The Changing Geopolitics of Energy – Part VI

Regional Developments in East Asia, China, and India

Anthony H. Cordesman
With the Assistance of Sarin Hacatoryan

Strategic Energy Initiative
Center for Strategic and International Studies

August 12, 1998
# Table of Contents

**ASIA IS RESHAPING THE GEOPOLITICS OF ENERGY** ................................................................................................................. 4

**KEY ISSUES AFFECTING ASIA** ................................................................................................................................................. 5

- Asia is Radically Changing the Distribution of World Energy Use: Future Share of World Energy Use: 1990-2020: ........................................ 6
- Asia is Vastly Increasing Its Use of Oil, Gas, and Coal: Asian Energy Consumption by Fuel ......................................................... 7
- World vs. Asian-Pacific Energy Demand ........................................................................................................................................ 8
- Primary Energy Demand by Type ...................................................................................................................................................... 8
- Individual Asian States Have Limited Reserves: ............................................................................................................................ 9
- Middle Eastern versus Asian Oil Reserves ....................................................................................................................................... 9
- Asia’s Rapidly Growing Dependence on the Gulf: ............................................................................................................................ 10
- Projected Asian Oil Imports by User and Source 1995 and 2020 ...................................................................................................... 10
- Estimated Trends in Middle Eastern Petroleum Exports By Supplier and Destination ........................................................................ 11
- Many Key Asian Economies Have Negligible Gas Reserves: Middle Eastern versus Asian Gas Reserves ........................................ 12
- Asian Gas Imports Are Critical to Clean Energy: ............................................................................................................................ 13
- Asian Gas Consumption .................................................................................................................................................................... 13
- Asian Gas Imports Change the Balance of World Use: ..................................................................................................................... 14
- Asian Gas Consumption as Percent of World Total ......................................................................................................................... 14
- Expanding Gas Demand in Asia by User Country ............................................................................................................................ 15
- World Nuclear Power Declines, Except in Asia: ............................................................................................................................... 16
- World Nuclear Energy Consumption: 1990-2020 ............................................................................................................................. 16
- The Importance of the Asian “Nuclear Gamble” ............................................................................................................................... 17
- Estimated Nuclear Capacity By Country ........................................................................................................................................ 17
- Demand for Oil Could Be Much Higher if Asia Cannot Massively Increase Coal Use ..................................................................... 18

**ASIA’S GROWING ENERGY NEEDS DRIVE GLOBAL EMISSIONS AND POLLUTION** ......................................................................................................................... 19

- Asian Development and Energy Use Greatly Alter the World’s Environmental Problems and Make Gas and Oil Imports Even More Critical ................................................................................................................ 20
- Asian Percentage of Average Annual Increase in Total Carbon Emissions 1995-2020 ......................................................................... 21
- Asia’s Current Impact on Carbon Emissions by Country ................................................................................................................ 22
- Asian Nations Have Had Very High Annual Growth Rates in Carbon Emissions ........................................................................... 23

**THE DEVELOPING STATES OF ASIA HAVE BEEN PROJECTED TO LEAD THE GROWTH IN WORLD DEMAND FOR ENERGY** .............................................................................................................. 25

**DEVELOPING ASIA: CHINA, KOREA, CHINA, SEA** .................................................................................................................... 26

- Developing Asia Has Been Projected to Lead the Increase in World Energy Consumption .................................................................. 27
- Projections of High Growth in Demand Before the Current Crisis: Developing Asia’s Energy Profile: 1990-2020 ............................................ 28
- These Projections Indicated that High Rates of Asian Economic Development Would More than Double Asian Total Energy Demands .................................................................................................................. 29
- China, Pacific Rim, and India Were Seen as the Source of Virtually All the Growth in Asian Demand .................................................. 30

**EAST ASIA’S ECONOMIC PROBLEMS MAKE ALL PROJECTIONS UNCERTAIN** ................................................................................. 31

- Recent Rates of Increase in East Asia Energy Demand ..................................................................................................................... 32
- East Asia Energy Demand in 1997 .................................................................................................................................................... 33
- Oil Use as a Share of East Asian Energy Demand in 1997 .................................................................................................................. 34
- The Changing Economics of East Asia May Now Alter Demand .................................................................................................. 35
- East Asia’s Oil Profile in 1997 ............................................................................................................................................................ 36
- East Asia’s Natural Gas Profile in 1997 .......................................................................................................................................... 37
- East Asia’s Coal Profile in 1997 ...................................................................................................................................................... 38
- East Asia’s Electric Power and Nuclear Profile ............................................................................................................................. 39
INDUSTRIALIZED STATES LIKE JAPAN AND AUSTRALIA ARE LIKELY TO SHOW SLOW GROWTH IN DEMAND................................................................. 40

