Promoting Growth, Ending Poverty
ASIA2015
www.asia2015conference.org

Session 2: Challenges and Risks to Development in Asia

Parallel Group 2A: Topic Paper 2

Energy Demands and Sustaining Growth in South and East Asia

Pragya Jaswal and Mitali Das Gupta

March 2006

Energy Demands and Sustaining Growth in South and East Asia[1]

1. Introduction

This paper looks at the energy sector of South,[2] East[3] and to some extent South-east Asian[4] countries and their energy demand projections for 2015. The paper starts with a short sector overview, and a description of the region's energy endowments. It highlights the main challenges that the region faces in meeting its energy requirements and the impact energy shortages have on their growth. It also discusses the efforts that are being taken in these countries in order to address the challenges in the energy sector.

With a population of over 2.75 billion and booming economic growth, East and South Asian regions are going to play an increasingly important role in the global economic matters and energy markets. China and India are by far the largest in terms of population, Gross Domestic Product (GDP) and land area in this region. These two countries also account for more than 80 per cent of the energy consumption in this region. Hence, the future of the energy markets in the region will be driven to a large extent by what is happening in China and India. The South Asian region's aggregate GDP is estimated to have expanded to 6.4 per cent in 2004 and is projected to move up to 6.7 per cent in 2005, dip to 6.2 per cent in 2006, and then recover to 6.9 per cent by 2007 (ADO 2005). East Asia's growth slowed in 2005, but economic activity remained robust in most economies. Aggregate growth for the sub-region in 2005 is forecasted to decline to 6.7 per cent, before rising to 7.0–7.2 per cent in the following 2 years (ADO 2005).

Given that these Asian regions are among the fastest growing regions in the world, they will require increasing energy supplies to fuel their rapid pace of economic expansion. Reliable supply of energy is also crucial for meeting the social and developmental objectives of these nations. The region's energy demand is characterised by a rapidly growing demand for electricity and increasing motorisation. Another characteristic feature of the energy sector here is that these regions are becoming increasingly reliant on energy imports. Hence, energy security is one of the biggest challenges that these economies face. The countries need to intensify efforts towards:

- more rigorous reforms in the energy sub-sectors, especially cost-reflective pricing and improved collection in the electricity sector
- development and exploration of new energy sources and supplies

---

1 Paper written by Pragya Jaswal and Mitali Das Gupta of The Energy and Resources Institute (TERI), New Delhi.
2 South Asian region contains: Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka. This paper will mainly focus on the larger countries leaving out Bhutan and the Maldives.
3 In this paper, East Asia region refers to China, Japan and Korea.
4 In this paper the South-east Asian region covers: Indonesia, Malaysia, Philippines, Thailand and Vietnam.

- diversification of the energy mix and promotion of alternative fuel sources particularly renewable energy
- facilitating energy efficiency and conservation
- promoting technological development in the energy sector especially for utilising existing hydrocarbon base (particularly for exploiting the rich coal base of the region) in an environmentally friendly manner
- enhancing emergency response coordination and preparedness in the event of energy supply disruptions
- promoting regional cooperation not only to better utilise the energy resources within the region but also to tackle competition and confrontation over energy resources, which are emerging between Asian countries especially between Japan, China and India.

2. Sector Overview

2.1. Energy Consumption in East and South Asia

Economic and population growth in these two regions has resulted in rapid increases in energy consumption in recent years, well above rates seen in other developed countries. However, more than half of the total energy consumption in South Asia is still contributed by non-commercial energy sources like animal waste, wood, or other biomass. The Energy Information Administration (EIA) estimates that South Asia's commercial energy consumption showed an increase of nearly 59 per cent between 1992 and 2003, thereby growing at an annual rate of 4.2 per cent. In 2003, South Asia accounted for approximately 4 per cent of world commercial energy consumption, up from about 2.8 per cent in 1990. Despite this growth in energy demand, South Asia continues to average among the lowest levels of *per capita* energy consumption in the world.

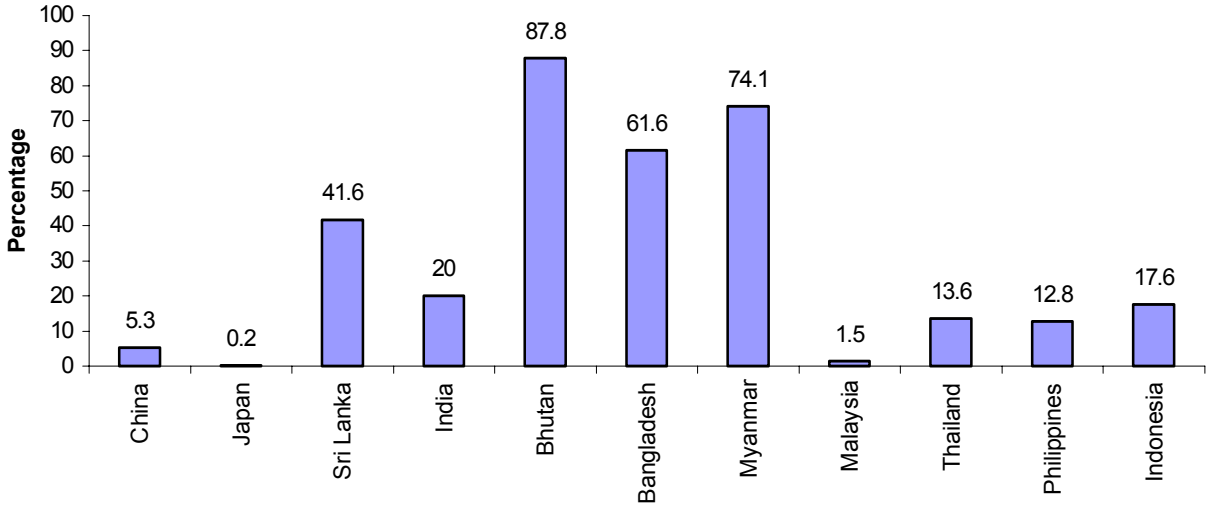
The East Asian countries are almost 100 per cent reliant on commercial fuels. Commercial energy consumption increased at an annual rate of 2.7 per cent between 1992 and 2003. This region with only three countries constituted about 18 per cent of the global commercial energy consumption in 2003, up from 14.6 per cent during the 1990.[5]

Unlike the South Asian countries, the East Asian countries show much higher *per capita* energy consumption. Table 1 gives the *per capita* energy consumption figures for these countries in 2003 and also its relation to the world average. It can be seen that the South Asian countries are far below the world average. For instance, Nepal is just 3.7 per cent of the world average of 66.7 million Btu per person, followed by Bangladesh, which is 6.3 per cent. India's *per capita* energy consumption is almost 20 per cent of the world average. In the developing East Asian region on the other hand, *per capita* energy consumption is higher. The figures in China and North Korea are more than half the world average. South Korea's *per capita* energy consumption is higher than the

[5] www.eia.doe.gov/emeu/international/energyconsumption.html (accessed: 29 November 2005).

world average by 2.7 times. Considering this stark difference, it is obvious that the South Asian region has a vast possibility for future growth in energy consumption.

Figure 1: Traditional fuel consumption as a percentage of total fuel use in 2002 for select Asian economies



Source: UNDP 2005.

Table 1: *Per capita* commercial energy consumption of the Asian countries in 2003

	***Per capita* energy consumption (million Btu/person)**	**Percentage of the world average**
South Asia		
Bangladesh	4.2	6.30
India	13.2	19.79
Nepal	2.5	3.75
Pakistan	12.4	18.59
Sri Lanka	10.3	15.44
East Asia		
China	34.9	52.32
Korea		
North	39.2	58.84
South	181.0	271.36

Source: EIA website.[6]

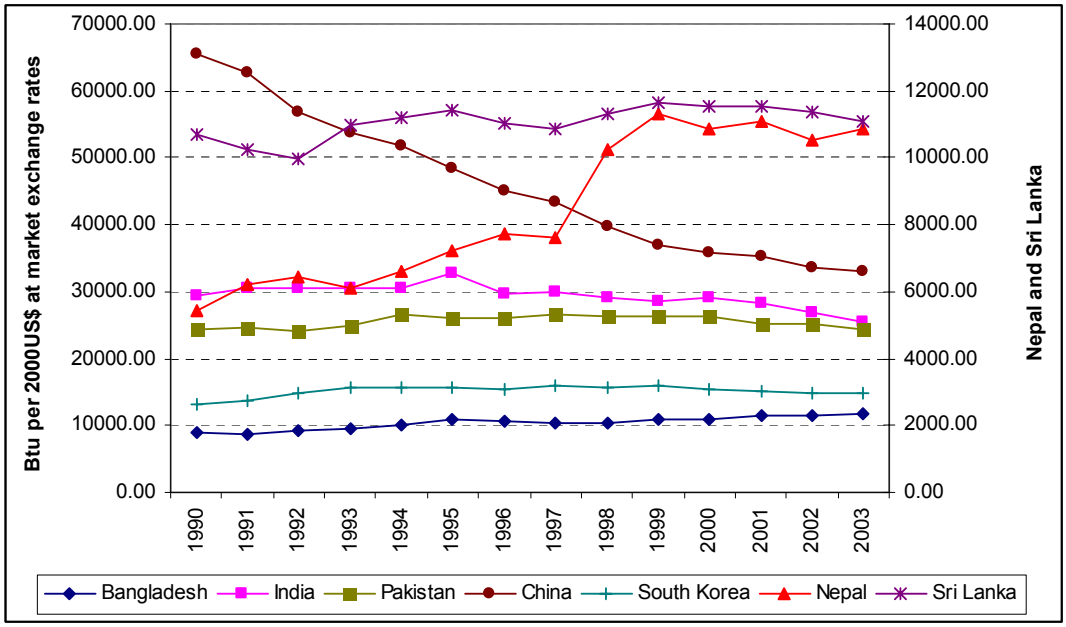
2.2. Energy Intensity

Though the *per capita* energy consumption figures are quite low for South Asian countries, they have among the highest levels of energy consumption per unit of GDP (see Figure 2). Even within these countries there are significant variations in the energy intensity values. For instance, the highest numbers are recorded by India, followed by Pakistan. The energy intensity values for the other South Asian countries like Bangladesh, Nepal and Sri Lanka are comparatively much lower. However, these countries have recorded increasing energy intensities, with the highest growth occurring in Nepal (6 per cent), followed by Bangladesh (2.1 per cent) and Sri Lanka (0.7 per cent). The reason for this is primarily inefficient use of energy in these countries. Pakistan has recorded a modest growth rate in its energy intensity at 0.2 per cent. India on the other hand has witnessed a

