

CSIS

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**The
Changing Geopolitics of
Energy – Part VI**

**Regional Developments
in East Asia, China, and India**

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**Strategic Energy Initiative
Center for Strategic and International Studies**

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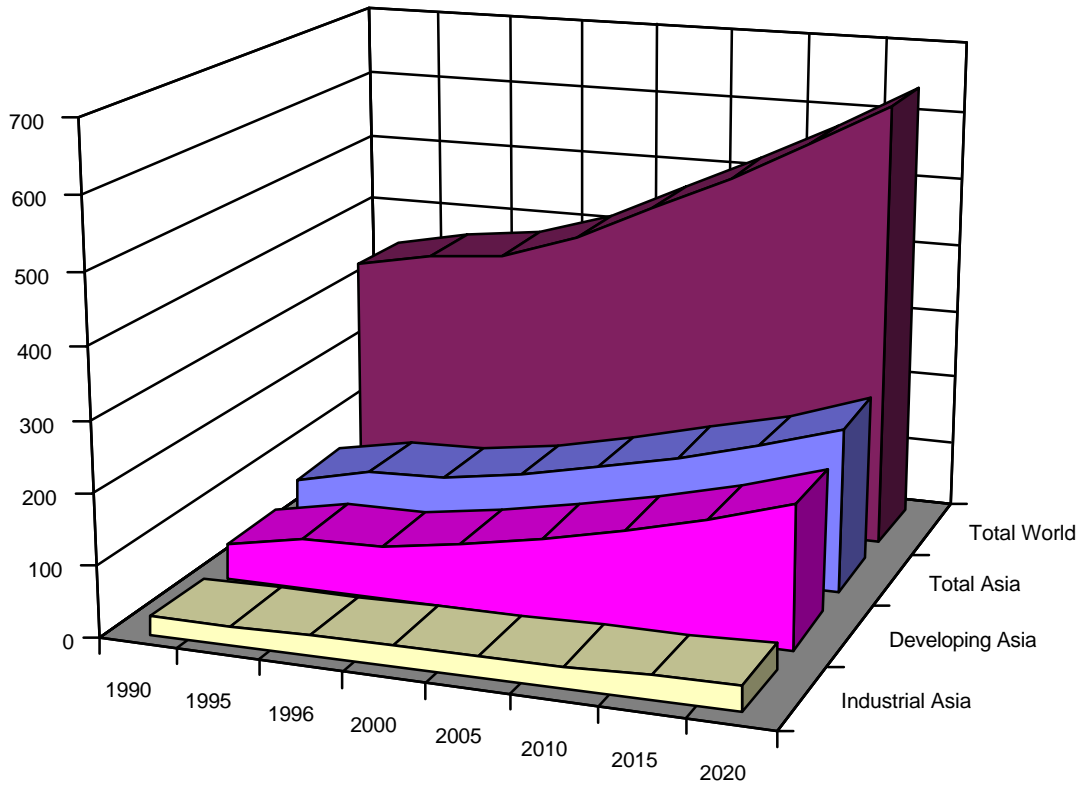
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Asia is Reshaping the Geopolitics of Energy

Key Issues Affecting Asia

- **Future rate of economic growth and resulting demand for energy**
- **Implementation of nuclear plans.**
- **Practical ability to make massive increases in coal use.**
- **Transportation problems in importing oil and gas.**
 - **Role of new pipelines.**
 - **Increase in tanker flows.**
- **Intra-regional issues: South China Sea, etc.**
- **New trade and economic patterns with rise in Asian oil imports from the Gulf.**
- **Environmental Problems.**

Asia is Radically Changing the Distribution of World Energy Use: Future Share of World Energy Use: 1990-2020:
 (in Quadrillions of BTU)

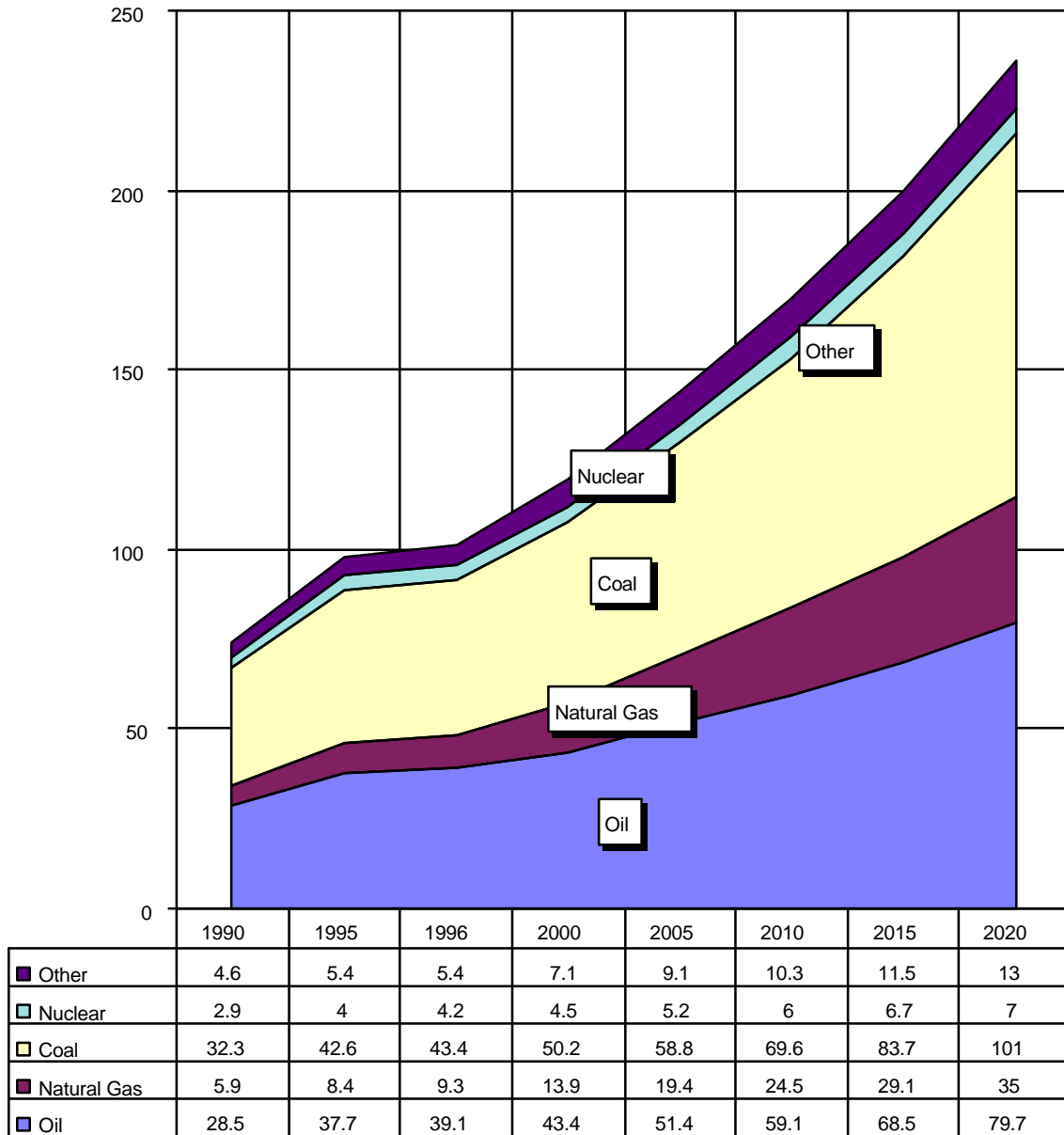


	1990	1995	1996	2000	2005	2010	2015	2020
Industrial Asia	23	26.3	26.9	28.4	30.1	32.1	34.1	36.3
Developing Asia	51.4	71.8	74.5	90.8	113.8	137.4	165.4	199.4
Total Asia	74.4	98.1	101.4	119.2	143.9	169.5	199.5	235.7
Total World	343.8	365.6	376.1	413	465.7	519.6	575.6	639.4

Source: Adapted by Anthony H. Cordesman from the “reference case” EIA, International Energy Outlook, 1998, DOE/EIA-0484(97), p. 133.

Asia is Vastly Increasing Its Use of Oil, Gas, and Coal: Asian Energy Consumption by Fuel

(In Quadrillions of BTUs, EIA Reference Case)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p.134-135.

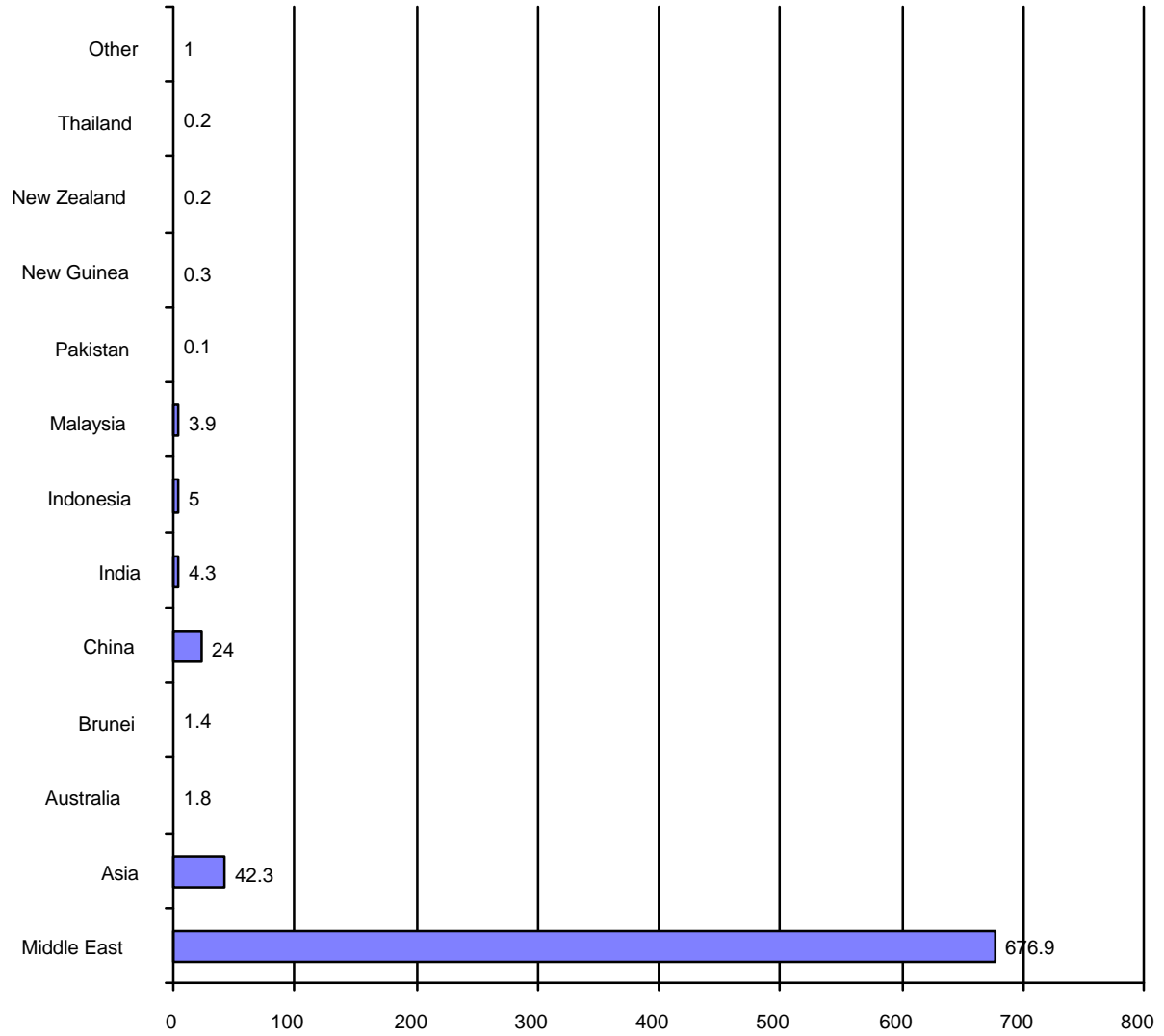
World vs. Asian-Pacific Energy Demand
Primary Energy Demand by Type
(Million Metric Tons of Oil - Mtoe)

<u>Energy Type</u>	<u>1995</u>			<u>2005</u>		
	<u>World Demand</u>	<u>Asia Pacific Demand</u>	<u>% of World</u>	<u>World Demand</u>	<u>Asia Pacific Demand</u>	<u>% of World</u>
Coal	2,455.4	967.2	39.4%	2,952	1,385.9	46.9%
Oil	3,372.8	899.4	26.7	4,100.5	1,309.0	31.9%
Natural Gas	1,804.1	192.1	10.6%	2,391.0	330.8	13.8%
Nuclear	577.9	97.8	16.9%	634.4	142.3	22.4%
Hydro	214.6	46.4	21.6%	298.7	92.0	30.8%
Other	49.6	12.8	25.9%	85.8	20.8	24.3%
Total	8,474.4	2,215.6	26.1%	10,463.2	3,280.8	31.4%

Source: Jim Placke, Cambridge Energy Research Associates, September 10, 1996.

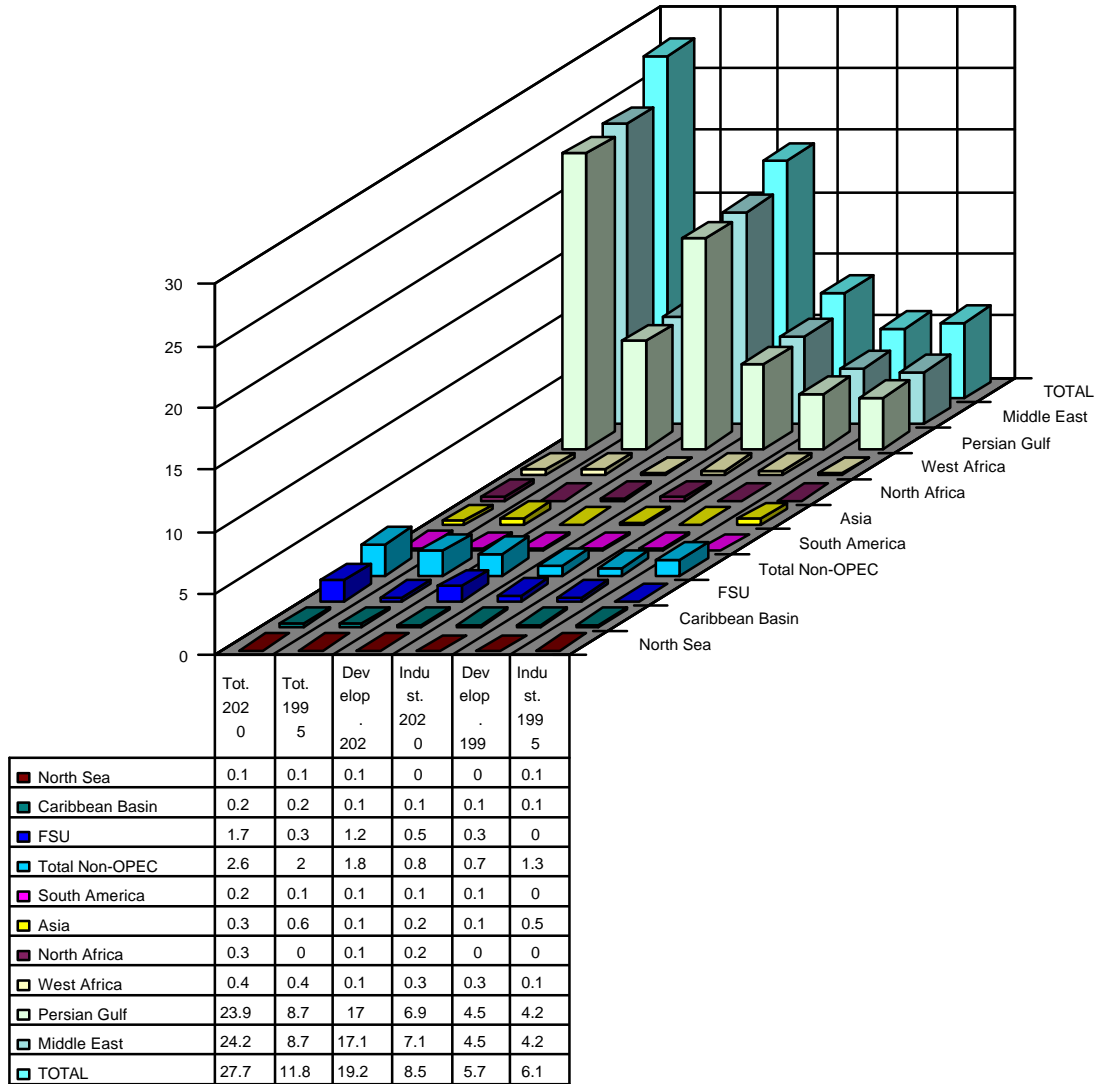
Individual Asian States Have Limited Reserves: Middle Eastern versus Asian Oil Reserves

(Thousand million barrels)



Source: Adapted by Anthony H. Cordesman from BP Statistical Review of World Energy, June, 1998, p.4.

Asia's Rapidly Growing Dependence on the Gulf: Projected Asian Oil Imports by User and Source 1995 and 2020 (MMBD, EIA Reference Case)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 36.

