ASIA PACIFIC ENERGY RESEARCH CENTRE

EMERGENCY OIL STOCKS AND ENERGY SECURITY

IN THE APEC REGION

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Asia Pacific Energy Research Centre
Institute of Energy Economics, Japan
Shuwa Kamiyacho Building, 4-3-13 Toranomon
Minato-ku, Tokyo 105-0001 Japan
Tel: (+813/03) 5401 4551
Fax: (+813/03) 5401 4555
www.ieej.or.jp/aperc

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FOREWORD

The project on emergency oil stocks and APEC energy security is one of the six research projects currently being conducted at the Asia Pacific Energy Research Centre. The five other projects are: energy pricing practices in APEC economies; energy efficiency indicators for industry; cost and benefit of large scale development of natural gas resources; regional power interconnection and electricity sector deregulation in the APEC region.

The main objective of the APEC emergency oil stocks project is to assess the energy security implications of the APEC region's high oil consumption and growing dependence on imported oil, and evaluate the value of building and maintaining emergency oil stocks for the region's oil supply security. Specifically, the project performs a comprehensive assessment of the costs and benefits of expanding the existing emergency oil reserves in the APEC region under a set of plausible oil supply disruption scenarios. The study also considers the issue of joint stockpiling by APEC member economies. This report presents the findings of the research. The research combines economic theory, best available technical tools and practical knowledge to generate the analytical results that could serve as a basis for formulating rational and prudent oil security policy for the region.

Many have contributed to this research project in the addition to the research team at APERC. I am particularly grateful to U.S. Department of Energy Office of Strategic Petroleum Reserves for its generous support, and the skilled research team at the Oak Ridge National Laboratory for its substantive contribution.

Keiichi Yokobori
President

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APERC CONTRIBUTORS

Project Leaders:

Keiichi Yokobori (Japan)

Inja Paik (U.S.A.)

Members:

Masao Takagi (Japan)

Jung Hua Wu (Chinese Taipei)

Mohamad Razif Haji Abd Mubin (Malaysia)

Punchalee Laothumthut (Thailand)

Zhong An Wang (China)

OTHER CONTRIBUTORS

Paul N. Leiby, Oak Ridge National Laboratory, U.S.A.
Don Jones, Oak Ridge National Laboratory, U.S.A.

ORGANISATIONS

Office of Strategic Petroleum Reserves, U.S. Department of Energy, U.S.A.

Oak Ridge National Laboratory, U.S.A.

PB-KBB Inc., Houston U.S.A.

EDITOR

Mohamad Razif Haji Abd Mubin (Malaysia)

ADMINISTRATIVE SUPPORT

Sutemi Arikawa, Shohei Okano, Sachi Goto, Asako Haga and Junko Oonawa.

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EXECUTIVE SUMMARY

EMERGENCY OIL STOCKS AND ENERGY SECURITY IN THE APEC REGION

The study assesses the growing oil import dependence of the Asia Pacific Economic Cooperation (APEC) economies, its implications on APEC energy security and evaluates the costs and benefits of expanding stocks and their optimum size, as well as offer potential policy options.

GLOBAL AND APEC OIL MARKET OVERVIEW

In the last decade, the world oil market has experienced sharp declines in oil production and consumption in the Former Soviet Union (FSU) economies, rapid increases in Asian oil demand, and gradual increases in OPEC shares in global oil supply. The low FSU oil demand and the surplus production capacity in OPEC had resulted in low world oil prices. However, when OPEC and other producers restrained their production, oil prices started to rise again. If oil prices return to lower levels again, it could discourage oil production capacity expansion.

Asia Pacific Energy Research Centre's (APERC) APEC Energy Demand and Supply Outlook and similar studies by other organisations indicate that Asian energy demand will grow substantially over the period to the year 2010, despite the current low level arising from the recent financial crisis. The expected resumption of economic growth in the early 2000's will increase the oil requirement and result in higher oil demand in the APEC region, particularly in Asia.

Although oil production inside the APEC region is expected to grow, its pace lags behind that of oil demand and thus increasing oil demand is likely to be met largely by increased imports in the coming decade. The supply from the Gulf area in the Middle East is already accounting for a major part of oil supply in Asia and is expected to account for a larger share in future oil supply in the APEC region. Growing dependence on oil imports from the Middle East is of concern because of the region's long history of political conflicts. Other potential new supply sources, such as Africa and Central Asia, are not reliable because of political instability and lack of secure supply systems.

OIL SUPPLY SECURITY AND RESPONSES MEASURES

The risks of oil supply disruptions could be reduced by long-term energy policy efforts including diversification of oil import sources, efficiency improvements of energy use, 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 threat of oil supply disruptions nor the large economic damages resulting from them. Only emergency measures that guarantee oil supply, such as stockpiling, limit the economic damages.

Oil supply disruptions could be responded by a wide array of measures, including information sharing, demand restraint, fuel switching, surge production and emergency oil stockdraw. Among these measures, oil stockdraw could be the most effective means for restoring the calm in the oil market. Surge production could offset lost supply of oil but is limited in potential among APEC economies. Demand restraint could be used by many economies during supply disruptions,

however the effectiveness is limited by the scale of the restraint, price effects and low levels of transparency. Fuel switching capability is generally of limited value and scope, primarily due to high one-off investment costs and ongoing maintenance costs.

APEC POLICIES ON EMERGENCY OIL STOCKS

Differing policies and measures followed by individual economies reflect the diversity among the 21 APEC economies. Five of the APEC member economies, namely the United States, Canada, Japan, Australia and New Zealand, are the members of the International Energy Agency (IEA). These economies are under the obligations of the Agreement of the International Energy Program (IEP) to carry stocks at least equivalent to 90 days of net imports. However, among them, only the U.S. and Japan are currently holding substantial emergency stockpiles.

Of the remaining, 16 non-IEA member economies, seven economies are net oil exporters and nine of the oil importing economies only Korea, and Chinese Taipei maintain emergency oil stocks. Among net oil exporting economies, only Indonesia, as an archipelago, maintains its oil stocks mainly to ensure that there is no disruption of fuel availability to the islands. Most of the APEC developing economies are facing financial difficulties in building stockpiles, especially in the current economic climate. Besides Korea and Chinese Taipei, only China and Thailand are considering building stocks. The ASEAN member economies signed the ASEAN Petroleum Security Agreement (APSA) to establish the ASEAN Emergency Petroleum Sharing Scheme for crude oil and/or petroleum products in times of both shortage and over supply.

During the Gulf War of 1990, imported crude oil prices doubled in the APEC region. The product prices also increased but with some delays in several Asian markets due to the government interventions. Further, the cold weather and military activity during 1990 - 1991 caused supply shortage in middle distillate, which resulted in the high product prices even after the crisis.

Operation Desert Storm in January 1991 together with the implementation of the IEA-Coordinated Energy Emergency Contingency Plan brought crude oil prices down to the precrisis level. The IEA measures amounted to offset the loss by 2.5 Mbd. Stockdraw accounted for four-fifth of the total response planned.

INTERNATIONAL COOPERATION IN EMERGENCY RESPONSE MEASURES

The risk of oil supply disruptions is intrinsic to oil supply systems. Oil emergency preparedness strategies such as emergency stockholding, take account of the risk of severe economic damage. Maintaining oil supply emergency response measures such as oil stocks in oil prices is one way of internalising the external cost of oil security. The failure to include these external costs in oil prices could distort competition and result in an inefficient allocation of resources.

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

In terms of international or regional cooperation, coordinated emergency response measures such as joint stockdraw would not only be beneficial to those economies implementing the measures but also to non-participants. This results from the nature of indivisibility and nonappropriability of the benefit of such an action. The actions taken by the IEA during the Gulf War including IEA stockdraw and other contingency measures as well as oil producers' surge production constitute international public goods. With the expected growing APEC economies' share in the world oil market, those APEC economies without emergency stocks and other emergency preparedness measures must strive to increase the quality of such international public goods. Thus, international and regional cooperation in enhancing the effectiveness of emergency response would be beneficial. Such cooperation could include joint stockholding arrangements. Further cooperation between producers and consumers could be explored.

ECONOMIC AND SIZE ANALYSIS OF APEC EMERGENCY OIL STOCK

Oil supply disruptions can adversely affect oil importing economies as well as oil exporting economies. The analysis of costs-benefits of expanding oil emergency stocks in the APEC region supports expanding the APEC reserves by several hundreds Mbbl for Asian oil importing economies as well as the planned expansion of reserves in the U.S., Japan and Korea. Though heavy financial burden could be the major impediment for each member economy to hold its own emergency oil stocks, the schemes of sharing a large-scale storage facility or leasing the excess storage facilities in this region could mitigate it.

CONCLUSIONS, POLICY IMPLICATIONS AND ISSUES FOR FURTHER STUDIES

The study concludes that APEC economies, especially oil importing economies, need to consider the creation or expansion of oil stocks and take appropriate emergency response measures to mitigate the negative effect of potential supply disruptions. The study recommends the following policy issues for further examination:

- Oil pricing policy needs to be developed to cover the cost of emergency stockholding and other response measures;
- The separation of emergency stocks from commercial stocks should be investigated in order to ensure transparency and neutrality to competition;
- Minimum stockholding of 30 days of net import levels is suggested as a first step toward building emergency stocks for oil importing economies;
- Emergency stocks could be jointly held by several economies in order to reduce the cost of such stockpiling. However, this requires the development of formal arrangements among economies to allow stockholding beyond their boundaries;
- Temporary lease of facilities in the industrialised economies by developing economies should alleviate the burden of the high cost of stockholding;
- The cooperation among oil producing, importing economies, and international organisations would be beneficial.

In addition, the report suggests further analyses on economic impacts of oil supply disruptions and determining the appropriate level of emergency stocks.

CHAPTER 1

INTRODUCTION

The world oil market has gone through profound changes in recent years. Driven by increasing oil production outside the Middle East, Organisation of the Petroleum Exporting Countries' (OPEC) diminishing share in the world oil market, increasing oil trade in spot markets, and the emergence of oil futures market, the world oil market has become increasingly globalised with enhanced transparency and efficiency. Like most other commodities, oil is traded in the open and competitive market with prices determined primarily by the fundamentals of demand and supply.

In spite of ample oil supply and expected trend for low prices in the world oil market, security of oil supply is of concern to many Asia Pacific Economic Cooperation (APEC) economies for a number of reasons. Oil has been a critical fuel for the decades of rapid economic growth in the Asia Pacific region, and even with the current economic difficulties, the demand for oil in the region is expected to remain high for the foreseeable future. According to many studies, oil will remain as a dominant fuel for the APEC region comprising 40 per cent of total primary energy consumption, at least until 2010. Moreover, no modern economy - developed or developing - can be sustained for long without uninterrupted oil supply. In particular, transport sector energy demand will continue to rely heavily on oil and remain highly insensitive to oil price rise. Because of the pervasive use of oil throughout the economies, and the relatively low price elasticity of oil demand (and supply) in the short run, sudden and large increases in oil prices have in the past given rise to large economic losses. These losses included high general price levels, a sharp drop in Gross Domestic Product (GDP), and rising unemployment.

Currently, some APEC economies are oil exporters, but because the majority of the larger economies are oil importers, the APEC region as a whole is and will remain a net oil importer. Further, a number of oil producing economies in the region either have recently become oil importers or will be importing oil from outside the region in the near future. As a result, by 2010, APEC will be importing 60 per cent of oil supply from outside sources. Moreover, East Asia will import over 75 per cent while East Asia excluding China will continue to import close to 100 per cent of oil supply. Of particular concern to East Asia is that most of the additional oil required to meet the rising demand is likely to be imported from the politically unstable Middle East over a long distance with a higher potential for supply disruptions.

Oil supply disruptions could occur for a variety of reasons. They could be caused by wars, politically-motivated embargoes, accidents, or even weather. Whatever the cause may be, when oil supply is interrupted and its price increases sharply, it is not possible to avoid macroeconomic damage altogether, but it would be possible to limit the costs through a range of policy measures. As a longer-term strategy, for example, removing regulatory and institutional impediments to the efficient functioning of oil markets would help the market provide correct signals for allocating oil during both normal times and emergencies. When oil flows quickly and smoothly where it is needed most in the economy during an emergency, economic damage from the lack, or misuse, of oil would be less. Diversifying oil supply sources as well as developing alternative fuels to oil would lower the risk of supply disruption thereby lowering potential economic losses.

In addition to these longer-term measures, there are emergency response measures that could reduce the macroeconomic damage of interrupted oil supply and oil price shocks by lowering oil demand or boosting supply during emergencies. The emergency response measures for lowering oil demand range from dissemination of accurate oil market information to discourage hoarding by oil consumers, to mandatory restraining of oil demand to reduce imbalance between oil demand

and supply, to switching from oil to other fuels. The measures for boosting oil supplies during emergencies include surge production and drawdown of emergency oil stocks.

The International Energy Agency (IEA) member countries are currently required to maintain emergency oil stocks equivalent to at least ninety days of the previous year's net oil import levels. The IEA emergency oil stocks have provided significant energy security to the member countries individually and collectively, and their release during the 1990-91 Gulf War contributed to bringing down oil prices. The purpose of this study is to assess the costs and benefits of establishing and maintaining emergency oil stocks in the APEC region, and to suggest a range of policy issues related to building emergency oil stocks.

Chapter 2 presents a broad overview of the global oil market, emerging regional oil markets, the growing importance of Asia in the global and regional markets and APEC's dependence on Middle East oil. Chapter 3 discusses alternative mechanisms for preparing for and responding to oil emergencies and their value to oil consuming economies. A number of APEC economies currently hold substantial amounts of emergency stocks. Chapter 4 reviews these stock levels and APEC economies' policies on emergency response measures. Chapter 5 discusses the rationale of emergency oil stocks and their implications for effective stockholding and cooperation in the APEC region. Chapter 6 analyses the cost benefit of various levels of stockholding, and possible cooperative measures to maintain emergency oil stocks in the APEC region. Lastly, the final chapter summarises the conclusions and policy issues of this study.

CHAPTER 2

OVERVIEW OF WORLD AND APEC OIL: RECENT TRENDS AND PROSPECTS

The global oil market has changed substantially in the 1990s. This chapter reviews the changes that have taken place in oil supply and demand in the world as well as in the APEC region, the emergence of three distinct regional oil markets, and their future prospects.

WORLD OIL SUPPLY: RECENT TRENDS

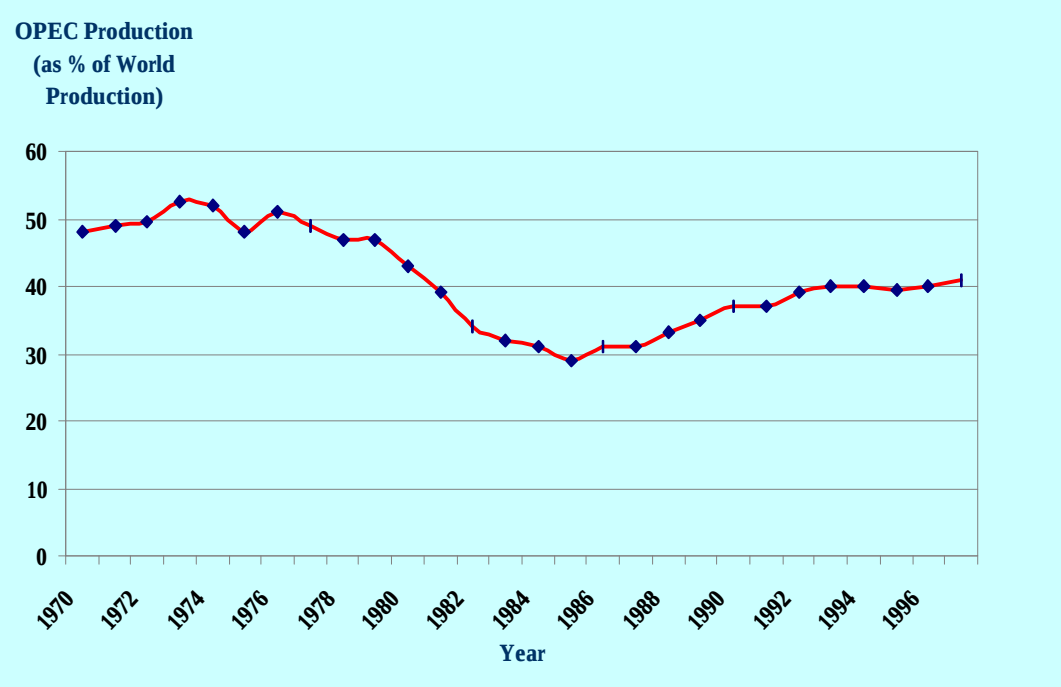
In the last decade, the structure of world oil supply has changed significantly. The principal phenomena since 1990 have been the sharp decline in oil production and consumption in Former Soviet Union (FSU) economies, and the rapid increase in demand in other areas, particularly Asia. FSU production declined by 4.2 million barrels per day (Mbd) from 1990 to 1998, falling from 17.6 per cent of world supply to 10.3 per cent. In the FSU, oil production has been decreasing due largely to political and economic turmoil following the breakdown of the Soviet Union in 1991 (Table 1). Over the same period, total world production increased by 7.4 Mbd. Therefore, between 1990 and 1998 world oil production without FSU increased by 11.6 Mbd. OPEC and non-OPEC producing regions each contributed roughly equally to satisfying the 11.6 Mbd gap between lost FSU production and increased world demand. The OPEC share increased slowly, climbing from 37 per cent in 1990 and remaining around 40 per cent for the last 7 years (Figure 1). At the same time, non-OPEC oil production (excluding FSU), primarily from the North Sea, has increased substantially, accounting for 49.4 per cent of the total increase (5.7 Mbd).

Table 1 **World Oil Production**
(1990 and 1998, 1,000 bpd)

	1990	1998	Increase
OPEC	24,865	30,730	5,865
Non-OPEC	29,285	35,015	5,730
Former Soviet Union	11,570	7,360	-4,210
World Total	65,720	73,105	7,385

Source: BP Amoco Statistics (1999).

Figure 1 OPEC Production Share
(OPEC Production Share Recovered and Held Steady at 40 per cent of World Supply)



Source: BP Amoco Statistics (1999).

RAPID GROWTH OF ASIAN OIL CONSUMPTION IN THE PAST

World oil consumption increased by 6.1 Mbd between 1990 and 1998, from 65.4 Mbd to 71.5 Mbd. During this period FSU economies fell by 4.7 Mbd. The fastest rate of demand growth by far was in the Asia Pacific region (including some non-APEC member economies such as India and Pakistan), where demand increased by 40 per cent, or 5.4 Mbd. This region consumed 26 per cent of total oil supply in the world in 1998 (Table 2). In other words, the world oil demand increase in this 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 fell in 1998. Oil demand in 1998 by those Asia Pacific economies decreased by about 0.5 Mbd, or 3 per cent, from 19.6 Mbd to 19.1 Mbd. Despite remarkable recoveries in Korea and Thailand, slow recovery or protracted economic difficulties in other economies such as Japan and Indonesia would delay the whole region's returns to the pre-crisis rapid oil demand growth. However, Asia will continue to play an important role in global oil markets in the coming decade, as will be discussed later.

THE IMPACT OF VOLATILE OIL PRICES ON THE OIL SUPPLY

From late 1997 through 1998 world oil prices fell and Brent and Dubai spot prices went below USD 10 per barrel in December 1998 and February 1999. These low oil prices were caused by several factors, which include: (1) lower oil demand in Asian economies; (2) OPEC's decision to

raise its production quotas at its general meeting in December 1997; and (3) increasing Iraqi oil exports.

Crude oil prices started rising from March 1999 and reached around USD 25 per barrel by the end of 1999. The major causes were the reversal of the factors contributing to the earlier price falls: (1) recovering Asian oil demand; (2) the high level of compliance with the OPEC production targets agreed in March 1999, helped by cooperation of some key non-OPEC producers; and (3) interrupted oil supplies from Iraq. In addition, the continued North American demand strength and the possible stockpiling with respect to Y2K* concerns helped higher oil prices. Among these, the single significant factor would be the oil producers' concerted reduction of oil production mentioned as (2) above.

However an imperfect monopoly cannot control both price and production simultaneously. Although it takes time for new production to respond to a higher price, this will lead to higher production and lower oil prices. Thus, price fluctuations, settling down again at an ever-lower price plateau, appears to be the market trend (Priddle, 1999).