6 www.eia.doe.gov/emeu/international/energyconsumption.html (accessed: 29 November 2005).

decline in its energy intensity between 1990 and 2003. Among the East Asian countries, Korea's (South) energy intensity values are quite high and it has registered a positive growth in its energy intensity at the rate of 0.5 per cent. China is the most energy intensive country, higher than that of India. However, over the years the Chinese economy has undergone a significant decline in its energy intensity, falling at the rate of 5.5 per cent on the average annual basis in comparison to India's decline of 1.1 per cent. This has been due to China's multifaceted effort towards energy conservation.

Figure 2: Energy intensity in the South and East Asian Countries (1990–2003)



Notes: Nepal and Sri Lanka are measured on the secondary axis. *Source*: Data from EIA website.[7]

2.3. Commercial Energy Mix

The commercial energy mix of South Asia is 46 per cent coal, 34 per cent petroleum, 12 per cent natural gas, 6 per cent hydroelectricity, 1 per cent nuclear and 0.3 per cent 'other'. However, there are significant variations within the region. The two major energy consumers, China and India, which account for more than 80 per cent of the energy consumption in the region, have very similar energy mix, with a high reliance on coal (65 per cent and 52 per cent respectively) and petroleum (25 per cent and 34 per cent, respectively).

7 www.eia.doe.gov/emeu/international/energyconsumption.html (accessed: 29 November 2005).

Table 2: Commercial energy consumption in South Asia in 2003

	Total consumption (Quadrillion Btu)	Petroleum (%)	Coal (%)	Hydroelectric (%)	Nuclear (%)	Others (%)	Natural gas (%)
Bangladesh	0.61	29.02	2.48	1.86	0.00	0.00	67.45
India	14.03	34.28	51.89	5.00	1.41	0.31	7.05
Nepal	0.06	51.67	14.25	37.81	0.00	0.00	0.00
Pakistan	1.91	38.22	5.56	14.00	1.01	0.00	21.99
Sri Lanka	0.19	84.21	0.02	15.85	0.00	0.02	0.00
South Asia	16.83						

Source: EIA website.[8]

Table 3: Commercial energy consumption in East Asia in 2003

		Total commercial energy consumption (Quadrillion Btu)	Petroleum (%)	Coal (%)	Hydroelectric (%)	Nuclear (%)	Others (%)	Natural gas (%)
China		45.48	25.02	64.78	6.27	0.93	0.05	3.02
Korea	North	0.88	6.16	81.79	12.26	0.00	0.00	0.00
	South	8.63	52.00	22.00	0.57	14.34	0.09	11.03
East Asia		54.99						

Source: EIA website.[9]

2.4. Comparison with South-east Asia

If we compare the figures of the South and East Asian countries with that of the South-east Asian countries, it is found that as far as *per capita* energy consumption is concerned, Philippines (15.7 million Btu per person) and Vietnam (12.1 million Btu per person) are quite close to that of India (13.2 million Btu per person). Malaysia has the highest *per capita* energy consumption figure (94.75 million Btu per person in 2003), which is almost three times that of China. Thailand (49.7 million Btu per person) and Indonesia (22.46 million Btu per person) are also quite high in terms of their *per capita* energy consumption figures. As far as energy intensity is concerned, the South-east Asian countries particularly Indonesia, Malaysia and Thailand are quite close to the values for India and Pakistan. In fact, Malaysia, which has the highest *per capita* energy consumption, is also quite high in terms of its energy intensity and also shows no improvement towards energy conservation over the years. On the other hand, a country like Philippines, which performs poorly in terms of its *per capita* energy consumption, has the lowest energy intensity figures.

Table 4: Commercial energy consumption in South East Asia in 2003

	Total commercial energy consumption (Quadrillion Btu)	Petroleum (%)	Coal (%)	Hydroelectric (%)	Nuclear (%)	Others (%)	Natural gas (%)
Thailand	3.12	52.94	11.59	2.37	0.00	0.83	32.34
Indonesia	4.72	50.73	16.28	1.82	0.00	2.78	28.40
Malaysia	2.31	44.54	7.04	2.59	0.00	0.00	45.81
Philippines	1.25	55.03	16.60	6.23	0.00	15.81	6.39
Vietnam	0.98	46.04	22.34	21.63	0.00	0.00	10.15

Source: EIA website.

Table 4 shows the commercial energy mix in these countries. It can be seen that all these countries are heavily reliant on petroleum products, coal and natural gas in their total commercial energy consumption. Coal and oil consumption is largely met through imports. Vietnam like some

[8] www.eia.doe.gov/emeu/international/contents.html (accessed: 29 November 2005).

[9] www.eia.doe.gov/emeu/international/contents.html (accessed: 29 November 2005). Data excludes Japan.

of the South Asian countries like Nepal, Pakistan and Sri Lanka is also dependent to a large extent on hydroelectricity. The country has currently five hydroelectric expansions underway. At present none of these countries uses nuclear power but Vietnam plans to complete its first nuclear power plant by 2020 as an alternate means of meeting demand. In Philippines in recent years, the government has made expanding natural gas use a priority, particularly for electric power generation, in an effort to cut oil import expenses. Liquefied natural gas (LNG) has begun to receive added attention as a potential source of natural gas consumption.
It is important to note that energy consumption is growing very fast in all the South-east Asian countries, much more than in India and China. Whereas energy consumption has grown at the rate of 4.6 per cent and 3.6 per cent, respectively in India and China on an average annual basis, the growth rates for Thailand, Malaysia, Indonesia Philippines and Vietnam during the same period are, respectively 6.7 per cent, 6.4 per cent, 5.8 per cent, 4.8 per cent and 9.8 per cent. Thus in years to come, the South-east Asian region will face a serious challenge in meeting its energy demands.

2.5. Projections on Energy Consumption

2.5.1. Coal

According to International Energy Agency, IEA (2000), the share of coal in the fuel mix for South, and East Asia (excluding Japan) is expected to decline from 53 per cent to 43 per cent over 1997–2020.

- In China, coal makes up 65 per cent of the primary energy consumption. The Chinese government has made major upward revisions to coal production and consumption figures covering the last several years. Over the longer term, China's coal demand is projected to rise significantly. While coal's share of overall Chinese energy consumption is projected to fall, coal consumption will still be increasing in absolute terms. The case with India is similar.

2.5.2. Oil

Growing demand for transportation fuels and industrial power has been a major factor behind recent growth in South Asian oil consumption. Between 1990 and 2000, South Asian oil consumption led by India, grew by about 75 per cent.

- India's oil consumption is forecast to grow by almost 5 per cent between 2003–4 and 2019–20.
- China was the world's second largest consumer of petroleum products in 2004, having surpassed Japan for the first time in 2003, with total demand of 6.5 million barrels per day (bbl/d). China's oil demand is projected by Energy Information Agency (EIA) to reach 14.2 million bbl/d by 2025, with net imports of 10.9 million bbl/d.

An important feature of the demand for oil in this region is the increasing share of transport sector. The Asian countries are on the threshold of motorisation, which is anticipated to gather momentum

in the near future with the rising standards of living. As per the World Energy Outlook projections for 2004, the Chinese vehicle ownership is going to reach more than 90 per 1,000 persons by 2030 increasing the vehicle stock to 130 million. In India, the transport sector accounts for more than one-third of the petroleum consumption. Total freight traffic has grown at 5.8 per cent while total passenger traffic (road & rail) has grown by 5.6 per cent between 1980 and 2001. As per TERI estimates, the share of transport sector in petroleum consumption is projected to go up to 75 per cent by 2030. Hence, this sector will have significant implications on energy demand in the medium and long term.

2.5.3. Natural Gas

At present, all natural gas production in South Asia is consumed domestically. Natural gas is seen as playing an important part in supplying new power plants in the region and a means of diversifying from expensive oil imports. As a result, natural gas usage has increased rapidly in South Asia over the last decade, growing by 59 per cent between 1992 and 2002.

