THE JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY OF RICE UNIVERSITY

THE POLITICAL, ECONOMIC, SOCIAL, CULTURAL, AND RELIGIOUS TRENDS IN THE MIDDLE EAST AND THE GULF AND THEIR IMPACT ON ENERGY SUPPLY, SECURITY AND PRICING

THE ASIAN OIL IMBALANCE

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I. INTRODUCTION

The central issue of this paper in conjunction with other subjects being investigated on the CIPE endeavor is to analyze the expected role that the Middle East oil producers will play in world energy markets and political affairs over the next few decades. Based in part by the steadily growing importance of the Asian economies in the areas of economic markets, global energy and the balance of world peace this paper attempts to identify the size and determinants of the Asian oil imbalance and to what extent the Middle East will provide supply.

The Asian oil imbalance which today is approximately 10 million barrels per day is expected to double in size over the next 15 years, with an estimated 95% of this shortage being supplied by the Middle East. The growing demand for Middle East oil is of particular importance to the Asian countries later described in this paper as having a 'moderate' or 'severe' exposure to market disruptions as history suggests the Middle East is not the world's most stable region politically. Not all Asian economies will be susceptible to Middle East market power and many are actively introducing national programs to slowdown both their oil intensity and reliance on foreign oil. Naturally some countries are expected to be more successful than others in diversifying their energy portfolios, however, as a region Asia's exposure to oil market disruptions today is 'severe' and will be getting worse over time.

With an objective of identifying the expected role that the Middle East will play in Asia's oil future this paper tries to answer three main questions:

1. What is the size and expected size of the Asian oil imbalance in 1996 and 2010 and what is driving the high rates of growth in Asian oil demand?
2. Which Asian countries have high levels of exposure to oil market disruptions and price spikes today and will this be getting better or worse by 2010?
3. What role does the Middle East producers play or will play as a supplier of crude oil to the Asian market now and by 2010?

To answer these three questions this report is divided into six sections:

1. INTRODUCTION: Paper's central theme and focus outlined
2. ASIA'S ROLE IN THE WORLD ENERGY MARKET: The position of Asia's energy market in a global setting. The importance of oil and gas in Asia and why governments and experts expect the demand growth trend to continue.
3. THE DETERMINANTS OF ASIAN DEMAND: Getting a better understanding of what is driving Asia's increase in energy demand. The differences among Asian nations in end use and fuel mix that are present today and forecast to 2010. This section also illustrates which countries have high exposure to oil market disruptions based on oil intensity and net import/export status.
4. THE AVAILABILITY OF ASIAN OIL AND GAS SUPPLY: Addresses the availability of 'local' supply sources and how they will satisfy the growing energy demand in the region. Argues the position that the net import trend for oil will continue in Asia throughout the forecast period as 'local' sources of supply stabilize despite rapid demand growth.
5. ASIA'S OIL IMBALANCE AND THE NEED FOR IMPORTS: Evaluates different forecasts for the imbalance between Asian supply and Asian demand and the role that imports and specifically the Middle East will play in balancing the Asian oil market. This section will also suggest an expected tightening in the Asian oil market over the next few decades as Asian consumers compete for marginal barrels from older Asian fields while increasing imports from non-Asian sources, particularly the Middle East.
6. CONCLUSIONS AND POLICY PROPOSALS: General highlights of this paper and policy proposals which could be implemented to lessen exposure for certain countries and lower the overall magnitude of the Asian oil imbalance expected by 2010.

II. ASIA'S ROLE IN THE WORLD ENERGY MARKET

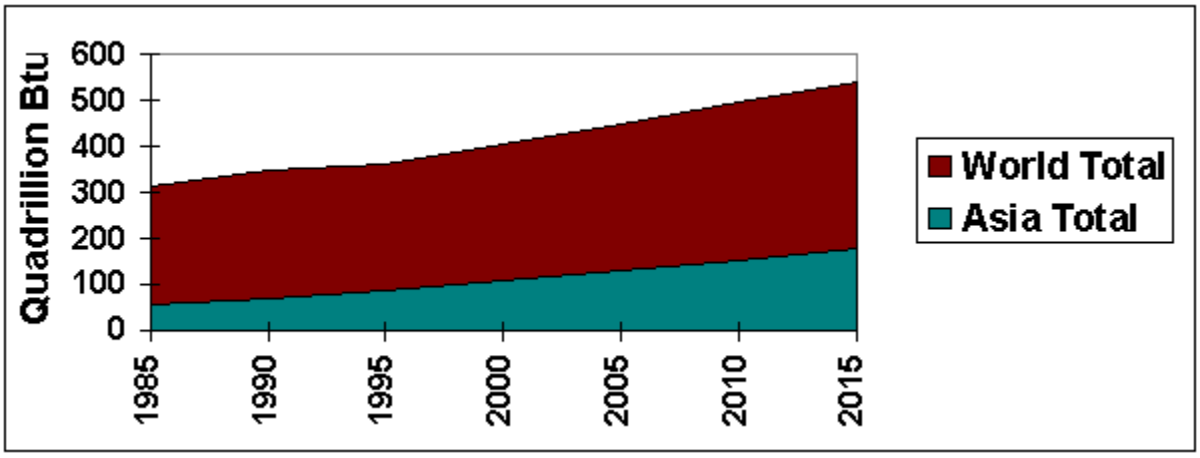
In 1985 total primary energy consumption in Asia was 58.3 quadrillion Btu's (quads), this amount represented 18.4% of the world's total of 315.8 quads. In 1985 Asia was considered by many a secondary energy market with only a few of its countries attracting the attention and investment dollars of upstream and downstream European and Western

Hemisphere energy companies. A decade later, total Asian energy consumption has grown substantially. In 1995 Asia consumed 87.3 quads, which is an increase of 50% over the past decade. By 1995 total Asian energy consumption accounted for 24.0% of the world's total. Asia as an energy consumer is now a larger market than Eastern and Western Europe, South America and is within a few quads to being equal in size to the United States, the world's largest energy market.

The growth in the Asian market is forecast by most experts to continue upwards well past the year 2020. The EIA predicts that by the year 2015, total Asian energy demand will be over 150 quads, representing one third of all energy consumed in the world (see FIGURE 1). Asia has developed into the world's fastest growing and most dynamic market. In many aspects it also represents the world's most complex in terms of culture and government policy when viewed from a westerner's perspective. Asia provides many excellent opportunities for foreign involvement in both the upstream and downstream, while in many instances provides equally sizable challenges.

FIGURE 1

WORLD ENERGY CONSUMPTION



source: EIA ANNUAL ENERGY OUTLOOK

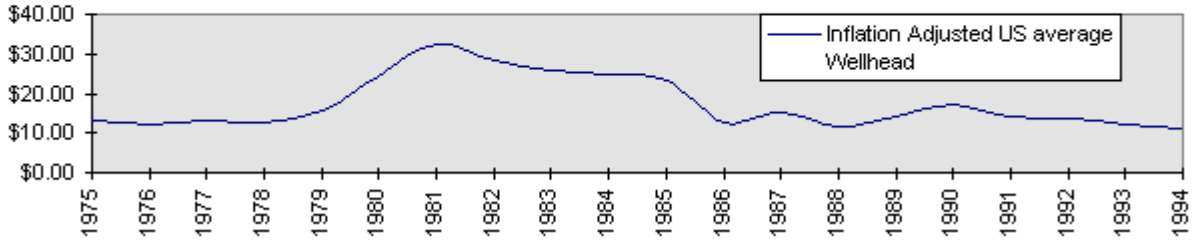
The growth and market potential in Asia has been addressed by many multinational companies from the United States, Japan, and Europe as they actively compete against and in many instances collaborate with the national oil companies of China, Indonesia, Malaysia, Vietnam and others. Most of the world's major energy companies are now actively involved in the Asian upstream oil and gas market. Royal Dutch Shell, Exxon, Mobil, Total and Caltex, are some of the major players working as partners with many of the Asian national oil companies, such as CNPC, Petronas, and Pertamina in exploring for and developing new and existing oil and gas fields. In the downstream, Japanese refining majors such as Idemitsu, Cosmo and JAPEX, multinationals Shell, Exxon and Mobil are also major players in Asia's very competitive downstream segment.

With the help of the international majors as well as financing from other international sources the Asian market will continue to develop. This will provide local supply for the developing and emerging countries and offer attractive investment opportunities for international investors. The availability of financing and technology will continue to be a major determinant on whether the optimistic forecast figures of most experts are realized. To enhance financing and technology transfer, continued political reform and the opening up of markets must continue. Advancements in this area have made great strides in Asia over the past decade and must continue. Both Asian policy makers and executives from international energy companies are optimistic.

To gain a better understanding of the growth in the Asian market it is important to look at what is the driving factors of this increasing demand and why are forecasters so optimistic about its prospect of continuing over the next few decades. Most experts agree that the rapid growth in Asian energy demand over the past 10 years can be attributed to five main factors: 1) relatively low costs of oil and gas, 2) relatively stable supplies of importable energy products, 3) an enormous population base, 4) the opening up of many energy related markets, and 5) sustained high levels of economic growth in both absolute and per capita measures. To thoroughly analyze each of these five factors would be a voluminous task, however a few words to highlight the key points of each would be beneficial.

FIGURE 2 shows the actual versus the inflation adjusted average wellhead price for crude oil in the United States. The graph though representing data from the U.S. would closely correlate with any Asian crude stream or world oil prices in general over the past twenty years. From this table it is clear to see that despite the volatility in prices during the early and mid 1980's, when adjusted for inflation crude prices are actually relatively low and have been reasonably stable over the past decade. On average, world oil prices are close to 50% lower from the 1985-1994 period than from the 1980-1985 period when adjusted for inflation (note this chart uses U.S. WTI prices and U.S. inflation data, however the results would be very similar if an Asian basket of crude or representative crude was chosen and then deflated over time to Asian inflation levels). Gas prices though not correlating perfectly to this pattern also show a similar trend. The reasons for the decade of stable prices are well documented and include technological reasons such as 3D seismic, advancements in offshore production and horizontal drilling technologies. As well as supply side factors which include no major sustained world supply disruptions. During the last decade the world has undergone a sustained period of supply stability with the brief exception of the Gulf War. Despite the war and in many ways because of it and the corresponding temporary price spikes of Fall 1990, the market quickly adjusted with additional oil and has withstood the absence of Iraqi oil for close to 6 years while maintaining relatively low and stable prices.

FIGURE 2
OIL PRICES



source: OGJ Databook 1996

Low crude and gas prices are of particular importance to many Asian economies as most are net importers of energy products (the larger countries in the net import group include Japan, South Korea, Thailand, Taiwan, Philippines, India and recently China). To an energy importing economy, low crude and gas prices represent lower costs for industry feed stocks, transportation and electricity generation. Low energy costs to the importer also will lessen the amount of domestic currency a country must use to fuel its industries and transport its people. Lower world energy costs alone would not explain the economic growth and energy demand growth of many Asian economies over the past decade. However, it would be safe to conclude that none of the energy importing emerging Asian economies would have been as successful over the past decade with $40 oil. Naturally, the Asian net exporters of energy (Indonesia, Malaysia, and Brunei) would have prospered to varying degrees under a higher oil cost scenario. Whether or not the Asian exporters prosper under a high price scenario (as the Middle East producers) or under lower prices is a subject up for debate and further study.

In addition to lower energy costs, increases in Asian energy demand is also attributed to the population size and growth the region has undergone over the past few decades. Over the past 25 years the Asian population has grown by over 1 billion people. The continent is the location of six of the world's most populated countries. In 1995 China and India alone accounted for 2.1 billion of the worlds 5.7 billion inhabitants (37.5% and growing). It is important to note that the size of the Asian population helps explain the size of total energy demand in the region. However, it also should be noted that in most countries (South Korea, China and Japan are best examples) the growth rate in energy demand over the last decade far exceeds the growth rate in population. Many energy experts look at the population of Asia as an indication of potential market size and not as the only determinant of recent market growth. Some national descriptive statistics will help illustrate why most forecasts for Asian energy are so optimistic (see TABLE 1).

TABLE 1

DESCRIPTIVE COUNTRY STATISTICS

Country	Population	Population	world	1994 GNP	Energy	Intensity
	1970	1996	rank	per capita	Consumption	Per Capita
SINGAPORE	2.0	3.4	126	NA	28.2	8.3
JAPAN	104.3	123.4	8	37,000	490.2	4.0
SOUTH KOREA	32.9	45.4	26	7,896	149.0	3.3
TAIWAN	14.6	21.5	46	11,180	66.1	3.1
MALAYSIA	10.9	19.9	48	3,483	35.1	1.8
THAILAND	44.2	58.8	18	2,378	49.2	0.8
CHINA	839.0	1,210.5	1	1,860	833.1	0.7
INDONESIA	122.6	206.6	4	838	69.9	0.3
PAKISTAN	65.7	129.2	7	399	31.6	0.2

INDIA	553.6	952.7	2	312	227.3	0.2
PHILLIPINES	37.5	80.9	13	926	18.8	0.2
BANGLADESH	67.3	123.0	9	206	9.2	0.1
U.S.	205.3	265.5	3	25,810	2,069.4	7.8
Asian Group	1,894.6	2,975.3			2,007.7	0.7
WORLD	3,722.0	5,771.0			8,135.8	1.4
Unit of Measure	millions	millions		1994$	million tons oil equivalent	Tons Oil Equiv. Per Year

source: U.S. Dept. Of Commerce, BP, MITI

The table ranks 12 major Asian economies by energy intensity. Energy Intensity is measured as tons of barrel of oil equivalent consumed per capita for primary energy consumption in 1995. The world and U.S. averages are also listed to help put the numbers in a global perspective.

