ENERGY RESOURCES: WILL THEY BE THE LAST FRONTIER IN SOUTH ASIA?[1]

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'Where the world lights up'

On a world map showing the lights of the world , South Asia – the seven countries of India, Pakistan, Bangladesh, Nepal, Bhutan, Sri Lanka And Maldives which together form not only a geographical entity but also the South Asian Association For Regional Cooperation (SAARC) - show up as a moderately well-lit area. It would be interesting to see an updated version of this map with the large strides that have been made in the last decade toward 'modernisation' because energy and its resources lie at the heart of the future prosperity of the South Asian region and the well-being of its large population. This region is a study in complex paradoxes; for example, although South Asia houses nearly 1.4 billion people which is around 25% of the world's population, it has a sizeable energy deficit that is filled up by imports. Although the South Asian region is a repository of the poorest people in the world, with more people without adequate access to energy than anywhere else in the world[2], ailed with pressing issues of mortality and health, economically it is also one of the fastest growing regions of the world. It has been predicted (Sachs 2003) that BRICs - Brazil, Russia, India and China – will become the leading forces in the global economy by 2050, by which time India may be the only country with a GDP growth rate of above 3%.

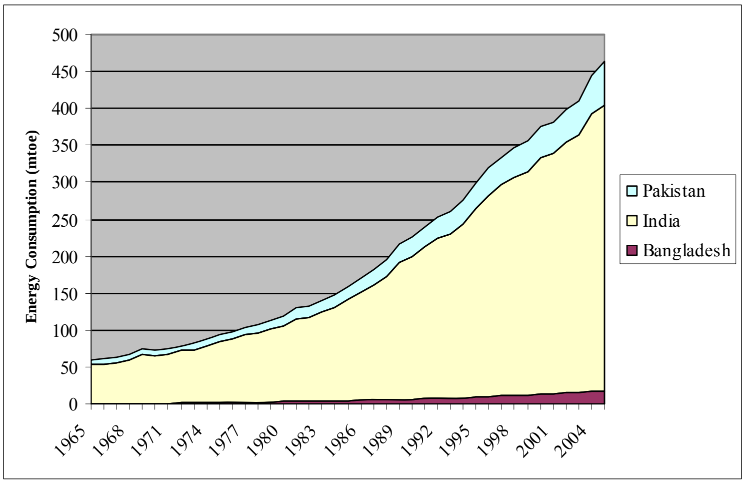

Figure 1 Trend in energy consumption for the three most populous S Asia countries (source: BP Historical Energy Statistics**)**

It can be readily appreciated from Figure 1 that India dominates the energy scene; as consumption by Bhutan and Nepal could barely be resolved on the scale used in the diagram. Consequently India will, *de facto*, be at the focus of this paper. However, if India were plotted on an equivalent graph to say USA or Europe, then India would fade to the relative insignificance of Bangladesh or Pakistan.

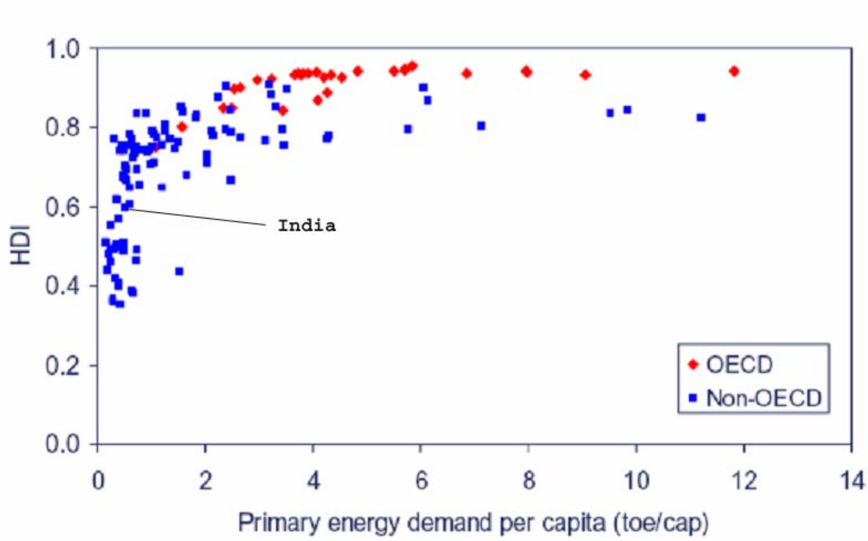

Figure 2 Relationship between the Human Development Indicator and energy demand (source: IEA World Energy Outlook, 2004)

There does indeed appear to be a nexus between the use of energy and societal development. Figure 2 shows the correlation for a number of OECD and non-OECD countries and the Human Development Indicator[3] (HDI). The increase in HDI is initially strong as per capita GDP increases then slowly flattens out. After then increases in income produce little extra in terms of HDI (and could be regarded as extravagance). It has been estimated that India would take 100 years to close the gap in incomes between itself and the high-income countries (UNDP Human Development Report, 2005), the deficit in HDI could be removed much earlier if energy use is tightly linked to income.

As the economies, especially the Indian economy, grow and record faster growth rates[4], they create substantial demands in their wake for energy resources: coal and oil to provide electricity, drive the industries and to fuel the land, sea and air transportation. Energy is the lifeblood of South Asian economies. Yergin et al (1998) posed a crucial question in their analysis of fuelling Asia's recovery: 'will energy spoil it?' implying that a failure to satisfy the enormous increases in the consumption of energy resulting from rapid economic growth would undermine this economic miracle. South Asia's *commercial* energy mix in 2002 was 46% coal, 34% petroleum, 12% natural gas, 6% hydroelectricity, 1% nuclear and 0.3% 'other'. There are significant variations within the region reflecting the nature of indigenous energy resources and amount of fuel that has to be imported. Bangladesh's energy mix, for example, is dominated by natural gas (66.4% in 2002), while India relies heavily on coal (54.5% in 2002). Sri Lanka and the Maldives are overwhelmingly dependent on petroleum (82% and 100%, respectively); Pakistan is diversified among petroleum (42.7%), natural gas (42.2%), and hydroelectricity (10%). The Himalayan countries of Bhutan and Nepal have the highest shares of hydroelectric power in their energy consumption mix at 80% and 31%, respectively, in 2002 (EIA 2004). All these data discount the 'non-commercial' or 'traditional' sources of energy including animal waste, wood, and other biomass, which except for India and Pakistan form the dominant source of energy (see Table 1).

South Asian nations are faced with rapidly rising energy demand coupled with increasingly insufficient energy supplies. Most of South Asia is already grappling with energy shortfalls, typically in the form of recurrent, costly, and widespread electricity outages. In India alone, the current electricity supply/demand deficit is around 8%, with a peak demand deficit of about 12%; yet a large part of the population is not yet connected to the electricity grid. Because of the economic and political ramifications arising from such shortfalls, improving the supply of energy, particularly the supply of electricity, is an important priority of national and local governments emphasising the firm belief that development and energy use go hand in hand. The term, ‘energy access’ has a dual meaning in South Asia; on one hand it implies an open access regime in which the urban, middle class consumers are offered a choice of energy to select from, and on the other it implies the enormous task of creating access for the large number of poor people who are still dependent on traditional energy sources. It is these poor who will be a factor in infrastructure development and the eventual energy future of South Asia. Looking at the current energy scenario in South Asia, we see a remarkable contrast – great demand and huge absolute consumption with extremely low per capita consumption; it is this South Asian situation that has been described as the ‘Asian energy pattern’ (Manning 2000).

In context of this low per capita energy consumption in South Asia, achieving targets such as electricity for entire populations; the ‘Power for All by 2012’ policy that India has adopted) would be a gigantic task for the region – indeed the original schedule (set in 2005) was for this to happen by 2009[5]. Besides economic growth, energy demand will increase from improved standards of living of the population, as more and more people enter the commercial energy market. As the population becomes urbanised and as standards of living improve, the changes in the nature of energy consumption, popularly known as *energy transition*[6], also assumes great importance. Much of the energy demand comes from the rising urban centres and the new industries. South Asia is experiencing rapid urbanisation; it has a large number of million-plus cities, including 10 million plus mega-cities that create a great energy demand. Yet, the vast majority of the population living in rural areas still depend on traditional (or non-commercial) energy sources, but gradually changing over to commercial fuels. Nearly 680 million people in rural areas and 110 million in urban areas of South Asia are without access to electricity (IEA, 2002). Providing energy to these poor, enabling them to switch over from traditional to modern sources, will be at the centre of sustained economic growth and improved well-being of South Asian nations.