- Indian consumption of natural gas has risen faster than that of any other fuel in recent years and accounts for approximately 6.5 per cent of the country's energy demand. At nearly 0.9 trillion cubic feet (Tcf) in 2002, Indian gas demand is projected in the *International Energy Outlook 2005* (EIA 2005) to significantly and rapidly increase, reaching 2.5 Tcf in 2025. Increased use of natural gas in power generation will account for much of this change.
- Like India, Pakistan plans to increase the use of natural gas for future electric power generation projects.
- As natural gas is already Bangladesh's primary source of commercial energy, gas exports are a controversial topic within Bangladesh, with many people feeling that Bangladeshi gas resources should be used for domestic purposes before exporting. Bangladesh's natural gas demand as projected by some independent analysts is expected to grow by around 6 per cent annually over the next two decades. Potential uses for natural gas in Bangladesh include petrochemicals, compressed natural gas (CNG) for vehicles, power generation and fertiliser. CNG is already used to fuel over 20,000 vehicles, mainly in the Dhaka area. Bangladesh also contains around 55 million barrels of natural gas liquids (NGLs), which could be used for petrochemicals production or as a cooking fuel.
- In China, natural gas currently accounts for only around 3 per cent of total energy consumption in China, but consumption is expected to nearly double by 2010.

2.5.4. Electricity

Electricity demand in most of South Asia is currently outstripping supply, and the region is characterised by chronic shortages. South Asia's rapidly rising electricity demand has heightened the need for additional investment by independent power producers (IPPs).

- In India, the requirement for electricity generation is expected to increase by around 6 times during 2001/2 and 2031/2 (TERI estimates 2005)
- Nepal has large untapped hydroelectric potential (estimated at 43,000 MW), which could be developed to provide for the 60 per cent of the population without electricity, as well as for export
- In Bangladesh, with only about 20 per cent of the population connected to the electricity grid, and with power demand growing rapidly, Bangladesh's Power System Master Plan (PSMP) projects a doubling of electricity generating capacity by 2010
- In Pakistan, at present, there is an excess power generating capacity. However, by 2010, power consumption is likely to strip power generation by about 5,000 million MW
- Growth in Chinese electricity consumption is projected at an average of 4.3 per cent per year through 2025. The largest future growth in terms of fuel share in the future is expected to be natural gas, due largely to environmental concerns in China's rapidly industrialising coastal provinces, though the largest increase in absolute terms is likely to be coal. If a truly competitive market for electric power develops as planned, the Chinese market may once again become attractive to foreign investment.

2.6. Energy Demand Forecasts

Table 5 gives the energy demand forecast estimates for the South Asian countries. It can be seen that between 2003–4 and 2019–20, electricity consumption will rise at the fastest pace in Bangladesh and Nepal. Demand for natural gas is projected to grow at the fastest pace in Bangladesh and India followed by Pakistan. Nepal, which is a major hydropower, will see significant increase in the demand for coal, along with Pakistan. Demand for oil will be very fast growing in almost all of the countries.

Table 5: Energy demand forecast in South Asia (2019–20)

Fuels	Unit	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Electricity (total)	BkWh	72.7	1756	8.08	251.06	23.8
Growth rate	(%)	8.2	7.1	8	7.5	7.2
Oil products	Mtoe	11.6	246.9	1.61	30.9	7.8
Growth rate	(%)	7.3	4.8	4.9	4.5	6.2
Natural gas	Mtoe	44.03	101.8	0	72.7	0
Growth rate	(%)	11	8	0	6.2	0
Coal	Mtoe	0.9	447.6	0.78	13.9	7
Growth rate	(%)	3.7	6.2	10	9.4	–

Source: Sankar (2005). Growth rates refer to the period 2003–4 to 2019–20.

With the present levels of energy consumption, the future growth in energy consumption for the East Asian countries as projected by the EIA are provided in Table 6. These projections are made for the year 2010, 2020 and 2025. The average annual growth in China's energy consumption is going to be quite robust, as projected by the EIA. Of the various commercial energy sources, the most spectacular growth will be in terms of nuclear energy and natural gas. In South Korea,

demand for cleaner fuels is expected to grow relatively faster in the future. Demand for hydroelectricity and other renewables is expected to increase significantly followed by natural gas.

Table 6: Projected primary energy consumption

	Units	Country	History		Projections			Average annual % change (2002–25)
			1990	2002	2010	2020	2025	
Total commercial energy consumption	Quadrillion Btu	China	27	43.2	73.1	97.7	109.2	4.10
		S Korea	3.8	8.4	10.6	12.7	13.5	2.10
Coal	Million short tons	China	1124	1422	2302	3037	3242	3.6
		S Korea	49	80	97	130	142	2.5
Net electricity	Billion kWh	China	551	1457	2801	3816	4260	4.8
		S Korea	93	267	381	480	520	2.9
Hydro-electricity and other renewables	Quadrillion Btu	China	1.3	3.1	5.2	6.2	6.7	3.4
		S Korea	0	0	0.1	0.1	0.1	4.6
Nuclear energy	Billion kWh	China	0	23	72	162	200	9.8
		S Korea	50	113	169	185	196	2.4
Natural gas	Trillion cubic feet	China	0.5	1.2	2.6	4.2	6.5	7.8
		S Korea	0.1	0.8	1.2	1.6	1.9	3.7
Oil	Million barrels per day	China	2.3	5.2	9.2	12.3	14.2	4.5
		S Korea	1	2.2	2.6	2.9	2.9	1.3

Source: EIA website.[10]

3. Energy Resource Endowments

Most of the South and East Asian nations are facing increasingly insufficient energy supplies. Many of these countries are grappling with energy shortfalls, largely in the form of power shortages. The net energy imports for the South Asian region have grown from 10 per cent in 1990 to around 19 per cent in 2002 (WDI 2005). In terms of overall resource endowments, the Asian-Pacific region is the richest in coal reserves (see Figure 3).

3.1. Coal

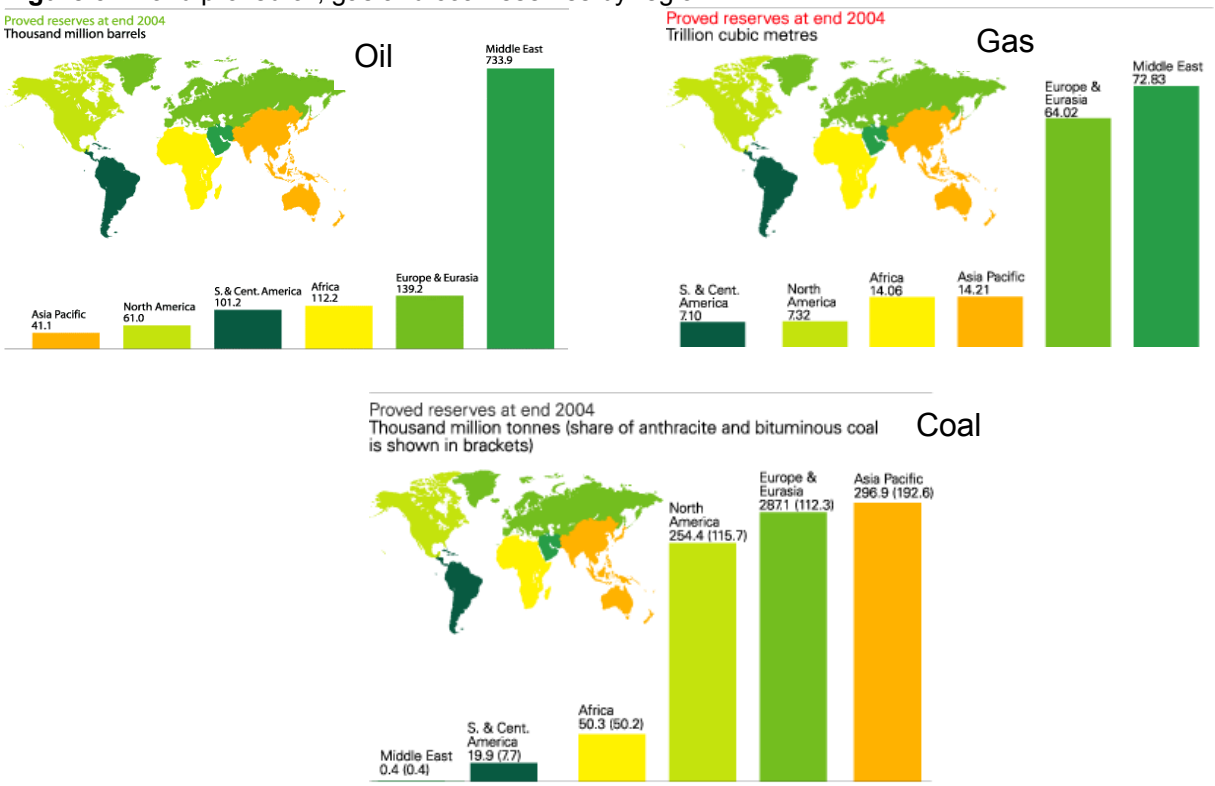
South and East Asia contain reserves of around 233 billion short tons, which is around 23 per cent of the world total.[11] The South Asian reserves are around 105 billion short tons (11 per cent of world's total). Bulk of the coal is produced and consumed in China (having about 126 billion short tons of reserves) and India (having about 102 billion short tons of reserves). Apart from these two countries, Pakistan and Korea have limited coal reserves. Coal plays a relatively minor role in the other South Asian countries. The South-east Asian region also has very small level of reserves of about 7.4 billion short tons.

In the past couple of years, the coal market has undergone substantial changes. As recently as 2002, China had a surplus of coal, and was seeking to export the extra coal to other markets in Asia, but since 2003, the country has been facing a tight coal supply situation due the surging domestic demand from energy-heavy sectors such as the power and metallurgical industries.[12] Similarly, for India as well the coal import market is coming into sharper focus with imports projected to grow from around 7 per cent of total coal requirement in 2001 to 71 per cent by 2031/2

10 www.eia.doe.gov/emeu/international/contents.html (accessed: 29 November 2005).
11 www.eia.doe.gov/pub/international/iea2003/table82.xls (accessed: 1 December 2005).
12 http://english.people.com.cn/200503/28/eng20050328 178376.html (accessed: 1 December 2005).