It is clear from TABLE 1 that despite the size and growth of energy development in many of the Asian economies over the past decade, the energy intensity of most of the major Asian economies (particularly China, India, and Indonesia) are still considerably low and are close to other developing nations around the world. Only the countries of Singapore, Japan, Taiwan and South Korea have an energy intensity suggestive of a fully developed country. It is important to note that the energy intensity average should be evaluated carefully. Highly developed countries such as Japan have policy goals to lower this

average in hopes of greater energy conservation. As a measure of energy complexity it is beneficial to evaluate the intensity averages in certain ranges such as <1, 1-2.9, >3.0 to obtain a general feeling for the energy complexity of a given region relative to similarly developed economies from the same region. It is informative to note that the Asian average of 0.7 TOE per capita per annum is only half of the world's average. This low average in conjunction with the population statistics would suggest large market potential. Three of the world's most populated nations (China, India, and Indonesia 0.7, 0.3 and 0.2 respectively) have intensities far below the world average of 1.4. Despite the substantial growth in energy intensity for all of Asia over the past decade, the market has considerable room to grow. This growth is expected to occur consistently over the next few decades.

The opening up to western interests (capital and technology) of many Asian energy industries has also help facilitate the sustained growth in Asian energy demand over the past decade. The lowering of trade barriers, the policy reforms to allow foreign investment and the adoption of open and more competitive markets has benefited many of the Asian economies in regards to improvements in their domestic economies. Though changes are happening in many industries many of the noteworthy advancements have occurred locally in their domestic energy production and infrastructure. Twenty years ago few would have thought that U.S. majors would be permitted to finance utility project's in India, participate in offshore drilling prospects in China or actively explore for hydrocarbons in Vietnam. The opening of the world's markets allows for a less restricted flow of ideas and technology, and in many instances a much needed supply of financing. The end result is energy markets operating at closer to competitive outcomes with domestic consumers and international investors reaping the rewards.

Though each of the four reasons listed above (cheap oil, no supply shocks, large population growth in low energy intense nations, and the opening of markets) have all contributed to increased demand for oil and gas in the Asian region, most would agree that the increased demand over the past decade has been primarily driven by a decade of substantial economic growth. This growth has averaged between 6-8% for many Asian economies over the past 10 years. Though it is very difficult to estimate a sensitivity or

elasticity of energy demand to economic growth for any one country over a long period of time, and the task is close to impossible to generalize for an entire continent with dozens of diverse nations in different stages of economic development, the statistics and data for Asia over the past decade strongly suggest a strong significant and positive relationship between the recent economic growth and energy demand growth of the past decade. The economic growth has been particularly high in South Korea, Thailand, Taiwan, and China.

Most would agree that the combination of all the factors discussed above played a pivotal role in the development of Asia into the world's most dynamic energy market. The continuation of all five will soon propel Asia into the world's largest energy and economic market.

To what extent each factor contributed over the past decade may not be clear. In many regards what drives demand in one Asian economy may have only a marginal effect in another. What is not in doubt is that the preliminary pieces are already in place for sustained economic and energy consumption growth well into the next two decades throughout most of Asia. Prices for crude and gas continue to be reasonable and are forecast by most sources to remain stable. Foreign investment continues to be available to help finance many of the larger industrial and energy based projects now being proposed in Asia. Barriers to market entry and anti competitive practices continue to be abolished in many Asian countries in hopes of giving consumers choices and low cost products. The population of the Asian continent continues to make it the world's largest center of economic activity and soon energy consumption as well. Asian governments and private companies continue to invest in the needed energy based infrastructure which is necessary for prolonged growth. To help attract capital to finance all of this growth in energy demand is the fact that most of Asia is expected to grow economically at a rate much faster than the world average or other developing areas such as Africa or South America. Because of this dynamic many Asian energy projects offer higher rates of return than alternative projects in other developing regions of the world and as a result the inflow of worldwide capital is expected to continue.

It is not in doubt that Asia's percentage of world energy demand will continue to grow and that soon after the turn of the century Asia will be the world's largest energy market. What is not as clear is how the supply and demand for oil and gas will be kept in balance and to what extent each country will be exposed to supply disruptions and price spikes. To analyze that we will first have to look at the components of Asian energy demand and Asian energy supply and how the market for oil and gas is being balanced today and how it is expected to be balanced by the year 2010.

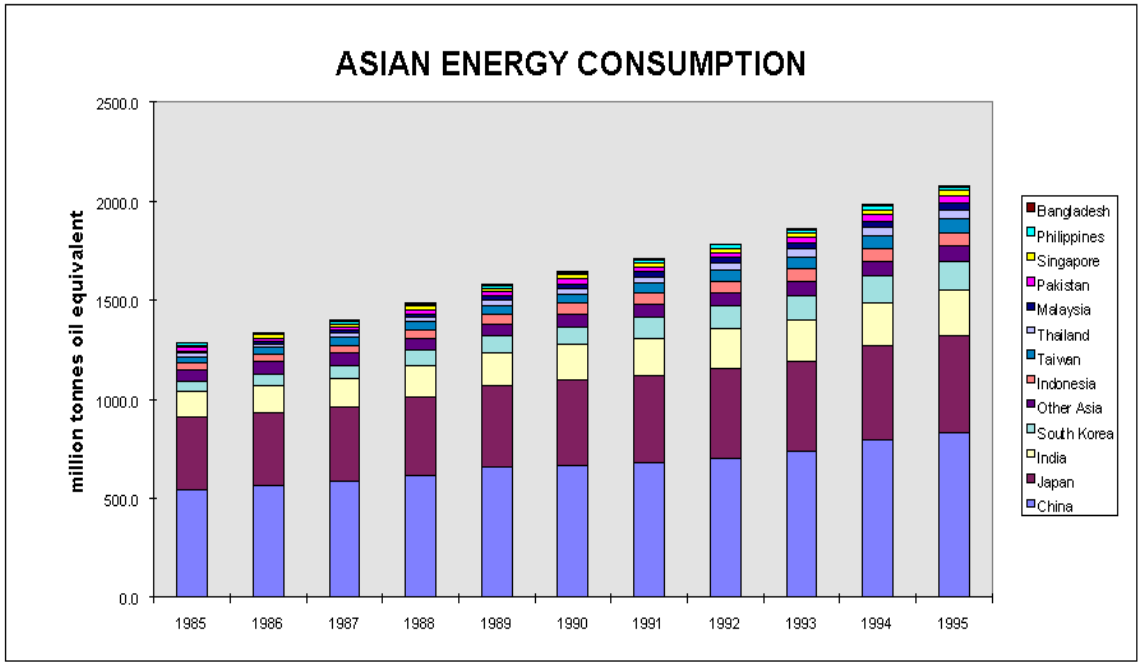
III. THE DETERMINANTS OF ASIAN DEMAND

While the world's total energy consumption has grown at rates between 0-3% over the past decade, Asian energy consumption has increased between 4-6% over the same period. The Asian market does remain dominated by the major consumers but is becoming less concentrated as the emerging "Tiger" economies continue to expand. In 1985 China and Japan accounted for over 70% of all total primary energy consumed in Asia (see FIGURE 3). By 1995 this number has decreased to 64% as Japan's energy growth has stabilized from its rapid growth periods of the 1970's and 1980's. Including India and South Korea, which are the third and fourth largest consumers of primary energy in the Asian market the concentration percentages of 1985 are slowly declining by 1995. In 1985 the top four consumers accounted for 84.7% of all energy consumed, by 1995 this number falls slightly to 81.6%. Though Asian energy demand has become less concentrated over the past decade this is not because the top consumers are consuming less energy, rather the smaller energy consumers are growing at remarkable rates. From 1985 to 1995 energy demand in the four largest Asian markets is up: China 53%, Japan 35%, India 77%, and South Korea 183%.

FIGURE 3

NATIONAL ENERGY CONSUMPTION

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
China	546.2	566.0	586.9	617.1	658.0	668.0	677.0	703.7	738.2	795.0	833.1
Japan	362.7	364.6	372.5	393.8	408.1	428.3	443.2	450.8	455.7	478.2	490.2
India	128.8	138.6	146.9	160.5	171.2	179.6	190.4	200.6	205.5	214.8	227.3
South Korea	52.7	59.4	66.1	74.2	80.7	91.1	102.9	115.5	126.4	136.8	149.0
Other Asia	57.1	60.1	61.5	62.3	63.3	64.5	65.4	68.4	70.9	71.0	73.6
Indonesia	35.4	37.5	39.7	40.6	47.6	53.1	56.3	59.7	63.5	65.7	69.9
Taiwan	33.3	36.5	39.9	44.1	46.5	48.9	52.2	55.2	58.6	62.3	66.1
Thailand	15.7	16.1	19.1	21.7	25.1	28.8	32.6	35.5	40.1	44.8	49.2
Malaysia	12.4	13.4	15.1	16.4	19.2	21.5	23.6	25.2	28.9	31.3	35.1
Pakistan	17.5	18.8	20.4	21.6	23.3	24.8	25.8	27.4	29.2	30.8	31.6
Singapore	11.8	13.9	14.2	16.5	18.9	19.5	19.9	22.0	23.7	27.4	28.2
Philippines	9.1	9.3	10.6	11.6	12.6	13.0	12.8	15.2	15.8	16.7	18.8
Bangladesh	4.4	4.8	5.3	5.8	6.4	6.8	6.5	7.2	7.7	8.5	9.2
TOTAL WORLD	6949.1	7117.0	7353.7	7614.5	7776.3	7855.2	7861.5	7876.6	7896.6	7990.4	8135.8
Total Asia	1287.1	1339.0	1398.2	1486.2	1580.9	1647.9	1708.6	1786.4	1864.2	1983.3	2081.3
Asian % of World	18.52%	18.81%	19.01%	19.52%	20.33%	20.98%	21.73%	22.68%	23.61%	24.82%	25.58%



SOURCE: BP Yearly Statistics

In addition to the increases in energy demand for the top four consumers, the smaller Asian economies have experienced even larger increases in demand for primary energy over the past decade. A few key examples include: Indonesia up 97%, Taiwan up 98%, Thailand up 213%, and Malaysia up 183% . It is not surprising that in the countries

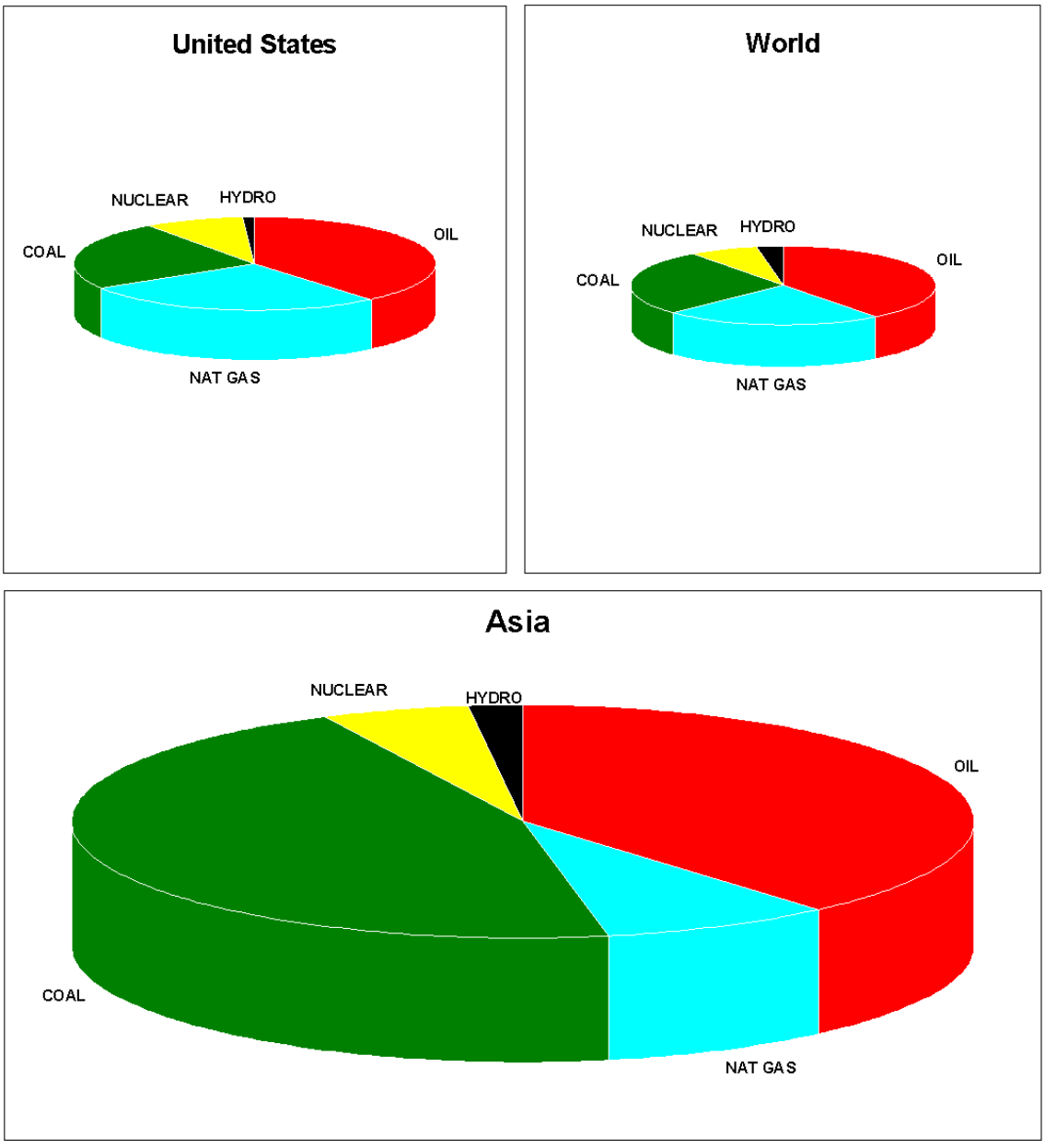
experiencing large volumes of increased energy demand, equal and even larger increases of economic growth have also been reported over the same 10 year period.

Even the countries of Pakistan, Singapore, Bangladesh, and Philippines which have been overshadowed by the other faster growing Asian energy consumers, have all reported increases in energy demand which have outpaced the world average considerably over the past decade. In terms of Millions of Tons of oil equivalent the world increased energy demand by only 17% from 1985-1995. Some would consider this rate of growth a satisfactory level as a result of the implementation of conservation programs and environmental awareness. However, as an indication of economic activity and prosperity in developing nations, the majority of Asian countries over the past ten years easily outperformed in terms of growth in energy intensity countries of similar development in Eastern Europe, Africa or Latin America.