South Asian countries are aiming at diversifying their energy baskets, and are promoting foreign investment for energy infrastructure development, attempting to improve energy efficiency, undertaking reform and privatizing their energy sectors, and endorsing and expanding intra and cross regional energy trade and investment. Procuring an energy secure future for South Asia would involve pressing environmental and ecological issues such as deforestation, soil erosion, desertification, air and water pollution, carbon emissions[7], water shortages in cities, climatic vagaries such as severe tropical storms, droughts, floods and flash floods. Above all, energy security for South Asia would involve a heightened level of geopolitical cooperation between the nations, and between South Asia and other regions, especially other parts of Asia, and require enhanced awareness of resource interdependencies, construction of infrastructure and transport, and building up of an atmosphere of mutual understanding and confidence.

However, the individual countries in South Asia are characterised by low availability of potential energy resources – particularly limited oil – and a mismatch between energy deposits and population concentration, making it imperative for the nations to look beyond their borders for sources of energy. *Energy security* - of crucial importance to the well-being of the billion people in the region - will be obtained predominantly by imports.

These two imperatives – energy security and energy transition - would be the major drivers of South Asian economic policy in the next few decades to come, and it is through energy that the national political borders would increasingly get blurred as resources and capital move from one location to another within the region, and across the region to the west and the east. The possibilities are open-ended fitting with the topic itself; this paper represents my own interpretations of the data or personal bias in approaching the subject. In this paper, I describe the two central concerns of energy security and energy transition in South Asia, and thrash out the main issues therein with the possible strategies of intra- and inter-regional co-operation being considered by the countries. The focal point of my argument is that whilst moving away from state controlled regimes to market regimes, the countries also need to explore, encourage and support alternative and possible options involving community initiatives, especially in context of the rural sector that is the repository of poor people. First, however, let me outline the current energy basket of the region.

Energy Consumption in South Asia

The present pattern of energy consumption has been as much a result of the natural endowment as the historical evolution. Originally dependent on traditional bio-mass fuels, the modern sectors of the countries moved on to the use of coal; coal mines being one of the first symbols of modernity in colonial times. Coal was ‘discovered’ in 1774, but mining began since mid-nineteenth century, primarily from eastern Indian collieries but also later from Assam and central India, fuelling the new railways and industries such as the jute mills around Calcutta metropolis. Oil and natural gas were late entrants in the energy basket, as modern means of transportation were introduced. Petroleum was struck in Digboy, Assam in 1889, and the Assam Oil Company went operational in the first quarter of twentieth century. Large-scale hydroelectric projects were heralded as part of multipurpose river valley projects in late 1040s. Population growth and urbanisation have been crucial factors in creating greater demands for modern energy sources. For example, between 1971 and 2000, the primary energy[8] consumption in India went up by as much as four times, and with increasing urbanisation, this demand is expected to grow further[9]. Other countries of South Asia have followed similar trajectories, with some variations.

Although India accounts for ~ 15% of the world's population, it only consumes about 3% of world's energy supplies (excluding biomass), with the per capita consumption being only 5% of that of developed countries (Reddy and Balachandra 2002). Of the total demand of nearly 1,500 million terajoules (MTJ) of total demand, about 65% came from other than non-commercial sources such as fuelwood and agricultural wastes (see Table 1). Even though the share of non-commercial energy in total energy consumption has reduced in recent years[10], this sector has maintained a steady growth with a still-substantial contribution. Reliable data on the supply and consumption of non-commercial energy sources is scarce; it has been estimated that over a third of India's energy supply is derived from traditional fuels. The International Energy Agency reported that about 41% of India's total primary energy supply (TPES) is derived from combustible renewables and waste (IEA 2000), while the Indian Planning Commission estimates put this proportion at 34% (Planning Commission 1997). Table 1 provides a breakdown of energy consumption for the S Asian countries

Table 1: Energy Consumption in South Asia, 2005 (million tonnes oil equivalent)

(numbers in parentheses are the significant percentage shares)

	B'desh	**Bhutan**	**India**	**Nepal**	**Pakistan**	**Sri Lanka**
Biomass/Traditional fuels	16.6 (57)	0.29 (63)	139 (29)	7.4 (87)	23.4 (31)	3.6 (49)
Coal	0.0	0.01	167 (35)	0.2	3.3	0
Oil products	3.71 (13)	0.04 (9)	116 (24)	0.8 (9)	15.2 (20)	3.0 (41)
Natural gas	8.3 (29)	0	29.7 (6)	0	27.4 (36)	0
Hydroelectricity	0.23	0.12 (26)	17.7 (4)	0.1	6.5 (9)	0.8 (11)
Nuclear/Renewable	0	0	5.3 (1.2)	0	0.4 (0.5)	0
Total Energy Consumption	28.9	0.46	475	8.5	76.2	7.4
Total commercial energy consumption	12.2	0.2	336	1.1	52.8	3.8
per capita (kg-oe/y)	89	243	316	44	355	200

Source: Raza (2005)

South Asia's oil reserves are rather limited and to meet the oil demands, the region will clearly remain dependent on imports. Although the natural gas reserves in Bangladesh, India and Pakistan are sizeable, they are not seen by experts as commensurate with medium and long-term demands (Raza 2005). The two countries – India and Pakistan – have large coal reserves, albeit of low quality. India is the world's third largest coal producer, and will continue to use coal as the primary commercial fuel for electricity generation, a model that Pakistan will probably follow in the years to come, although oil and gas are plentiful in regions to the north and west of Pakistan. Pakistan's immense coal reserves are yet untapped and estimated at 175 billion tonnes in the Thar area of Sindh province. Pakistan also has plans to develop its lignite resources and to set up mine-head power plants by 2010. Bangladesh has limited coal reserves and plans to develop them; although its one large open-cut colliery in Phulbari has been shelved just before beginning production due to mass demonstrations about the displacement of local communities. Sri Lanka intends to begin coal imports by 2010 for power generation. The region's hydro-electric resources are located primarily in India, Pakistan, Nepal and Bhutan, and for the two last countries, far in excess of their current or projected demands. Traditional fuels such as biomass and animal waste continue to contribute handsomely in the region's energy mix, but at the same time, nuclear sources provide increasingly sizeable portions of power (in India and Pakistan), as do solar and wind power projects in India.

Table 2 shows that of the fossil fuels, coal and gas are available in plentiful quantities in South Asia, and will most probably remain the two main sources of energy in the near future. However, not the entire quantities of the reserves outlined in the table are available or exploitable; for example, India's large gas reserves are not available for commercial production.

Table 2: Fossil Fuel Reserves of South Asia, 2004

Type of Energy	Proven Reserves	Annual Production
Oil (mtonnes)		
Bangladesh	0.96	-
India	795	33
Pakistan	107	3
Gas (bcm)		
Bangladesh	790	12
India	165,500	32
Pakistan	8180	34
Coal (mtonnes)		
Bangladesh	724	1
India	91,631	-410
Nepal	5	0
Pakistan	3,300	3

note bcm = billion cubic metres

Source Raza (2005), Oil and Gas Journal, 2005

Country Scenarios

India

India's energy consumption is increasing by leaps and bounds; from 4.16 quadrillion Btu (quads) in 1980 to 12.8 quads in 2001, recording a 208% increase. In 2001, coal accounted for 50.9% of India's primary energy consumption, with petroleum accounting for 34.4%, hydroelectricity 6.3%, natural gas 6.5%, geothermal/wind/solar (non-conventional) 0.2%, and nuclear power 1.7%. Despite this growth and high population, India's energy consumption is still below that of US, China, Japan or Germany. India's electricity is generated overwhelmingly by coal (70%), with hydroelectricity making up for about 25%, followed by natural renewables which account for the remaining 5%. This fuel mix has remained more or less similar, with coal remaining the dominant source of energy, although India's gas use has been increasing steadily[11].