(TERI 2005 estimates). This trend raises concerns not only with regard to the magnitude of imports and its impact on monetary outflows, but also regarding the sources from which coal could be imported, as well as the infrastructure requirements including handling facilities for such volumes of imports, and further transportation networks.

Figure 3: World proved oil, gas and coal reserves by region



Source: BP Statistics 2005.[13]

3.2. Oil

The South and East Asian region has oil reserves of 24.02 billion barrels of oil, comprising around 1.9 per cent of the world's reserves. A substantial percentage of these oil reserves (around 76 per cent) are in China. The remaining reserves of oil are in India (5.37 billion barrels) and Pakistan (0.29 billion barrels).[14] In the face of growing oil demand, several South Asian countries have responded with plans to expand their refining and transportation capacities. The South-east Asian region has around 10.44 billion barrels of oil reserves with Indonesia accounting for about 45 per cent and Malaysia accounting for about 28 per cent of these regions' oil reserves[15]; the remaining reserves being in Brunei, Vietnam and Thailand.

13 www.bp.com/sectiongenericarticle.do?categoryId=9003066&contentId=7005906; www.bp.com/sectiongenericarticle.do?categoryId=9003054&contentId=7005895; www.bp.com/sectiongenericarticle.do?categoryId=9003072&contentId=7005912 (all accessed: 8 December 2005).

14 www.eia.doe.gov/emeu/international/reserves.xls (accessed: 30 November 2005) *Oil and Gas Journal* 2005 estimates.

15 www.eia.doe.gov/emeu/international/reserves.xls (accessed: 30 November 2005) *Oil and Gas Journal* 2005 estimates.

Oil production in China is expected to start declining very soon. It became a net oil importer about a decade back in 1993. The import dependency for China is 45 per cent at present and is projected to grow to 74 per cent by 2030, importing almost 10 mb/day (IEA 2004). In South-east Asia, Singapore, Thailand and Philippines are the key net oil importers. Indonesia, which was a key oil power in the region has been facing an uneasy demand-supply situation and has recently become an importer from an exporter. India, at present is importing over 70 per cent of its crude requirement and its import dependency is projected to go up to 91 per cent by 2030.[16] While there is no prospect for Pakistan to reach self-sufficiency in oil, the government has encouraged private (including foreign) firms to develop domestic production capacity. World Energy Outlook[4] projects that the South Asian oil import dependency will increase from 72 per cent in 2000 to 95 per cent in 2030. Hence, almost all of the incremental oil demand in the future will have to be met by imports. The primary source of the region's imports is the Middle East. China imports almost half its oil imports while India imports more than 65 per cent from the Middle East.[17] This increases the region's vulnerability to embargoes or blockades of Middle Eastern oil supplies.

3.3. Natural Gas

The natural gas reserves for South and East Asia are around 122 Tcf, around 2 per cent of the world's reserves. Around 67.57 Tcf of these reserves are in the South Asian region (approximately 1 per cent of the total world's reserves). China has the largest share of gas reserves of around 53.33 Tcf. India, Pakistan and Bangladesh are the other countries in this region which have gas reserves (around 30.14, 26.83 and 10.6 Tcf, respectively). The South-east Asian region is very rich in natural gas with reserves of the order 213 Tcf. Indonesia and Malaysia account for more than 75 per cent of the region's reserves (90 and 75 Tcf, respectively). The other countries of the region, which have natural gas reserves, include Brunei, Thailand, Vietnam and Philippines.

In order to meet the increasing gas demand, the region will have to look at enhanced domestic production and/or imports. Korea and Taiwan are almost entirely dependant upon gas imports for meeting their gas demands. They also have a well-developed gas import infrastructure in place. As per certain estimates, China and India are also heading for 30–50 per cent import dependency for gas (Herberg 2004). Relying on the import option for the South Asian countries, like India and China, will imply putting in place the infrastructure in terms of either cross-border gas pipelines and/or LNG terminals. India already has commissioned two LNG terminals and is proposing to set up several other terminals. Construction of two LNG terminals in Southern China is also underway.[18]

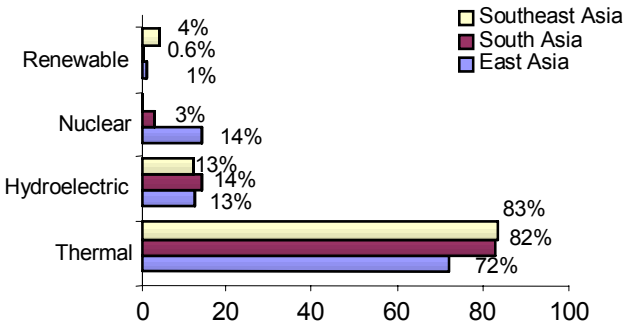
3.4. Electricity

The electricity generation in the South and East Asian region in 2002 was to the tune of 3,600 Bkwh, of which around 663 Bkwh was generated in South Asia. In South-east Asia, about 397

16 World Energy Outlook (2004) International Energy Agency: 117.
17 www.enecho.meti.go.jp/english/policy/oil/fundamental_view.html (accessed: 30 November 2005) (PetroFed 2005) (Seminar 2005).
18 www.eia.doe.gov/emeu/cabs/china.html (accessed: 1 December 2005).

Bkwh of electricity was generated. A major proportion of the electricity generation was from conventional thermal power plants (see Figure 4).

Figure 4: Electricity generation by fuel for South and East Asia in 2002



Source: EIA website.[19]

India accounts for more than 80 per cent generation in the South Asian region. This is followed by Pakistan (11 per cent), Bangladesh (3 per cent) and Sri Lanka (1 per cent). China is the second largest producer of electricity in the world.[20]

In the South Asian region, the level of electrification is very poor particularly in rural areas. The access to electricity in India (in 2001/2) was around 46 per cent, while it was 30 per cent for Bangladesh. Only 11 per cent of Bhutan's population has access to electricity and for Nepal, it was around 15 per cent (SASEC Issue paper). The situation is similar in South-east Asia.[21]

Electricity demand has outpaced the supply in most of South and East Asia. In India, the current installed capacity stands at nearly 115 GW.[22] In 2003/4, there was supply and peaking deficit to the tune of 7.1 per cent and 11.2 per cent, respectively. The Chinese economy is also facing shortages in the electricity sector. This was largely due to the policy of the Chinese Government of restricting the setting up of new power plants (until 2002) in response to the oversupply problem that the country faced in the late 1990s. At the end of 2002, China had a generating capacity of 360 GW. However, the surging demand surpassed the supply. In the wake of power shortages that the country faced in 2003, the Chinese government has approved a number of new electric power projects including 35 GW of capacity during 2003 and another 40 GW during 2004 (IEA 2004). However, given the long gestation time of these projects, the country is facing a significant

19 www.eia.doe.gov/pub/international/iea2003/table63.xls (accessed: 2 December 2005).

20 web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPENERGY/0,,contentMDK:20502907~pagePK:34004173~piPK:34003707~theSitePK:574015,00.html (accessed: 15 December 2005).

21 web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPENERGY/0,,contentMDK:20326395~menuPK:622489~pagePK:34004173~piPK:34003707~theSitePK:574015,00.html (accessed: 16 December 2005).

22 *Source*: Ministry of Power 2005; www.powermin.nic.in/JSP_SERVLETS/internal.jsp (accessed: November 2005).

shortfall, estimated at around 30 GW at the end of 2004.[23] As per the Chinese government forecasts, power shortage of about 10–15 per cent will be faced in the key manufacturing areas.[24] Countries, like Nepal and Bhutan with substantial hydropower potential have not been able to harness it fully. Nepal which has a huge hydropower potential has a *per capita* electricity consumption of about 42 kWh, among the lowest in the world. Domestic supplies have not been able to meet local demand. Nepal also imports electricity from India.[25] Despite having a high potential of exportable power and a large market in India, Nepal has not been to utilise this fully. One of the reasons for this is the high power generation costs. The poor level of progress in developing the hydropower potential is due to lack of financial resources and poor development of infrastructure. India too has an unutilised hydropower potential of more than 150,000 MW.[26]

4. Impact of energy shortages on growth

Energy is a prerequisite to economic development and in turn the prosperity that economic development brings stimulates the demand for more and better energy services. While the energy and growth inter-linkage is well understood, not much work has been done to estimate what impact energy shortages will have on the growth of the South and East Asian economies.

4.1. Energy Shortages

The energy shortages that these countries are currently facing already impose significant losses on the economic outputs of these countries. As per World Bank estimates, Bangladesh loses US$1 billion per year in economic output due to power outages and unreliable energy supplies.[27] In India, a study[28] estimating the cost of unserved power in one of the Indian states (Karnataka) shows that the economic loss due to power outage in the agriculture sector varies from 1.9 per cent to 3.6 per cent of total State Domestic Product (SDP), i.e. Rs 950 billion at 1999/2000 prices, while in industry, the economic loss varies between 0.04 per cent and 0.17 per cent of total SDP depending upon the size of industry during the study period in 1999.

