change issue, would support this view by recognising 'common but differentiated' responsibilities between developed and developing economies (UNFCCC Article 3.1).

Further, the recent erosion of the existing emergency response capability, which will be described below, also calls for increased recognition by those APEC economies whose future oil demand is expected to grow at a faster rate than others.

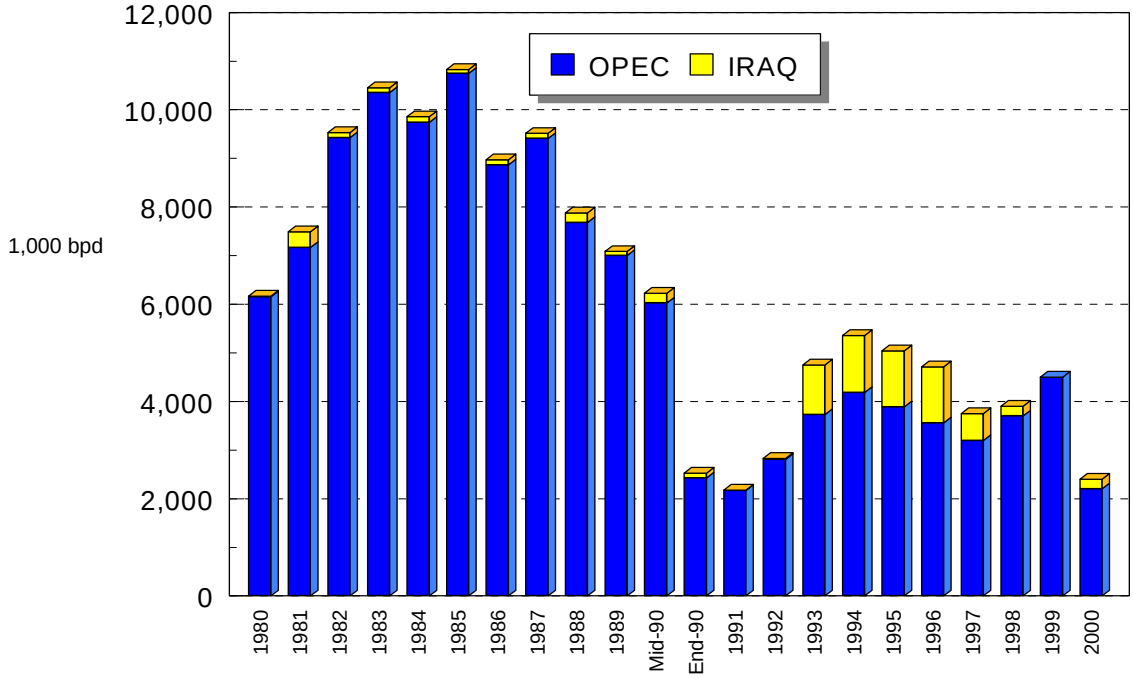
The first indication of the erosion is the declining surplus production capacity in the producing economies, particularly OPEC economies, as shown in Figure 6. The low crude oil prices of 1997-98 made it difficult to maintain or improve capacity in oil producing economies. Despite recent price increases, the expected price volatility provides little incentive for capacity expansion. However, some increases in capacity in anticipation of higher demand that has not materialised due to the worldwide economic slowdown of 2001-02 does mean that spare capacity is currently around 6 mbd. As with spare capacity of any type, it has its attendant high cost of non-productivity[20].

The second indication is the declining oil import coverage of IEA members' oil stocks. It peaked in 1986 with around 160 days of net oil imports of IEA importing countries and has steadily declined since then. It stood at around 110 days at the end of 2000 (Figure 7). The IEA projected it could fall to 100 days by 2010 if the current trend continued[21].

[20] Al-Muhanna, I. *East Asia, West Asia and the World Oil Market*, paper presented at the 2nd Seminar on Energy Security in Asia, Tokyo, March 2001, p15.

[21] International Energy Agency, 1999, The Standing Group on Emergency Questions, "The Global Oil Stock Situation", IEA/SEQ(99) 47, OECD, Paris.