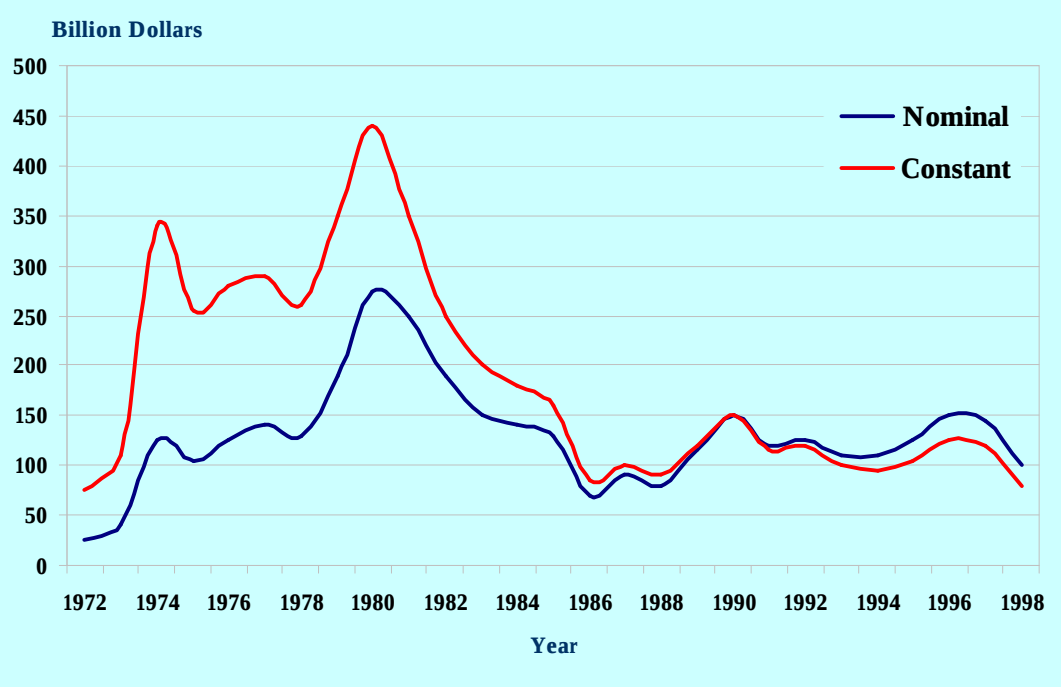
Oil price drops and subsequent wild fluctuations have prompted restructuring, re-engineering and globalisation of the oil industry, as well as mergers and strategic alliances. Examples include the formation of such major oil companies as BP/Mobil (in Europe), BP/Amoco which ARCO may join (worldwide) and Exxon/Mobil (worldwide). It is believed that these mergers were motivated by the giant companies' expectation that worse business environments with an oversupplied oil market and lower oil prices with high volatility would prevail for the foreseeable future and that these mergers would allow them to squeeze profits from every aspect of their business activities.

However, low oil prices and price volatility could create problems such as diminishing excess oil production capacity in the world in the long run. They may also trigger problems within the OPEC member countries, social and political turmoil due to dwindling oil revenues. According to a recent study by the EIA (1998b), OPEC oil export revenues for 1998 were USD 80.5 billion (in constant USD 1990), the lowest level since 1972, and less than one-fifth of the peak revenue year (in constant USD 1990) of 1980. The estimated revenues for 1998 are one-third less compared to 1997 (Figure 2).

This is true for the Middle Eastern oil producing countries. Saudi Arabia, the largest oil producer and exporter in OPEC, was most seriously hit by the recent oil price collapse, because of its heavy dependence on oil revenues (as much as 88 per cent of total export revenues). The oil price decline would affect Saudi Aramco's budget plan and finally might delay a series of new oil and gas field development projects. This might be of crucial importance both for Saudi Arabia in the context of losing potential future revenue sources and for the oil consuming countries in the world which might suffer from crude oil shortage in the future. The OPEC production restraint to stop price falls would not generate high revenue increases at least in the long run. The price increase at the cost of their production decline could induce other producers (and even some OPEC members) to expand their production, which could soften the price. Thus, the price increases seen in 1999 might not produce an optimistic outlook for future production capacity increase.

* Year 2000 computer problem

Figure 2 OPEC Oil Revenues
(1972-1998)



Source: EIA (1998b).

ENHANCED TRANSPARENCY IN THE OIL MARKET

The emergence of such international oil commodity markets as New York Mercantile Exchange (NYMEX) and International Petroleum Exchange (IPE) has contributed substantially to enhancing transparency in the world oil market. The number of contracts in the futures market have been growing steadily worldwide and its hedging function has become a necessary tool for managing the volatility of oil prices and the resulting risk.

In addition to the increased transparency in the oil market, the recent explosive development in the field of information technology has tremendously improved the efficiency of the world oil industry. Any information, either good or bad for oil producers and/or consumers, could reach anywhere in the world instantly, thus affecting oil prices instantaneously in the world oil market.

EMERGENCE OF THE REGIONAL OIL MARKETS

With the changes in the structure of the global market, new regional oil demand and supply groups have emerged. They are the Americas group, consisting of North America, Central and South America; the Euro-African group; and the Asia-Middle Eastern group. These regional groups can be illustrated more clearly in the context of the shifts in these groups' dependence on the Middle East as the source of oil imports (Table 2).

Table 2 World Oil Import by Groups
(1990 and 1998) (1,000 bpd)

	Consumption (a)	per cent	Production (b)	per cent	Import [(a) - (b)]	Import from Middle East	per cent
			1998				
Americas	26,040	36.4	20,895	28.6	5,145	2,769	14.7
Euro-Africa	22,135	30.9	21,770	29.8	365	5,281	28.2
Sub total	**48,175**	**67.3**	**42,665**	**58.4**	**5,510**	**8,050**	**42.9**
Asia	19,125	26.8	7,645	10.4	11,480	10,652	57.1
Middle East	4,230	5.9	22,795	31.2	-18,565	-	-
Sub total	**23,355**	**32.7**	**30,440**	**41.6**	**-7,085**	**10,652**	**57.1**
Grand Total	**71,530**	**100.0**	**73,105**	**100.0**	**-**	**18,702**	**100.0**
			1990				
Americas	23,000	35.2	18,360	27.9	4,640	2,268	16.0
Euro-Africa	25,345	38.7	22,800	34.7	2,545	4,355	30.6
Sub total	**48,345**	**73.9**	**41,160**	**62.6**	**7,185**	**6,623**	**46.6**
Asia	13,700	20.9	6,730	10.3	6,970	7,589	53.4
Middle East	3,385	5.2	17,830	27.1	-14,445	-	-
Sub total	**17,085**	**26.1**	**24,560**	**37.4**	**-7,475**	**7,589**	**53.4**
Grand Total	**65,430**	**100.0**	**65,720**	**100.0**	**-**	**14,212**	**100.0**

Source: BP Amoco Statistics (1999).

THE AMERICAS GROUP

Total oil consumption in this group has been increasing 1.6 per cent per year for the past 8 years. Oil consumption has grown by 3.3 per cent per year in the Central and South American economies, where remarkable economic development has brought about increasing oil consumption. As for oil production, while U.S. oil production decreased, total oil production in this group as a whole has been increasing slowly but steadily, with additional production coming from such economies as Venezuela, Mexico, Columbia and Canada. It should be noted that the U.S., the biggest oil importing economy, finds it economical to import short-haul crude oils and oil products from near Latin American economies and, if necessary, even from the Euro-African group, namely the North Sea and West Africa, just across the Atlantic Ocean.

As a result, the Middle Eastern oil producing countries have been losing their market share year after year in this group. In 1998, the U.S. and Central and South American economies imported 2.7 Mbd from the Middle East, which amounts to only 15 per cent of total exports from the region, while it was 16 per cent in 1990. In 1998, the major sources of imports and their percentage shares were: South and Central America, 22.2 per cent; Middle East, 21.4 per cent; West Africa, 13.3 per cent; Canada, 12.2 per cent; Mexico, 11.7 per cent; and Western Europe, 7.8 per cent. The Middle Eastern economies are expected to continue facing competition from both Latin American and West African oil exporting economies in the future.

THE EURO - AFRICAN GROUP

In this group, the gap between oil consumption and production has narrowed significantly, primarily reflecting stable oil consumption in the European countries and aggressive oil production in the North Sea and African countries, including Nigeria, Algeria and Angola. In the near future, they may have other large new oil and natural gas sources in the Caspian Basin and Central Asia (for example, Kazakhstan, Azerbaijan and Turkmenistan). Therefore, the Middle Eastern oil producing countries have also been forced to retreat from their traditional European markets and may face even more serious challenges in the future from these newly emerging oil and gas suppliers.

Further, the traditionally tight relationship between the Americas group and the Euro-African group could make up for each other's supply shortfalls. The consuming countries in these groups have wide choices among short haul crude oils or oil products, and they can easily switch among their import partners without resorting to Middle Eastern oil producing countries. Consequently, the total import for these two groups from the Middle East also has been decreasing, dropping from 47 per cent in 1990 to 43 per cent in 1998 (Table 2).

THE ASIA - MIDDLE EASTERN GROUP

The oil consumption in the Asia region has grown by as much as 4.2 per cent per year since 1990, while oil production in this area has increased by only 1.6 per cent per year. The increasing demand/supply gap has been filled by oil imports mostly from the Middle East. As the gap between regional consumption and indigenous production in Asia grew to as much as 11.4 Mbd in 1998, 10.6 Mbd (about 92 per cent of its imports) was covered by imports from the Middle East (Table 2).

More than 90 per cent of the Philippines' oil imports came from the Middle East. Japan depended on the Middle East for about 80 per cent of its oil imports, a figure that has not changed much since the mid-seventies. The import dependence on the Middle East for Korea, Singapore, and Thailand remained high at 70 per cent in 1998, and Chinese Taipei had 60 per cent dependence on the Middle East.

Oil trade between the Asia region and Middle Eastern oil producing countries such as Saudi Arabia, Kuwait, United Arab Emirates (UAE), and Iran has been steadily increasing. This is because oil importing economies in the Asia Pacific region have few economical alternatives for replacing Middle Eastern oil with oil from other sources, except for some limited import sources from the West African oil producing countries and Alaska. In this regard, while the African crude oils are highly valued for their low sulfur quality, the Alaskan crude oil is regarded as expensive compared to those from the Middle East in the Asia Pacific oil market.

In turn, the Asia region is also important from the perspective of Middle East oil exporters. Asia imports account for 57 per cent of total oil exports from the Middle East, slightly higher than 53 per cent (7.6 Mbd) in 1990 (Table 2). For the Middle Eastern oil producing countries, whose 674 billion barrels of proved oil reserves are equivalent to 84 per cent of total OPEC and 64 per cent of the world's total proved reserve. The Asia market, especially, the East Asian market, consisting of China, Korea, Japan and Chinese Taipei, has become most crucial and indispensable now and in the future in view of their falling market share in the American and European regions.

In short, the oil trade links between Asia and the Middle East are more important than ever. For this reason, oil supply interruptions in the Middle East region could cause serious turmoil in the Asia region, warranting establishment of emergency response measures.

PROSPECT FOR WORLD OIL SUPPLY AND CONSUMPTION IN THE NEXT DECADE

The "International Energy Outlook 1999" (EIA, 1999) expects world oil demand to resume steady growth by the start of the next decade. It will reach 110.1 Mbd in 2020, and oil price is projected to be USD 22.73/bbl (in 1997 dollars). This relatively lower oil price, even as the demand for oil increases, reflects continued optimism about the potential growth of production in both the OPEC and the non-OPEC nations.

The Business As Usual Case in the "World Energy Outlook" (IEA, 1998) predicts world oil demand to increase from 3,324 Mtoe (about 66.5 Mbd) in 1995 to 5,264 Mtoe (about 105.3 Mbd, an increase of 38.8 Mbd) in 2020. During the period 1995-2010, the Organisation for Economic Cooperation and Development's (OECD) total demand is expected to grow at a little over 1 per cent per annum on average and then to slow after 2010. Non-OECD demand is projected to grow strongly throughout the projection period at an average rate of 2.9 per cent per annum. As for the oil price forecast, the IEA set future prices flat at average 1991-1995 levels (USD 17/bbl in USD 1990, average IEA crude oil import price) for 1998-2010, based on the relationships between prospects for demand and supply and on the likely cost of marginal supplies. The general demand slowdown after 2010 results from an increase in world oil prices over the period 2010 to 2015.

Over the next decade, world oil consumption is expected to increase, but at a slower growth rate partly reflecting the decline in Asian oil demand as a result of slower economic growth. At the same time, the world oil supply will be sufficient to meet the growing demand in the short and medium term. In this regard, OPEC's "surplus management viability" would be a key factor for the world oil supply, in particular under the weaker oil demand in Asian economies. Meanwhile, non-OPEC oil production is not likely to be affected seriously under the oversupply situation as long as the price of oil remains above cost. However, as discussed earlier, a volatile oil price and its potential low levels could hamper the expansion of oil production capacity in the world, particularly diminishing OPEC's surplus capacity.

GROWING APEC OIL CONSUMPTION AND IMPORT IN THE FUTURE

The IEA (1998) expects non-OECD increase in demand for oil to be dominated by demand growth in Asian economies (Table 3). Asian net imports in 2010 will be about 15.2 Mbd, while consumption and production within the area will be 21.3 Mbd and 6.1 Mbd, respectively. The IEA's outlook is more or less in line with the recent "APEC Energy Demand and Supply Outlook"

(APERC, 1998). The Asian APEC economies import reliance (ratio of import volume to total consumption), will be 71.4 per cent, compared to only 43.8 per cent in 1995.

Table 3 World Oil Demand, Supply and Net Import
(Mbd)

	1995			2010		
	Demand	Supply	Net Import	Demand	Supply	Net Import
OECD	41.4	18.4	23.0	48.1	13.4	34.7
Non-OECD	30.4	52.1	-21.9	46.0	79.3	-33.4
(Asia)	(12.1)	(6.8)	(5.3)	(21.3)	(6.1)	(15.2)
Others	0.2	1.5	1.1	0.7	1.6	1.3
World	**72.0**	**72.0**	**0.0**	**94.8**	**94.8**	**0.0**

Source: IEA (1998).

APERC (1998) projects that the Asian financial crisis that started from July 1997 is expected to slow oil demand growth in the East and South East Asia in a few years, but regional oil demand is still projected to grow. And the gap between the region's oil consumption and production is widening. In the 1998 baseline scenario (B98), oil consumption is projected to increase 34 per cent (2.0 per cent per annum), from 1,496 Mtoe in 1995 to 2,067 Mtoe in 2010 (Table 4).

In 1995, the United States was the leading oil consumer in the region (with a total oil consumption of 803.2 Mtoe) followed by Japan (205.9 Mtoe) and China (106.9 Mtoe). By 2010, the U.S. will remain the largest oil user (996.6 Mtoe). The fastest growth is expected in China at 118 per cent, which will make China's oil consumption (254.5 Mtoe) exceed that of Japan (223.2 Mtoe).

Oil production is projected to increase 12 per cent (0.7 per cent per annum) from 973 Mtoe in 1995 to 1,085 Mtoe in 2010. In 1995, the U.S. was the largest oil producing economy in the region followed by China (148.4 Mtoe), Mexico (139.3 Mtoe), Canada (118.7 Mtoe), Indonesia (66.1 Mtoe), Malaysia (35.1 Mtoe) and Australia (28.3 Mtoe). By 2010, the U.S. still leads in production although its share is expected to decline. The fastest growth will take place in Australia while other economies in the Americas namely, Mexico and Canada, will contribute the most, 63 per cent, to the projected increase.

Net oil imports in the APEC region are projected to increase 65 per cent (3.4 per cent per annum), from 735 Mtoe in 1995 to 1,211 Mtoe in 2010. In terms of net oil imports, the U.S. was at the top, followed by Japan and Korea in 1995. However, due to the rapid growth of oil imports in China, the United States and China will together contribute 72 per cent of the increase in net imports between 1995 and 2010. Although some APEC member economies are net oil exporters, oil consumption is forecasted to grow faster so that oil import dependence for the APEC region will rise from 43 per cent in 1995 to 53 per cent in 2010.

Table 4 Oil Demand and Supply for APEC Member Economies
(1995 and 2010) (Mtoe)

	Net Imports (A)	Production	Total Supply (B)	(A/B) x 100 per cent
		1995		
Australia	6.4	28.3	34.8	18.4
Brunei Darussalam	-8.2	8.8	0.6	-
Canada	-34.6	118.7	84.1	-
Chile	8.5	1.0	9.5	89.5
China	8.1	148.4	156.5	5.2
Hong Kong, China	5.3	0.0	5.3	100.0
Indonesia	-34.7	66.1	31.4	-
Japan	262.3	0.8	263.1	99.7
Korea	90.4	0.0	90.4	100.0
Malaysia	-17.8	35.1	17.3	-
Mexico	-66.1	139.3	73.1	-
New Zealand	3.4	1.7	5.1	66.7
Papua New Guinea	-5.1	5.8	0.7	-
Philippines	15.9	0.1	16.0	99.4
Singapore	20.4	0.0	20.4	100.0
Chinese Taipei	32.7	0.1	32.8	99.7
Thailand	31.6	2.6	34.1	92.7
United States	416.3	416.4	832.7	49.9
		2010		
Australia	5.4	44.0	49.4	10.9
Brunei Darussalam	-7.7	8.5	0.9	-
Canada	-43.9	147.0	103.1	-
Chile	21.9	0.6	22.5	97.3
China	146.0	195.0	341.0	42.8
Hong Kong, China	9.0	0.0	9.0	100.0
Indonesia	-20.1	66.2	46.0	-
Japan	279.7	0.6	280.3	99.8
Korea	112.0	0.0	112.0	100.0
Malaysia	-3.7	35.1	31.4	-
Mexico	-49.1	181.5	132.4	-
New Zealand	6.1	3.3	9.4	64.9
Papua New Guinea	-6.2	7.5	1.3	-
Philippines	21.4	1.0	22.4	95.5
Singapore	21.4	0.0	21.4	100.0
Chinese Taipei	54.8	0.1	54.9	99.8
Thailand	44.5	4.4	48.9	91.0
United States	619.9	390.5	1010.4	61.4

Source: APERC (1998).

APEC DEPENDENCE ON MIDDLE EAST OIL

As discussed earlier, most Asian APEC economies depend heavily on the Middle East for their oil supplies. Over the past decades, the U.S. has diversified its oil imports away from the Middle East by reducing its imports from the region from about 28 per cent in the mid-seventies to about 18 per cent in the mid-nineties.

By contrast, for most other member economies, the dependence on Middle East oil was still very high in 1998. As discussed earlier, most Asian APEC economies depend heavily on the Middle East for their oil supplies.

APEC economies' heavy dependence on Middle East oil is likely to continue, because of the constraints of the regional market. For example, the EIA (1998a), which predicts the growing Asian oil imports, expects the Middle East to account for 86 per cent of the imports of Asian Pacific Rim economies (which roughly correspond to Asia APEC economies) in 2020. This could increase the region's vulnerability to supply interruptions in the future.

SUMMARY

In the last decade, the principal phenomena observed have been a sharp decline in oil production and consumption from FSU economies, a rapid increase in oil demand in other areas especially Asia and a gradual increase of OPEC share in oil supply. However, the Asian financial crisis in 1997, together with low FSU demand and OPEC surplus production capacity caused a low oil price which could in turn discourage the future oil production capacity expansion. The subsequent higher oil prices would not provide an optimistic prospect in this regard as it would represent high oil price volatility and induce more uncertainty in the investment climate.

At the same time, three distinct regional groupings of the Americas, Euro-African and Asia have emerged. In contrast to the two former groups, the dependence on Middle East oil supply in the Asia group has been increasing. APERC (1998) as well as IEA (1998) and EIA (1999) point in common to the growing Asian energy demand despite the recent economic downturn and their higher dependence on the oil supply from the Middle East.

CHAPTER 3

OIL SUPPLY SECURITY AND RESPONSE MEASURES

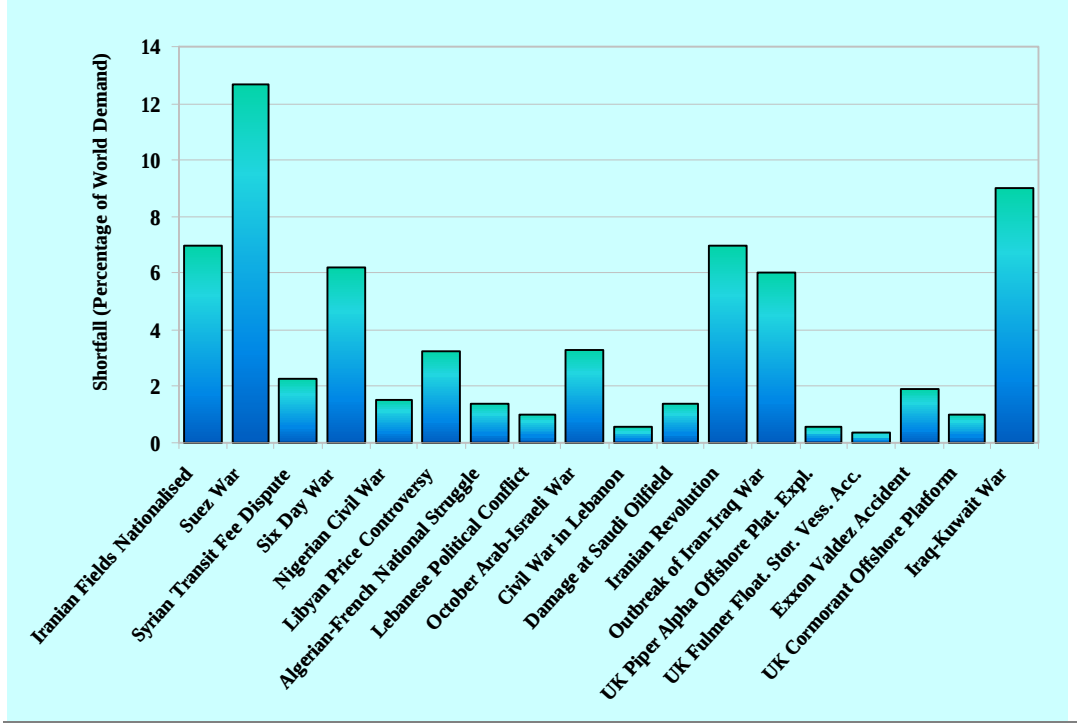
In the face of ample supplies of oil, combined with increased efficiency and transparency in the global oil market, the possibility of a major oil supply interruption taking place in the immediate future may appear remote. Nonetheless, oil supply from the Middle East retains some scope for instabilities that could cause disruptions in oil supplies. No one can predict with confidence whether and when a major oil supply interruption may occur. More recently, IEA member economies put a 2 Mbd collective response plan on the shelf in December 1999 to prepare for possible oil supply disruptions arising from Y2K problems.