4.2. Vulnerability to Oil Prices

Most of the region's economies are highly vulnerable to oil shocks as their energy sectors are characterised by increasing oil import dependency. This has become very important given the recent oil price rise due to an unforeseen steep increase in demand, most notably from China and geopolitical tensions. The crude oil prices breached the US$70/barrel mark in August 2005.[29] The prices are projected to remain above US$50 per barrel for the remaining 2006.[30] According to the

23 www.eia.doe.gov/emeu/cabs/china.html (accessed: 2 December 2005).
24 web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPENERGY/0,,contentMDK:20502907~pagePK:34004173~piPK:34003707~theSitePK:574015,00.html (accessed: 15 December 2005).
25 www.nepalnews.com.np/contents/englishweekly/spotlight/2004/sep/sep03/viewpoint.htm (accessed: 3 December 2005).
26 www.indiabudget.nic.in/es2004-05/chapt2005/chap93.pdf (accessed: 3 December 2005).
27 www.eia.doe.gov/emeu/cabs/bangla.html (accessed: 5 December 2005).
28 Cost of unserved power/Energy PolicyJEPO_395/EP/2005/3066.
29 www.newsflash.org/2004/02/hl/hl102715.htm (accessed: 8 December 2005).
30 www.globalsecurity.org/military/intro/oil.htm (accessed: 8 December 2005).

Oxford Economic Forecasting Ltd's 'World Macroeconomic Model', an additional US$10 increase in oil prices would increase the rate of inflation in Asia by 0.5 per cent and cut GDP growth by 0.6 per cent. A US$20 hike would worsen the scenario and would leave the Asian economies with a 1.2 percentage point loss in GDP growth and a 1.1 per cent hike in consumer prices (Table 7).[31] Philippines, Singapore and Thailand are the worst-hit Asian economies. The impact differs substantially across the countries, shown in Table 7, and can be direct or indirect. The indirect effect of an oil price shock is seen in the impact on exports to the rest of the world and, again, depends on the composition of exports and export demand elasticities.

Table 7: The impact of a temporary oil price increase in selected Asian countries

	US$10/bbl increase			US$20/bbl increase		
Region	GDP (percentage points)	Trade balance (% of GDP)	Consumer price	GDP (percentage points)	Trade balance (% of GDP)	Consumer price
Asia excluding Japan	–0.6	0.1	0.5	–1.2	0.1	1.1
Asia including Japan	–0.5	0.0	0.5	–0.9	0.0	1.0
China	–0.6	0.2	0.3	–1.2	0.3	0.6
Hong Kong, China	–0.5	–0.5	0.2	–0.9	–0.9	0.3
India	–0.6	–0.1	0.9	–1.1	–0.1	1.8
Indonesia	0.0	0.1	0.6	0.0	0.1	1.2
Korea	–0.5	0.0	0.4	–0.8	–0.2	0.8
Malaysia	–0.7	0.8	0.7	–1.8	1.7	1.4
Philippines	–1.5	–0.4	0.7	–3.0	0.1	1.4
Singapore	–1.2	–0.2	0.6	–2.4	–0.3	1.2
Taipei, China	–0.3	0.0	0.2	–0.5	0.0	0.3
Thailand	–1.7	–0.1	0.8	–3.3	–0.2	1.5

Source: ADO 2004.[32]

There is a need to study further the impact these kinds of shortages have on growth prospects of these nations. However, it is evident that energy shortages and energy price volatility have significant implications on the growth of South and East Asian countries. High rates of economic growth cannot be sustained if the gap between energy supply and demand is not narrowed.

5. Challenges in the Energy Sector

With the growing demand of energy and constraints in the domestic resource availability, the South and East Asian countries face a number of challenges in terms of provision of energy services. The energy demand is going to grow rapidly. Some of the important challenges are discussed in the following paragraphs.

5.1. Increasing Supplies and Investment Needs

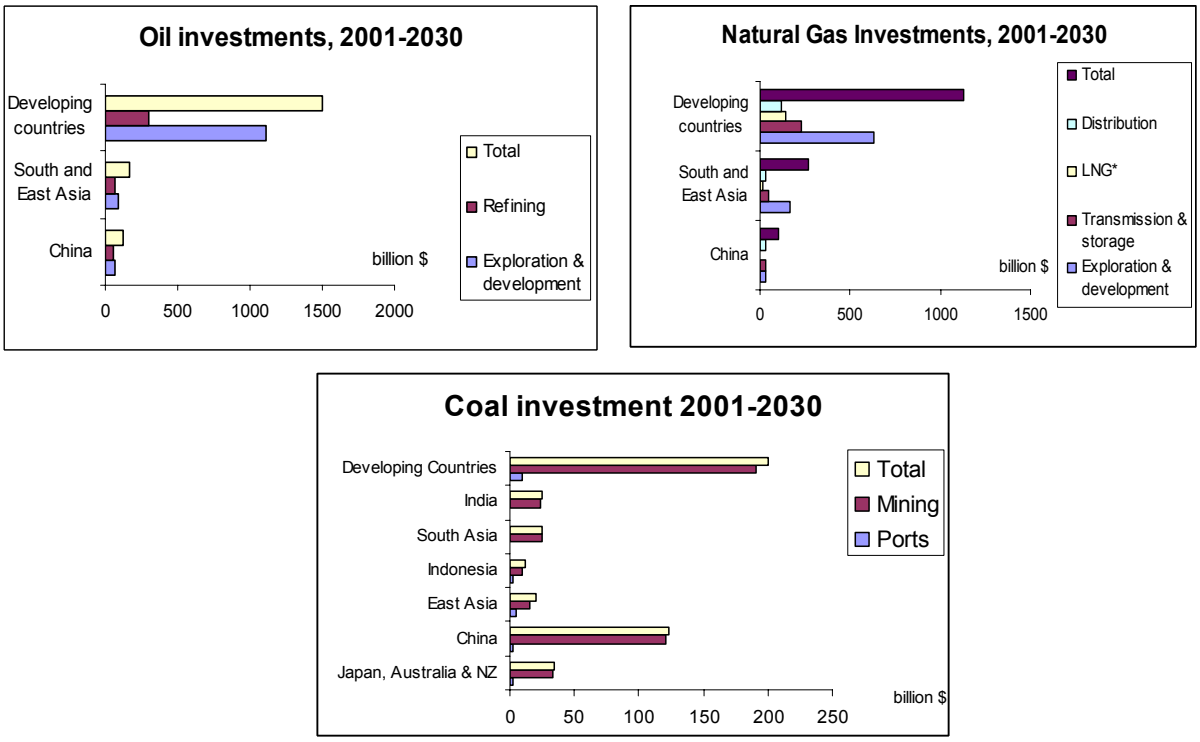
Given the energy demand supply gap, a major challenge for the region is to increase the supply of energy. This entails finding new energy sources as well as investing in infrastructure. Figure 5 summarises the region's investment needs for oil, natural gas and coal, covering the period 2001–30. These figures are compared with global investment needs in future energy supplies. Developing countries will require almost half of global investment in the energy sector, which amounts to about US$8 trillion. China alone is estimated to require US$2.3 trillion or 14 per cent of

31 www.adb.org/Documents/Books/ADO/2004/update/part030200.asp (accessed: 6 December 2005).

32 www.adb.org/Documents/Books/ADO/2004/update/part030200.asp (accessed: 6 December 2005).

world investment in the energy sector. Capital needs will be almost as big in the rest of Asia including India and Indonesia (IEA 2003). In India, the investment required to meet the projected increase in generation capacity, transmission and distribution is estimated to be US$680 billion until 2030 (IEA 2004). As per IEA estimates, China's electricity investment requirement from present to 2030 is around US$2 trillion of which more than US$1 trillion will be for transmission and distribution.[33] South-east Asian countries also require substantial investments, particularly in the power sector.

Figure 5: Investment required in oil, natural gas and coal sectors



Source: IEA 2003.

Energy sector projects are characterised by high capital intensity involving large initial investments before production/supply can begin. For instance, the electricity sector requires two to three times as much investment as manufacturing industries (IEA 2003). The financial markets, particularly in South Asia, are not well developed. This limits access to capital, especially long-term capital and imposes an important constraint on the level of funds available. Access to international credit will also be limited by the exchange-rate risk, deficiencies in the legal and regulatory systems and fears of economic and political instability. The private sector will have to play an increasingly important role. However, the private sector will be constrained by the poor financial situation of energy sub-sectors, particularly the electricity sector.

[33] www.unescap.org/esd/energy/information/electricpower/2001-2002/html/china.htm (accessed: 2 December 2005).

5.2. Inefficiency in Energy Production and Consumption

Inefficiency is a major strain on volume needs in most of Asia. One of the reasons for the low level of efficiency in energy production in this region is the high level of technical losses. The power sector, for instance, faces problems of high technical losses. These are due to poor quality transmission lines, pilferage, unmetered connections as well as low plant load factors due to aging generators and poor maintenance of equipment at existing plants (plus low-quality coal in many cases). Transmission and distribution (T&D) losses of electricity are very high in the region. For instance, the T&D losses as a percentage of availability for India in 2002/3 was around 38 per cent (TERI 2004) and in some areas of Pakistan, transmission losses were approximately 30 per cent.[34] An integrated national grid for India is still evolving. China also lacks a truly national grid. This has led to a situation where, despite the national shortage of generating capacity, there are some locations which still have surplus capacity, but lack of transmission capacity to move it to areas with a capacity shortage.