Figure 6 OPEC Spare Production Capacity



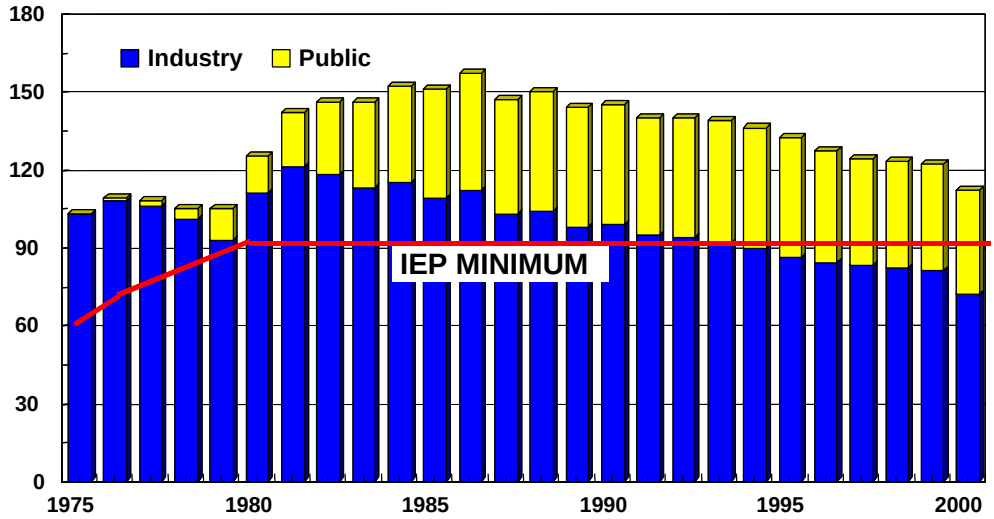
Source: Jacoby, K.-D. 2001, Current IEA Response Capability, paper presented at IEA Millennium Conference, IEA, 21-22 March 2001.

Third, stocks held by industry, which still account for the bulk of the stocks mandated by the IEA, continue to decline, as illustrated in Figure 7 and from a slightly different perspective in Figure 8. With increased competitive market pressures, industry stocks tend to be the minimum needed for commercial operations. This implies that the industry will have a limited capability to respond to oil supply disruptions.

In short the APEC economies would not be able to depend on others' response capabilities in a supply disruption and therefore have to realise a growing responsibility for their own contributions. This burden could be considered an 'insurance' premium to avoid the negative impacts of oil supply disruptions.

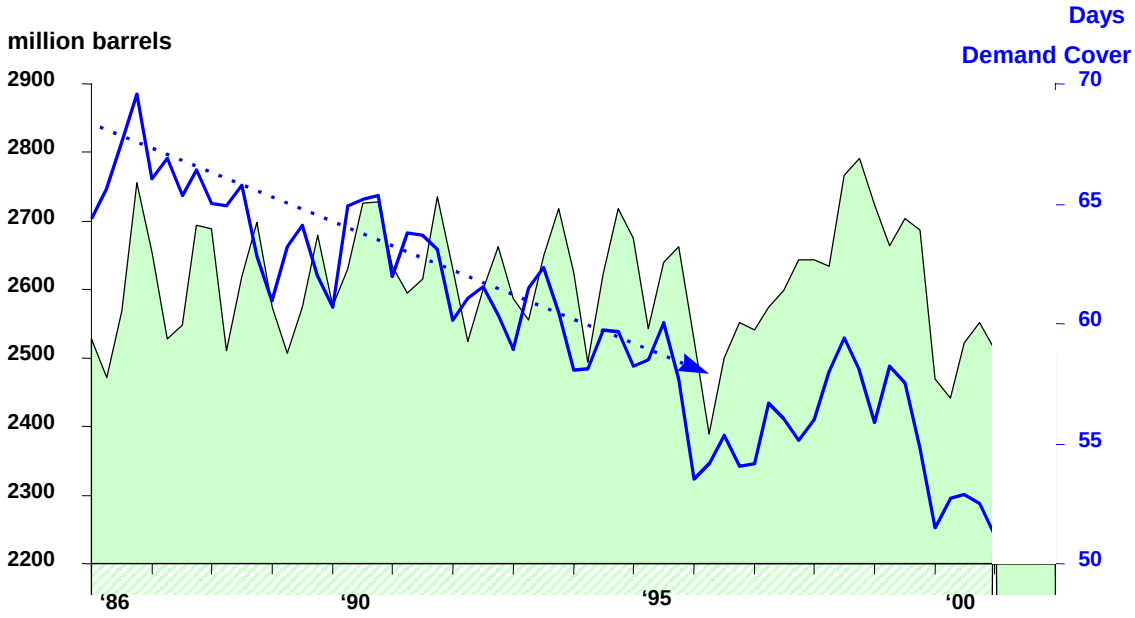
In order to enhance the effectiveness of oil emergency actions as an international public good, economies should develop a framework of cooperation and harmonisation on emergency response capabilities such as the holding and use of stocks to ensure cost-effective implementation, operation and use, and to avoid unnecessary market distortions. In a case where stockpiles are located outside the territory of an economy, an institutional framework would be necessary to ensure their access and transfer when drawdowns become necessary.