There have been 18 major oil supply disruptions since 1951, caused by wars, embargoes and accidents, and the economic costs of the major oil supply disruptions were very high (see chapter 6). Oil consuming economies, in particular, the Asian economies are likely to become vulnerable to oil supply interruptions in the coming decade. In part because they rely heavily on oil as a source of fuel (40 per cent), and in part because their dependence on imported oil, in particular, on Middle East oil (60 per cent) is growing. But, the vulnerability can be reduced, and oil supply security strengthened, if appropriate policy measures are taken.

OIL SUPPLY DISRUPTIONS

Since 1951 there have been 18 significant crude oil supply disruption events (Figure 3).

Figure 3 Significant Crude Oil Supply Shock Events since 1951



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

The causes of these disruptions vary, but can be generally classified as war (3-5 events), internal political struggles (5 events), economic disputes and embargos (3-5 events), and accidents (5 events). The effects of an oil shock, if they are felt, are usually global in nature. Oil supply disruptions did not always translate into sharp oil price increases. Some events had little price effect due to the ability and willingness of suppliers to offset the shortfall, or due to the existence (mostly prior to 1973) of long-term pricing and supply contracts.

On the other hand, some disruptions have led to large and long-lasting price increases (for example, the 1973 and 1979-80 events). This history supports the important conclusion that not all supply disruptions are alike. Not only do they differ in cause and duration, but they can differ in terms of price effect. A key issue is the availability of excess supply capacity to offset the lost supply and the willingness of the owner of such capability to use it.

APEC'S VULNERABILITY TO OIL SUPPLY DISRUPTIONS

Security of oil supply is a concern to APEC economies.

First, because of the pervasive use of oil throughout modern economies, and the relatively small price elasticity of oil demand in the short-run, a sudden and large increase in oil prices resulting from supply disruptions could give rise to large economic losses, as has been the case in the past.

Second, before surplus production capacity of over 7 million barrels per day resulted from the sharp oil production cuts in 1999, spare oil production capacity in the world was trending down to a low level. If OPEC and other oil producers failed to maintain their adherence to their production reduction agreement, the large amount of surplus production capacity would disappear again. This would mean that in an emergency additional oil supply from increased production cannot be expected to readily supplement shortage.

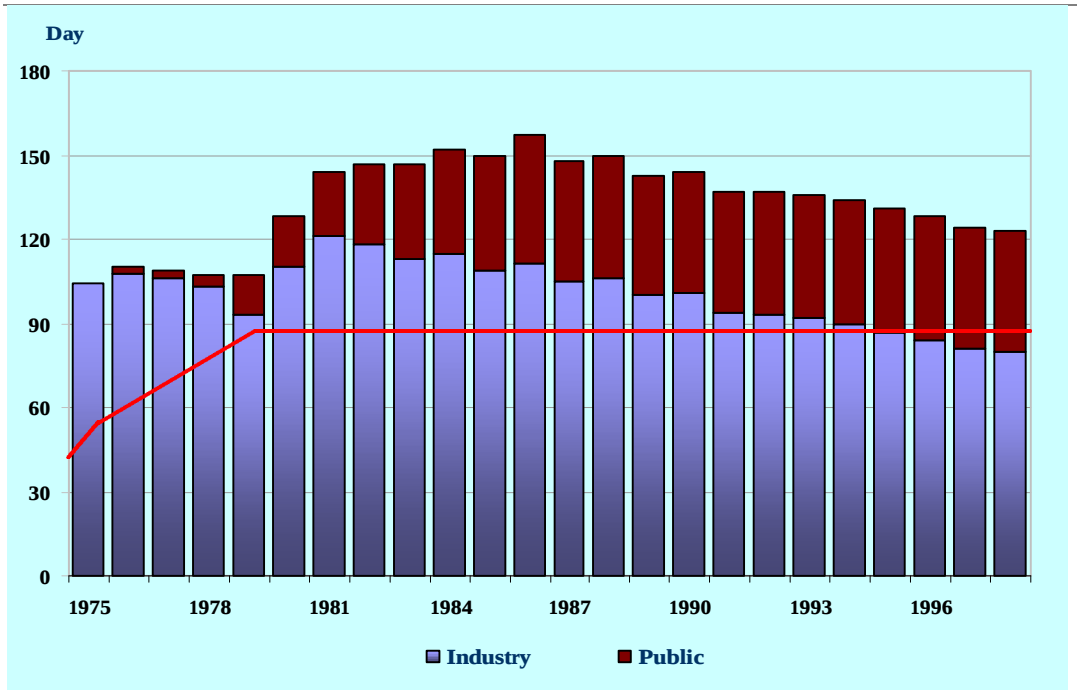
Third, of the estimated 1 trillion barrels of proven world oil reserves, over two-thirds are located in the Middle East. Moreover, with the expected slowdown in non-OPEC oil production, OPEC's market share is expected to grow from the current 40 per cent to 50 per cent by 2020 (EIA, 1999). Heavy reliance on one region for oil supply, that region's history of political instability, and OPEC's growing market share, would suggest an increasing possibility of politically or economically motivated, or other accidental supply interruptions.

Fourth, the protection against major oil supply disruptions afforded by the emergency oil reserves held by IEA members has eroded in recent years. One of the main reasons is the increased share of oil consumption by non-IEA economies in the global oil market with only a few economies, including, Korea and Chinese Taipei, holding emergency oil stocks. According to Priddle (1999), in 1973, OECD countries consumed 66 per cent of the world's total commercial energy supply and 70 per cent of its oil. Today, these shares have dropped to 55 per cent and 56 per cent, and they will fall to less than half by 2010. As a result, two thirds of the projected increase of world energy demand between now and 2020 will arise in non-OECD countries.

In addition, the stocks in IEA net oil importing countries have been declining steadily from the 1986 peak of 157 days to only 123 days of net oil imports on 1 April 1999 (Figure 4). This level is 20 per cent below the 1986 peak. This trend is expected to continue with the growing competitive pressure on the oil industry. Without automatic stock adjustment with increasing oil imports projected by the IEA's World Energy Outlook (WEO) 98, their stock coverage for net importers could decline by 15 per cent to 105 days of net imports by 2010 (Figure 5). In short, the IEA's

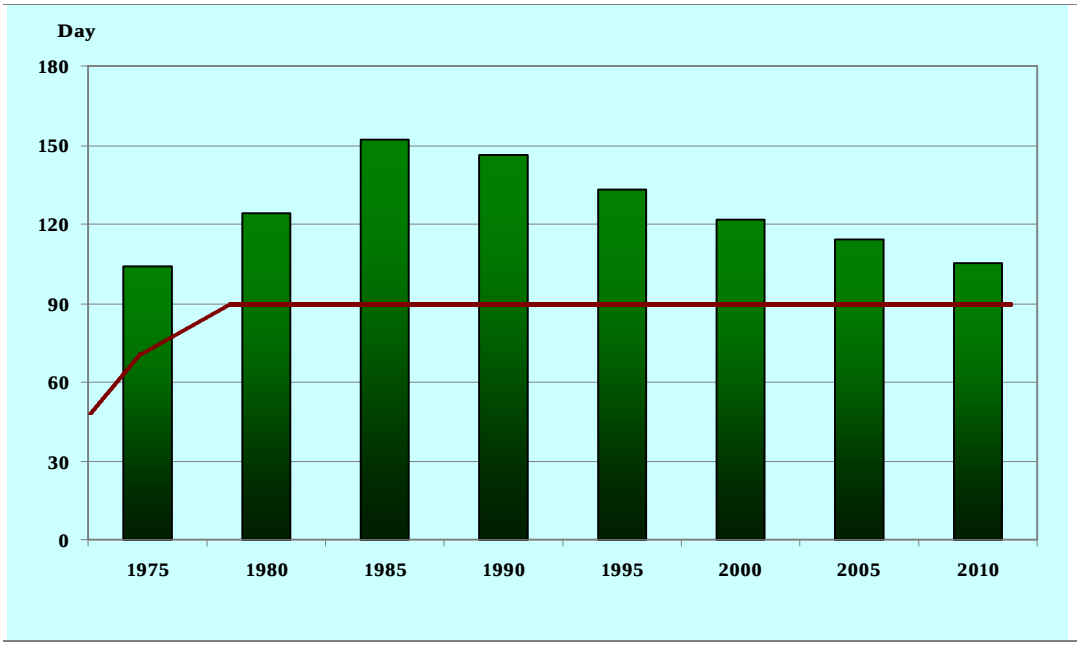
effectiveness for stabilising the global oil markets during emergencies has diminished in this regard (IEA 1999).

Figure 4 Stocks of IEA Net Importers: Days of Net Imports



Source: IEA, 1999.

Figure 5 Outlook for IEA Stocks (Net Importers only)



Source: IEA, 1999.

ENHANCING APEC OIL SECURITY

APEC economies could strengthen their oil security, or reduce vulnerability to oil supply disruptions through implementing a number of long-term policy measures. However, they could not eliminate the possibility of the occurrence of supply disruptions. When oil supply is interrupted and oil prices rise rapidly, resulting economic damage could be limited through various emergency preparedness and response measures.

LONG-TERM POLICY MEASURES

Long-term policy measures include the following.

DIVERSIFICATION OF OIL IMPORT SOURCES

The APEC region as a whole is a net oil importer and is expected to increase its import dependence. Relying on a single source for oil imports, in general, is far riskier than importing oil from multiple sources. One way of reducing vulnerability to oil supply disruption therefore is to diversify sources of oil imports. Over the years, the U.S. has not only shifted its oil imports away from the Middle East to the Western Hemisphere, but also broadened its oil import sources substantially to include Venezuela, Canada, Mexico, in addition to West Africa and Middle East countries because of the economic advantage of these resources over the Middle East. Japan's oil imports from Sakhalin and China's investment in the development of oil fields in the Central Asian region will provide further diversification of sources for the East Asian economies, although their qualitative contribution would be limited.

IMPROVEMENTS ON OIL USE EFFICIENCY

Oil is one of the most widely used inputs in virtually all sectors of modern economies. Since the oil crises of the 1970's and 80's, most developed economies have substantially improved the way oil is used in all sectors of the economy. As a result, oil consumption per unit of output has declined steadily. Improved oil efficiency means, *ceteris paribus*, lower oil consumption, thus leading to lower oil imports. Moreover, the lower the level of oil imports, the lower the transfer of wealth to oil exporters when oil prices are higher. Added benefits to improved oil efficiency are lower cost of production, higher economic productivity, and improved environmental quality.

INVESTMENT IN ALTERNATIVE ENERGY SOURCES AND TECHNOLOGIES

As diversifying oil import sources would reduce the risk of oil supply disruptions, so would the diversification of energy sources or technologies, including development of substitute fuels for oil. In power generation, the use of oil has been reduced in both developing and developed economies by increased use of nuclear and other fossil fuels including coal and natural gas. Modern transportation relies close to 100 per cent on petroleum products, and currently, there are no economically viable substitutes. Substantial investment made in the development of alternatives such as electric and natural gas based automobiles, when they are successfully commercialised, could reduce oil consumption significantly. Investment in energy research and development (R&D) is the key to the successful development of economical and environmentally benign energy technologies including substitute fuels for petroleum. Technologies which promote short-term flexibility and price responsiveness in fuel usage could be valuable in the event of oil supply shocks.

REMOVAL OF MARKET IMPEDIMENTS

Unfettered and efficient functioning of the oil market is as critical during energy emergencies as in ordinary times to ensure that oil flows to where it is needed most, thereby ameliorating the adverse impacts of oil supply disruptions. If a regulatory regime distorts oil prices, wrong signals

would be given to oil producers and consumers, leading to misallocation of scarce oil resources. The current trend among APEC economies towards privatisation and liberalisation of oil markets, including removal of oil price subsidies, would contribute to the overall market efficiency, higher domestic production, and would limit economic losses during emergencies.

PROMOTION OF DIALOGUE WITH OIL PRODUCERS

Today's oil markets have undergone fundamental changes since the 1970s. For one thing, with the emergence of futures markets, and the increasing globalisation of the oil markets, oil trade has become more transparent and efficient. For another, as a means of securing oil supplies, oil companies in consuming economies have been investing in the upstream part of oil production and consumption chains, namely, oil exploration, oil fields, and pipelines developments. At the same time, oil producers have been investing in the downstream, namely, refineries, gas stations, and so forth. The interlocking of oil producers' interests in downstream operations and oil consumers' interests in upstream operations could facilitate both sides' understanding of the mutual benefits arising from supply security. Thus, dialogue between oil consuming and producing economies could contribute to avoid or reduce the possibility of oil supply interruptions.

EMERGENCY PREPAREDNESS AND RESPONSE

None of the measures described above, however, would eliminate the adverse impact of an oil emergency such as, skyrocketing prices, panic and hoarding, and the rapidly rising costs of goods, fueling inflation. The following are short-term or emergency response measures that could be implemented to alleviate imbalance in oil supply and demand.

INFORMATION SHARING

Fundamental to the success of international cooperation is reliable information about factual and scientific knowledge on causes of supply disruptions, oil demand and supply conditions as well as individual economy's preferences, intentions, capabilities, political institutions, laws regarding response actions. Uncertainty in the oil market can cause irrational behavior on both oil consumers and suppliers to hoard oil and bid up oil prices, exacerbating the oil market's turmoil. Sharing reliable information on the oil market situation among oil consuming economies as well as between oil consuming and producing economies would calm the market and remove pressures of rising oil prices. The IEA has such a system in place as a prerequisite for implementing emergency response measures, and it has helped member countries manage the past oil crises.

DEMAND RESTRAINT

During an oil emergency, when oil prices rise rapidly, consumers will naturally react by cutting back on oil consumption. However, as the short-term price elasticity of oil demand is relatively small, the price induced oil demand reduction could be much smaller than the amount necessary to offset the price increases. Thus, oil demand can be brought down further to the desired level either through persuasion or mandatory measures. Some of the more commonly used demand restraint measures have been restrictions on the use of private automobiles and instituting or enforcing speed limits. A variant of demand restraint is allocation of oil supply. One of the main problems with such non-market measures is that the cost of implementation could be very high. In addition, the macroeconomic cost of restraining oil demand could be substantial (Paik, 1987). Another main problem is the difficulty to evaluate clearly the amount of oil demand thus reduced. The market may not respond to such demand restraint measures.

FUEL SWITCHING

Another way of reducing oil consumption during an emergency is to switch out of oil using equipment and into another fuel. How much oil could be saved by switching to other fuels would

depend on the energy technology embedded in existing capital stock and also on the availability of substitutes. Clearly, at present little, if any, fuel switching can be accomplished in the transportation sector because few transportation vehicles are equipped with technology for fuel switching. Limited switching capability is believed to exist in the manufacturing and power generation sectors. In particular, power sectors' oil use accounts for only about 10 per cent of oil consumption in APEC economies.

There are three additional constraints. First, equipment with fuel switching capability often costs more to purchase and maintain. Second, even if fuel-switching capacity exists, say, between oil and natural gas, when the price of oil rises, unless the price of natural gas remains the same or at least costs less, fuel switching is not going to happen. Finally, unless there is surge production capacity and distribution infrastructure in place for the non-oil substitute, there is little scope for widespread fuel switching. In the IEA's International Energy Program (IEP) (IEA, 1974), the provision is made to substitute fuel switching for emergency reserve commitment (Article 3, paragraph 1 of IEP). However, this provision has never been used. This suggests the limited scope of fuel substitution potential as an emergency measure.

SURGE OIL PRODUCTION

Capacity utilisation of oil production wells varies from time to time for economic, technical and other reasons. If, by design or chance, there is excess production capacity, and oil production can be increased during an emergency, it would help supplement oil supply shortfall and stabilise the oil market. Such excess production capacity could normally result from the lower production level than the level of sustainable production capacity. Further, for a short period of time, an increase of production above such a sustainable capacity could be technically possible. Again, maintaining spare oil production capacity carries substantial costs.

In the past oil supply disruptions, in particular, during the Gulf Crisis of 1990-91, the surge production by Saudi Arabia and other producing economies contributed to alleviate the supply shortfalls. At that time, under the IEA Contingency Plan, surge production by IEA members was modest as seen later. Further, since then, oil producers' excess production capacity has been declining, although the low oil demand since 1998 may create a temporary expansion of idle capacity. In the IEA countries, similar to fuel switching, surge production (stand-by production) capacity could replace part of stock obligation (Article 3, paragraph 1 of IEP). But no actual application of this provision has been made either.

EMERGENCY OIL STOCKS

In 1974, following the 1973 oil crisis, the IEA was established to develop collective means of responding to future oil crisis. The cornerstone of IEA response measures has been the emergency oil reserves of no less than 90-days of net imports maintained by member countries. Stocks of 90 days of net imports should be set aside for the use under the IEA oil sharing scheme and the amount in excess of that level could be used for the Coordinated Emergency Response Measures (CERM) which do not involve the oil sharing. Under the IEA Contingency Plan in 1991, 2.0 Mbbl (Million barrel) out of 2.5 Mbbl of oil released resulted from oil stock drawdown contributing to the precipitous drop in oil prices to the pre-crises level. Demand restraint accounted for 0.3 million out of the remaining 0.5 Mbbl (Scott, 1994). Of the five APEC/IEA economies, only the U.S. and Japan participated in the stockdraw (see chapter 4).

OIL STOCKS AS A RESPONSE MEASURE

As seen above, oil stock drawdowns have some clear advantages over other alternative response measures. First, compared with fuel switching or surge 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 the market perceptions more effectively. By the same token, 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 and most importantly, as indicated above, stock drawdowns constitute the significant proportion of the IEA Contingency Plan in 1991 to offset the supply shortfalls of oil.

Therefore, oil emergency stocks could be considered as a main measure among the emergency response measures to be taken by oil consumers at the supply disruptions. Thus, in the subsequent sections, oil emergency stocks will be treated as a major representative of emergency response measures.

STOCKHOLDING OPTIONS

There are many options for holding emergency stocks in terms of ownership (government or company), crude oil or products, stocks owned jointly or individually by countries.

PUBLIC AND PRIVATE STOCKHOLDING

Emergency oil stocks can be either government-owned and controlled as in the case with the U.S. Strategic Petroleum Reserves (SPR), or privately owned but controlled by government as in many IEA member countries. The main advantage of government-owned and controlled stocks is that they are stored separately from private commercial stocks, and because the procedures for releasing them are more transparent, their impacts on the oil markets would be greater. However, some economies consider the government owned stocks as a "last resort" of emergency response measures. For example, at the IEA Contingency Plan in 1991, the reduction of mandatory stockholding level by private oil companies, not the direct release of the Japan National Oil Corporation (JNOC) stock, was chosen by Japan. The U.S. SPR is financed entirely by the federal government while the cost of stocks held by JNOC is passed through to Japanese oil consumers in the form of "Oil Tax". Another variant of these types of stocks is German EBV and Dutch COVA stocks. They are owned by private companies but held separately from company stocks.

CRUDE OIL AND PETROLEUM PRODUCTS

Currently some countries hold only crude oil (U.S.) while others hold both crude oil and products (Japan, Germany), and some countries hold only products. In Japan, a separate reserve requirement is imposed on liquefied petroleum gas (LPG). The decision on the type of oil stocks held depends on a number of factors including the types of products needed, availability of refinery capacity and geography.

For the U.S., the most economical form of stockpile is crude oil because of the large number of different products to be refined and distributed over large geographical areas. Moreover, because of the advanced refining technologies, crude oil can produce almost any product needed, without

delay. On the other hand, for a small economy with a well-established set of product needs, stocking products may be more advantageous. Additional advantage of holding products is its immediate availability to consumers during emergencies. During the Gulf crisis of 1990-91, aviation fuels saw supply shortfalls due to the increased military operational needs and low refining capacity in relation to domestic demand. But one major problem associated with product stocks has been that the quality of products deteriorates over time.

JOINT AND INDIVIDUAL STOCKHOLDING

APEC emergency oil stocks can be established either jointly or individually. The advantage of the collective stockholding arrangement mentioned earlier could also be considered among several oil consuming economies. In the European Union, the Directive allows such joint stockholding provided that those concerned members shall be jointly responsible for meeting the stockholding requirements (Council of the European Union, 1998). As the internal transactions are in principle completely free inside the European Union, this Directive also permits stockholding outside the national territory of the Member States under the agreements between governments. However, in practice, joint stockholding among several Member States has not yet been widely observed.