Highly prevalent energy subsidies are a major reason for inefficiency in energy consumption. These subsidies end up giving wrong signals to consumers creating distortions in the energy markets and promoting unnecessary wastage of resources. They also impose a heavy burden on the supply system as well as government tax revenues. In many of the South and East Asian countries, electricity rates are widely subsidised. The state electricity companies are faced with the challenge of incurring higher cost of generation or having to pay independent power plants their asking price while providing lower rates to their customers. Further, subsidies are made in a non-transparent manner and are not properly accounted for. Also, subsidies in a number of cases are provided through elaborate systems of cross-subsidisation, which provide wrong kind of signals. An analysis carried out by the International Energy Agency revealed that the distortion in energy prices in China and India were around 11 per cent and 14 per cent. The phasing out of energy subsidies could imply energy saving potential of 7–9 per cent for these two countries (IEA 1999).

However, progress has been quite slow in phasing out subsidies in the region due to entrenched interest and political resistance. In India, for instance, despite reforms in the power sector and commitment to gradually remove subsidies, the commercial and industrial sector continue to cross-subsidise agricultural and domestic sectors. This is unlike most industrial countries, where the cost of supplying electricity to household consumers is on average 50 per cent higher than to industrial consumers (UNEP 2004). While agricultural sector tariffs have been increased in some states, power is still underpriced for the agricultural sector in a few states. The gross subsidy for states (for agriculture and domestic sector) in the year 2004/5 is estimated to be in the range of Rs34,311 million. There was an uncovered subsidy of Rs175,200 million.[35] In addition to underpricing, subsidies also stem from poor recovery of revenues, largely due to inadequate metering, poor credit control and theft. The Korean electricity sector is also characterised by cross-subsidisation. The industrial and agricultural sectors are cross-subsidised by residential and commercial

[34] www.eia.doe.gov/emeu/cabs/sasia.html (accessed: 1 December 2005).

[35] Economic Survey of India 2004/05. indiabudget.nic.in/es2004-05/chapt2005/chap93.pdf (page 193) (accessed: 3 December 2005).

customers. The commercial customers are estimated to pay on average 34 per cent more than the economic price (UNEP 2004).

Another energy sub-sector where subsidies are widespread is petroleum and petroleum products. In India, the Government has historically maintained heavy subsidies through the public distribution system on the two principal household fuels, LPG and kerosene. During the process of dismantling Administered Pricing Mechanism (APM) in 2002, the Government had committed to remove subsidies in a period of 3 years. However, the two fuels continue to be subsidised. In fact the increase in the international product prices have severely dented the profitability of public sector oil marketing companies who have not been able to raise the domestic retail price in line with international prices. Indonesia, which has recently turned importer for oil, is crippled with subsidies with fuel prices less than half the import cost. Subsidies account for up to one-quarter of the state budget.[36] In Korea, subsidies to the coal mining sector amount to around US$500 million per year (UNEP 2004).

While one cannot expect subsidies to be phased out completely, effective targeting of the beneficiary group(s) might actually add to national welfare. Subsidy reform is a pre-requisite for attracting private sector investment.

5.3. Inadequate Regulatory and Institutional Framework

The energy sector of many of the countries in East and South Asian region face problems relating to regulatory regimes and institutional frameworks. The power sector in this region suffers from inadequacies in their regulatory structure, generating companies and own management practices. Energy utilities in most of South Asia are operated to a large extent at the public sector level. In China, the electric utility sector is characterised by fragmentation and all of the power generators are state owned. In most of the cases, the public sector operates in a commercially unviable manner. Revenue from sale of energy does not realise the full costs of supply. As a result, most of the power utilities are faced with poor financial health and consequent deterioration of service delivery. In India, while in the past few years, the rate of return of State Electricity Boards (SEBs) has improved, it continues to be negative. In 2004/5, it was –28 per cent.[37] The weak financial position of the SEBs not only limited their own ability to invest in new projects but also acted as a deterrent for attracting private investment to the sector.

The situation is similar in other energy sub-sectors. In China, for instance, one of the major hurdles for natural gas pipelines is the lack of a unified regulatory regime. India also does not yet have a regulator for the petroleum and natural gas sector. Another challenge that India faces is in terms of the institutional structure for the energy sector. It does not have a single energy ministry but the energy sector is looked after by six different government ministries/departments. As a result of the large number of agencies, the system suffers from lack of coordination and integration. For the smooth operation of the energy sector, integration is essential. This is because the success of

[36] Platt's presentation on Energy Markets in South-east Asia: The impact of the emergence of India and China.
[37] Economic Survey of India 2004/5. indiabudget.nic.in/es2004-05/chapt2005/chap93.pdf (page 193) (accessed: 3 December 2005).

reform in one energy sector is intricately linked to the level of reforms in the other sector, for instance reform in the power sector in India at present is stymied by lack of progress in coal reforms, which itself is suffering because of absence of rationalisation in the railway freight rates. One of the major implications of the inadequacies in the regulatory and institutional frameworks is the constraint it imposes in terms of attracting private sector participation. With the growing realisation of the important role that the private sector will have to play in the development of energy sector, providing the right kind of framework for stimulating and sustaining private sector participation is an important challenge that these countries face.

5.4. Environmental Concerns

Energy processing and generation is one of the major sources of air pollution in the region. There are many energy-related environment problems, including urban and transboundary pollution and global climate change. While coal is the fuel of comparative advantage for this region, there is a whole set of concerns in the coal using nations of this region which relate to the need to address the environmental impact of the heavy coal use in Chinese and Indian industries. Coal-fired power plants with outdated pollution control equipment, using poor quality coal, have increased the frequency of acid rain, particularly in China, India, Republic of Korea and Thailand.[38] Acid rain falls at about 30 per cent of China's land mass.[39] In India, the management of fly ash has been a source of environmental concerns with over 60 per cent power generating being coal-based and power grade coal containing on an average over 40 per cent ash. The environmental challenges facing Asia are discussed in a companion paper on the environment by Steve Bass and Paul Steele in this publication.[16]

6. Policy Response

The rapid growth in demand and increase in oil imports, steeply rising oil prices in the international oil markets, progress in new energy technologies and concerns about the long-term stability of oil supplies, all highlight a rapidly changing landscape of the energy markets with evolving energy needs, vulnerabilities and opportunities. Hence, the energy challenges that these countries face are more formidable than ever before and require policy measures to guard against them. A few policy measures that have contributed and can further contribute towards energy management in a better way are discussed below.

6.1. Increasing Supplies

In an effort to increase the energy supplies, some of the strategies that have been adopted by many of the Asian countries include developing alternative sources of energy, particularly renewable energy sources, investing in equity oil and exploring regional pipelines projects, particularly for natural gas, promoting regional cooperation and enhancing emergency response preparedness.

38 www.adb.org/Documents/Speeches/2004/ms2004062.asp (accessed: 12 December 2005).

39 web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPENERGY/0,,contentMDK:20502907~pagePK:34004173~piPK:34003707~theSitePK:574015,00.html (accessed: 15 December 2005).

6.1.1. Development of Alternative Sources of Energy

The South Asian region has a great potential in *renewable energy* forms, which has not been explored to a substantial extent. Experience in South Asia indicates that the main initiative for promotion of commercialisation of renewable energy technologies has to come from governments. International and regional organisations should continue to enhance their catalytic role, particularly in terms of capacity building and promoting regional and sub-regional cooperation. However, some activities on renewable energy technologies have already been started in these countries. To list a few, research and demonstration activities carried out in Bangladesh, have led to a start of large-scale utilisation of PV (solar photovoltaic) by various organisations and by NGOs like Grameen Shakti. Around 10,000 biogas plants already exist in the country which have been installed by BCSIR (Bangladesh Council of Scientific & Industrial Research), IFRD (Institute of Fuel Research & Development), LGED (Local Government Engineering Department) and a few other organisations. Activities are further undertaken for the promotion of biogas technologies. In India, one of the largest programmes of its kind, the Wind Resource Assessment Programme (WRAP) has been carried out to reassess the wind potential covering around 900 wind monitoring and mapping stations in 24 states and union territories. India is the fifth largest wind power producer in the world after Germany, the USA, Denmark and the UK, with a wind power capacity of 1,870 MW.[40] The Chinese government has decided to adopt a policy for building demand for renewables by mandating electricity suppliers to meet some of their needs from renewable resources. The policy is to be implemented through the enactment of a Renewable Energy Promotion Law which has been ratified by the People's Assembly in February 2005.[41]

In recent years, *natural gas* has emerged as an alternative for oil. Prior to 1970, natural gas demand and production was confined to North America and the Former Soviet Union. Its transformation into a global fuel after the oil price increase, created a fresh competitor for oil. Gas has the added advantage of being a clean fuel. For instance, China has embarked on a major expansion of its gas infrastructure. Beijing's goal is to increase its share of gas in total energy consumption to 8–10 per cent by 2020. The government is also developing preferential financing, pricing regulations and tax policies to encourage investment in natural gas. CNOOC (China National Offshore Oil Corporation) has signed agreements with Chevron and Australia LNG to establish a joint venture to exploit fields in Western Australia (Cole 2004). Japan is also looking at the natural gas option to reduce oil intensity. At present, India is working hard on the India–Iran gas pipeline project, which will address the gas demand in India and Pakistan to a significant extent.

Nuclear energy has also received a lot of attention. China is trying to embark on nuclear energy in a major way. Mainland China has nine nuclear power reactors in operation and a further two units under construction. China's nuclear energy policy focuses on indigenous fabrication and supply of nuclear fuel, maximising domestic manufacturing of plant and equipment with self-reliance in design and project management, while at the same time encouraging international cooperation. China's total installed capacity for nuclear power generation increased from 2 GW at the beginning

40 Status of Renewable energy and energy efficiency (REEE) in South Asia.

41 web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPENERGY/0,,contentMDK:20502907~pagePK:34004173~piPK:34003707~theSitePK:574015,00.html (accessed: 15 December 2005).

of 2002 to 15 GW as of mid-2005. With the recent Indo–US agreement on nuclear issues, the nuclear power sector in India also has come into focus.