Of the developed Asian nations, the countries whose increase in energy demand appears the most remarkable is South Korea. South Korea a nation of 45 million people and an average 1994 GNP per capita of $7,896 was one of the fastest growing consumers of energy in the region (behind only Thailand and Malaysia). South Korea's growth between 1985-1995 is surprising because of the relatively large base load it was starting from in 1985 as well as the continued political struggle it encounters with North Korea. In 1985 South Korea was already a highly developed nation with high levels of energy complexity and intensity. South Korea's energy growth has been attributed to many factors including: sound government policies, double digit economic growth, active foreign investment and the world wide exposure and infrastructure improvements obtained from hosting the Olympics.

FIGURE 4

ENERGY CONSUMPTION BY SOURCE



source: BP YEARLY STATISTICS

Though the international statistics are informative, they usually express energy consumption in a basic unit of measure such as Btu's or tons of oil equivalent. To obtain a better understanding of how exposed a country is to a supply disruption or sudden price shock, it is helpful to look at the consumption by source or what is referred to as fuel mix (see FIGURE 4).

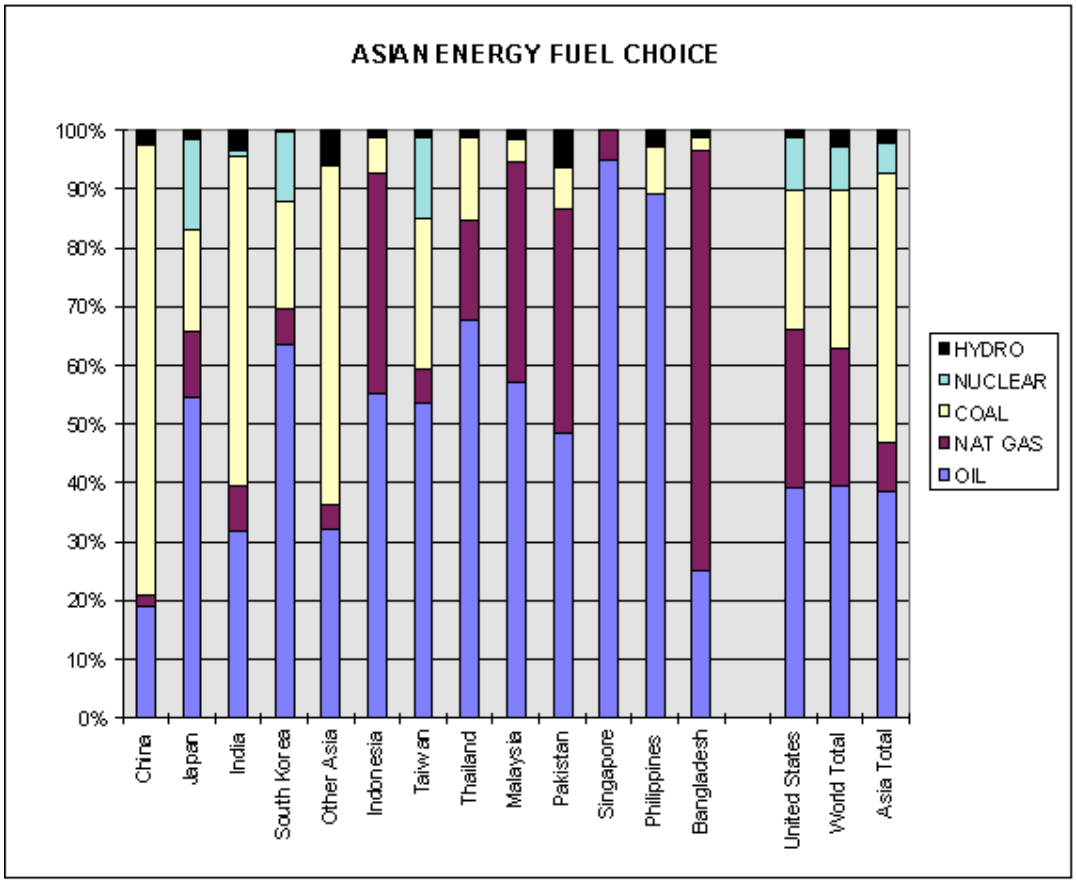
Comparing the consumption by source breakdown for Asia, the United States and the world we see the fuel mix is quite different. From a supply stability perspective, the United States and world averages suggest a moderately diverse fuel mix of the major sources of primary energy. Both the United States and world average rely on close to 40% on oil for meeting its fuel needs. Natural gas and coal in the United States comprise approximately 27% and 23% of energy consumption respectively. The remaining 11% in the U.S. is made up of nuclear and hydroelectric sources. The world average is equally diverse relying on 40% oil, 23% gas, 27% coal and the remaining 10% nuclear and hydroelectric.

The Asian energy fuel mix is not as diverse as either the world or United States average. Asian consumption of oil averages 38%, and coal a very large 46%. Natural gas plays only a minor role in Asia at 8% and the remaining 7% being shared between nuclear and hydroelectric sources. As 85% of all Asian consumption is either coal or crude oil it is not surprising that Asia is the world leader in carbon emissions with China and India topping the list.

A closer look at the fuel mix by source when broken down by individual country reveals some very interesting points (see FIGURE 5).

FIGURE 5: **ENERGY CONSUMPTION BY SOURCE** (MILLIONS OF TONNES OF OIL EQUIVALENT)

	OIL	NAT GAS	COAL	NUCLEAR	HYDRO	Total
China	157.5	15.8	640.3	3.3	16.2	833.1
Japan	267.3	55.0	85.9	74.3	7.7	490.2
India	72.5	17.0	128.3	2.0	7.5	227.3
South Korea	94.8	9.2	27.3	17.3	0.5	149.0
Other Asia	23.6	3.0	42.6	0.0	4.5	73.6
Indonesia	38.6	26.3	4.2	0.0	0.8	69.9
Taiwan	35.4	3.9	17.0	9.1	0.8	66.1
Thailand	33.3	8.3	7.0	0.0	0.6	49.2
Malaysia	20.1	13.1	1.4	0.0	0.5	35.1
Pakistan	15.3	12.1	2.2	0.1	1.9	31.6
Singapore	26.9	1.4	0.0	0.0	0.0	28.2
Philippines	16.8	0.0	1.5	0.0	0.5	18.8
Bangladesh	2.3	6.6	0.2	0.0	0.1	9.2
United States	806.8	559.5	494.4	182.9	25.8	2069.4
World Total	3226.9	1883.6	2210.7	596.4	218.5	8135.8
Asia Total	804.4	171.7	957.9	106.1	41.6	2081.3



source: BP Yearly Statistics

On average Asia consumes 46% of its energy in the form of coal. However this average is being skewed by the presence of China and India in the statistics. China consumes 77% of its energy in the form of coal, India 56%. Together the two countries account for over 80% of all Asian coal consumption in 1995. With the noted exception of China and India coal is actually not a very popular fuel source for Asian energy consumers. Only Taiwan at 25% consumes more coal on a percentage basis than the U.S. and even they are below the world average.

The average statistics would also lead us to believe that few Asian countries are consumers of natural gas. When looking at the country by country statistics we can clearly see that Indonesia, Malaysia, and Pakistan all consume close to 40% of their energy consumption in the form of natural gas. Even more striking is the country of Bangladesh which consumes close to 72% of its primary energy in the form of natural gas. Once again the region's statistics are being skewed by the presence of China and India which rely on gas for only 2% and 7% of their fuel mix respectively.

The country statistics also indicate that nuclear energy is prominent in some Asian countries. For Japan, South Korea, and Taiwan, in 1995 nuclear sources accounted for 15%, 12% and 14% of these country's fuel mixes respectively and these numbers are expected to increase over the forecast period. The country by country statistics also illustrate that hydroelectric power is a fuel source playing only a small role in the Asian fuel mix accounting for between 2 and 3% of energy consumption in China, India and Pakistan, and even less in the other major Asian economies.

As this analysis is concerned with identifying which countries are exposed to disruptions in the oil market the country by country statistics provide a much different picture than the Asian average. It was previously mentioned that Asia as a whole consumed oil for 39% of its energy needs. This is very close to both world and United States averages and would suggest a moderate exposure to supply disruptions. By moderate we are implying levels close to the world average of exposure (these points do not take into account, emergency stockpiles, inventory management, or any other emergency program a country may have adopted to lessen oil shock exposure). When looking at the individual country

breakdown the level of exposure varies considerably across Asian nations. Looking only at the Asian net oil importers for both 1995, and forecast to 2010, estimated exposure positions can be assigned to each importing nation. If we were to assume an oil dependency (measured in terms of fuel mix, not import volumes) of less than 20% as a minor intensity, 21%-40% as moderate intensity (similar to world averages), and 40%+ as severe intensity, the statistics reveal interesting conclusion. The fuel mix intensity gives us an indication or likelihood of whether or not supply exposure is an issue for a particular country. This intensity then should be considered along with each individual country's levels of domestic crude production and import status which would then provide an indication of how serious an experienced supply disruption would be to a particular country. Together the two variables (oil intensity and oil import/production status) provides a fair assessment of possible sensitivity to a world oil shock.

Only China with a dependence on oil of 19% and relatively low levels of imports satisfies the criteria of minor exposure in 1995. India, and Pakistan are two nations described as having moderate exposure under this definition. This leaves seven of the twelve largest Asian economies falling under the description of serious exposure in 1995 (described as oil intensity of over 40% and intense net import status).

It is important to note that two of the twelve largest Asian economies are Indonesia and Malaysia who are net oil exporters . To these two countries a supply disruption is potentially a preferred scenario as revenues may increase under a high oil price market (this would have to be viewed with the social costs of higher energy costs).

Six of the eight countries (Japan, South Korea, Taiwan, Thailand, Singapore and the Philippines) not only fit the definition of serious exposure by relying on crude oil in excess of 50% for their energy needs but they are also major oil importers. They have a combined crude oil production of only 70,000 b/d compared to consumption of 9.5 million b/d. These six countries in 1995 relied on oil for approximately 60% of their energy needs and then proceeded to import 99.2% of all the oil they consumed. This by any reasonable definition would be considered serious exposure.

Many policy planners and energy officials of the Asian consuming nations have addressed the high level of exposure and reliance on imported energy into their country's economic plans and formal energy policy. Many of the Asian emerging economies are trying to balance the objectives of sound energy policy and environmental considerations while attempting to sustain prolonged economic growth. Though these objectives often contradict one another, they are issues which are being debated in political forums every day in the developed and emerging Asian economies. Just as important to some is a sound energy security policy which provides both a diverse fuel source and a diverse fuel supply. For many of the Asian economies who import a majority of their energy supply, a diverse mix of oil, gas and coal from multiple sources would be a preferable alternative to a single source single supplier model. In addition to multiple importers, whenever possible countries should always attempt to make advancements in domestic based energy production and alternative sources of supply such as nuclear, hydroelectric, solar and others, in hopes of broadening their fuel mix and supply source.

Evaluating forecasts for the eight major Asian economies for 2000 and 2010, most of the nations have adopted, policies to address the high level of exposure and reliance on oil that is apparent in the 1995 statistics. In many instances based in part by the size and nature of the energy industries themselves, changes in fuel mix and supply patterns occur only gradually in well developed, energy intense economies. However, for Asia a 15 year forecast does show significant variation in fuel mix and end use. This trend is most evident in the smaller and emerging Asian economies (see FIGURE 6A, 6B and FIGURE 7A, 7B).

FIGURE 6A: Sources of Total Primary Energy Supply

percentages of total

SOURCES OF TOTAL PRIMARY ENERGY SUPPLY
PERCENTAGES OF TOTAL

	1995				2000				2010			
	OIL	GAS	COAL	OTHER	OIL	GAS	COAL	OTHER	OIL	GAS	COAL	OTHER
China	18.9	1.9	76.8	2.4	19.6	2.2	75.9	2.2	20.3	3.2	72.1	4.4
Japan	54.5	11.2	17.5	16.8	52.9	12.9	16.4	17.8	47.7	12.8	15.4	24.1
India	31.9	7.5	56.4	4.2	30.8	8.0	56.3	4.9	30.5	8.6	58.2	2.7
South Korea	63.6	6.2	18.3	11.9	55.7	7.9	22.7	13.7	48.0	10.9	23.1	18.0
Indonesia	55.2	37.6	6.0	1.2	57.5	22.3	12.4	7.8	50.3	18.3	20.8	10.7
Taiwan	53.5	5.9	25.7	14.9	48.8	9.7	26.3	15.1	44.4	17.6	21.9	16.1
Thailand	67.6	16.8	14.2	1.4	62.4	21.7	14.8	1.1	53.7	23.2	19.5	3.6
Malaysia	57.2	37.3	4.0	1.5	42.4	52.5	3.7	1.4	33.6	56.5	8.4	1.5