Oil and Natural Gas

Although the oil production has significantly gone up, the offshore Bombay High Field accounting for about 2/3rds of Indian production, of the total oil demand, only 25% is produced within the country, and only about 1% is used for electricity generation the rest being used for transportation. By 2010, oil demand will cross 150 million tonnes putting immense pressures on foreign exchange. India will therefore keep exploring alternatives for oil. The upstream oil industry is undergoing privatisation, the MoPNG recently has finalised a new policy permitting 100% private equity ownership of oil exploration and production ventures. The downstream sector is also undergoing privatisation including the gradual sale of IOC and partial privatisation since 1991 of six other refineries. Although oil and natural gas are clubbed together conventionally, the correlations are increasingly moving towards the alignment of coal and gas as taking up each other's market shares as well as reflecting price fluctuations. According to Graczyk (2006), the Manager for South Asia in the International Energy Agency, the overall prospect for the role of gas in India's power sector is positive given its potential for sustained high economic growth, the need to integrate the entire population into the commercial energy economy, the discoveries of gas, and the opening of the country's first two LNG terminals. It has been predicted (Chakraborty 2005) that the rate of increase of growth in the demand for natural gas would make it the most important potential alternative to coal, and that by 2006-07, gas may provide 15% of India's energy supply. India has been aggressively exploring for both oil and gas, and there have been substantial finds especially off the coast of Andhra Pradesh (Tongia 2005).

Presently, 60% of the natural gas in the country is associated gas, which comes along with crude oil, while the rest is free gas. Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL) are the two main producers in India, producing about 54 million standard cubic metres per day (mmscmd), sold through Gas Authority of India Limited (GAIL) pipelines. The power sector (40%) and the fertiliser sector (25%) are the main consumers, the rest being consumed by glass, cement and ceramics industries as well as in the form of Liquefied Petroleum Gas (LPG) to urban consumers.

The *Hydrocarbon Vision 2025* saw gas as a 'bridge fuel', to a hydrogen economy in the future, environmentally more benign than coal, and lending itself to separating carbon from hydrogen which could be sequestered to avoid CO_2 build up. The document predicted a great increase in gas demand in India, to meet which, New Exploration Licensing Policy came into force. Cairns Energy and Reliance Industries have discovered gas in the Krishna-Godavari basin and off the Gujarat coast. India has also begun to construct LNG terminals on the west coast, has signed a long-term deal to import 7.5 MMT/annum LNG from Iran, and is undertaking talks to procure gas from central Asia, Bangladesh and Myanmar. The termination points of these trans-national pipelines would be Rajasthan on the west and the east coast[12].

Though the gas transported overland through pipelines is likely to be cheaper than R-LNG, the associated geopolitical risks make contractual arrangements difficult. The problem is further accentuated by the history of hostilities between India and Pakistan and the strong anti-India sentiments in Bangladesh. The contract with Iran, for example, is set up as a tripartite agreement between Iran, India and Pakistan, which will include transit fees for Pakistan whilst making the country a co-recipient of gas. It has been argued that whilst this arrangement assuages India's security fears, it also raises the cost of gas to India whose needs are more pressing than Pakistan's nebulous needs (Tongia 2005, p. 2034).

<u>Coal</u>

Coal is still very much the 'king' amongst the energy resources of India, with estimated reserves at more than 250 bn tonnes, India is self-sufficient at present and in future for more than a hundred years to come. The coal deposits are confined to the eastern, central and southern parts of the country. In 2002, India produced 359 Mt of coal, the third largest in the world, and of which 90% was accounted for by Coal India Limited. Coal industry accounts for a turn around of Rs 340 billion which is around 1.2% of the GDP (ICRA 2006). Railways used to be one of the main consumers of coal in India, but with the phasing out of steam locomotives, the user base is restricted to primarily thermal power plants, steel, cement and fertiliser industries, with coal demand expected to rise to 0.6 bn tonnes by 2011-12. Indian coal, however, contains high ash and has a low calorific value, forcing the steel industry to depend on imports for most of its requirements. The volume of reserves that can be economically exploited is also uncertain, as at current rates of exploitation, the coal near the surface will be exhausted by 2010. Even at a depth of 300 metres, the reserves would not last for over 50 years, necessitating either more expensive deep shaft technology or switching to other fuel sources. With the growing dependence on open cut mines in the last few decades (the current ratio of open cut and underground coal is ~10:1) this return implies the need for readiness with technology and a rise in coal prices, particularly as current productivity in underground mines is less than a tenth that of open cut (ICRA, 2006) .

According to the National Thermal Power Corporation data, of the various grid-based power generation coal entirely dominates the energy scene as apparent from the following table.

Table 3: Grid-Based Power Generation in India, March 2002

Type	**Proportion in the Energy Mix (%)**
Thermal - coal	59.22
Thermal - natural gas	10.64
Thermal - oil	1.08
Hydroelectric	25.03
Nuclear	2.59
Wind	1.44

Source: NTPC

As compared to other sources, coal-based power generation is the least expensive, and consequently 55% of India’s power generation is through coal-based thermal power plants. India had 73 such plants at the last count, but they are ailed by a range of problems. The power plants chronically suffer from problems of poor capacity utilisation and poor quality coal (often with high ash contents).The distance of the power plants from the source of coal has been a point of consternation; at least 50 were located between 500 to 1,000 kilometres away from the sources of coal but near centres of demand with about 50% of the generating capacity concentrated in them. It has been argued that transportation cost constitutes a major component of the power generation cost, also saturating the railway network, making pithead generation and grid-based transmission of power a more viable option (Bhattacharyya 2005).

Sending electricity to the end user results in so-called 'transmission losses'. In Australia, this is measured by the difference in the electricity sent out by the power station and the billable electricity received by the consumer. Such losses depend on the average length of the transmission lines and typically are around 5%. According to a UNDP website, 'Of all the electricity generated in India, only about 55 per cent is even billed and slightly more than 40 per cent is regularly paid for'. Transmission losses have actually increased and are predicted to rise from about 20% in 1992 to about 28% at the end of the Ninth Plan. 'Actual' loss levels are reported to be far higher, between 35-45%, and particularly high in some states as Delhi (47%) and Jammu and Kashmir (56%). The losses are due to several factors: technical deficiencies, low voltage meters and such others, in combination with pilferage and unmetered connections[13]. Pricing of electricity is highly politicized in India (Allison, 2001). Rich and influential farmers use electricity heavily, however they pay almost nothing. Moreover, a lot of electricity is 'wasted' because charges for irrigation pump use, for example, are based on the capacity of the pump, not its usage. (www.forum-adb.org/pub/briefers accessed 12/09/06). These losses are called 'non-technical transmission losses' which in effect means stealing (or at least neglecting to pay). (www.tve.org/ho/doc.cfm?aid=1676&lang=English accessed 12/09/06) As a consequence most SEBs are financially unviable.

However, experts in India have drawn attention to the vulnerability of depending entirely on coal; especially to the severe social and environmental costs involved in mining and power generation. The engineering and technology-driven large coal mining operations taken up by the state sector – without detailed social impact assessment and plans to deal with large-scale displacements – have been subject to intense criticism by both academics and non-governmental organisations.

The resettlement and rehabilitation policy have been clearly inadequate in handling the subsistence needs of displaced poor and indigenous families (Lahiri-Dutt 2003). According to Fernandes (1998), more than 2.5 million people have been displaced by the mines since independence in India. As coal mining has increased in pace in the last eight years since this report, we may take this number to be an extremely conservative figure. For example, in a recent study in Jharkhand state alone, Ekka and Asif observed that during 1950-91 mining was responsible for 27% of the total displacement in that State (coal mining 18% and non-coal mining 9%) (Ekka and Asif 2000, p. 95)[14].

The coal economy suffers from serious problems; it has been controlled by the nationalised Coal India Limited that has operated under a protective environment. Till now, coal mining operations are under state ownership excepting only a few captive mines, and the (just deregulated) prices are yet to catch up with the international fluctuations. Coal prices in the international market have been buoyant in the last few years, and hence domestic prices have been steadily going up. A large black economy exists in the Indian coal sector: informal coal mines on individuals' lands, and pilferages from legal mines and coal dumps together may well amount to many million tonnes annually (see eg Lahiri-Dutt and Williams 2005). The rising prices have the potential of increasing the illegal mining sector.

The Indian government has initiated steps to deregulate the coal mining industry. In March 1996, the government passed the Colliery Control Order 1996, which decontrolled the prices of all categories of coking coal. In other recent legislation, the government has decontrolled the distribution of coal and cut the non-coking coal import tariffs. However, there are problems in going ahead full steam on this front. The Coal Mines Nationalisation Act 1973 categorically states that 'no person, other than the central government or a government company or a corporation owned, managed or controlled by the central government shall carry on coal mining operation in India, in any form'. Therefore, instead of rapid privatisation, the government has been looking for ways to get round the Act and 'outsourcing' has been the prime means for the privatisation of coal mining industry (Roy 2003). Outsourcing means the use of contractors or companies in raising and loading of coal along with overburden removal[15]. The Piparwar Coal Mine in eastern India, funded by AusAID under a technology transfer scheme, was a disappointment in its poor resettlement and rehabilitation, and although the coal prices have been deregulated, it is clear that large-scale foreign investment in this sector will not be welcomed very soon.