JAPAN AND AUSTRALIA ARE PROJECTED TO BE MODEST SOURCES OF NEW DEMAND .................................................. 41

Slow Growth in Demand: Japan and Australasia’s Energy Profile: 1990-2020................................................................. 42

OIL USE IN MMBD ................................................................................. 42

CHINA HAS A MASSIVE IMPACT ON WORLD ENERGY DEMAND, SUPPLY, AND THE ENVIRONMENT......................................................... 43

ISSUES AFFECTING CHINA ........................................................................ 44

China’s Energy Profile: 1990-2020................................................................. 45

Chinese Oil Production: ........................................................................ 46

Chinese Oil Production versus Chinese Oil Consumption: ................. 47

China Turns to the Gulf: ........................................................................ 48

Growth of China’s Oil Imports by Source: 1995 and 2020...................... 48

The Importance of Chinese Coal Consumption Relative to World and Asian Use ...................................................... 49

The Environmental Problem Inherent in Chinese Coal Consumption............................................................................ 50

China’s Ambitious and Uncertain Energy Plans - Part One...................... 51

China’s Ambitious and Uncertain Energy Plans - Part Two....................... 52

China’s Ambitious and Uncertain Energy Plans - Part Three..................... 53

INDIA IS EMERGING AS A MAJOR PLAYER IN WORLD ENERGY SUPPLY AND DEMAND .......... 54

KEY ISSUES AFFECTING INDIA ........................................................................ 55

India’s Energy Profile: 1990-2020................................................................. 56

Indian Oil Production versus Indian Oil Consumption: ......................... 57

India’s Uncertain Energy Needs - Part One ............................................ 58

India’s Uncertain Energy Needs - Part Two ........................................... 59

India’s Uncertain Energy Needs - Part Three........................................... 60
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)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Asia</td>
<td>23</td>
<td>26.3</td>
<td>26.9</td>
<td>28.4</td>
<td>30.1</td>
<td>32.1</td>
<td>34.1</td>
<td>36.3</td>
</tr>
<tr>
<td>Developing Asia</td>
<td>51.4</td>
<td>71.8</td>
<td>74.5</td>
<td>90.8</td>
<td>113.8</td>
<td>137.4</td>
<td>165.4</td>
<td>199.4</td>
</tr>
<tr>
<td>Total Asia</td>
<td>74.4</td>
<td>98.1</td>
<td>101.4</td>
<td>119.2</td>
<td>143.9</td>
<td>169.5</td>
<td>199.5</td>
<td>235.7</td>
</tr>
<tr>
<td>Total World</td>
<td>343.8</td>
<td>365.6</td>
<td>376.1</td>
<td>413</td>
<td>465.7</td>
<td>519.6</td>
<td>575.6</td>
<td>639.4</td>
</tr>
</tbody>
</table>

Asia is Vastly Increasing Its Use of Oil, Gas, and Coal: Asian Energy Consumption by Fuel
(In Quadrillions of BTUs, EIA Reference Case)

### World vs. Asian-Pacific Energy Demand

**Primary Energy Demand by Type**

(Million Metric Tons of Oil - Mtoe)

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

Individual Asian States Have Limited Reserves:
Middle Eastern versus Asian Oil Reserves
(Thousand million barrels)

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>North Sea</td>
<td>0.1</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Caribbean Basin</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>FSU</td>
<td>1.7</td>
<td>0.3</td>
<td>1.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Total Non-OPEC</td>
<td>2.6</td>
<td>2</td>
<td>1.8</td>
<td>0.8</td>
</tr>
<tr>
<td>South America</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Asia</td>
<td>0.3</td>
<td>0.6</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>North Africa</td>
<td>0.3</td>
<td>0</td>
<td>0.1</td>
<td>0</td>
</tr>
<tr>
<td>West Africa</td>
<td>0.4</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Persian Gulf</td>
<td>23.9</td>
<td>8.7</td>
<td>17.1</td>
<td>6.9</td>
</tr>
<tr>
<td>Middle East</td>
<td>23.2</td>
<td>8.7</td>
<td>17.1</td>
<td>6.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>27.7</td>
<td>11.8</td>
<td>19.2</td>
<td>8.5</td>
</tr>
</tbody>
</table>