In the IEA countries, the IEP also allows holding stocks outside the territory of a member country provided that the free cross-border transfer of stocks in crisis is guaranteed by the agreements between the governments concerned.

SUMMARY

The risks of oil supply disruptions could be reduced by long term energy policy efforts including diversification of oil import sources, oil use efficiency improvements, 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 the disruption occurs.

Oil supply emergencies could be responded to by a wide array of measures, including information sharing, demand restraint, fuel switching, surge oil production and emergency oil stock drawdowns. Among these, except for information sharing which will be essential, oil emergency stock drawdown would be most useful because of its transparency and lack of ability of some other measures for many consuming economies.

Oil stockholding could take many forms such as holding by public or private entities, in crude or product forms, and individually or jointly. In terms of public and private stockholding, the issue is the separation of emergency stocks from operational stocks and the proper internalisation of the cost of emergency stock in the price of oil supplied to the market. The decision on the type of oil stockpile held depends on a number of factors including the types of products needed, availability of refinery capacity and geography.

As to the issue of joint and individual stockholding, if international joint stockholding can be expected among APEC economies, it would reduce the cost of building up sizeable level of stocks for supply emergency. Further, joint stockholding arrangements would facilitate the effective coordination of stockdraws in the case of supply disruptions.

CHAPTER 4

APEC EMERGENCY OIL STOCKS AND POLICIES

APEC consists of a diverse group of 21 economies in terms of economic development, size of territory and population, natural resource reserves and culture. Their policies and situations with respect to emergency oil stocks are quite diverse. This chapter describes the stockholding and stockdraw policies of APEC economies and the amounts of emergency stocks they hold. The chapter also reviews the reactions of the oil markets in some selected APEC member economies and the actions taken by IEA and its APEC members during the Gulf Crisis in 1990-1991.

EMERGENCY OIL STOCKS AND POLICIES OF IEA/APEC ECONOMIES

The decision whether or not to stockpile emergency oil, and if so, how much, depends on many factors including economic development, level of oil consumption, import level, security of oil supply, legal obligations, and others. The emergency preparedness for oil supply disruption among APEC economies varies substantially. Five of the 21 APEC member economies, namely Australia, Canada, Japan, New Zealand and the United States, are the members of IEA. They are under the obligations of the IEP and are required to carry stocks equivalent to 90 days of net imports. This stock situation and related policies are described below. Of the remaining 16 members, seven economies are net oil exporters and nine economies maintain some emergency oil stocks.

AUSTRALIA

The Australian Government does not hold any emergency stocks and does not promulgate a mandatory rule for industry to hold minimum stock levels. Since all stocks are held by private industry, any Government prompted stockdraw would require the cooperation of the industry, under the supervision of the National Oil Supplies Advisory Committee and the National Fuels Emergency Consultative Committee.

Stocks would be released to the market in accordance with guidelines specifying the quantities available to suppliers, user groups and retail customers. Guidelines for the identification and assessment of the essential and high priority users have been established. State and Territory authorities have the primary responsibility to identify the priority user, while the Federal Minister is responsible for identifying users which are principally related to defence, imports and exports.

Although Australia imposes no stock obligation on oil companies, the oil companies hold a significant volume of stocks. Australian oil stocks levels remained around 300 days of net imports, but around 48 days of forward demand on 30 September, 1999 (IEA, 2000). Compared with consumption, stocks in Australia are generally at a lower level than the average in the IEA. Storage capacity of crude oil and products gives about 102 days of demand cover if tanks were full; on average they hold 60-65 days of consumption coverage.

CANADA

Canada is a net oil exporter, and all oil stocks held are company owned. However, in a declared emergency, the Federal Government would receive the authority to regulate company-held

stocks through the Mandatory Allocation Program. The government in consultation with the petroleum industry would decide the threshold level at the time of emergency.

Under the Mandatory Allocation Program, the companies will carry out drawdown of stocks. Stocks would be released to the market to meet their crude oil entitlement and the product entitlements, issued monthly, of their customers. While this has been tested several times on paper, no physical tests have yet been carried out.

Company oil stock levels, in particular product stock levels, declined significantly during the 1980's largely as a result of the high costs associated with holding them. Total stocks at the end of September 1998 stood at 149.6 Mbbl around 75 days of the forward demand (IEA, 2000).

JAPAN

Mandatory oil stockpiling was enforced under the Petroleum Stockpiling Law 1983. To meet the IEA's IEP stockpiling commitments, the Japanese Government started to maintain its own emergency reserves in accordance with the Japan National Oil Corporation Law 1978.

In the meanwhile, the Japanese government also imposes stockholding obligations on the oil industry through the Petroleum Stockpiling Law 1983. Besides oil refiners, oil marketers, and oil importers, are also obligated to maintain emergency LPG stocks. JNOC has promoted the construction and the operation of national stockholding facilities through its eight affiliated companies, which are mainly financed by the JNOC (about 70 per cent), oil refiners, and local governments.

Government stocks could be released by the JNOC on the basis of an instruction by the Ministry of International Trade and Industry (MITI) in accordance with the Japan National Oil Corporation Law. The Government, in principle, considers that release of government stocks should be a measure of last resort and that industry stocks should be made available to the market prior to government stockdraw. Nevertheless, the Government envisages that government stocks could be released under the following two cases:

- If international consensus is achieved to use government stocks as part of a coordinated emergency response; or
- If the Government considers it is necessary to release government stocks, taking into account the nature of a supply disruption.

In July 1999, the Petroleum Policy Council, an advisory body to the Minister of International Trade and Industry, recommended MITI to consider the release of government stocks at the early stage of supply disruptions and to increase the government stocks to the level comparable to that of other key IEA member countries (namely, by some 5 million kilolitres (Mkl) (31.4 Mbbl)).

Total stocks at the end of September, 1999 stood at 651.8 Mbbl around 125 days of the forward demand, which is close to net imports (IEA, 2000).

NEW ZEALAND

New Zealand does not hold any emergency oil stocks and does not require oil companies to hold stocks at compulsory levels for emergency purposes. Company stocks, including stocks held by producers, oil refinery, oil companies and major users, are the only stocks in New Zealand. The Petroleum Demand Restraint Act 1981 provides for regulations on stockdraw.

The Network Directorate of the Ministry of Economic Development would be in charge of coordinating any emergency response measures required in sub-crisis and crisis situations.

Stockholders are responsible for operational aspects. Hence, a stockdraw is expected to be achieved on a mutually agreed basis between the Government and the major stockholders. The stockdraw would be a maximum of 10 per cent of stocks during a 3-month period. Industry stocks would be released through normal commercial channels with prevailing market prices.

As of the end of September, 1999, total oil stocks were 11.4 Mbbl, around 80 days of forward demand.

THE UNITED STATES

The policy of the U.S., in response to an oil supply disruption, is to rely primarily on the market for the allocation of petroleum resources, and in the event of a major oil supply disruption, to drawdown the SPR early and in large quantities, in coordination with other IEA countries to limit economic losses. Under the Energy Policy and Conservation Act (EPCA), as amended in 1992, the President has the authority to order release of the SPR, if it is determined that: (a) an emergency situation exists and there is a significant reduction in supply which is of significant scope and duration; (b) a severe increase in the price of petroleum products has resulted from such emergency situation; and, (c) such price increases are likely to cause a major adverse impact on the national economy.

Upon a presidential decision to drawdown the SPR, the EPCA requires that the drawdown and distribution of oil from the SPR be accomplished in accordance with the Distribution Plan. The principal method for distributing SPR oil under the Plan is competitive bidding open to all interested buyers, with awards going to the highest bidders. The U.S. is currently capable of drawing down SPR oil at the rate of 3.5 Mbbl a day.

The U.S. SPR holds only crude oil. According to the data of recent years, a portion of the SPR stocks had been released in 1996 while the total inventory fell to 566 Mbbl from 592 Mbbl in 1994 and 1995. In the last quarter of 1998, the SPR was replenished and total stocks reached 571 Mbbl, or 77.9 Mtoe as of the end of 1998. The U.S. does not require oil companies to hold compulsory stocks for emergency purposes. However, if company stocks are combined with the SPR, total stocks at the end of September, 1999 stood at 1,608.2 Mbbl around 80 days of the forward demand (IEA, 2000).

EMERGENCY OIL STOCKS AND POLICIES OF NON-IEA APEC ECONOMIES

For the remaining 16 APEC member economies, oil emergency preparedness varies considerably between the oil exporters and the net importers. It is evident that all net oil importing economies, whether they are developed or developing, have been concerned about oil supply disruptions and have considered building emergency stockpiles. However, for most of the developing economies, the financial burden involved is substantial, especially in the current economic climate. Only a few developing economies in APEC have established emergency oil stocks, while the others are still considering this option.

CHILE

Chile has a very high oil import dependence of about 90 per cent in 1995. This dependence is going to increase over the period to 2010 according to APERC's projection done in 1998. In recent years, more than 80 per cent of oil imported to Chile came from South America (Argentina, Venezuela and Ecuador).

Considering this high dependence, Chile has established an oil stock regulation. Article 7 of the Decree with Force of Law (DFL) 1 of 1978 of the Mining Ministry, modified by the Law 18179 of 1982 says: "Each producer or importer of liquid fuels derived from oil will have the obligation of maintaining an average stock of each product equivalent to 25 days of its average sales in the previous 6 months or of its average imports in the same period, if those imports are used for its own consumption."

Currently, all refineries in Chile are state-owned and are asked to respect the obligation. According to information obtained, this 25-day obligation on oil stock could be considered as working stocks. Accurate inventory of stocks is not available. But Chile is now going to expand its storage capacity by carrying out two new projects, which will add another 0.2 Mkl (0.75 Mbbl) of storage capacity.

CHINA

China was a net oil exporter in the 1970's and 1980's until 1993. It neither holds strategic oil stocks nor places obligation on company stocks. As a new net oil importer, China is considering an oil stockpiling system for responding to an emergency situation.

In the absence of an emergency stock system, the only reserves are those held by oil companies, including domestic oil producers, oil importers, refineries and product marketers for operational purposes. According to oil company statistics, the total storage capacity at the end of 1997 was around 50 Mkl (315 Mbbl) of which 26 Mkl (164 Mbbl) were for crude oil and 24 Mkl (151 Mbbl) were for products. These tanks and other storage facilities are mainly located in independent oil fields, refineries, pipelines, and transportation systems in ports. Because of the switch to more imported oil, some storage facilities have remained idle while others lack in flexibility in storing different mixes of oil and products. All stocks owned by companies are regarded as operational stocks. Specific figures of reserve volumes are not available.

HONG KONG, CHINA

All oil products consumed in Hong Kong, China are imported. To cushion its economy from the adverse effects of any shortage of oil supplies which may occur in contingency situations beyond its control, the Government of Hong Kong, China has entered into a voluntary Code of Practice with major oil importing companies and the gas company. Under the voluntary Code, these companies will hold a 30-day strategic reserve of gas oil and naphtha, as determined from the level of total import in the preceding year, net of re-exports.

KOREA

Korea is currently a member of OECD but not yet an IEA member. As a member of the OECD, its oil stockpiling policy is moving toward those of OECD and IEA members. Korea is holding both national strategic oil stocks and stockpiling obligation imposed on private oil companies (Hwang, 1998; and Sim, 1998).

Korea introduced a government oil stockpiling system in 1979 by establishing the PEDCO (Korea Petroleum Development Corporation), which was renamed as the Korea National Oil Corporation (KNOC) on 1st January 1999, is responsible for the government stockpile (including crude oil, oil products, and LPG) planning, construction of storage facilities, acquisition and maintenance of stockpile and stockdraw operation.

In 1991, Korea revised the Petroleum Business Act with the introduction of a private stockpiling obligation, enforced from 1993. The obligation is imposed on petroleum refineries, petroleum importers, and petroleum sellers for crude oil, gasoline, kerosene, diesel, B-C, jet oil, and LPG.

Under the Korean Petroleum Business Law, KNOC is entrusted with the responsibility for stockdraw and maintenance of the government oil stocks. Stockdraw is mainly implemented through leasing contracts between KNOC and refiners or importers.

There are two cases of stockdraw in Korea:

(1) In severe and long-term disruption cases, drawdown is implemented by government directive; and

(2) In milder short-term cases, drawdown is made in response to requests by refiners and importers.

Total stocks at the end of September, 1999 stood at 75.8 Mbbl around 37 days of the forward demand, which is close to net imports (IEA, 2000).

On July 8, 1999 KNOC inaugurated the world's largest underground oil storage terminal (Yosu) which is capable of storing 30 Mbbl of crude oil. The commissioning of this terminal completed the second phase of the KNOC emergency stocks plan. KNOC has now the ability to stockpile petroleum to about 95 Mbbl, which is equivalent to 51 days of consumption. The Korean government is going to complete the third construction phase of its governmental oil stockpiling by 2004. Thus the total storage capacity of KNOC will reach 162 Mbbl for up to 84 days of domestic consumption. Together with private stocks, Korea will meet the 90 day requirement of the IEA.

Statoil, the Norwegian oil company, has concluded a contract with KNOC in June 1999 to rent two Korean oil storage terminals, including the just completed Yosu terminal, to store 8 Mbbl of North Sea oil for commercial purposes. Statoil agreed to give KNOC initial access to the stockpile during emergencies at 5 cents below international price for each barrel. Statoil will deliver the oil over the next three years to the tanks of the terminals (The Korea Times, 1999).

THE PHILIPPINES

There was no government regulation on oil stockpiling prior to 1996 in the Philippines. The stocks held by companies were limited to working stocks and monitored by the Government. However, in terms of inventory levels the oil industry has traditionally maintained an average of 60 days supply.

Republic Act No. 8180 in 1996 required oil refineries and importers to maintain a minimum stock inventory equivalent to 10 per cent of annual sales, based on the previous year's consumption, or 40 days of supply, whichever is lower. For this purpose, the 40-day supply inventory consisted of 20 days of supply of crude oil and 20 days product supply. For entities engaged only in the marketing of finished products, including LPG, only 20 days equivalent of product supply was required. As this minimum inventory requirement has since been criticised as a barrier to the entry of new players in the oil market, a remedial legislation enacted in February 1998, RA 8479, does not require industry players a minimum inventory.

Total storage capacity maintained mainly by its only three refineries, Petron, Shell and Caltex is 20.3 Mbbl, which is equivalent to about 58 days of 1997's consumption (128 Mbbl) in the Philippines. Including oil in transit from overseas, stocks of around 45-50 days equivalent were held in 1997 (Koyama, 1998). These stocks are recognised as working stocks.

SINGAPORE

Singapore neither holds strategic oil stocks nor places obligations on company stocks. It once set up crude oil stockpiling when the Singapore National Petroleum Corporation was inaugurated, but abolished stockpiling in 1983 (Tong, 1998).

Total oil storage capacity was 84.9 Mbbl in the first half of 1998. Of this, 25.5 Mbbl were for crude oil and 59.4 Mbbl were for products. The average amount of inventory from January to July 1998 was 26.5 Mbbl, which could cover 56 days of consumption in Singapore or 193 days of domestic consumption if international bunkers and aviation were not served.

CHINESE TAIPEI

Chinese Taipei holds emergency oil stocks by imposing stockpiling obligations on state owned companies, Chinese Petroleum Corporation and Taiwan Power Company. Both companies are monopolies in their own sectors of oil and power respectively. It is the responsibility of the two companies for oil stockpiling for emergency purposes in Chinese Taipei. Since there is a proposed "Oil Management Code," in which deregulation of the oil sector and privatisation of the Chinese Petroleum Corporation (by 2001 are proposed, and under discussion for approval in Chinese Taipei, the oil stockpiling system or the detailed provisions of the obligation are likely to be changed (Chuu, 1998).

According to the regulation of Energy Management Law, which was amended in October 1993, the stockpiling obligation was reduced to 60 days from 90 days before it was amended (Koyama, 1998). The stockpile consists of crude oil and petroleum products. For product reserves, more than 45 days of gasoline, diesel and fuel oil, and at least 25 days of LPG are stocked. The total stockpile in 1996 was some 6 Mkl (38 Mbbl), of which about 30 per cent was crude oil. However, most of the stockpiles held by Chinese Petroleum Corporation are working stocks, which amount to around 30-40 days.

THAILAND

Thailand introduced an oil stockpiling obligation on oil companies under the Petroleum Act enacted in 1978. The obligation was imposed on refineries, importers, and marketers who had throughput of more than 100,000 metric tons per year. Refineries were required to hold mandatory stocks of crude, while importers and marketers were required to hold products.

The company stock obligation was cut down in recent years to reduce cost. Since September 1993, crude oil importers were required to hold a stock of 5 per cent of their annual supply plan. For oil products, domestic producers were required to hold a 5 per cent reserve while importers were required to hold 10 per cent. From December 1996, imported diesel and imported fuel oil was subjected to a 5 per cent reserve, with plans to increase it to 10 per cent in 1999. But from December 1997, the Thai Government again reduced the obligation quotas: 3 per cent to crude oil and domestically produced products, 6 per cent for imported gasoline and kerosine/JP1, and 3 per cent for imported diesel and imported fuel oil, with plans to increase to 6 per cent in 1999 (Suwarn, 1998).

In June 1998, oil marketing companies made further requests for: (1) a reduction of oil stockpiling obligation from 3 per cent to 1.5 per cent; (2) more flexibility for the substitution between crude and finished products; and (3) removal of minimum daily basis in favour of monthly average.

However, in July 1998, the government had decided to maintain a reserve level at 3 per cent for finished products, and still under consideration for the following requests made by oil marketers:

1) To reserve the finished products in form of crude oil at 60 per cent of total required volume;

2) Oil marketing companies to reserve its crude oil at refineries; and

3) Omit crude oil reserve used for petrochemical production.

Under the last revised quotas, the current total oil reserves are equivalent to 21-day supply of the nation, which half of it is in the form of crude oil and the rest is in finished products. Specific figures of stock volume for the time being are not available.

Currently, there is a joint study between National Energy Policy Office and Petroleum Authority of Thailand to investigate the feasibility of national long-term oil reserve. The study includes the estimated oil reserve level recommended by study. Preliminary result of study suggested the reserve to extend to 60 days. The study is expected to be completed within 1999.

No information on emergency oil stocks and policies is available for Peru.

EMERGENCY OIL STOCKS AND POLICIES OF APEC OIL EXPORTERS

The following APEC economies are net oil exporters:

- Brunei Darussalam;
- Indonesia;
- Malaysia;
- Mexico;
- Papua New Guinea;
- Russia; and
- Viet Nam.

As net exporters of oil, they do not hold any emergency oil stocks. Crude oil and petroleum products, if stock piled, are for operational purposes only. The exception is Indonesia, which imposes stockpiling obligation on the national oil company, PERTAMINA. Indonesia, as an archipelago, maintains its oil stocks mainly to ensure that there is no disruption of fuel availability to the islands.

INDONESIA

The oil stock obligation imposed on oil companies is 34 days of domestic consumption, which consists of 17 days for domestic sales (distribution), 12 days for refineries and 5 days for vessels in port. Actually the stocks are recognised as working stocks. Average stock levels throughout the year 1997 were 28 days, and there is a tendency to decrease due to the recent economic downturn (Djuharmi, 1998).

MALAYSIA

As a net oil exporter, stockpiling for crude oil and products is for operational purposes only. Total storage capacity of crude oil is about 14 Mbbl, or at least a 29-day supply. Total storage capacity of products is about 11 Mbbl, or a 26-day supply.

VIET NAM

Viet Nam is a net oil exporter, exporting all of its crude production and importing all products needed. According to its plan, the first refinery in Viet Nam, with a capacity of 6.5 Mtoe (33 Mbbl) per year will be in operation in 2000 (Tran, 1998).

ASEAN PETROLEUM SECURITY AGREEMENT

The ASEAN Petroleum Security Agreement, commonly known as APSA in ASEAN was signed by the ASEAN foreign ministers on 24 June 1986, in Manila on the same occasion as the signing of the Agreement on Energy Cooperation. The APSA was signed by all six ASEAN member economies then, namely, Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore and Thailand, and was subsequently ratified by Viet Nam, Laos, Myanmar, and Cambodia when these economies joined as new members of ASEAN in later years.

Under the Agreement, ASEAN member economies agreed to establish the ASEAN Emergency Petroleum Sharing Scheme for crude oil and/or petroleum products in times of both shortage and over supply. Specifically, when members experience critical shortage, the oil-exporting members of ASEAN are committed to supply a necessary quantity of crude oil and/or petroleum products. In the event of indigenously-sourced crude oil or petroleum products over supply, the importing member economies are required to purchase exports of member economies in distress to increase their level of exports to at least 80 percent of the normal exports.

In the Seventeenth ASEAN Ministers on Energy Meeting (17th AMEM) which took place in Bangkok on 3 July 1999, the ministers expressed a need to review the provisions of the ASEAN Petroleum Security Agreement in relation to the financial crisis and increasing price of oil.