Figure 7 Stocks of IEA Net Importers (Days of Net Imports)



Source: IEA, 2001.

Figure 8 Total Industry Stocks in OECD Countries – Closing Stocks



Source: Kinder, D. 2001, The Impact of Industry Stocks and the Futures Market on Oil Market Dynamics, Shell International Petroleum Company, paper presented at IEA Millennium Conference, IEA, 21-22 March 2001.

IMPORT DEPENDENCY AND STOCKPILING POLICIES

Table 5 summarises net oil import dependency for APEC member economies as they currently are and as projected for 2020 in the 2002 APERC Outlook, together with their oil stockpile statuses. As expected, in net exporting economies there exist generally no stockpiling arrangements, as oil supply loss could be met by increased production elsewhere (although the magnitude of existing surplus production capacity is not shown in this Table. Indonesia maintains some emergency reserves to meet supply requirements in the archipelago.

Among net oil importing economies, Japan, the US and Korea (IEA members), as well as Chinese Taipei maintain oil stocks above commercial operational requirements through their respective designated oil stockholding entities. Australia and New Zealand import relatively small amounts of oil, and their IEA obligations are met with commercial stocks.

In addition, the ASEAN economies maintain the ASEAN Petroleum Security Arrangement (APSA), in which oil exporters and importers mutually assist in supply surpluses and shortfalls. However, this arrangement has been rarely activated and thus its effectiveness has not been tested.

Table 5 Summary of Oil Import Dependency and Emergency Arrangements/Policies

Economy	1999 (%)	2010 (%)	2020 (%)	Stockpiling Arrangements/Policies/Status
Net Exporters – Brunei Darussalam; Canada; Mexico; Papua New Guinea; Russia; Viet Nam	0	0	0	No emergency stockpiling policies; generally operational stocks only; some emergency legislation available in Canada
Indonesia	0	0	58.0	Indonesia maintains emergency stock to secure domestic supplies in the archipelago.
Malaysia	0	0	36.9	No emergency stockpiling policies. A “Five Fuels” policy is in place to enhance energy diversity and security.
Australia, New Zealand	30.5, 64.7	38.3, 72.7	46.1, 80	No emergency stockpiles, commercial stocks meet IEA requirements
Japan, United States	99.7, 58.5	100, 67	100, 70.7	Emergency stockpiles; generally exceed IEA requirements
Korea	99.6	99.7	99.7	Emergency stockpiles; meets IEA requirements and joined the IEA in April 2001
Chile	96.2	98.5	99.5	Commercial stocks only to meet around 25 days product sales
China	21.7	52.1	69.5	Currently no emergency stocks but stockpiling system planned to build stocks up to 3 months imports by 2010 (10th 5-Year Plan).
Chinese Taipei	99.9	99.9	100	Producers of products and importers are required to hold emergency stocks of no less

Economy	1999 (%)	2010 (%)	2020 (%)	Stockpiling Arrangements/Policies/Status
				than 60 days' consumption. Petroleum Business Act passed in Nov 2001 to establish strategic reserves.
Hong Kong, China	100	100	100	Voluntary code involving companies storing 30 days of natural gas and naphtha. An Oil Contingency Plan being developed
Philippines	99.8	95.1	97.0	No requirements since 1998. An Energy Contingency Plan being developed
Peru	16.6	22.8	24.3	Wholesalers required to keep 15 days of average dispatch
Singapore	100	100	100	Fuel oil stockpile for electricity generation only
Thailand	87.8	87.3	95.1	Company stock obligations amount to around 22 days' demand of crude and products. Investigating stockpiling programmes.