Estimated Trends in Middle Eastern Petroleum Exports By Supplier and Destination

(Millions of Barrels Per Day)

<u>Exporting Region</u>	<u>Importing Region</u>			Total Non- Industrial <u>Asia*</u>	Total <u>Asia</u>
	<u>Industrialized Asia</u>	<u>Non-Industrialized Asia Pacific Rim</u>	<u>China</u>		
<u>Use of Exports in MMBD</u>					
<u>1995</u>					
Persian Gulf	4.2	4.1	0.4	4.5	8.7
North Africa	0.0	0.0	0.0	0.0	0.0
Total	4.2	4.1	0.4	4.5	8.7
<u>2020</u>					
Persian Gulf	6.9	10.1	6.9	17.0	23.9
North Africa	0.2	0.1	0.0	0.1	0.3
Total	7.1	10.2	6.9	17.1	24.2

Percentage of Total Middle Eastern Petroleum Exports Going to a Given Region

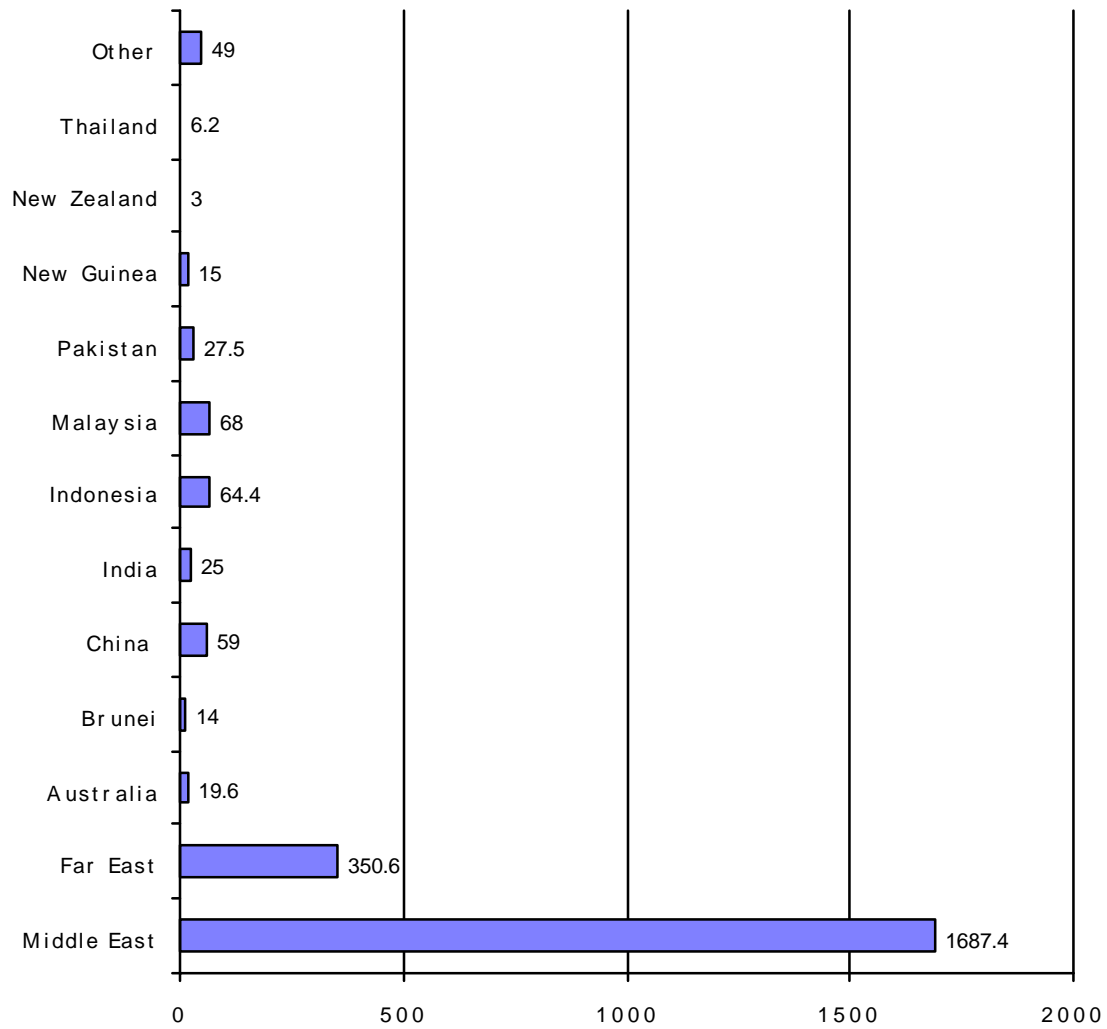
<u>1995</u>					
Persian Gulf	27.3	26.6	2.6	29.2	56.5
North Africa	0.0	0.0	0.0	0.0	0.0
Total	27.3	26.6	2.6	29.2	56.5
<u>2020</u>					
Persian Gulf	16.5	24.2	16.5	40.7	57.2
North Africa	7.4	3.7	0.0	3.7	11.1
Total	23.9	27.9	16.5	44.4	68.3

* Excludes India and Pakistan which EIA reports as part of total for non-industrialized world

Source: Adapted by Anthony H. Cordesman from estimates in International Energy Outlook, 1999, Washington, DOE/EIA, April, 1998, pp. 36.

Many Key Asian Economies Have Negligible Gas Reserves: Middle Eastern versus Asian Gas Reserves

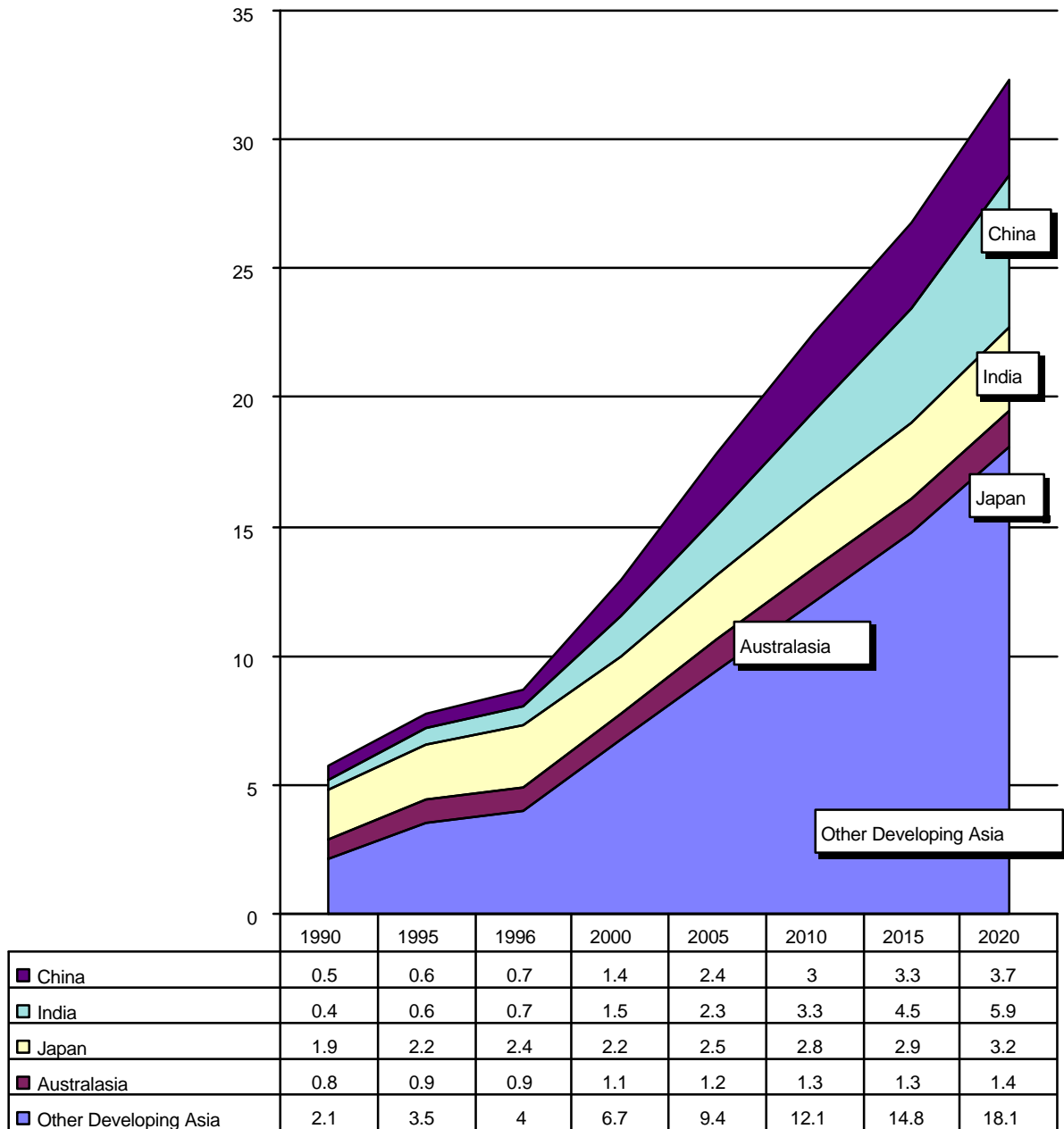
(Based on Oil and Gas Journal Forecast and total of 4,981.7 TCF)



Source: Adapted by Anthony H. Cordesman from EIA, Annual Energy Review, 1995, p. 293.

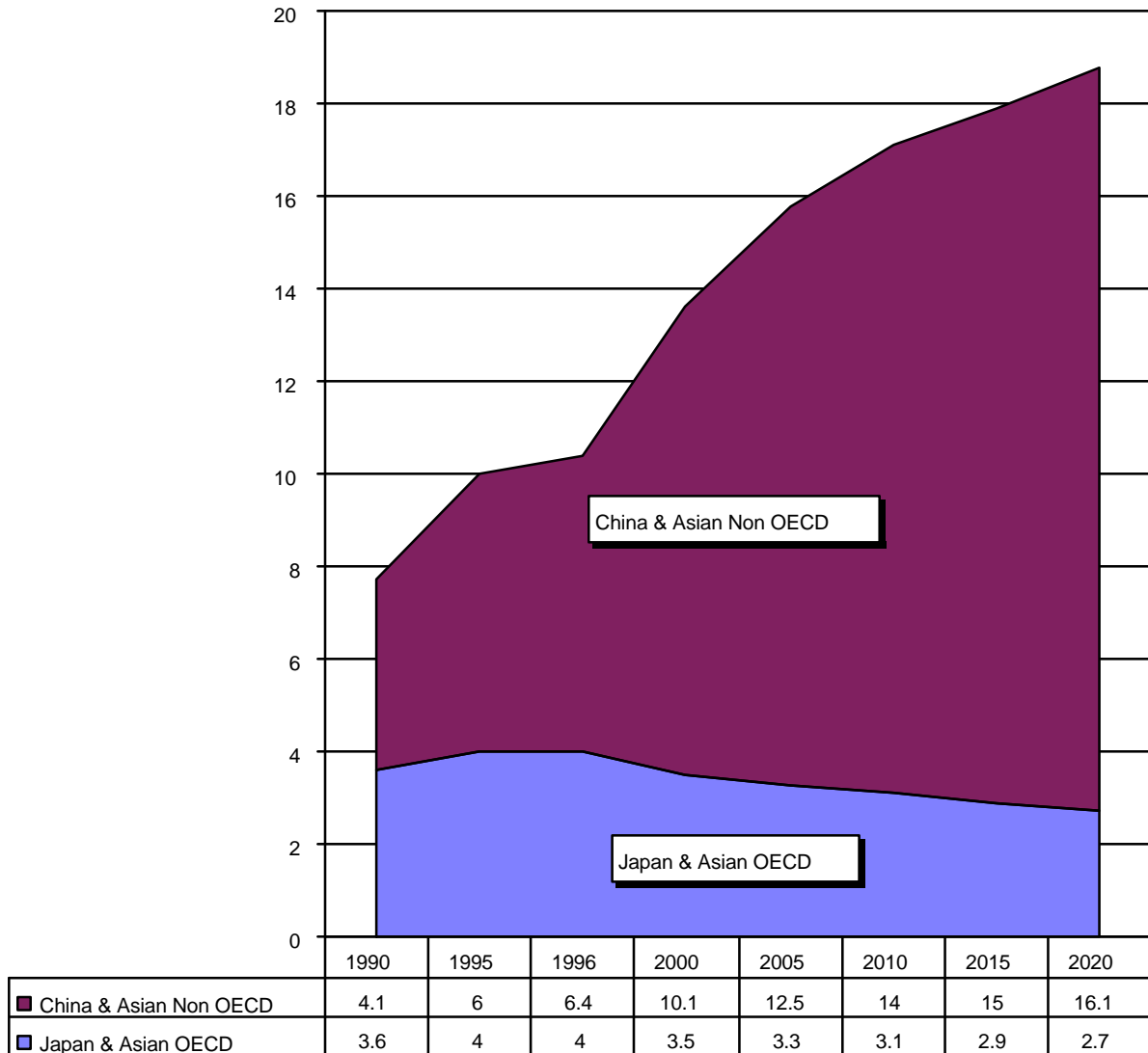
Asian Gas Imports Are Critical to Clean Energy: Asian Gas Consumption

(In Trillions of Cubic Feet, EIA Reference Case)



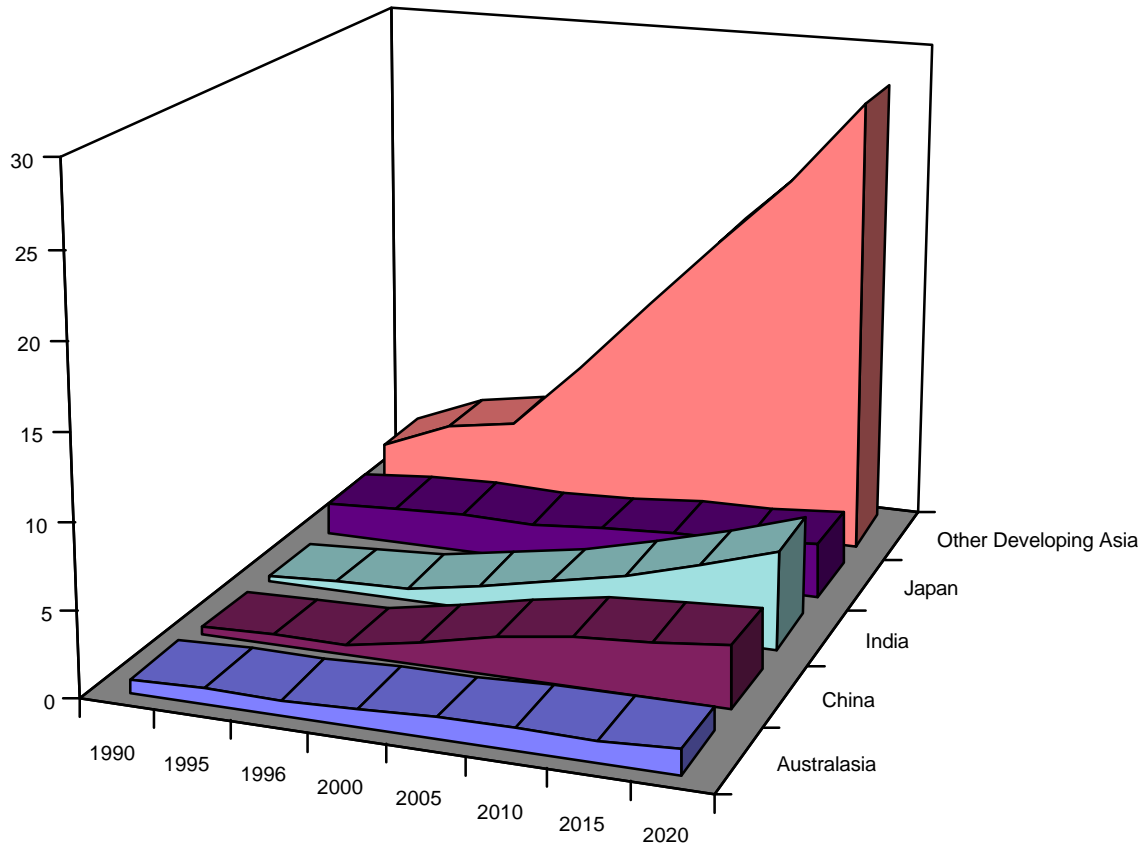
Source: Adapted by Anthony H. Cordesman from EIA, *International Energy Outlook, 1998*, DOE/EIA-0484 (97), April 1998, pp. 137.

**Asian Gas Imports Change the Balance of World Use:
Asian Gas Consumption as Percent of World Total**
(EIA Reference Case)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, pp. 137.

Expanding Gas Demand in Asia by User Country (In Trillions of Cubic Feet, EIA Reference Case)

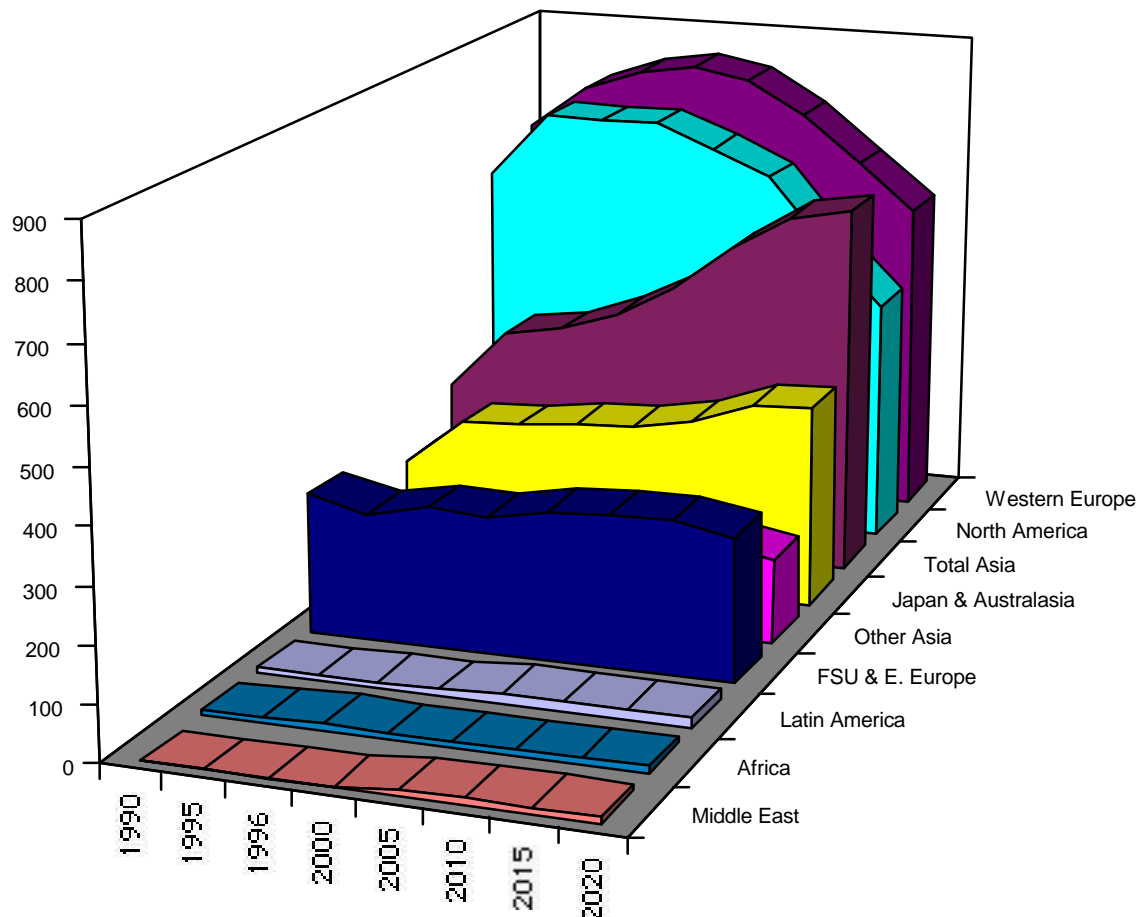


	1990	1995	1996	2000	2005	2010	2015	2020
Australasia	0.8	0.9	0.9	1.1	1.2	1.3	1.3	1.4
China	0.5	0.6	0.7	1.4	2.4	3	3.3	3.7
India	0.4	0.6	0.7	1.5	2.3	3.3	4.5	5.9
Japan	1.9	2.2	2.4	2.2	2.5	2.8	2.9	3.2
Other Developing Asia	3	4.7	5.3	9.5	14.1	18.5	22.6	27.7

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 137.

