AN ASSESSMENT OF THE ASIA-PACIFIC ENERGY SITUATION

F Fesharaki
Resource Systems Institute
East-West Centre
Honolulu, Hawaii

Introduction

The 1980s ushered in what many analysts enjoy calling the "Pacific Century." The region is seen as the emerging centre of gravity for the world economy, and even if economic growth slows during the 1990s, there is wide acceptance of the idea that the region will continue to be one of the fastest-growing in the world. The 1980s witnessed spectacular growth rates in the Asia-Pacific region, the rising economic power of Japan, an unprecedented opening of China's economy, the emergence of the "Four Tigers" or the "Little Dragons" (Singapore, South Korea, Taiwan, and Hong Kong), a rapid growth of exports from the region—in short, remarkable economic success and an increase in entrepreneurialism and the free-market philosophy. Even the United States, which historically has been Atlantic-oriented, sat up and took notice.

While the relationship between economic growth and energy consumption is not necessarily one-to-one, energy is a required input for economic activity and trade. Energy demand growth in the Asia-Pacific region has been accordingly rapid. At this point in history, oil and economic growth are so interrelated that changes in one invariably have major repercussions on the other. During the coming decade, continued economic growth is foreseen for the Asia-Pacific region, coupled with the fastest rate of oil-demand growth of any region on earth. Pressure will come to bear on the regional oil and gas markets, since demand growth will take place concurrently with a decline in the availability of local, low-sulphur crudes. The region will become even more dependent on imports of Middle Eastern crude, which will result in a higher-sulphur crude slate. Moreover, we anticipate that the existing and planned refinery complexes will lack the capacity and the flexibility to fully satisfy product demand. The consequence will be a higher level of refined-product imports.

The problem facing the regional market is one of both quantity *and* quality. Petroleum product specifications are tightening significantly, due in part to a rising environmental consciousness. Octane requirements are increasing, not merely because of demand for premium gasoline but because the regular grades in many nations are significantly underpowered (some have research octane numbers in the low-eighties) and the long-term costs to the motor vehicle fleet are becoming all too apparent. At the same time, many countries are phasing in low-lead and unleaded gasoline grades, which places additional pressure on the octane pool. Additionally, the higher-sulphur crude slate will correspond with a tightening of sulphur standards for middle distillates and fuel oil. The 1990s should prove exciting for the regional oil and gas industry.

In this paper, we examine the Asia-Pacific energy situation and the outlook for the regional oil and gas market, beginning with a look at the structure of demand, the extent of the regional oil and gas resource, and the prospects for crude oil production through the year 2000. Following this, is our assessment of the Asia-Pacific supply/demand balance (or imbalance, as the case may be) and the future of the regional refining sector.

The Structure of Energy Demand: World Versus Asia-Pacific

The world energy markets consumed 160.2 million barrels per day of oil equivalent (MMBDOE) in 1989, of which two-thirds was consumed in the non-Centrally Planned world. Thirty percent of world energy consumption was supplied by oil, 21 % by gas, 28 % by coal, 7 % by hydro, and 5 % by nuclear power (Table 1). If only non-Centrally Planned countries are considered, the share of oil in energy demand rises—primarily because the use of natural gas and coal in the Centrally Planned world is higher than it is in the rest of the world.

When comparing the Asia-Pacific region with the world, the size of China's energy market poses a serious problem. Since China's coal consumption accounts for nearly 80 % of its total commercial energy demand, the overall Asia-Pacific picture is affected. As a result, oil consumption in the region is shown to be only 36 %, gas 7 %, and coal 47 %. Since China's inclusion in the table distorts the regional picture, we have constructed a column excluding China. The emerging picture actually makes the region not all that different from the non-Centrally Planned global economy—except for gas. The Asia-Pacific region depends on oil for 48 % of its energy

	Total World		Asia-Pacific*		Asia-Pacific (excluding China)	
	MMBDOE	%	MMBDOE	%	MMBDOE	%
Oil	62.0	39	12.4	36	10.0	48
Gas	34.1	21	2.4	7	2.2	10
Coal	44.6	28	16.3	47	6.2	29
Hydro	10.5	7	2.0	6	1.4	7
Nuclear	9.0	5	1.3	4	1.3	6
Total	160.2	100	34.4	100	21.1	100

*East, South East, and South Asia plus Australia.
Source: BP Statistical Review of Worlds Energy 1990.

Table 1: Primary energy consumption by fuel (1989 million barrels per day of oil equivalent).

demand, coal for 29 %, hydro for 7 %, and nuclear for 6 %, but gas is used for only 10 % of energy demand in the Asia-Pacific region. In contrast, global energy demand is supplied 21 % by gas.

Indeed, the role of gas in the supply of energy in the Asia-Pacific region is lower than in any other part of the world (Table 2). In the Soviet Union, gas makes up 40 % of energy demand, in the United States 25 %, and in the Middle East 37 %. Even Latin America and Africa consume more gas than the fast-growing Asia-Pacific region. It is only natural to expect that the share of gas consumption will rise dramatically in the region by the year 2000.

Our own assessment of the future Asia-Pacific energy demand is shown in Table 3. The share of different energy sources clearly varies by oil price. If we assume an oil price of around $23 per barrel by the year 2000 (in real 1990 prices), we expect the share of oil to decline to 45 % (though in absolute terms oil demand will rise significantly), the share of coal to decline to 25 %; the share of gas to rise dramatically to 15 %, and the share of nuclear power to rise to 8 %. A higher oil price would reduce oil demand to 37 % and result in higher demand for other energy sources. In both price scenarios, however, the share of gas will expand significantly. In fact, we believe that current economics already warrant increased gas use in many parts of the region. Gas use will expand with additional discoveries and, even more importantly, with progressive development of a "gas utilisation culture." Use of gas is new in the region. As the governments and industries become familiar with established and new uses of gas, and as they prepare to make the heavy start-up investments in infrastructure and distribution, the consumption of gas is sure to rise by leaps and bounds. Assuming an annual energy demand growth of 3.5 to 5 % annually, we are likely to see demand for gas of 5 to 6 MMBDOE in the year 2000, compared to 1.9 MMBDOE in 1988. And still, we may well be on the conservative side.

Insofar as nuclear power is concerned, our forecasts do not include any nuclear power production in Indonesia, China, Pakistan, and the Philippines. In fact, we assume that there will be no additional nuclear development in nations outside of the few already with current involvement in nuclear power generation. Most of the projected additions are for the power plants already under construction or firmly planned. Nuclear power generation in Taiwan has faced severe political opposition and faces a moratorium. At most, one new nuclear facility (consisting of two units) may be built in Taiwan by the end of the century. In Japan, a significant amount of new generation capacity from nuclear power has been postponed. In Korea, as yet there is no active opposition, but it will be surprising if the environmental concerns already surfacing do not extend to nuclear power as well. Essentially, after a jump in nuclear capacity during the 1990s because of facilities already firm or under construction, we do not see many prospects for growth of nuclear power in the region.

USA	25%
Western Europe	16%
Asia-Pacific	7 to 10% *
(China)	(2%)
USSR	40%
Middle East	37%
Latin America	24%
Africa	14%
World	21%

* 7% including China and 10% excluding China.
Source: BP Statistical Review of World Energy 1990.

Table 2: Share of gas in the structure of energy demand 1989.

	1989	Year 2000* I	II
Oil	48	45	37
Gas	10	15	17
Coal	29	25	28
Hydro/Other	7	7	8
Nuclear	6	8	10
Total	100	100	100

*Corresponding to our Low Price Scenario I of $23 per barrel and High Price Scenario II of $35 per barrel of oil in the year 2000.

Table 3: Current and future Asia-Pacific demand structure, scenarios I and II (%) (excluding China).

Asia-Pacific Oil and Gas Reserves

In the global context, the Asia-Pacific region has only a small oil and gas resource base. Proven oil and gas reserves are shown in Table 4. The Asia-Pacific region contains around 47 billion barrels of proven oil reserves equivalent to only 4.6 % of world proven reserves, with a reserve-to-production ratio of 20 years. Indonesia and China together account for over 70 % of the regional oil reserves.

Gas reserves in the Asia-Pacific region account for nearly 7 % of proven world reserves and indicate a reserve-to-production (R/P) ratio of 56 years. There are many more countries with gas resources than with oil reserves, and the outlook is generally brighter.

If we were to look at an updated version of Table 4 in, say, 5 years time, we would probably see very little change in the oil picture, but a substantial change in the gas picture. Oil reserves will not change dramatically, but both gas reserves and R/P ratios will be very different. We are only in the early stages of finding gas and learning how to use it in the Asia-Pacific region. In addition, we do not believe there will be any new LNG importers. Therefore, new gas discoveries will be used domestically on a much wider scale in almost every country with significant gas reserves.