CHAPTER 4

THE SCALE OF COSTS AND BENEFITS OF APEC EMERGENCY OIL STOCKS

THE COST OF BUILDING APEC EMERGENCY OIL STOCKS

ESTIMATION OF STOCKHOLDING COSTS

It is not a simple task to estimate exactly how much money was spent by those economies currently holding emergency reserves, or compare the stockholding costs among different economies. The difficulties arise from the lack of sufficient data on some economies, different accounting methods used, varying coverage of costs (such as the inclusion or exclusion of costs of land acquisition or utilisation, some ancillary facilities and oil acquisition), the size of facility capacity, currency fluctuations, inflation, technological factors, and so forth. For these reasons, any cost estimate of existing oil stock facilities would indicate only the rough order of magnitude of actual costs.

According to the Japan National Oil Corporation (JNOC), in the fiscal year starting in April 1996 it paid facility fees of 125.8 billion yen to National Oil Storage companies, and leasing fees of 50.2 billion yen to private refining companies. These were for storing 206.6 Mbbl and 99.8 Mbbl of oil, respectively. The latter cost US$4.62/bbl, about 40 percent cheaper than the former, which cost US$7.56/bbl. JNOC costs include land acquisition and some ancillary costs. For JNOC, leasing storage facilities is clearly a less costly option than building new facilities.

Between 1981 and 1990, JNOC also invested 147.1 billion yen in stockpiling 39 Mbbl of oil in 57 aboveground tanks. The estimated cost amounts to US$27.3/bbl.

In the case of Korea, Hwang[22] (1997) reported that under the first (1980-89) and second (1990-96) petroleum stockpile plans, a total of 961.19 billion won had been spent on the construction of facilities by 1996. Sim[23] (1998) indicated the total capacity planned under the two plans to be 94.1 Mbbl. The estimated cost of stockpiling is US$26.1/bbl, comparable to the JNOC cost of US$ 27.3/bbl.

The US reports construction costs of US$3.50/bbl (salt cavern), operating costs of US$0.20/bbl/year and drawdown costs of US$0.11/bbl.[24] The Strategic Petroleum Reserve (SPR) facility represents an investment of around US$20 billion with an annual requirement of US$158 million for operation and maintenance[25].

THE COSTS OF CONSTRUCTING OIL STORAGE FACILITIES

A PB-KBB study[26] prepared for APERC calculated the cost of developing three oil storage facilities: in-ground trench, hard rock mine, and salt cavern, as shown in Table 6. The major cost

[22] Hwang, S. 1998, The Petroleum Stockpiling Situation in Korea, Paper presented at the Asia Pacific Energy Research Centre's Workshop on Emergency Oil Stocks and Energy Security in the Asia Pacific Region; Tokyo, July.

[23] Sim, Y.S. 1998, Korea's Petroleum Stockpile Plan and Its Implementation, Paper presented at the Third Oil Stockpiling Seminar, Okinawa, October.

[24] Hoffman, R. 2001. US Strategic Petroleum Reserve, US Department of Energy, Washington D.C., paper presented at Meeting on APEC Oil Security Initiative, Seoul, 13-15 March 2001.

[25] Office of Fossil Energy, USA (http://www.fe.doe.gov/)

[26] PB-KBB Inc. 1998, *Strategic Oil Storage Concepts and Costs for Asia Pacific Region*, Final Draft Report, prepared for APERC, 30 October.

categories are capital costs, and operations and maintenance (O&M) costs. O&M costs are given for standby operations (in US$/bbl/year) and fill and draw operations (US$/bbl). These costs are expected to vary slightly with the location of the site.

Table 6 Summary of Storage Facility Costs

	In-Ground Trench	Hard Rock Mine	Salt Cavern
Capital Cost, (US$ /bbl) – undiscounted sum	15.68	15.44	5.51
Operations & Management Cost, (US$ /bbl-yr)	0.16	0.09	0.17
Fill/Refill Cost (US$ /bbl)	0.05	0.05	0.09
Drawdown Cost (US$ /bbl)	0.07	0.07	0.10

Source: PB-KBB (1998).