Some steps are being taken to address the demand-supply gap in energy by the coal sector; experts see Clean Coal Technologies including coal gasification as the only way to bridge the shortfall of natural gas. Coal Bed Methane (CBM) is another area where initiatives are being taken to develop commercial production. A CBM policy has been formulated and production from some blocks is expected soon. Coal India Limited is planning to expand its export market beyond Nepal and Bangladesh to Japan, Korea and China.

Hydro

The current ratio between hydro and thermal power, which used to be 35:65 during early 1950s, is 25:75, clearly indicating the sharp rise in mostly fossil energy in India. India's total hydro-based capacity is 32,135 MW, and as per the National Hydro Power Corporation's 2004 document, power projects amounting to over 10GW are under various stages of construction and will be available within 10 years. The hydro-electric potential of the Northeast is high but involves serious environmental concerns due to the fragile ecology of the eastern Himalayas. Although many civil society organisations have retaliated against the possibility of building large dams in the Indian Northeast, the World Bank appears to have returned to support large-scale hydro projects across South Asia, as apparent from its Senior Water Advisor for South Asia, John Briscoe's recent (2006) publication. The possibility of importing hydel power from Nepal and Bhutan and been explored through treaties such as Mahakali and Saptakosi to meet the Indian demand[16]. Large ('multipurpose' as they are known) river valley projects have, however, been subject to intense opposition from the members of civil society and the academia[17]. According to Fernandes, about 16 million people have been displaced by various water development projects all over the country during 1950-1990 (Fernandes 1998, p. 250). Another estimate puts the number displaced people (DP) at 33 million, displaced by the big dams alone, in post independence India (Roy 1999, p. 9-10). N C Saxena, secretary to the Planning Commission, guessed in a lecture that the total number might be 50 million (quoted in Roy 1999, p. 10). In fact such projects have failed to deliver in most cases; the Damodar Valley Corporation for example has metamorphosed into a major thermal power producer rather than hydro-power (Lahiri-Dutt, 2003). One recent development in the area of hydro power has been the promotion of Small Hydro Projects (SHPs) – producing less than 3 MW each – by the Ministry of Non-conventional Energy Sources. The Tenth Plan envisages a capacity addition of 800MW from these projects. The SHPs are deemed as cost-effective at an estimated Rs 40,000,000 per MW of installed capacity, and the Government of India expects at least 600 MW to be generated in the private sector[18].To demonstrate the technical and economic viability of SHPs, and to increase private sector investment in them, Punjab Energy Development Agency has established eight mini plants on the Abohar Branch Canal and Bhatinda Branch Canal with a capacity of 1-1.5MW, and a variety of incentives are being offered (Mehta 2005).

Non-conventional energy sources

India has a gross potential of approximately 45,000 MW from wind (Ministry of Non-Conventional Energy Sources, 2004). The present installed capacity is a little over 3,000 MW – making India the fifth in the world. This was made possible through a set of measures meant to encourage the use of wind power (such as subsidies and 100% depreciation allowance), resulting in many projects coming up without proper site selection. Most wind power sites in India are located in Tamil Nadu, Karnataka, Andhra Pradesh, Maharasthra and Gujarat where power densities unlike in European countries are not strong enough (200-300 W/m2 as compared to about 500 W/m2). However, in meeting the future need of over 100GW, the contribution of wind is expected to remain modest, not exceeding 3GW.

The potential for generating power from biomass has been under scrutiny in recent years. Bio-diesel, the 'green engine, can be potentially blended with fossil fuel in motorised vehicles, and it is expected that contract farming of plants such as *Jatropha.* The current thrust in this sector is on soft loans, tax holidays, subsidies and simplification of investment procedures.

Nuclear

India has a reasonably large nuclear energy programme with 14 operating reactors including two boiling water reactors (BWRs) and 12 Pressurised Heavy Water Reactors (PHWR). Yet, the growth of nuclear energy in India has been slower than envisaged, and it has been noted that nuclear power might be the cheaper and safer option for securing energy security for India (Srinivasan et al 2005). The recent Indo-

US declaration on civilian nuclear power cooperation has sparked off intense debates. The proposal envisages the separation of civilian and military areas from the present unified structure of the Indian Atomic Energy Establishment, and building cooperation between India and the rest of the world in areas of civilian nuclear power. Such cooperation does not presently exist because India has not signed the nuclear non-proliferation treaty (NPT) and is not a member of Nuclear Suppliers Group (NSG)[19]. Because of the atomic weapon tests, India and Pakistan are on the outer fringes of the nuclear establishment. As a result, India's nuclear programme had become self-sufficient from extracting nuclear materials to building power reactors – a trajectory that has been seen as unsustainable mainly because of the modest domestic reserves of uranium (Bharadwaj et al 2006).

Perkovich's (2005) analysis of India's nuclear policy from the 1940s to the May 1998 tests and the Indo-US nuclear deal reveals that India's nuclear programme has been shrouded in secrecy and closely associated with weaponisation[20], and hence this separation may not be successful. However, the prevailing mood is to enhance the nuclear programme and to see the declaration as recognition for India's outstanding nuclear non-proliferation practices. Mattoo noted (2005) that: 'For a variety of reasons that may not find favour with anti-nuclear absolutists, there is a consensus, across the major political parties, that given India's existing and future energy needs nuclear power provides a potentially attractive source'. Bharadwaj et al (2006) agree, and suggest that the best model may be for the foreign partner, perhaps in collaboration with an Indian power corporation, to undertake to build the power plant, supply fuel, and produce power, which Indian power utilities can buy at reasonable rates. They also suggest that the nuclear operator takes on the risks of uncertainty, unlike in the Enron case in which the risks and costs were passed on to the Indian side[21]. Their opinion has some validity: '...nuclear power is a worthwhile option to pursue. India stands to benefit from imported nuclear fuels and reactors to significantly augment its indigenous capabilities. The economics may also turn out to be favourable, especially if there is foreign investment. While nuclear plants are capital intensive, operating costs are low, and fuel costs are unlikely to escalate similar to rises seen for fossil fuels.' Consequently, they argue that 'The recent US-India declaration on civilian nuclear power and cooperation should be viewed not with suspicion or alarm but rather as an opportunity for India to increase its power generation using nuclear and also as recognition for its outstanding nuclear non-proliferation practices.' (Bharadwaj et al 2006, p. 1211).

Sectoral Analysis

From a sectoral perspective, nearly half (49%) of the total energy demand in India comes from the industrial sector, with the expanding transportation sector claiming 22%, and the residential sector account for about 10%, with agriculture claiming only 5% and 'others' 14% of India's energy consumption respectively.

Clearly, the industry/power generation sector in India accounted for the largest chunk of the total final energy demand. The largest share of energy source in this sector was coal, supplying 51% of total industrial/power generation while petroleum products and electricity each provided 25% and 15% respectively. The growth in transport demand is at a rate of 3 or 4% per annum, which is lower than other sectors. Consequently its share in the total energy consumption has fallen. Transportation depends on oil; in 1998, the total energy consumption in the transport sector was 35 mtoe out of which the share of oil was the highest with 98% of total (Reddy and Balachandran 2002, p. 5265). Railways are the most energy efficient mode of transport and although India has an extensive railway network, the share in the total energy consumption through railways is declining. The inadequacy of railway infrastructure in terms of the ratio of route density to population increases the dependence on road transport, which in turn has significant impact on the energy consumption levels and the environment. In road transport, automobiles and trucks consume about 85% of total transportation energy of which passenger transport accounts for two-thirds.

Table 4: Consumption of Energy Carriers in Transport, India (1970-'98)

Energy Carrier	**1970**	**1980**	**1990**	**1998**
Coal (mt)	16.47	12.55	3.90	0.21
Oil (mt)	4.89	9.89	20.95	35.00
Electricity (GWh)	158.40	250.80	475.20	726.00

Source: Economic Intelligence Service: Energy, Centre for Monitoring Indian Economy, 2000.

The residential or domestic sector has doubled its energy consumption in the last 20 years. The rapid growth is caused by urbanisation and reduction in the use of traditional and non-commercial fuels.