6.1.2. Quest for Equity Oil and Gas

Oil demand in Asia has increased concomitantly with the high economic growth rate in the region. The low price of oil since the mid-1980s has not provided the necessary incentive for investment in energy conservation and development of alternative energy sources in the region. The main oil producers in the South and East Asian region are India and China. While these countries have introduced new capital and technology in their upstream sectors and carried out policy reforms to encourage private participation in exploration and production, oil production in the future is not expected to increase substantially over the current level. Against this background, acquisition of equity oil abroad is one of the major strategies adopted to enhance the security of oil. For instance in China, the state-owned oil companies are investing in overseas oil exploration and development projects. In 2003, Chinese state-owned oil companies pumped 0.22 million b/d of equity oil. The figure is projected to rise by 8 per cent annually until 2020, when it will hit 1.4 million b/d (Logan 2005). Leading the drive among Chinese state-owned companies, China National Petroleum and Gas Company (CNPC) claims to have petroleum assets in 30 countries, which include among others, oil concessions acquired in Kazakhstan, Venezuela, Sudan, Iraq, Iran and Peru, and Azerbaijan. It plans to spend US$18 billion in overseas oil and gas development between now and 2020. In India too, there is an active pursuit of equity oil by the State-run exploration firm ONGC's overseas investment arm, OVL (ONGC Videsh Ltd). OVL holds equity in oil and gas projects in Sudan, Russia and Vietnam and has interests in exploration blocks in Iran, Myanmar, Iraq, Libya, Syria and Sudan. The Indian Government aims to produce 20 MT/annum of equity oil and gas abroad by 2010, with a long-term target of acquiring 60 MT/annum of equity oil and gas overseas by 2025. The government is also considering equity in coal mines abroad.[42]

6.1.3. Cross Country Pipeline Projects

Some of the Asian countries are also exploring the option of cross-country gas pipelines for meeting the increasing gas demands. One such proposal, which has received a lot of attention lately, is the Iran–Pakistan–India pipeline. The proposal is to connect the South Pars gas field with the Hazira Bijapur Jagdishpur (HBJ)[43] pipeline in India. India has also been keen to import hydrocarbon resources from Myanmar and more so with the discovery of 4–6 Tcf gas field in Myanmar's Rakhine State in January 2004[44] in which Indian state-owned companies Oil and Natural Gas Corporation and Gas Authority of India have 20 and 10 per cent shares, respectively. The Asian Development Bank has been pursuing a 2000 km pipeline connecting Turkmenistan with Pakistan and India pipeline. Yet another pipeline, which is being discussed in the South Asian region, is the India–Bangladesh pipeline connecting the large Bangladeshi reserves to meet the Indian demand. Similarly, in East Asia, a pipeline project is proposed to link the Russian natural gas grid in Siberia to China and possibly South Korea.[45] However, there are several concerns

42 Bhandari, P (2005) Energy Security: Indian Perspective. TERI presentation.
43 HBJ pipeline is the main gas distribution pipeline of India.
44 www.ibiblio.org/obl/show.php?cat=1506 (accessed: 1 December 2005).
45 www.eia.doe.gov/emeu/cabs/china.html (accessed: 1 December 2005).

relating to these pipelines emanating from techno-economic considerations as well as geo-political and security considerations, which influence the implementation of these transnational pipeline projects. Further, various bilateral and multilateral agreements will have to be executed at the government-to-government level. While, several initiatives have been taken by the governments of the involved countries to understand and resolve these issues, much needs to be done to make these projects a reality.

6.1.4. Regional Cooperation

Regional cooperation in energy is intended to offset discontinuities imposed by national frontiers and thus increasing trade within the region thereby stimulating production and providing enhanced investment opportunities. The richly endowed natural resources such as water potential of Nepal, Bhutan, India and Pakistan, the natural gas of Bangladesh and Pakistan, and the coal of India are in abundance for the generation of power (energy), which can be of tremendous benefits to the region. To fulfill such an initiative, creation of an apex energy institution of South Asia comprising companies like Petrobangla of Bangladesh, ONGC and Coal India Limited of India, Sui Gas of Pakistan and Ceylon Petroleum Corporation of Sri Lanka could be a right step. This apex body may join hands for a comprehensive resource assessment of material, manpower and technology in the region, joint R&D, consultancy and HRD activities and sharing of experiences for mutual benefit. There can also be substantial gains derived from the collective promotion of non-conventional sources of energy. Hence there is a further need for a firm commitment and understanding among the countries in the region to reap benefits from energy cooperation.

A few examples of regional cooperation in energy in the South Asian region include the South Asia Regional Initiative for Energy (SARI-Energy) programme is working to expand and improve access to economic and social infrastructure in the energy sector. The South Asia Regional Energy Coalition (SAREC) established by the US Chamber of Commerce Coalition is a networking mechanism through which public and private sector stakeholders can influence regional energy policy and reform throughout South Asia.

In January 2004, the South Asian Association for Regional Cooperation, constituted a high level-working group to focus on energy as an area of cooperation. Cooperation will be pursued in exchange of energy information, environment friendly energy, creation of a regional power-grid and cooperation regarding renewable energy.[46] More recently in a bid to create a sense of Asian identity in the global oil market, a round table was convened by the Indian Petroleum Minister, Mr Mani Shankar Aiyyar, for the principal West and South-east Asian suppliers and the four principal Asian consumers in January 2005. This was followed by another round table meeting in November 2005 between principal North and Central Asian suppliers and the same group of principal Asian oil consumers (Seminar 2005).

Some of the existing cooperation arrangements include the following:

[46] www.saarc-sec.org/main.php?t=2.2 (accessed: 8 December 2005).

- Bhutan and India already have bilateral exchanges of power. India has been purchasing most of the energy generated from the 336 MW Chukha hydroelectric projects in Bhutan through 220 KV transmission lines. Another 1,020 MW Tale hydropower project is under construction under the technical and economic cooperation between India and Bhutan.

- Bilateral cooperation already exists between India and Nepal in the exchange of electric power. The power exchange agreement signed between India and Nepal in the 1970s provides for an exchange of up to 50 MW. Nepal also utilises about 70 GWh of energy over a 132 KV transmission line from the Tanakpur project in India in accordance with the provision made under Mahakali treaty between Nepal and India.

- Efforts are under way to bring about cooperation in hydropower development in the sub-region. An intergovernmental task force consisting of the Energy and Water Resources Secretaries of Nepal, India, Bhutan and Bangladesh have recently agreed to jointly develop the hydropower resources in Nepal.

6.1.5. Strategic Reserves and Emergency Supplies

Given that the import dependency on oil and gas is likely to increase in the future, the Asian governments and industries could act proactively to adopt and implement strategies such as building oil stockpiles and diversification of energy supply sources. While all of these options are feasible, their implementation timeframes vary considerably. In designing a response mechanism for Asian countries, The International Emergency Program (IEP) of the OECD countries provides a framework that could be suitably modified and applied to the Asian region. As a response to the oil crisis of 1973, the OECD countries formed the International Energy Agency (IEA) to implement the IEP. Emergency response is the main element of the IEP and it includes the important commitment of the member nations to hold oil stocks equivalent to 90 days of net oil imports in the preceding year.[47] China's 10th Five-Year Plan (2001–5) calls for the construction and use of strategic petroleum reserves. It is planned to create 75 days of emergency reserves in four locations.[48] The Chinese government has also set up an oil reserves office under the National Development and Reform Commission (NDRC) which is responsible for coping with unexpected crises and doing away with any serious impact of an oil supply shortage on both economic development and people's daily lives.[49] To prepare for an emergency situation, Bangladesh is also planning strategic stocks of oil, natural gas and coal. The Draft National Energy policy 2004 in Bangladesh clearly puts forth strategic direction with regards to setting up these emergency stocks. However, in the Asian context, though diversifying the source of energy is an important option, reliance on emergency stocks might tend to be low, as most countries can ill afford such expensive stocks. This can be inferred from the high costs for financing and maintaining these stocks particularly in the context of the low-income countries of the region.

47 TERI (1999) Energy security issues and implications for Asia, http://www.teriin.org/energy/asia.htm#region

48 'Setting the Stage for a New Cold War: China's Quest for Energy Security' 25 February 2005, http://www.pinr.com/report.php?ac=view_report&report_id=272&language_id=1

49 Feng Jianhua. Energy Crises? http://www.bjreview.com.cn/200403/Business-200403(A).htm

6.2. Enhancing Energy Conservation

Efficiency enhancement and energy conservation measures have received considerable attention globally. In Korea, the Ministry of Commerce, Industry and Energy (MOCIE) is responsible for developing and implementing energy policies and programmes, maintaining energy security, administrating the energy industry, supporting research and development of new energy technologies and formulating international cooperation on energy related matters (APEC 2003). It also promulgated the Rational Energy Utilization Act (REUA) in December 1979, in an attempt to ensure energy security in an emergency as well as promote energy efficiency and conservation. China's energy efficiency strategy is multifaceted. China has focused most of its energy conservation policies in the industrial sector. One of the unique features of China's drive for energy efficiency was the scale of institutional capacity developed (Sinton et al. 1998). Over 200 energy conservation technology service centres were created and attached to various ministries and municipal governments. These service centres worked most closely with the end users. In May 1994, a national centre – The Dalian Chinese Energy Conservation Education Centre was established and is apparently China's largest and most advanced efficiency training facility. In 1998, the National Energy Conservation Law came into force, codifying the country's approach for promoting energy efficiency under a more market-oriented economic system.