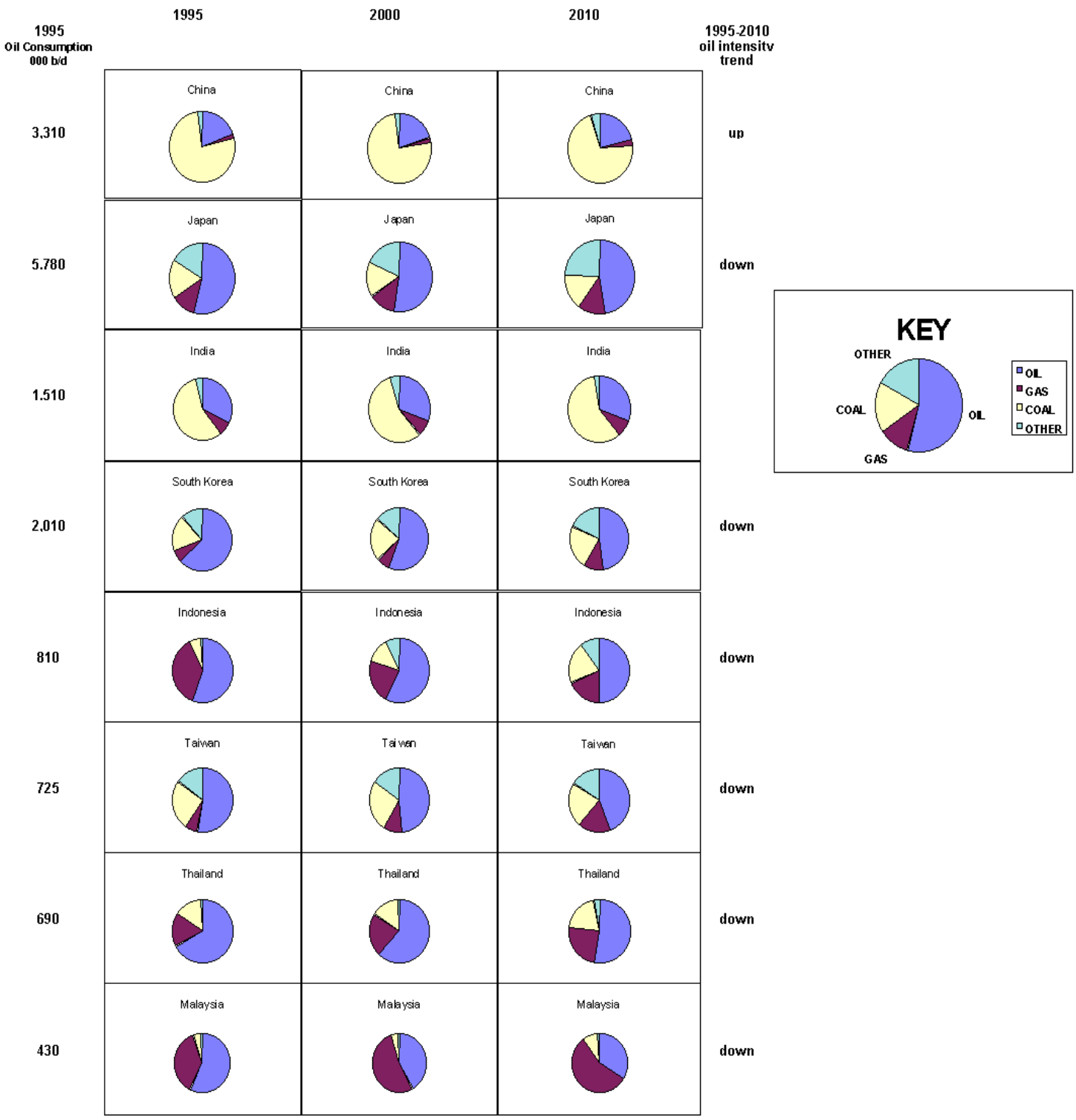
FIGURE 7A: TOTAL FINAL ENERGY CONSUMPTION

percentages of total

TOTAL FINAL ENERGY CONSUMPTION
PERCENTAGES OF TOTAL

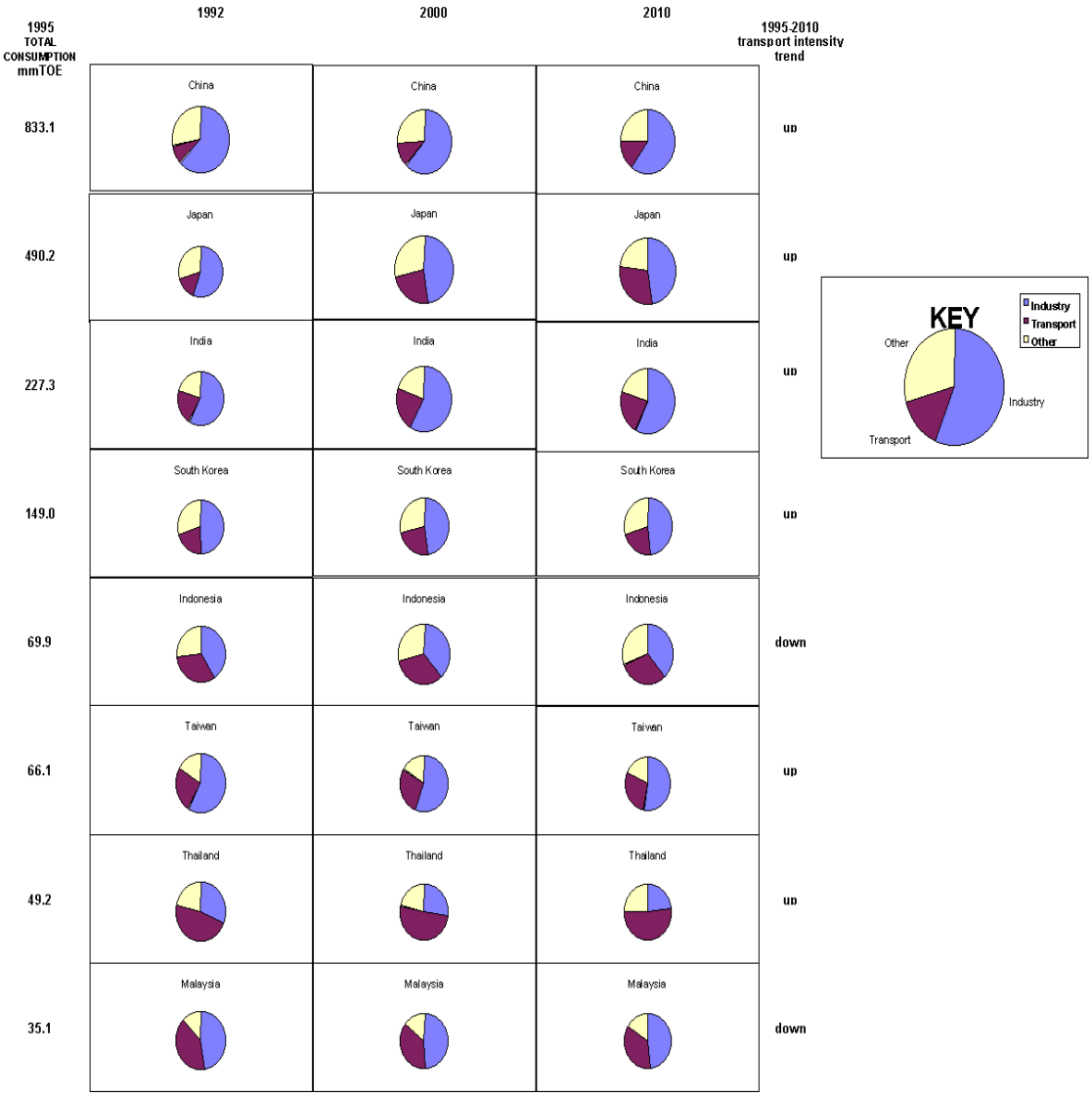
	1992				2000				2010			
	Industry	Transport	Other	Total	Industry	Transport	Other	Total	Industry	Transport	Other	Total
China	63.2	8.9	27.4	100.0	62.2	12.4	25.4	100.0	60.3	15.3	24.2	100.0
Japan	50.0	13.1	25.8	100.0	48.2	23.7	28.1	100.0	47.3	30.3	22.5	100.0
India	59.2	20.9	19.9	100.0	58.7	21.5	19.8	100.0	57.5	22.1	20.4	100.0
South Korea	50.1	20.5	29.4	100.0	48.0	23.5	28.5	100.0	48.4	22.1	29.5	100.0
Indonesia	40.7	33.1	26.2	100.0	38.9	32.7	28.4	100.0	38.5	30.6	30.9	100.0
Taiwan	58.8	24.6	16.6	100.0	56.3	27.2	16.5	100.0	53.4	28.2	18.4	100.0
Thailand	30.7	48.2	21.1	100.0	27.1	51.5	21.5	100.0	22.7	52.8	24.5	100.0
Malaysia	48.0	39.1	12.8	100.0	49.4	36.2	14.4	100.0	48.3	35.6	16.1	100.0

FIGURE 6B: SOURCES OF TOTAL PRIMARY ENERGY



source: BP, MITI, IEA, EIA, author's projections

FIGURE 7B: FINAL ENERGY CONSUMPTION



source: BP, MITI, EIA, IEA, East West Center, author's projections

It will now be beneficial to highlight some of the major points regarding fuel mix and end use forecast for Asia up to 2010.

The forecasts reveal that China, the only Asian oil importer which is identified as having a minor exposure position for 1995, will increase its percentage of oil intensity slightly over the forecast period. China already consumes 3.3 million b/d, and will slowly increase the percentage of oil in its fuel mix from 18.9% in 1995 to 20.3% in 2010. This will still represent the lowest level of oil intensity for the major Asian economies. Gas consumption will remain relatively stable over the forecast period contributing only marginal amounts to total energy consumption. Coal demand is forecast to decline in percentage terms but increases in absolute volumes over the next 15 years. China will remain as Asia's top coal consumer and top carbon emitter. The percentage decline in coal and increase in crude is attributed to the decline in percentage terms for industrial uses of energy and increasing percentage attributed to transportation and motor fuels. China also has the lowest percentage of fuel use for transportation in Asia. Even by the year 2010 transportation will only account for 15% of fuel consumption in China. China a minor net importer of crude oil in 1995 is forecast to be a larger importer of crude by 2010 as domestic demand is expected to be close to 6.5 million b/d. With oil intensity and imports increasing China's crude oil exposure in 2010 will be moderate.

Japan already possess the regions most diverse energy mix. Consuming large amounts of gas and coal in addition to 54.5% of total energy consumption met with crude oil. Over the forecast period Japan is expected to lessen its percentage of oil to less than 50% by 2010, while maintaining levels of gas and coal intensity. The Japanese plan is to increase consumption of domestic based energy sources such as: nuclear, hydroelectric, geothermal, solar and renewables. Japan would be able to reduce its oil dependence further were it not for the expected increase in demand for transportation fuels. Continued conservation in the residential and industrial sectors will continue to lessen waste. Despite these initiatives, Japan which imports all of its oil will remain exposed to supply disruptions. In 1995 Japan imported all of its 5.7 million b/d of crude oil. Crude oil exposure in 2010 will continue to be severe.

India will be home for over 1 billion people by 2010. In terms of fuel choice, supply options and consumption patterns India will probably remain the most constant nation in Asia. Its size prohibits individual energy projects from having major effects on national

consumption patterns and averages. To make matters more complex its government makes foreign companies with investment capital somewhat skeptical, despite recent high levels of E&P from multinationals. Coal will remain the fuel of choice, providing much of the country's needs for electricity. Gas and other sources are forecast to play only minor roles in India's consumption mix by 2010. Stability in end use will also be the trend in India over the next 15 years as only minor percentage shifts are forecast while consumption volumes are expected to increase. Demand for transportation fuels will continue to increase slightly with this sector accounting for 30% of all energy consumption. India presently consumes 1.5 million b/d of crude oil and is a net importer for over 50% of its crude supply. Offshore India is one of Asia's most highly explored for regions so import intensity for crude by 2010 remains a question. India's crude oil exposure in 1995 is moderate and will remain so by 2010 with the small possibility of declining if large scale oil reserves and production are logged within the next decade.

South Korea, in many ways is Asia's most dynamic high growth economy despite continued political problems with the North. Under South Korea's five year economic plan and "Green Vision" directive the country is instituting a major program of fuel switching. In 1995 South Korea consumed 63.6% of its energy in the form of oil. South Korea has no domestic oil reserves. Crude oil imports and consumption for 1995 were over 2.0 million barrels per day. South Korea's exposure to oil disruptions in 1996 was severe. South Korea in an attempt to lessen this exposure and need for oil has attempted to shift to a heavier dependency on coal and import Asian LNG for its industrial and electrification needs. Though transportation fuel demand is expected to grow in both percentages of fuel use and absolute fuel consumption, South Korea is expected to lessen its oil intensity by 2010. Even under the most optimistic forecasts, South Korea will still rely on oil for close to half of its energy supply, and though lessening their exposure marginally, South Korea will remain with severe crude oil exposure.

Indonesia, is one of the few countries in Asia which can have an oil intensity of over 50% and still remain as a minimally exposed country. This is because Indonesia is one of only two major Asian net oil exporters. In 1996 the country has domestic consumption of 810,000 b/d and domestic production (OPEC quota limited) of 1.3 million b/d. However,

due in part by decreasing field production, replacement less than previous decades and most notably increasing domestic demand, Indonesia is expected to be a net oil importer (by small amounts) by the year 2005. As a result of declining domestic availability and the prospect of importing from foreign sources Indonesia is forecast to diversify its fuel mix considerably over the forecast period. By 2010 crude oil demand is expected to contribute 50% of total energy demand with coal advancing as the percentage for natural gas is forecast to decline. Though having considerable reserves of natural gas Indonesia is planning on supplementing its declining revenue from export oil with increased revenues from the natural gas trade (mostly LNG to Japan, South Korea, and Taiwan). Indonesia is currently spending billions of dollars to upgrade its gas production capabilities. Indonesia's fuel use portfolio is expected to remain virtually unchanged over the next 15 years with transportation accounting for 30% of total fuel use by 2010. By 2010 Indonesia's exposure to oil disruptions will continue to be minimal as crude oil imports will comprise a very small percentage of the country's energy portfolio.

Taiwan is a country whose fuel consumption patterns over the past few years closely resembles that of Japan but on a much smaller scale. In 1995 Taiwan imported all 725,000 b/d of the crude oil it consumed. Crude was the fuel of choice in Taiwan as it is the source of 54% of all energy consumed in Taiwan. Over the forecast period Taiwan is expected to increase its import of natural gas (from Malaysia, Indonesia, and Brunei) in an attempt to diversify its fuel mix and lessen its need for imported oil. Taiwan will increase production of hydroelectric and nuclear sources in an attempt to diversify its fuel mix. Taiwan is one country that is expected to change its fuel mix considerably by 2010 by decreasing the percentage of oil intensity from 54% to 44%. Despite this substantial change over the forecast period, Taiwan will still import 100% of its oil, which will account for 44% of its energy. As a result Taiwan's exposure to oil market disruptions will be severe up through the forecast period.