Construction lead times are around eight to 13 years. The discounted capital cost stream for salt caverns lies well below those of the other two technologies. Salt cavern storage is available sooner and at lower cost. At a discount rate of seven percent, the net present value (NPV) cost of a salt cavern completed by 2008 is US$4.03/bbl. The study presents much lower stockholding costs compared with the costs incurred by both Japan and Korea in stockpiling emergency oil. This is due in part due to the low cost of salt dome technology and in part to economies of scale associated with large storage facilities assumed in the study.

SIZE ANALYSIS OF EXPANDING EMERGENCY OIL STOCKS IN THE APEC REGION

Analysing the costs and benefits of emergency oil stocks and efficient stock sizes involves a large set of variables and complex interactions among these variables. By using the DIS-Risk model, Leiby and Bowman[27] (1999a, 1999b) evaluated the net economic benefits of emergency oil stocks in the APEC region, especially in Asian economies.

Among the key variables are the likelihood of major oil supply disruptions taking place, and the duration of supply disruptions, and how much additional oil can be put on the market by oil producers. Also important are how oil-consuming economies react to oil price shocks during emergencies (demand elasticities). The DIS-Risk model also takes into account the uncertain nature of these variables as well as their complex interactions. Stock costs are based on a large-scale salt cavern from the aforementioned PB-KBB study. These simulation results provide considerable insights into understanding the plausible consequences of oil supply disruptions, namely economic losses, and developing effective policy measures, including emergency stocks, for ameliorating these consequences.

Figure 9 presents the base case simulation results showing the NPV of benefits netted out of costs of expanding emergency oil stocks for the six groupings of the APEC economies. For the first three groupings, the economic benefits of stocks exceed the costs of stockpiling, that is, the net economic benefits are positive, while for the remaining three groupings, the costs are greater

[27] Leiby, P. N. and Bowman, D. C. 1999a, *The Value of Expanding Asian Pacific Emergency Oil Stocks*, Oak Ridge National Laboratory, ORNL-1999/39, February.

1999b, Recent Findings Regarding Emergency Oil Stockpiling Net Benefits For Various APEC Country Groupings, unpublished APEC Size Study Technical Note, September.

than the economic benefits. Specifically, for APEC as a whole, the total net economic benefit will be highest at US$10 billion when the reserve expansion reaches 1,000 Mbbl; for APEC minus the US it is US$2.5 billion at 600 Mbbl; and for Asian Group I, a little less than US$1 billion at 400 Mbbl. For the remaining three groups, the net economic benefits are negative at all levels of stocks.

The following conclusions can be drawn from these simulation results.

First, the larger the economy (or economy grouping), the larger the net economic benefits are likely to be. This is because the net economic benefit calculation is based on the impact of oil stock release on the global oil price, and the magnitude of economic benefits is roughly proportional to the size of GDP.

Second, while the economy that does the stockpiling bears the cost, all oil consuming economies share the benefits of stockdraw, namely, less severe economic disruptions and lower oil prices, through its effects on the world oil market.

