Power sector reform, private investment and regional co-operation[1]

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5 November 2005

Abstract

Modern infrastructure, particularly electricity, is critical to economic development. Deficits cause shortages that constrain total output, magnifying the return to their elimination. South Asia, faced with inefficient and bankrupt state-owned vertically integrated electricity supply industries, was under strong pressure to reform. An imperfect diagnosis encouraged private investment in generation to address shortages, with IPPs selling power under long-term contracts to the largely unreformed state electricity boards (SEBs). Buying IPP power at prices above retail tariffs when the SEBs could not even cover the cost of under-priced electricity from state-owned generators exacerbated financial distress and was a recipe for conflict. Reforming the SEBs, though unbundling, full metering, effective accounting and management structures creating commercial discipline, under multi-annual regulation insulated from clientalist political pressures, is an essential first step. Privatisation of the distribution companies once they are properly "enterprised" should then follow to sustain reform. Reducing losses, both non-technical and technical, and increasing plant load factors yield far higher returns than generation investment, where India and Pakistan already appear above predicted levels of electric intensity, perhaps because of low effective prices, and could eliminate most shortages. The Indian *Electricity Act 2003*, requiring metering, multi-annual regulation and regulated third party access to the national transmission grid, is a useful start.

Private investors will require assurances that the contracts needed for IPPs are honoured, that legal disputes are efficiently and fairly resolved, subject to fall-back international arbitration, and that their purchasers are credit-worthy. This is easier with cheap gas, which is available to Bangladesh, but scarce in India. Regional energy trade would therefore do much to improve the investment climate, and a South Asia Energy Charter could underwrite increased energy trade. The European Energy Charter has helped integrate the transition countries of Central Europe and stimulated FDI in the power sector, and might have similarly stimulative effects in South Asia, quite apart from creating profitable trade opportunities and increasing regional security of supply and greater resilience against external oil shocks.

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Introduction

Modern infrastructure, particularly electricity, telecoms and roads, is critical to economic development. Electricity provides light, the ability to use modern equipment, computers and access to ICT. Telecoms facilitate information exchange and access to the rest of the world, while transport infrastructure is critical for trade, and by lowering transport costs extends the market and increases competition. Studies of the productivity of infrastructure (Canning, 1999; Canning and Bennathan, 2000) suggest that infrastructure has strong complimentarities with other human and physical capital. If there is a surplus of infrastructure, more investment adds little to total output, but if there is a deficit, then shortages constrain total output, magnifying the impact, so that the return to reducing that deficit can be very high indeed.

This can be seen most clearly for electricity. Once there is an adequate reserve margin of generation and adequate transmission and distribution to deliver the power to customers, more capacity has almost no extra value, and the efficient (and competitive) price of power falls to its short-run avoidable cost, essentially the cost of the fuel used in the least efficient plant dispatched. If there is a shortage, the value of lost load can be tens or even one hundred times as high. This in Britain during the period 1990-2001, the wholesale market (the electricity Pool) set a capacity payment based on the value of lost load, initially taken as £2,000/MWh when the average wholesale price net of the capacity payment was less than £20/MWh.[2] The value of lost load reflects the considerable inconvenience of unexpected disconnection, while the value of unserved energy in a country familiar with power shortages may be lower, as users take precautions such as installing back-up or stand-alone systems. Nevertheless, these are often many times as costly as reliable centrally generated power, showing the potentially high returns to investing to deliver that power, particularly to customers with a high willingness to pay (commercial and industrial customers in particular).

The demand for infrastructure, and particularly electricity, is growing rapidly in the region, and at low levels of income per head, can be expected to grow more rapidly than GDP as the economies modernise and shift resources from agriculture to industry. Figure 1 shows the electricity intensity of a selection of South Asian and other countries, measured by production of electricity per thousand US$ GDP (at 1995 constant prices). Indian production is rising considerably faster than GDP, as is that in Pakistan and even more so in Bangladesh (although the arithmetic scale may not show this clearly).

[2] The price paid to generators was the sum of the System Marginal Price, the price of the most expensive bid accepted (if they were dispatched), and the capacity payment for plant declared available.

Electricity Intensity SE Asia and comparators 1971-99

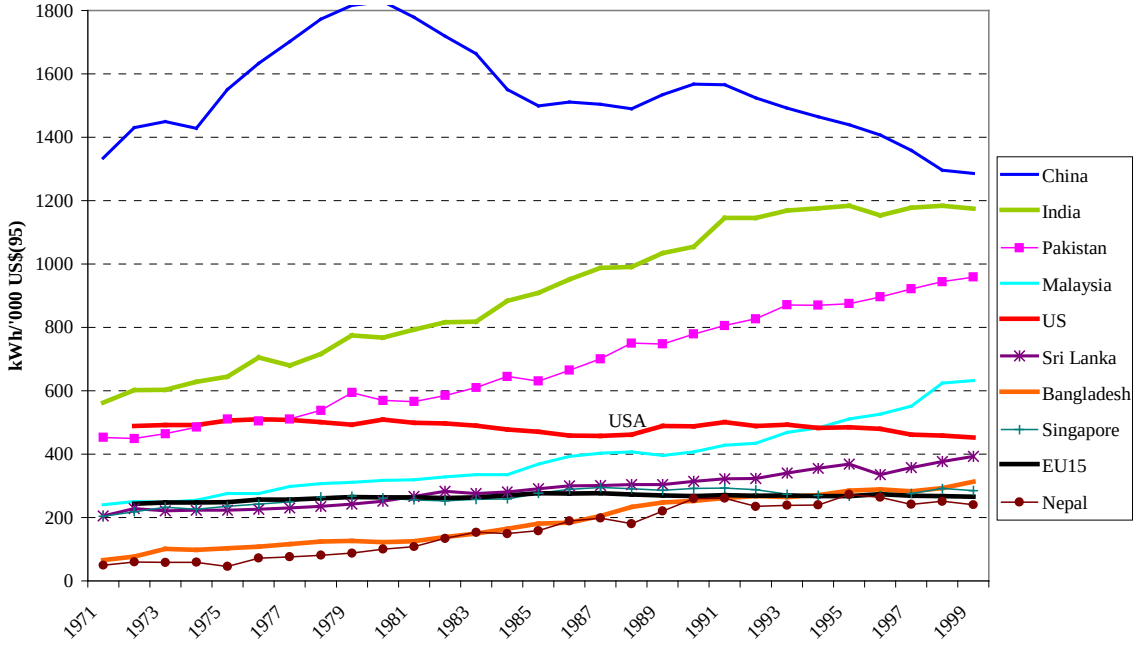

Figure 1 Comparisons of electricity intensity of SE Asia, the US, China and the EU-15
Source: World Bank Development Indicators 2002

Table 1 Rates of growth of energy intensity 1986-8 to 1996-8 *% p.a.*

Country	Electricity production	GDP $95	PPP $96	Electricity prod/US$(95)	Electricity cons./$PPP (96)
India	7.78%	5.84%	4.08%	1.84%	1.59%
Pakistan	7.39%	4.59%	1.77%	2.70%	2.47%
Bangladesh	7.90%	4.44%	2.70%	3.34%	5.48%
Malaysia	12.38%	8.57%	5.64%	3.53%	4.46%
Sri Lanka	6.53%	4.75%	3.42%	1.68%	1.35%
Nepal	8.10%	5.02%	2.61%	2.92%	3.28%
Singapore	8.34%	8.81%	6.71%	-0.44%	-0.44%
China	8.52%	9.67%	5.91%	-1.03%	0.42%
US	3.07%	2.91%	1.86%	0.16%	-0.03%
EU15	1.91%	2.10%		-0.19%	

Source: World Bank Development Indicators 2002

Table 1 gives the rate of growth of electricity production and of GDP (at constant US$ and also constant PPP$) and of electricity intensity (which is also the rate of growth of

electricity production *less* the rate of growth of GDP).[3] India (and even more so China) looks surprisingly electricity intensive at market exchange rates (nearly three times as much as the US and over four times as much as the EU-15). This continues to be true for India and Pakistan when GDP is measured at Purchasing Power Parity. Figure 2 shows *consumption* (rather than production) per thousand $PPP,[4] together with the predicted consumption for South Asian countries as a whole (excluding Bhutan) using the regression estimates presented in the Appendix. India and Pakistan track each other closely, and are considerably more electricity intensive than (more than three times as much as) the smaller countries, Sri Lanka, Bangladesh and Nepal, and almost twice the predicted level.