Asia-Pacific Crude Oil Production and Exports

The late 1980s saw an astonishing turnaround in the Asian oil market. After years of stagnation, three main factors—economic dynamism, lower oil prices, and reduced government regulation of the market—resulted in a consumption surge that surprised even those analysts that were already predicting recovery. A chronically capacity-surplus refining industry saw a leap in profitability, and a new construction boom began. Rapid demand growth spread from the middle distillates to such formerly depressed products as gasoline and fuel oil, and naphtha markets began

to expand again as the petrochemical industry resumed rapid growth. Across the Pacific, the US West Coast also experienced a renaissance in demand; although nowhere near as striking as the growth rates seen in Asia, the growth in gasoline demand from its huge base has begun to pose problems in terms of future supply.

The demand boom is only part of the story, however. At the same time that demand has been rising and demand patterns have been shifting, other changes have begun. A new environmental awareness has taken root in Asia, and new environmental standards are being set almost daily, not only in the richer countries of East Asia, but also in many of the developing nations of the region. Tetraethyl lead is rapidly being phased out of the gasoline pool, and sulphur specifications are being tightened on most products. In some of the larger economies, construction of nuclear power stations has come to a halt, and new coal plants are opposed as well. Although virtually every country remains committed on paper to controlling reliance on fuel oil in the power sector, old fuel burning facilities are being revamped and brought back online—in part, to meet the unexpected growth rates in electricity demand, but also as a stopgap measure to deal with political opposition to coal and nuclear power.

Unfortunately for the power-sector planners, however, traditional sources of low sulphur oil for power generation may be limited in the near term. Despite many new discoveries around the region, Asian crude availability is shrinking, both in terms of availability on the international market, and in terms of its percentage contribution to regional oil demand. After years of decreasing reliance on the Middle East, the region will face rapid increases in imports from the Persian Gulf in the 1990s.

This paper does not provide a major synthesis of all these factors; to do so would take a lengthy and highly detailed study. Instead, this report will merely identify and discuss a number of emerging questions in the market, and perhaps raise even more questions in the process.

Oil	Billion barrels	Share of total(%)	R/P Ratio
Total World	1,011.8	100.0	44.0
OPEC	757.9	75.0	100.0+
Asia-Pacific	46.8	4.6	20.0
Brunei	1.4	0.1	26.7
Indonesia	8.2	0.8	16.6
Malaysia	3.0	0.3	13.7
India	7.5	0.7	29.3
Australia	1.7	0.2	8.9
China	24.0	2.0	22.8
Gas	**Trillion cubic feet**	**Share of total (%)**	**R/P Ratio**
Total World	3,989.9	100.0	56.3
OPEC	1,620.1	40.6	100.0+
Asia-Pacific	283.6	7.1	55.3
Brunei	11.4	0.3	38.6
Indonesia	87.0	2.4	62.0
Malaysia	51.9	1.5	79.0
India	23.0	0.5	52.4
Australia	16.5	0.5	26.2
China	35.3	0.9	69.9
New Zealand	5.1	0.1	30.4
Bangladesh	12.4	0.4	98.8
Pakistan	18.0	0.5	40.9

Source: BP Statistical Review of World Energy 1990.

Table 4: Proven Oil and Gas Reserves (as of January 1, 1990).

Crude Supply and Crude Quality

Following the second oil crisis in 1979/80, Asian oil production and exploration increased rapidly. Formerly small players in the market, such as India, Australia, and Malaysia, , emerged as important producers. China expanded an already large industry. Only Indonesia showed rather disappointing results, but, given the difficulty in enforcing OPEC restraints on production, many producers saw this as a blessing. By 1985, regional reliance on imports from the Middle East was at an all-time low.

Asian production from supergiant fields is limited; most Asian fields are smaller, and keeping production levels up in most countries requires a high and continuous level of investment in exploration. Therefore, most analysts foresee a long-term decline in production, particularly in Southeast Asia.

The decline is not ready to happen yet. New finds in both Indonesia and Malaysia, coupled with new greenfield sites in Vietnam and Papua New Guinea, will continue to push up regional production in the near term; indeed, in the next two or three years, there may be a minor glut of heavy, waxy crudes, as Duri, Intan, and Widuri production hit full stride.

Our estimates of regional production by country are shown in Figure 1. This figure is based on projections of individual fields, coupled with major additional finds in Papua New Guinea, Burma, India, China, and Vietnam. As the figure shows, we anticipate a fairly rapid increase in regional production through the mid-90s, followed by a gradual decline through the end of the century. From a 1989 level of 6 million b/d, we expect production to rise to about 6.8 million b/d in 1995, falling back to just over 6.5 million b/d in 2000. Even with the decline, this leaves Asian production well above the levels it attained in the 1980s.

Demand for Asian crudes in producer countries is rising far more rapidly than production, however China, India, and Australia need all the crude they can produce; any exports from these countries will be offset against increased imports from elsewhere. Indonesia and Malaysia will remain major net exporters, but both face a general decline in production, and both plan a major increase in domestic refining that will consume large volumes of their own crude. Burma, Vietnam, and Papua New Guinea will all increase their exports dramatically in relative terms, but the increase is small in terms of the overall market. Brunei is the one constant factor in the Asian oil scene; Brunei could easily continue its current rate of production essentially unchanged until late in the twenty-first century.

Figure 2 shows our projections of Asian crude exports through 2000, with historical data beginning in 1977. Despite the continued increase in production through the middle of the decade, exports begin a very sharp decline after 1993. From present levels of around 2 million b/d, Asian crude exports will decline modestly to 1.9 million b/d in 1995, and then fall sharply to under 1.1 million b/d by 2000. Although the "other" producers, such as Burma, Vietnam, Papua New

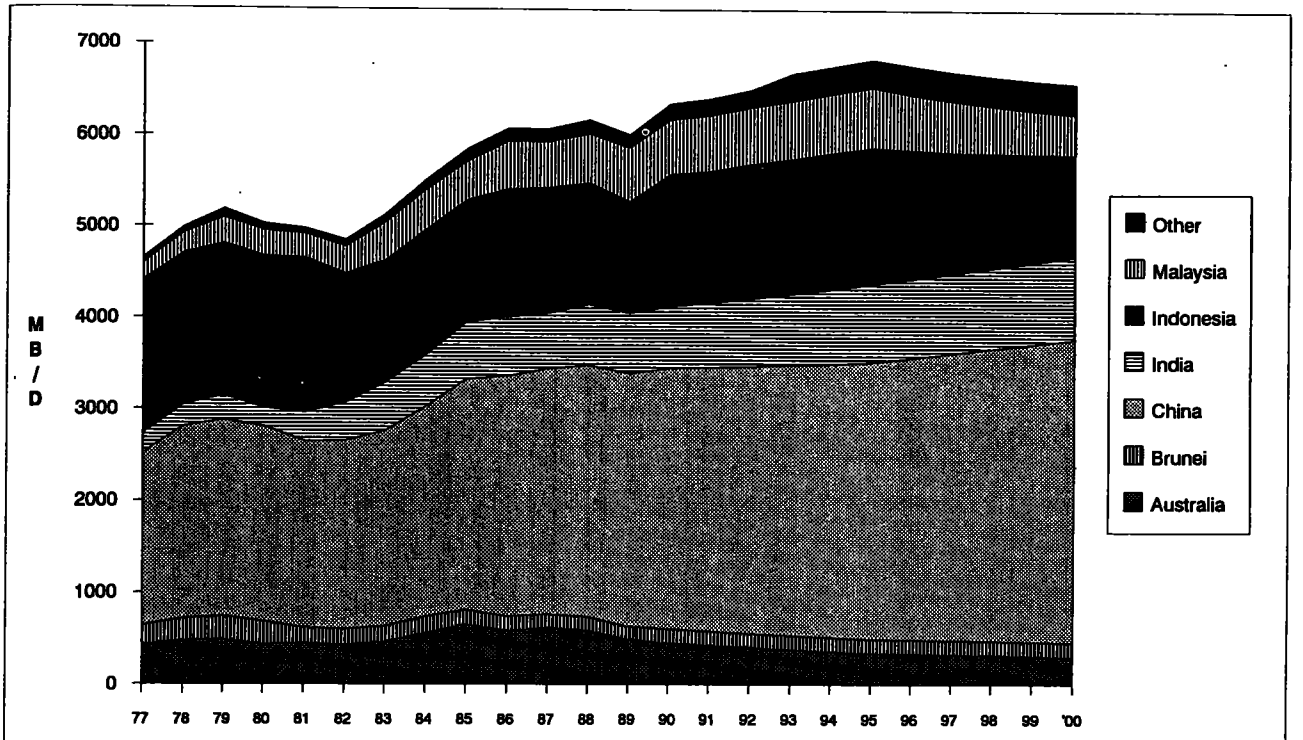

Figure 1: Historical and projected Asia-Pacific crude production, 1977-2000.