Table 5: Utilisation of Energy Carriers in Households (1970-'98)

Energy Carrier	1970	1980	1990	1998
Coal/charcoal (mt)	6.78	8.73	13.65	20.15
Kerosene	3.1	4	7.5	9.1
LPG (mt)	0.2	0.3	2.1	4.1
Electricity (GWh)	436	1043	3102	8580
Fuelwood	112	156	185	220

Source: Economic Intelligence Service: Energy, Centre for Monitoring Indian Economy, 2000.

Pakistan

Pakistan's economy too is at the crossroads, with a projected growth rate between 7-8% in the next five years. The trends of energy consumption are shown in Table 6 broken down by fuel for the period 1992-2004. Apart from oil the other fuels showed strong growth. However 1997 and 2001 showed drop (2.2% and 0.1% respectively) in overall energy consumption from the previous year due to a decrease in oil use.

Table 6: Trends in Energy Consumption by Fuel Source, Pakistan

Source	1992	1996	2000	2004
oil (mtoe)[1]	8.5	11.2	12.0	11.1
gas (mtoe)[2]	5.3	6.9	8.1	10.1
lpg (mtoe)	0.14	0.22	0.26	0.38
electricity (mtoe)[3]	2.8	3.4	3.7	4.7
Total (mtoe)	18.0	23.1	25.3	29.0

[1] Excludes consumption for power generation.

[2] Excludes consumption for power generation and feedstock.

[3] energy equivalent of electricity – does not account for conversion losses in generation etc (~70%)

Source: Pakistan Energy Yearbook, 2005

The consumption breakdown by sector is listed in Table 7. The decline in 1997 was in the industrial sector whilst that in 2001 was in the transport sector.

Table 7: Sectoral Breakdown on Energy Consumption in Pakistan

Sector	1992	1996	2000	2004
Domestic	3.3	4.8	5.7	6.3
Commercial	0.52	0.69	0.78	0.93
Industrial	7.0	8.7	8.7	11.1
Agriculture	0.77	0.81	0.68	0.73
Transport	5.9	7.5	8.7	9.3
Other	0.51	0.66	0.67	0.66

Source: Pakistan Energy Yearbook, 2005

The per capita consumption of energy remains low near 200 kgoe the breakdown being listed in Table 8.

Table 8: Trends in per-capita energy consumption (kgoe) by Fuel

	1992	1996	2000	2004
pop. (millions)	112	124	136	150
Oil	75.9	90.3	88.2	74.0
LPG	47.3	55.6	59.6	67.3
Gas	1.3	1.8	1.9	2.5
Electricity	25.0	27.4	27.2	31.3
Total	160.7	186.3	186.0	193.3

Source: Pakistan Energy Yearbook, 2005

The energy sector consists of natural gas 45%), oil (15.2%), hydroelectricity (6.43%), coal (3.3%), nuclear (.42%) and renewables (negligible). Natural gas is currently utilised by the power sector (35.4%), fertiliser (23.4%), industrial (18.9%), household (17.6%), commercial (2.8%), and cement (1.5%). In electricity consumption, the domestic sector demands 41.4%, with industries claiming 31.1%, agricultural 14.1%, other government sectors 7%, and commercial consumers 6%. The government has recently published a 25 year Energy Security Action Plan (ESAP) with two main thrusts: first is to clearly separate short-term, mid-term and long-term goals, and secondly to increase self-reliance on indigenous fuels (Ali 2005). Natural gas is the fuel of choice, and the country is considering various pipeline options from Iran, Qatar and Turkmenistan as well as enhancing exploration. This Plan also aspires to change the hydel-thermal mix in favour of hydel power, and increase the share of nuclear energy to 5-6% by 2025.

Bangladesh

One of the poorest countries in the world, Bangladesh is rich in natural gas resources, and has some coal. The demand for energy has been growing steadily over the past 30 years, driven almost entirely by population growth as per capita consumption has altered little over this period (WRI Earth Trends; available at http://earthtrends.wri.org/text/energy-resources/country-profile-14.html)The major primary energy source is biomass/fuelwood (57%), the remainder being supplied from natural gas (29%) and oil, mostly imported. A coal mine near Phulbari has been closed due to public pressure concerning displacement of people in the lease area. The World Bank (http://lnweb18.worldbank.org) had already recommended that the Barakpukuria coal-fired power station be abandoned due to uncertain coal supply and that natural gas was cheaper.

Table 9: Energy Primary Energy Consumption by Sector, 1999

Sector	mtoe	%
Industry	3.72	25.1
Transportation	1.25	8.4
Agriculture	0.47	3.2
Commercial & public services	0.12	0.8
Residential	8.81	59.5
Non-energy Uses	0.42	2.8
Total Final Energy Consumption	14.8	100

Source: WRI Earth Trends (available at http://earthtrends.wri.org/text/energy-resources/country-profile-14.html)

Bhutan

Bhutan has the lowest per-capita GDP of all the countries considered in this paper (see Table 12). However, unlike the next poorest, Nepal, it has greater access to electricity and has about an eight-fold higher per-capita energy consumption.

In 2000, 55% of Bhutan's commercial energy consumption (which totalled 380.7 million kWh) was provided by hydroelectric power, 24% from petroleum, and 21% from coal. Electric power was introduced in Bhutan in 1962; by the mid-1980s, six hydroelectric and six diesel power stations were in operation. The 336-MW Chukha hydroelectric project, in south-western Bhutan, was completed in early 1987 and is connected to the Indian power grid; the project was funded by India, which is to receive all the electrical output not used by Bhutan. As of 2002 the major hydroelectric project under construction was the 1,020 MW Tala plant, slated for completion in 2004/05. In 2001, Bhutan's net installed capacity was 425,000 kW; in 2000 production totalled 1,900 million kWh, of which 99% was hydroelectric. Bhutan suffers frequent power outages and shortages (www.nationsencyclopedia.com/Asia-and-Oceania/Bhutan-ENERGY-AND-POWER.html).

The breakdown of energy consumption by sector is not available for Bhutan.

Nepal

After Bhutan, Nepal is the poorest of the South Asian countries (see Table 12). As can be seen from Table 10, nearly all energy consumption was in the residential sector and most of that energy was derived from fuelwood. Nepal has little or no fossil fuel reserves so it relies on totally on imports. Because of this, some emphasis is being put on renewable sources of energy. For example, the 10th Five Year Plan (2002-2007) aimed to provide more access to energy to rural families from alternative energy sources, as a means for poverty alleviation (Centre for Rural Technology, Nepal 2005.). This is to be achieved through installation of:

- 52,000 units of solar PV home systems
- 200,000 biogas plants
- 250,000 improved cook stoves in 45 districts of Nepal
- Installation of extra 10 MW of electric capacity through pico and micro hydro installations within the plan period.

Table 10: Energy Consumption by Sector, Nepal, 2000

Sector	mtoe	%
Transportation	0.34	4.0
Agriculture	0.09	1.0
Commercial & public services	0.09	1.0
Residential	7.72	90.0
Industry	0.34	4.0
Total Final Energy Consumption	8.58	100

Source: Centre for Rural Technology, Nepal 2005.

Sri Lanka

Fuel wood and oil provide Sri Lanka with about 90% of its primary energy supply, in roughly equal proportions. Nearly half of the oil is used for transportation and a quarter for power generation. In terms of electrical power produced, roughly equal amounts come from hydro and thermal plant. Some of the issues Sri Lanka will have to deal with concerning electrical power are (Wijayatunga, 2003):

- Inadequate generation capacity additions
- Absence of cost reflective pricing
    - Absence of a coherent policy towards sector expansion such as weak public-private partnership situation
- Increased dependence on imported fossil fuels in the thermal generation sector and increased fuel switching, biomass to LPG

The installation of improved cooking stoves is also being planned.

Table 11: Energy Consumption by Sector, Sri Lanka, 1999

Sector	mtoe	%
Transportation	1.89	25.3
Agriculture	0.00	0.0
Commercial & public services	0.24	3.2
Residential	3.38	45.2
Industry	1.69	22.6
Total Final Energy Consumption	7.47	100

Source: WRI Earth trends available at http://earthtrends.wri.org/text/energy-resources/country-profile

Energy-Poverty Nexus

That there is a close relationship between energy access and use, and poverty is clear, but in South Asia, the political ecology of its manifestations is not widely agreed upon. Poverty is one of the fundamental issues that need to be urgently addressed in South Asia especially in dealing with energy. The energy dimension of poverty is termed as ‘energy poverty’, defined as the absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign energy services to support economic and human development (Reddy 2000). Energy poverty increases with other manifestations of poverty and according to Clancey et al (2004), it is important to explore the issues that surround it, including the gender aspects. Energy is not only important for economic development, it is also one of the most essential inputs for sustaining people's livelihoods. Early on, the World Resources Institute (1975) christened this as the 'Other energy crisis': the fact that biomass in rural areas is collected at zero monetary cost mainly by women and children, making this procurement fall outside of national energy accounts, rendering invisible the issues thereof.