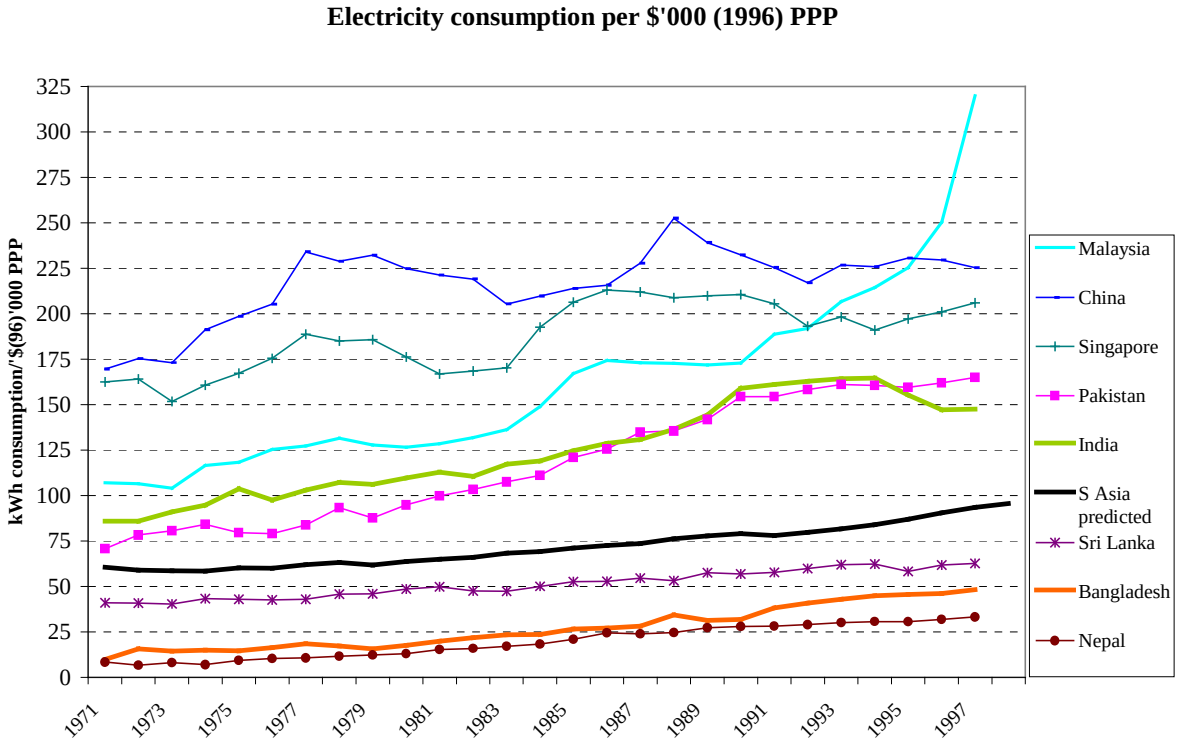

Figure 2 Electricity consuumption in S Asia compared to predicted per $'000 PPP
Source: World Bank Development Indicators 2002, Penn World Tables 6 and Appendix

Thus whether one compares electricity intensity at market exchange rates or at PPP rates, India and Pakistan appear more electric-intensive than might be expected. One obvious explanation of this high intensity is that electricity is under-priced in many countries (both

[3] PPP is purchasing power parity and is a measure of the real standard of living, taken from the Penn World Tables version 6. The relationship between the growth rates is not exact as the rates of growth are found by averaging the initial and terminal values over three years.

[4] The difference between consumption and production is mainly losses, except for exporting countries like Bhutan (not shown) or India (which imports a very small share of consumption from Bhutan). Purchasing power parity measures come from the Penn World Tables and attempt to correct for different relative prices in poorer countries, primarily the lower prices of non-tradables, as well as distortions that cause differences between domestic and world prices for tradables.

directly, and effectively through the failure to collect bills and prevent theft). Countries that have a lower than expected electric intensity usually also have a low penetration of electricity, particularly in rural areas. In that respect India appears to do quite well, given its per capita income.

The problem

Not all South Asia countries suffer from the same problems, but as a generalisation the region still has the legacy of state-owned vertically integrated electricity supply industries, often with the characteristic politicisation of tariff setting that leads to excessively cheap electricity to domestic consumers, high levels of non-technical losses (i.e. theft or failure to collect bills), high levels of debt or arrears, high levels of manning, and poor commercial performance (as measured by the ability of revenues to cover costs). As a result, it is difficult for the sector to finance its investment needs on commercial terms. The shortage of revenue leads to poor maintenance with frequent equipment failures (e.g. as measured by transformer failures and low generation availability), leading to power shortages and load shedding. Figure 3 gives time series of losses as reported by the World Bank, although for India these are considerably below those reported by various States.

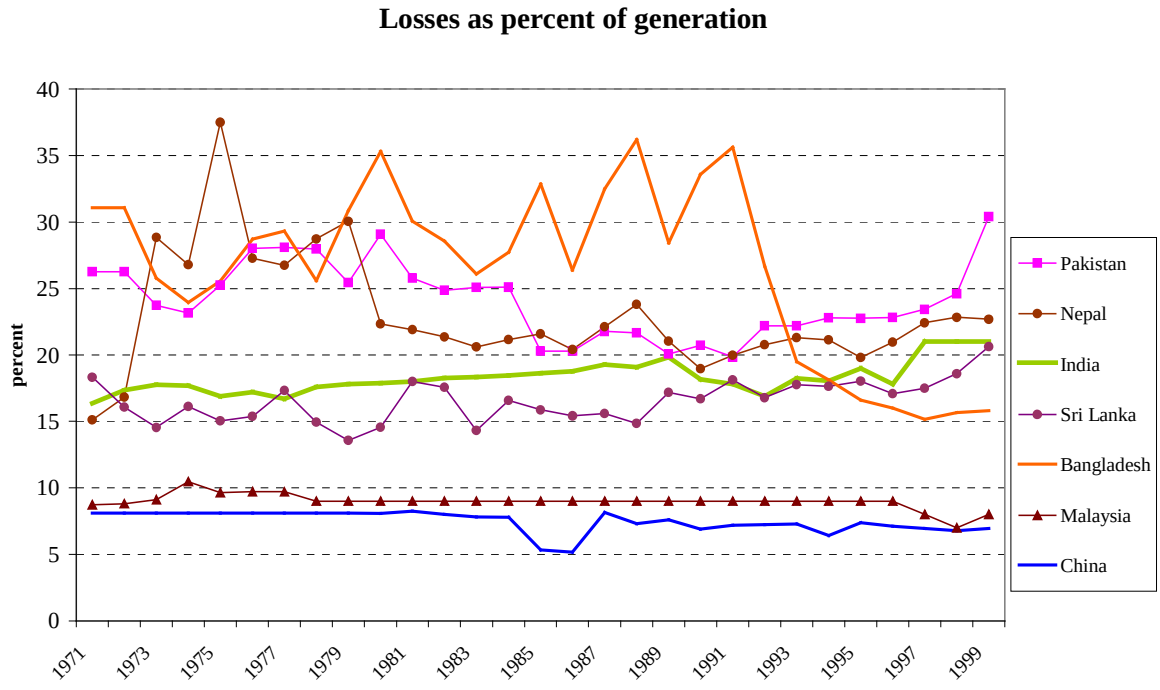

Figure 3 Electricity losses in S Asia and China

Source: World Bank Development Indicators 2002

The India National Electricity Plan notes that "the country faced energy shortage of 7.1% and peaking shortage of 11.2% in 2003-04" (CEA, 2004). ICRA (2004) gives state-wise score card data for India for 2004 stating that "the power sector in the country is grossly over staffed leading to low productivity…" and "the proportion of billing on metered basis at less than 50% of energy input into the system." (ICRA 2004, p10). "Despite progress, the