APEC OIL MARKET AND RESPONSE ACTIONS IN 1990-1991

OIL PRICE MOVES IN SELECTED APEC ASIAN ECONOMIES

This section reviews how the Asian oil markets whose dependence on Middle East oil supplies is high reacted to the loss of the oil supplies from Kuwait and Iraq after the latter's invasion to the former in 1990. Movements of prices of imported crude oil and retail products of gasoline, diesel and kerosene in four Asian economies, Japan, Korea, Chinese Taipei and Thailand are reviewed.

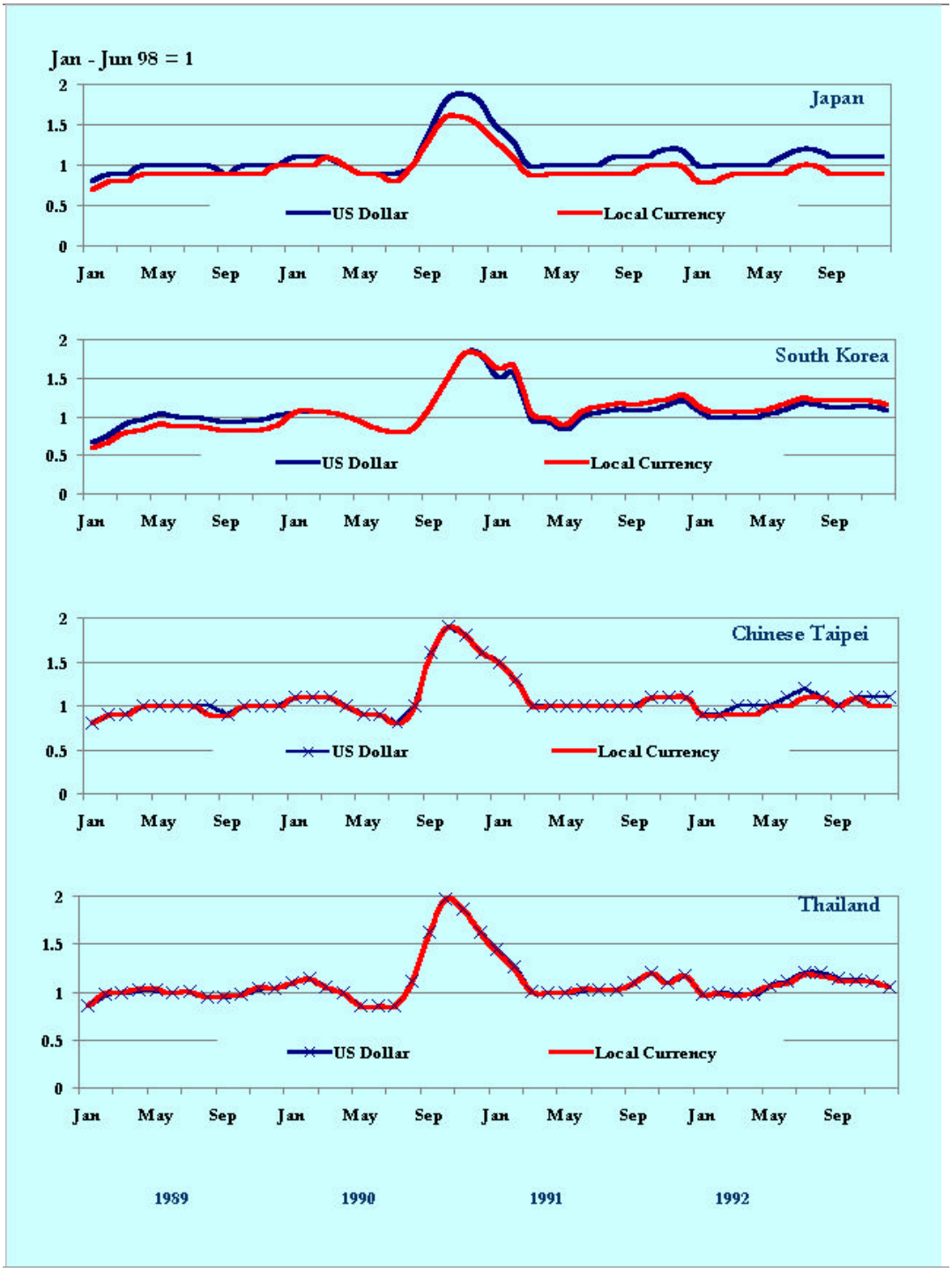
Crude oil prices in all the Asian markets studied started rising from August 1990 and reached the peak in September in Thailand and in October in other economies (Figure 6). The lag in the peak among these economies could result from the difference in contract forms and distance from the supply origins. The imported oil price returned by March 1991 close to the level prevailing in the six months prior to the Iraqi invasion to Kuwait. Dollar denominated oil import prices almost doubled to the average level between January and June 1990. The currencies in Korea, Chinese Taipei and Thailand were more or less linked to the U.S. dollar during this period and accordingly imported oil priced in their currencies showed the same pattern as the dollar denominated ones. But Yen denominated oil import price in Japan increased by only 60 per cent from the pre-Gulf crisis level. This means the smaller impact of oil price increases on Japanese economy than on other Asian economies.

The retail price of petroleum products may not move in parallel with the crude oil price due to taxes and subsidies and other regulations in APEC economies. Indeed the retail price levels of gasoline, diesel and kerosene remained fairly stable for certain period of time in observed Asian economies (Figure 7). In particular, the oil price increases was not passed over to the retail product prices immediately in Korea and Thailand. This particularly holds for diesel that was primarily used for trucks and kerosene that could be largely used by households. Further while gasoline prices went back towards the pre-Crisis level (except for unleaded gasoline in Korea), both kerosene and diesel prices remained high even after the crisis was over.

The different product market situations were also seen in the Singapore market (Figure 8). Particularly, jet/kerosene price increased larger than gasoline or kerosene during the period of the Gulf Crisis and diesel price moves somewhat followed this kerosene price move. This could be explained by two factors. The first peak in both prices of jet/kerosene and diesel could result from high demand for heating oil due to possible inventory build up in the winter of 1990/1991. The second peak could be attributable to cold weather particularly in Europe and the aviation fuel (which is similar to kerosene) use increase due to the military activities in the Gulf region. Because of the flexibility constraint in refinery operations, the increased yield of kerosene would cause shorter supply of diesel. This would also explain why gasoline prices generally stayed at the pre-Crisis level while that of kerosene and diesel remained above that level thereafter. This situation could cause their higher price levels in several Asian economies.

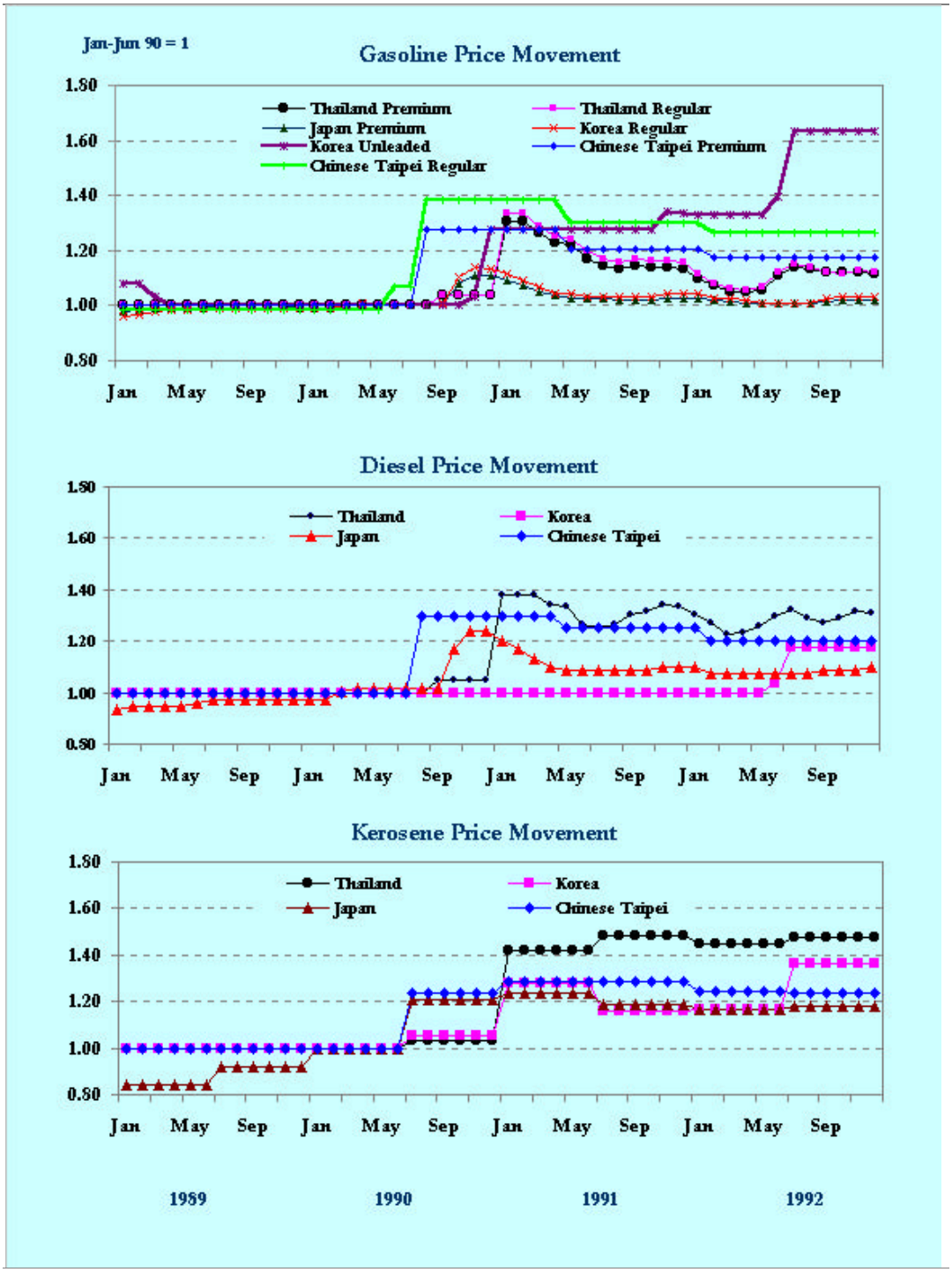
In short in Asian market, imported crude oil price increased sharply following the break out of the Gulf crisis but declined quickly after reaching the peak around in October 1990. The peak was almost twice as high as the pre-crisis level in dollar terms. The price of products increased but with some delays in several Asian markets due to the government interventions. Further, the cold weather and military activity in the winter 1990/1991 caused supply shortage in middle distillate which remained even after the crisis.

Figure 6 Crude Oil Import Prices for Selected Economies during the Gulf Crisis



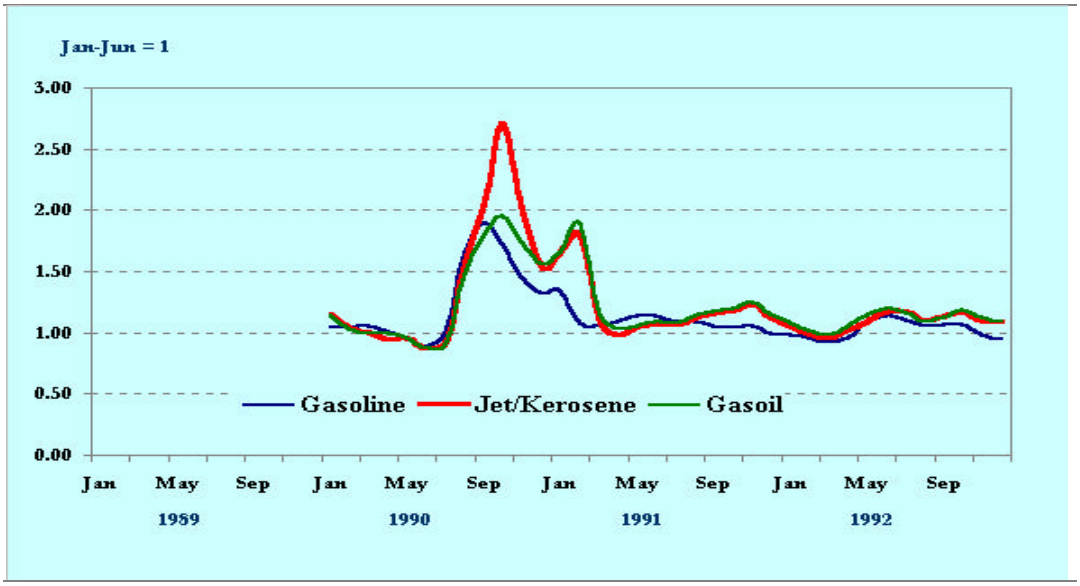
Source: IEA, Korea Petroleum Association, Ministry of Economic Affairs - MOEA (Chinese Taipei), National Energy Policy Office - NEPO (Thailand) 1989 - 1993.

Figure 7 Comparison of Oil Product Prices of Selected Economies



Source: IEA, Korea Petroleum Association, , Ministry of Economic Affairs - MOEA (Chinese Taipei), National Energy Policy Office - NEPO (Thailand) 1989 - 1993.

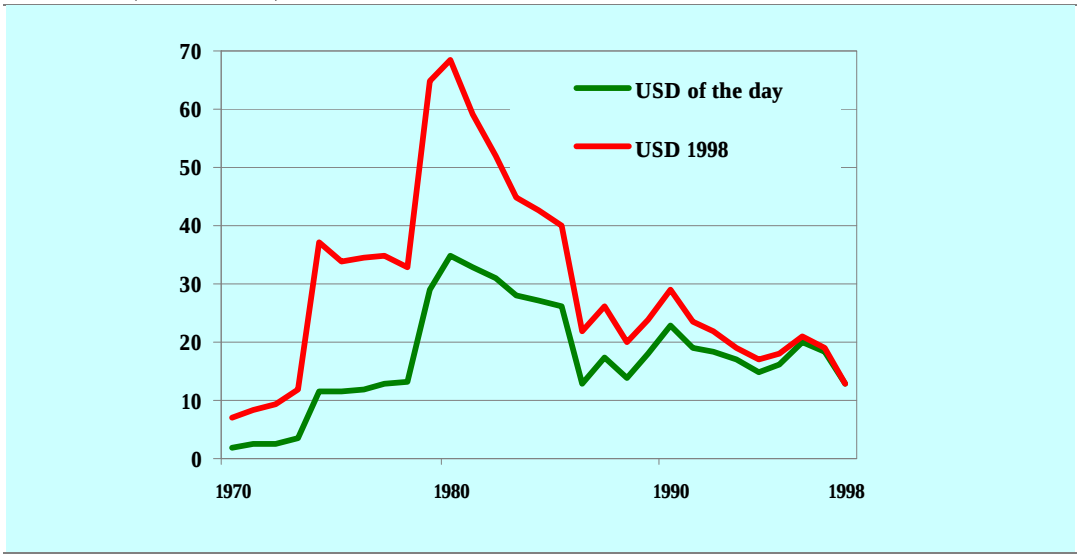
Figure 8 Singapore Oil Product Prices Movement



Source: Platt's, 1989 - 1993.

As seen above, the Gulf Crisis caused the price increase which adversely affected Asian economies by reducing GDP growth, contributing inflation and deteriorating balance of payments (The Bangkok Post, 1990 and 1991). But the price increase of crude oil and oil products was more moderate than in the previous oil crises in 1973 and in 1979-80 (Figure 9). Even in Southeast Asia, this moderate impact was attributed to the presence of relatively high stocks held through the world, particularly by large economies such as the U.S. and Japan, and the excess production capacities of a number of OPEC economies (The Bangkok Post, 1990).

Figure 9 Crude Oil Prices
(1970 – 1998)



Source: BP Amoco Statistics (1999).

The Operation Desert Storm in January 1991 did not cause the oil price increase partly due to the activation of the IEA Contingency Plan, which will be discussed in the next section.

DRAWDOWN OF IEA EMERGENCY OIL STOCKS IN 1991

Following the Iraq invasion of Kuwait on 2 August 1990, which caused a world oil supply disruption of 4.3 Mbd, the IEA activated its Coordinated Energy Emergency Response Contingency Plan just before the U.S.-led multi-nations coalition troops launched the 43 day Operation Desert Storm on 16 January 1991. The IEA Governing Board Meeting of 11th Jan. 1991 adopted an OECD Country 2.5 Mbd Emergency Response Programme. Of which, 21 IEA members accounted for 2.356 Mbd of response and 3 non-IEA OECD members took the remainder, namely Finland, France and Iceland. The Plan consisted of four measures as stockdraw, demand restraint, fuel switching and increased indigenous production. Four-fifth of the total response planed were stockdraw and one-fifth other measures, mostly demand restraint (IEA, 1995).

The five IEA/APEC economies participated in the response:

AUSTRALIA

Australia responded immediately to the invasion of Kuwait on 2 August 1990. The National Fuels Emergency Organisation was convened on next day. In response to the IEA's Contingency Plan, Australia increased indigenous production and adopted necessary demand restraint measures. However, no drawdown of stocks was carried out. At a very early stage of the Gulf Crisis, the Australian government announced a 21-day freeze on wholesale petroleum product prices. After the freeze, wholesale petroleum product prices were liberalised step by step. It is considered that progress to full price liberalisation assisted proper functioning of the market and reduced demand through higher prices in the oil supply disruption.

CANADA

Canada prepared a comprehensive response package to the Gulf Crisis. In the first stage, extensive communication was conducted with the IEA, the provincial/territorial governments, industry, and the Canadian public. Then some demand restraint measures were initiated. A Coordinated Emergency Response Measures (CERM) type implementation was already under way. Furthermore, Canada also reviewed contingency plans in case the IEA Emergency Sharing System had been invoked. In general, all the response measures are on a voluntary coordination basis. Various activities have been implemented accordingly. For example, a Policy and Communications Group to coordinate Federal and provincial/territorial government demand restraint programmes and associated public relations efforts is established. Furthermore, oil companies were prepared to reduce their oil stocks if market conditions had warranted this type of action.

JAPAN

The onset of the Gulf Crisis, the Japanese government introduced demand restraint measures with immediate effect and then it requested the oil industry temporarily to utilise almost full refining capacity, a substantial part of which had been held in reserve. Within the context of the IEA Coordinated Energy Contingency Plan, the Government lowered the compulsory level of stockholding obligations for companies by four days of consumption (from 82 days to 78 days), thus putting some 2.32 Mkl (15 Mbbl) at the disposal of the market.

NEW ZEALAND

New Zealand also responded quickly to the Gulf Crisis. During the Gulf Crisis, stockdraw made a significant contribution to meet New Zealand's obligation under the IEA Coordinated

Energy Contingency Plan. The oil companies were requested to provide a full explanation to the public of any price rises. The oil industry, in the deregulated, competitive environment showed a considerable willingness and capacity to cooperate with the Government during the Gulf Crisis.

UNITED STATES

The United States announced approval for a release of up to 33.75 Mbbl of crude oil from the SPR on the 16th of January 1991. This was the first occasion that SPR oil had been shipped under non-test conditions. The crude oil offered for sale consisted of 11.25 Mbbl of sweet crude oil and 22.5 Mbbl of sour crude oil from 7 storage sites of SPR. On 17th January the U.S. DOE issued a Notice of Sale to 251 prospective offerors of purchase. On 25 January, the DOE received offers from 26 companies to purchase a total of 44.8 Mbbl, of which 27.9 Mbbl of sweet and 16.9 Mbbl of sour (U.S. DOE, 1991).

The SPR Sale was by price competition, where bidders submitted an offer in relation to a Base Reference Price (BRP). The BRP is calculated for both the sweet and sour crudes and is determined as a 5-day average of Daily Index Prices ending 2 days before the Notice of Sale was issued. A Price Adjustment Factor (PAF) is determined for each of the bids in relation to the BRP. The price at the time of delivery is then determined by the PAF applied to the 5-day average of spot prices surrounding the delivery date.

The DOE selected those offers which were above 97.5 per cent of the DOE's benchmark prices. Accordingly, contracts were awarded to 13 companies for 14.35 Mbbl of sweet crude oil and 2.95 Mbbl of sour, for a total of 17.3 Mbbl. The first crude oil delivery of the sale occurred on 5th February and all deliveries were completed by 31st March. The reason for the smaller sales compared to the initial offer of DOE include inadequate prices and a mismatch between the quality of crude that offered and the quality refiners were looking for.

SUMMARY

APEC consists of a diverse group of 21 economies in terms of economic development, size of territory and population, natural resource reserves and culture. Their policies and situation on emergency oil stocks are quite diverse. Five of the 21 APEC member economies, namely the Australia, Canada, Japan, New Zealand, and the United States are the members of the IEA. They are under the obligations of the IEP and are required to carry stocks equivalent to 90 days of net imports. However, among them, only the U.S. and Japan hold substantial amount of emergency stocks largely held under the government or affiliated bodies.

Of the remaining 16 members, seven economies are net oil exporters and nine economies are net oil importers. However, for most of the developing importing economies, the financial burden involved is considered substantial, especially in the current economic climate. Only a few developing economies such as Korea and Chinese Taipei, in APEC have established emergency oil stocks, while the others such as China and Thailand are considering. Among net oil exporters, only Indonesia, as an archipelago, maintains its oil stocks mainly to ensure that there is no disruption of fuel availability to the islands.