Guinea, and New Zealand, play only a minor role in regional production, by the end of the decade they may play a pivotal role in the region's crude supply situation. At present, "other" producers supply only a little over 3 % of the region's exports; by 2000, over 20 % of the region's exports could come from today's small producers.

The overall outlook is summarised in Figure 3, which shows the trend of regional production against the trend of available exports in the region. The story is simple—increasing domestic refining in producer countries results in decreasing crude exports—but the consequences may be complex.

Japan already has stringent specifications on sulphur in oil products. In the last few years, Taiwan and Korea have both tightened sulphur specifications, and Korea plans further dramatic reductions in the sulphur contents of both fuel oil and diesel. Formerly, such specifications were considered to be the concern only of rich countries, but environmental legislation has spilled down to medium-income nations as well, and now even many of the developing countries in the

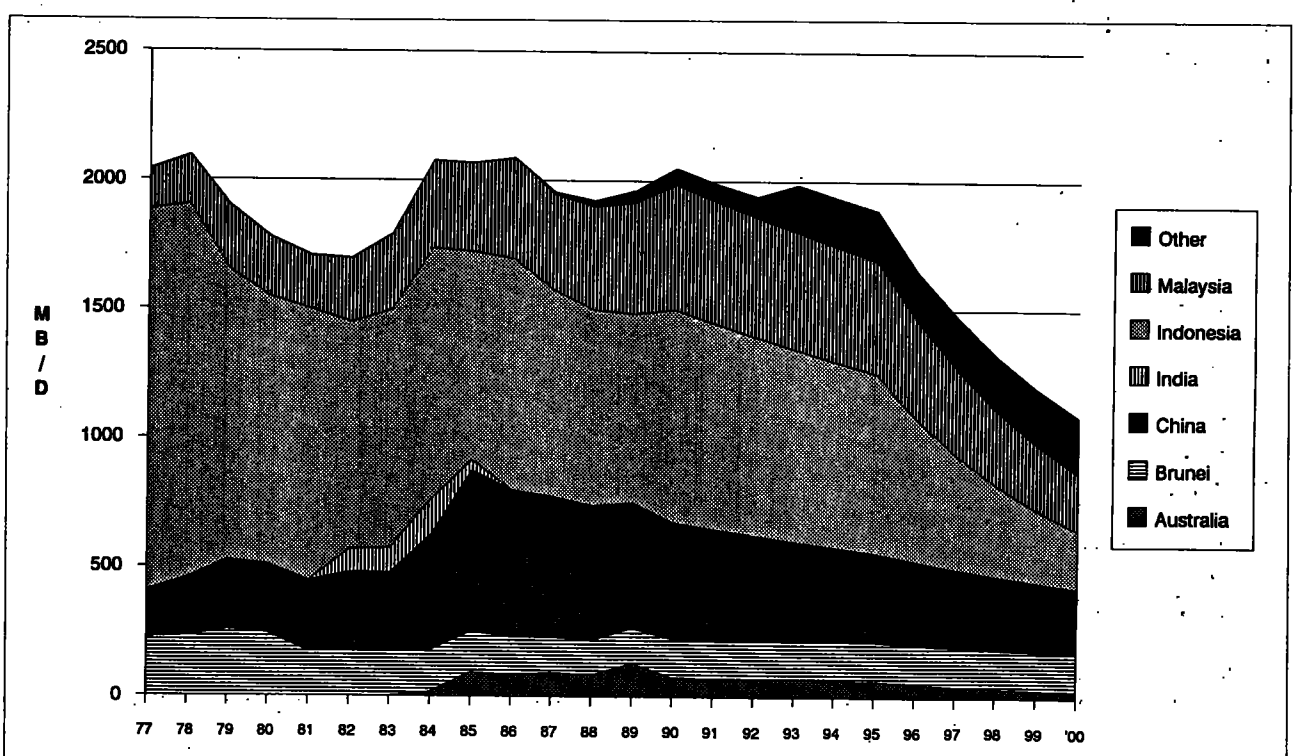

Figure 2: Historical and projected Asia-Pacific crude exports, 1977-2000.

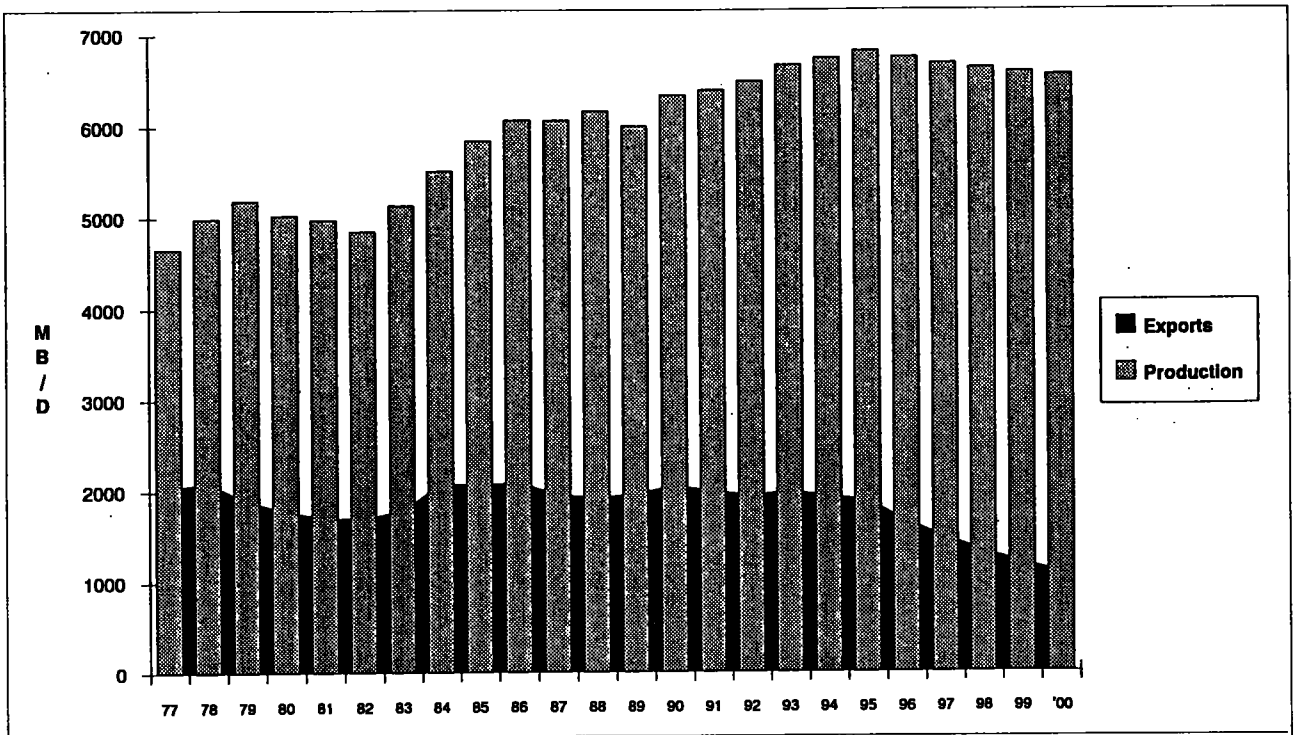

Figure 3: Asia-Pacific crude production vs. export availability 1977-2000.

region, such as Thailand, are considering tightening controls on sulphur emissions.

Unfortunately, the nearby sources of low-sulphur crudes are disappearing, and there are no obvious solutions to this problem. Other import sources, either west to the Middle East or east to Latin America, are notoriously high in sulphur; the "low-sulphur" crudes from these regions are typically much higher in sulphur than the "high-sulphur" Asian crudes. Although substantial new production of low-sulphur crude is expected from West and North Africa in the 1990s, the transport distances and competition for supplies by Europe and the US suggest that African crudes will continue to play only a minor role in the Asian crude slate. Thus, the 1990s will see a change in the region's overall slate. An assessment of the likely effects is given in Table 5.

Table 5 shows the probable crude slates for Asia as a whole in 1990, 1995, and 2000. The assumption implicit in the table is that Asian refining will continue to grow roughly in pace with demand, although the gap between refinery runs and demand will widen from 1.1 million b/d in 1990 to almost 2 million b/d in 2000; much of this gap is accounted for by imports of LPG. The calculations in the table are based on analysis of 50 crude streams in Asia, the Middle East, and Latin America. After 1990, it is assumed that virtually all Asian production will be consumed in Asia. The characteristics of all major Asian streams, including sulphur, specific gravity, and distillation yields, are tabulated along with forecasts of production by stream. For Middle East and Latin American streams (the latter playing only a minor role), similar characteristics are tabulated, and crude selections are made to fill the gap between regional production and anticipated refinery runs. Although the crude selection process is entirely judgmental, current patterns of imports, existing overseas tie ups, production profiles by stream, and product-demand patterns were all weighed in determining the import patterns.