Pachauri and Spreng (2004, p. 271) argue that there are *three approaches* to estimate the number of energy poor: deriving an 'energy poverty line' or 'fuel poverty line', engineering type estimations for determining the direct energy required to satisfy the basic needs, and in terms of access to energy services. Energy use involves issues of cost and resource allocation, as the decision to use any particular energy source revolves around money. Although no Millennium Development Goals and targets were set for energy, the crucial role played by the access by the poor to energy services has been well recognised, most recently at the World Summit on Sustainable Development in Johannesburg in 2002. Table 12 reveals the immensity of the problem in South Asia.

Table 12: Populations without Electricity Access, South Asia, 2000

Country	Population without access to electricity* (million)	Population without access to electricity (% of World)	Per capita GDP purchasing power parity (US$)	Per capita PEC[22] (toe)	Per capita electricity use (kWh)
India	579 (57)	35	1800	0.49	393
Bangladesh	104 (69)	6.4	1470	0.14	102
Pakistan	65 (47)	4.0	2000	0.46	390
Nepal	19.5 (85)	1.1	1100	0.34	374
Bhutan	2,1 (89)	0.1	1060		
Sri Lanka	12 (62)	0.7	2600		
World Total	1634 (27)	100	6800	1.68	2343

Sources: IEA (2002), World Resources Institute, Teri Institute, www.teriin.org/projects/ES/ES2004ER25.pdf, CIA Worldfact Book 2000
* note there are significant uncertainties in these estimates

The National sample Survey Organisation (NSSO) of India in 2001 provided detailed data on the use of energy sources pertaining to the two vital areas of cooking and electrification. The access to energy differs significantly between rural and urban areas, with rural areas often lacking access to the more efficient and cleaner sources of energy. The NSSO data revel that 76% of rural households used firewood and chips, 11% relied on dung cake, and only 5% used LPG; 44% of urban households used LPG, 22% kerosene, and only 22% wood and chips. The survey showed that 139 million households in India (72%) rely on traditional forms of energy for cooking, with more than 124 living in rural areas, whereas firewood remains by far the major cooking fuel, used by more than 100 million households. Firewood is the major fuel in rural areas (88 million households), being used by 90% of lowest income group households to around 64% for the highest[23].

Table 13: Distribution of Households by Type of Fuel Used

Type of Fuel	Percent of Households
Kerosene	2
Kerosene, Biomass and Electricity	27
Kerosene, Electricity and LPG	5
Kerosene and Electricity	5
Biomass and Kerosene	43
Electricity and LPG	4
Others	14

Source: NSSO, 1993-94 (Round 50).

However, the data also showed that poor households tend to use multiple fuels to enhance the security of supply, do not necessarily follow a linear or unidirectional process of energy switch as ensconced in the 'energy ladder' theory (propagated amongst others by Leach 1992), and often the choice may even be dependent on cultural, social or taste preferences (Barnett 2000; Masrera et al 2000).

The use of firewood has serious health repercussions and social costs (World Bank, 2003). The use of such energy sources also have grave costs on women in rural communities, who are forced to spend inordinately large amounts of time in collecting fuel wood and cow dung.

Cleaner fuel use, such as LPG or electricity, is concentrated in general in urban areas and amongst better off income-groups. According to Ailawadi and Bhattacharyya (2006, p. 6), firewood and LPG are the two major cooking fuels in India, and although increasing wealth might render households amenable to shifting away from firewood, the threshold income at which a switch from firewood to LPG would occur is much higher than can be achieved through employment generation schemes.

Use of energy for lighting is also vital for rural development and the link between the two has been clearly established. Kerosene and electricity are India's main energies for lighting, and although 56% of Indian households use electricity, there are wide disparities between rural and urban areas. About 60 million rural households (43.5%) have electricity while some 78 million rely on kerosene or other forms of energy (Bhattacharyya 2006).

One crucial area often ignored by energy policy-makers is *gender*. Recent studies have also brought to the fore the complex inter-relationships between energy and the socia-economic position of women in rural areas of South Asia. According to Kelkar and Nathan (2002, p. 5), ‘where fuel is collected rather than purchased there is a sustained under-investment in labour-saving devices that would save women’s labour time, and also save fuel’. This observation upsets many of the myths associated with concepts such as ‘energy transition’ that see this transition in domestic energy use only as a function of household income, and points out the low valuation of women’s time as compared to that of men within rural households, and a systematic male bias in energy decision-making. The policy considerations that emanate from their work clearly indicate to the need for increasing the productivity of women’s labour and less stress on public subsidy of domestic fuel consumption. Thus, to ensure access of rural poor to clean and efficient energy, efforts must be made to strengthen women’s capabilities and eliminate the limits to the opportunity cost of women’s labour. Moreover, the promotion of the use of commercial energy to directly increase women’s productivity in income-generating activities is a necessity; increase in the representation of women in energy use and management bodies as well as in all agencies and institutions with influence in energy field would also help in voicing women’s concerns. For this, it is necessary to develop new approaches to integrate decentralised energy supply options with other development sectors (Cecelski 2000).

Two major initiatives have renewed the interest in the complex energy-poverty nexus: the Electricity Act of 2003 and the promulgation of a National Policy on Electricity and rural electrification. This policy aims to achieve universal access to energy within five years and meeting demand in full by 2012 (MoP, GoI) A new programme, the Rajiv Gandhi Grameen Vidyutikaran Yojana (rural electrification programme) was launched in April, 2005, and the older programmes such as Kutir Jyoti are being consolidated under a new initiative to be implemented by the Rural Electricity Corporation. However, the programes have been envisioned and implemented in a top-down fashion, and are founded on disputed beliefs which translate the resource dependence of rural people as main cause of deforestation and its attendant environmental damage. Leach (1988 pp. 54-55) pointed out that ‘rural people, who account for most woodfuel use, rarely fell trees primarily for fuel’.

Ailawadi and Bhattacharyya (2006, p. 10) conclude that rural electrification programme leaves out the question of cooking fuel, and may not be successful despite its popular political appeal because of the preference of poor people to use versatile sources of energy[24]. Consequently, Ailawadi and Bhattacharyya (2006, p. 11) have argued that there is a need for an alternative energy strategy to address the access problem in its entirety. They showed that electricity reforms have not improved electricity access to the poor, the removal of subsidies and cross-subsidies would further make commercial energy expensive for the poor to access keeping them dependent on traditional sources such as firewood, and that the Indian government must consider renewable energy technologies in addition to non-renewable sources. Above all, they recommend that improving the energy access of the poor has to happen through local development, and that a targeted subsidy mechanism be evolved to be implemented within a local framework.

South Asian nations have ignored the possibility of supporting community or locally based systems for supplying energy to rural areas. Clearly, the attention so far has favoured the two extremes of small systems for individual consumers or large central schemes that cover wide areas. Barnes and Floor (1996, p. 521) described such projects as 'overlooked assets', giving two examples of successful community-based energy enterprise in the Karnataka State of India, and Bangladesh's rural electrification programme. In the village of Pura near Bangalore in Karnataka, supported by the Karnataka State Council for Science and Technology and the Centre for the Application of Science and technology to Rural Areas, household electricity and water is administered by local communities in a participatory manner. The power is generated from large community biogas digesters. Initial attempts to promote community biogas systems failed because they were aimed at substituting wood - abundant locally - as the main cooking fuel. Subsequent community discussions revealed that villagers were more interested in obtaining clean and reliable water supplies located near their houses. This was done through a system of biogas production for fuelling a five-horsepower diesel generator, the electricity from which was supplied through a microgrid to households and also powered a deep tubewell pump that supplied water to a local system. In Bangladesh, the rural electrification programme is based on a co-operative organisational structure and has achieved considerable success in levels of connections and operational performance. Billing recoveries are close to 100%, and operational and consumer/employee ratios are far superior to those of the two parastatal power companies (Barnes and Floor 1996, p. 521-22). These two, however small, are evidence that ‘people’s power’ through community involvement is an area that may offer solutions for the rural energy access problem.