## Estimated Trends in Middle Eastern Petroleum Exports By Supplier and Destination

(Millions of Barrels Per Day)

<table>
<thead>
<tr>
<th>Exporting Region</th>
<th>Industrialized Asia</th>
<th>Non-Industrialized Asia</th>
<th>Importing Region</th>
<th>Total Non-Industrialized Asia*</th>
<th>Total Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrialized</td>
<td></td>
<td></td>
<td>Importing Region</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
<td>Pacific Rim</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persian Gulf</td>
<td>4.2</td>
<td>4.1</td>
<td>0.4</td>
<td>4.5</td>
<td>8.7</td>
</tr>
<tr>
<td>North Africa</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4.2</strong></td>
<td><strong>4.1</strong></td>
<td><strong>0.4</strong></td>
<td><strong>4.5</strong></td>
<td><strong>8.7</strong></td>
</tr>
<tr>
<td>Non-Industrialized Asia</td>
<td></td>
<td></td>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persian Gulf</td>
<td>6.9</td>
<td>10.1</td>
<td>6.9</td>
<td>17.0</td>
<td>23.9</td>
</tr>
<tr>
<td>North Africa</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7.1</strong></td>
<td><strong>10.2</strong></td>
<td><strong>6.9</strong></td>
<td><strong>17.1</strong></td>
<td><strong>24.2</strong></td>
</tr>
</tbody>
</table>

### Use of Exports in MMBD

**1995**

- Persian Gulf: 4.2
- North Africa: 0.0
- **Total**: 4.2

**2020**

- Persian Gulf: 6.9
- North Africa: 0.2
- **Total**: 7.1

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

**1995**

- Persian Gulf: 27.3%
- North Africa: 0.0%
- **Total**: 27.3%

**2020**

- Persian Gulf: 16.5%
- North Africa: 7.4%
- **Total**: 23.9%

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


Copyright Anthony H. Cordesman, all rights reserved.
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)

Asian Gas Imports Are Critical to Clean Energy:
Asian Gas Consumption
(In Trillions of Cubic Feet, EIA Reference Case)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>1.4</td>
<td>2.4</td>
<td>3</td>
<td>3.3</td>
<td>3.7</td>
</tr>
<tr>
<td>India</td>
<td>0.4</td>
<td>0.6</td>
<td>0.7</td>
<td>1.5</td>
<td>2.3</td>
<td>3.3</td>
<td>4.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Japan</td>
<td>1.9</td>
<td>2.2</td>
<td>2.4</td>
<td>2.2</td>
<td>2.5</td>
<td>2.8</td>
<td>2.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Australasia</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Other Developing Asia</td>
<td>2.1</td>
<td>3.5</td>
<td>4</td>
<td>6.7</td>
<td>9.4</td>
<td>12.1</td>
<td>14.8</td>
<td>18.1</td>
</tr>
</tbody>
</table>


Copyright Anthony H. Cordesman, all rights reserved.
Asian Gas Imports Change the Balance of World Use:
Asian Gas Consumption as Percent of World Total
(EIA Reference Case)

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australasia</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>China</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>1.4</td>
<td>2.4</td>
<td>3</td>
<td>3.3</td>
<td>3.7</td>
</tr>
<tr>
<td>India</td>
<td>0.4</td>
<td>0.6</td>
<td>0.7</td>
<td>1.5</td>
<td>2.3</td>
<td>3.3</td>
<td>4.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Japan</td>
<td>1.9</td>
<td>2.2</td>
<td>2.4</td>
<td>2.2</td>
<td>2.5</td>
<td>2.8</td>
<td>2.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Other Developing Asia</td>
<td>3</td>
<td>4.7</td>
<td>5.3</td>
<td>9.5</td>
<td>14.1</td>
<td>18.5</td>
<td>22.6</td>
<td>27.7</td>
</tr>
</tbody>
</table>