The ASEAN Petroleum Security Agreement (APSA) was concluded among ASEAN member economies. Under this Agreement, ASEAN member economies agreed to establish the ASEAN Emergency Petroleum Sharing Scheme for crude oil and/or petroleum products in times of both shortage and over supply.

In response to the loss of the oil supplies (some 4.3 Mbd) from Kuwait by the Iraqi invasion in 1990, in Asian market, imported crude oil price increased sharply but declined quickly after reaching the peak around in October 1990. The peak was almost twice as high as the pre-crisis level in dollar terms. The price of products increased but with some delays in several Asian markets due to the government interventions. Further, the cold weather and military activity in the winter 1990/1991 caused supply shortage in middle distillate which remained even after the crisis.

The Operation Desert Storm in January 1991 did not affect the oil price move partly due to the implementation of the IEA Contingency Plan. Stockdraw accounted for four-fifth of the total response taken under the plan. The IEA measures amounted to offset the loss by 2.5 Mbd. The five IEA/APEC economies participated in the response.

CHAPTER 5

APEC EMERGENCY OIL STOCKS AND INTERNATIONAL COOPERATION

Foregoing chapters present the needs for strengthening the APEC region's oil security in the light of APEC's high level of oil consumption and its expected growth in oil demand in the coming years with the diminishing protection afforded by IEA stocks. This holds for the APEC region as a whole and Asian APEC economies in particular. Although currently a number of Asian APEC economies hold emergency oil stocks as an oil security measure, additional stocks and other emergency response measures are needed for adequate protection against economic and other kinds of damages resulting from interrupted oil supplies. This chapter will address some theoretical issues associated with emergency stocks which will bear the relevance on the financial burden, modality of stockholding and cooperation among APEC member economies as well as non-member economies.

EXTERNAL COSTS OF OIL SUPPLY

THEORY OF EXTERNALITY

As seen in the past, a major disruption in oil supply will accompany sharp increases in oil prices and cause severe economic damage (in hundreds of billions of dollars according to some estimates) to oil consuming economies and to oil producers as well (See chapter 6 for a quantitative analysis). The large economic losses are largely external to the market system. So long as this risk exists, the economic costs to the society of using oil are much greater than what the consumers of oil normally pay.

The economists have long recognised that the market system often produces undesirable and desirable spillover effects that are external to the market system. When these externalities (external costs and benefits) are present so that there is a divergence between social and private costs, and social and private benefits, the market will fail to give consumers and producers the correct signals for resource allocation. The market will tend to under-allocate resources in the production and consumption of goods and services, and their prices will be too high, when these activities confer (external) benefits to others. Conversely, the market will over-allocate resources into the production and consumption of goods and services, and their prices will be too low, when these activities impose (external) costs to others. A mechanism for solving these externality problems is for the public, represented by its government, to force private agents to take full account of the external costs and benefits resulting from their economic activities (Bator, 1958; Cornes and Todd, 1996; Sandler, 1998).

INTERNALISATION OF EXTERNAL COSTS OF OIL SUPPLY

When there is a shortage of oil and prices increase sharply, a way of restoring stability in the market is to bring oil supply and demand into balance by providing additional supply of oil in the market. Most private firms in the oil supply industry have incentives for stocking additional inventories for unexpected fluctuations in oil supply and demand. The quantities which they store are adequate in magnitude for keeping their operations uninterrupted. The major oil supply disruptions of 1970s, 1980s and 1990, have posed larger-scale disruptions to physical supplies, and

even more so to oil prices, than private inventories are intended to buffer. The high oil prices caused the cost of producing most products higher, lower demand for these products because of a decrease in real income, and higher unemployment. But the oil companies have no incentives to maintain inventories large enough to protect against the costs that are external to them.

The failure of the market to internalise the external costs could be dealt with by government actions. Several options exist to reduce the magnitude of this particular oil supply externality. First, the public, represented by its government, could wholly or partially subsidise private companies to keep larger inventories. A variant is for the government to maintain additional oil under its control for use during emergencies as Bohi and Toman (1996) justified the U.S. Strategic Petroleum Reserve on this ground. Alternatively, the government could impose a tax on oil consumption to raise the private cost of oil to a level that would cover the expected value of this macroeconomic cost. A variant is to impose a levy on oil consumption to raise funds to finance the consumption and maintenance of emergency stocks.

Another option is for the government to oblige private companies to hold a minimum level of emergency stocks. IEA member countries have implemented one or a combination of these options. Currently, many IEA oil importing economies enforce minimum stockholding requirements on oil companies. In some IEA countries, such as Japan, France and Germany, as well as in some non-IEA member economies, such as Korea and Chinese Taipei, the centrally controlled or jointly held stocks by the designated stockholding entity are covered by taxes or levies collected from oil consumers.

However, among these measures, the use of subsidy fails to internalise the external cost of supply security, as the market does not give consumers and producers the correct signals for resource allocation. This failure would be of significant importance in the globalised competitive oil and energy markets. The internalisation of externalities such as emergency oil stocks as well as environmental costs associated with oil and other energy sources are increasingly justified to improve energy supply, energy efficiency and environmentally friendly energy use and production. U.S. Energy Association report (1992) suggests, "taxes on oil products to maintain strategic reserves could have the added benefits of reducing oil consumption and thus decreasing dependence on foreign oil. The uneven internalisation of externalities could also distort the competition." The need to internalise appropriately the externality of oil supply security will also affect the modality of stockholding as will be discussed later.

BASIS FOR STOCKHOLDING – OIL CONSUMPTION OR IMPORT

Currently, the IEP uses oil imports as a base of the IEA members' oil stockholding requirements of 90 days. However, the European Commission's Directive which applies to the many of IEA countries ask Member Countries to base stockholding requirements on the domestic consumption not on imports. In the today's globalised and interlinked oil markets, oil supply disruptions of significant magnitude, regardless of supply origin, could affect the whole market negatively and, eventually, the global economy.

In one of the past IEA's Allocation Systems' Tests, which occasionally took place to maintain its emergency response capability, there was a scenario where oil supply disruptions including the one through Trans-Alaska Pipeline supply was assumed to cause the stock drawdowns by IEA members (IEA, 1989). Further, for oil importers with marginal oil import dependence, the commercial stock would be sufficient enough to meet the IEA requirement of a 90 days net import level. For example, Australia which does not have oil emergency reserves held stocks equivalent of some 300 days of net imports on 30 September 1999 (see chapter 4). This suggests justifying the use of domestic consumption rather than imports as a base for the stockholding obligations.

At the same time, the use of domestic oil consumption as a basis of stockholding obligations will raise a series of difficult issues such as the proper assessment of the role of surge production capacity in an oil supply emergency. It will certainly entail more difficult conceptual and practical work. Surge production made a small contribution to the IEA Contingency Plan. Further, at that time, the non-IEA oil producers' increased production alleviated oil supply shortage. IEP, as indicated before, allows the stockholding obligations to be replaced by the maintenance of surge production capability as well as fuel switching capability, although these provisions have never been used.

In the European Union's Directive, Member States producing oil indigenously have the right to deduct from their internal consumption the percentage corresponding to this indigenous production. In December 1998, the maximum derogation ceiling was raised to 25 per cent by the afore-mentioned revision of the Directive (Council of the European Union, 1998). In the absence of the clear mechanism of evaluating the value of indigenous production and with the need for the political negotiation process on this issue, the choice of imports could be regarded as a minimum starting point for the basis of the emergency stockholding. This issue would remain to be investigated in the future study and for policy discussions.

SEPARATION OF EMERGENCY AND COMMERCIAL STOCKS

There are two aspects of the separation issue of emergency and commercial stocks.

The first concerns whether the emergency stock obligation is based on the total stock levels encompassing both commercially needed stocks and stocks ear-marked for emergency purposes. The second pertains to the question of whether emergency stocks should be held separately or commingled with commercial stocks.

On the first point, both the IEA and EU stockholding requirements are based on the total level of stocks. However, this approach has two following problems. First, it would mask the actual amount of oil stored which would be actually available in the case of emergency. The IEP stipulates to exclude 10 per cent of oil stored as absolutely unavailable in calculating the number of days of net import coverage (Annex Article 1.3) (IEA, 1974). However, an industry survey shows that such an 'absolutely unavailable' portion is almost nil in the agencies stocks and at maximum 5 per cent (monthly 2 percent) in industry stocks (Brouwer 1999).

Further, IEA has investigated the amount of "Minimum Operating Requirements" (MOR), which are needed to keep the refinery run at minimum out of stored oil. This amount also varies by company and region. The IEA study indicates that the MOR accounts for about 90-95 per cent of industry stocks in U.S. due to the lack of mandatory stockholding requirements for the company and to severe management pressure, combined with increasing use of shorter-haul imports and new computer technology, while the situation is different in Europe and Japan where domestic requirements for minimum compulsory stocks do not allow companies to operate at low stock levels. MOR's in some major European companies account for around 70 per cent of total stocks and in Japan around 65 per cent (IEA, 1999). Perhaps, it would be extremely difficult to get the precise estimate due to the proprietary nature of information needed. The higher commercial stocks in Europe and Japan would mean that the portion of stocks held for the supply security could be smaller than what could be considered.

The increased competitive pressure would encourage companies to reduce the commercially needed stocks to minimum using such techniques as the just-in-time delivery. By nature, the level of commercial stocks should be left to the business decision. The requirement to hold a uniform level of mixed inventories could thus discourage the efforts to reduce the commercial stocks.

But more importantly, it would also prevent the externality nature of emergency stocks from being explicitly internalised. In this sense, the requirements for companies to hold a uniform level of stocks combining the commercial and emergency stocks could distort the resource allocation. Furthermore, the stockholding obligations imposed only on oil companies would discriminate them against other competitors such as importers. Also this would discourage the better resource allocation. This would suggest the benefit of separating commercial stocks from emergency reserve requirements.

Another problem is that the marginally net oil importers such as Australia and New Zealand could qualify the stockholding requirements by simply holding commercial stocks, as discussed before. For those economies, the stockholding requirements would be meaningless.

On the second issue, stocks can be held together with commercial stocks by private company or separately by the agencies or government. The advantages claimed by advocates of mingled emergency stock with commercial ones would include ease in tuning with operational needs and more efficient and less costly organisation of stocks (Commission of the European Communities, 1998). But operating stock commingled with security stock can potentially weaken security of oil supply and jeopardise the efficiency of a stock drawdown (Commission of the European Communities, 1998). Further, the process of drawdown of company-held stocks is less transparent, and consequently its impact on the oil market could be less effective.

The separation of commercial stocks from emergency stockholding obligations would encourage more centralised stockholding by a joint stockholding entity for the emergency oil stocks. This could be justified on the ground of the economy of scale and of the ease of managing stocks. This would allow costs to be transparent and to be distributed to all market players equitably (Commission of the European Communities, 1998). It will further enable costs to be eventually passed on to the consumers.

In the EU where market integration and competitive pressure are more advanced, more than half of the Member States (8 out of 15) have the centralised stockholding agency. This suggests the advantage of competition neutrality of this centralised form of emergency stockholding. This consideration led to the EU to revise the Council's Directive to endorse "recourse to a joint stockholding body or entity" (Council of the European Union, 1998) upon the proposal from the European Commission in late 1998 (Commission of the European Communities, 1998).

In essence, it is not a question whether the emergency stocks are held in private or government hands. The issue is the separation of emergency stocks from operational stocks and the proper internalisation of the cost of emergency stock in the price of oil supplied to the market. For this reason, it is preferable to separate emergency stocks in both mandatory requirement and form of stockholding.

EMERGENCY OIL STOCKS AS AN INTERNATIONAL PUBLIC GOOD

THEORY OF PUBLIC GOODS AND EMERGENCY OIL STOCKS

When oil is stored for the specific purpose of mitigating the adverse effects of interrupted oil supplies, it has the characteristics of being a public good. The concept of public goods has been part of economic theory for centuries. Paul Samuelson, in his landmark article, The Pure Theory of Public Expenditure, defines public goods as "collective consumption goods … which all enjoy in common in the sense that each individual consumption of such a good leads to no subtraction from any other individual's consumption of that good" (Samuelson, 1954).

Public goods have two properties that distinguish them from private goods. They are nonrivalry (or indivisibility) and nonexcludability (nonappropriability). A good is nonrivalrous when its consumption by one individual does not reduce the amount available to others. Another feature of a public good is that its benefits are nonexclusionary, that is, the benefits are available to all whether they pay for it or not. National defence, scientific knowledge, clean air, lighthouse are some of the classic examples of (pure) public goods. In contrast, most of everyday goods such as food, clothing, automobiles are private goods as they are rivalrous in consumption and exclusionary in benefits. In between pure public goods and private goods are impure public goods that are partially rivalrous and/or excludable. Such public goods are called as "congestable public goods".

With the increasing globalisation of economic activities and interdependence among countries, national economic boundaries have blurred and, at the same time, the benefits of public goods are no longer appropriable by the nations who have provided such goods. Likewise, because of the globalisation of oil markets, oil supply disruption anywhere in the world would affect oil markets everywhere, and actions taken by any oil consuming economy to mitigate the adverse effects of the supply disruption, including oil stockdraw would affect all oil markets. Since the benefits conferred by the release of these stocks during oil supply emergencies spill across national borders, and they are nonrivalrous and nonexcludable, the emergency oil stocks as well as other emergency response measures have the necessary attributes of being international public goods.

UNDERPROVISION OF INTERNATIONAL PUBLIC GOOD - EMERGENCY OIL STOCKS

Economists have long recognised the problem of underprovision of public goods, or the failure of the market to provide adequate supply of public goods. Because of the nonrival and nonexcludable attributes of public goods, the market has little or no incentive to allocate scarce resources to produce them. Consequently, all public goods - national, regional, or international - tend to suffer from underprovision. Moreover, since from an individual standpoint, "free riding," or having others pay for the public goods, is the best and rational strategy, without government intervention, the market will fail to produce socially optimal level of public goods (Buchanan, 1968; Olsen, 1971; Cooper, 1984; Kindleberger, 1986; Cornes and Todd, 1996).

Whereas at the national level, government can force their citizens to take actions, if it is deemed necessary, against underprovision of public goods, there is no counterpart for doing the same at the international level. As discussed above, the emergency oil stocks held by some APEC economies benefit other economies without stocks, and this is giving rise to free ride and lower overall benefits of stockpile for the region. However, in the absence of a global governing body, it would be extremely difficult, if not impossible, to take corrective actions against the free riders.

With the globalisation of economic activities and national politics, a large body of new literature on international cooperation and international institutions has been developed over the recent decade. These theories often assume that "states are self-interested and have conflicts of interest with one another" (Oye, 1986), and the mixed motives of "the prisoner's dilemma." But, even with the pessimistic assumptions about state interests and intentions, and the states' incentives to renege on commitments while recognising gains from cooperative agreements, theories identify conditions under which states would find it beneficial to cooperate with one another.

They suggest that the maintenance of the international public goods would require the presence of well-concerted international policy efforts as well as some division of responsibility among participating economies. Some argue for the need for the existence of the hegemony that would accept the ultimate responsibility and the ability to police the doctrine (Gilpin, 1989). In contrast, Keohane (1984) considered that the IEA arrangement was a model of an institutional arrangement in the post hegemonic era where several economies share the leading role in coordination.

In practice, there is a growing recognition that the cooperation among differing economies would be necessary and the differing degree of responsibility shared among economies for the maintenance of international public goods. The most noted recent example could be found in the United Nations Framework Convention on Climate Change. Its preamble acknowledged the need for "the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities" and recognised "the need for developed countries to take immediate action in a flexible manner"(United Nations, 1992).

The recognition of this sharing responsibility for common goods is a basis for considering the APEC wide energy security issue.

APEC NEEDS FOR EMERGENCY STOCKS

This shared responsibility would mean that, while the developed economies continue to improve their emergency stock situation and other response mechanism, those oil import-dependent economies currently without emergency stocks are suggested to begin building emergency stocks to prevent the overall APEC oil supply security from declining.

Certainly, the basic foundation for reaching a rational decision on stockpiling would the economic calculus of costs and benefits of stocks. But the decision on stockpiling involves a complex set of questions including, what would be the adequate size of additional stocks, what type of stocks are to be held, and what kind of institutional arrangements are needed, etc. Simply stated, it must make good economic sense to build or expand stocks. For many developed economies, it has been proven that the estimated benefits of emergency stocks have proven to be many times more than the cost. As an example, the U.S. has so far spent approximately USD 21 billion in its SPR (U.S. DOE, 1998). In comparison, the potential economic benefit of the SPR has been estimated to be USD 500-600 billion.

But there is a reason to believe that the current level of emergency stocks is inadequate to provide a sufficient buffer against a large oil price shock, and this under provision of emergency oil stocks has far-reaching implications for APEC energy security (as will be presented in chapter 6). In particular, the overall size of global emergency oil stocks has not kept up with the growth of the global oil market with the result that the potential effectiveness of these stocks has eroded (see chapter 3). Developing economies' contribution to halting the erosion of energy security by taking emergency response measures would also constitute self-rewarding efforts for them. Thus, developing economies are encouraged to build emergency stocks and join the international or regional cooperation in their use to the extent which their benefits could justify such undertakings (see chapter 6 for the cost benefits analysis of stockholding).

In particular, the current low oil demand partially reflecting the Asian economic crisis enables APEC economies to buy time to improving their emergency response capability. The current level of oil stocks in IEA member economies, together with surge production potential in producers appears to be sufficient to cope with the oil supply disruptions for several years. In this situation, developing APEC oil importers are encouraged to steadily build and increase their emergency oil stocks. IEA countries are suggested to support them and to make available their emergency stocks to these developing economies in supply disruptions to occur during this period of transition. This will also prevent developing importing economies from the panic buying (see section below for more detail).

BENEFITS OF ASIAN APEC JOINT STOCKS

As stated in chapter 3, individual economies have options to hold stocks jointly or individually. The former arrangement involves establishing a single (or more) stockpile(s) in one (or several) location(s), but jointly owned or managed by all member economies concerned. The latter option, on the other hand, would have all economies build and maintain their own stocks on their own soil. The former options would merit serious considerations for Asian oil importing economies whose import dependence is expected to rise. The main advantage of jointly held Asian APEC stocks is that the cost of storage would be lower because of the economy of scale in storage facilities and management (the illustrative cost calculation will be presented in chapter 6). This would be especially attractive for developing economies. Another advantage is that it would greatly facilitate coordination for release during emergencies.

If such arrangements were to be implemented, the institutional and legal framework would be needed to ensure the free transfer of stocked oil outside the economy's territory when they are drawn down and, where necessary, to harmonise the relevant administrative procedures.

INTERNATIONAL COOPERATION ON EMERGENCY STOCKS

In order to enhance the effectiveness of the stocks as international public goods, economies should develop a framework of cooperation and harmonisation on the use of stocks to avoid the unnecessary market distortion and to ensure the cost-effective use.

Indeed, multilateral cooperation particularly with international organisations could play a major role in achieving this. For example, over the past 25 years, the IEA has played a major role in strengthening oil supply security. It ensures that member countries meet their stockholding requirements under the IEP, provides them with relevant information for building strategic oil stocks and have them ready for release during emergencies. The IEA has also played a critical role in assembling and disseminating relevant information on oil markets during emergencies as well as normal times. From the IEA experience, APEC economies could benefit greatly by cooperating in planning for coordinated emergency response that would have the maximum benefits at the lowest possible costs. Cooperation between IEA member countries and APEC economies in pursuit of expanding global emergency oil stocks also benefits all parties.

At the same time, the developed economies could assist them by reversing the declining trend of their emergency reserve positions, by transferring their experience to them and by providing other arrangements. For example, Japan and the U.S. could temporarily lease a portion of their emergency stocks in excess of the IEA commitments to those oil importing economies, which plan to introduce or expand their own emergency stocks. Such an arrangement could be justified on several grounds.

First, this will not only encourage those developing economies to build strategic stocks but also reduce the risk of panic actions at the occurrence of supply disruptions. The building of stock facility and sufficient stock levels would take time, around 10 years as we see in chapter 6. This arrangement will give some adequate supply security cover during the transition stage of stock building for these economies.

Second, oil demand and imports would remain low in the APEC region in the initial years in the 21st century (APERC, 1998). The temporary lease of the U.S. SPR or JNOC stocks will not weaken substantially their emergency response capability, as their stock levels will remain considerably high above the IEP commitment of 90 days of net imports.

Third, the import size is still smaller in these economies than in Japan or the U.S. and, therefore, the same amount of stock size will cover the higher number of imports days in these

economies. For example, a stock level of 5 days of imports in Japan is worth that of 10 days in Korea. Thus, this kind of arrangement would be mutually beneficial for those economies currently holding a high level of emergency stocks and those planning to build emergency stocks.

At the same time, not only the IEA but also producing countries collaborated in the recent oil supply emergency coordinated actions. The broadening stocks by oil importers would benefit oil exporters whose GDP could also be damaged by supply disruptions (see chapter 6) and whose customers would continue rely on oil by securer oil supplies. In this regard, where necessary, cooperation with other consumer countries and producers, should be considered. For example, oil supply infrastructure such as pipelines and storage facilities could be jointly constructed and/or managed by oil producing and consuming economies or their firms. The arrangement between KNOC and Statoil mentioned in chapter 4 where the former leased the storage to the latter in exchange for some preferential treatment during the oil supply disruption is suggestive in this regard.