coverage of costs through revenues is still low for most states." "… in the North East, the coverage … is very low and typically less than 35%". (*ibid.* p11). Taking a sample of states, we find that for Delhi "the generation plants are aged and have a low PLF (48.5%) and low availability (62.2%). The commercial viability of DISCOMs is contingent upon improvements in the low level of metered billing … reduction in the high levels of AT&C losses of 52.8% and improvement in distribution infrastructure. … The power sector as a whole has negative net worth ... with a low cost coverage ratio of 43%" (*ibid.* p15).[5] For Andhra Pradesh, initially one of the more progressive reformers, "the GoAP has deferred the time frame (of privatising its distribution companies indefinitely and currently has no time frame for the final privatisation of these distribution entities." (*ibid.* p17) "The average adjusted book losses declined to Rs. 2526 Crores in the years 2001-2 and 2002-3 from Rs. 3166 Crores in 2000-01" (i.e. from roughly $630 million down to $500 million). "The power utilities had realised average revenue per unit of Rs 1.71 (3.6 US cents/kWh) in 2002-3 against an average cost of supply of Rs 2.17" (5.65 US cents/kWh) or a coverage of 78%.

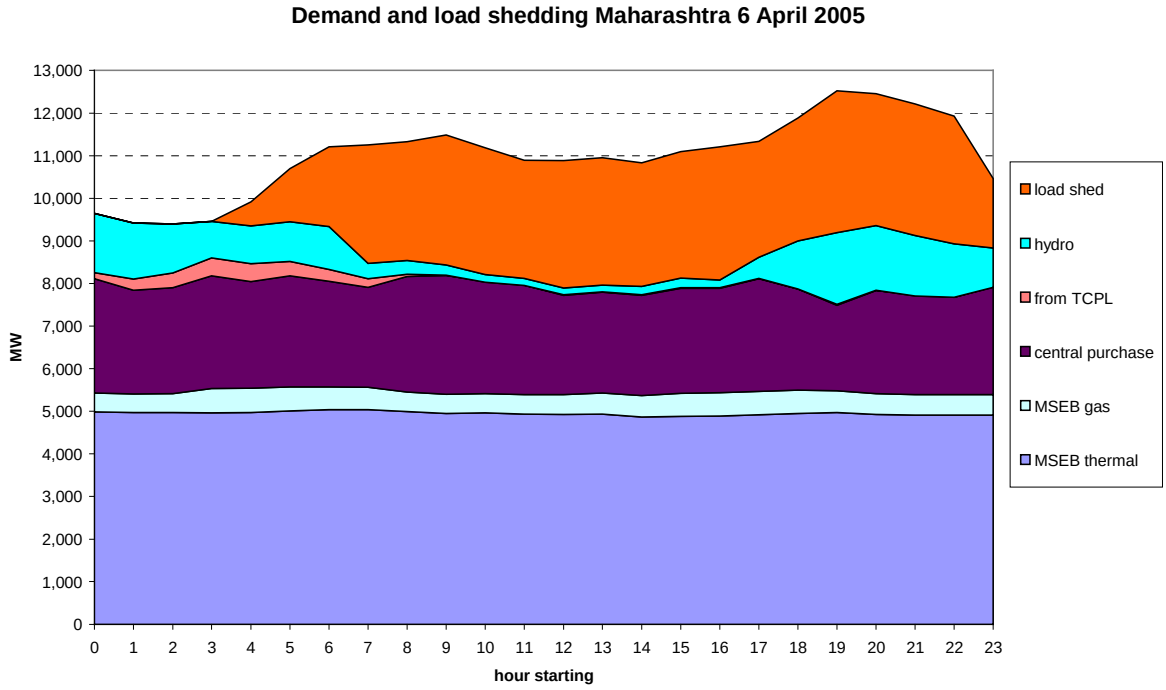

Figure 4 Load shedding in Maharashtra
Source: http://www.sldcmsebindia.com

For Maharashtra "MSEB has been unable to meet the reform schedule laid down" (in the Memorandum of Understanding with the Ministry of Power). "(A) significant number of consumers (85% of agricultural consumers) continue to be unmetered. Further there has been no addition to the generation capacity either by MSEB or from the private sector in the last few years. This is a cause for concern in the face of mounting demand supply deficits in the state power sector." (*ibid.* p47). Evidence for daily load shedding can be downloaded from

[5] PLF is plant load factor, AT&C is aggregate technical and commercial losses.

the dispatch centre web site (http://www.sldcmsebindia.com), and a randomly chosen weekday in April this year is shown in figure 4.[6]

Orissa is another disappointment, given that it was the first Indian state to start power sector reforms, with the passage of the Electricity Reforms Act in 1997 setting up the Regulatory Commission. "The state government has directed district administrators and police officials to support the distribution companies for curtailing frauds, theft, etc., but the actual implementation of the same had so far been quite lax. The government has not enacted the anti-theft legislation like most other majority states" (*ibid.* p90). "(P)rivate investors in distribution companies have faced steep distribution losses till OERC recognized them in 2002. … OERC has been advocating the multi-year tariff policy as per GoO directions to embark upon long-term business plans by power utilities." Lengthy legal litigation has delayed the introduction of SERC's tariff orders, and generation availability is 10% below norms. "AT&C losses were quite high at 54% .. " and "long-term viability of the power sector reforms heavily depends on the state government's support and far reaching operational improvements in distribution segment." (*ibid.* p61).

The former Minister of Power, Yoginder Alagh, who introduced The Electricity Regulatory Bill to the Lok Sabha in 1997, noted that "by early 2001, SEBs (State Electricity Boards) as a whole faced an average 50 per cent level of technical plus non-technical losses, and they collectively owe around $5 billion to the Government of India undertakings" (Ruet, 2005a, p13). The situation does not seem to have improved since then, with losses of the SEBs overall reported as Rs. 21,000 crores (about US$4.2 billion) by the Prime Minister in May 2005. He expressed concern over continuing electricity shortages, and argued that the power sector needed urgent reforms, including unbundling.[7]

These problems are not peculiar to India, although their sheer scale there dwarfs those elsewhere. Thus Bangladesh suffered energy shortages for much of the 1990s. In the fiscal year to June 1998, Bangladesh Power Development Board (BPDB), the main electricity producer, provided uninterrupted supply on only 49 days. Much of the time 25% of peak power was unserved (World Bank, 1998). Unreliable power is estimated to have led to a loss of 10% of industrial output. As industry accounts for 15% of GDP, compared to electricity at only 1%, the social cost of electricity shortfalls are substantially larger than just the value of the unproduced power. Only 2,400 MW or 77% of nameplate capacity of 3,100 MW was available in 1998. The plant load factor was only 55%, despite excess demand. The poor availability and load factors result from poor maintenance and plant derating. This situation appears to have continued, with the EIA reporting in August 2005[8] that "The World Bank has estimated that Bangladesh loses around $1 billion per year in economic output due to power outages and unreliable energy supplies. …(O)nly two-thirds of Bangladesh's total electric generating capacity is considered to be 'available.' Problems in the Bangladeshi electric power sector include high system

[6] There are curious features of this graph that raise questions, specifically why hydro supply remains high in the early hours and then falls when load is shed.