Energy Strategies

Internal strategies

Energy strategies for South Asia would be required to primarily address the global imperatives, such as addressing the question of contributions to global warming. Whilst as developing countries, South Asian nations are not obliged as per the United Nations Climate Convention to reduce their greenhouse gas emissions – a major fraction of which are energy-related - they will, however, continue to be part of a world community through their participation in the Clean Development Mechanism of the Kyoto Protocol. The interest of South Asian nations lies in contributing to the mitigation of the ill-effects of climate change on domestic agricultural productivity and vulnerabilities for populations (Gupta 2005). It has been shown that India is currently the fifth largest emitter of fossil-fuel derived carbon dioxide, and its total emissions grew at an annual average rate of almost 6% in the 1990s (Marland 2001). Although India’s annual per capita emission is far lower than the global average (0.3 tonnes as compared to 1.1 tonnes), its absolute amount would invariably draw the country to a negotiating table.

The challenge for individual nations in South Asia is clear: each country must be able to expand and improve the delivery of energy services to various sections of their citizenry whilst fuelling the economic growth without harming the environment and injustice to any part of their societies. This can be achieved through a portfolio of approaches; demand- or supply-side management of energy resources, and more expenditure in R&D.

In *demand-side management*, options are fuel switching (in residential uses, from firewood to kerosene LPG for cooking), transportation mode shifts, formulation of appropriate pricing policies, good housekeeping practices and load management strategies (Parikh et al 1994). Conversion of inefficient and polluting two-stroke engines and buses to four-stroke engines and Compressed Natural Gas (CNG), and the introduction of Euro II norms for pollution emissions from new automobiles have been underway in the major cities.

In *supply-side management*, the easiest options include coal beneficiation (washing) to reduce the ash and sulphur contents. Coal gasification (to turn coal into natural gas) has also been experimented with. Clean Coal Technologies to produce thermal power with relatively lower levels of pollution are also important options. Reducing the losses in transmission is another area of supply-side management that the Tenth Plan document has emphasised. The overall efficiency of thermal power plans has been consistently low in spite of efforts to improve it; by the end of Ninth Plan, the Plant Load Factor was around 69.9% (the average for Australia being over 90%). Renovation, modernisation and Life Extension have also been given priority in the Tenth Plan Document.

Given the importance of the energy sector in advancing India's human well-being and economic growth, a substantial part of the government efforts have been devoted towards its development. Similarly, the government is enhancing expenditure on power; from the Fourth Five Year Plan onwards, the energy sector has accounted for around 10% of the total plan outlays. In the Ninth Plan (1997-2002), the allocation was increased slightly of the public sector outlay. Power sector reforms such as the Draft Electricity Bill that was introduced in 2001 have also been undertaken to make the first step towards outlining a National Electricity Policy. This Policy has evolved following the Electricity Act of 2003 in India, setting definite targets for the country including power demand to be fully met by 2012; per capita availability of power to rise to over 1,000 units by 2012 – a minimum consumption of 1 unit/household/day, and the commercial viability and financial turnaround of the State Electricity Boards. The policy also aims to develop a National Power Grid (NPG) and public-private partnerships. The NPG will enable inter-regional power transfer capacity by connecting the major generators including hydro projects in the northeast. After the initial enthusiasm, the participation of private sector in power generation has been ailed with controversies including delays in the finalisation of power purchase agreements, guarantees and counter-guarantees, environmental clearances, matching transmission networks, but above all the bankruptcy of the monopoly purchaser, the State Electricity Boards. For example, currently India has cleared 58 private power generation projects, but only 15 have been built (and another 7 are under construction). Captive power generation by industries have been made easier and these producers have been allowed in the NEP to sell directly to other consumers by wheeling power through the grid under an open access regime.

However, as noted by Sagar (2002, p. 3925): ‘Enhancing and upgrading energy delivery is not the only issue facing India’s energy sector. Provision of various energy services has also led to significant environmental and social impacts in India, as in other parts of the world. For example, activities such as extracting coal and harnessing hydropower have led to substantial environmental impacts and displacements of large numbers of people, the ongoing controversy over the Narmada hydroelectric project being a case in point. The local air pollution issue has also been the focus of increasing concern, this attention being spurned on by the rapidly deteriorating air quality in not only large, but also many smaller cities.’ According to him, the energy sector has received only marginal attention within the S&T establishment in India, especially in the planning process, and in tern, the country’s energy or environmental policies have not focussed on R&D. Sagar identifies (2002, p. 3953) three areas that need more research funding; non-commercial sources of energy on which a majority of the country’s population relies, development and dissemination of energy-efficient technologies, and direct research into developing cross-cutting capabilities that are also relevant to other sectors of the economy.

In meeting the energy needs, each nation in South Asia would have to face the tangled interactions between energy, ecology, economics and politics. The efforts so far have been to seek government-based resource management and diplomatic solutions. However, the solution of the potential energy insecurity would necessitate not only a shift away from centrally planned approach to market/consumer approach, but would involve the adoption of innovative energy approaches and strategies such as the adoption of community-based investments especially for the rural sector. This would include demand-driven, diversified approaches involving multiple fuels, multiple borrowers, smaller projects, greater local participation and investment. In rural sector, it is also necessary to routinely disaggregate energy use, supply and impacts by gender, at all stages of the rural electrification projects.

External strategies

With regard to the geopolitics of energy supplies, we envisage two kinds of strategies: within the SAARC region and across it. Vucetic in 2004 noted that the current cross border energy trade – especially in network energy such as electricity and pipeline gas - in South Asia has been minimal, and was primarily concentrated in electricity trade between India and Bhutan and India and Nepal. Over the years, there has been an erosion of trade linkages and increases in external dependence (only about 3% of South Asian trade is intra-regional). This is in spite of the great potential for regional cooperation and enhancement of trade amongst the nations, as energy offers an attractive market opportunity. The possibility of establishing an Eastern Power/Energy Grid has been debated since late 1990s, the ESCAP secretariat had undertaken in the mid-eighties a study on trans-country power exchange in two subregions: the first comprising Indonesia, Malaysia, Singapore and Thailand, and the second covering Bangladesh, India and Nepal. In these intra-regional linkages, the role of India would be vital as none of the other countries can possibly interact with the other without Indian cooperation and permission to cross its territory with a transmission line.

It is now more or less well-recognised that greater integration encourages regional economic development by increasing energy access and supply, improve energy security, reliability and quality. This cooperation also has the potential to attract global investment flow and technology transfer. South Asian nations have considerable *resource inter-dependencies* – in hydropower and natural gas utilisation, and renewable energy exploitation. However, energy constitutes a fundamental part of the pattern of regional resource management in which complex (and disputed) questions such as riparian rights and water-sharing issues are involved. There are technical challenges too: the system sizes and parameters (voltages adopted), structure of the electricity industry, institutional mechanisms (for coordinated power system operation and control and commercial transactions), and above all procuring finances for system interconnections. Still, the future will most probably see a greater understanding of the need for regional cooperation at the SAARC level.

According to Pachauri, 1999, this will require further dilution of government control, proper accounting, better management, improved legal frameworks, rational tariffs and above all, political and economic stability and mutual trust. Regional cooperation would possibly focus on both the hardware and software sides. Whilst the hardware side of regional cooperation receives more attention in the acknowledgement of the need for transmission infrastructure, transport coordination, and equipment/ machinery, the software side involves three main areas of training and capacity-building, understanding of each others' tariffs, methods and approaches, and accurate market-demand forecasting. However, the mobilisation of resources will pose a serious handicap to the vision of a unified & integrating South Asia, and much will depend upon how the South Asian leadership responds to this challenge through focussing on the right mix of policies and committed actions.

However, energy needs would also force India to look beyond SAARC. The World Energy Outlook (IEA, 2002) forecasts that India's dependence on oil imports will grow to 91.6% by the year 2020. Concerned about the strategic vulnerability of the growing reliance on oil from West Asia, which supplies over 65% if the country's energy, India has been exploring possible alternative options. It appears that the country would follow the footsteps of other major oil importing economies, and explore the possibility of sourcing oil from outside the Gulf region. This 'source diversification' is being done through a variety of measures: Indian investment in overseas oilfields (projected to reach US$3 billion next year), particularly in Sudan and Nigeria[25], and the Caspian Basin (Tajikistan, Kazakhstan, Azerbaijan and Iran).