In 1990, about 43 % of Asian refinery runs will come from outside the region. The average sulphur content of the Asian streams is 0.25 %, while the sulphur content of imported crudes averages 2.11 %, resulting in a total slate average of about 1.06 %. By 1995, over 51 % of the region's runs will come from imports; Asian crude sulphur content will average 0.28 %, imported crude will average 2.11 %, and, because of the greater role of imported crudes, total average slate sulphur will increase 15 % to 1.22 weight%. The trend continues through the end of the decade; although the average sulphur content of imported crudes dips slightly (owing to higher Middle East output of lower-sulphur crudes, plus increased Asian demand for lighter crude grades), the average slate sulphur increases to almost 1.4 % as a result of imported crude's share of the total slate increasing to 61 %.

Despite years of dire predictions about increasing gravity of the crude slate, our forecast does not see this as a factor in the Asian market. The API of Asian crude production is practically constant at 32 degrees, and we anticipate that the average gravity of imports from the Middle East will increase slightly as a result of Asian refiners seeking higher-quality crudes to make up for their loss of sulphur advantages.

Although the sulphur content increases only gradually across the period, when considered volumetrically, the problems refiners will face in an era of more-stringent specifications become obvious. On a straight-run basis, after accounting for refinery fuel use, refiners will have about 3.1 million b/d of low-sulphur resid and 2.2 million b/d of high sulphur resid in 1990. By 1995, this will increase to rough equality between the two pools; low-sulphur resids will total 3.4 million b/d, and high-sulphur resids will total 3.2 million b/d. In 2000, the straight-run yields of high-sulphur resids will dominate; low-sulphur yields will total 3.1 million b/d, while high-sulphur resids will total 4.4 million b/d.

The straight-run yields, when compared to demand, give an indication of the need for upgrading (or, alternatively, for

	Asia crude	Other crude	Total crude	Demand	Call on trade or upgrading
1990					
% of Slate	56.9	43.1	100.0		
Average Wt% Sulphur	0.254	2.114	1.057		
Average API	32.5	29.1	31.0		
Volume, mb/d	6,265	4,755	11,020	12,130	(1,110)
Straight-Run Yields:					
LPG	21	36	57	820	(763)
Naphtha/Gasoline	988	984	1,971	2,940	(969)
Kerosene/Jet Fuel	696	632	1,329	1,470	(111)
Diesel/Gasoil	1,305	831	2,136	3,350	(1,214)
Fuel Oil/Other	3,107	2,215	5,322	3,550	1,772
1995					
% of Slate	48.6	51.4	100.0		
Average Wt% Sulphur	0.278	2.111	1.220		
Average API	32.0	31.4	31.7		
Volume, mb/d	6,707	7,093	13,800	14,900	(1,100)
Straight-Run Yields:					
LPG	21	50	71	988	(917)
Naphtha/Gasoline	1,038	1,465	2,503	4,133	(1629)
Kerosene/Jet Fuel	732	913	1,645	1,759	(114)
Diesel/Gasoil	1,364	1,254	2,618	4,382	(1764)
Fuel Oil/Other	3,393	3,233	6,626	3,638	2,988
2000					
% of Slate	38.8	61.2	100.0		
Average Wt% Sulphur	0.296	2.099	1.399		
Average API	32.0	31.6	31.7		
Volume, mb/d	6,140	9,675	15,815	17,813	(1998)
Straight-Run Yields:					
LPG	20	55	75	1,097	(1022)
Naphtha/Gasoline	958	1,983	2,941	5,062	(2121)
Kerosene/Jet Fuel	672	1,258	1,930	2,112	(182)
Diesel/Gasoil	1,248	1,757	3,004	5,465	(2460)
Fuel Oil/Other	3,096	4,380	7,476	4,078	3,398

* Based on characteristics, yields, and forecast production profiles for 50 major crude streams.

Table 5: Implications of likely changes in Asian crude slate, 1990-2000*

trade to make up supply/demand mismatches). In 1990, about 1.8 million b/d of fuel oil will have to be disposed of; by 1995, this will increase to almost 3 million b/d, and by 2000 will climb to 3.4 million b/d. Since the demand for fuel oil around the region is becoming increasingly oriented toward low-sulphur material, most of the fuel oil that needs to be disposed of will be high in sulphur content. At present, many of the refiners around the region are ill prepared, in terms of feed pretreatment equipment, to handle a dirtier feedstock slate.

Gasoline Supply, Gasoline Quality and Naphtha Demand

One of the big surprises of the late 1980s was the revival of the gasoline market in Asia. Beginning in 1987, gasoline demand began to rise rapidly everywhere in the region; the increase was spectacular in some nations, such as Korea, where demand increased by 31 % in 1988. Traditional high consumers, such as Australia, are seeing additional increases, but even countries that have had low levels of gasoline consumption historically, such as Japan, have seen a massive growth in demand.

The increase in demand for gasoline has been accompanied by a revival in the naphtha market, mostly as a consequence of the renewed vigour of the Asian petrochemicals market. Starting from 1989, the base year of the increase, naphtha is expected to grow at annual rates of 6.7 % through to 1995; gasoline demand is expected to grow at 3.9 % across the same period. Although the surge slows after 1995, in the last half of the decade, both products are expected to grow at about 3 % per year.

Figure 4 shows our forecast of regional demand for naphtha and gasoline, aggregated from our country-by-country product demand forecasts. From a 1987 base of 2.6 million b/d, the demand for naphtha and gasoline is expected to reach 4.0 million b/d by 1995, and nearly 4.6 million b/d by 2000. Despite this large increase, however, the share of light distillates in total demand does not increase substantially. Because of rapid growth across the barrel, the share of light distillates in total demand increases only modestly from 27 % of the "non-LPG barrel" in 1990 to 28 % in 2000.

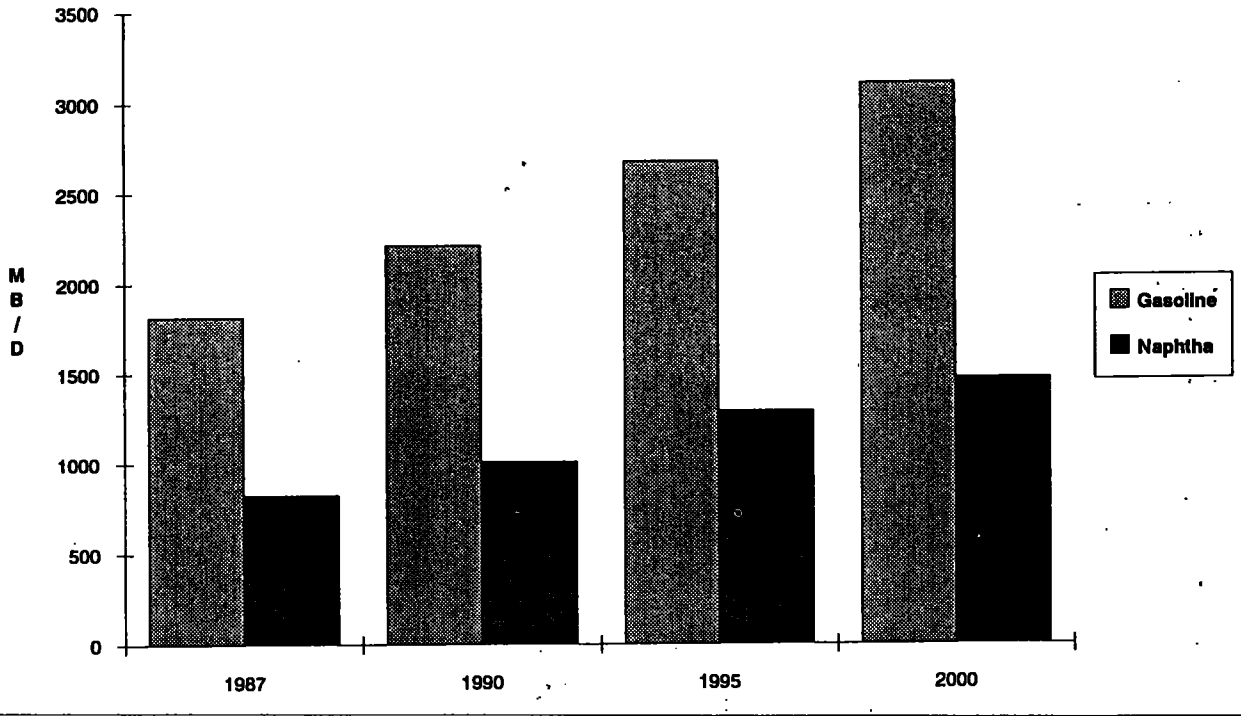

Figure 4: Increase in Asian demand for light distillates, 1987-2000.