[7] The Hindu, 30 May 2005 at http://www.thehindu.com/2005/05/30/stories/2005053007010100.htm

[8] Available at http://www.eia.doe.gov/emeu/cabs/bangla.html

losses (up to 40 percent), delays in completion of new plants, low plant efficiencies, natural gas availability, erratic power supply, electricity theft, blackouts, shortages of funds for power plant maintenance, and unwillingness of customers to pay bills. Overall, the country's generation plants have been chronically unable to meet system demand over the past decade."

The same EIA source[9] notes that in Pakistan "Rotating blackouts ("load shedding") are, however, still necessary in some areas. Losses are about 30%, due to poor quality infrastructure and a significant amount of power theft. Periodic droughts affect the availability of hydropower." The World Bank notes that in the Karachi Electricity Supply Corporation (KESC) "System losses have increased from 17% in 1985-86 to 40% in 2001-2002. The experiments with public sector management through non-traditional methods including the induction of army personnel in uniform as top managers since 1999 have not shown any signs of significant improvement." (Alexander et al, 2003). The Government of Pakistan still heavily subsidises the power sector.[10] Losses in KESC have fallen a small amount since then, as have total losses for the public utilities (down to 27.6% for the year up to June 30, 2003, according to the *Pakistan Energy Yearbook 2003*).

Reforms

The high rates of growth of electricity production shown in Table 1 (typically 7-8% p.a.) and the high levels of unserved demand in some parts of the region (certainly in Bangladesh, India and Pakistan) appear to require high rates of investment in generation if supply is not to become an increasing constraint on growth. State and central budgets are under stress, the electricity companies are often effectively bankrupt, so the apparent solution has been to bring in private capital.

Under pressure from the International Financial Institutions (IFIs) and prompted by the apparent success of reforms in Latin America, many countries in the region have considered or embarked upon reform programmes to allow private investment in the sector. The first step involves passing an Electricity Law to allow private investment, then establishing regulatory agencies to set tariffs, unbundling the natural monopoly transmission and distribution businesses, and in some cases privatising distribution companies and some generation assets. The typical form of private participation has been by Independent Power Producers (IPPs) signing long-term Power Purchase Agreements (PPAs) with the Single Buyer (normally the incumbent power company or State Electricity Board, but the standard model recommended is with a separate Transmission Company buying in a non-discriminatory way from existing and new generation companies).

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[9] Available at http://www.eia.doe.gov/emeu/cabs/pakistan.pdf

[10] WAPDA was reported in May 2005 requesting Rs 26 billion (nearly $US 500 million) for 2004-5, (http://www.dawn.com/2005/05/04/top5.htm), while in Nov 2004 the *Daily Times* reported that the federal government had decided to pay Rs 15 billion ($250 million) to "to subsidise electricity for domestic and agricultural consumers throughout Pakistan" as the distribution companies could not afford the subsidised tariff. See http://www.dailytimes.com.pk/default.asp?page=story_5-11-2004_pg7_12

The results of these reforms have often been disappointing (Ranganathan**,** 2003**)**.[11] Elsewhere in Asia, currency crises undermined the ability of the Single Buyer to honour the PPAs, which were often largely denominated in foreign currency (Newbery, 2002). More generally, the tariffs needed to finance foreign direct investment (given the perceived level of risk and the short tenor of most debt finance) has led to high initial charges for electricity purchased from these IPPs. The mismatch between the cost of these new PPAs, the average cost of existing generation (with tariffs based on written down asset values and often under-priced fuel),[12] the lower average tariff of retail electricity, and the even lower average revenue per unit generated, placed the State Electricity Boards or their counterparts under increasing financial stress.

Ruet's (2005a, b) analysis of the problems of the SEBs is that they currently act as administrative bodies that are unresponsive to incentives, and for whom the concept of cost do not apply. Their concept of rationality involves following procedures (particularly based on paper-work) rather than taking cost-benefit based decisions. The lack of proper management accounting, the absence of a proper internal allocation of discretionary power (to take sensible day-to-day operational decisions), and the pre-eminence of administrative rules, makes attempts to reform the structure of incentives and property rights (through privatisation) ineffective without first changing the nature of the Boards. Of course, there are major beneficiaries from this opacity of accounting that may account for the extreme resistance to meaningful reform. Reflecting on the reforms of the 1990s, Ruet notes (2005a, p206) "the structural reforms as envisaged by the Government of India and enforced by some States do not lead to any substantial change neither of the organisation nor of the administrative nature of SEBs."

The solution Ruet proposes is "enterprisation", to be contrasted with corporatisation, which just changes the legal status of the Boards, and which in any case would be a necessary first step towards the kind of restructuring envisaged by the reform programme. The institutional changes required involve fundamental changes in management accounting, creating cash flow rights for the enterprise and allocating rights to and control over these cash flows to the relevant decentralised units, limiting the executive instructions from the state, while providing the information needed to expose corruption and clientalism.[13]

One central problem is that much electricity is not sold at remunerative prices, and a large fraction of customers are either not charged at all (agricultural consumers in some areas) or bills are not collected. The obvious solution is to install meters where these are lacking, to set remunerative tariffs by regulators charged to ensure that tariffs are cost-reflective and capable of financing both operations and investment of efficient companies, and then to privatise distribution companies to provide incentives to collect bills due. This

[11] There is growing recognition that the early enthusiasm for privatisation, particularly by the World Bank, was "oversimplified, oversold, and ultimately somewhat disappointing." (Kessides, 2005), but see Kikeri and Nellis, 2004 and Kessides, 2004).

[12] In India, the required rate of return on assets was set at 3% in 1947, which even in real terms is well below a sensible economic rate.

[13] See also Irwin and Yamamoto (2004).

strategy worked well in Chile (Galal et al, 1994), but appears not to have been successful in Orissa, where it was first tried. Apart from Ruet's diagnosis of the need to create proper enterprises before privatisation (as was done in Chile in a lengthy preparation to eventual privatisation), there are several serious difficulties facing distribution companies in India. Dealing with the high levels of non-technical losses requires installing (and reading) meters, ensuring that they are not tampered with, ensuring that those collecting the money are not corrupt, and protecting them when reading the meters and collecting bills, and, most important, having the legal authority and actual will to cut off those not paying.

One practical problem is forecasting a realistic set of targets over time at which the non-payment rate will be reduced – too low and the distribution company will make a windfall gain, while too stringent may cause financial distress, and an inability to make investments to reduce losses (Ranganathan, 2005). This requires sophisticated multi-year regulation (probably with profit-sharing arrangements) insulated from political pressures that keep tariffs low and provide free electricity. Here the record is disappointing, with frequent political reversals of cost-justified tariff increases. Of course, when the whole industry is riven with over-manning, poor maintenance, poor bill collection, and other obvious inefficiencies, it is easy for politicians to argue that removing such inefficiencies would deal with losses without tariff increases, and there is some force in these arguments, as discussed below.