Copyright Anthony H. Cordesman, all rights reserved.
World Nuclear Power Declines, Except in Asia:  
World Nuclear Energy Consumption: 1990-2020  
(In Billions of Kilowatt Hours, EIA Reference Case)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East</td>
<td>0</td>
<td>0</td>
<td></td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Africa</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Latin America</td>
<td>9</td>
<td>9</td>
<td>10</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>FSU &amp; E. Europe</td>
<td>256</td>
<td>229</td>
<td>254</td>
<td>248</td>
<td>271</td>
<td>279</td>
<td>278</td>
<td>261</td>
</tr>
<tr>
<td>Other Asia</td>
<td>82</td>
<td>98</td>
<td>107</td>
<td>128</td>
<td>150</td>
<td>170</td>
<td>172</td>
<td>150</td>
</tr>
<tr>
<td>Japan &amp; Australasia</td>
<td>192</td>
<td>277</td>
<td>283</td>
<td>298</td>
<td>303</td>
<td>324</td>
<td>363</td>
<td>370</td>
</tr>
<tr>
<td>Total Asia</td>
<td>280</td>
<td>394</td>
<td>411</td>
<td>450</td>
<td>508</td>
<td>593</td>
<td>662</td>
<td>683</td>
</tr>
<tr>
<td>North America</td>
<td>649</td>
<td>774</td>
<td>770</td>
<td>773</td>
<td>730</td>
<td>683</td>
<td>559</td>
<td>451</td>
</tr>
<tr>
<td>Western Europe</td>
<td>703</td>
<td>785</td>
<td>824</td>
<td>841</td>
<td>821</td>
<td>763</td>
<td>674</td>
<td>588</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Pakistan</td>
<td>0.1</td>
<td>0.4</td>
<td>0.7</td>
<td>0.7</td>
<td>0.6</td>
<td>-</td>
</tr>
<tr>
<td>North Korea</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1.9</td>
<td>1.9</td>
<td>-</td>
</tr>
<tr>
<td>India</td>
<td>1.7</td>
<td>2.1</td>
<td>2.7</td>
<td>3</td>
<td>4.8</td>
<td>-</td>
</tr>
<tr>
<td>China</td>
<td>2.2</td>
<td>2.2</td>
<td>6.7</td>
<td>11.5</td>
<td>11.5</td>
<td>11.5</td>
</tr>
<tr>
<td>South Korea</td>
<td>9.1</td>
<td>10.7</td>
<td>12.3</td>
<td>12.3</td>
<td>13.7</td>
<td>11.9</td>
</tr>
<tr>
<td>Japan</td>
<td>39.9</td>
<td>43.5</td>
<td>43.5</td>
<td>43.5</td>
<td>43.2</td>
<td>42.9</td>
</tr>
</tbody>
</table>

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

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

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)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>274</td>
<td>281</td>
<td>291</td>
<td>303</td>
<td>320</td>
<td>342</td>
<td>361</td>
<td>385</td>
</tr>
<tr>
<td>China</td>
<td>620</td>
<td>792</td>
<td>805</td>
<td>978</td>
<td>1202</td>
<td>1481</td>
<td>1866</td>
<td>2340</td>
</tr>
<tr>
<td>US</td>
<td>1346</td>
<td>1411</td>
<td>1463</td>
<td>1577</td>
<td>1689</td>
<td>1803</td>
<td>1888</td>
<td>1956</td>
</tr>
<tr>
<td>Asia</td>
<td>1065</td>
<td>1427</td>
<td>1474</td>
<td>1758</td>
<td>2161</td>
<td>2603</td>
<td>3158</td>
<td>3835</td>
</tr>
<tr>
<td>World</td>
<td>2885</td>
<td>2933</td>
<td>3023</td>
<td>3216</td>
<td>3437</td>
<td>3667</td>
<td>3870</td>
<td>4066</td>
</tr>
<tr>
<td>World</td>
<td>5786</td>
<td>5841</td>
<td>5983</td>
<td>6598</td>
<td>7434</td>
<td>8330</td>
<td>9315</td>
<td>10447</td>
</tr>
</tbody>
</table>

Asian Percentage of Average Annual Increase in Total Carbon Emissions 1995-2020
(Total Carbon Emissions In Millions of Metric Tons, EIA Reference Case)


Copyright Anthony H. Cordesman, all rights reserved.
Asia’s Current Impact on Carbon Emissions by Country
(Total Carbon Emissions In Millions of Metric Tons in 1997)

- China: 804.8
- Hong Kong: 11.8
- Indonesia: 60.9
- Japan: 290.7
- Malaysia: 25.7
- Philippines: 15
- Singapore: 21.6
- South Korea: 112.5
- Taiwan: 51.2
- Thailand: 43.5

Total Asian Emissions Less India = 1,439.2 Million Metric Tons

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


Copyright Anthony H. Cordesman, all rights reserved.
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)

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

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

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)


Copyright Anthony H. Cordesman, all rights reserved.
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)

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)

**East Asia Energy Demand in 1997**

(in Quadrillions of BTUs)