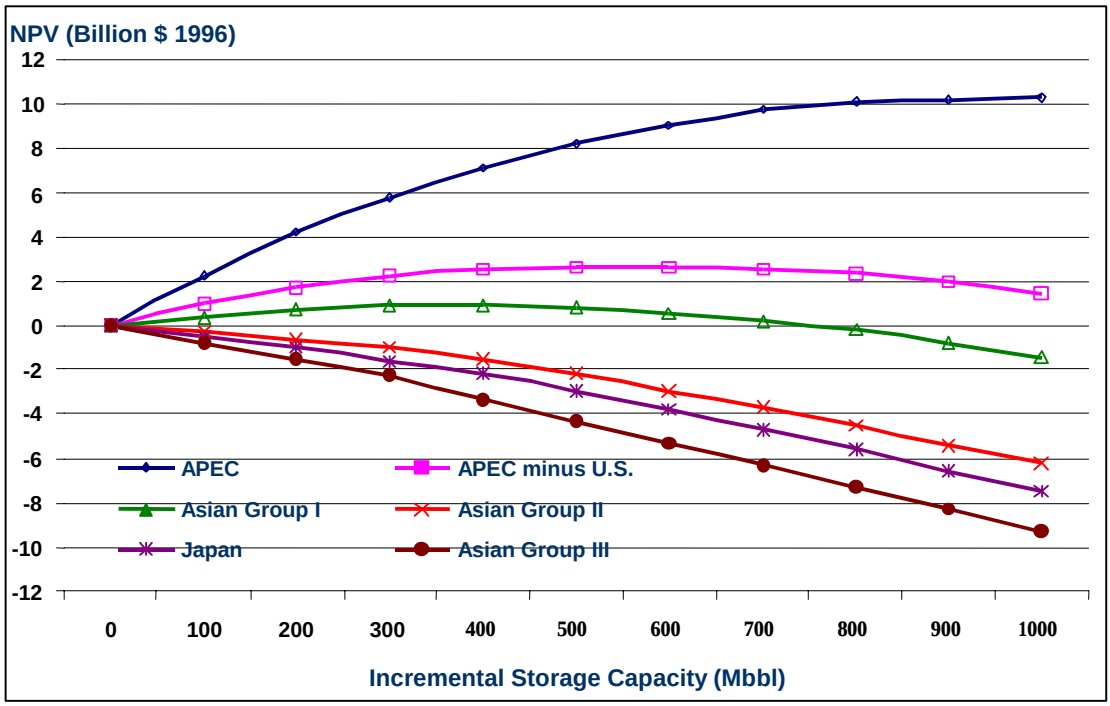
Third, for those economies in Asian Groups II and III, it does not pay to go it alone in stockpiling emergency oil because the benefits are also shared by the larger economies (through the public good aspect), while the costs are borne alone by these smaller economies. They should instead coordinate their stockbuild and stockdraw with other APEC economies to maximise the collective economic benefits and at the same time reduce the costs.

Figure 9 represents the base case scenario simulation. A more severe disruption scenario would show larger economic benefits of emergency stocks. Table 7 summarises these results together with the number of days of imports these stocks could cover. Based on oil import levels projected by APERC's 2002 Outlook for 2010, for APEC as a whole the additional stock of 1,000 Mbbl would provide an additional 42.5 days of oil import coverage. Likewise, for APEC minus the US, 600 Mbbl will provide an additional 63.9 days of import coverage, and for Asian Group I, 400 Mbbl will provide an additional 26.6 days of import coverage.

The simulation could be revisited in future with updated information on stock costs and other salient variables.

The above simulation results also illustrate the benefits of expanding emergency response capability through other measures such as standby production so long as their costs are no more than the costs of stockpiling. Thus, it demonstrates the benefits of cooperative expansion of emergency response capability among the APEC economies.

Figure 9 Net Economic Benefits of Expansion for Various APEC Economy Groupings



Source: Leiby and Bowman (1999b). Note: **Asian Group I**: China, Japan, Korea, Philippines, Singapore, Chinese Taipei and Thailand; **Asian Group II**: Asian Group I minus Japan plus Hong Kong, China; **Asian Group III**: Asian Group I minus Japan and China plus Hong Kong, China.

Table 7 Expected Oil Stocks Additions by APEC Groupings

Economy Groups	APEC	APEC minus U.S.	Asian Group I
Stock Additions (Leiby and Bowman, 1999) (Mbbl) (A)	1,000	600	400
Net Oil Imports (2010) (APERC, 2002) (Mbd) (B)	23.5	9.4	15.0
Net Imports Days Covered (A/B)	42.5	63.9	26.6

Source: Leiby and Bowman (1999b) and APERC (2002).

THE BENEFITS OF JAPAN'S EMERGENCY OIL STOCKPILING IN THE APEC REGION

One of the key assumptions in the foregoing section's simulation is the stock costs arising from the PB-KBB study, which are based on a low-cost and large-scale salt cavern facility. However, this size of storage would be too large for some emerging Asian oil importing economies. For example, APERC projects net oil imports of Thailand to reach 40.6 Mtoe or 0.81 Mbd in 2010. Thirty days of net imports in that year would be 24.4 Mbbl. Therefore, this simulation implicitly assumes joint stockpiling by the smaller Asian oil importing economies.