Obstacles to private investment

The main obstacle to private investment is the fear that once the investment is sunk, it will not be allowed to earn a remunerative return. The electricity sector is particularly problematic as private investors supply an essential service directly to a large fraction of the voting population in competition with under-priced supply from the state-owned sector. As prices will have to rise to ensure that the investments are remunerative, the price rise will be associated with the reforms that brought in private investors, and will be doubly resisted on that account. Many of the current beneficiaries of opaque accounting, cross-subsidies, patronage in the appointment of regulators and senior management, etc., will have an interest in preserving the status quo, including the low prices that deter efficient commercial competition. The fact that external bodies such as the World Bank are pressing for such reforms provides additional reasons for populist resistance, for the price rises that are needed to ensure investment adequacy yield current pain while the benefit of improved quality of service may be some way in the future, and beyond the politician's invariably short time horizon.

Private foreign investors are wary of investing in hydro capacity, which is both capital intensive, with long construction periods, and often subject to water management regimes that may conflict with power generation. Coal-fired power stations can be similarly problematic where they are dependent on domestic coal, as coal mining is often fraught in

terms of labour relations.[14] Coal-fired stations using imported coal could be economically attractive but may be discouraged if there are inefficient domestic mines whose employees may object. The logical choice for IPPs is therefore gas-fired combined cycle plant using either indigenous piped gas (as in Bangladesh, Pakistan or India), or where local gas is not available, LNG imports. India is increasingly turning to that source to supplement inadequate domestic gas. Petronet LNG has a 5 million tonne LNG terminal at Dahej that is being expanded to 12.5 million tonnes.[15] Petronet is also setting up a new 5 million tonne facility at Kochi, and is also taking over completion of the 5 million tonne terminal at Dabhol (as described below).

The Dabhol power plant in Maharashtra illustrates some of the problems facing private investors. In 1992 India opened up the electricity sector to foreign investment, and officials visited the USA to encourage investors, an invitation that Enron rapidly followed up with a proposal to build a large LNG terminal to supply a combined cycle gas turbine generating station of about 2,000 MW at Dabhol, on the coast some 180 kilometres south of Mumbai. Negotiations ensued with respect to the Project contracts and led to the signing of a PPA in 1993.[16] The first phase of 740 MW was commissioned in 1997 before the LNG terminal was completed and ran on liquid fuel (initially distillate but then naphtha). The price charged by MSEB to consumers for power was less than it cost to generate power at the Dabhol plant, given the high cost of fuel and the capital costs associated with the Project. As the amount of power purchased increased, the financial ability of MSEB to pay came under increasing stress, in large part because of the Government of Maharashtra's failure to effect necessary (albeit politically unpopular) reforms in the power sector, such as charging market rates for the power produced. "Payment problems with the Maharashtra State Electricity Board (MSEB), however, prompted Enron-backed Dabhol Power Corporation (DPC) to serve notice of breach of contract on MSEB in May 2001. Construction on Phase II was halted in June 2001." [17] The resulting acrimonious dispute lasted from 2001 until July 2005, when

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[14] That does not stop some apparently uneconomic coal-fired stations being built. In June 2005, a consortium of the China National Machinery Import and Export Corporation (CMC) and the Xuzhou Coal Mining Group Company Ltd. signed a contract to run the management and production of the Barapukuria mine in Northwest Bangladesh. The only use for such coal would be for electricity generation in a country well-endowed with cheap indigenous gas.
See http://www.eia.doe.gov/emeu/cabs/bangla.html

[15] Petronet is a joint venture between Oil and Natural Gas Corporation (ONGC), the Indian Oil Corporation (IOC), the Gas Authority of India Ltd. (GAIL), the National Thermal Power Corporation (NTPC), and Gaz de France.

[16] There is extensive material on Dabhol, e.g. http://www.atimes.com/reports/CA13Ai01.html
and for more recent material and an archive http://www.rediff.com/money/enron.htm. The author should declare an interest as an expert witness acting for the some of the investors in DPC, which was, however, settled before going to arbitration. The text is based solely on material publicly available from the web and whose accuracy is not guaranteed, and makes no use of any confidential material that may have been seen by the author.

[17] From http://www.eia.doe.gov/emeu/cabs/india.html

settlements were reached between MSEB and GE and Bechtel (the surviving equity holders after the bankruptcy of Enron) of various arbitration claims.

The successor company Ratnagiri Gas and Power Pvt Ltd (RGPPL) with the NTPC and the Gas Authority of India Ltd (GAIL) subsequently took over the almost completed 2,148 MW plant.[18] On 22 September 2005 the Bombay High Court issued an order on a consent term jointly filed by the DPC, RGPPL and the IDBI-led lenders.[19] Petronet LNG was then asked by the Ministry of Petroleum and Gas to complete the LNG terminal that will supply the power plant. Effectively what was originally the largest IPP in India has now been taken back into public ownership after a lengthy and costly dispute during which the 2,000 MW that was potentially available to deal with shortages that were typically of the order of at least 2,000 MW (see figure 4 above) were not available to MSEB and the state.[20]

Three problems compound the difficulties facing such plants in India. The first is that while GAIL sells its domestic gas at a price below import parity (i.e. subsidizes it), imported liquid fuels such as naphtha and distillate are taxed. There are sound public finance principles arguing that inputs into production should not be taxed (except to correct externalities such as pollution or CO_2 emissions), and any taxes should fall on final consumers.[21] As the public power is invariably subsidized to most final consumers, it is particularly perverse to tax fuel inputs into electricity.[22] Not surprisingly, RGPPL appealed to the Maharashtra government in October 2005 for a "waiver in sales tax and excise in a bid to maintain the per unit tariff of Dabhol phase-I (740 MW) at around Rs 3.60 as against Rs 2.50 by use of LNG." [23]

The second is that LNG prices are both volatile and typically linked to oil prices, which have considerably increased in recent years, undermining the apparent attractiveness of gas-fired power stations. The third is that the energy cost of gas-fired generation can rise above that of indigenous fuels, encouraging dispatch centres to dispatch gas at lower load factors, further increasing the average cost of electricity, and straining the contractual relationship with the IPP when it is the average and not the marginal cost that is reported.[24]

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[18] See http://www.tribuneindia.com/2005/20050721/nation.htm#2

[19] See http://www.financialexpress.com/fe_full_story.php?content_id=103402

[20] See *The Times of India* 10 October 2005

[21] Diamond and Mirrlees (1971), Newbery (2005). The case for taxing distillate, given the prevailing emissions standards, while under-pricing domestic coal is perverse on environmental grounds

[22] Oil taxation is justified on a variety of grounds, of which the most relevant here are to prevent substitution of legitimately taxed road fuels, and as part of an optimal import tariff to cover the costs of maintaining security of supply. Nevertheless, there should be less distorting ways of meeting these objectives for large power station fuel supplies.

[23] http://www.financialexpress.com/fe_full_story.php?content_id=105176

[24] The situation is further complicated by the terms under which the gas is purchased. LNG contracts are typically long-term take-or-pay contracts and the relevant opportunity cost may be near zero, arguing for base-load dispatch, while the apparent energy cost may suggest that it should run only at the peak. Such confusions undermine rational discussion between IPPs, regulatory agencies, politicians, and consumers who may appeal tariff decisions, delay tariff adjustments and reduce investor confidence.

Pakistan's experience with IPPs also dates back to the mid-1990s, under encouragement from the World Bank's Power Sector Development Project. The Bank's project goals included restructuring and privatisation, investment, and technical assistance to improve the operations and managerial efficiency of the power system (World Bank, 1994). Before that date, there was little investor interest in Pakistan's power sector after the Government first allowed private investment in 1992, because of the high duties on imported equipment and the time taken to deal with the bureaucracy. In 1994 the Government published its *Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan*. This provided an attractive formula for setting the PPA terms (according to the World Bank a bulk tariff of 6.5 US cents/kWh indexed to fuel prices, US and Pakistani inflation, exchange rate fluctuations, O&M costs, etc.), tax holidays, and a standardised security package which included model agreements (Fraser, 2005).