Like other fractions of the barrel, gasoline is now subject to new environmental pressures. On the US West Coast, these have included RVP reductions, elimination of tetraethyl lead, olefin controls, and now, discussions are underway for legislative limitations on aromatics content and minimum oxygenate contents. In Asia, the environmental focus has thus far been restricted to lead content, but the aromatics situation and the role of oxygenates is now under study in Japan.

Somewhat surprisingly, Asia already has one of the largest percentages of unleaded gasoline among the world's regions. The two biggest gasoline-consumers in Asia, Japan and China, are virtually lead-free, although the reasons for this situation in the two countries are quite different.

Excluding China, leaded and unleaded gasoline have about equal shares of the Asian market at present. Japan accounts for nearly 90 % of all the unleaded gasoline demand. In no other nation however, (other than China) does the share of unleaded presently exceed 25 %.

The situation is undergoing rapid change. Just a few years ago, many nations allowed leading up to O.8 g/l; now 0.4 g/l is widespread, and most of the countries with this standard have announced moves to 0.15 g/l or lower in the next three years. Almost all of the nations outside of the Indian subcontinent have plans for eliminating lead by the middle of the next decade.

Based on current legislation and plans under discussion (coupled with country-by-country specifications, grades, and demand forecasts) the outlook for the Asian gasoline pool outside China is shown in Table 6. In the late 1980s, unleaded gasoline accounted for 51% of demand, at 729,000 b/d; by 1995, unleaded demand will more than double to 1.66 million b/d, and will account for 84 % of the total.

Closer examination of Table 6 shows some curious trends. Although the average octane of the unleaded pool stays constant, the octane of the leaded pool falls, even though the average levels of lead in the leaded pool increase slightly. This counter-intuitive development is the result of the fact that the conversions to unleaded are taking place mainly in nations where relatively high octane grades predominate, and where leading levels already tend to be lower than in many of the poorer nations. The leaded pool past 1995 is restricted primarily to nations with low octane standards and heavy use of lead.

The rapid phase out of lead at a time of soaring demand might seem to place impossible pressures on the Asian octane pool. Surprisingly, however, the current levels of upgrading firmly planned, plus facilities already in place, can easily cope with the octane problem. Asia has always had more catalytic cracking than appropriate, given the level of gasoline demand, partly because the capital and operating costs for hydrocracking have proven to be too big a hurdle for the industry in many countries. The revival of demand for light distillates has led to plans for additional resid catalytic cracking, as well as major investments in catalytic reforming. If facilities operate near capacity, Asian gasoline demands can be met easily in both volumetric and octane terms based on units we expect to be onstream by 1995. This excess of octane is not surprising in light of the fact that many Asian countries (from Thailand to Indonesia, and possibly even Japan) have aspirations to be gasoline exporters in the 1990s. Furthermore, the expansion of MTBE production in the region offers alternatives that will give even more flexibility in gasoline blending; Asian countries should be producing a minimum of 28,000 b/d of MTBE by 1995.

The difficulty that Asian refiners will face is not one of octane, but rather one of total light-distillate volume. In the past, naphtha has been a high-volume, low-cost trade commodity in the region. A number of countries, notably Indonesia, Singapore, and India, have had substantial naphtha surpluses for export, and these have been augmented by large volumes of trade from the Middle East. Demand

	1987 ('000 b/d)	1987 g Pb/l	1987 % vol	1995 ('000 b/d)	1995 g Pb/l	1995 % vol
Unleaded						
95-97	88.6		6.3	428.0		21.8
91-93	640.1		45.2	1206.3		61.4
<85	0.6		0.0	23.9		1.2
Subtotal unleaded	729.3		51.5	1658.1		84.4
AVG RON	92.5			92.5		
Leaded						
97-98	284.9	0.32	20.1	61.3	0.24	3.1
95-96	140.7	0.35	9.9	38.5	0.38	2.0
91-93	4.8	0.84	0.3	0.5	0.84	0.0
88-90	52.0	0.66	3.7	39.1	0.84	2.0
85-87	144.4	0.64	10.2	127.0	0.55	6.5
81-83	35.1	0.51	2.5	14.2	0.40	0.7
79-80	23.6	0.46	1.7	25.9	0.46	1.3
Subtotal leaded	685.6		48.5	306.5		15.6
AVG RON	92.6			89.5		
AVG g/l		0.44			0.49	
Total	1414.9		100.0	1964.6		100.0
AVG RON	92.5			92.0		
% Unleaded	51.5%			84.4%		

Table 6: Asia (excluding China) current and projected gasoline pool by grade.

growth and gasoline blending in the region now suggest that the naphtha surpluses from regional exporters are likely to dry up in the 1990s. Furthermore, continued naphtha supplies from the Middle East face an uncertain future as well; Middle East countries are studying ways of upgrading current naphtha exports into gasoline, and though gasoline and naphtha markets elsewhere in the world do not show the dramatic levels of demand increase seen in Asia, growth is strong almost everywhere.

Many countries in Asia now envision themselves as gasoline-exporters and naphtha importers. Unfortunately, few are now inclined to view themselves as naphtha-exporters and gasoline-importers. A major collapse of gasoline prices is not likely, but a major strengthening of naphtha prices now seems almost inevitable.

This prediction should not be surprising; what is surprising is the extent to which the Asian market has remained unlinked with market conditions elsewhere. Figure 5 shows gasoline-naphtha differentials in the US, Rotterdam, and Singapore markets. Singapore differentials are far wider than those seen elsewhere. Examination of the data shows that this is not a result of the gasoline prices, which are fairly closely linked around the world, but rather the result of unusually low naphtha prices in Asia. A prediction of narrowing gasoline-naphtha differentials in Asia is essentially a prediction of increased relative naphtha prices.

Given the many countries that currently aspire to be major gasoline exporters, it is logical to ask where the exports will go. In the short term, there are many markets in nations that have found themselves overtaken by the demand surge, but in the longer term, most nations have plans that entail gasoline self-sufficiency at the minimum, and exportable surpluses in many cases. When this is pointed out, the inevitable response is to point out the situation on the US West Coast.

Gasoline demand is growing on the West Coast. Although growth rates are slower than in Asia, demand is growing from a large base. West Coast crude supplies are tightening, and new environmental restrictions, especially in California, will require major investments in emission controls at refineries. There is also widespread opposition to construction of new refineries, or indeed new oil facilities of any sort. Coupled with high operating costs, many West Coast refiners have begun to ponder increased gasoline imports as a means of meeting their market needs, and some have even explored the concept of locating new refineries "offshore" to serve West Coast markets. Thus, on the face of it, the West Coast would appear to be a promising market for Asian exporters.

The nature of gasoline on the West Coast is undergoing major shifts at present, however. As mentioned before, new specifications, new kinds of "reformulated gasolines," and new controls on emissions are being widely discussed. Although the West Coast market for gasoline may be attractive, it is unclear if most Asian refiners will be able to meet new US West Coast specifications. Until recently, the RVP restrictions and the requirement that the gasoline be unleaded were perceived as the major hurdles; currently, proposed limitations on the aromatics content of gasoline could add an even more significant barrier to Asian exporters.

The exact form of future aromatics standards is uncertain. A limitation on maximum benzene content of 0.8 % seems likely; full elimination is possible. Some restriction on C9 and C10 aromatics may come into place, and there are many pieces of legislation that propose lowering total aromatics content to a level of 25 % by volume.