World Nuclear Power Declines, Except in Asia: World Nuclear Energy Consumption: 1990-2020

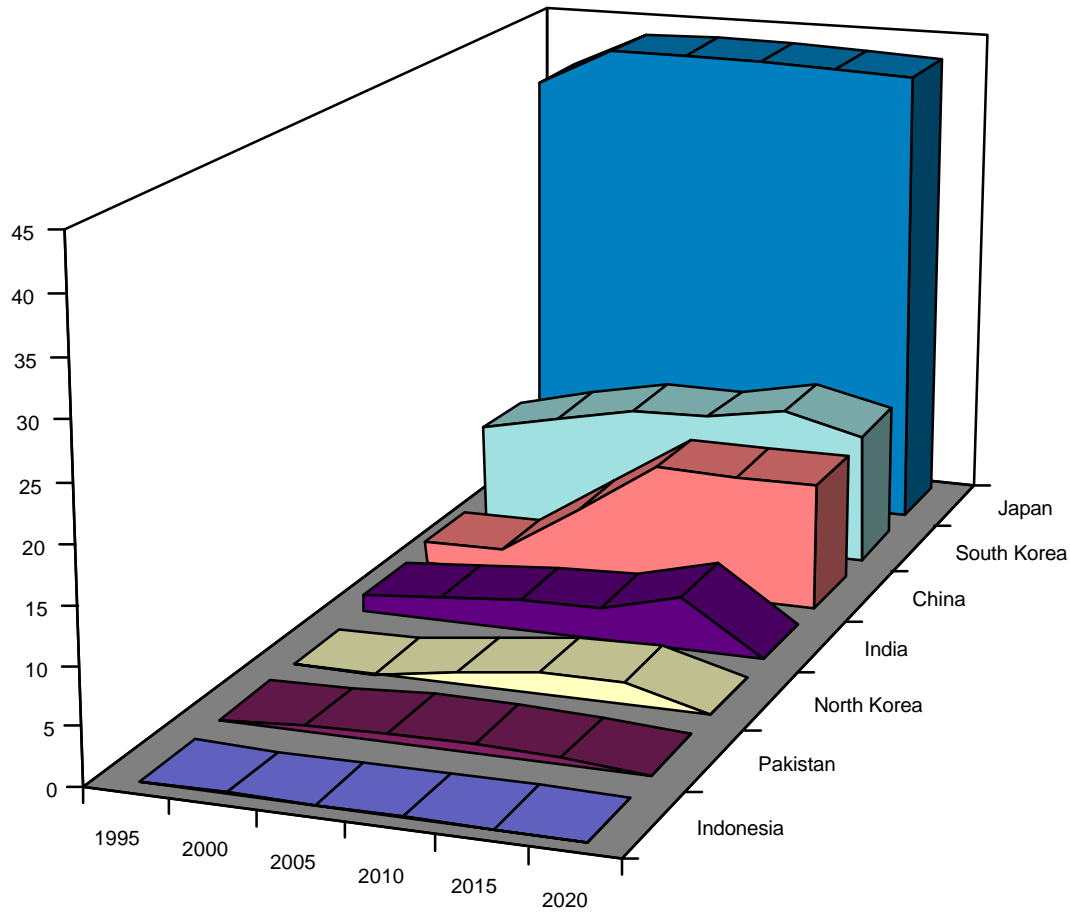
(In Billions of Kilowatt Hours, EIA Reference Case)



	1990	1995	1996	2000	2005	2010	2015	2020
■ Middle East	0	0		0	10	10	10	10
■ Africa	8	11	12	11	11	11	11	11
■ Latin America	9	9	9	10	17	17	17	17
■ FSU & E. Europe	256	229	254	248	271	279	278	261
■ Other Asia	82	98	107	128	150	170	172	150
■ Japan & Australasia	192	277	283	298	303	324	363	370
■ Total Asia	280	394	411	450	508	593	662	683
■ North America	649	774	770	773	730	683	559	451
■ Western Europe	703	785	824	841	821	763	674	588

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 139.

The Importance of the Asian “Nuclear Gamble”: Estimated Nuclear Capacity By Country (Net Gigawatts, EIA Reference Case)

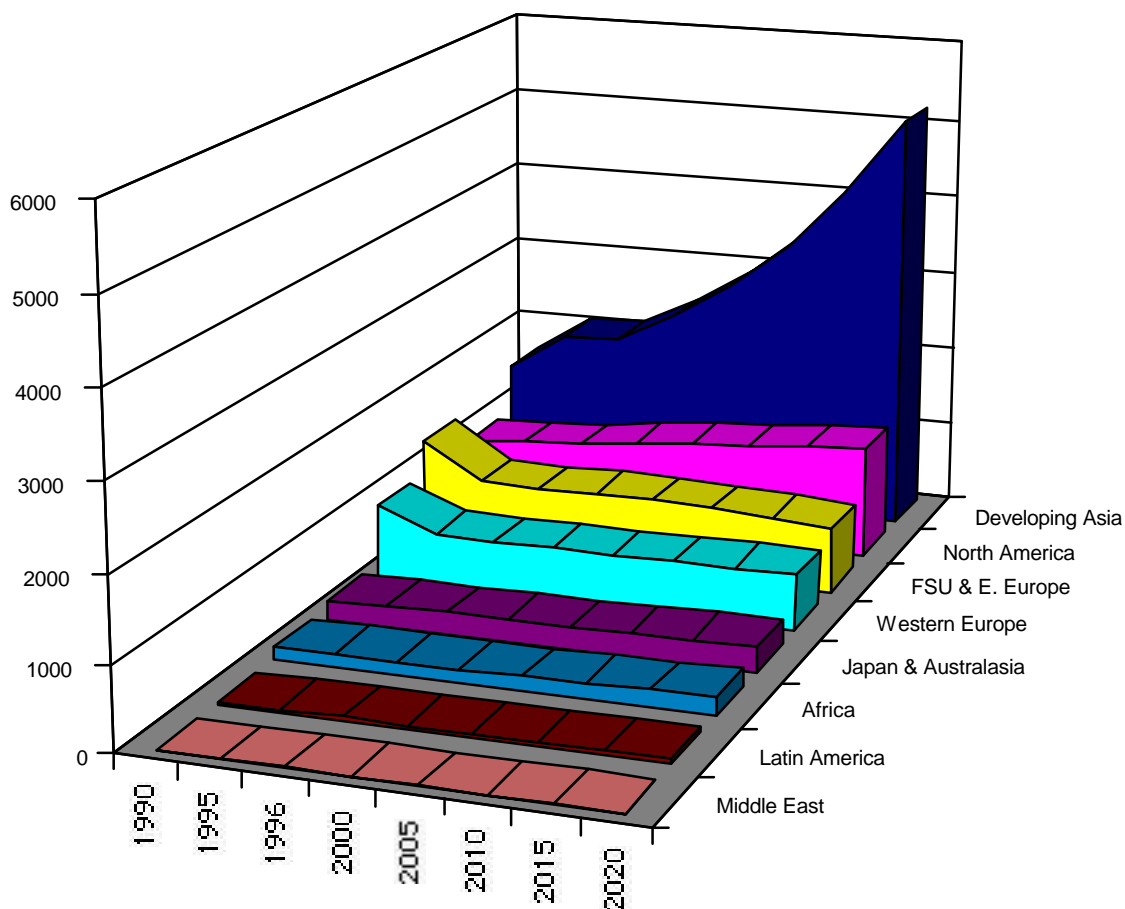


	1995	2000	2005	2010	2015	2020
Indonesia	0	0	0	0	0	-
Pakistan	0.1	0.4	0.7	0.7	0.6	-
North Korea	0	0	1	1.9	1.9	-
India	1.7	2.1	2.7	3	4.8	-
China	2.2	2.2	6.7	11.5	11.5	11.5
South Korea	9.1	10.7	12.3	12.3	13.7	11.9
Japan	39.9	43.5	43.5	43.5	43.2	42.9

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 89.

Demand for Oil Could Be Much Higher if Asia Cannot Massively Increase Coal Use

(Coal Use In Millions of Short Tons, EIA Reference Case)



	1990	1995	1996	2000	2005	2010	2015	2020
■ Middle East	6	8	9	10	12	13	15	16
■ Latin America	30	32	40	37	44	47	53	59
■ Africa	152	172	174	171	178	191	203	217
■ Japan & Australasia	233	257	266	267	273	286	292	301
■ Western Europe	958	674	671	679	670	676	681	686
■ FSU & E. Europe	1372	934	885	919	918	887	848	805
■ North America	957	1013	1056	1148	1209	1263	1319	1365
■ Developing Asia	1555	2030	2065	2430	2893	3464	4235	5178

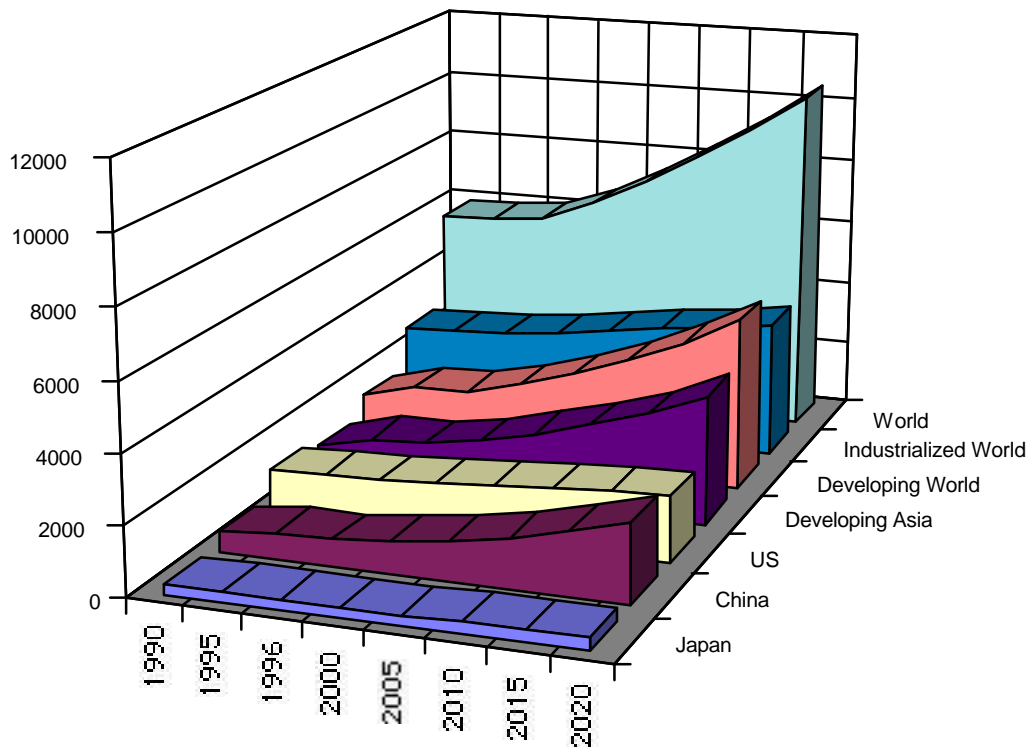
Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, pp. 138.

Asia's Growing Energy Needs Drive Global Emissions and Pollution

- **Environmental problems of Asia drive global growth in total emissions.**
 - **Percentage of annual increase twice that of industrialized states.**
- **Virtually all growth comes from developing Asia.**
- **Coal use creates more problems than transportation unless China and India shift to clean coal.**
- **Transportation sector will be major issue.**
- **Effluents and solid waste will be major problems.**
- **Nuclear power growth will create major fuel cycle, proliferation, and nuclear waste disposal problems.**
- **Water presents major problem. Great uncertainties over the efforts of major hydroelectric and flood control projects.**

Asian Development and Energy Use Greatly Alter the World's Environmental Problems and Make Gas and Oil Imports Even More Critical

(Total Carbon Emissions In Millions of Metric Tons, EIA Reference Case)

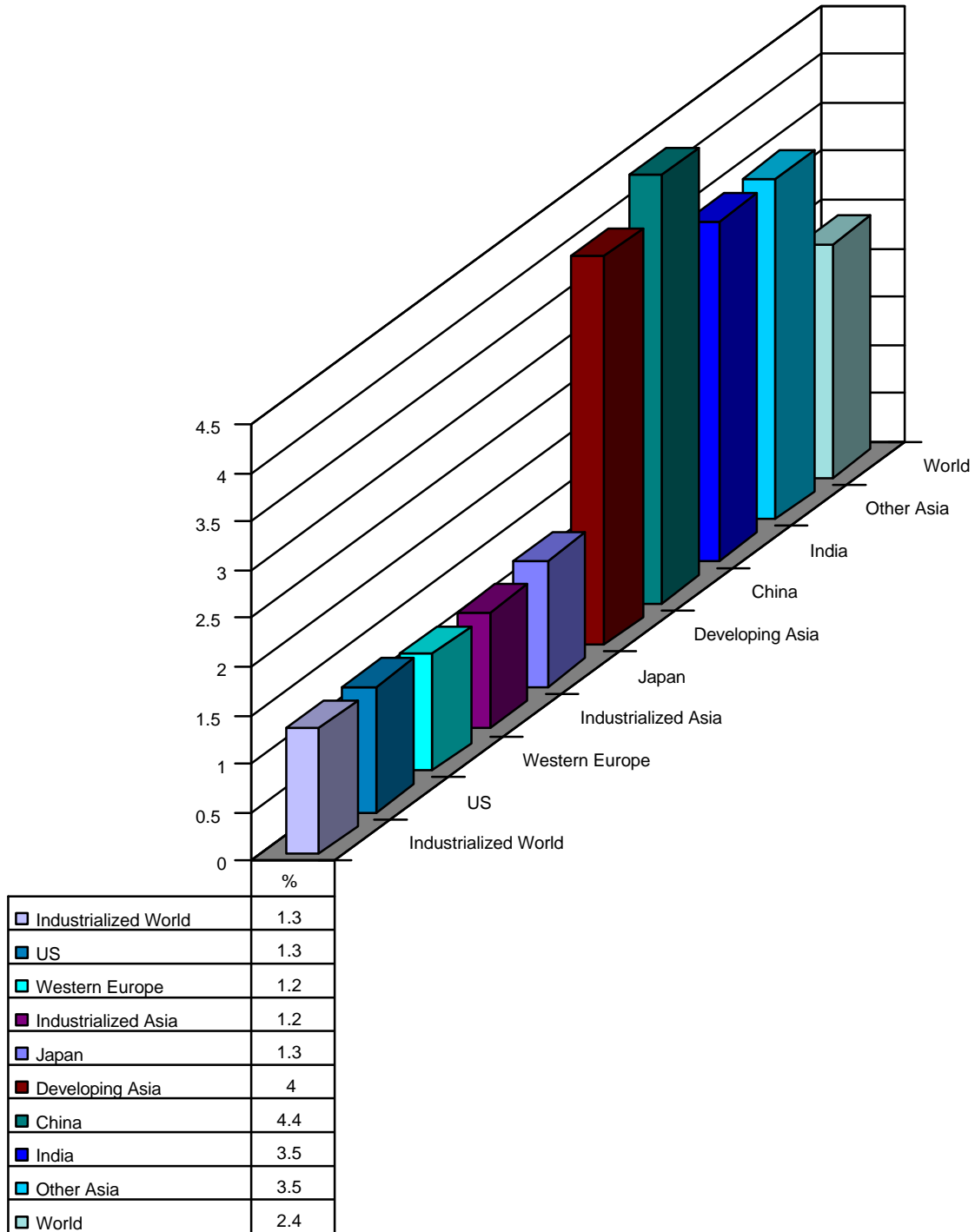


	1990	1995	1996	2000	2005	2010	2015	2020
Japan	274	281	291	303	320	342	361	385
China	620	792	805	978	1202	1481	1866	2340
US	1346	1411	1463	1577	1689	1803	1888	1956
Developing Asia	1065	1427	1474	1758	2161	2603	3158	3835
Developing World	1611	2043	2118	2480	3011	3591	4302	5158
Industrialized World	2885	2933	3023	3216	3437	3667	3870	4066
World	5786	5841	5983	6598	7434	8330	9315	10447

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 142.

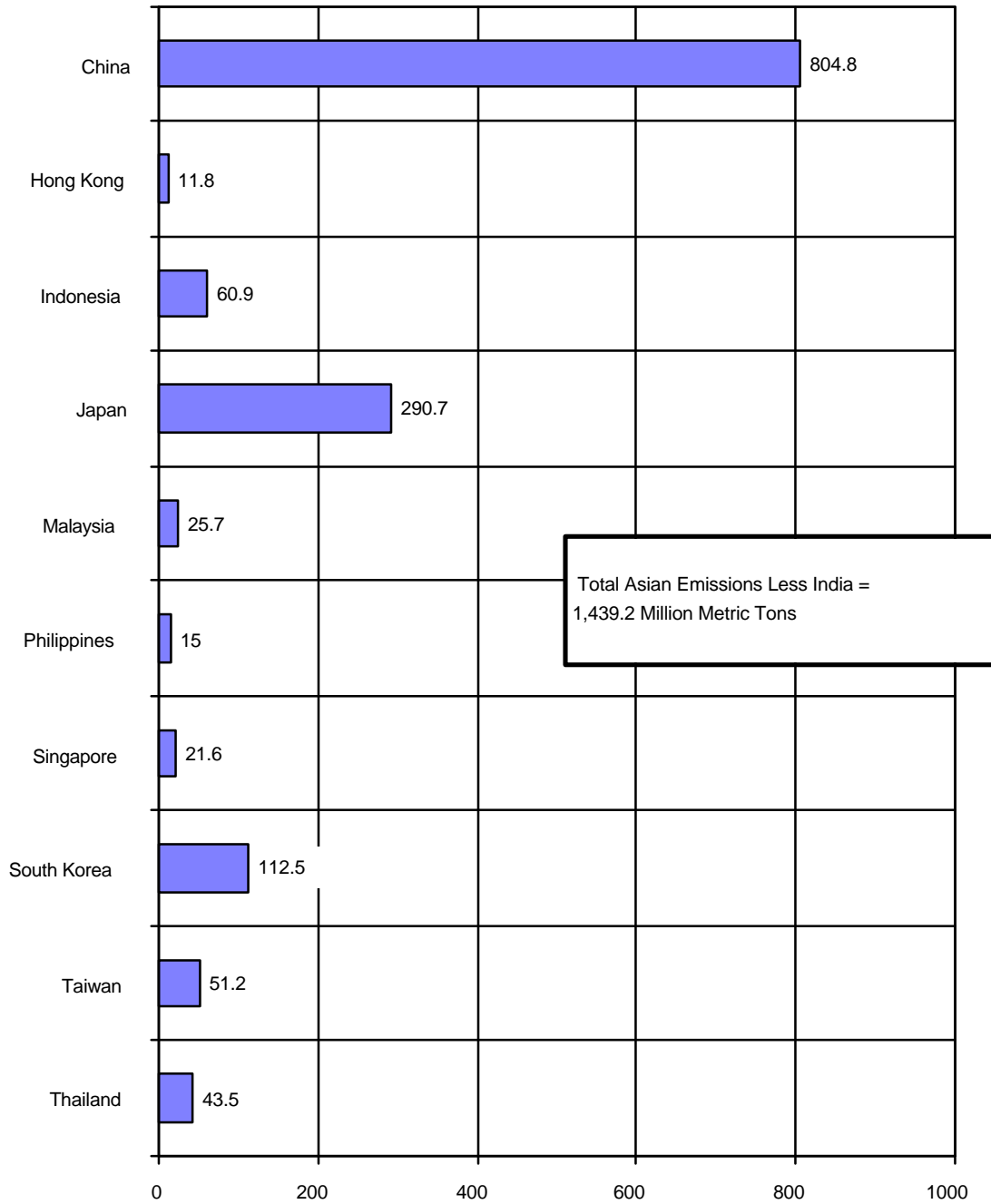
Asian Percentage of Average Annual Increase in Total Carbon Emissions 1995-2020

(Total Carbon Emissions In Millions of Metric Tons, EIA Reference Case)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 142.