Thailand is another of Asia's rapidly growing economies which benefited considerably over the past decade from low oil and gas prices. As a nation Thailand relies on crude oil for 68% of its energy (the highest percentage in Asia) and has to import 99% of its crude oil. Thailand's need for imported oil is close to 700 thousand b/d and is growing steadily.

The remaining fuel supply for Thailand is split almost evenly between coal and natural gas. Other sources of energy contribute less than 2% to the country's fuel mix. The high reliance on oil is easy to understand when the fuel use trend is looked at. Thailand consumes almost half of its primary energy in the form of transportation and motor fuels. This is the highest percentage in Asia. Over the forecast period the percentage for transportation is expected to increase slightly with industry accounting for only 23% of total energy consumption by 2010. The low levels of industrial energy consumption is the lowest for all of Asia's eight leading economies. In 1995 Thailand had severe exposure to an oil supply shock, by 2010 the scenario will be unchanged. Thailand's best hope for continued economic prosperity, will be low world oil and gas prices and no long term supply disruptions in the world's oil market.

Malaysia along with Indonesia are the only major exporters of crude oil in Asia. Similar to Indonesia, Malaysia may have preferred oil prices to have been higher over the past decade. Malaysia receives a large percentage of the country's hard currency from the exportation of crude oil. In 1995 Malaysia produced 685,000 b/d and consumed only 430,000 b/d of crude. As a result of increasing domestic demand, declining field production and only fair replacement of produced reserves, Malaysia is also expected to cease being a net exporter of crude within the next decade. As a result of recent government policies, driven by the goal of increased oil conservation Malaysia is expected to decrease its intensity of oil consumption over the forecast period as its fuel mix will start to reflect its declining crude base and increasing natural gas production. By the end of the forecast period Malaysia is expected to be the largest (in percentage terms) consumer of natural gas in Asia. While at the same time declining its oil intensity from 57% to 33% by 2010. Malaysia is one of a few economies where fuel use for transportation is expected to decline. Malaysia in 1995 was considered to be at a minimal exposure for an oil market disruption as it is a net oil importer and could actually benefit from higher prices. By the end of the forecast period Malaysia will still be at minimal risk due to the small amounts of oil it is expected to import by 2010 and the declining significance oil will play in its energy portfolio.

In sum, the eight largest Asian economies have very different fuel mixes and end use consumption patterns. As demand increases for primary energy and particularly oil the Asian consumers are trying to diversify their fuel mix in hopes of limiting reliance on import oil and shielding themselves from potential supply shocks. The eight major Asian energy consumers highlighted above, will either be in a similar position as today or a worse position in regards to exposure to supply disruptions by the year 2010 (see TABLE 2).

TABLE 2

FORECASTED EXPOSURE TO OIL MARKET DISRUPTIONS

	China	Japan	India	S. Korea	Indonesia	Taiwan	Thailand	Malaysia
1995	minor	severe	moderate	severe	none	severe	severe	none
2010	moderate	severe	moderate	severe	minor	severe	severe	minor
net oil Importer by 2010	ü	ü	ü	ü	ü	ü	ü	ü

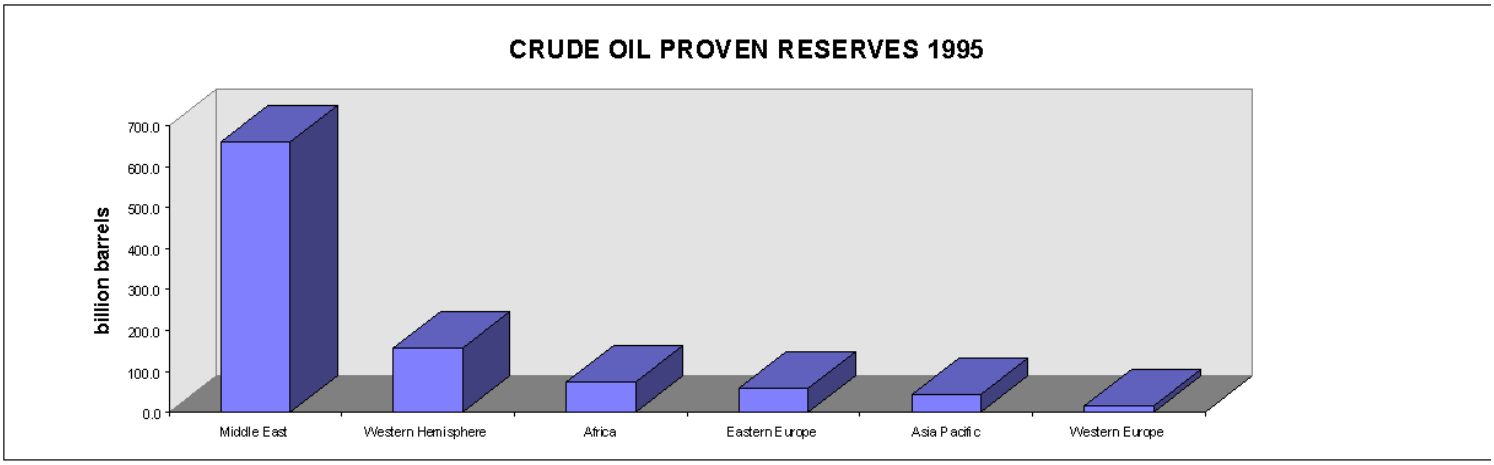
TABLE 2 does illustrate a few important points: 1) the reliance of import crude to the major Asian economies will continue to grow, and 2) each of the major Asian economies will be no better off in terms of oil dependence in 2010 as they are today. What the table fails to make clear is where the oil will be coming from. Another important question that should be addressed is how does the exposure statistic (determined solely by fuel mix and import levels) vary depending on who the exporter is (i.e. stable Malaysia or the tumultuous Middle East). What will probably be helpful in this analysis is to present the supply side of the oil balance equation so that the real question can be addressed. That being what will the size of the oil imbalance be by 2010, who will provide the missing barrels and what countries will have severe supply exposure.

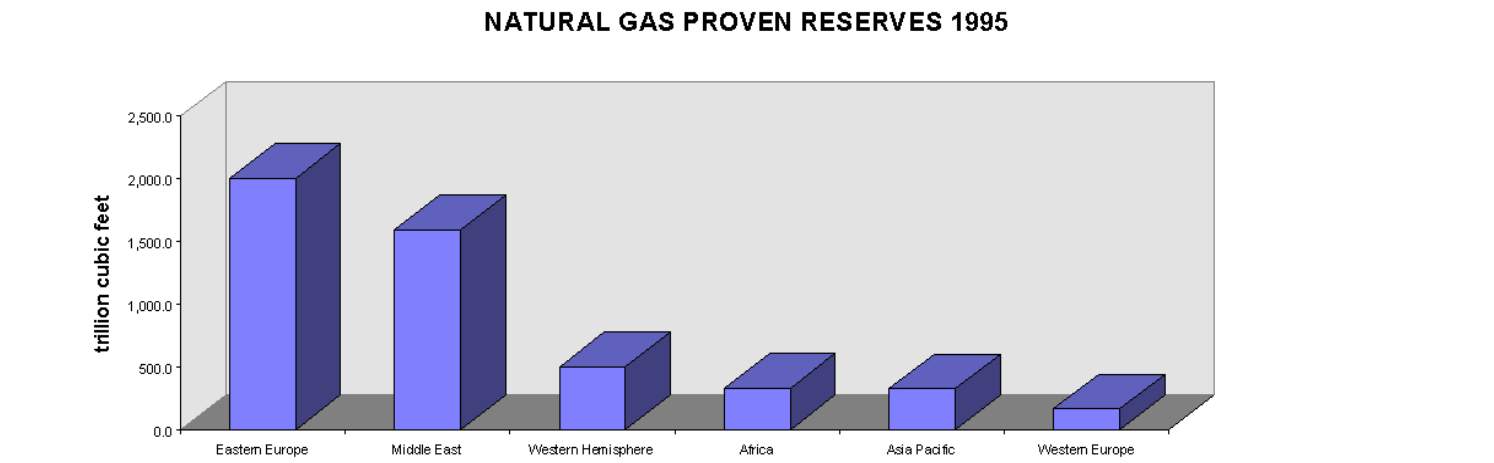
IV. THE AVAILABILITY OF ASIAN OIL AND GAS SUPPLY

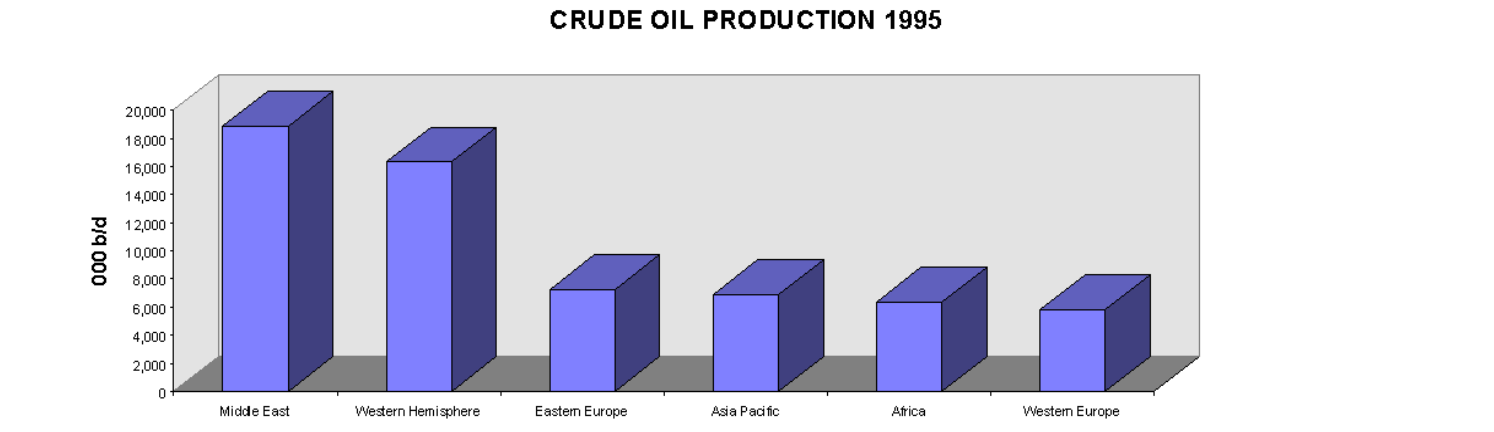
Sections II and III of this paper illustrate two very important points: 1) What is driving the growth in the Asian energy market and how it is expected to continue into the next century to become the world's largest and fastest growing market, and 2) to what extent oil will play in the energy fuel mix of various countries and as a result which nations are at risk to oil supply disruptions. To obtain a better understanding of why the Asian oil import market will continue to grow in importance over the next decade and why many Asian nations will be in a severe exposure position to world oil market disruptions, the subject of Asia's supply of oil and gas should be discussed.

Despite having considerable reserves quantities of coal (especially in China and India) Asia is not the world's most heavily endowed region for oil and natural gas reserves. Comparing aggregate world data Asia ranks ahead of only Western Europe for its volumes of proven crude oil reserves. By January 1996, best estimates of Asia's total proved reserves (recoverable at world prices and with given technology) stood at 43.9 billion barrels of oil (19.9 billion excluding China). This level of total Asian proven reserves is less than the oil reserves found in the C.I.S, Mexico, Venezuela, and five individual Middle East countries. The level of proved reserves is approximately just over 4% of the world's total (see FIGURE 8).

FIGURE 8: Crude Oil and Natural Gas Proven Reserves 1995, Crude Oil Production 1995







source: OGJ BP

Asia's oil reserve base peaked in the late 1980's and has been relatively stable over the past six years. In 1986 Asian proven reserves stood at 19.0 billion barrels (excluding China), this peaked to 20.5 billion in 1993 and has remained between 19-20 billion barrels throughout the 1990s. Prior to 1992 reliable Chinese reserve estimates were difficult to obtain. China's crude oil reserves have been estimated at a constant 24 billion barrels. This statistic has been stable over the past 4 years, which leaves some question to its accuracy. Being that the Chinese estimate has in four years not been reduced (despite over 1 billion barrels of oil production per year), added to (despite aggressive E&P programs in both on and offshore), revised (such as most other reserve estimates around the world over time) and comes primarily from government sources makes some analysts question its accuracy.

Asian indigenous natural gas supply is a little more abundant in terms of percentages of world totals and production to reserve ratios. Asia's total proved natural gas reserves in January 1996 are estimated at 328.5 tcf. This represents 15% of the world's total proven reserves of natural gas and in many ways a viable alternative to coal and crude oil in primary energy consumption for the developed and emerging Asian economies. Excluding China, Asia's proven reserves of natural gas is 269.5 tcf. Unlike oil reserves which have been stable over the last decade, natural gas reserves in Asia have been quite volatile over the past decade. In 1986 Asian reserves of natural gas (excluding China) were estimated at 198 tcf. By 1990 reserves increased by 25% to 248 tcf, and by 1993 up to 298 tcf. In seven years Asian (excluding China) proven natural gas reserves increased by 50% from 1986-1993. By 1996 the trend reversed slightly as natural gas reserves are now estimated at 269 tcf (excluding China) which is a decline from the previous year of 22 tcf. China's natural gas reserves have grown rapidly over the past five years (as opposed to an unchanged crude oil estimate). China over the past five years has increased its reported reserves of natural gas from 35.4 tcf in 1992 to 59.0 tcf in 1996.

Despite the limited reserves of crude oil and natural gas found in Asia, the region does produce large quantities of both to satisfy some primary energy demand. As a region Asia produced 6.8 million barrels of oil per day in 1995. This is a slight increase of 2.8% from 1994. Asia's oil production has remained relatively constant over the past decade. Asian

production (excluding China) has averaged between 3-4 million barrels per day over the past decade. China has also been a stable producer averaging between 2.7 and 3.1 million b/d over the past decade.