SUMMARY

Despite the prevailing expectations for abundant oil supply, the concern for oil supply security is growing in the future. This is primarily due to continuously pervasive use of oil in modern economies, declining spare oil production capacity in the world, growing dependence of oil supply on a single region which has been politically unstable, declining IEA emergency reserve levels and fast growing oil demand in APEC especially Asian economies.

The risk of supply disruptions is intrinsic with the use of oil which is not reflected in its cost unless it is legally obliged. The internalisation of this supply security externality is not only theoretically justified but also practised by many economies. The failure of internalisation of the externality cost will distort competition and resource allocations. Therefore, the cost of emergency reserves and other emergency response measures should be reflected in the price of oil to be supplied to the consumer.

With respect to this externality, the question would arise whether it is external to imports or to supply. The practices followed by IEA and EU differ, as the former links it to the net imports and the latter does so to supply (which is identical to consumption). While supply disruptions related to domestic supply could cause or intensify the magnitude of damage and import linked stockholding obligations would be meaningless to the marginal importers, domestic production is also generally regarded as more secure. While this issue merits further investigations, the use of imports as a first step would be a practical compromise for the time being.

The externality considerations would also favour the separation of emergency stocks from commercial stocks to avoid the moral hazard by requiring the minimum level of both stocks combined and to ensure the transparency of stockdraws to the market, irrespective of private or public holding form.

Joint stockdraws and other coordinated emergency response measures would be not only rewarding those economies doing so but also benefiting non-participants. They constitute international public goods whose attributes include indivisibility and nonappropriability. The IEA stockdraws and other contingency measures as well as oil producers' surge production during the Gulf War in 1991, were a typical example.

With the expected growing APEC economies' share in the world oil market, the continuous lack of emergency stocks and other emergency preparedness in many APEC importing economies,

which could be seen as free riding, would reduce the effectiveness of this type of international public goods. This in turn reduces the benefits to these economies lacking the emergency preparedness. Therefore, those economies would also benefit from their own emergency stock building or other emergency response measures so long as their benefits justify cost.

Thus, international and regional cooperation in enhancing the effectiveness of emergency response would be beneficial. Such cooperation could include joint stockholding arrangements. Further cooperation between producers and consumers could be explored.

CHAPTER 6

ECONOMIC AND SIZE ANALYSIS OF APEC EMERGENCY OIL STOCKS

This chapter presents an economic analysis of APEC emergency oil stocks including the costs of stockholding, economic benefits of stockdraw and efficient stock sizes. Probabilistic cost-benefit and computer simulation approach was used to perform the analysis.* The chapter also evaluates joint stockholding among a group of small Asian economies based on the number of days of oil import coverage.

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 in some economies, different accounting methods used, varying coverage of costs (such as inclusion or exclusion of costs of land acquisition or used, some ancillary facilities and oil acquisition), the size of facility capacity, currency fluctuations, inflation, technological factors, and so forth. For these reasons, any cost estimates of existing oil stock facilities would indicate only the rough order of magnitude of actual costs.

According to JNOC, in Fiscal 1996, it paid facility fees of 125.8 billion yen to the National Oil Storage companies, and the leasing fees of 50.2 billion yen to private refining companies. They are for storing 32.84 Mkl (206.6 Mbbl) and 15.86 Mkl (99.8 Mbbl) of oil respectively. The latter costs USD 4.62/bbl and is about 40 per cent cheaper than the former, which costs USD 7.56/bbl. JNOC costs include land acquisition and some ancillary costs. For JNOC, clearly leasing storage facility is a less costly option than building a new facility.

Between 1981 and 1990, JNOC also invested 147.1 billion yen in stockpiling 6.4 Mkl of oil in 57 above-ground tanks (average of 0.7 Mbbl in unit size). Adjusting for the average exchange rate during the period and GDP deflator in U.S., it would amount to around USD 27.3/bbl in 1997 price.

As for the cost of stockpile in Korea, Hwang (1997) reported that under the first (1980-1989) and second (1990-1996) petroleum stockpile plans, a total of 961.19 billion won had been spent on the construction of facilities by 1996. Sim (1998) indicated the total capacity planned under the two plans to be 94.1 Mbbl. As two KNOC facilities of Yosu and Koksong with the combined capacity of 32 Mbbl have been completed (The Korean Times, 1999), KNOC stockpiling facility at the end of 1996 should be 62.1 Mbbl. Using the average exchange rate and U.S. GDP deflator, the estimated costs of stockpile would be USD 26.1/bbl. This is roughly comparable to the JNOC cost of USD 27.3/bbl.

* This chapter draws heavily on the work reported in Paik, Leiby, Jones, Yokobori and Bowman (1999 (Copyright 1999, IAEE. Portions and figures used here with the authors' permission. For further detail on the methodologies and data, see Leiby and Bowman (1999a), Jones (1999), and PB-KBB (1998)).

PB-KBB STUDY

PB-KBB Inc.,* estimated the costs of developing alternative storage facilities for stockpiling emergency oil in the APEC region (PB-KBB, 1998). The study is based on storage capacity unit of 16 Mkl or 100 Mbbl, using three different storage technologies: solution mined salt cavern, hard rock mine, and in-ground concrete trench (cut and cover). The cost estimates include the cost of constructing, operating and maintaining oil storage facilities of 40 year design life. Further, a maximum drawdown rate of 1.17 Mbd and a maximum fill rate of 0.27 Mbd are also assumed.

The design for crude oil storage is based on: reasonable cost of construction; relative stability for a long duration; no appreciable loss of stored material. Certain geological, geographical, functional and facility design criteria required for the storage of crude oil are also considered. Facilities necessary to transport oil to and from storage are included in the study. All three types of storage facilities must be located in areas free from seismic activity and flooding. All necessary concept level drawings that form the basis for the design and cost estimates are also included. The study estimated that salt cavern storage facilities can be fully developed several years earlier than in-ground and mined storage facilities. If desired, the development of either in-ground trench or salt cavern storage facilities could be phased in order to commence oil fill operations at an earlier date.

There are many potential areas for these storage facilities throughout the APEC Region. In Australia, the north-eastern and north-west central regions are suitable for in-ground storage. There are numerous potential locations for conventionally mined cavern storage. Other possible areas for conventionally mined storage include areas from Newcastle to Cape Howe. Salt formations for solution mined caverns potentially exist along the coastline of the Gulf of Carpentaria in Northern Australia, and the Canning Basin near Broome, on the coast of Western Australia.

In China, Eastern China appears to be suitable for in-ground storage. The entire coastline along the East and South China Seas also appear attractive for conventionally mined cavern storage. The area around Hong Kong, China appears particularly attractive. Sufficient salt formation exist in China for solution mined storage, the Bohai Bay area, in particular, appears attractive for solution mined caverns.

It is possible to locate conventionally mined storage in Indonesia and New Zealand because of availability of suitable rock mass. However, since the region is subject to seismicity, careful consideration must be given to site location. There appears to be no suitable salt domes either in Indonesia or New Zealand. In-ground storage may not be possible due to seismicity these two economies.

Korea appears to have adequate land area and low seismicity suitable to in-ground storage. There appears to be adequate rock formations for conventionally mined oil storage along the western shoreline of the Yellow Sea. No salt cavern is available. Due to low seismicity, Thailand appears to be suitable for in-ground storage. Conventionally mined caverns are possible due to granite intrusions along the Peninsular Malaysia. Also, there are massive bedded salt formations sufficient for solution mined caverns. The salt formation, however, is located inland, which may make location there cost prohibitive.

It should be noted that the potential areas for locating storage facilities mentioned above are based on very preliminary geologic surveys. Other APEC economies could have qualified sites and more detailed investigations are required. Table 5 summaries a comparative overview of three types of oil storage facilities.

* An engineering firm with extensive experience in oil storage facility development, located in Houston, Texas, U.S.A.

Table 5 Comparison of Oil Storage Facilities

	In-Ground Trench	Hard Rock Cavern	Salt Cavern
Facilities Feature			
Siting Requirement	Earthquake and flood-free, ground-water below ± 30'	Earthquake and flood-free, suitable rock mass	Earthquake free, suitable salt mass, water source and brine disposal zone
Real Estate Requirements	775 Acres – surface	50 Acres – surface; 300 Acres – subsurface	174 Acres – surface
Installed Primary Horsepower (hp)	12,000 hp	18,800 hp	39,000 hp
Pipelines	Oil	Oil	Oil, water and brine
Environmental			
Storage integrity/ Security	More risk	Low risk	Lowest risk
Oil Recovery	Good	Good	Good
Greatest Concerns	Storage integrity, Large land area	Muck disposal	Brine disposal
Development Time	11 years	13 years	8 years
Operability			
Critical Design Feature	Storage trench and oil pump structure	Pump shaft	Casing seat
Critical Systems	Vent/ inert gas system	Vent/ inert gas system	Water source, Brine disposal
Potential Areas	China, Australia, Korea, Thailand	China, Australia, Korea, Thailand	China, Australia, Thailand

Source: PB-KBB (1998).

THE COSTS OF CONSTRUCTING OIL STORAGE FACILITIES

PB-KBB Inc. 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 categories are capital costs, and Operations and Maintenance (O&M) costs. O&M costs are given for standby operations (in USD/bbl-year) and fill and draw operations (USD/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, (USD /bbl) – undiscounted sum	15.68	15.44	5.51
Operation & Management Cost, (USD /bbl-yr)	0.16	0.09	0.17
Fill/Refill Cost (USD /bbl)	0.05	0.05	0.09
Drawdown Cost (USD /bbl)	0.07	0.07	0.10

Source: PB-KBB (1998).

Although there are some differences among the three storage technologies in operating, filling, and drawing costs, the capital costs dominate by far. For all technologies, there is an initial 3-4 year period of modest costs, and then the bulk of capital costs occur around the middle of the development period. Completion of the facility will take 8 to 13 years. The discounted capital cost stream for salt cavern lies well below those of the other two technologies. Salt Cavern storage is available sooner and at lower cost. At the discount rate of 7 per cent, the Net Present Value (NPV) cost of salt cavern completed by 2008 is USD 4.03/bbl. In NPV costs per barrel, both the rock and trench technologies are almost 3 times as expensive as salt cavern completed in the same year. Based on costs and operating characteristics alone, salt cavern storage excels trench or hard rock storage, regardless of when it is built.

The PB-KBB study presents much lower stockholding costs compared to the costs incurred by both Japan and Korea in stockpiling emergency oil. This is due in part due to the low cost salt dome technology and in part to economies of scale associated with large storage facilities assumed in the study.

THE BENEFITS OF APEC EMERGENCY OIL STOCKS

The relationship between oil price and macroeconomic performance is complex, and there is extensive literature on the inquiry into how sudden and large increases (and decreases) in the prices permeate through economies and affect economic activities (Jones, 1999). Economic losses resulting from oil price shocks have been estimated to be substantial, and needless to say not all of the losses can be measured in quantitative terms. Losses in GDP and higher costs of imported oil are often used as the proxy for the adverse economic impact of oil supply disruptions. The economic benefit of oil stocks then is the sum of avoided GDP losses and oil import costs due to the lower oil prices resulting from oil stock release during oil emergencies.

The foundation for estimating the economic benefits of oil stocks is the quantitative relationship between oil price and the macroeconomy known as oil price-GDP elasticity. Table 7 presents oil price-GDP elasticities for selected APEC economies, estimated with annual data and controlling for monetary policy (Bachman and Ingram, 1999). The equations for the economies were estimated using seemingly unrelated regressions. A satisfactory estimate for the People's Republic of China was not available. Additionally, the Philippines' elasticities estimated from annual data were of the theoretically incorrect sign and nonsignificant; re-estimation with quarterly data yielded correct signs but nonsignificant elasticities.

Table 7 Oil Price GDP Elasticities for Selected APEC Economies

	Oil price up		Oil price down	
	Oil Price – GDP Elasticity	t-statistic (ratio of elasticity to standard error)	Oil price-GDP elasticity	t-statistic (ratio of elasticity to standard error)
Hong Kong, China	-0.065	-1.51	n.s.[1]	
Indonesia	-0.043	-2.07	n.s.	
	(lag)-0.043	(lag)-2.22		
Japan	-0.058	-5.69	+0.021	+2.07
Malaysia	(lag)-0.056	-2.27	+0.086	+2.07
Philippines	-0.036[2]	n.s.	n.s.	
Singapore	-0.042	-1.80	n.s.	
Korea	-0.087	-3.06	-0.067	-1.82
Chinese Taipei	-0.084	-3.41	(lag)+0.041	(lag)+1.43
	(lag)-0.068	(lag)-2.73		
Thailand	-0.084	-4.91	n.s.	

Source: Jones (1999). Note: [1]n.s. = not statistically significant; [2]Annual average based on lagged quarterly estimates.

The APEC economies shown in Table 7 demonstrate considerable sensitivity to sudden oil price increases, or positive price shocks (statistically non-significant elasticities for negative shocks are not presented). Oil exporters such as Indonesia and Malaysia also reveal this vulnerability. This is because their diversified and sophisticated manufacturing sectors face the same shadow price of oil as all other manufacturers in the world, when oil prices spike (although the revenues coming to the oil extraction sector increase in the short run). Thus, their economy as a whole would feel the contracting effects of the sudden oil price increases, as their manufacturing sector is large enough relative to their oil sector to yield a substantial, net negative impact. The GDP-weighted aggregate of all the APEC economies' elasticities to positive oil price shocks is -0.065, corresponding to a 6.5 per cent GDP loss for an oil price doubling.

WEFA (Wharton Econometric Forecasting Associates) maintains the most extensive time series of economic data on world economies including the APEC economies. Bachman and Ingram (1999) used the WEFA data in estimating the oil price-GDP elasticities of the APEC economies. However, they ran into some serious data problems. For some economies, there were no reliable GDP data series, and even if there were, often they did not go far enough to cover all major oil supply disruptions. For other economies, oil price controls and subsidies effectively shielded their economies from global oil price fluctuations, thereby masking the true relationship between oil price and the macroeconomy.

Nonetheless, based on the past studies, the average oil price-GDP elasticity of –0.065 for the APEC region is considered a reasonable index for assessing the economic losses of oil supply disruptions and as a basis for estimating the economic benefits of emergency oil stocks.

Some experts have argued that measuring the benefits of stocks solely on the basis of oil price moderation seriously underestimates the true benefits of stocks. For example, the existence of sufficient amounts of emergency stocks could effectively deter politically or economically motivated supply interruptions. These stocks would also discourage oil consumers from panic buying during emergencies thereby removing pressures off oil prices, as was the case during 1990-1991 oil crisis. These benefits, though not easily quantifiable, would confer significant economic benefits to all consuming economies. And to the extent that these benefits are not captured in the analysis, the economic benefits in this study could be underestimated.

SIZE ANALYSIS OF APEC EMERGENCY OIL STOCKS

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 (1999) evaluates the net economic benefits of emergency oil stocks in the APEC region. DIS-Risk is a comprehensive and versatile model capable of simulating a real world phenomenon, such as oil supply disruption, and performing a probabilistic cost-benefit and oil stock size analysis involving many variables.

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 (oil price-GDP elasticities); and the level of oil imports and its response to higher oil prices. These variables are critical in assessing the economic losses caused by rapidly increasing oil prices, and the economic benefits of releasing oil stocks during emergencies.

Much uncertainty surrounds these variables. The DIS-Risk model explicitly takes into account the uncertain nature of these variables as well as their complex interactions. In short, 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.

The magnitude of economic benefits of oil stocks would vary according to the scenario about oil supply disruption, the economy, the world oil market, and so forth. Many different scenarios are plausible. For instance, an oil supply interruption of moderate magnitude and duration with sufficient additional oil supplies from spare capacity, and more resilient and flexible economies in response to higher oil prices, would have smaller economic losses, and consequently the economic benefits of stocks would be smaller as well. On the other hand, a more severe scenario with a larger oil supply disruption and longer duration, smaller spare capacity, and more rigidity in the economies, would have larger economic losses and therefore greater economic benefits of stocks (for detailed sensitivity analysis, see Leiby and Bowman, 1999).

As noted earlier, some APEC economies already hold emergency stocks: the U.S. and Japan hold substantial amounts of emergency stocks; and Korea and Chinese Taipei hold some stocks. Other economies including Thailand and China are considering building stocks. The remaining APEC economies do not hold any stocks at present. Given the diverse levels of stockholding among APEC economies, and also recognising the importance of increasing emergency stocks among Asian APEC economies, the economic and size analysis was performed for six different groupings of the economies. They are: All APEC; APEC minus U.S.; China, Japan, Korea, Philippines, Singapore, Chinese Taipei and Thailand (Asian Group I); Asian Group I minus Japan plus Hong Kong, China (Asian Group II); Japan alone; Asian Group I minus China and Japan plus Hong Kong, China (Asian Group III).

Specifically, the study compares the NPV of benefits arising from the release of stocks in oil supply disruptions and the NPV of costs of holding emergency stocks. The benefits include avoided GDP losses and avoided net oil import costs. The avoided GDP losses are derived from the estimated parameters for GDP elasticity with respect to oil price shocks. Net import costs are determined as price times import quantity. By far the largest benefit of the reserve is the avoided GDP losses.

The costs consist of the costs of constructing and operating the storage facility and the net costs of buying and selling the oil itself. The former is derived from the PB-KBB study, about USD 5/bbl for the salt cavern facility of 100 Mbbl in unit capacity. The latter consists of oil purchase price plus transaction costs minus the expected discounted sales price (either in subsequent disruption or in the reserve "salvage" calculation for the end year 2030).

The probabilities for different disruption sizes were drawn from the 1990 United States Department of Energy's Interagency Strategic Petroleum Reserve Size study (U.S. DOE, 1990). The duration of oil supply interruptions was assumed to be random, from 1 to 6 months. A Monte Carlo simulation on thousands of randomised projections of the world oil market through the year 2030 was used to determine the expected benefits of expanding APEC emergency oil stocks. In a disruption, any available offset such as excess production capacity is assumed to be used first, then the APEC reserve, in coordination with the IEA reserve, is assumed to be used to offset the disruption. The emergency stock levels are defined as the sum of government-owned stocks and government-mandated commercial stocks in excess of normal working stocks of about 40 days.

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

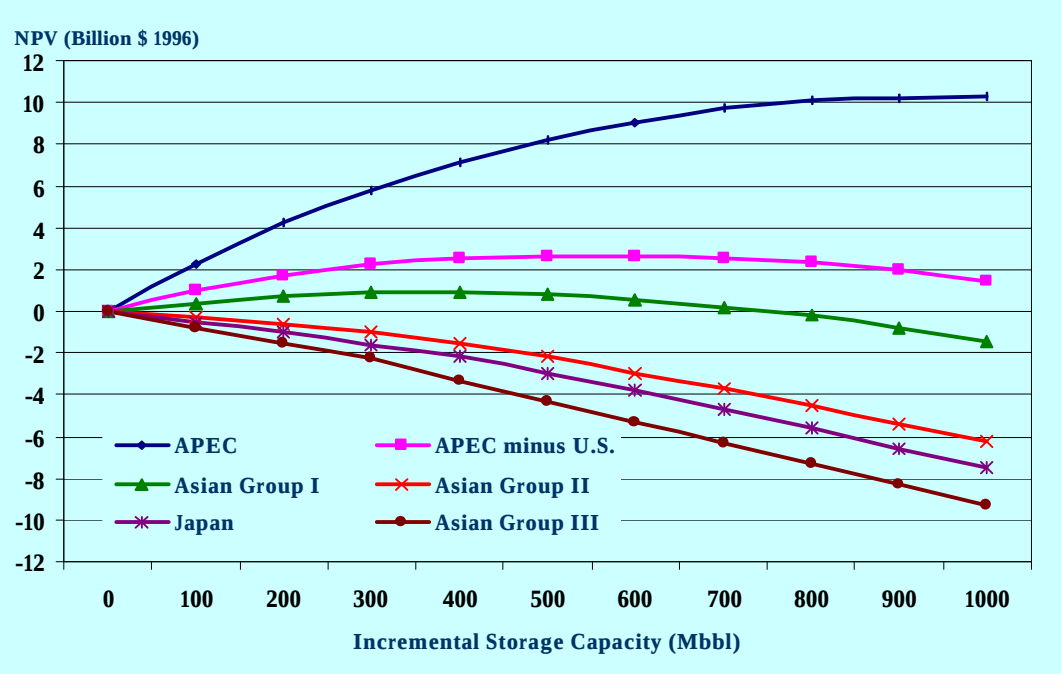
A number of important conclusions can be drawn from these simulation results. First, the larger the economy (or economy grouping), the larger the net economic benefits. Because the net economic benefit calculation is based on the impact of oil stock release on global oil price, and the magnitude of economic benefits are roughly proportional to the size of GDP.

Second, while the economy that does the stockpiling bear its cost, all oil consuming economies share the benefits of stockdraw, namely, lower oil prices, through its effects on the world oil market.