These and other incentives resulted in considerable foreign interest, and led to the development of the Hub Power Company (Hubco). Hubco built a 1,300 MW oil-fired power station located on the Hub River estuary owned by a consortium of International Power (UK), Xenal (Saudi Arabia), and Mitsui Corporation. It is described by WAPDA as "the first and largest power station to be financed by the private sector in Southern Asia and one of the largest private power projects in the newly industrialised world."[25] The Hubco project, completed ahead of schedule and on budget ($1.6 billion) in 1997, was structured through four detailed agreements following the standardised model: the Power Purchase Agreement, the Fuel Supply Agreement, the Implementation Agreement and the Operations and Maintenance (O&M) Agreement. These four key agreements formed the security package against which project funding was secured.

The 1994 policy was also very successful in attracting private interest. "Including Hubco, 20 IPPs with a total installed capacity of about 4,500 MW reached financial close, of which four totaling 435 MW were later terminated. The total investment was about US$5.3 billion, of which 25% was financed by foreign equity. An estimated US$3 billion was financed with foreign exchange debt with an average maturity of 10 years. Roughly 85% of the foreign debt or 66% of total debt was from official sources." (Fraser, 2005). The problem was that the programme was too successful in eliciting investment, but less successful in ensuring that the plants were on the least cost expansion plan and were competitively secured at least cost.

A slow-down in economic growth, devaluation, a failure to reform WAPDA and raise tariffs, and a deteriorating fiscal situtation, prompted the Government in 1997 to attempt to lower IPP payments. In 1998 The Government issued seven Notices of Intent to Terminate –

[25] WAPDA, the Pakistan Water and Power Development Authority, was created in 1958 and is one of two vertically integrated state-owned electricity companies, the other being the Karachi Electricity Supply Corporation (KESC), which serves only Karachi and surrounding areas. Together, WAPDA and KESC transmit and distribute all power in Pakistan—over half to household consumers. See http://www.hubpower.com/n/about.html

actions "perceived by the developers as means to delay the completion of IPP projects[26] under the 1994 Policy and to extort tariff concessions given WAPDA's cashflow problems, political pressure not to increase retail tariffs, as well as the shortage of foreign exchange available in the country." (Fraser, 2005). In 1998 a tariff dispute with Hubco caused the suspension of all dividend payments for a three-year period until it was resolved in December 2001.[27]

Reforms of the state-owned companies continue, and WAPDA has recently been unbundled to "in an attempt to create a more competitive, market-oriented environment."[28] However, "Due to weak investor interest, KESC was not privatised as planned during 2002 and the process of unbundling WAPDA, although formally completed by December 2003, has not yet created the needed financial and managerial autonomy." (World Bank, 2004). WAPDA continues to control all financial flows in the sector, including practically all decisions on allocation of funds, while non-technical losses and subsidies remain. KESC was reported to be finally privatised by the *Daily Dawn* on 22 February 2005, although the deal fell through, and the cabinet then approved the sale of 73% to the second highest bidder, Hassan Associates.[29] The transfer was finally signed in November, 2005.

Investors appear to have responded positively to the Private Power Investment Board's announcement of three large power projects, "including a proposal from AES to develop a $1 billion coal project in Thar, and the announcement of increased investment to the tune of $1 billion from CDC Group's Globeleq, which already owns 50% of the Lahore-based Orient Power."[30] In addition, if the Government finds enough uninterruptible gas, Hubco may be allowed to build two gas-fired power generation plants (of 300 and 600MW) at Karachi. Shares in Hubco are locally traded, allowing the foreign investors to withdraw equity and invest in other power projects. Thus International Power had cut its holdings in HUBCO from 26% to 16% by May 2004 but recently acquired 40 per cent equity stake in the 586 MW Uch Power project, a 400MW dual-fired project to supply the textile industry in Faisalabad. Whether these positive responses will translate into further investments will in part depend on resolving the sector's chronic financial problems.

Bangladesh has also been successful in attracting foreign private investment in electricity generation. According to EIA "Given Bangladesh's electricity supply shortage, in 1996 the government issued the *Private Sector Power Generation Policy of Bangladesh* and began to solicit proposals from international companies for IPPs. Among the first IPPs were a 360-MW gas-fired combined-cycle plant at Haripur, which began operation in October 2001, and a 450-MW gas-fired combined-cycle plant at Meghnaghat, which began operation in November 2002. Both plants were sold to the British firm CDC Globeleq in December 2003.

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[26] WAPDA had an inherent incentive to delay the completion of projects since capacity payment obligations did not begin until a project achieved commercial operations

[27] A detailed chronology of Hubco's legal disputes is presented in Annex 2 of Fraser (2005).

[28] http://www.nytimes.com/ads/global/pakistan/three.html 18 October, 2005

[29] reported in *Khaleej Times*, 3 November 2005

[30] http://www.nytimes.com/ads/global/pakistan/three.html 18 October, 2005

India's Bharat Heavy Electricals Ltd. (BHEL) completed a 124-MW gas-fired Baghabari generating unit in November 2001." [31]

It is worth asking why Bangladesh (and to some extent Pakistan) appear to have been more successful than India in continuing to attract foreign private investment. The case of Bangladesh is particularly interesting as it was, according to Transparency International, the most corrupt country in the world in 2005.[32] The most obvious reason is that indigenous gas is cheap, and Bangladesh was lucky in attracting AES to invest. AES is a company noted for its enthusiasm to build power stations in risky parts of the world supported by PPAs with very reasonable terms. The combination of cheap gas, moderately cheap capacity charges and excess demand for power made the project attractive both to the investor and also to the Government. Unfortunately, AES's share price fell from a peak of $70 in 2000 to less than $2 in 2002, forcing asset sales, and making expensive foreign ventures both unattractive and infeasible. It is perhaps noteworthy that AES sold to CDC Globaleq,[33] which has a mission to help developing countries improve their power sectors, and may not be the best test of commercial willingness to invest in the depressed post-2000 power sector investor climate.

If Bangladesh has the advantage of cheap gas, then Pakistan, which appears to have some 33 years of reserves at current rates of consumption, also might expect to be attractive to gas-fired private generation investment, but reliable supplies of the required volumes appear to be problematic. It is hardly surprising that an oil-fired plant like Hubco (using expensive imported fuel) experienced difficulties over the tariff, although it is not clear to what extent the domestic cost of fuel oil is insulated from world oil price movements. Given that domestic consumers are still heavily subsidised, and non-technical losses remain high (T&D losses had only fallen from a high of 41% in 2002 to 38% in 2004, when KESC was to be privatised), one must be cautious in judging whether the apparent recent interest in private investment reflects confidence in the reform programme or reassurance that the model agreements will adequately protect investors. The fact that the army was called in to manage KESC in 1999 may indicate that there is more evidence of political commitment to reform than in India, although as noted above their arrival in 1999 did not noticeably improve KESC's performance .[34]

To summarise, private investors need confidence that the necessary contractual underpinnings (PPA, fuel purchase agreements, sovereign guarantees, etc) will be honoured,

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[31] http://www.eia.doe.gov/emeu/cabs/bangla.html

[32] India was ranked 88 out of 159 and Pakistan is ranked 144.

[33] The Commonwealth Development Corporation (CDC) was set up in 1948 as the UK Government's instrument for investing in the private sector in developing economies. In 2002, CDC launched Globeleq, an operating power company solely focused on the emerging markets of Africa, the Americas, and Asia.