As the frontiers begin to dissolve, South Asian nations would need to look across the region to both east and west. Of these cross-regional connections, the western one has been under greater limelight so far[26], but increased capital flows between South and Southeast Asia can be predicted, mainly due to the sheer physical proximity. Kumar et al noted (2006 p. 9): 'With the accession of Myanmar as a member of ASEAN, India and ASEAN now share a land boundary. India shares maritime frontiers with three ASEAN members, viz Indonesia, Thailand, and Myanmar. India's Andaman and Nicobar Islands, which are strategically located near the Straits of Malacca, are geographically closer to the ASEAN members than to India.' There is indeed a growing interest in multinational capital operating in Southeast Asia on the energy sector in South Asia, particularly in coal mining and thermal power generation. For example, the Indonesia-based Bumi Resources has considered options to purchase interests in the Phulbari coal mine in Bangladesh owned and operated by Asia Energy. Similarly Pearl Energy has been negotiating for coal mining investments. Another aspect of increased interaction will be the purchase of coal from Indonesia and even Vietnam. The latter has a crude oil production surplus and lacks refining capacity. Progress so far has been limited in this area since the coal sector in India has been swaying between privatisation and deregulation, as coal is still equated with national pride and mining it seen as only for the national interest.

One important point needs to be mentioned here. The adoption of energy strategies will also require a sensitive understanding from the international community with regard to the immensity and urgency of the problem. The Iran gas pipeline talk has been ongoing since 1994, and the parties involved are well-aware of the risks involved. The American threat of imposing sanctions in case the project goes ahead seems unreasonable for the aspiring minds of developing country politicians.

Last but not the least, the provision of energy security through local community-based generation and supply systems may, in the interim at least, prove a means of enhancing access to energy.in rural areas. There is a space here between the state and the market options that needs to be evaluated.

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Notes

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[1] I would like to gratefully acknowledge the kind help extended to me by Dr David Williams formerly of the Division of Energy Technology, Commonwealth Scientific and Industrial Research Organisation, and currently Conjoint Fellow, University of Newcastle, in explaining many technical terms and interpretation of data whilst preparing this draft.

[2] The term energy 'access' generally means access to clean, affordable and reliable energy services, covering both urban and rural areas, and all forms of energy, including traditional sources (Ailawadi and Bhattacharyya 2006). In South Asia, however, it has remained a controversial term. During the year 2003-04, 4267 inhabited villages were electrified. The Government has decided to amend the definition of an electrified village to the village where the number of households electrified is at least 10 % of the total number of households in the village.

[3] HDI is a composite measure of a societies well-being based on a comparative measure of poverty, literacy, education, life expectancy, childbirth, and other factors. Child welfare is heavily weighted.

[4] In 2005-06, the Indian Government projected a growth rate of 8.1%, a significantly higher growth rate than the previous year (7.5%), and that has exceeded the expectations of the Finance Ministry and the Reserve Bank of India. The drivers of this growth are a 9.4% growth of the manufacturing sector and over 8% growth in the services sector, which together form the dominant share of the GDP (54%).

[5] For example, India alone would need capacity additions of more than 100 gigawatts (GW) in the next six years to take installed capacity to more than 225 GW. With populations being forecast to reach 1.4 billion by 2030, installed capacity will need to reach 400 GW by that year – requiring an annual growth of 5%.

[6] This concept envisages a simple ‘energy ladder’ of biomass to modern fuels, and hence has been intensely critiqued in recent years. It is now more or less well-known that the poor use an ‘energy basket’ – a range of available choices to draw upon according to the contingency.
[7] India accounts for 3.5% of world carbon emissions. The country’s carbon emissions are rising rapidly as industrialisation occurs. Between 1986 and 1995, India’s carbon emissions rose 40%. Sulphur dioxide and airborne particulates levels – caused mainly by the growth in transportation and the use of high ash content coal as a fuel - in nearly all Indian cities exceed international standards. (http://www.eia.doe.gov/emeu/cabs/archives/india/indiach1.htm accesses on 30 June, 2006).
[8] Primary energy is the energy contained in fuels of one sort or another such as coal oil, gas, wood and other biomass fuels. Primary energy is different from end-use energy. It is the intrinsic energy content of the fuel but, when burned in a power station, for example, only about 30% of this energy can be converted to electricity and sent to the end-user due to thermodynamic constraints. If heat is what is required rather than electricity, then direct heating of a boiler with a gas or oil flame can be much more efficient overall. Energy units can be a problem when comparing statistics; a common standard is the weight of oil needed to supply an equivalent amount of primary energy; the other is the amount of (joules) contained in unit mass or volume of the fuel. On this basis 1BCM natural gas is equivalent to 0.9 million tonnes of oil (mtoe), 1 tonne coal ≡ 0.67 toe. Electricity is more problematic; 1 tonne of oil contains 42 GigaJoules (GJ) of energy, equivalent to 12 MWh electricity. However due to conversion losses, it only makes ~ 4 MWh available for the end user. It should be noted that because the quality of fuels varies with source, these conversion coefficients are only approximate.
[9] This growth involves a 50% increase per capita, but still less than a third of the global average, and only about a tenth of the Organisation for Economic Cooperation and Development (OECD) countries’ average.
[10] In 1950, non-commercial energy sources accounted for nearly three-quarters of the country’s energy supplies.
[11] The Ministry of Oil and Natural Gas in their Hydrocarbon Vision 2050 have forecast demands of 117-140 bn cm by 2025. About 70-80% of the gas demand is imported and the situation is unlikely to change unless the country makes some major gas discovery. The discovery of large reserves in the Krishna-Godavari basin offer hope, but the resources will not be on stream until at least 2008-09.
[12] Examples of such long distance trans-national pipelines are many; the Maghreb pipeline from Algeria to Morocco to Europe, the Bolivia-Brazil pipeline, and the Trans-Siberian pipeline carrying gas from Russia-Belarus to Germany.
[13] For more information see
http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/v2_ch8_2.pdf P. 8.
[14] The number of people who have been displaced by large infrastructure projects in India may well be similar in size to the population of eg the UK see discussion next page
[15] Accordingly, the Coal India (Regulation of Transfers and Validation) Bill, 1995 has been in the Indian Parliament since 1995, and has been referred to a Standing Committee in 2000.
[16] The Kosi High Dam Project was first proposed (as the Barahkshetra Dam) in 1947 to control floods provide irrigation water and generate 3300MW electricity. Since then new feasibility reports were prepared in 1980. India has renewed its interest in constructing this dam which will cost 10 times the annual Bihar state budget
[17] The inherent conflicts in such ‘water resource planning’ models as they are called are apparent by now: the water needs to be stored in the reservoir to produce electricity throughout the year, but for irrigation, it needs to be released into the canal systems.
[18] Environmental clearances are not required for projects of up to 10-12 MW capacity and although these projects have low adverse impact on the environment, shorter gestation periods and little or no displacement of local populations, the involvement of and control by local communities is not yet a feature ingrained in them.
[19] The NSG consists of a group of 45 countries who, with the unanimous agreement of their members, can supply nuclear technology to non-member countries.
[20] This view has again been critiqued by Jayaprakash (2000) who notes that it was India that first introduced the proposals which led to the NPT and CTBT in a grossly modified form which qualitatively overturned the intent and purpose of these proposals.
[21] They also advise the Indian Atomic Energy Establishment to devote all its resources on building more PHWR and to explore the plutonium and thorium option by building a sizeable nuclear reactor and specialised reprocessing facilities. They advice against using the uranium-based technologies is mainly due to the fact that the UK, having expended the most part of its North Sea fossil fuel resources, is veering back to nuclear power, causing a tightening of the uranium resources.
[22] PEC – Primary Energy Consumption

[23] Higher income groups, however, have a higher per capita consumption; they use almost 50% more wood in absolute terms

[24] Fuels meeting only a few household needs are less competitive than those satisfying multiple needs, and thus electricity used only for lighting, representing less than 10% of a poor household's energy needs, has a lesser chance of succeeding in the cost competition (Ailawadi and Bhattacharyya 2006, p. 11).

[25] In Sudan, India has invested US$750 million in oil and Nigeria with which India has reached a deal last year to purchase about 44 million barrels of crude oil per year on a long term basis. Additionally, India has recently finalised a contract with Syria for the exploration and production jointly with a Syrian company. Sakhalin in Russia, and Vietnam and Myanmar in Southeast Asia are also potential suppliers `to the Indian market.

[26] And this western connection remains an important one; for example Pakistan has two major pipeline projects on board: oil from Sharjah under Persian Gulf Waters and hydrocarbons from Turkmenistan through a pipeline to Afghanistan and the port of Gawadar, to be exported to the rest of the world.