Although the Asian octane pool is relatively rich, and likely to become richer in the 1990s, Asian refiners rely heavily on catalytic cracking and catalytic reforming for their high-octane blendstocks; these technologies result in high-aromatics blendstocks. Indeed, catalytic reforming

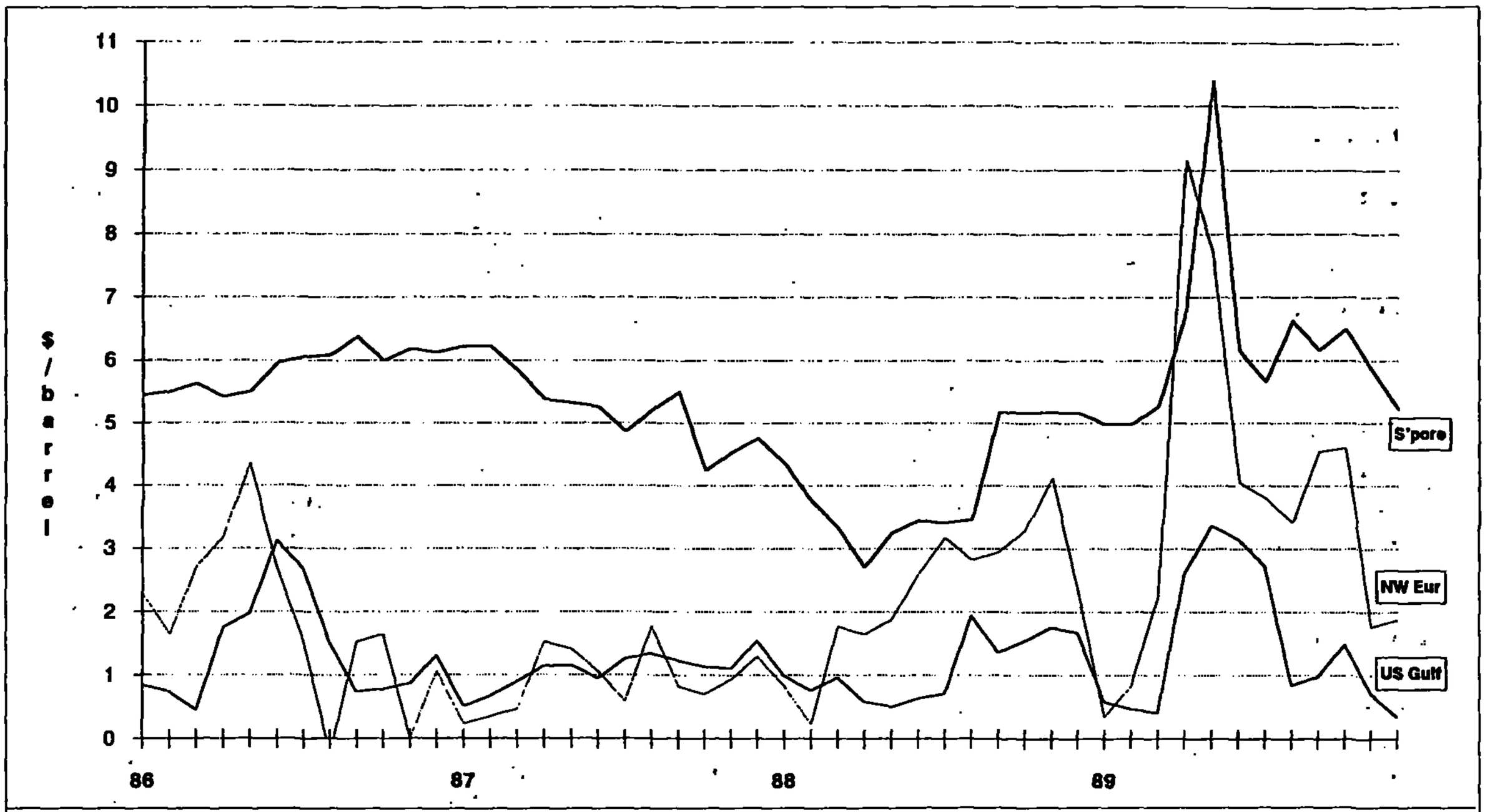

Figure 5: Gasoline-naphtha differentials in three markets.

exists primarily to convert non-aromatics to aromatics. Because of this high reliance on these two technologies, Asian gasoline blendstocks tend to be higher in aromatics than the US average. This is shown more clearly in Figure 6, which provides estimates of the average aromatics content of gasoline produced in various countries, based on the unit sources of their blendstocks, corrected for BTX extraction, and, in the cases of India and China, for operation of catalytic crackers at low conversion rates. As the figure demonstrates, to meet a 25 % limit on aromatics content, all refiners would have to cut substantial amounts of high-octane material, which would be particularly severe in many Asian countries. Furthermore, this graph displays the present situation; most countries, including low-aromatics Thailand and India, have plans for additional RCCs and/or catalytic reformers that will push their pool composition even higher in terms of

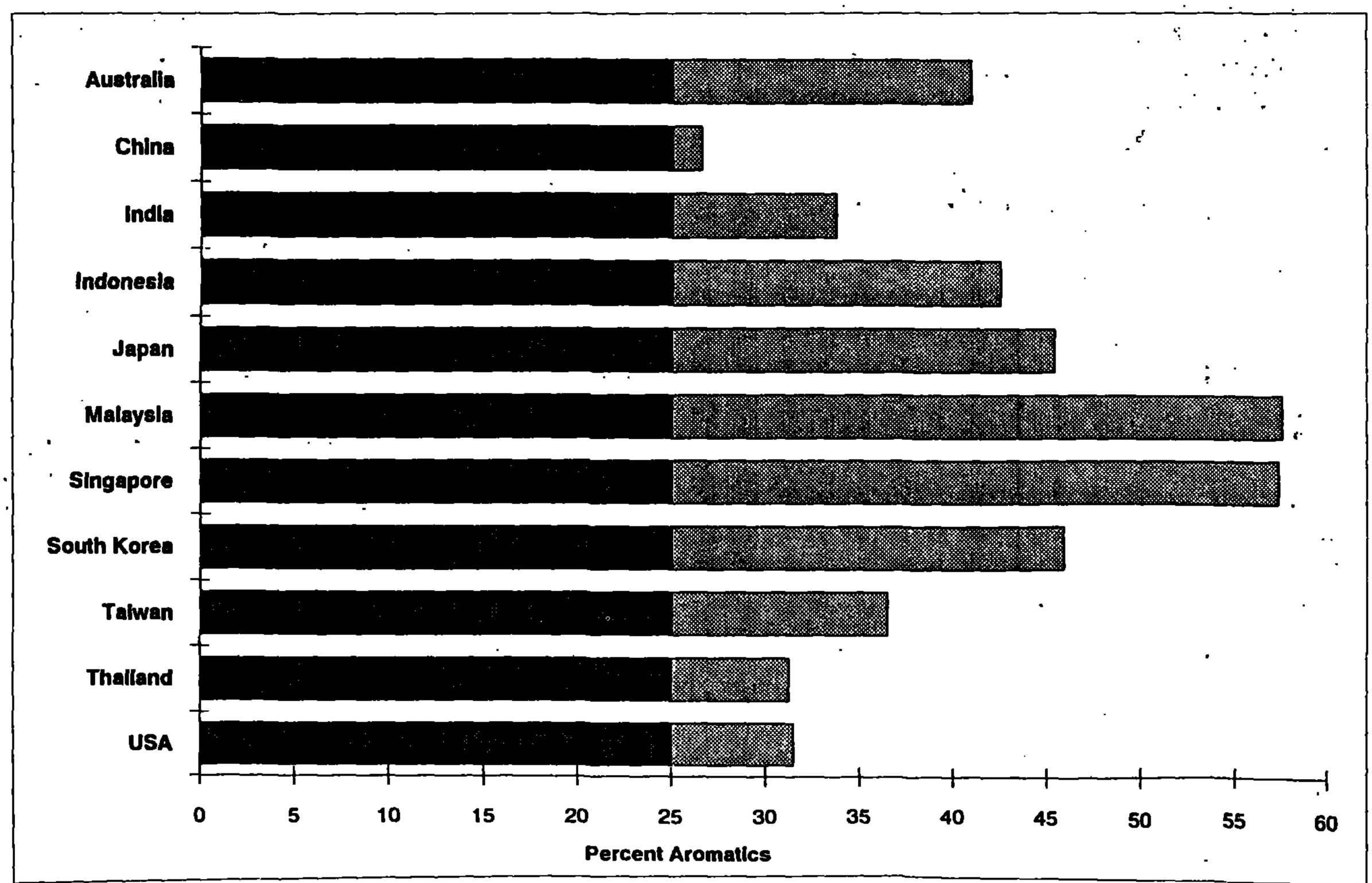

Figure 6: Estimated gasoline-aromatics content compared with 25 % standard.

Year	LPG	Naphtha*	Mogas	Jet/Kero	Gasoil	Fuel Oil	Asph/ Lube/etc.	TOTAL
1987	921	826	1,815	1,207	2,818	2,764	623	10,974
1990	1,016	1,012	2,214	1,512	3,570	3,059	684	13,067
1995	1,201	1,292	2,678	1,791	4,510	3,269	877	15,618
2000	1,403	1,473	3,111	2,070	5,562	3,130	969	17,718
AAGR 87-95	3.37%	5.75%	4.98%	5.06%	6.05%	2.12%	4.37%	4.51%
AAGR 90-95	3.40%	5.01%	3.88%	3.44%	4.79%	1.34%	5.10%	3.63%
AAGR 95-2000	3.16%	2.66%	3.04%	2.94%	4.28%	-0.87%	2.02%	2.56%
AAGR 87-2000	3.29%	4.45%	4.23%	4.24%	5.37%	0.96%	3.46%	3.75%
AAGR 90-2000	3.28%	3.83%	3.46%	3.19%	4.53%	0.23%	3.54%	3.09%
Increase, 87-95	280	466	863	584	1,692	505	254	4,644
Increase, 87-90	95	186	399	305	752	295	61	2,093
Increase, 90-95	185	280	464	279	940	210	193	2,551
Increase, 95-00	202	181	433	279	1,052	-139	92	2,100

*Note: Includes naphtha, solvents, and petrochemical feedstocks. Some Chinese petchem feeds are heavy gasoils included in "Asph/other" category.