[34] "Improvement of the availability and quality of power supply in Karachi is a priority for the GOP. To facilitate this, management control of the company (KESC) was handed to the army in 1999. The army management has made progress in a number of areas, such as reductions in commercial losses, decreases in accounts receivable and restructuring of the organisation aimed at increasing the quality of customer services and the profitability of the company." Quote from *The Dawn* Mianwali, April 9 http://www.tribuneindia.com/2005/20050410/world.htm .

that any legal disputes will be settled rapidly and fairly, with appeal to expeditious international arbitration, and that the underlying causes of disputes (inability of the counter-party, either the Single Buyer, SEB, or the distribution companies to pay because of inadequate revenue) will be sustainably addressed. Opening access to the national transmission grid is one obvious step to reduce reliance upon populist-swayed state governments and bankrupt SEBs, providing there is enough transmission capacity and a sensible way of pricing access and use, and providing large customers can secure reliable power as a result (which may require direct connection to the grid rather than to the local distribution network). The Indian *Electricity Act 2003* requires non-discriminatory open access in transmission and the adoption of multi-year tariff principles, while the creation of the Power Trading Corporation in 1999 is gradually increasing power exchanges between state utilities and private generators, reaching 4.2 TWh in 2002-3 (Singh, 2003). The five regional grids are interconnected with high voltage DC lines with a capacity of 5,000MW (4% of installed generation capacity) and inter-regional transfer capacity is 9,450 MW carrying 12 TWh. POWERGRID has plans to increase this to 37,150 MW by 2012.[35] If these principles are effectively implemented, they will go some way to improving a commercial approach to the sector, although reforming the distribution companies remains critical.

If anything, private involvement is far more important in the distribution sector than in generation, for without commercial distribution charging cost-reflective tariffs, the counter-parties to any power contracts will be financially weak and the PPAs will lack the credibility needed to attract private investment into generation. Reforming the distribution companies therefore has high priority. There is general agreement that sustained improvements will require privatisation, although preparing the companies or boards for privatisation requires considerable care, not least in ensuring adequate information (from metering, management budgetary systems, etc) is available to regulators and investors before final privatisation, to avoid costly mistakes and painful policy reversals (Ranganathan, 2005; Ruet, 2005a).

Alternative sources and uses of investment finance

Foreign private investment in power has a major advantage but one obvious disadvantage. The advantage is that it brings best practice in terms of contracting and efficiency (both in construction and operation) that puts pressure on the country's electricity supply industry to shape up, make necessary reforms, and establish sensible regulatory bodies and tariff-setting practice. The model agreements proposed by Pakistan,[36] and insurance against opportunistic tax and legal changes, may provide a good model, but will have to be supported by evidence of enforcement. There is ample evidence from elsewhere that private ownership delivers more efficient construction and operation than state-ownership. The disadvantage is that the

[35] http://www.cea.nic.in/nep/nep-transmission.htm published in July 2005

[36] This requires PPAs that reward capacity availability and pass through energy costs at a specified energy efficiency to encourage efficiency operation, to give sensible average and marginal cost signals to the dispatch centre.

cost of finance is likely to be high, as sovereign and regulatory risk are perceived as high. If a larger fraction of the finance could come from low cost debt finance (supplied either by the Government through its state banks or IFIs, with suitable exchange rate guarantees), then the overall cost of finance will fall (although the equity component is still likely to be costly, its share may be low enough to reduce the overall cost).

Some South Asian Governments have now accumulated considerable foreign exchange reserves that allow both increased domestic lending and foreign exchange rate guarantees, although it still ought to be preferable to agree conditions under which IFI finance becomes available, as this is likely to give better signals to the private investment community. Clearly, the lending by India to Bhutan to finance dams (discussed below) suggests that public funds can be used effectively, and for high capital cost low running cost projects such as dams and transmission, cheap finance can be critical to economic success.

The central problem in making use of this cheaper finance is that unless the distribution companies are reformed to become commercial and regulated to set (and collect) cost-reflective tariffs the revenue flows even to service cheaper debt will be lacking. If capital (including the revalued modern equivalent asset value of existing plant) earns a sensible return (8-10% real) then the electricity supply industry would become largely self-financing at current demand growth rates (from table 1 of 7-10%). If power were sensibly priced, then excess demand might rapidly disappear, providing the time and resources to improve maintenance and availability, further reducing costly load shedding. The paradox is that without reforming distribution (which will eventually require privatisation to sustain the reforms) private investment in generation may fail, and with effective reform in distribution and a more intelligent approach to losses, private finance in generation may not be necessary (although good practice management and operations still argue for private ownership or at least management).[37]

Ruet (2005b) has demonstrated most effectively that finance should not be a constraint by comparing the profitability of investing in new generation capacity (and the associated transmission) in India, with alternatives. He estimates that eliminating non-technical losses at 2002 tariff levels would give an internal rate of return (IRR) of 339%, compared with new generation yielding 8.6%, although increasing the plant load factor (PLF) from 67% to 70% would reduce the amount of new capacity required and would deliver an IRR on the total investment needed of 13.4%. Just investing in refurbishment and maintenance to raise the PLF alone yields 116% return, while investing in better transmission and distribution to reduce technical losses yields 27% return. The implication is that much can be done to bridge the supply-demand gap with less finance than just building more generation capacity. If existing resources can be reallocated to reduce various losses then considerable extra cash flow would be generated to expand the system when needed, but this will require a radical change in management culture in the SEBs.

The role of energy trade

[37] The case for privatisation has been recently summarised by Kikeri and Nellis (2004).

The Agreement on the South Asian Free Trade Area was signed on 6 January 2004 to enter into force on 1 January 2006. However, progress seems somewhat troubled as Bangladesh on 8 August 2005 "once again outright rejected an Indian proposal for signing Free Trade Agreement (FTA) with her, urging the counterpart to sign the proposed South Asia Free Trade Agreement (SAFTA) for boosting the regional trade and commerce."[38] Counterbalancing this, on 15 August 2005, the *Indian Express* announced plans for promoting trade between India and Pakistan via a free trade area in Kashmir. "In a radical proposal to end the current Indo-Pak conflict over water resources of J&K (Jammu and Kashmir), Burki is calling for joint development of the power potential of the Indus waters that run through the state. Instead of separately developing hydel power in their own parts of J&K and raising suspicions across the border, Burki proposes joint generation of hydel power for use in both parts of J&K and selling the surplus to northern Pakistan and India through a common electric grid. Such an approach, according to Burki, does not involve either a renegotiation of the Indus Waters Treaty or a reduction of water flows to either India or Pakistan. It needs a mutually satisfactory reinterpretation of the Treaty and negotiating a sub-regional agreement on hydel power generation and distribution."[39]

The potential for mutually advantageous energy trade in South Asia is considerable. India is short of indigenous gas and is actively importing expensive LNG. Bangladesh has substantial reserves estimated by the *Oil and Gas Journal* in 2005 at 10.6 trillion cubic feet (Tcf) and net proven reserves estimated by Petrobangla in 2004 at 15.3 Tcf, compared with a 2003 production (and consumption) of 420.2 billion cubic feet (Bcf). At that rate based on Petrabangla's estimate, reserves would last 36 years, although if demand grows at a projected 6% p.a. the reserves would only last 19 years. In addition to proven reserves, the US Geological Survey has estimated that Bangladesh contains 32.1 Tcf of additional "undiscovered reserves," which would increase the ratio of reserves to use to over 100 years or nearly 50 years at a growth rate of 6%.[40] On the other hand, Bangladesh has been suffering from gas shortages, despite these abundant gas reserves. The immediate cause is a combination of underpricing, poor collection rates and theft, which have created serious financial shortfalls, and hence an inability to finance the required maintenance and investment. The deeper cause is poor management and extensive political interference in tariff setting and reform efforts. The fundamental problem is one of pervasive corruption, in turn sustained by a lack of political accountability.