Thus, by separate stockpiling individual economies could forgo some of the benefits of economies of scale and cause capital outlays to be larger to the extent that stockpiling might not be justified.

The PB-KBB study also identifies several potentially suitable sites for salt caverns in Thailand and other economies in the Asia Pacific region. Certainly, depending on the cost, more than one site could be considered for a joint stockpiling facility.

Another option for cheaper joint stockpiling is the leasing of spare storage facilities either individually or jointly. The JNOC experience shows that leasing is 40 percent cheaper than building a new facility.

Thus there are several practical ways to jointly stockpile oil to insure against supply disruptions.

REGIONAL COOPERATION ON STOCK MANAGEMENT

SEPARATION OF EMERGENCY STOCKS FROM COMMERCIAL STOCKS

The IEA experience on emergency stock management indicates a trend towards the separation of emergency stocks from commercial (industry) stocks. In many cases, emergency stocks are jointly owned, controlled or managed under state responsibility. In the APEC region, emergency stocks are held by the US federal government's Strategic Petroleum Reserve (SPR) or by state entities such as JNOC or KNOC in Japan and Korea (although Japanese refiners are mandated to hold stocks equivalent to 70 days of net imports).

A globalising and more competitive oil market justifies this trend, as the industry could minimise stock costs to operational requirements, while sharing the external risk through taxes or charges to finance emergency oil stock costs.

This separation of emergency and commercial stocks should also be considered by APEC oil importing economies that plan to build stocks. Further, considering the aforementioned joint stockpiling, a regional joint stockpiling entity would merit further consideration.

This separation of public and private responsibility over other emergency response measures, such as standby production, should be considered in a similar manner.

INTERNALISATION OF EMERGENCY RESPONSE COSTS

The cost of oil supply emergency response measures, such as emergency stocks, is also an externality.

Free-riding by governments by mandating the industry to hold stocks to a certain level without consideration of commercial factors or subsidising emergency stocks without charging the costs to oil consumers would distort competition in the oil market. Therefore, the cost of stockpiling should be reflected in oil prices appropriately charged to the consumer.

The need for internalisation certainly applies to other forms of emergency response measures. The magnitude of the externality costs may not be small, although it should be accepted as an insurance premium against supply disruptions.

FURTHER ISSUES FOR RESEARCH AND SHARING EXPERIENCE

In designing oil stockpiling and other emergency responses, there remain several issues which could require the sharing of experience and further research.

For example, in the case of oil emergency stocks, the decision to stock oil in either crude or product form would depend on a number of factors including the types of products needed, the availability of refining capacity, and other limiting factors such as environmental standards, product specifications and geography.

Similarly, how quickly oil stocks could be drawn down and delivered would require harmonisation of institutional and technical frameworks as well as the training of the personnel concerned.

More importantly, the sharing of information on stocks, associated costs, evaluation methodologies of impacts of supply disruption as well as response measures would produce more useful information for decision-makers. They would also include how to evaluate the effectiveness of differing response options as well as costs so that member economies could choose the most beneficial options.

At the policy-making level, it is also useful to consider what institutional mechanism would be most desirable in promoting more effective cooperation in response to oil supply disruptions.

CHAPTER 5

CONCLUSIONS

The APEC region's energy security concerns have been heightened by the events and consequences of 11 September.

(a) The APEC region is a significant net importer of oil. In the coming decades, the region's oil production and export potential is likely to decline, while its imports will increase. This is the case, in particular, for APEC Asia. The Middle East is likely to increase its importance as the region's leading supplier of oil.

(b) Oil supply disruptions could result not only from intentional acts such as terrorism but also from unexpected events such as accidents. The growing tanker traffic through chokepoints such as the Straits of Malacca and Strait of Singapore region, for example, need particular attention.

(c) Oil supply disruptions would adversely affect not only oil importing economies but also exporting economies. For example, Asia depends on the Middle East for around 70 percent of its imports and the Middle East exports around 60 percent of its production to Asia. Stable oil supply is a common interest for both producers and consumers.

(d) Oil supply emergency measures and responses constitute an international public good, which entails the risk of erosion by free riding.