Table 7: Asia-Pacific oil demand, 1987-2000.

aromaticity. This is good news in terms of the region's drive towards unleaded gasoline; it may not be quite so appealing to exporters planning to penetrate US markets.

Product Demand and Refining Capacity.

Table 7 shows our base case demand forecast for the Asia-Pacific region for 1995 and 2000, with 1987—the first year of renewed growth—as a reference benchmark. Total demand for oil is expected to expand from its 1987 base of 11 million b/d to an estimated 13.1 million b/d in 1990, to 15.6 million b/d in 1995, and to 17.7 million b/d in 2000. The total average growth rate across the 1987-2000 period is about 3.8% per annum, with faster growth in the earlier portion of the period.

Figure 7 shows the 1990 demand barrel (excluding LPG) compared with the incremental barrel of demand for the period through 1995. The current barrel consists of around 8% naphtha, 18% gasoline, 13% kerosene, 30% diesel, 25%

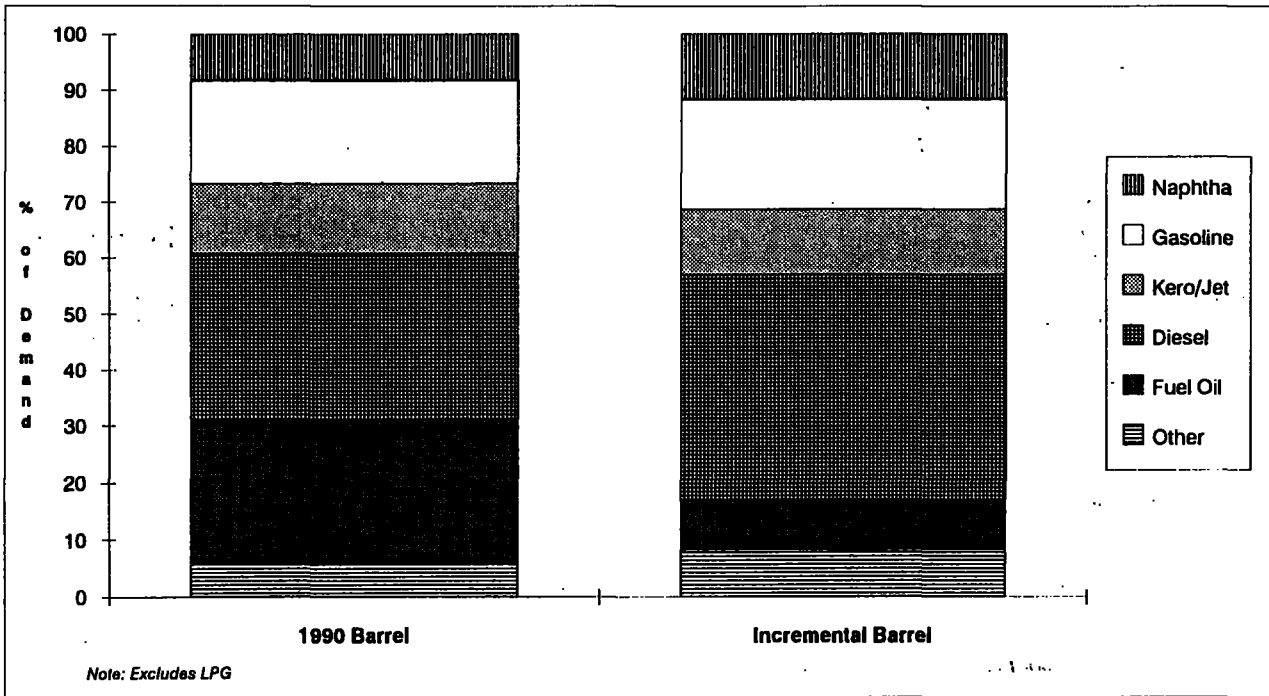

Figure 7: Asia-Pacific incremental demand barrel, 1990-95.

fuel oil, and 8 % "other" (primarily lubes, greases, and asphalt). The marginal demand barrel shows quite a different composition: 12 % naphtha, 20 % gasoline, 12 % kerosene, 40 % diesel, 9 % fuel oil, and 8 % "other." Despite the revival in fuel oil demand, the incremental barrel is composed of 83 % middle and light distillates. The need for additional upgrading to balance the barrel is obvious.

Additions of 2 million b/d to current crude capacity are firmly planned, and another 1 million b/d of capacity is under serious study. Associated with current plans are 665,000 b/d of firmly planned cracking capacity, and another 467,000 b/d of cracking under study. The scope of present upgrading activity is shown in Figure 8.

Additions of 160,000 b/d to current coking capacity of 273,000 b/d is probable by 1995; another 60,000 b/d is under study. Planned catalytic cracking expansions are more modest relative to current capacity, adding 276,000 b/d to the current base of 1.7 million b/d. While this may not seem like a substantial addition, much of the new FCC/RCC capacity is planned for countries where catalytic cracking has not previously made a major penetration: Singapore, Korea, Indonesia, and Thailand. Hydrocracking will expand by 230,000 b/d from its current base of 452,000 b/d; another 105,000 b/d is under study. Along with the cracking facilities planned, there are also firm plans for 135,000 b/d of new resid desulphurising and 426,000 b/d of additional catalytic reforming.

The impact of this new upgrading on the regional refining system is greater than might be implied by looking at the relative increases in cracking capacity, simply because so much Asian cracking capacity is under-utilised. China and India both run their catalytic crackers at relatively low conversion rates to increase the output of cycle oils for middle distillate blending; China has also experienced problems in getting sufficient feedstock to some of its conversion units outside the Northeast provinces. Japanese utilisation of cracking has until recently been relatively low because of the production-quota system, and the refusal of MITI to allow product exports from Japan. Indonesia has had poor success at running its hydrocrackers at anything near capacity because of various minor problems. Many of these new units, on the other hand, will be located in more market-oriented settings, often in refineries geared to exports. The presence of international oil companies as partners in many of the new ventures will help ensure better utilisation. Thus, the new units may have a larger effect on the market than would be suspected from past experience, and there is also a possibility that the new tightness in the refining market will encourage fuller utilisation of existing facilities. Together, new units plus fuller utilisation of existing facilities can go a long way towards meeting the incremental-demand barrel.

The greatest increase in demand, however, continues to be in the middle distillates. Some additional upgrading beyond that firmly planned will certainly be needed, but it is not clear that catalytic cracking—the technology currently most under study—will help much in achieving balance. Indeed, given the overall octane situation discussed in the previous section, if much additional catalytic cracking capacity is built, some refiners may find themselves running catalytic crackers to produce naphtha rather than gasoline.

There has been some concern expressed recently that Asia may be overbuilt. The concern might be given more credence if most of the parties expressing concern were not engaged in capacity expansion themselves. Nonetheless, overbuilding is always a risk in the oil industry, where profitability tends to attract capital sufficient to smother the profits. How real is the risk?