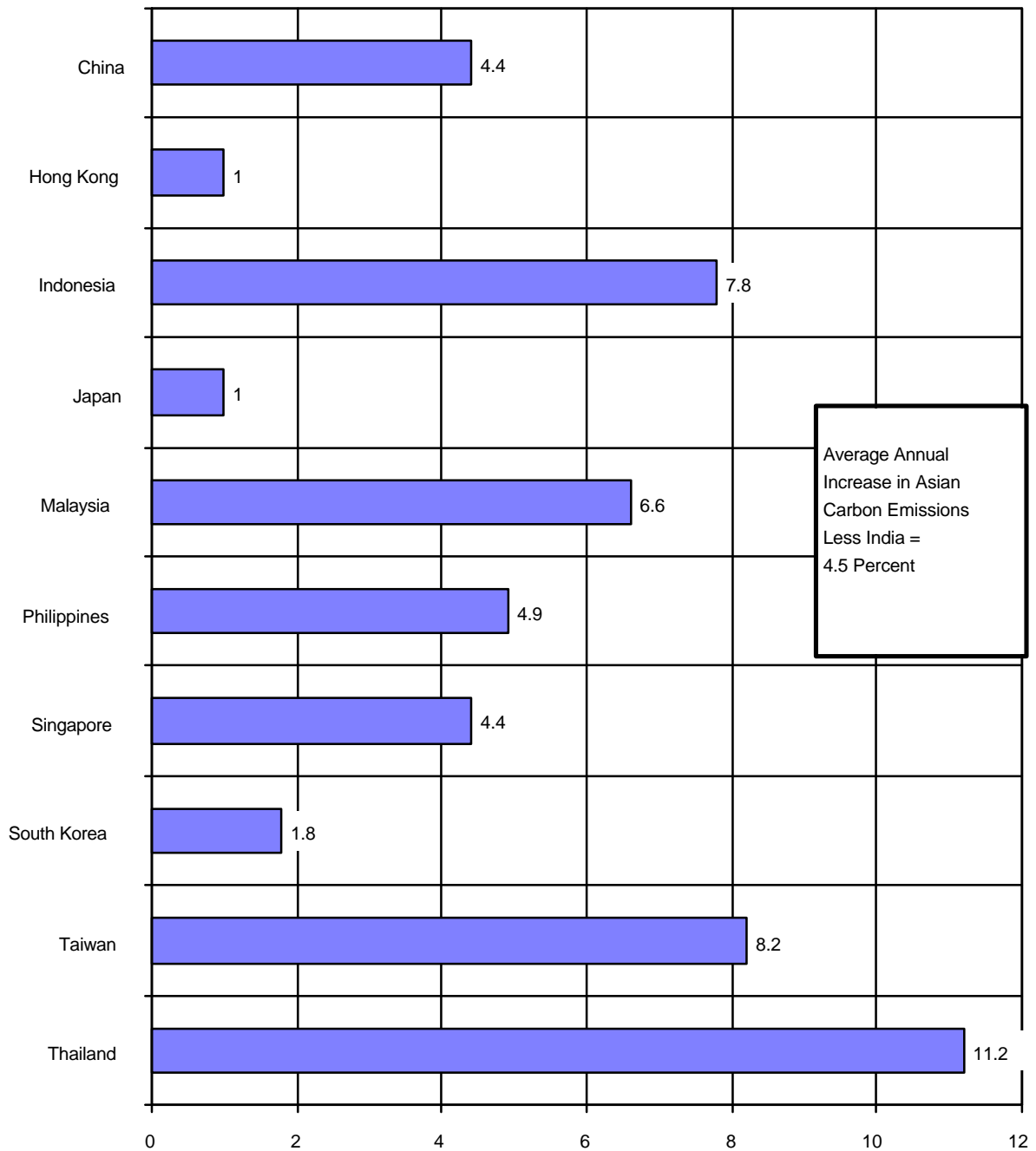
Asia's Current Impact on Carbon Emissions by Country (Total Carbon Emissions In Millions of Metric Tons in 1997)



Source: Adapted by Anthony H. Cordesman from DOE/EIA, East Asia: The Energy Situation, February, 1998

Asian Nations Have Had Very High Annual Growth Rates in Carbon Emissions

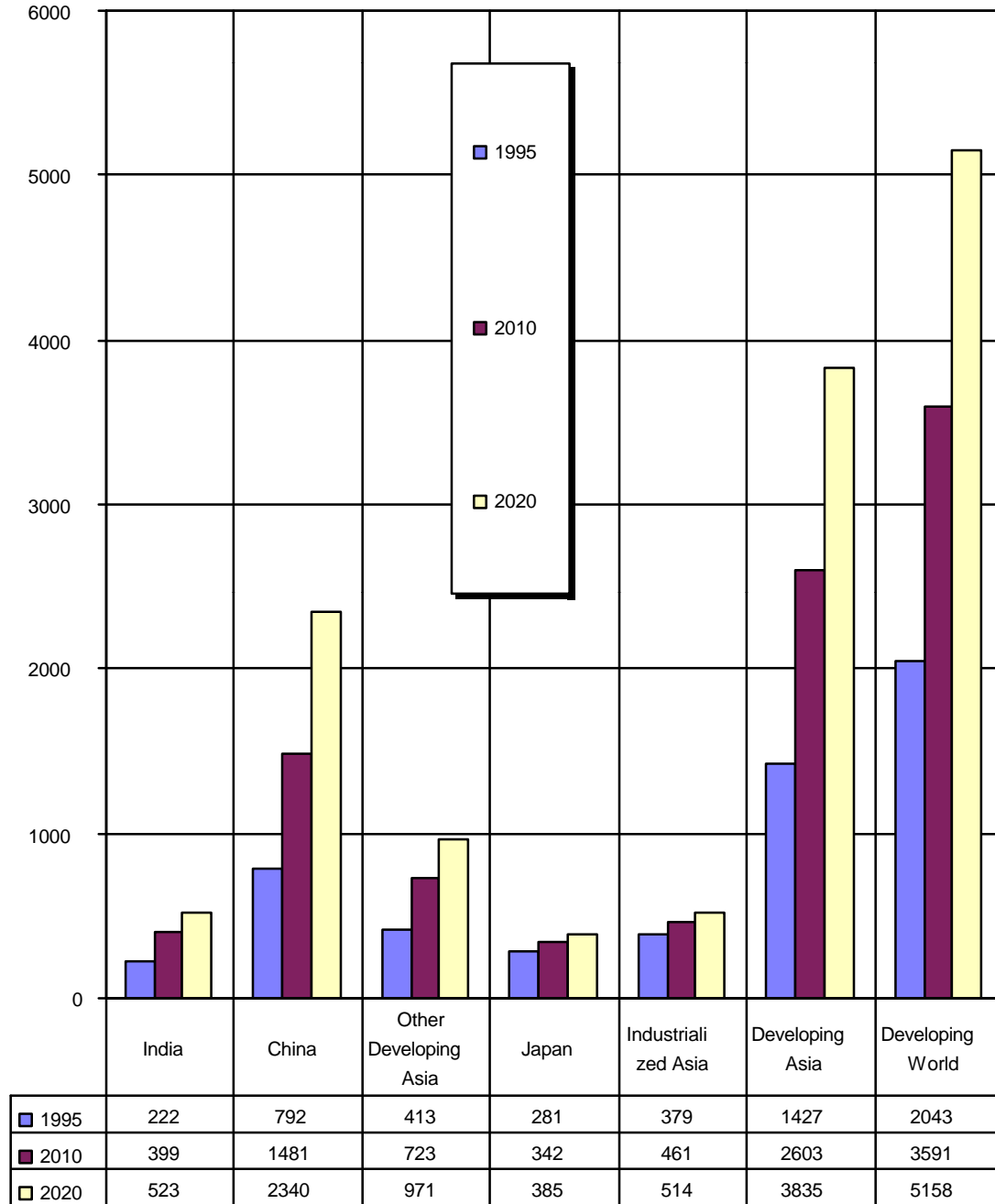
(Average Percent of Increase in Carbon Emissions In Millions of Metric Tons During 1990-1996)



Source: Adapted by Anthony H. Cordesman from DOE/EIA, East Asia: The Energy Situation, February, 1998

Asia's Massive Projected Increases in Carbon Emissions 1995-2015

(Total Carbon Emissions In Millions of Metric Tons, EIA Reference Case)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 142.

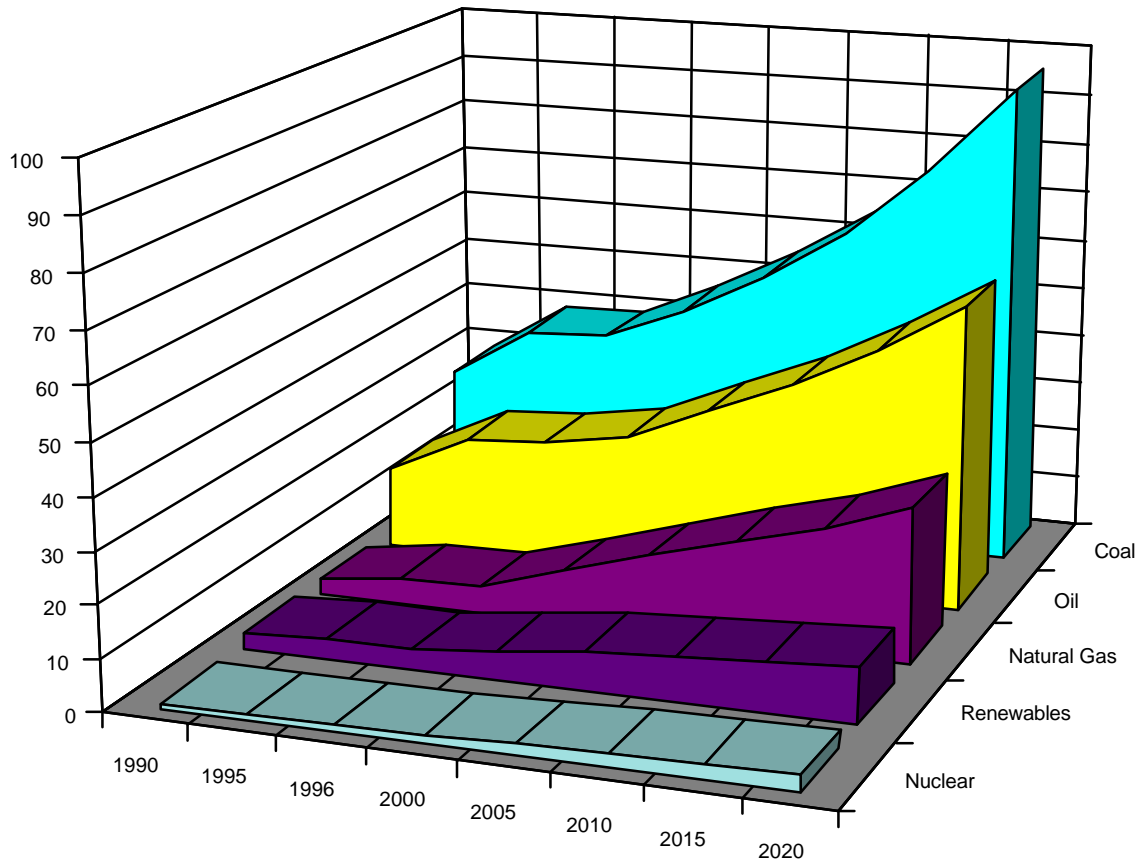
The Developing States of Asia Have Been Projected to Lead the Growth in World Demand for Energy

Developing Asia: China, Korea, China, SEA

- **Future rate of economic growth and resulting demand for energy is uncertain, but still likely to lead world.**
- **Most nations are oil and gas poor and must import.**
- **China and India present major problems in terms of nuclear power and clean coal use.**
- **Koreas and China may create new gas pipeline geopolitics.**
- **Southeast Asian states must generally meet new energy needs with oil and gas brought in by tanker.**
- **Intra-regional issues: South China Sea, etc.**
- **Environmental Problems.**

Developing Asia Has Been Projected to Lead the Increase in World Energy Consumption

(In Quadrillions of BTUs, EIA Reference Case)



	1990	1995	1996	2000	2005	2010	2015	2020
■ Nuclear	0.9	1.2	1.3	1.5	2.1	2.7	3	3.2
■ Renewables	3.2	4	4	5.7	7.6	8.6	9.7	10.9
■ Natural Gas	3	5.1	5.7	10.3	15.3	20	24.5	30
■ Oil	16	23.6	24.8	27.8	34.9	41.6	49.8	59.8
■ Coal	28.1	38	38.7	45.4	53.9	64.4	78.4	95.6

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 135.

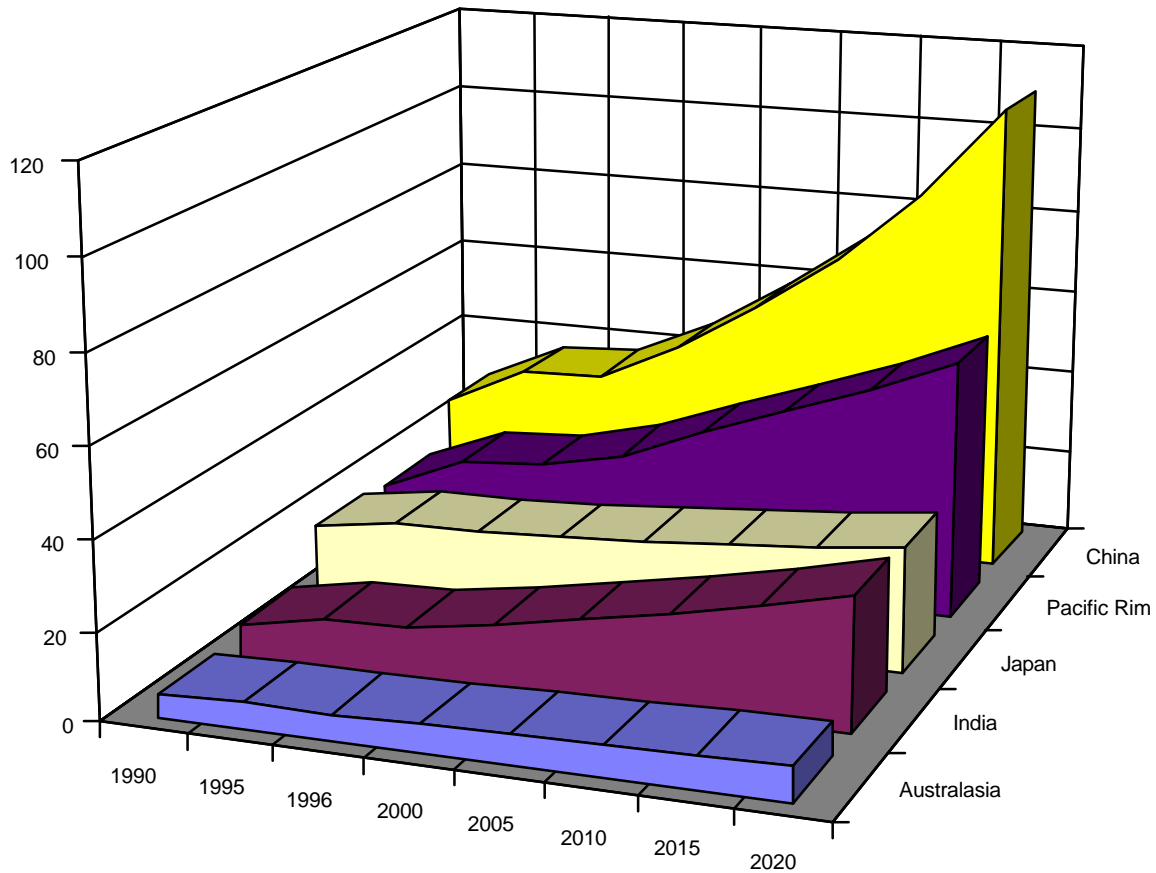
Projections of High Growth in Demand Before the Current Crisis: Developing Asia's Energy Profile: 1990-2020

<u>Fuel Use</u>	<u>1990</u>	<u>1996</u>	<u>2000</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	% of Annual Change
<u>1995-2020</u>								
Oil Use in MMBD	7.6	11.9	13.3	16.7	19.9	23.8	28.6	3.8
Natural Gas Use in TC	3.0	5.3	9.5	14.1	18.5	22.6	27.7	7.3
Coal Use in Millions of Short Tons	1,555	2,065	2,430	2,893	3,464	4,235	5,178	3.8
Nuclear Use in Billions of Kilowatts	88	128	152	205	269	299	313	4.0
Hydroelectric and Renewable Consumption in Quadrillions of BTU	3.2	4.0	5.7	7.6	8.6	9.7	10.9	4.1
Electricity Generation in Billions of Kilowatts	1,268	2,002	2,489	3,283	4,160	5,255	6,665	5.1
Carbon Emissions in Millions of Metric Tons	1,065	1,474	1,758	2,161	2,603	3,158	3,835	4.0

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 136-142.