Third, for those economies in Asian Group II and III, it does not pay to go it alone in stockpiling emergency oil. 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.

Fourth, Figure 10 represents the base case scenario simulation. As pointed out earlier, a more severe disruption scenario would show the larger economic benefits of stock release, and consequently, might produce positive net economic benefits for even those three groupings of economies currently showing negative net economic benefits.

Figure 10 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.

JOINT STOCKHOLDING SCHEMES AMONG APEC ECONOMIES

OIL STOCK EXPANSION AND IMPORT COVERAGE

The previous section presented the economic rationale for building and maintaining emergency oil stocks in the APEC region. The results showed that the larger the economy (or group of economies) is, the larger the net economic benefits of stocks. Further, for small Asian economies with high levels of oil consumption and imports, stockpiling emergency oil individually, under most scenarios, would result in negative net economic benefits. In short, the most cost effective way of protecting their economies from oil supply disruptions would be to stockpile emergency oil jointly and coordinate its release during emergencies. This section examines a number of options for joint stockholding among Asian APEC economies.

As discussed earlier, the U.S. and Japan account for the bulk of existing APEC oil reserves. The U.S. recently began refilling its SPR, and it is expected to reach about 600 Mbbl by the end of 2000. In Japan, MITI plans to expand JNOC stocks by 5 Mkl (31.4 Mbbl) following its Advisory Council's recommendation. Korea also plans to expand its stocks to meet IEA's requirements of 90 days of net oil import level in the foreseeable future. While these stock expansions would add substantially to the total APEC stock, they would be short of ensuring oil supply security in the APEC region. As suggested by the earlier economic analysis, coordinated stock expansion with other economies as well as those larger economies' efforts will produce more benefits for the oil supply security of the APEC region.

Table 8 summarises the net benefit maximising stocks for APEC, APEC minus U.S., and Asian Group I, generated by Leiby and Bowman, and the number of days of import these stocks could cover. Based on the oil import levels projected by APERC Outlook's baseline scenario for 2010, for APEC as a whole, the additional stock of 1,000 Mbbl would provide additional 37.3 days of oil import coverage. Likewise, for APEC minus U.S., 600 Mbbl will provide additional 41.7 days of import coverage, and for Asian Group I, 400 Mbbl will provide additional 29.4 days of import coverage. Thus, the economic analysis suggests the expansion of APEC emergency oil stocks to cover roughly 30 to 40 days of additional import coverage for these three groupings of economies.

Table 8 Expected Oil Stock 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, 1998) (Mbd) (B)	26.8	14.4	13.6
Net Imports Days Covered (A/B)	37.3	41.7	29.4

Source: Leiby and Bowman (1999b). Note: Asian Group I: China, Japan, Korea, Philippines, Singapore, Chinese Taipei and Thailand.

For those small Asian APEC economies without any emergency oil stocks, joint stockpiling would be beneficial for a number of reasons. It allows them to share the large capital costs of building storage facilities and take advantage of economies of scale by using a single large storage facility instead of many small facilities. For example, Thailand is projected to have net imports of oil of 44.5 Mtoe in 2010 under the baseline in the APERC Outlook. Assuming even 90 day coverage of net imports (stockholding obligation for IEA countries), the required stock level for Thailand would be only 80 Mbbl. They can also take advantage of picking the most economical storage site, such as salt caverns available only in certain areas within the APEC region. Moreover, their collective decision on stockdraw, in coordination with other stockholding countries, could greatly increase the effectiveness of the stocks on the global oil market thus enhance economic benefits.

On the other hand, the U.S., Japan and Korea have not utilised fully the current existing facility and may not join the joint stockpiling scheme to meet the expected stock increases. Further, China, which currently examines the introduction of oil emergency reserve, is likely to build its own storage site inside its territory for its expected large size and the potential site availability.

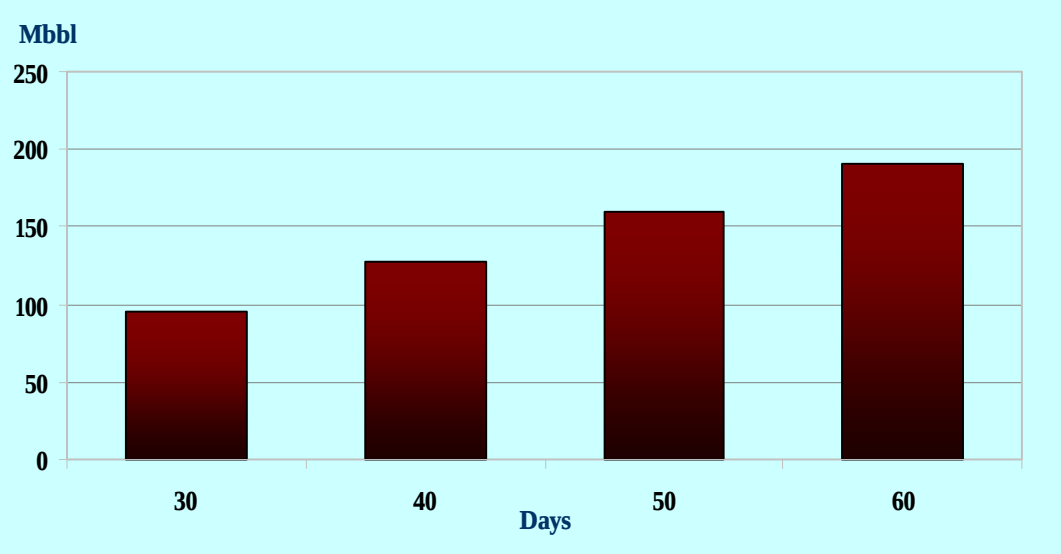
In the following section, a stock-sharing scheme by a group of APEC member economies will be examined.

ILLUSTRATIVE CASES OF OIL STOCK FACILITY SHARING

A preliminary assessment was made of the level of oil stocks required for covering certain number of days of imports, and the capital costs for maintaining these stocks. Specifically, for Hong Kong, China, Philippines, Singapore, Chinese Taipei and Thailand (Asian Group IV), joint stocks covering 30, 40, 50 and 60 days of oil imports in 2010 (Figure 11), and capital costs to be incurred in developing salt cavern storage and above ground facilities, were estimated (Table 9). Considering the level of working or commercial stocks of around 30 days of imports in many APEC importing economies (see chapter 4), this range of jointly held stocks would correspond to the total stock level of 60 to 90 days of imports. It would be worth noting that the initial IEA's

mandatory stock level was set at 60 days of net imports covering both commercial and emergency stocks. This was later revised to 90 days. From the perspective of the IEA experience, evaluating the joint stockholding of 30 to 60 days of net import coverage for these small Asian APEC economies does not seem unreasonable.

Figure 11 Joint Stockholding and Days of Import Coverage



Source: APERC.

Table 9 Emergency Oil Stocks, Import Coverage and Capital Costs
(Asian Group IV)

Days of Net Import	30 Days	40 Days	50 Days	60 Days
Required stock level (Mbbl)	95.7	127.6	159.5	191.4
Salt Cavern				
Storage Capacity (Mbbl/unit x unit)	100 x 1	100 x 2	100 x 2	100 x 2
Capital Cost (Million USD)	551	1102	1102	1102
Above Ground Storage				
Storage Capacity (Mbbl/unit x unit)	0.7 x 137	0.7 x 183	0.7 x 228	0.7 x 274
Capital Cost (Million USD)	2493.4	3330.6	4149.6	4986.8

Source: PB-KBB (1998), APERC.

According to the estimates, these economies would need to stockpile at least 95.7 Mbbl of oil to cover 30 days of oil import, 127.6 Mbbl to cover 40 days, 159.5 Mbbl to cover 50 days, and 191.4 Mbbl to cover 60 days of oil import. At the capital cost of storing oil at USD 5.51/bbl, 30 day import coverage would cost them USD 551 million for a single combined unit capacity of 100 Mbbl, 40 to 60 day import coverage, would cost them USD 1102 million for two units of 100 Mbbl capacity.

A more economic option for stockpiling emergency oil for the Group may be to lease existing excess storage facilities within the APEC region. Currently, not all of the storage facilities in the U.S., Japan and Korea are fully utilised, and some of these excess capacities could be leased for temporarily storing the Group's emergency oil. This would delay spending large construction costs required for building new facilities at least until these Asian economies recover fully from the recent economic setback. Because of industrial restructuring in Asia, Japan is expected to have excess storage capacity in oil storage tanks. As shown in Table 10, currently available storage facility for crude oil and products, owned by refineries and JNOC affiliated stock companies, is equivalent to 160 days of net oil imports in 2010 (APERC Outlook). This capacity far exceeds that needed by Japan to meet the IEA stockholding obligation. The Group IV economies could lease some of this excess capacity for storing their stocks thereby reducing the costs of building stocks.

Table 10 Oil Storage Capacity in Japan

	Tank Capacity
Refinery Owned Capacity (1,000 bbls) (Crude)	370,066
(Products)	277,364
Subtotal	647,430
JNOC Affiliated Capacity (Crude)	251,600
Total	899,030
Net Oil Imports In 2010(Base Case) (1,000 bbls/d)	5,617
Tank Capacity for the days of Net Oil Imports in 2010	160

Sources: Petroleum Association of Japan, Japan National Oil Corp., and APERC (1998).

SUMMARY

This chapter analysed the costs and benefits of building and maintaining emergency oil stocks and efficient stock sizes in the APEC region. For a large economy, the economic benefits of stocks far exceed the costs. For smaller economies, to maximise economic benefits, they should consider joint stockholding and coordinating stockdraw during emergencies. Building of emergency stocks of 30 days of oil imports could be suggested as a first step for those economies which do not hold emergency stocks currently. A less costly stockholding option for the small Asian APEC economies may be to lease spare storage capacity existing within the APEC region including the storage tanks in Japan.

CHAPTER 7

CONCLUSIONS, POLICY IMPLICATIONS AND ISSUES FOR FURTHER STUDIES

CONCLUSIONS

DECLINING OIL SUPPLY SECURITY IN THE APEC REGION

EXPECTED OIL IMPORT GROWTH

APERC's APEC Energy Demand and Supply Outlook indicates that the region's oil demand will grow substantially over the period to 2010, despite the current Asian financial crisis. The expected economic recovery in the APEC region in the early 2000's and continuation of high oil consumption will result in high oil imports in the region, and in particular, in Asia.

INCREASING VULNERABILITY TO OIL SUPPLY DISRUPTIONS

Although oil production inside the APEC region is expected to grow, its pace will lag behind that of oil demand and thus expected increase in oil demand is likely to be met largely by increased imports. The supply from the Gulf area in the Middle East is already accountable for major part of oil supply in Asia and is expected to become a larger share of the region's oil supply in the coming decades. However, this region has had a long history of political instability and conflicts causing oil supply disruption. There are other sources for crude oil supply such as Africa and Central Asia, but these new sources also could be politically unstable and physically remote to rely on. In addition, causes of oil supply disruptions are not limited to political motives and events. The possibility of accidents and other unintended supply disruptions cannot be excluded. Especially, the prolonged oil supply logistics and the increased tanker traffic could raise the risk of accidents and cause unanticipated oil supply disruption.

NEGATIVE ECONOMIC IMPACTS OF OIL SUPPLY DISRUPTIONS

Historically, economic costs resulting from oil supply disruptions were significant in the OECD economies. With the growing oil import dependence of APEC economies, disruptions in oil supply are likely to cause severe economic damages to these economies as well. Such damages would also occur among oil exporting economies, as the oil producing sector typically constitutes only part of the whole economy and oil price increases could adversely affect non-oil sectors. Further, oil consumption could drop sharply which will, in the long run, hurt oil producers.

NEEDS FOR OIL SUPPLY EMERGENCY RESPONSES

The risk of oil supply disruptions could be reduced by lowering demand. Improved energy efficiency and increased supply of other fuels, particularly non-fossil fuels, could help achieve this in the long run. But they are not expected to replace the expected increase in oil demand over the period to 2010, in any case. Further, these measure are not effective in mitigating the adverse economic impacts of oil supply disruptions in the very short run.

OIL STOCKS AS AN EMERGENCY RESPONSE

Among the measures to respond to oil supply disruptions, emergency oil stocks could be the most effective means for minimising the economic costs of interrupted supplies and high oil prices. Surge production within the APEC region could offset some of the lost supply of oil but would be limited in potential. Demand restraint could reduce oil consumption during oil supply disruptions.

But their effectiveness is not often transparent and therefore is limited. They could also lead to misallocation of resources. Fuel switching could also be of limited scope, as its maintenance could be costly.

ECONOMIC BENEFITS OF APEC EMERGENCY OIL STOCKS

Oil supply disruptions will give rise to substantial economic losses to APEC economies, in term of lower GDP and higher oil import costs. Simulation results show that the economic benefits of emergency oil stocks exceed the cost of building and maintaining stocks. It is particularly true for the large economy or groups of economies. For smaller economies, the most cost-effective way of building emergency oil stocks is to hold stocks jointly with other economies and coordinate stockdraw to maximise the economic benefits.

OIL EMERGENCY MEASURES AND MARKET

INTERNALISATION OF OIL SECURITY EXTERNALITY

The risk of oil supply disruptions is intrinsic to oil supply systems, and oil supply disruptions give rise to large external costs including economic losses. The failure to include these costs in oil prices, or internalise these external costs, would bring wrong price signals to the market and lead to the misallocation of resources.

NEEDS FOR NEUTRALITY TO COMPETITION

The modality of stockholding would affect the competition in the oil market. The stockholding form mixing commercial and emergency stocks would mask the true availability of oil during emergencies and would discourage the oil industry's efforts to minimise stockholding costs. To increase transparency, these emergency stocks should be held by separate stockholding entities and their costs be shared fairly by the entire industry.

INTERNATIONAL/ REGIONAL COOPERATION ON EMERGENCY STOCKS

INTERNATIONAL PUBLIC GOODS

While oil stocks and other emergency response measures are intended as the means for protecting individual economies from the adverse consequences of oil supply disruptions, the positive effects, in particular, of stock release will benefit all oil consuming economies whether they hold stocks or not. This kind of free riding will eventually weaken oil security for all oil consuming economies. In addition, spare production capacity in oil producing economies in both APEC and non APEC economies is declining. The level of oil stocks relative to imports in the IEA economies and the share of the IEA economies in the global oil markets are also declining. By increasing APEC stocks and coordinating their use among APEC economies, and with IEA countries, APEC will benefit from substantially enhanced oil security.

LOWER STOCKHOLDING COSTS THROUGH COOPERATION

For small Asian APEC economies, particularly, the oil stockholding costs could be reduced by choosing less costly storage site within the APEC region and by taking advantage of the economy of scale through collective stockholding arrangements. The leasing storage facilities could offer more economical options than building new storage facilities.

POLICY IMPLICATIONS

ENERGY SECURITY REMAINS CRITICAL TO APEC ECONOMIC GROWTH

In the face of Asian APEC economies' recovery from the recent economic setback, and expected growth in energy demand, energy security, in particular oil security, will become increasingly critical to sustaining economic growth in the APEC region. Energy emergency preparedness should be an integral component of energy security policy and planning for APEC economies.

EMERGENCY OIL STOCKS WOULD PROTECT APEC ECONOMIES DURING OIL CRISIS

The costs of being unprepared for oil supply disruptions have been high. Economic damages caused by high oil prices include lower GDP, inflation, and unemployment. The policy of stockpiling emergency oil among IEA countries and releasing the stocks during oil supply interruptions in a coordinated way has proven to be the most effective means of protecting their economies from large economic losses. APEC has benefited from these stocks because of their effects on the world oil market. By expanding emergency oil stocks, APEC economies would strengthen regional and global oil security and benefit from larger economic gains.

DEVELOP POLICY MEASURES FOR REDUCING EXTERNAL COSTS OF OIL SUPPLY DISRUPTIONS

In addition to building stocks, the APEC economies should develop effective policy measures for reducing large external costs associated with oil supply disruptions. The failure to internalise these costs would distort oil prices and misallocate energy and other resources. Subsidies in the oil sector would have the same effects. On the other hand, passing the costs of emergency measures, such as emergency stocks, to oil consumers would lower the level of oil consumption and at the same time help limit the external costs.

SEPARATION OF EMERGENCY AND COMMERCIAL STOCKS

The oil stocks for emergency purpose should be separated from commercial stocks to ensure transparency and neutrality to competition. On this account, stockholding by the government entity or collective entity with cost financed through levies or taxes should be encouraged.

JOINT OIL STOCKHOLDING

This study suggests the benefits of coordinated stockholding such as joint stockholding of oil emergency stocks by the small Asian APEC economies rather than doing so individually. This will allow the use of low cost options such as large scale salt cavern storage. It will also require the development of arrangements to allow stockbuilding beyond their boundaries. A minimum of 30 days of net import levels is suggested as a first step of building an emergency oil stocks for APEC oil importing economies.

TEMPORARY STOCK LEASE FROM INDUSTRIALISED TO DEVELOPING IMPORTING ECONOMIES

The increased oil emergency stocks should be encouraged for oil importing economies, which include those expecting large increase of imports in future. Given the present oil market conditions, they are encouraged to plan to introduce and increase oil stocks gradually over a span of time. At the same time, as an incentive, those APEC economies with currently high oil stocks should offer their stocks to those economies whose stocks are low at present in case of supply

emergency during the transitional. One option is a lease of extra oil emergency stocks in Japan and the U.S. to other oil importing economies.

COOPERATION BETWEEN OIL PRODUCERS AND IMPORTERS

In oil supply disruptions, coordination is needed to ensure the effectiveness of the emergency response measures such as oil stockdraws. Cooperation with other economies and international organisations will be necessary. In particular, the experience gained by the IEA and the EU will be important for APEC economies. At the same time, cooperation with oil producing economies, which have the surge production potential, has to be pursued. Their participation in the construction and operation of oil supply infrastructure, such as pipelines and storage facilities would be welcome.

ISSUES FOR FURTHER STUDIES

The analysis contained in this report is based on the limited information and the studies available to the APERC. The new and additional information and studies would help improve the analysis on oil emergency stocks in the APEC region. Those issues for the future studies would include those listed below.

MORE INFORMATION NECESSARY

In this regard, more information on stock building and holding, including their costs, should be carefully collected for a more accurate evaluation.

MORE INDEPTH ANALYTICAL STUDIES NECESSARY

More comprehensive assessments of the economic impacts (direct and indirect, and short-term and long-term) of oil supply disruptions could provide further insights into the magnitude of economic damage. The assessment of exact economic impacts (such as indirect impacts) of oil supply disruptions could be improved with more insightful studies. The size of 1,000 million barrels of stock additions was suggested by a study as appropriate level for the APEC region for the period to 2030. However, further refinements would be needed to determine the appropriate level of emergency stocks.

BASIS OF EMERGENCY STOCKS: CONSUMPTION OR IMPORTS

Whether oil supply emergency is a function of oil imports or supplies would merit further examinations. While oil consumption based stockholding obligations as in the European Union may be more reasonable than imports based obligations as in the IEA, the role of domestic oil production would have to be carefully assessed.

CRUDE OIL OR PRODUCTS

Products demand and supply imbalances as seen during of the Gulf Crisis of 1990-1991 would suggest the value of stockholding of products. However, the proper mixture of crude and products in oil emergency reserve should be investigated further.

IMPLICATION FOR OTHER ENERGY RESOURCES

The issue of supply security could hold also for other energy resources, such as natural gas, coal and electricity. Considerations could cover whether and to what extent emergency oil stocks

improve the supply security of these energy resources and whether similar arrangements could be contemplated for them.

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GLOSSARY

AMEM	ASEAN Ministers on Energy Meeting
APEC	Asia Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APSA	ASEAN Petroleum Security Agreement
ARCO	Atlantic Richfield Company
ASEAN	Association of Southeast Asian Nations
bbl	Barrel
BRP	Base Reference Price
CERM	Coordinated Emergency Response Measures
DFL	Decree with Force of Law
EPCA	Energy Policy and Conservation Act
EU	European Union
FSU	Former Soviet Union
GDP	Gross Domestic Product
IEA	International Energy Agency
IEP	International Energy Program
IPE	International Petroleum Exchange
JNOC	Japan National Oil Corporation
KNOC	Korea National Oil Corporation
LPG	Liquefied Petroleum Gas
Mbbl	Million barrel
Mbd	Million barrel per day
MITI	Ministry of International Trade and Industry
Mkl	Million Kilo Litres
MOEA	Ministry of Economic Affairs (Chinese Taipei)
MOR	Minimum Operating Requirements
Mtoe	Million Tonnes of Oil Equivalent
NEPO	National Energy Policy Office (Thailand)
NPV	Net Present Value
NYMEX	New York Mercantile Exchange
O&M	Operation and Maintenance
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of the Petroleum Exporting Countries
ORNL	Oak Ridge National Laboratory
PAF	Price Adjustment Factor
PEDCO	Korea Petroleum Development Corporation
PERTAMINA	Indonesian State Oil & Gas Mining Company
R&D	Research and Development
SPR	Strategic Petroleum Reserves
U.S. DOE	United States Department of Energy
UAE	United Arab Emirates
USD	United States Dollar
WEO	World Energy Outlook