If every refinery project discussed in the region were actually to be built, there is no doubt that a major overcapacity

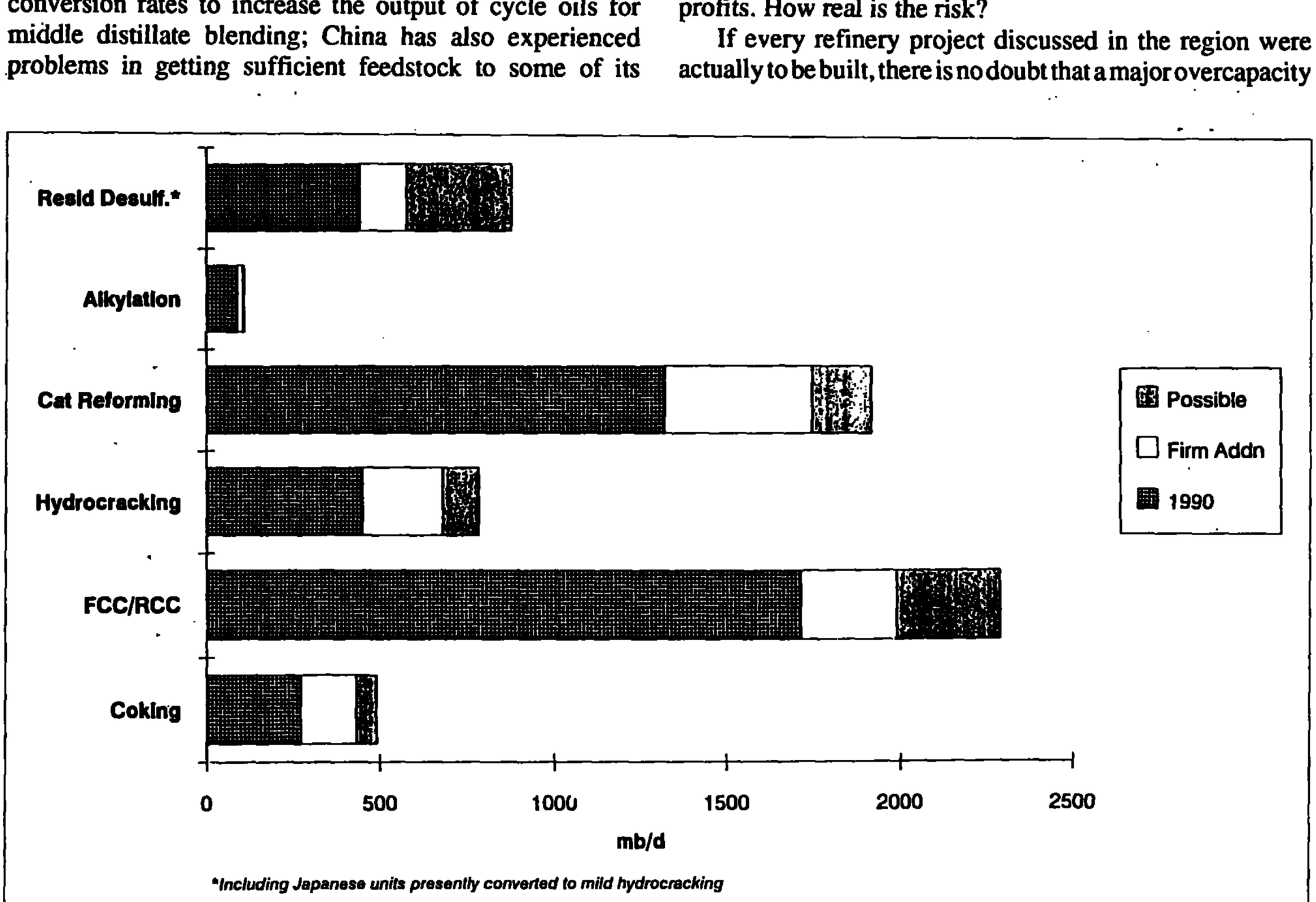

Figure 8: Asia-Pacific upgrading capacity: current, firmly planned by 1995, and possible.

would emerge. It would be a mistake to assume, however, that every project talked about will be built; in the last two years, we have seen proposals for at least 500,000 b/d of new capacity proposed, discussed, studied at various levels of detail, and then abandoned. We believe that there will be a major expansion in capacity, but we also believe that some of the projects currently put forth as "planned" will be shelved, and others will be built, but on a longer time horizon than initially foreseen. Already several schedules have slipped for various reasons.

Current capacity in the region is about 12.6 million b/d; most of the current excess is in Japan, although Japanese demand growth may erode this surplus rapidly. Another 2 million b/d is firmly planned in our estimation, and likely to be built by 1995, bringing the regional total to 14.6 million b/d. By that date, we expect regional demand, excluding LPG, to total about 14.4 million b/d. If anything, this suggests a slight shortfall in capacity, depending of course on the level of product imports. Even if non-LPG product imports are 1 million b/d, this would imply a capacity utilisation rate of 92 %.

On the other hand, there are plans for an additional 1.1 million b/d of capacity that we believe are likely to be built someday, but unlikely to be completed before 1995. If these projects were all to be completed by 1995, this would raise the regional total to 15.7 million b/d. If this is then compared with non-LPG demand and 1 million b/d of imports, capacity utilisation would drop to about 85 %.

Our expectation is for a relatively tight market. We consider it unlikely that 3.1 million b/d of new capacity will be built between 1990 and 1995; we also believe that product availability from the Middle East is unlikely to expand in the near term, and may contract significantly. In any case, if the existing product demand forecasts are correct, slight overbuilding would quickly be absorbed by demand growth in the second half of the decade.

What are the risks, then? The first possibility is that a new wave of export refineries will be constructed in the Middle East. Although various expansions are under study, only modest expansions now seem likely between now and 1995; late in the decade, it may be a different story.

The second possibility might be entitled "The Oil Crisis: Part III." Asia's booming demand will be fuelled mainly with imports from the Middle East. Imports from the Middle East are likely to increase by around 1.7 million b/d from 1990 to 1995, and by another 2.4 million b/d between 1995 and the year 2000. This is not, of course, unique to Asia; most regions will be turning to the Persian Gulf for their marginal supplies in the 1990s. At some point in the 1990s—possibly as early as 1992—the world will enter a situation where a disruption in the Middle East will matter again. If the current crisis had occurred later in the decade, the market would likely be very different. In the 1980s, the top OPEC producer, or two or three smaller ones, could have gone out of business without causing more than a slight firming of prices. The production overhang is vanishing rapidly, despite the large new investments Middle East countries are making in new capacity. By the mid-90s, the stage will be set where another price shock could occur. It remains to be seen whether the current situation will provide a lasting lesson.

Note that the preconditions for a price shock does not mean that a shock will happen; OPEC countries suffered as much as anyone from the aftermath of 1979, and many of the key players may now be more prudent. Saudi Arabia and Venezuela are both examining plans to raise capacity well beyond the levels at which they would like to produce; this could leave them in control of a market that might otherwise explode. Both have boosted production in the months following the Iraqi invasion of Kuwait. Nonetheless, there is no certainty that either country would be in a position to control the market in a future crisis, and by the time conditions are ripe for another price shock, the current decision-makers may have been replaced by a new generation. The possibility of yet another replay of 1973 and 1979 at some point in the 1990s cannot be ignored.

In terms of refining strategy, in the aftermath of an oil shock, middle distillates maintain much of their growth momentum—largely because of government policies that continue to protect middle distillate consumption either as a "productive" use of energy, or, in the case of kerosene, for political reasons. Gasoline is less protected, but it is hit harder in countries where it is a "consumer" good; in developing countries, where private auto ownership is not widespread, much of the growth is maintained by the use of cars for business and tourism. This latter fact suggests that following future oil-price shocks, declines in gasoline might also be seen in the wealthier developing countries, where private auto ownership is more widespread. Finally, fuel oil is the easiest target for government policy, and is likely to be the first point of attack in future years.

In short, if an oil crisis occurs in the 1990s, the refiners who will cope best will be those who have the cracking flexibility to achieve considerable conversion; again it will be the hydroskimming facilities that suffer. Yet another oil shock will be different to 1979; refinery capacity surpluses were already looming before the Iranian revolution. Given the current capacity situation in Asia, unless building speeds greatly beyond current plans, even a major price increase would not result in the kind of widespread misery seen in the early 1980s. The one factor that could change this is refining policies in the Middle East. If Asian nations continue to build to meet their own demand, and the Middle East countries also launch a major refining expansion for completion in the late 1990s, and then a price shock occurs as well, the effective capacity overhang could be very large. This problem we all hope will never arise again.

Author

FEREIDUN FESHARAKI is the Leader of the Energy Program at the Resource Systems Institute, East-West Centre, Honolulu, Hawaii. Born in Iran, he received his Ph.D. in Economics from the University of Surrey in England. During 1977-78 he attended the OPEC Ministerial Conferences in his capacity as Energy Adviser to the Prime Minister of Iran. After completing a Visiting Fellowship as Harvard University's Centre for Middle Eastern Studies, he joined the East-West Centre in 1979.

His area of specialization is oil and gas market analysis and the downstream petroleum sector, with special emphasis on the Asia-Pacific region, Middle East, Caribbean and United States. He has been a consultant to a number of major oil companies, independent oil companies, utilities, mining companies, shipping/storage firms and governments in the Middle East, Pacific basin and the Caribbean, and as well as the United States government.

Dr Fesharaki is the author of more than 50 papers and has authored or edited twelve books, the latest of which are "Economic and Political Incentives to Petroleum Exploration: Developments in the Asia-Pacific Region" (University Press of America, 1990), and "The Oil Market in the 1990s: Challenges for the New Era" (Westview Press, 1989). He is also Vice President for International Affairs of the International Association for Energy Economics and serves on the editorial board of the Energy Policy Journal. He is a member of the Council on Foreign Affairs.