Since 1996, India has been able to reduce its energy intensity to some extent, however, it has not been as successful as China. Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001. The Act provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country. The Central Government formally appointed a bureau, called Bureau of Energy Efficiency (BEE) to implement the Act. The primary objective of BEE is to reduce energy intensity in the different sectors of the Indian economy.

6.3. Providing the Right Regulatory and Institutional Framework

Many of the countries in South and East Asian region have acknowledged the need and also initiated steps for reform through institutional restructuring and privatisation. In the power sector, the existing state-owned utilities are being unbundled into separate components, private sector (both domestic and foreign) is coming to play a greater role and regulatory agencies are being established to ensure efficiency gains and more reasonable competitive tariffs. Private investors are managing several energy projects in this region.

Since the early 1990s, the power sector in India has been going through a process of reforms and restructuring. As a part of these reforms, regulatory commissions have been established at the central and state level. The regulator's mandate is to determine tariff for bulk and retail supply. Subsidies in tariffs are to be eliminated gradually and tariffs are to move towards cost of supply approach. A total of 24 states in the country have either constituted or notified the constitution of the regulatory commissions. The Pakistan government has been trying to initiate reforms in the state-held electric companies. However, efforts in that direction continue to stall. As a part of the restructuring process, the Water and Power Development Authority (WAPDA) is to be transformed

into three generation companies, eight distribution concerns and a transmission entity. In addition, the government has sought the sale of Karachi Electricity Supply Corporation (KESC) to private investors.[50] The South Korean government has plans to privatise the state electricity utility, Korean Electric Power Corporation (KEPCO) and the natural gas monopoly Korea Gas Company (KOGAS). The privatisation programme has moved at a slower pace than originally planned, due in part to strong opposition from labour unions to some of the privatisations and delays in passing implementing legislation. The South Korean government decided in June 2004 to limit privatisation of the electric power sector to generation facilities, retaining ownership over the transmission and distribution assets of KEPCO.[51]

Similarly, the oil and gas sector are also undergoing reforms. In Pakistan, steps are being taken to privatise the state-owned companies and setting up a Gas Regulatory Authority (GRA) and Petroleum Regulatory Board (PRB).[52] In India, the Administered Pricing Mechanism, which regulated the petroleum sector, was dismantled in April 2002 to move to market determined pricing system.[53] In order to enhance domestic exploration and production, the Indian government is pursuing the New Exploration Licensing Policy (NELP), first announced in 1997, which permits foreign involvement in exploration, an activity long restricted to Indian state-owned firms. China has also gone in for restructuring in this sector. In 1998, the Chinese government reorganised most state-owned oil and gas assets into two vertically integrated firms – the China National Petroleum Corporation (CNPC) and the China Petrochemical Corporation (Sinopec). Before the restructuring, CNPC had been engaged mainly in oil and gas exploration and production, while Sinopec had been engaged in refining and distribution. This reorganisation created two regionally focused firms.[54] Also as a part of its commitments to World Trade Organisation, to gradually open the crude and refined oil sectors to private traders, import quota management for the three state-owned oil companies, Sinopec, CNPC and China National Offshore Oil, has been removed since January 2004. The retail oil distribution has been opened up allowing private and foreign sector participation (ADO 2005).

6.4. Meeting Environmental Targets

With growing awareness about the adverse environmental implications of usage of energy, particularly coal usage, efforts are being made to move towards reducing their environmental impacts. At the global level, efforts to combat climate change are already taking place under the United Nations Framework Convention on Climate Change (UNFCCC), which regulates greenhouse gas emissions for the signatories of the Kyoto Protocol and coordinates carbon trading under the Clean Development Mechanism (CDM). In addition, world leaders recently launched two important initiatives. First, the Group of Eight (G8) at Gleneagles in July 2005 issued a communique and Action Plan on Climate Change, Clean Energy and Sustainable Development. The Asian Development Bank (ADB) is participating in the consultations of international financial institutions to develop an investment framework under this Action Plan. The second is the Asia

50 www.eia.doe.gov/emeu/cabs/Pakistan/Electricity.html (accessed: 5 December 2005).
51 www.eia.doe.gov/emeu/cabs/skorea.html (accessed: 5 December 2005).
52 www.eia.doe.gov/emeu/cabs/Pakistan/Oil.html (accessed: 5 December 2005).
53 The prices of petrol and diesel are still administered by the Government to a large extent.
54 www.eia.doe.gov/emeu/cabs/china.html (accessed: 5 December 2005).

Pacific Partnership for Clean Development and Climate. The partnership was signed by Australia, China, India and the USA, inaugurated at a Ministerial Meeting in Sydney on 11 January 2006, and will be consistent with the UNFCCC and complement the Kyoto Protocol. The Partnership aims to promote development and transfer of cleaner, more efficient technologies that can address greenhouse gas mitigation and energy security – issues that are crucial not only to the region but the entire world.

For reducing the adverse environmental implications of coal consumption and production, measures such as clean coal technologies are being considered. In this direction, the world's four largest coal-consuming nations under the Asia Pacific Pact on Clean Development and Climate have agreed to share technology for limiting greenhouse gas emissions. Both the US and Australian governments have been investing heavily in recent years in research and development for 'clean coal' technologies and the other countries can benefit from it. Another strategy being adopted by countries like China, India, Indonesia, is to increase the proportion of natural gas and renewables in their energy mix. Actions that might be considered to address some of the environmental challenges facing Asia are discussed in the companion paper on the Environment by Steve Bass and Paul Steele (2006) in this publication.[16]

7. Conclusions

Asia's growth depends on securing adequate supplies of energy. The region is dependent on energy supplies from outside, and these are likely to increase as growth proceeds into the future. The region already suffers from supply deficiencies, and governments have put in place a number of policy responses to address these problems. These include:

- Reforms in the energy sub-sectors, especially cost-reflective pricing and improved collection in the electricity sector
- Development and exploration of new energy sources and supplies
- Diversification of the energy mix and promotion of alternative fuel sources particularly renewable energy
- Measures to improve energy efficiency and conservation
- Technological developments especially for utilising the existing hydrocarbon base (particularly for exploiting the rich coal base of the region) in an environmentally friendly manner
- Enhancing emergency response coordination and preparedness in the event of energy supply disruptions
- Promoting regional cooperation not only to better utilise the energy resources within the region but also to tackle competition and confrontation over energy resources, which are emerging between Asian countries especially between Japan, China and India.

Acknowledgements

The research team would like to acknowledge inputs from Ms Monica Dutta and useful comments received from Mr R.K. Batra and Dr Ligia Noronha.

Bibliography

ADO (2005) *Asian Development Outlook 2005*. Promoting competition for long-term development. Hong Kong: ADB

APEC (2003) *APEC Energy Overview 2003*. Asia Pacific Energy Research Centre

Bass, S. and Steele, P. (2006) Asia 2015: Managing the Environment for Development and to Sustain Pro-Poor Growth, paper for Asia 2015 Conference, London, March

Cole, B. (2004) 'Oil for the Lamps of China' – Beijing's 21st-Century Search for Energy', McNair paper no. 67, Institute for National Strategic Studies, National Defense University, Washington DC, www.ndu.edu/inss/mcnair/mcnair67/198_428.McNair.pdf

EIA (2005) *International Energy Outlook*

Herberg, Mikkal E. (2004) 'The Geopolitics of Natural Gas and LNG in Asia', The National Bureau of Asian Research. Conference on Energy Security in Asia and Implications for the US, Washington, September

IEA (2004) 'World Energy Outlook', Paris: IEA; 570

IEA (2003) 'World Energy Investment Outlook', *Insights*, Paris: IEA; 511

IEA (2000) 'World Energy Outlook', *Insights*, Paris: IEA

IEA (1999) 'World Energy Outlook', *Insights*, Paris: IEA

Logan, Jeffrey (2005) 'Energy Outlook for China: Focus on Oil and Gas', Hearing on EIA's Annual Energy Outlook for 2005, Committee on Energy and Natural Resources, US Senate, 3 February, Testimony of Jeffrey Logan, Senior Energy Analyst and China Program Manager, International Energy Agency, www.iea.org/textbase/speech/2005/jl_china.pdf

PetroFed (2005) *Fuelling India's Growth – Past trends & Scenarios*, PetroFed; 2011–12

Sankar T.L. (2005) Energy Security – Regional Cooperation in South Asia – Issues and Opportunities, paper presented at the World Energy Council Regional Forum

SASEC Issues paper. SASEC Issues paper on Regional Energy Cooperation, prepared by TERI

Seminar (2005) 'Eye on Oil', Seminar 555, November, New Delhi

Sinton, J.E., Levine, M.D. and Qingyi, W. (1998) 'Energy Efficiency in China: Accomplishments and Challenges', *Energy Policy* 26.11

TERI (2004) 'TEDDY 2003/04', *TERI Energy Data Directory & Yearbook*. New Delhi: TERI; 486

UNDP (2005) Human Development Report, hdr.undp.org/statistics/data/indicators.cfm?x=205&y=1&z=1 (accessed: 29 November 2005)

UNEP (2004) Energy Subsidies – Lessons learned in assessing their impact and designing policy reforms. UK: UNEP; 183

WDI (2005) World Development Indicators, 2005, 'Managing the Environment for Development and to sustain Pro-Poor Growth', this Conference, Washington: World Bank; 402