These Projections Indicated that High Rates of Asian Economic Development Would More than Double Asian Total Energy Demands

(In Quadrillions of BTUs, EIA Reference Case)

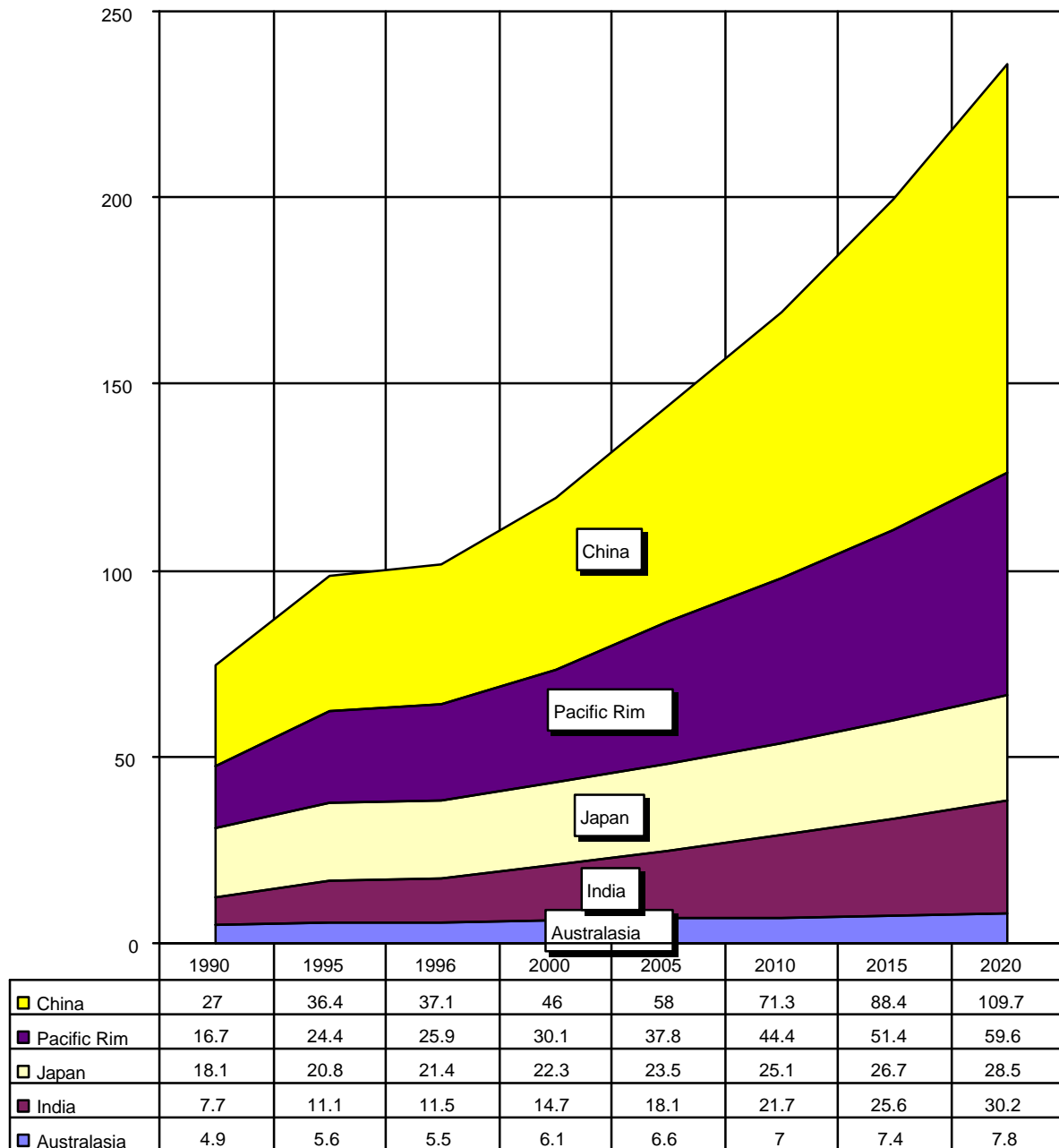


	1990	1995	1996	2000	2005	2010	2015	2020
■ Australasia	4.9	5.6	5.5	6.1	6.6	7	7.4	7.8
■ India	7.7	11.1	11.5	14.7	18.1	21.7	25.6	30.2
■ Japan	18.1	20.8	21.4	22.3	23.5	25.1	26.7	28.5
■ Pacific Rim	16.7	24.4	25.9	30.1	37.8	44.4	51.4	59.6
■ China	27	36.4	37.1	46	58	71.3	88.4	109.7

Source: Adapted by Anthony H. Cordesman from EIA, *International Energy Outlook*, 1998, p. 133.

China, Pacific Rim, and India Were Seen as the Source of Virtually All the Growth in Asian Demand

(In Quadrillions of BTUs, EIA Reference Case)

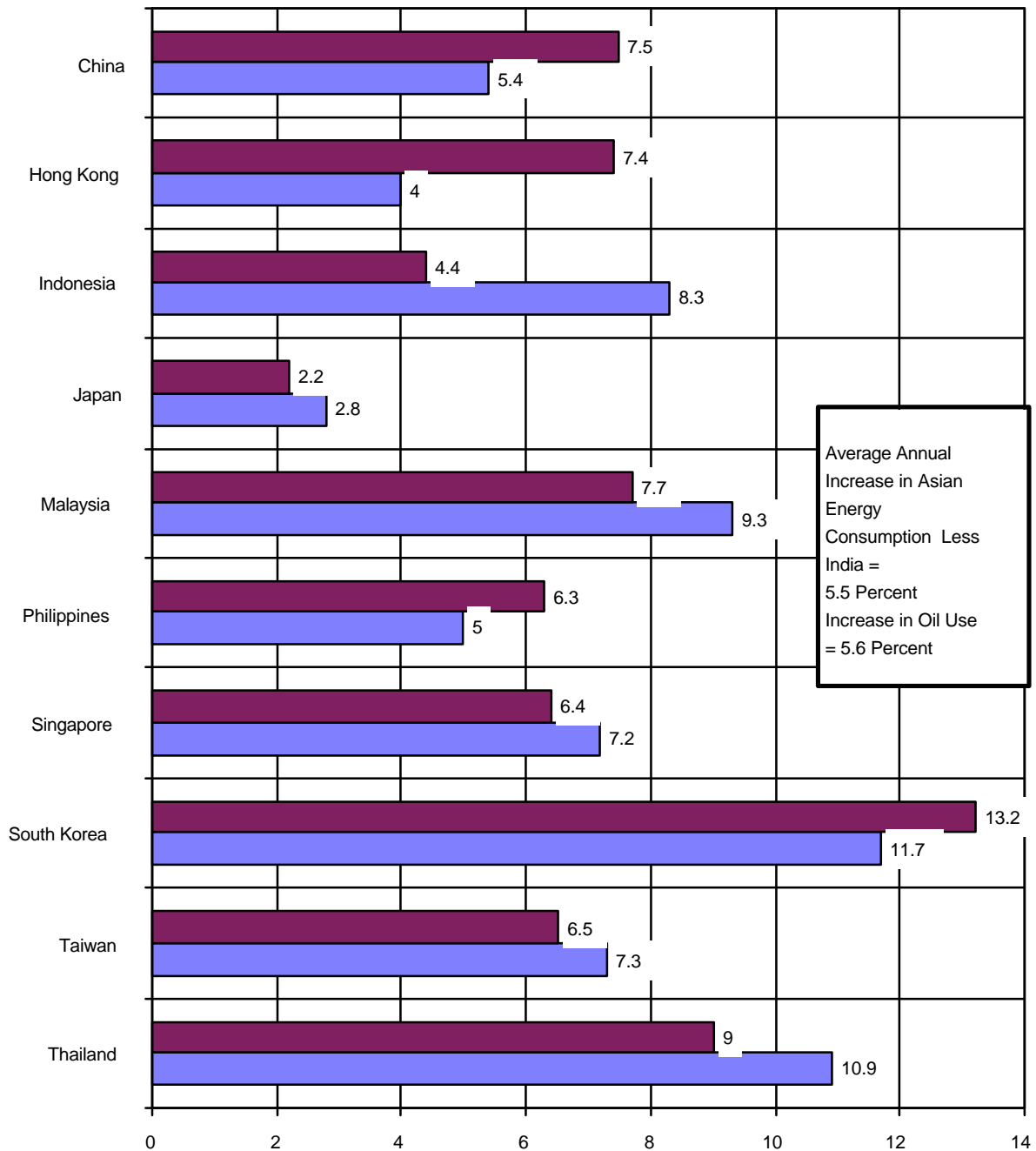


Source: Adapted by Anthony H. Cordesman from EIA, *International Energy Outlook, 1997*, p. 115.

East Asia's Economic Problems Make All Projections Uncertain

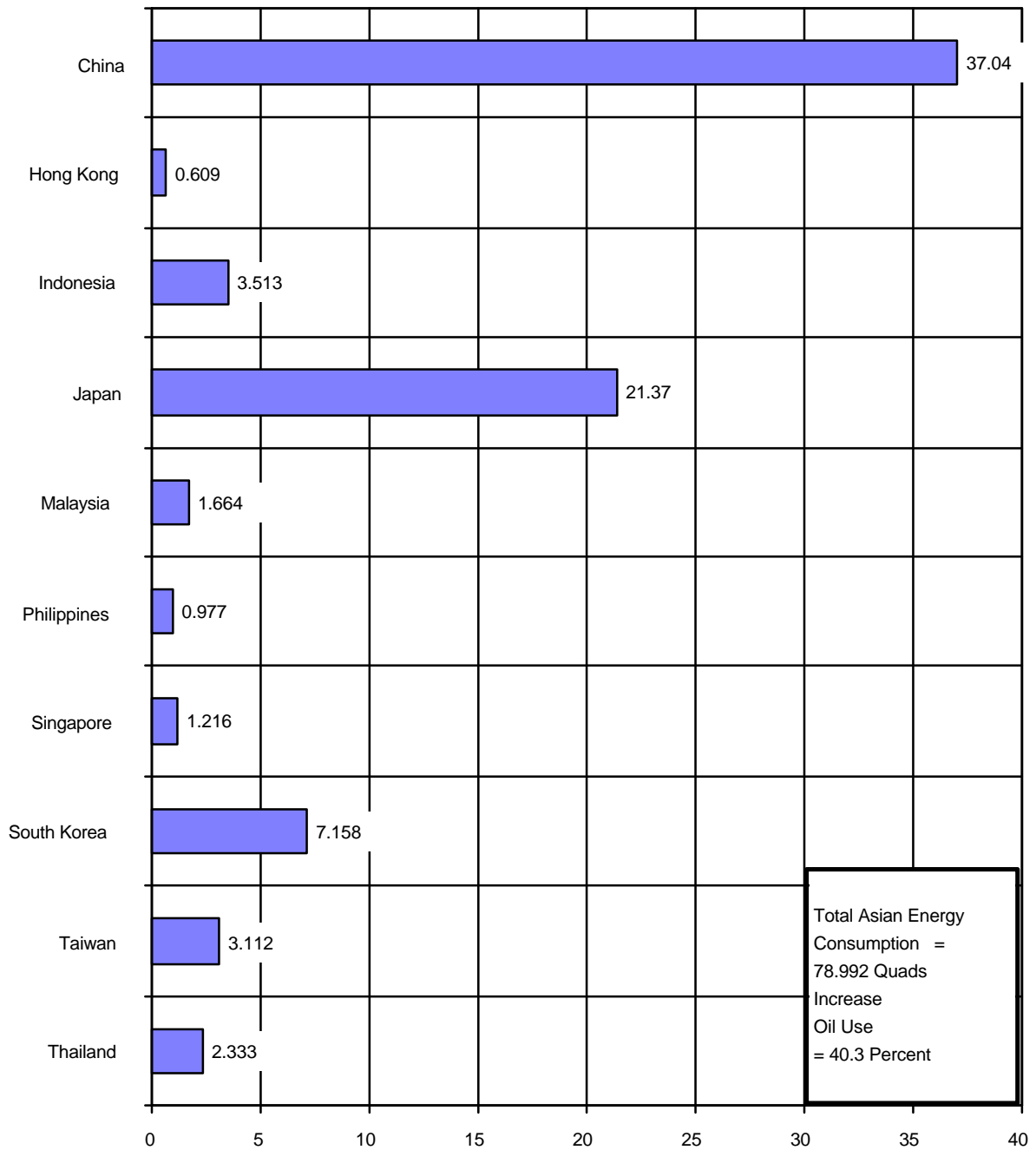
Recent Rates of Increase in East Asia Energy Demand

(Average Annual Increase in Quadrillions of BTUs – 1990-1996)



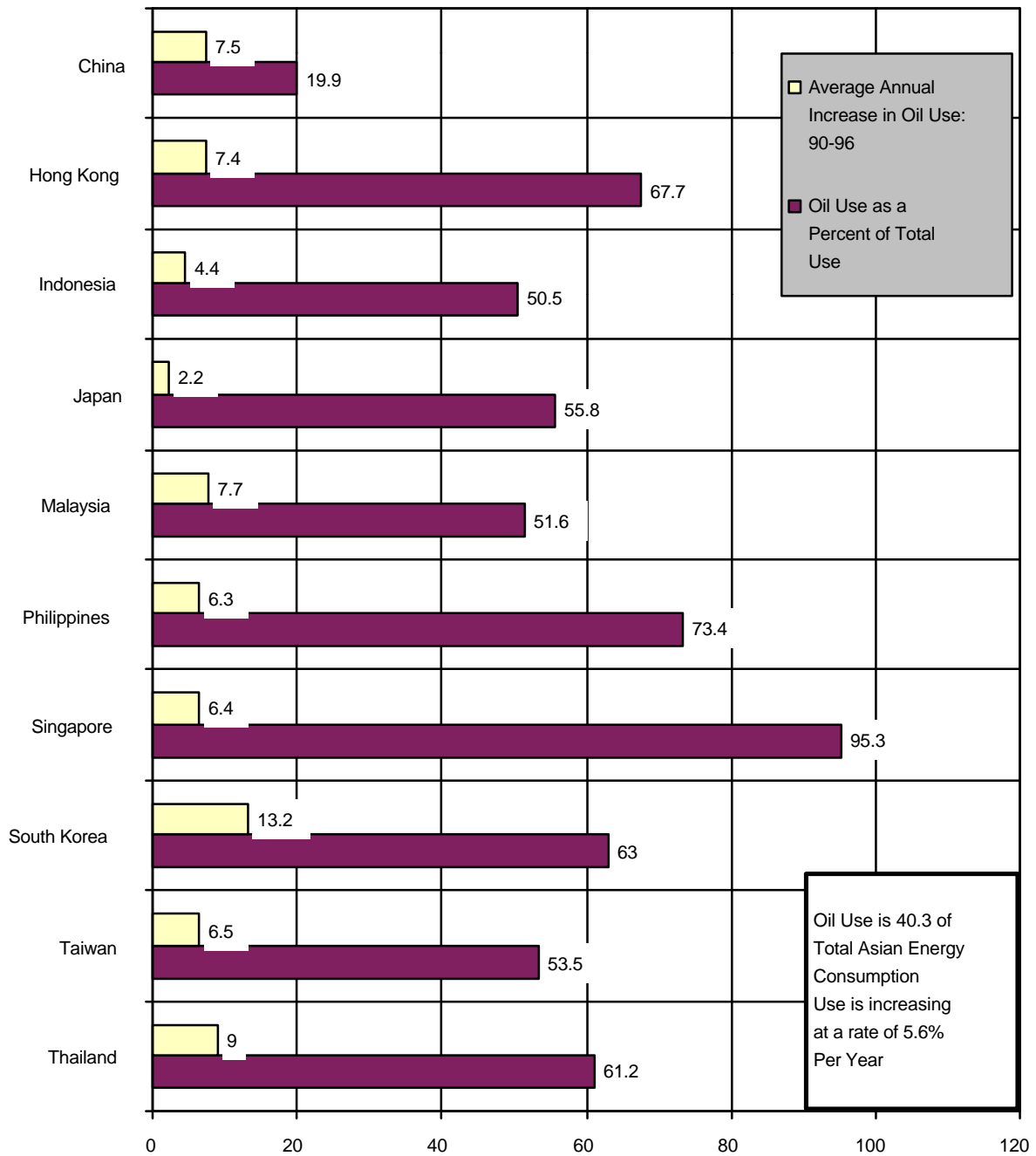
Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1997, p. 115.

East Asia Energy Demand in 1997 (in Quadrillions of BTUs)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1997, p. 115.

Oil Use as a Share of East Asian Energy Demand in 1997 (in Percent)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1997, p. 115.