(e) As evidenced in the Iraqi invasion of Kuwait, oil production increases by oil producers and stockdraws by consumers play a key role in responding to supply disruptions and stabilising the market.

(f) While Asian economies, which do not hold sufficient oil stocks, are increasing their imports, the emergency response capability outside the region, namely spare oil production capacity in the OPEC members and IEA members' oil stocks, are declining, especially as a percentage of increasing demand. Unless APEC economies contribute to improving response capability, the response capability worldwide will deteriorate further.

(g) While oil stock costs are not easily comparable, the PB-KBB study suggests that a large-scale salt cavern will provide the least costly option.

(h) Using this information and other assumptions, Leiby and Bowman's simulation using the DS-Risk model suggests the benefits of cooperative emergency stockholding by a larger number of APEC economies. Some 30 days imports are suggested as the most economic level of stocks for the smaller APEC economies.

(i) Smaller importing economies would benefit from a joint stockpiling scheme either sharing a common large-scale facility or using surplus storage capacity (of other economies).

(j) In order to promote improvement and cooperation on emergency response measures including facilitating the actual building of emergency stocks in the region, the following are suggested:

a. The separation of emergency stocks from commercial stocks;

b. Internalising the costs of emergency response measures such as emergency stocks in the price of oil products rather than subsidising them;

c. Analysis of the merits of holding stocks of crude oil and of products;

d. The harmonisation of institutional and technical aspects of rapid stock drawdown and delivery;

e. The sharing of information on stock costs and evaluation methodologies of impacts of oil supply disruption and effectiveness of response options; and

f. Policy level cooperation to address relevant institutional issues.

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ANNEX I

The Energy Security Initiative was proposed at the 20th meeting of the Energy Working Group (EWG), Cuzco, Peru, October 2000.

ENERGY SECURITY INITIATIVE: PETROLEUM STOCKS AS AN OPTION TO RESPOND TO OIL MARKET DISRUPTIONS

OBJECTIVE

The objective of the initiative is to provide member economies with further options to consider in addressing the economic impacts of oil market volatility and more fundamental energy security concerns. Consistent with the Energy Working Group's approach to all of the initiatives it develops and executes, participation in developing the initiative and any follow-up action by individual member economies based on agreed elements of the initiative would be fully voluntary.

APPROACH

The initiative would provide exchanges of information and experience on policy, analytical and technical issues, stock holdings and drawdown arrangements, costs and integration with other energy security measures. It is proposed that the Energy Working Group would use the 'Best Practice model' of previous initiatives and would emphasise shared experiences.

It is proposed that the initiative be progressed through a series of informal workshops commencing in April 2001 and draw on existing expertise in the Energy Working Group and its Expert Groups, the Asia Pacific Energy Research Centre, member economies, and other appropriate organisations in accordance with relevant APEC guidelines.

ANNEX II

The following are extracts from the APEC Leaders and Ministers Meeting, Shanghai, October 2001.

Extract: APEC Energy Ministers' Statement

Energy

64. Energy security stands as an important issue for economic development and regional prosperity. In light of the terrorist attacks in the United States, Ministers directed the EWG to intensify its work on strengthening the security and reliability of affordable energy to all in APEC, through such means as exchange of information and experience on oil stockpiling, on facilitating energy efficiency and conservation, and on facilitating improved stability in the provision of energy supply to meet demand. They called for further energy technology development, exchange, application and deployment, and for the facilitation of a diverse and efficient supply mix to avoid the risks posed to the economy by volatility in the international oil market. Ministers welcomed the progress made on the Energy Security Initiative and directed the EWG to implement the concrete work in the progress report on the Initiative. They also called on economies to encourage greater private-sector involvement in the EWG work program and the EWG to cooperate closely with the EWG Business Network. Ministers requested Senior Officials to report in 2002 on progress made in the Initiative.

Extract: APEC Leaders' Statement on Counter-terrorism

6 Leaders are determined to enhance counter-terrorism cooperation in line with specific circumstances in their respective economies, through: (among other things)

- Strengthening of energy security in the region through the mechanism of the APEC Energy Security Initiative, which examines measures to respond to temporary supply disruptions and longer-term challenges facing the region's energy supply.