- **China**: 37.04
- **Hong Kong**: 0.609
- **Indonesia**: 3.513
- **Japan**: 21.37
- **Malaysia**: 1.664
- **Philippines**: 0.977
- **Singapore**: 1.216
- **South Korea**: 7.158
- **Taiwan**: 3.112
- **Thailand**: 2.333

Total Asian Energy Consumption = 78.992 Quads

Increase Oil Use = 40.3 Percent

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


Copyright Anthony H. Cordesman, all rights reserved.
The Changing Economics of East Asia May Now Alter Demand

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1226.3</td>
<td>818.3</td>
<td>11.6</td>
<td>9.2</td>
<td>8.4</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>6.5</td>
<td>108.1</td>
<td>4.9</td>
<td>5.1</td>
<td>3.4</td>
</tr>
<tr>
<td>Indonesia</td>
<td>209.8</td>
<td>187.0</td>
<td>7.1</td>
<td>7.6</td>
<td>-2.1</td>
</tr>
<tr>
<td>Japan</td>
<td>125.7</td>
<td>3,324.9</td>
<td>1.8</td>
<td>3.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Malaysia</td>
<td>20.5</td>
<td>74.8</td>
<td>8.7</td>
<td>8.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Philippines</td>
<td>76.1</td>
<td>54.4</td>
<td>2.7</td>
<td>6.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Singapore</td>
<td>3.4</td>
<td>64.5</td>
<td>8.1</td>
<td>7.3</td>
<td>2.5</td>
</tr>
<tr>
<td>South Korea</td>
<td>45.9</td>
<td>411.2</td>
<td>7.4</td>
<td>6.0</td>
<td>-2.0</td>
</tr>
<tr>
<td>Taiwan</td>
<td>21.7</td>
<td>248.4</td>
<td>6.2</td>
<td>6.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Thailand</td>
<td>59.5</td>
<td>138.8</td>
<td>8.2</td>
<td>7.4</td>
<td>-3.5</td>
</tr>
<tr>
<td>Total</td>
<td>1,795</td>
<td>5,430.3</td>
<td>3.7</td>
<td>4.9</td>
<td>1.8</td>
</tr>
</tbody>
</table>

**East Asia’s Oil Profile in 1997**
(in Thousands of Barrels Per Day)

- **China**: Total Consumption 3458, Net Oil Imports 417
- **Hong Kong**: Total Consumption 5867, Net Oil Imports 195
- **Indonesia**: Total Consumption 845, Net Oil Imports -780
- **Japan**: Total Consumption 5786, Net Oil Imports 195
- **Malaysia**: Total Consumption 415, Net Oil Imports -301
- **Philippines**: Total Consumption 340, Net Oil Imports 337
- **Singapore**: Total Consumption 527, Net Oil Imports 523
- **South Korea**: Total Consumption 2159, Net Oil Imports 2156
- **Taiwan**: Total Consumption 789, Net Oil Imports 785
- **Thailand**: Total Consumption 683, Net Oil Imports 586

Total East Asian Oil Use = 15.4 MMBD
Imports = 9.7 MMBDr

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

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

## East Asia’s Electric Power and Nuclear Profile

(In Millions of Kilowatts)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Current Electric</th>
<th>Total Current Nuclear</th>
<th>Additional Planned Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>204</td>
<td>2.1</td>
<td>9.2</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Japan</td>
<td>205</td>
<td>42.4</td>
<td>12.6</td>
</tr>
<tr>
<td>Malaysia</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Philippines</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Singapore</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>South Korea</td>
<td>32</td>
<td>9.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Taiwan</td>
<td>24</td>
<td>4.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Thailand</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Total East Asian Generation = 537 Million Kilowatts
Existing Nuclear Generation = 58.5 Kilowatts
Planned Additional Nuclear Generation = 32.0 Kilowatts

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

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

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

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

Chinese Oil Production:
Estimated Oil Production Capacity in MMBD)


Copyright Anthony H. Cordesman, all rights reserved.
Chinese Oil Production versus Chinese Oil Consumption:
(Estimated Domestic Oil Production Capacity versus Domestic Consumption in MMBD)

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

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

(In Millions of Short Tons, EIA Reference Case)

The Environmental Problem Inherent in Chinese Coal Consumption
(In Millions of Short Tons, EIA Reference Case)


Copyright Anthony H. Cordesman, all rights reserved.
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 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 Yuncheng 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

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

Indian Oil Production versus Indian Oil Consumption:
(Estimated Domestic Oil Production Capacity versus Domestic Consumption in MMBD)

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, Krisha-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 billion 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.