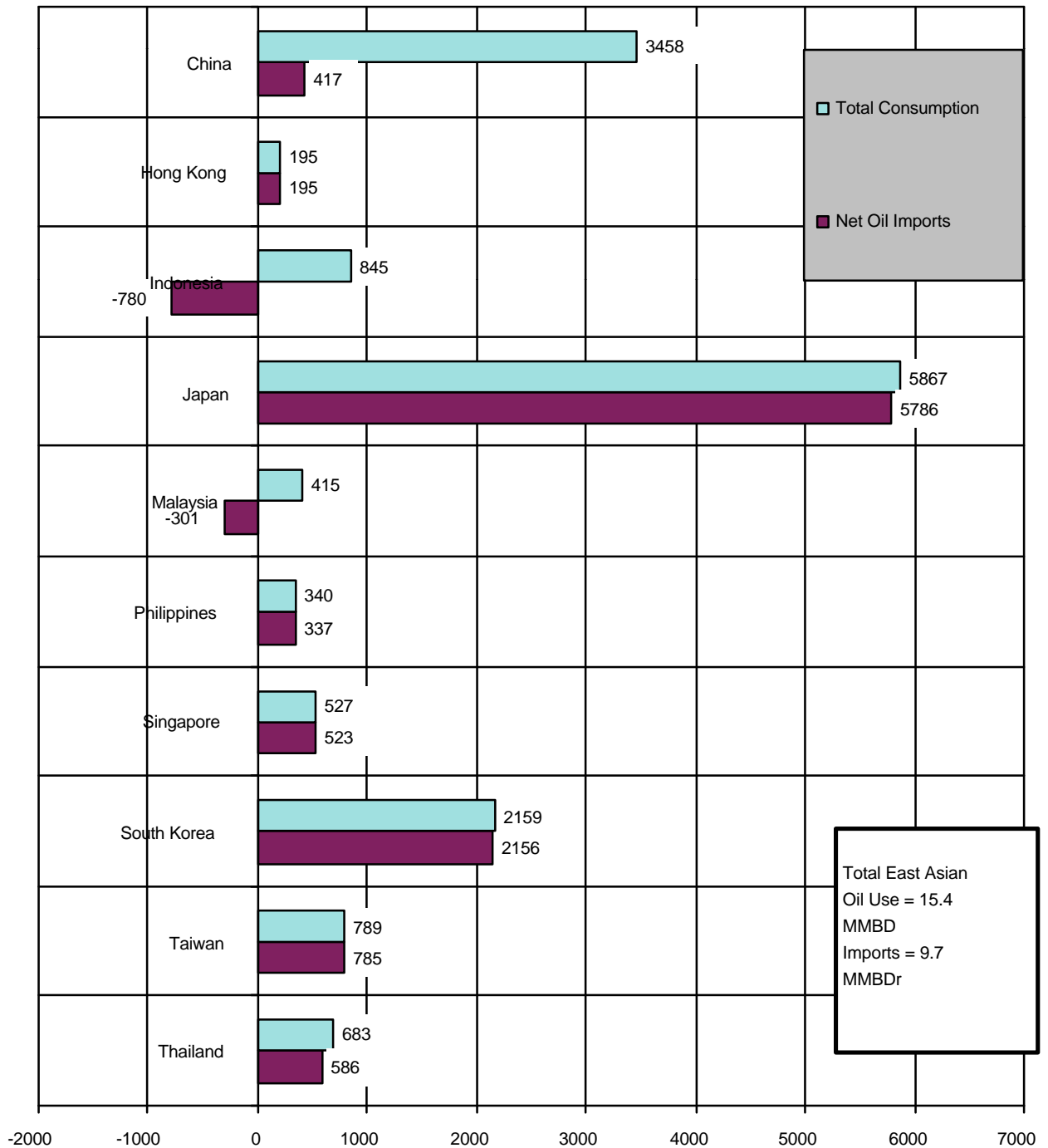
The Changing Economics of East Asia May Now Alter Demand

<u>Country</u>	Population-97 (Millions)	GDP-97 (\$US billions)	<u>Real GDP Growth Rate</u>		
			<u>90-96 Average</u>	<u>1998 Forecast</u>	
				<u>6/97</u>	<u>1/98</u>
China	1226.3	818.3	11.6	9.2	8.4
Hong Kong	6.5	108.1	4.9	5.1	3.4
Indonesia	209.8	187.0	7.1	7.6	-2.1
Japan	125.7	3,324.9	1.8	3.2	0.8
Malaysia	20.5	74.8	8.7	8.3	2.0
Philippines	76.1	54.4	2.7	6.0	3.0
Singapore	3.4	64.5	8.1	7.3	2.5
South Korea	45.9	411.2	7.4	6.0	-2.0
Taiwan	21.7	248.4	6.2	6.1	5.1
Thailand	59.5	138.8	8.2	7.4	-3.5
Total	1,795	5,430.3	3.7	4.9	1.8

Source: DOE/EIA Country Analysis Briefs, East Asia, The Energy Situation, February, 1998.

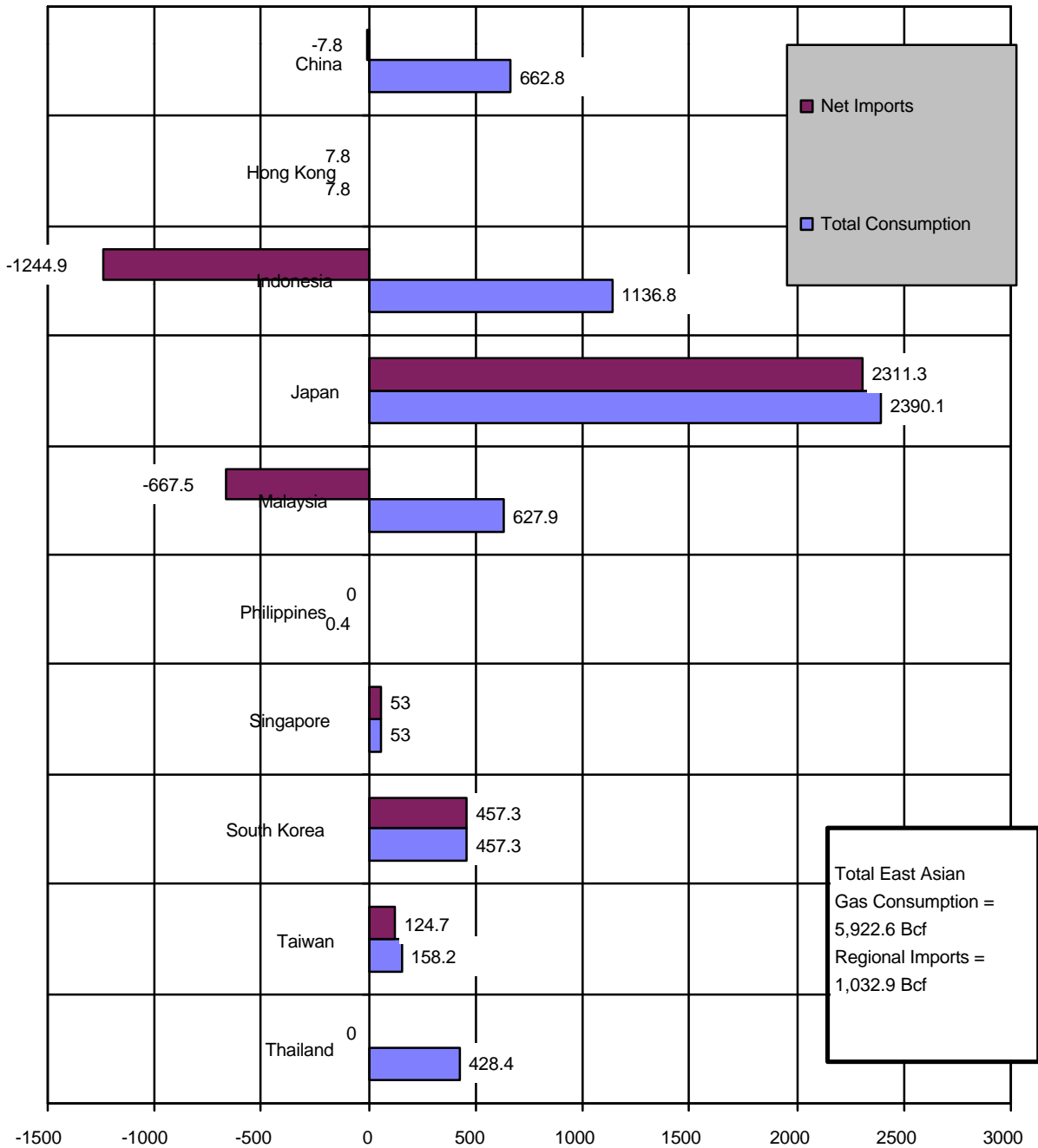
East Asia's Oil Profile in 1997

(in Thousands of Barrels Per Day)



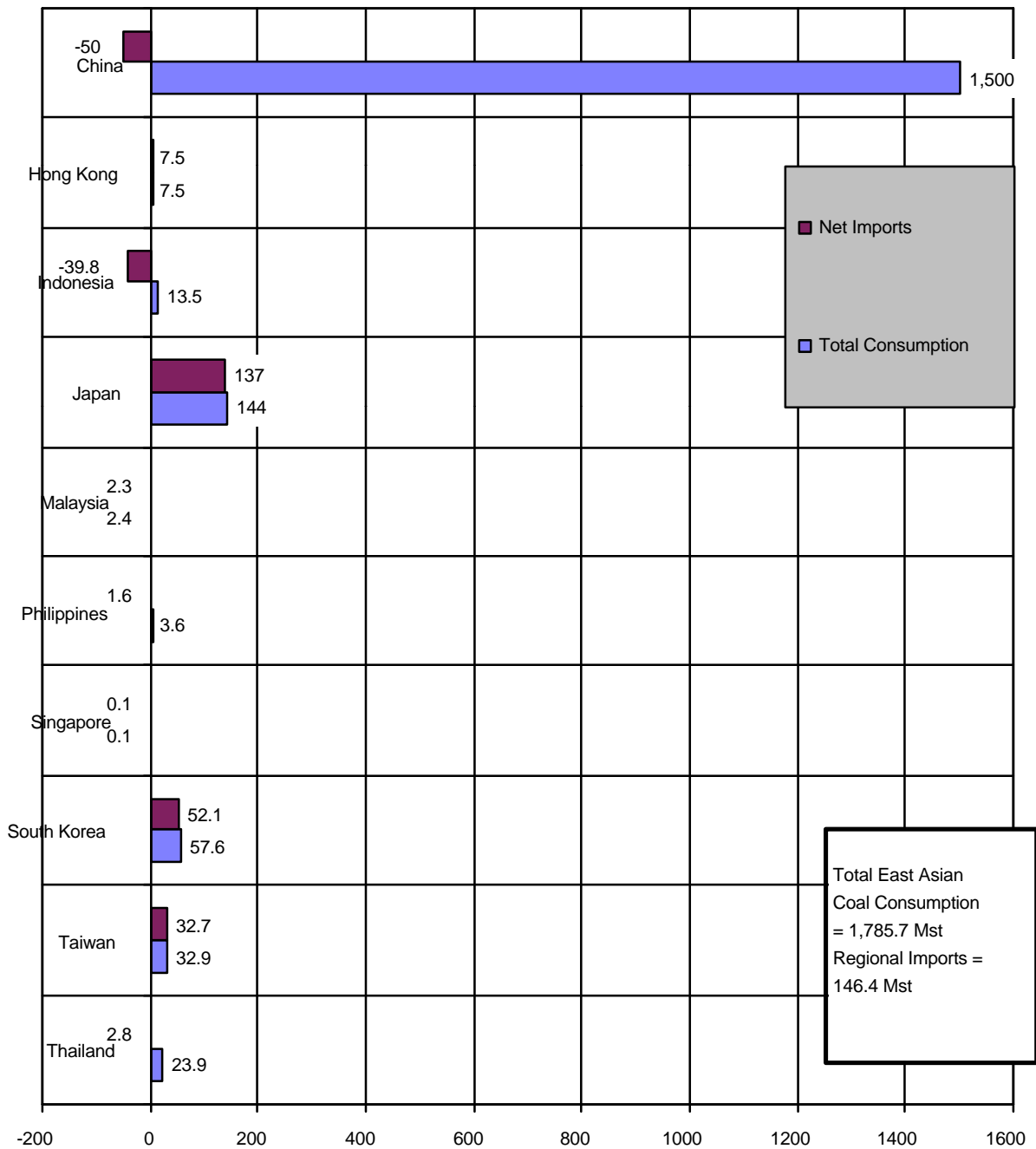
Source: Adapted by Anthony H. Cordesman from EIA, *International Energy Outlook, 1997*, p. 115.

East Asia's Natural Gas Profile in 1997 (in Billions of Cubic Feet)



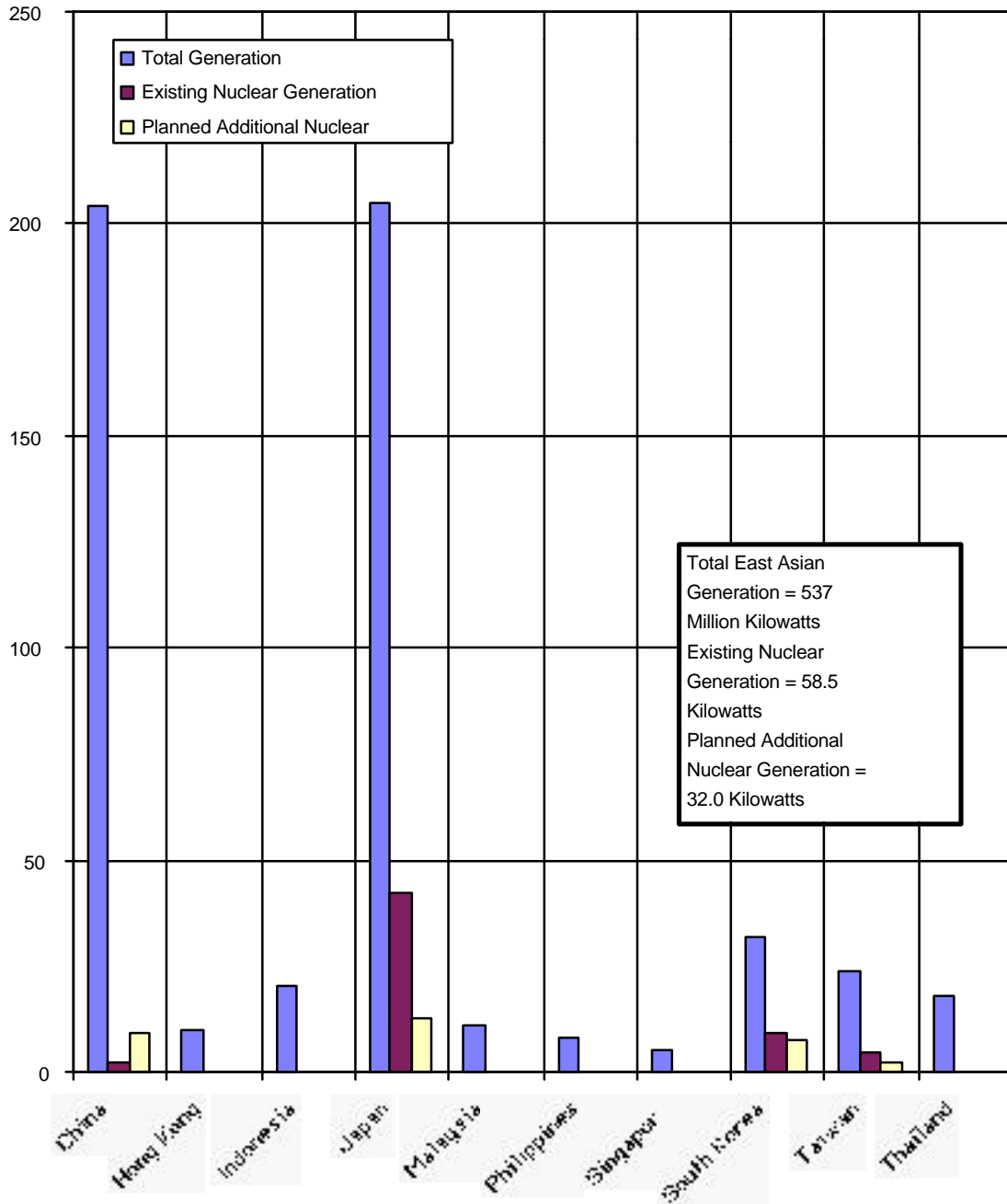
Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1997, p. 115.

East Asia's Coal Profile in 1997 (in Millions of Short Tons)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1997, p. 115.

East Asia's Electric Power and Nuclear Profile (In Millions of Kilowatts)



	China	Hong Kong	Indonesia	Japan	Malaysia	Philippines	Singapore	South Korea	Taiwan	Thailand
Total Current Electric	204	10	20	205	11	8	5	32	24	18
Total Current Nuclear	2.1	0	0	42.4	0	0	0	9.1	4.9	0
Additional Planned Nuclear	9.2	0	0	12.6	0	0	0	7.7	2.5	0

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1997, p. 115.

Industrialized States Like Japan and Australia are Likely to Show Slow Growth in Demand

Japan and Australia are Projected to Be Modest Sources of New Demand

- **Oil use up average of 1.2% during 1995-2020.**
- **Rate of increase in natural gas is over twice that of rising oil use.**
- **Nuclear and coal use will increase at an average rate of about 1%.**
- **Carbon emissions will rise at about 1.4% to 1.6% annually.**

Slow Growth in Demand: Japan and Australasia's Energy Profile: 1990-2020

<u>Fuel Use</u>	<u>1990</u>	<u>1996</u>	<u>2000</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	% of Annual Change
<u>1995-2020</u>								
Oil Use in MMBD								
Total	6.2	7.1	7.7	8.1	8.6	9.2	9.8	1.4
Japan	5.1	5.9	6.3	6.7	7.0	7.5	8.0	1.4
Natural Gas Use in TCF								
Total	2.6	3.3	3.3	3.7	4.1	4.3	4.6	1.6
Japan	1.9	2.4	2.2	2.5	2.8	2.9	3.2	1.5
Coal Use in Millions of Short Tons								
Total	233	266	267	273	286	292	301	0.6
Japan	125	144	148	151	163	166	172	0.8
Nuclear Use in Billions of Kilowatts								
Total	192	283	298	303	324	363	370	1.2
Japan	192	283	298	303	324	363	370	1.2
Hydroelectric and Renewable Consumption in Quadrillions of BTU								
Total	1.4	1.4	1.4	1.5	1.7	1.8	2.1	1.7
Japan	1.0	0.9	0.8	0.9	1.0	1.0	1.1	0.8
Electricity Generation in Billions of Kilowatts								
Total	930	1,090	1,263	1,393	1,531	1,666	1,812	2.1
Japan	750	882	976	1,063	1,162	1,258	1,363	1.8
Carbon Emissions in Millions of Metric Tons								
Total	364	389	409	434	461	485	514	1.2
Japan	274	291	303	320	342	361	385	1.3

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 136-142.