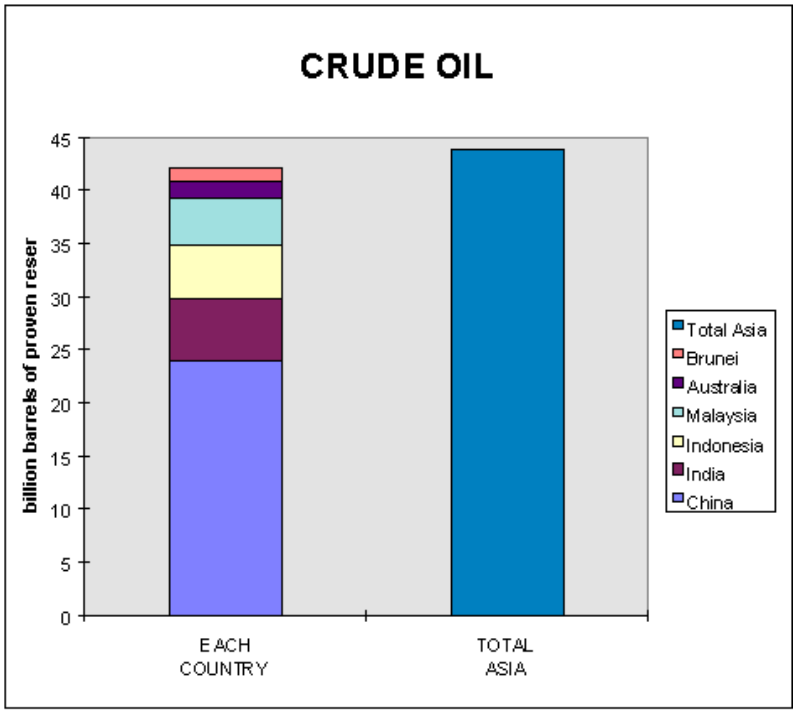
For both reserves and production of natural gas and crude oil, reserves and production are present in only a few major producing economies and of these producers, the concentration is still very high among the top three or four nations.

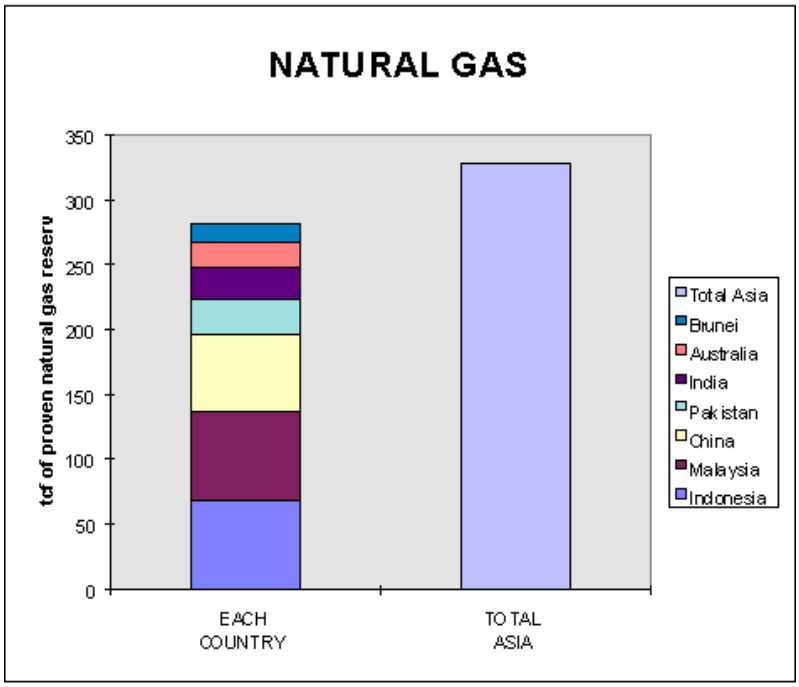
As mentioned above crude oil reserves are estimated to be approximately 43.9 billion barrels. Of this reserve base over half is located in China (24 billion barrels). Other countries with major reserves include India (5.8 billion), Indonesia, (5.1 billion) and Malaysia (4.3 billion). These four countries account for close to 90% of all Asian reserves. Other countries with marketable reserves include Australia, Brunei, and Vietnam (see FIGURE 9).

Natural gas in Asia is less concentrated than crude oil reserves but still far from equally distributed among all consuming nations. The Asian countries with the largest reserves of natural gas are, Indonesia (68.9 tcf), Malaysia (68.0 tcf), China (59.0 tcf), and Pakistan (27.0 tcf). These top four countries combined account for 68% of all of Asia's natural gas reserves. Other Asian countries with marketable reserves include: India, Australia, Brunei, Myanmar and Bangladesh (see FIGURE 9).

FIGURE 9

ASIA'S RESERVES 1995





source: OGJ

Production concentrations for both oil and gas are also high in Asia. Asia has only two countries with the ability to produce over 1 million b/d of crude oil: China 2.9 million b/d and Indonesia 1.3 million b/d (OPEC monitored). India, Malaysia, and Australia also produce marketable volumes of crude oil: 708,000 b/d, 685,000 b/d, and 558,000 b/d respectively. The top five Asian oil producers account for 91% of all crude produced in Asia. It is important to note that of these top five producers China, India and Australia are already net oil importers and Indonesia and Malaysia are forecast to be importers within the next decade.

With the exception of Indonesia and Malaysia, all Asian economies are net oil importers to varying degrees. Japan and South Korea import a combined 7.8 million barrels of crude per day (an amount very close to the United States) in 1995. The tightness in the supply market is due in part by the only sources of "local" crude (Asian based for this analysis) is Indonesia and Malaysia who are collectively net exporters of only 700,000 b/d of oil. An important point should be addressed regarding the volume of oil trade between nations. Though the ‘net’ export or import statistic for any given country gives analysts a good indication of whether a country has minimal, moderate, or severe, exposure to supply shocks or price spikes, it does not provide an accurate assessment of the actual volume of oil trade among nations. Though oil demand, consumption and reserve statistics are always quoted as if all crude were equal, the fact remains crude oil is only a partially fungible product. Due in part by the nature of varying gravity and sulfur content, the refining process, and the end use for consumed oil, crudes have varying value to different nations. As a result, many Asian nations are actively involved in both the importing and exporting of crude oil. The oil trade is particularly active in the Asian market where many countries at different levels of development have varying refinery complexities and uses for oil all within a relatively close geographic proximity.

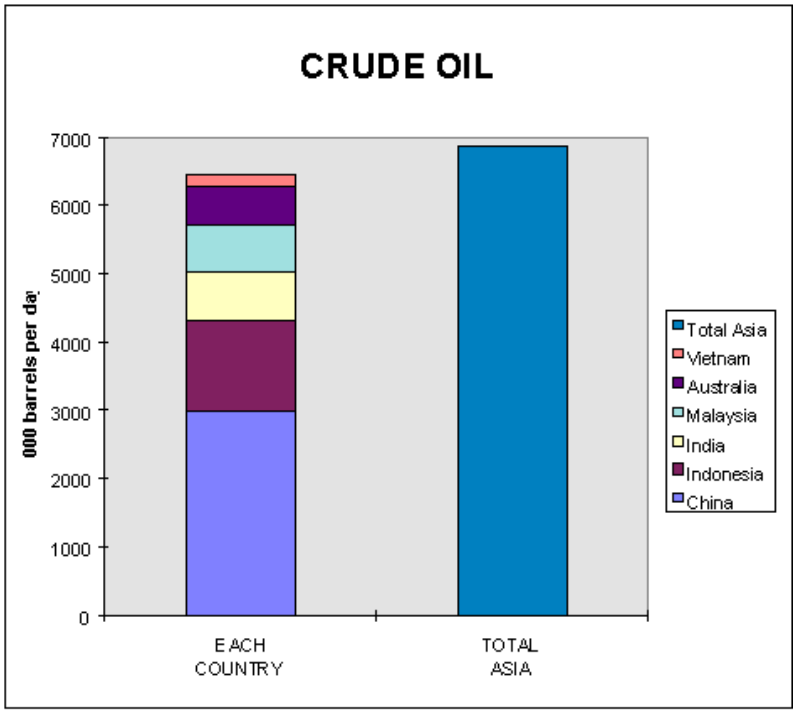
A good example of the volume that oil can be traded despite having a country with an import neutral position is China. Though China’s net import and export status was close to being in balance for the year (net importer by 200,000) the nation imported 644,000 b/d and exported 447,000 b/d in 1995. This accounts to over 1 million b/d that China actively traded in world markets despite being close to import neutral. A good example of

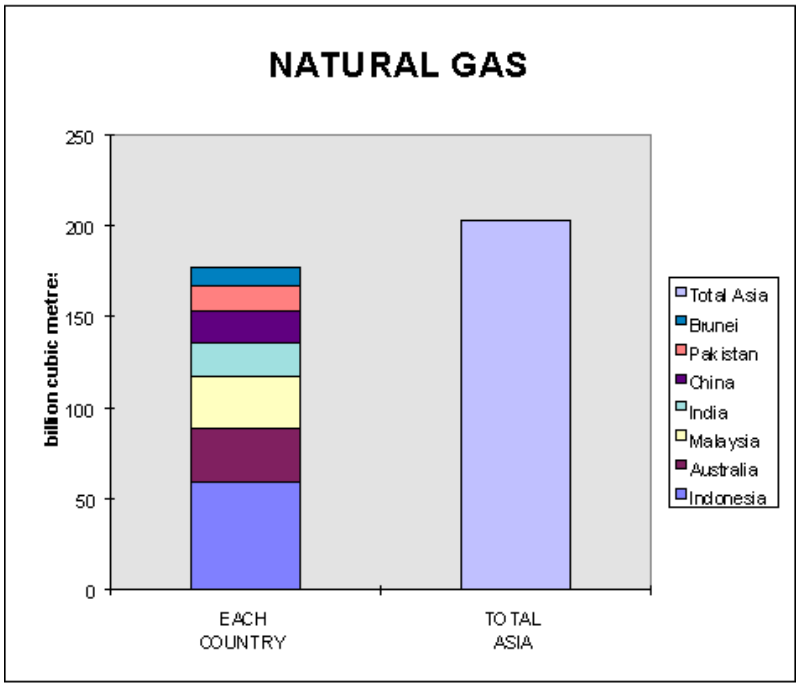
oil trade being driven by fuel use is the case for Indonesia. Indonesia has a net export balance of close to 500,000 b/d. However, because much of Indonesia's oil is low sulfur, high gravity crude (good for gasoline) it exports close to 1 million b/d to countries including Japan, China, and South Korea. To make up the difference Indonesia then imports higher sulfur content heavier crude oils in the world market (from countries such as China) for its residual fuel consumption and industrial demand. Though trade volumes and movements indicate various countries trying to optimize their position and capitalize on price spreads as well as giving analysts a good indication of a country's refining complexity this statistic may overstate the level of oil trade in the Asian market. In the event of a crisis this trading volume would be cut substantially as governments and private companies would attempt to stockpile and build inventories with less concern for gravity and sulfur content. In the event of an oil crisis oil becomes very fungible as a political commodity. In essence the trade volume statistic is informative, however, the net import/export statistic is a superior measure of exposure and dependence.

Unlike the international oil market which is characterized by a product which is easily transportable the natural gas market (with the exception of LNG) is primarily a domestic market. Similar to natural gas reserves, marketable natural gas production is also present in only a small group of Asian countries. The production statistics for natural gas show a more diverse group of players than the Asian oil market with seven different countries producing over 10 billion cubic meters (bcm) per year (see FIGURE 10).

FIGURE 10

ASIA'S PRODUCTION 1995





source: OGJ, BP

Indonesia (58.5 bcm), Australia (29.6 bcm), Malaysia (29.0 bcm), India (18.7 bcm), China (17.6 bcm), Pakistan (13.4 bcm), and Brunei (10.3 bcm) all have marketable volumes of natural gas. These seven nations account for 87% of all natural gas production in Asia.

Improvements and development to infrastructure has led to impressive additions to production volumes from 1994 to 1995 of natural gas in Asia. Brunei and Malaysia have increased production by over 10% from previous years totals, while India, China, and Australia have upped production by 8%, 6.1% and 5.2% respectively despite stable world prices. The only major Asian producer of natural gas that has not increased gas production considerably over the past year has been Indonesia, where production is flat due in part by aging fields and insufficient replacement. Indonesia has invested substantially in domestic natural gas infrastructure over the past few years. Much of the expenditures are focused at increasing LNG exports.

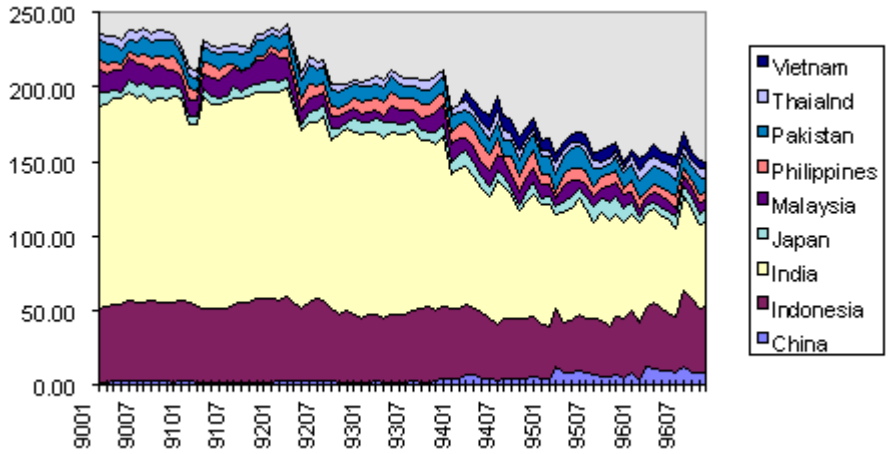
In 1995 Asia consumed 215 billion cubic meters of natural gas. Asian producers also transported 70.8 billion cubic meters of LNG from gas producers to gas consumers in Asia. Approximately 33% of all Asian natural gas consumed in 1995 came in the form of imported LNG from Asian suppliers, an additional 7.0 bcm (3% of total gas consumption) came from non Asian producers. Indonesia, Australia, Malaysia and Brunei actively export their natural gas in the form of LNG to Asian consumers. Japan is the major recipient of imported Asian LNG. In 1995, Japan imported 57.9 bcm of LNG (23.4 from Indonesia, 10.8 from Malaysia, 7.5 from Brunei, 9.2 from Australia, 5.4 bcm from UAE, and 1.6 bcm from U.S.). South Korea imported 9.4 BCM of LNG (all from Asian producers) while Taiwan imported 3.5 bcm of Asian LNG.