China Has a Massive Impact on World Energy Demand, Supply, and the Environment

Issues Affecting China

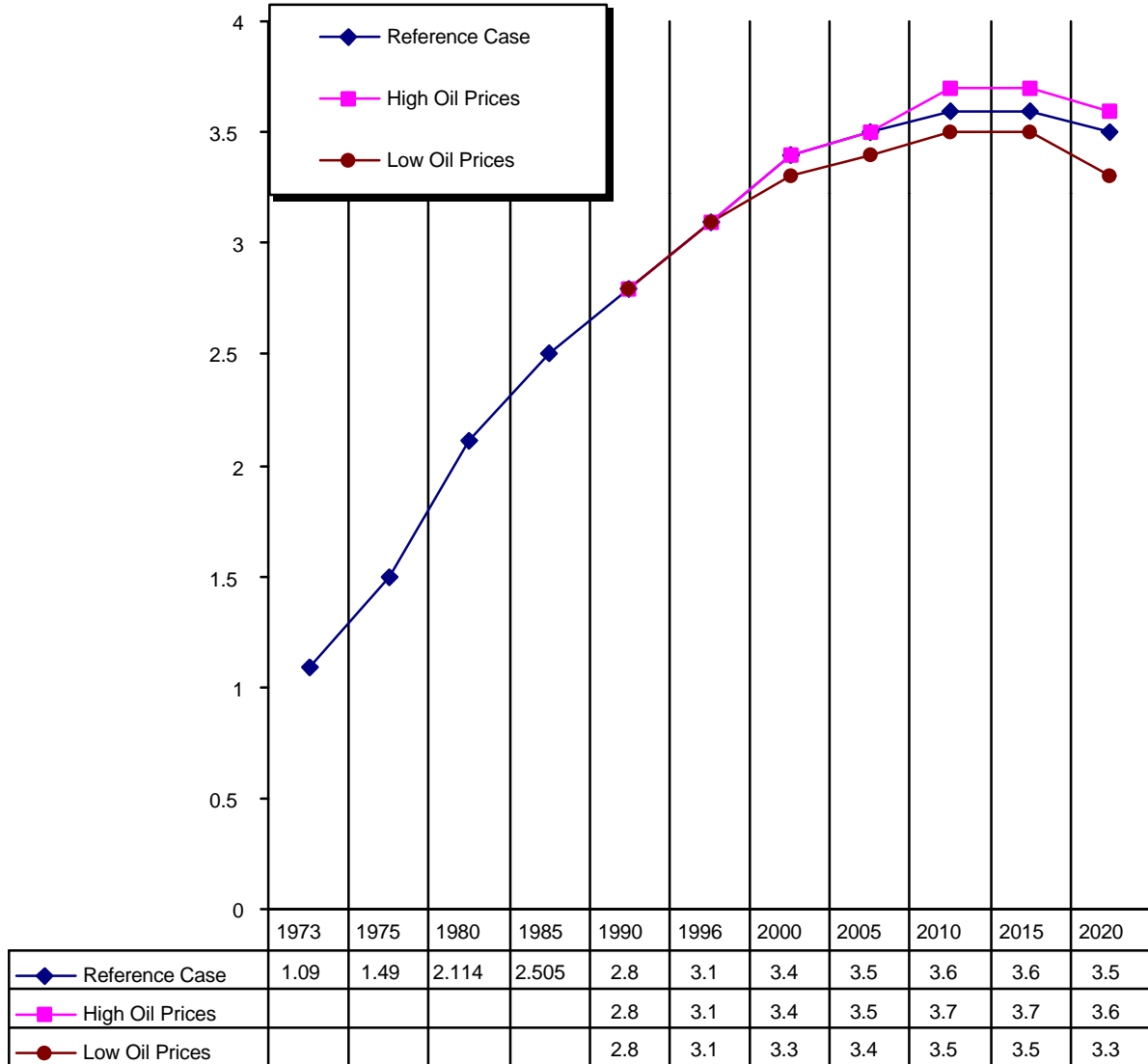
- **Demand for imports is leading China to reach out to Central Asia, seek to secure oil supplies from Gulf.**
 - **Little success in finding oil in Western China.**
 - **Consumption could exceed demand by 5 MMBD by 2020.**
 - **Most of new oil may come from Gulf.**
- **China is seeking over 10% annual growth in nuclear energy and gas use.**
- **Coal use will rise by 4% annual through 2020.**
 - **Chinese coal use drives most of new world demand through 2020.**
- **China may create new gas pipeline geopolitics.**
- **Intra-regional issues: South China Sea, etc.**
- **Emissions will rise at over 4% annually. Most come from coal and not transportation.**

China's Energy Profile: 1990-2020

<u>Fuel Use</u>	<u>1990</u>	<u>1996</u>	<u>2000</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	% of Annual Change
<u>1995-2020</u>								
Oil Use in MMBD	2.3	3.5	4.4	5.6	7.0	8.8	11.2	5.0
Natural Gas Use in TCF	0.5	0.7	1.4	2.4	3.0	3.3	3.7	7.5
Coal Use in Millions of Short Tons	1,124	1,500	1,796	2,176	2,666	3,374	4,242	4.3
Nuclear Use in Billions of Kilowatts	0	14	13	38	69	86	111	9.2
Hydroelectric and Renewable Consumption in Quadrillions of BTU	1.3	1.9	2.9	4.2	4.7	4.8	5.0	3.9
Electricity Generation in Billions of Kilowatts	551	925	1,076	1,476	1,975	2,657	3,574	5.8
Carbon Emissions in Millions of Metric Tons	620	805	978	1,202	1,481	1,866	2,340	4.4

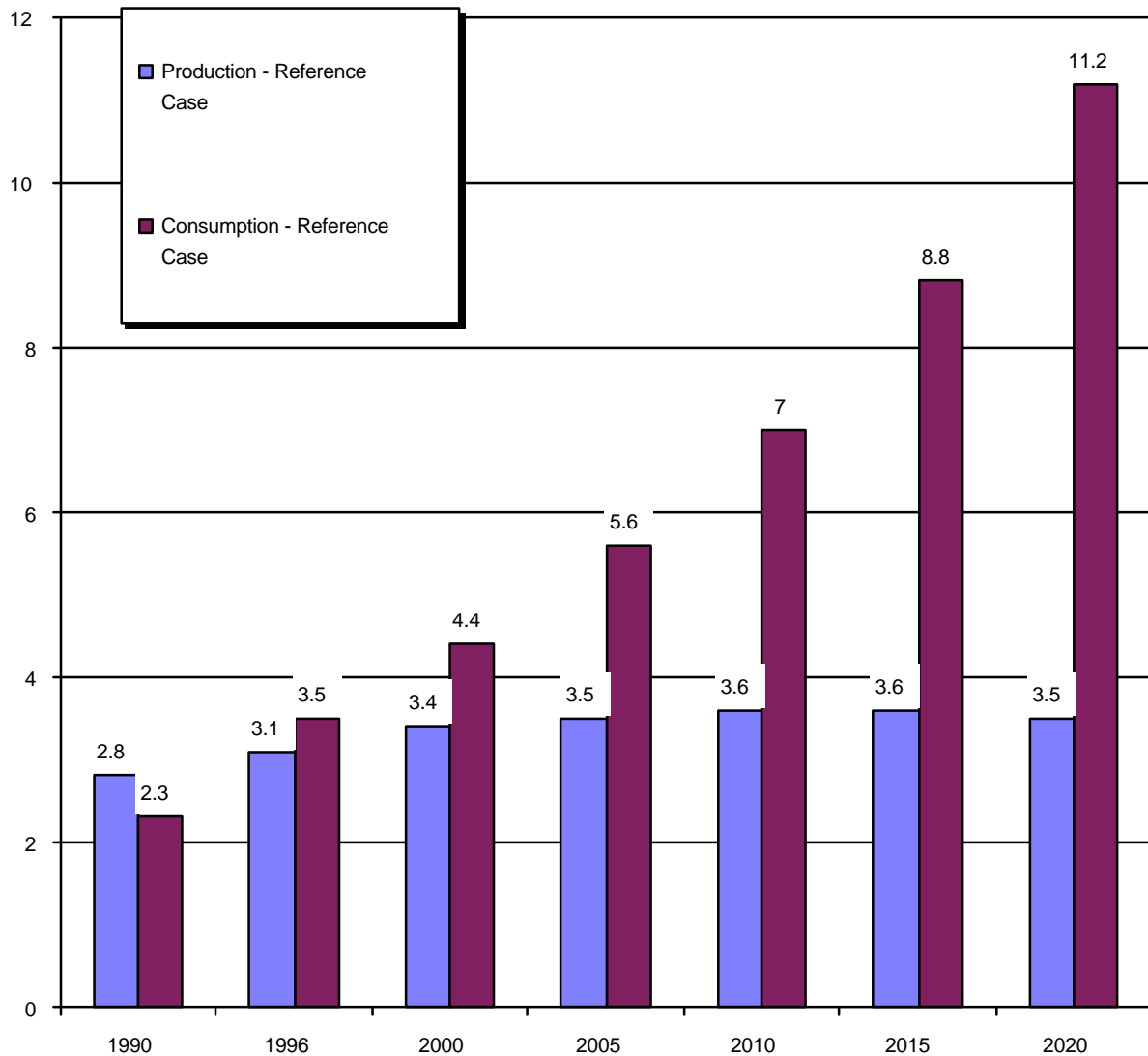
Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 136-142.

Chinese Oil Production: Estimated Oil Production Capacity in MMBD)



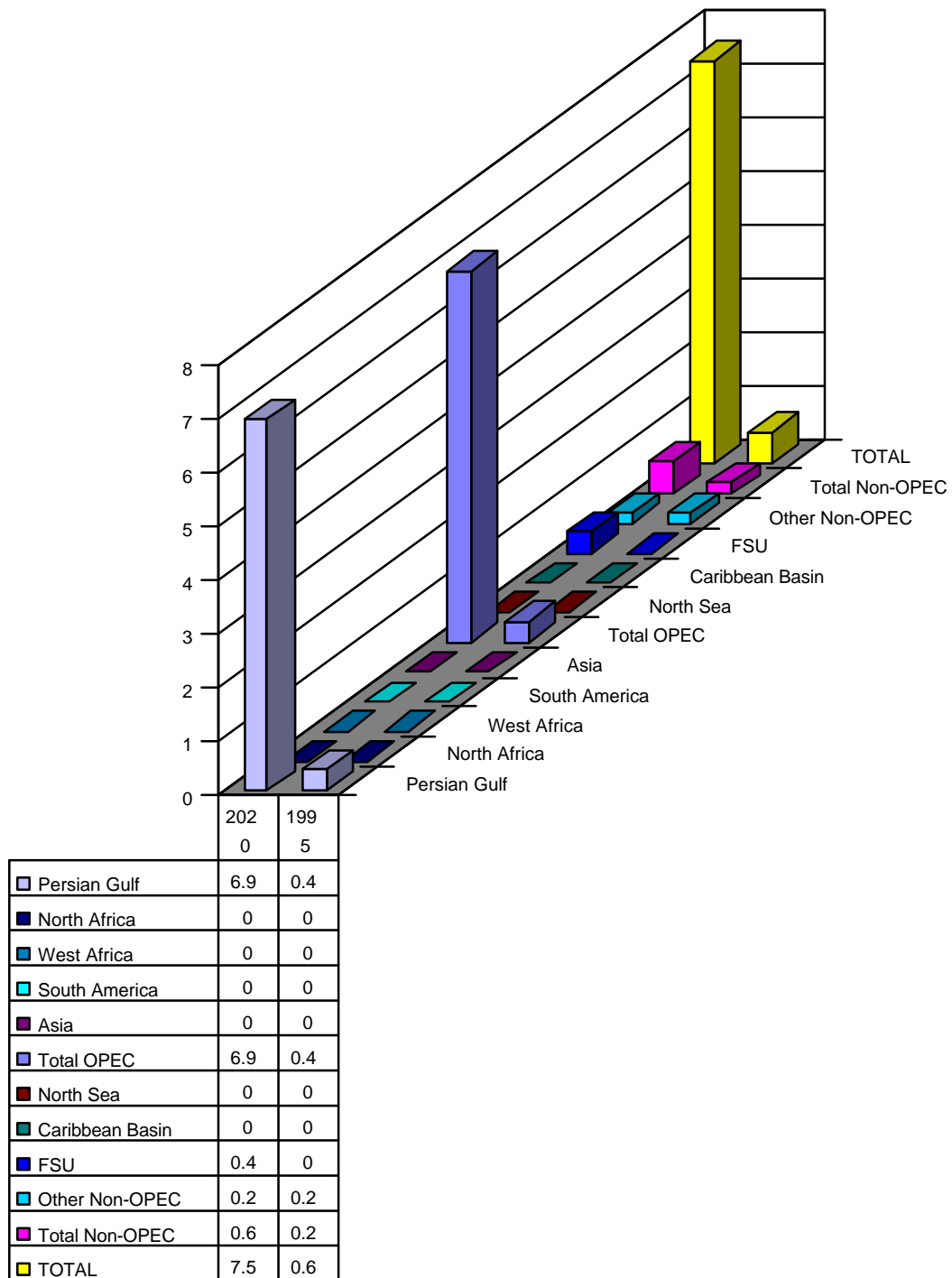
Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 175-177, and EIA, Monthly Energy Review, April, 1997, pp. 130-131.

Chinese Oil Production versus Chinese Oil Consumption:
 (Estimated Domestic Oil Production Capacity versus Domestic Consumption in MMB/D)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 136 and 179, and EIA, Monthly Energy Review, April, 1997, pp. 130-131.

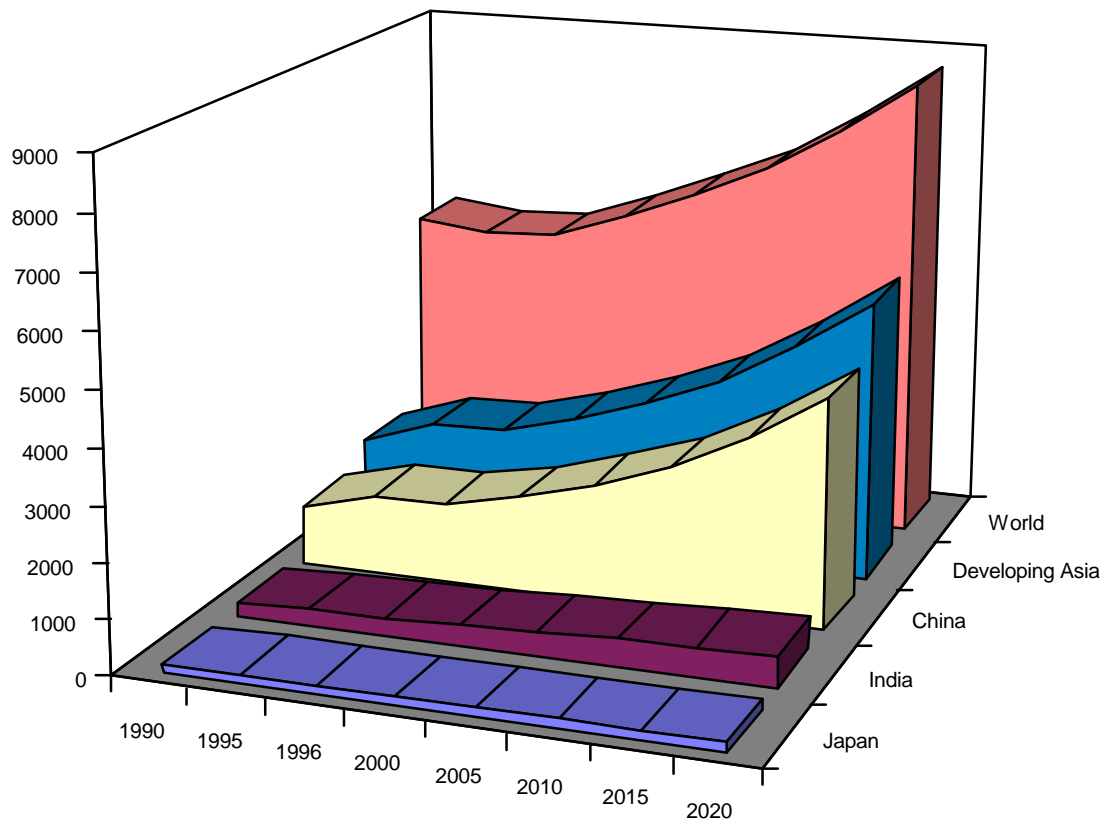
China Turns to the Gulf: Growth of China's Oil Imports by Source: 1995 and 2020 (MMBD, EIA Reference Case)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 36.

The Importance of Chinese Coal Consumption Relative to World and Asian Use

(In Millions of Short Tons, EIA Reference Case)

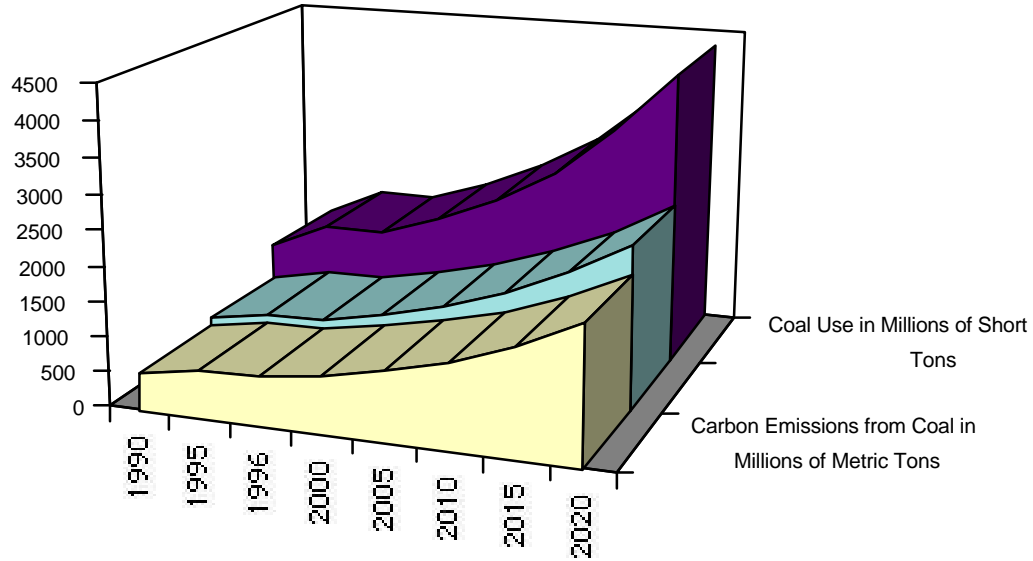


	1990	1995	1996	2000	2005	2010	2015	2020
Japan	125	140	144	148	151	163	166	172
India	242	312	321	387	444	499	537	581
China	1124	1489	1500	1796	2176	2666	3374	4242
Developing Asia	1555	2030	2065	2430	2893	3464	4235	5178
World	5263	5120	5167	5662	6197	6827	7646	8627

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, p. 138.

The Environmental Problem Inherent in Chinese Coal Consumption

(In Millions of Short Tons, EIA Reference Case)



	1990	1995	1996	2000	2005	2010	2015	2020
■ Carbon Emissions from Coal in Millions of Metric Tons	514	677	682	816	989	1212	1534	1928
■ Total Carbon Emissions in Millions of Metric Tons	620	792	805	978	1202	1481	1866	2340
■ Coal Use in Millions of Short Tons	1124	1489	1500	1796	2176	2666	3374	4242

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 138, 142, and 145.