In 1995 Indonesia, exported 33.1 bcm of natural gas (57% of all domestic production) to other Asian economies. Other major Asian producers actively involved in the LNG trade to other Asian economies in 1995 included: Malaysia exporting 12.9 Bcm to Asia (44% of all domestic production), Australia 9.8 bcm exporting to Asia (33% of all domestic production) and Brunei 8.4 bcm exported to Asia (82% of all domestic production).

Though the LNG trade is very lucrative to Asian countries who have a surplus of natural gas production (Indonesia, Malaysia, Australia, and Brunei), customers of LNG tend to be Asian economies with high energy intensities and high energy complexities and who are also willing to pay a premium for an improved environment (Japan and South Korea true for both points, Taiwan true for first point questionable for second). The likelihood that LNG could compete with imported or indigenous Asian coal on a cost basis for developing economies such as China, India, and Thailand for large scale power projects is highly unlikely assuming the relatively low natural gas price experienced over the past few years which are expected to continue over the forecast period.

FIGURE 11

ASIA'S RIG COUNT 1990-1996



source: OGJ

Looking for new Asian supplies of 'local' oil and gas, energy companies and national oil companies continue to look in the same locations (see FIGURE 11). However, the overall volume of activity in the Asia region has been declining steadily over the past three years. This can be attributed to softer prices and more efficient exploration with 3D seismic and other technologies. Exploration is still very active in both Indonesia and India though both having slipped from late 1980 and early 1990 peaks. In the last twelve months the

areas attracting the most new activity is Vietnam, and Pakistan. The former for oil prospects the latter for natural gas (the China statistic in FIGURE 11 represents offshore China only).

In sum, Asian energy supply is concentrated among a few countries. Oil reserves and production concentrated in five main countries, natural gas production and consumption is less concentrated than oil and still not equally distributed among Asian consumers. The Asian natural gas market is comprised of seven main producing countries. Trade among Asian energy consumers in both oil and gas (LNG) is concentrated in the two primary net export countries of Indonesia, Malaysia, and to a lesser extent Brunei. Asia's energy imbalance (Asian 'local' demand in excess of 'local' Asian supply) is already 10 million barrels of oil per day and is growing rapidly. The imbalance is being caused by the leveling off of production in all major Asian oil producers and dramatic increases in Asian oil demand. Though exploration and development activity is particularly active in Indonesia and India major additions to reserves and production volumes have yet to be logged. The consensus among many experts is that new oil fields perhaps in India, Philippines, Thailand, Vietnam and most likely China will eventually add to reserve and production volumes for Asia. However, this new production is expected to only replace the diminishing production in other Asian countries (Indonesia and Malaysia). Even under the most optimistic of forecasts Asian oil production peaks at 8.3 million b/d, with most other scenarios forecasting total Asian production closer to 7.2 million b/d by 2010.

V. ASIA'S OIL IMBALANCE AND THE NEED FOR IMPORTS 1995-2010

Many forecasts are available which estimate the long term oil supply and demand balance around the world. Some of the more respected forecasts are produced by such groups as the World Bank, The International Energy Agency (IEA) and the Energy Information Administration (EIA). Each forecast is based on a set of assumptions, most of these assumptions are the product of other forecasts. Though many of these forecasts have been constructed by teams of talented economists and analysts, their conclusions often vary considerably. A good example of this is to look at a set of oil price assumptions by some of the world's "BEST" energy forecasters.

TABLE 3

COMPARISON OF WORLD OIL PRICE PROJECTIONS 2000-2010

Year	IEO96	IEA	PEL	PIRA	DRI	GRI	WEFA	NWS	NERA
2000	19.27	23.48	14.66	14.66	16.82	16.17	19.61	19.52	21.60
2005	21.86	28.59	14.64	15.37	20.83	16.17	21.30	NA	21.10
2010	23.70	28.59	12.32	NA	23.22	16.17	22.06	NA	21.49
source:	1	2	3	4	5	6	7	8	9

1.
2. IEO96 Energy Information Administration
3. International Energy Agency, World Energy Outlook
4. Petroleum Economics Limited, Oil and Energy Outlook to 2010
5. Petroleum Industry Research Associates, Annual Retainer Client Seminar, October 1995
6. DRI/McGraw Hill, Oil Market Outlook
7. Gas Research Institute, GRI Baseline Projection of U.S. Supply and Demand
8. WEFA, Long Term Economic Outlook
9. NatWest Securities, Strategic Assessment

10. National Economic Research Associates, Energy Outlook

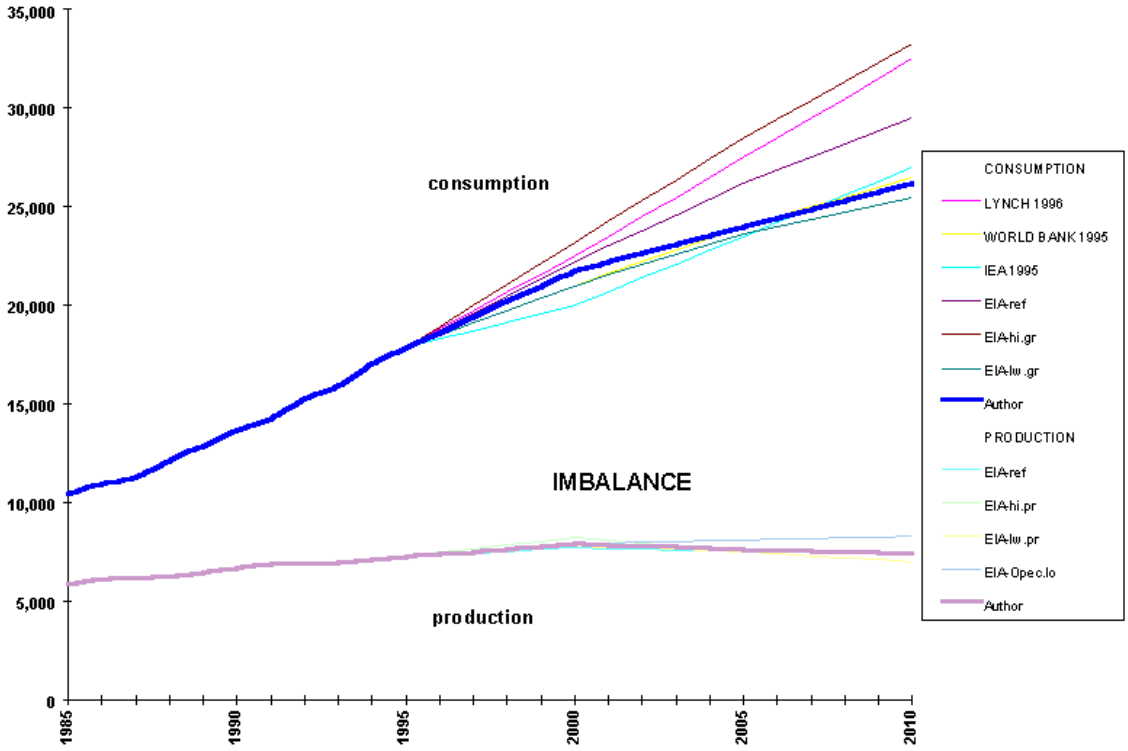
Forecasting the supply and demand scenario for the world, a country or a region of the world is just as imprecise as forecasting prices. Even if the forecaster has the ability and foresight to correctly predict world energy prices (a major component of the supply and demand forecast), the forecaster then must make accurate assumptions on technological advancements, weather conditions, political stability, and most important economic growth trends. In the end, many times a forecaster is right for the wrong reasons or wrong for the right reasons. In hopes of avoiding both of these scenarios many analysts find it better to look at a range of forecasts and explain the common ground before attempting to explain the differences. This is the approach this paper employs.

For the Asian crude oil supply (production) and demand (consumption) scenario. Many forecasts were looked at to get a good feeling for what will be driving this market into the next decade and to determine what will be the size and trend of the region's oil imbalance. Forecasts were collected from MITI, East West Center, EIA, IEA, private research firms, individual analysts and other government sources to get a wide range of opinions on the oil supply and demand scenario for the world and Asia up to 2010.

An important note must be added concerning the differences in forecasts. Being that various forecasters define "Asia" differently, adjustments had to be made in certain forecasts so that fair comparisons could be made. Most common were the (in)exclusion of Australia and New Zealand and other Pacific nations in some forecasts for Asia and not in others. In these instances average values for supply and demand from the other reliable sources were used for the missing country data. These adjustments are not expected to have biased the results and in most instances represented very small amounts of the region's total. For Asian consumption seven forecasts are highlighted (see FIGURE 12) and for production five.

FIGURE 12

ASIA'S EXPECTED OIL IMBALANCE



These forecasts were chosen to show a wide range of outcomes from respectable sources based on the different assumptions made by the forecasters for such variables as economic growth and oil prices up through 2010.

The forecasts do agree that the imbalance in the Asian oil market will continue to widen as Asian consumption is forecast between 25.0-33.3 million barrels per day by 2010. This is a considerable increase form the 1995 Asian consumption of 17.8 million barrels per day. What is striking is the differences among the high and low economic growth forecasts. Forecasts for the EIA were chosen to illustrate the importance of the economic growth variable. Essentially all three EIA forecasts are the same, the only varying assumption is that of Asian economic growth. The three forecasts from one source were reported here to illustrate the magnitude of the alternative outcomes by simply tweaking the economic growth assumption. The EIA forecasts divides countries into sub groups.

The variation form the low to high economic growth models for each sub group are as wide as 3.4% (6.1% low growth case vs. 9.4% high growth) for China to as narrow as .8% for the Asia Pacific region (2.3% low growth vs. 3.1% high growth case). Over the span of 15 years with the only difference being the economic growth assumption, the two models produce estimated oil consumption levels which are 8.3 million b/d apart.

The IEA consumption forecast has computed economic growth for Asia between the EIA's reference and high growth rate models. However the price assumption in the two groups forecast is different by a few dollars per barrel. As a result of the higher price assumption, consumption is forecast at a rate much lower than the IEA's high growth case and moderately below the EIA's reference forecast. Being that forecasts are very similar with the exception of the price assumption, this shows the importance of an accurate price assumption as the EIA high growth model and IEA model has forecast consumption 6 million b/d apart from each other. It is very important to note that on a percentage basis, the sensitivity of the forecast estimates are much more responsive to changes in economic growth as opposed to oil prices. This further supports the earlier statement that the Asian market is mainly driven by economic growth over the past few years and will continue this trend into the foreseeable future. Most other forecasts that were obtained plotted results that were in between the EIA's high and low growth oil demand of 25 million to 32 million barrels of Asian consumption by the year 2010.

This author based on assumptions of stable oil prices over the forecast period (which would place prices between the EIA and IEA assumptions) and economic assumptions which would fall into the less optimistic category of forecasts (below both EIA's reference case growth assumption and IEA's model but above EIA's low growth model), makes for the authors projection for an approximate Asian oil consumption of 26.2 million barrels per day by the year 2010. This would represent an increase in the regions oil demand by 8.4 million b/d over the next 15 years.

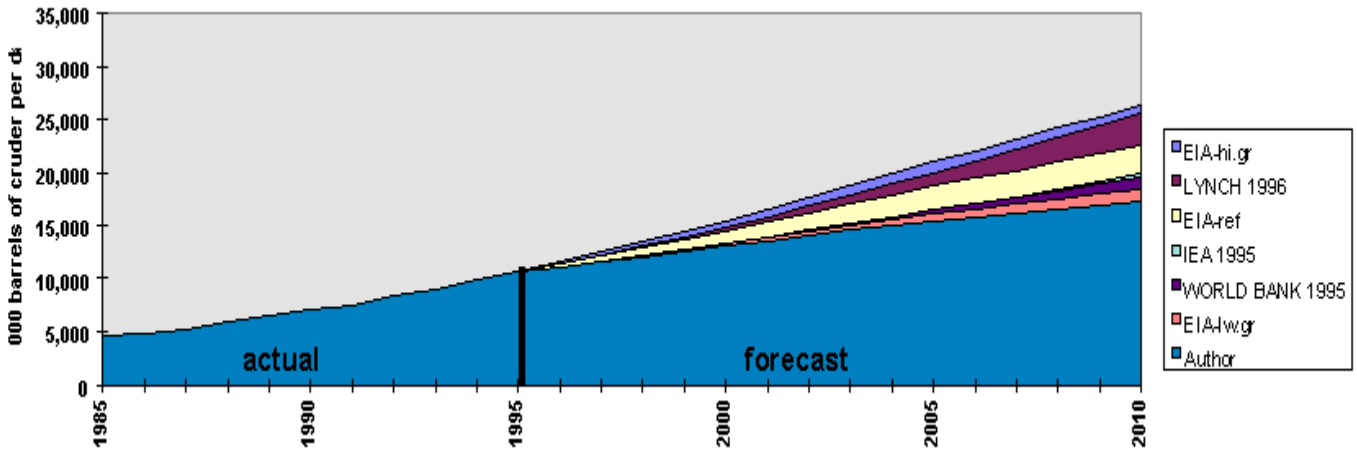
On the supply side most forecasts that were looked at provided relatively consistent outcomes over the forecast period. The variation in production among the forecasts is small as a direct result of the nature of stability in the production side of the crude oil

market. What helps in forecasting Asian production is that the area contains very few totally unexplored regions and contains mostly mature production formations and basins. Some of the trendier exploration plays such as India, offshore Vietnam and Western China are only expected to produce in quantities which will peek Asian oil production capacity to approximately 8 million barrels per day by 2000 and then taper off after that with the decline in production volumes from the aging oil fields. Of the forecast that were looked at for the Asian region, production is expected to be between 7.0 and 8.3 million barrels per day by the year 2010. What end of this spectrum will actually be realized will depend on world prices, OPEC production, technological advancements and the success of new exploratory projects in Asia. This author forecasts production slightly above the average of the other forecasts. This can be explained mostly by the author's higher oil price assumption as mentioned above.