China's Ambitious and Uncertain Energy Plans - Part One

Oil

- China became a net oil importer in 1993, as rapid increases in oil demand associated with high economic growth rates exceeded slow increases in petroleum production.
- China plans to maintain production at about 3.1 million barrels/day to meet its production target under its current Five-Year Plan, and is seeking to limit its growing dependence on imported oil,
- Even so, gross imports (crude oil plus petroleum products) are projected to increase to about 1 million barrels/day by 2000, compared with about 600,000 barrels/day in 1995. Imported crude oil currently comes mostly from Indonesia and the Middle East.
 - Current production is concentrated onshore (about 90 percent of total) in a single field -- Daqing, in the Songliao basin of northeastern China.
 - Since 1993, China has held three onshore licensing rounds to attract foreign investment in western China (particularly the remote Tarim Basin) and in enhanced oil recovery at mature fields.
 - China originally estimated that the Tarim Basin could contain 80 billion barrels or more of oil and 350 trillion cubic feet or more of natural gas. However, initial experiences of foreign oil companies have not been encouraging. Exxon's first well, drilled in July 1996, was a dry hole. Australia's Broken Hill Proprietary (BHP) shut down its operations in Tarim, and British Petroleum pulled out of its block without drilling a single hole
 - This has led some observers to speculate that reserves may be less than anticipated. Others have complained that China has offered only its less promising blocks to foreign investors.
 - For whatever reason, discoveries to date have not been large enough to confirm Tarim as a major oil basin by world standards (less than 4 billion barrels of oil reserves had been verified as of July 1996
- Chinese projections estimate 1996 production will average 92,000 barrels/day). As reserves are developed, significant infrastructure investment will be needed to transport oil long distances over difficult terrain to consuming regions.
- In addition, China operates 19 offshore oil fields). The offshore petroleum industry has been developed with significant foreign investment and offshore production is expected to reach 280,000 barrels/day in 1996 -- a 75 percent increase over 1995 levels. Contributing to this increase is the April 1996 start-up of production at Liahua 11-1, China's largest offshore field discovered to date (estimated reserves of more than 1 billion barrels, production capacity of 65,000 barrels/day).
- Offshore oil exploration activities, however, are complicated by territorial disputes in the South China Sea (particularly over the Spratly Islands area) and the East China Sea, both of which contain potentially large amounts of oil.
- China plans to boost its refining capacity to limit future growth in product imports, additional crude oil imports (probably from the Middle East) will be needed. China's first joint venture refinery with a foreign partner -- a 100,000 barrel/day facility in which French company Total has a 20 percent interest -- is scheduled to begin operating in late 1996. Final approval of
- several other joint venture refineries is pending.

China's Ambitious and Uncertain Energy Plans - Part Two

Natural Gas

- China has only recently begun to tap its reserves of natural gas, and major infrastructure investment will be needed to transport the gas to market.
- Most natural gas is currently produced in Sichuan province, but China is targeting several large onshore and offshore fields for future development as a substitute for coal and oil. The current 5-Year Plan sets an annual production target of 25 billion cubic meters of natural gas (about 882 billion cubic feet) by 2000.
- China's largest offshore gas field, Yacheng 13-1 (with proven reserves of 3 trillion cubic feet) began production in early 1996. It is the first of several planned to supply natural gas to power plants, primarily to areas such as Guangdong province which are a long distance from coal supplies. One likely source is Dongfang 1-1, with confirmed reserves approaching those of Yacheng 13-1.
- China is also building pipelines to supply natural gas to its major cities. A pipeline from Shaanxi to Beijing and Tianjin is scheduled to begin operating in late 1997; another line will transport offshore production to Shanghai. Future imports of liquefied natural gas (LNG) are also under consideration.

Coal

- China is the world's largest producer and consumer of coal, which supplies about 75 percent of the country's total energy needs.
- The largest coal-consuming sectors are industry and electric power generation.
- China is also a net exporter of coal to neighboring countries including Japan, Hong Kong, South Korea, and North Korea.
- Most of China's coal reserves are located in relatively remote areas of northern China, especially Shanxi Province, and more than half of all recoverable reserves are bituminous. Industry concerns include inefficiency, transportation bottlenecks and large regional imbalances between supply and demand.
- Meeting production targets under the current 5-Year Plan (1.6 billion short tons by 2000) will require development of additional coal deposits and expansion of the country's railway system. China is upgrading locally owned coal mines and establishing wholly state-owned conglomerates which will have access to international financing, foreign trade, and export markets
- China is also seeking foreign investment and technology for construction of pilot plants to convert coal to liquid fuel and has approved construction of the country's first coal slurry. In addition, the country plans to develop its coalbeds and strengthen its clean coal technology program.

Electricity

- China's electric power sector has a major role to play in supporting economic growth under the country's current 5-Year Plan, about 15-20 percent of the country's demand for electricity already is not being satisfied.
- China's goal is to increase electric generating capacity to a target level of 300 gigawatts by 2000 (from about 215 gigawatts in 1995).
- An estimated 15,000 megawatts of generating capacity will be added each year, at an annual cost of about \$15 billion. About 20 percent of this additional capacity is expected to be funded by foreign investment.

China's Ambitious and Uncertain Energy Plans - Part Three

- China also plans to expand its electric power transmission system and establish a national grid linking the country's five regional grids and several provincial grids by 2009.
- In implementing the current 5-Year Plan, China plans to use high-efficiency generators with capacity of 300 megawatts or higher, and is giving priority to projects in the central and western parts of the country. These projects will continue to make use of China's large domestic coal supplies (about 70 percent of China's existing capacity is coal-fired) while expanding nuclear capacity and taking greater advantage of the country's enormous hydropower potential.
- China's largest coal-fired station, consisting of three 660-megawatt units in Dongguan, began operating in August 1996.
- The Yancheng power plant adjacent to coal mines in Shanxi Province is China's first major "coal by wire" project; the first of its six 350 megawatt generators is scheduled to begin operating in 1999. The "coal by wire" program sites power plants adjacent to coal mines rather than
- near the final consumers.
- China is proceeding with plans to build the world's largest dam -- Three Gorges -- on the Yangtze River. With costs exceeding \$20 billion, the dam will support 26 hydropower generating units with capacity of 700 megawatts each, for a total of about 18 gigawatts. Target date for completion is 2009.
- China operates two nuclear power plants - Qinshan and Daya Bay - whose combined capacity of 2.1 gigawatts currently supplies less than 1 percent of the country's total energy needs. During 1996, China announced plans to advance its nuclear program by 10 years -- the target of 20 gigawatts in new capacity is now 2010 instead of 2020. This includes 1.8 gigawatts using French technology at Lingao, 2 gigawatts using Russian technology at Liaoning and 1.4 gigawatts using Canadian technology at Qinshan.

Hydrocarbon Emissions

- The coal and oil industries are major polluting industries targeted in China's plan to curb pollution and limit environmental damage, at a cost of nearly \$40 billion over the next 5 years.
- The country is the world's second largest emitter of carbon, due primarily to its economy's high dependence on coal. Although China's energy consumption per unit of output has been cut nearly in half since 1970, the country's major industries, including electric power generation, continue to use energy far more intensively than in most developed countries.

Source: Adapted from EIA country data base as of 12/96.

India is Emerging as a Major Player in World Energy Supply and Demand

Key Issues Affecting India

- **Geography and foreign labor tie closely to Gulf.**
- **India a rising naval power.**
- **Key new sources of energy are gas and nuclear: Rise at over 6% a year through 2020.**
- **Nuclear tied closely to proliferation issue.**
- **Oil use will rise nearly 4% annually. All must come from imports.**
- **Hydroelectric projected to rise 5.6% annually.**
- **Carbon emissions will rise 4.0% per year.**

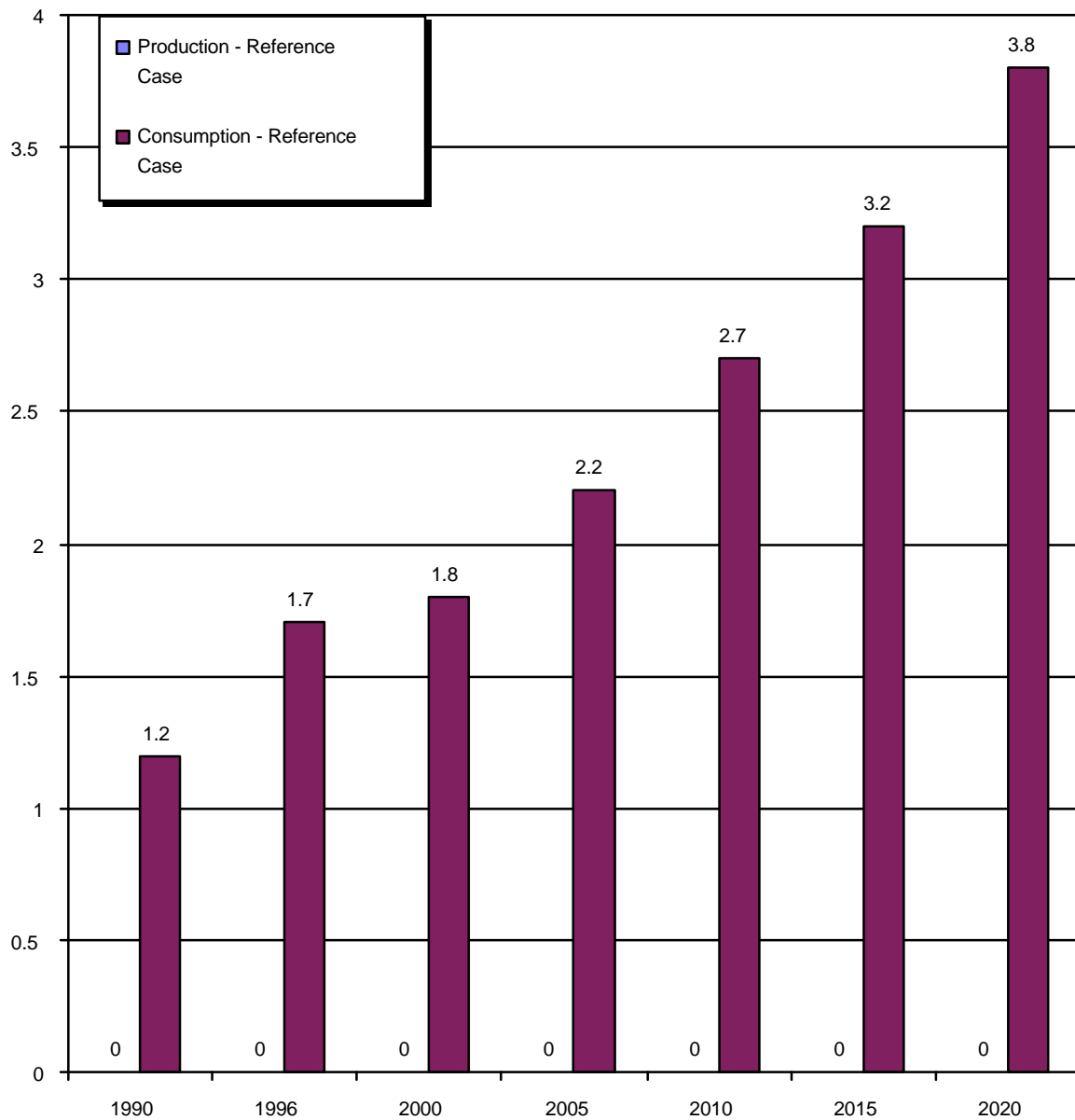
India's Energy Profile: 1990-2020

<u>Fuel Use</u>	<u>1990</u>	<u>1996</u>	<u>2000</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	% of Annual Change
<u>1995-2020</u>								
Oil Use in MMBD	1.2	1.7	1.8	2.2	2.7	3.2	3.8	3.6
Natural Gas Use in TCF	0.4	0.7	1.5	2.3	3.3	4.5	5.9	9.4
Coal Use in Millions of Short Tons	242	321	387	444	499	537	581	2.5
Nuclear Use in Billions of Kilowatts	6	7	11	16	30	41	52	8.7
Hydroelectric and Renewable Consumption in Quadrillions of BTU	0.7	0.7	1.4	1.6	1.9	2.4	3.1	5.8
Electricity Generation in Billions of Kilowatts	257	378	541	706	888	1,092	1,344	5.3
Carbon Emissions in Millions of Metric Tons	153	230	281	340	399	456	523	3.5

Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 136-142.

Indian Oil Production versus Indian Oil Consumption:

(Estimated Domestic Oil Production Capacity versus Domestic Consumption in MMB/D)



Source: Adapted by Anthony H. Cordesman from EIA, International Energy Outlook, 1998, DOE/EIA-0484 (97), April 1998, pp. 136 and 179. No oil production is listed for India.

India's Uncertain Energy Needs - Part One

Oil

- Oil accounts for about one-third of India's total energy consumption. The majority of India's 5.8 billion barrels of oil reserves are located in the Bombay High, Upper Assam, Cambay, Krishna-Godavari, and Cauvery basins.
- Domestic oil production fell from 680,000 barrels per day (b/d) in 1989 to 543,000 b/d in 1993.
 - Reasons for the decline in output included a lack of investment in exploration and development, poor reservoir management, and reliance on old Soviet-era equipment.
 - However, increased investment and new fields have resulted in a rebound in oil output since 1993, from 585,000 b/d in 1994 and an estimated 710,000 b/d in 1995.
 - Oil fields in Bombay High continue to account for the bulk of India's production, although, output from the basin has fallen recently, from 440,000 b/d in 1990 to around
 - 250,000 b/d in 1995.
- India imported roughly half of its 1.5 million b/d domestic oil requirements in 1995. Oil imports came primarily from Saudi Arabia, Kuwait, Iran, Abu Dhabi, and Malaysia.
- India embarked upon an Accelerated Exploration Program (AEP) in 1993.
 - The AEP originally proposed investing \$23 billion in the oil sector between 1994 and 1996, and called for exploration of oil shales, deepwater drilling in fields up to 3,900 feet deep, development of coalbed methane, horizontal drilling, and implementation of enhanced oil recovery (EOR) projects.
 - By 1998, the government optimistically hopes to increase the country's oil production to 890,000 b/d. Domestic oil demand is expected to reach 2 million b/d by 2000. Consequently, India's oil imports are expected to remain relatively constant at around 55-60 percent.
 - In early 1994, Enron Corporation entered a profit-sharing agreement with India's Reliance Petroleum. Enron has undertaken development of India's largest upstream oil and gas projects. These comprise the 1.1-trillion cubic foot (Tcf) Mid and South Tapti fields as well as the offshore Mukhta and Panna fields, which have combined reserves of 175
 - barrels of oil and 250 billion cubic feet (Bcf) of gas.
 - Also, ONGC is undertaking further development work at the offshore Neelam field, which has reserves of 460 million barrels of oil and 300 Bcf of gas
- The Indian oil industry is undergoing gradual privatization. In late 1995, however, further
- privatization efforts were postponed until the 1996/97 fiscal year and until
- after the April 1996 national elections..
- In 1995, India's domestic oil demand rose over 9 percent, to almost 1.5 million b/d.
 - This has necessitated an increase in the country's refining capacity through higher utilization rates, existing plant expansions, and new grassroots projects.
 - In order to meet increasing domestic oil demand, India has embarked on an aggressive refinery expansion program with over 12 new projects underway.

India's Uncertain Energy Needs - Part Two

Natural Gas

- Natural gas supplies about 10 percent of India's energy demand.
 - Domestic gas consumption is expected to increase 15-18 percent per year through 2000 and to reach 4-6 billion cubic feet (Bcf) per day by 2005.
 - Almost 70 percent of India's natural gas reserves are found in Bombay High and Gujarat. Over 20 percent of India's offshore gas production is flared, because of a lack of distribution infrastructure.
 - The government hopes to reduce this level to 2 percent through new gas pipeline development. Gas Authority of India Limited (GAIL) plans to spend at least \$2-billion by 2000 to expand India's gas production and related infrastructure. This would include a new gas pipeline link between Bombay and Bangalore.
- In September 1994, India and Oman reached an initial agreement to build a \$5-billion subsea pipeline to supply Omani natural gas to India's west coast. In January 1995, however, the Omani Oil Ministry stated that it was unable to make the gas supply commitments required. Previously, initial shipments of 1 billion cubic feet per day (Bcf/d) had been scheduled to start in July 1997.
- India is considering other gas pipeline options, including a 1.5-Bcf gas line from Iran which would run either of offshore or onshore from Assaluye in southern Iran to India via Karachi. In October 1995, Prime Minister Rao and Iranian Foreign Minister Ali Akbar Velayati discussed other routing alternatives, including one which would run through Turkmenistan, Afghanistan, and Pakistan.

Coal

- India's coal reserves are estimated at 69 billion short tons, or 6 percent of the world's total. The country's reserves include lignite and bituminous coal, but not anthracite. The country's primary coal fields are located in Bihar, West Bengal, and Madhya Pradesh.
- Coal satisfies about 60 percent of India's energy demands. India is the world's fifth largest coal producer and ranks third in the production of hard coal behind the United States and China.
 - Roughly two-thirds of India's 530 operating mines are underground. Opencast mines accounted for roughly three-quarters of India's total coal production despite employing only about 16 percent of the mining work force. Most of the coal industry's growth over the past 20 years has been in surface mining.
 - As a result of environmental constraints and land availability, surface mining is unlikely to support the growth in domestic coal demand after 2010.
 - The Indian government has begun to take steps to deregulate the nation's coal industry and to allow an increase in coal imports. At the same time, CIL is planning to export Indian coal beyond its traditional markets in Nepal and Bangladesh, to new markets in Japan, Korea, and China. Export earnings should help to offset any losses to domestic producers because of the cut in import tariffs.

India's Uncertain Energy Needs - Part Three

Electricity

- At present, over 80 percent of India is electrified.
 - The government estimates that the country will need 142,000 MW of new capacity by 2005.
 - The current five-year development plan, in effect since 1992, called for adding 48,000 MW of electrical generating capacity to its then existing capacity of 75,000 MW.
 - In 1994, this goal was lowered to 30,000 MW. About 3,000 MW of this capacity will come from independent power projects (IPPs) and the rest from NTPC projects. IPPs are expected to add most of India's electrical capacity after the year 2000.
- In mid-1994, the Indian government ended its practice of subsidizing electricity sales. India's five regional power boards have cost the government over \$1.6 billion in recent years.
- India has nine operational nuclear reactors and another eight under development. At the beginning of 1995, total net nuclear generating capacity was 1,493 MW, although actual utilization rates are estimated at under 30 percent.
 - Planned reactors will add a projected 1,100 MW of capacity, and Indian officials estimate that the country has enough uranium supplies to support a nuclear power program of 8,000 MW. In mid-1995, designs for the \$636-million, 500-MW Tarapur-3 power plant were completed.
 - In January 1996, India signed agreements with Brazil and Thailand to help those countries develop their nuclear energy programs. In December 1995, Russia's Ministry for Atomic Energy agreed to provide technical assistance for India's nuclear program.
 - India has declined to sign either the Nuclear Non-Proliferation Treaty or the Comprehensive Test Ban (CTB) Treaty.

Source: EIA Country data base as of 12/96.