The difference between what is consumed by Asian economies and what is produced by Asian economies is Asia's oil imbalance (see FIGURE 13).

FIGURE 13

ASIA'S EXPECTED OIL IMBALANCE



A chart of the imbalance shows a few interesting points. For the benefit of simplicity the different consumption forecasts were compared with only one production forecast

(arbitrarily chosen as the EIA Reference Case). The conclusions would not change much under the alternative production scenarios as they deviated from the EIA reference case in most years by only a couple of hundred thousand barrels per day for all of Asia (and would in most cases just shift the curve up or down slightly).

The most interesting observations about the imbalance concerns its general size in volume and rate of growth. These forecasts that are representing 5 different sources, which contain varying degrees of economic growth and different estimates of world price give a good indication of the possible ranges of the Asian oil imbalance out to the year 2010. It seems like most analysts and policy makers are in agreement over the long term trend of the imbalance, all that is being debated is the rate at which it will grow.

The real question of interest is not whether the imbalance by 2010 will be 20 or 22 million barrels per day but rather where will all of this oil supply outside of Asia come from? It has already been well documented that in the 1990's only two Asian countries provided sustained levels of import crude (Indonesia and Malaysia), and by 2010 both will be net oil importers. Other Asian sources of import crude have been suggested to be Papua New Guinea, India, Vietnam and China. Though most experts believe these regions will produce additional barrels of oil in the next decade, practically all of this incremental supply (with the possible exception of Papua New Guinea) will be devoted to increases in domestic oil demand of the producing nations.

In all likelihood (for both high and low economic growth and high and low oil price scenarios), any Asian country which needs to import oil will be forced to look outside of Asia for an overwhelming majority of its supply. This includes all of the high growth Asian economies as well as the mature Asian consumers. Some countries have the potential of being import neutral by 2010, they include Indonesia, Malaysia, Vietnam, India, and China. The likelihood of the latter two being import neutral is small but under a scenario highlighted by a massive program of domestic upstream activity and exploratory good fortune including large amounts of technology and capital infusion and the lessening of oil demand and slowing of economic growth China and India could be import neutral. However for the other major Asian economies highlighted earlier, Japan,

South Korea, Taiwan and Thailand imports of crude oil will continue, volumes will increase and 'local' sources eliminated.

An interesting subject for energy analysts and energy policy planners is to forecast the dependence on Middle Eastern crude to meet domestic oil needs. As discussed above the major oil importers will surely be Japan South Korea, Thailand, Taiwan and most likely China and possibly India. These countries will no longer be able to count on Asian crude supply from such country's as Indonesia, Malaysia and China. As a result they will be forced to look outside of Asia for supplies of import crude oil.

To obtain a good indication of the expected pattern and reliance on Middle East oil for Asian consumers over the next 15 years, one only has to look at the import patterns of two key nations. They are Japan and South Korea. Collectively these two nations already import 7.7 million barrels of crude per day, and in 1995 they make up the majority of the Asian oil imbalance. These two nations despite having complex refineries, a diversified fuel mix and varied product demand, have both started in 1988 a trend of increasing Middle East imports of crude oil that is expected to grow steadily over time. The increases in imports from non Asian sources (almost all of which will be form Middle East producers) will be realized in both percentage terms and on a barrel basis. This trend is expected to continue as local Asian oil import sources which have supplied Japan and South Korea in the past (Indonesia, Malaysia, China, Australia, Vietnam, India, and Brunei) will be unable to export oil as rising domestic demand will necessitate that the oil be consumed domestically.

Japan in 1995 imported 79.4% of its oil from the Middle East. In addition to the high Middle East percentage, Japan also imported 19.1% of its oil from seven Asian producers. Producers in Europe, Africa, and the entire Western hemisphere provided Japan with less than 1.5% of its crude oil imports. Over time as Asian oil demand grows, and Asian oil production peaks and then declines, all of the oil consuming Asian economies will continue to compete for the marginal barrels being produced from the few remaining Asian exporters. The 19.1% source of Asian supply for Japan will gradually but steadily decline over time. This declining availability of Asian crudes for import has already

appeared in the statistics, as Japan's imports of Asian oil has declined steadily over the past eight years.

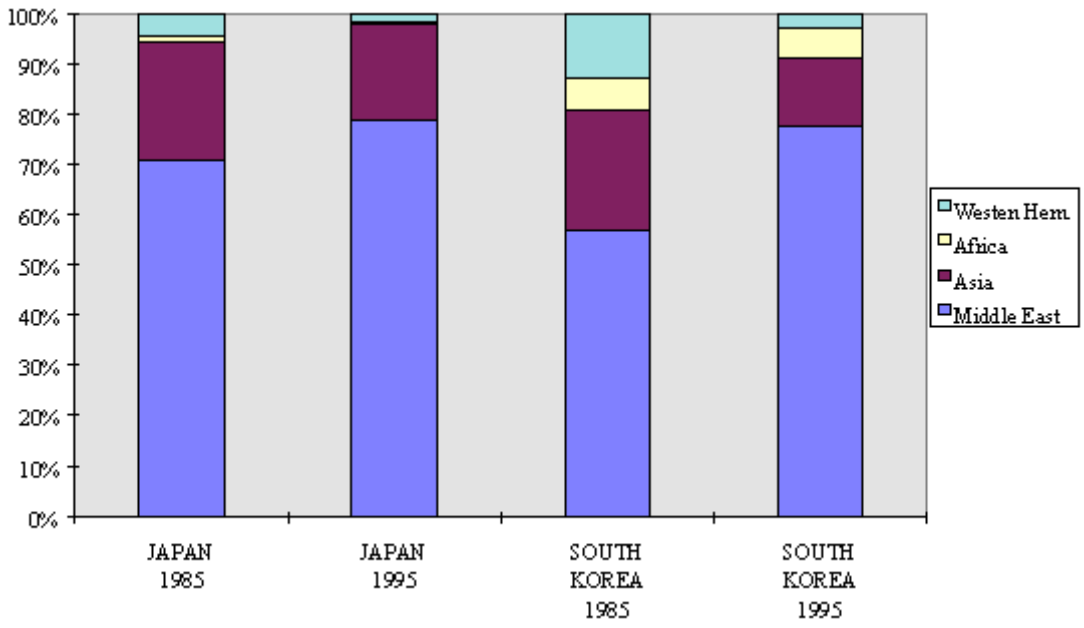
Just as important for Japan and other Asian importers is the 1.5% statistic of non Middle East and non Asian oil supply. This percentage is this low purely for market reasons. Though the price of spot crude oil is determined by the world financial markets, the cost of shipping oil via tanker has always been dictated by among other things the simple distance function. As long as the European market is closer to the North Sea, and The U.S. market is closer to Venezuela (two examples of hundreds), these markets can purchase and ship crude to their markets at a lower cost than Asian consumers. Naturally, there is nothing stopping Japan's refinery managers from importing crude oil from Mexico and Venezuela among other places and paying the additional $1.50-$2.50 per barrel to ship the oil across the world. However, supply decisions in Japan as well as in many Asian import markets are made at the refinery management level where supply source decisions are motivated by profit objectives (driven by lowering costs) with little regard for national fuel source diversity. In addition to having marginal production costs of $2-$5 per barrel of crude, Middle East exporters also have a considerable geographical advantage in location over other oil exporters in supplying Asia's increasing thirst for oil. Japan, South Korea and other Asian importers are in essence a captive market for Middle East producers as long as import decisions are based on profit motives.

The situation for Asia's second largest importer South Korea is very similar to Japan. Over the past seven years South Korea and Japan have had almost identical import concentrations of Middle East crude. This is not surprising when the similarities of these two importers are addressed. Both countries have an oil import intensity of 100%, have very similar energy consumption patterns and both posses refineries with relatively high upgrading complexity. South Korea in 1995 did have a slightly more diverse import mix relying also on marginal sources form the Western Hemisphere and Africa.

FIGURE 14

JAPAN and SOUTH KOREA

OIL IMPORT PROFILE

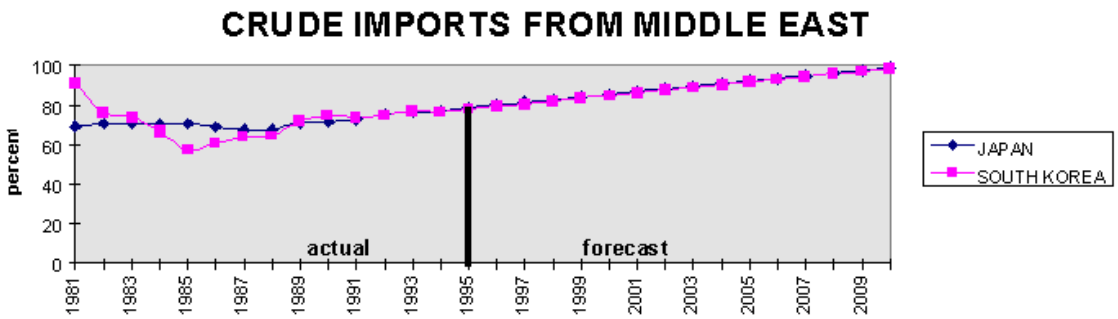


source: PAJ, MITI

The profiles in Japan and South Korea give U.S. a fair indication of what to expect in Asia up through 2010 (see FIGURE 14). The 1985 to 1995 chart highlights a trend which will continue over the next decade as well. Expect to see for all Asian importers, a lessening of imports from Asia and increasing percentages of Middle East crude. The decline in available Asian oil is a result of increased Asian demand growing much quicker than stagnant Asian oil production. Forecast over time, unless actual policy is adopted in the major importing nations which mandates a diverse supply source of crude oil from non Middle East suppliers, Asian importing nations will have a reliance on Middle East oil in excess of 95% by the year 2010. The intensity quickly approaches 100% if the current trend for Japan and South Korea continues (see FIGURE 15).

FIGURE 15

CRUDE IMPORTS FROM MIDDLE EAST



source: PAJ, MITI, author's projections

Of course in the event of an unexpected massive discovery of affordable oil in close proximity to the Asian market (from a location such as Sakhalin, Tarim Basin, offshore Vietnam, Azerbaijan, etc.) these estimates of Middle east intensity could be lowered slightly. What is not likely to happen is for large quantities of oil from the Western hemisphere being shipped to Asia, as this production will satisfy increases in oil demand which is closer in proximity and cheaper to transport.

VI. CONCLUSIONS AND POLICY PROPOSALS

As we all know the oil and gas industry is comprised of some of the world's sharpest minds in the areas of geology, engineering, finance and chemistry. The industry's history is built on surprising advancements that seem elementary today but shocked the world when first thought of. Looking back just a few years ago many able forecasters and 'experts' were predicting oil prices to be approximately $75 per barrel by 1995. These analysts were making their best assumptions on all the available information of the time. Few would have thought that technological advancements over the past 10 years would

have changed the way the industry fundamentally operates. It was not to long ago that offshore exploration and production was limited to the 1000 foot barrier, seismic surveys took six months to analyze and Iraq was a major oil supplier. It is amazing how an industry's environment can change so rapidly.

It is not inconceivable that ten years from now the estimates and forecasts described in the previous section could greatly exaggerate or even underestimate the actual oil imbalance in Asia by the year 2010. It is also possible that the Tarim play contains 20 billion barrels of oil and the Spratley's are sitting atop 100tcf of natural gas. However, under a most probable scenario of the oil market remaining relatively stable over the forecast period, Asia will be the world's largest importer of crude oil with the Middle East providing an overwhelming majority of it. This paper estimates that by the year 2010 the oil imbalance for all of Asia will be between 18 to 27 million barrels per day and the Middle East will be supplying over 95% of the needed crude to balance the Asian market . Of this large imbalance between 17 and 26 million b/d are expected to come from the Middle East. At a world oil price of $20 per barrel this represents a capital flight from Asia to the Middle East of between $124.1 to $189.8 billion dollars per year. The major oil consumers will continue to be Japan, China, India, and South Korea. It should also be noted that all Asian economies will have some level of increasing oil market exposure throughout the forecast period.

Based in part by the forecasts of energy consumption mix and fuel use patterns from now through 2010, the major importers will have varying degrees of import intensity and potential exposure to oil supply shocks and price spikes. Each of the eight leading Asian economies' oil exposure either remains the same or gets worse from 1995 to 2010. Only Indonesia and Malaysia have minor exposure, China and India will have moderate exposure, and Japan, South Korea, Taiwan and Thailand will have severe exposure.

Though the future trend of Asia's imbalance is hard to dispute, the possibility of lessening the rate of growth and exposure could be envisioned if certain policies were adopted. Policies which could lessen the need of Middle East crude over the next decade and lessen exposure include: tax credits for non petroleum consumption, national

consumption targets for oil energy supply, collaborative and joint venture programs linking Asian capital with international oil sources, the introduction of inventory and stability programs (similar to the U.S. SPR) to lessen the impact of a future oil shock, major energy conservation initiatives, and the creation of an Asian oil security council (similar to the IEA). Though each of these policy proposals could be the subject of independent research, any of these proposals would only lessen the rate of growth of the Asian oil imbalance. The answer may rest with the continued cordial relationship among Middle east suppliers and Asian consumers.

In any event, being that the conclusions of this report are of a worsening exposure scenario and increasing import intensity with the Middle East becoming increasingly more important for the continuing advancement of many Asian economies, additional research on the Asian oil imbalance to the year 2010 and beyond is justified.