Bangladesh is short of foreign exchange and government revenue, both of which would be significantly enhanced by exporting gas to India, ideally by pipeline to the Delhi area where electricity demand is high (in comparison to the adequate supply of coal-fired generation near the India-Bangladesh border).[41] Finding an outlet for exported gas priced in foreign exchange would encourage more gas exploration and development. It is therefore particularly perverse that both major political parties are officially committed to reserving gas for domestic use until

[38] http://www.bilaterals.org/recherche.php3?recherche=SAFTA
[39] http://www.bilaterals.org/article.php3?id_article=2487&var_recherche=SAFTA
[40] http://www.eia.doe.gov/emeu/cabs/bangla.html
[41] It is cheaper to move gas than transmit electricity, hence the preference for a pipeline.

"proven reserves will cover 50 years of domestic demand". [42] One confidence-enhancing step might be to allow transit gas from Burma to India via Bangladesh, and this is under discussion.

The case for a South Asia Energy Charter

Energy trade requires costly infrastructure that can be stranded without continuing co-operation, so the case for some legally binding treaty underwriting assurances on continued co-operation is strong. The European Energy Charter signed on 17 December 1991 might form a useful model to promote such trade. The 51 signatories agreed to co-operate under a legally binding Energy Charter Treaty "designed to promote east-west industrial co-operation by providing legal safeguards in areas such as investment, transit and trade." [43] The proposed gas pipeline from Burma to India might encourage the signing of an Energy Charter and if Bangladesh believed that Burmese gas could supplement domestic gas in future if local supplies proved inadequate, then the deadlock over Bangladesh gas exports might be broken.

Similarly, India would then have access to two additional sources of gas (although both coming through Bangladesh) and would feel greater security of supply. A similar transit proposal to deliver gas from Iran through Pakistan to India would have the additional advantage of securing additional gas to meet Pakistan's rapid growth in demand for power generation, although again mistrust between the two countries (and US hostility to trade with Iran) have hampered progress. Again an Energy Charter guaranteeing security of transit might break the deadlock. According to the EIA, Pakistan could earn $600 million p.a. in transit fees from this $3 billion project.[44]

Apart from the obvious benefit that India should enjoy cheaper additional supplies of gas than from LNG imports and more diverse and thus more secure sources of supply, there are further benefits from the kinds of agreements, treaties and contracts needed to underwrite gas imports. Most obviously (and this is also a potential benefit from LNG imports) the gas would be priced in foreign exchange at market levels, and would provide pressure to set fuel and electricity prices at market levels. Second, and perhaps more important in the longer run, it ought to encourage a more commercial approach to contracts in the energy industries, and that would provide the kind of comfort that foreign private investors seek. That in turn should lower the cost of capital, which in capital-intensive industries such as electricity, feeds straight through to consumer (and creditor) benefits. Third, gas (particularly pipeline gas) has lower CO_2 emissions per unit of electricity generated than coal or oil. At some stage this will have a cash benefit when emissions trading is extended more widely. Finally, creating a regional gas market with proper pricing would encourage private investors to develop indigenous gas fields, and might eventually lead to gas-on-gas competition (as occurred in the US and Britain) to mutual benefit.

[42] http://www.eia.doe.gov/emeu/cabs/bangla.html
[43] http://europa.eu.int/scadplus/printversion/en/lvb/l27028.htm
[44] http://www.eia.doe.gov/emeu/cabs/pakistan.html

The other major potential source of mutually beneficial trade relates to the more efficient exploitation of hydro resources, particularly in Nepal and Bhutan, where domestic electricity demand may be inadequate to justify large dams, but where exporting electricity to India would earn valuable foreign exchange and relieve India's power shortages in a zero-emissions way. Nepal has large untapped hydro potential, estimated by EIA at 43,000 MW (of which 244 MW has been developed).[45] Promisingly (at least from the viewpoint of regional energy co-operation),[46] in October 2002 "Australia's Snowy Mountains Hydro (SMEC) signed a memorandum of understanding (MOU) for the development of the 750-MW West Seti hydroelectric dam. It is scheduled for completion in 2005 and will export power primarily to India. Renewable power sources are increasing in Nepal through rural electrification programs which aim to lessen the disparity in electricity access between rural (30%) and urban (90%) areas. The overall quality of Nepal's electricity infrastructure, however, is low and is frequently a target for attack by Maoist rebels."[47] In 2003, Nepal's industrial sector was reported as losing $25 million annually, 4.4% of its gross output value. If hydropower were developed for export, the annual contribution to GDP could rise from $96 million in the early years up to $1.51 billion by 2027. By 2010 royalty earnings at 10% of electricity sales would yield $46 million p.a. and rising (USAID, n.d.).

Bhutan's hydropower potential is estimated by EIA at 30,000 MW (of which 16,000 MW are safe and exploitable). Bhutan and India have been actively co-operating in its exploitation since the signing of the Jaldhaka agreement in 1961, and hydro-electric exports are the largest single source of foreign exchange, demonstrating the value of such regional co-operation. According to *Bhutan News Online*,[48] "the Chukha Hydro Power Corporation (CHPC) has been earning more than 40 percent of the national (Government) revenue of Bhutan." Exports in 1995-6 were 1,564 GWh, and are projected to rise to 6,400 GWh in 2006 when the 1020 MW run-of-river Tala Hydroelectric Project Authority (THPA) is commissioned. "India's Tata Power Company and the Power Grid Corporation of India Ltd. have formed a partnership to construct the 1,020-MW Tala hydropower project in Bhutan and a 750-mile transmission line to export power produced by the Tala project to New Delhi and surrounding areas of India."[49]

Clearly it would be desirable to develop a regional electricity grid connecting India, Bhutan, Nepal and Bangladesh, to increase security, allow profitable exports from land-locked countries, and further build confidence in regional energy trade and investment. The Bhutan example shows what can be achieved, although the political obstacles remain

[45] http://www.dams.org/kbase/submissions/showsub.php?rec=opt024

[46] As always, large dams attract considerable criticism, and there are particular concerns that a high (195m) rock-filled dam might be unsafe in such a geologically active area. See http://www.nepalnews.com.np/contents/englishweekly/spotlight/2004/dec/dec31/opinion.htm and http://www.dams.org/kbase/submissions/showsub.php?rec=soc031

[47] http://www.eia.doe.gov/emeu/cabs/nepal.html

[48] http://www.bhutannewsonline.com/hydro_electricity.html

[49] http://www.eia.doe.gov/emeu/cabs/nepal.html

significant. The USAID (n.d.) study reports estimates of the benefits of a regional grid in reducing power losses by 90 MW (sic), saving $79 million in investment.

Conclusions

South Asia started the 1990s with growing disillusionment with the existing inefficient and bankrupt state-owned vertically integrated electricity supply industry and strong internal and external pressure to reform the sector. The incompletely understood diagnosis was to encourage private investment to overcome the lack of finance for the investment needed to address shortages and power cuts. The simplest route appeared to be to allow IPPs to sell power under PPAs to the largely unreformed SEBs. Buying increasing amounts of higher cost power when these SEBs could not even cover the cost of under-priced wholesale electricity from state-owned generators was a recipe for financial distress and conflict. Reforming the SEBs, though unbundling, creating commercial disciplines in retailing electricity, and subjecting the sector to multi-annual regulation insulated from clientalist political pressures, is therefore an essential first step, although one that was bound to be keenly resisted by current beneficiaries. When this has been successfully completed, privatisation is the logical next step to ensure that the reforms are sustainable (Ranganathan, 2005, Ruet, 2005a). With commercially viable privatised distribution companies successfully operating under multi-annual cost-reflective tariffs, the way is open for more sustainable private investment in generation.

In India the central Government appears to have relatively few effective levers with which to reform the SEBs, although the *Electricity Act 2003* has good intentions, particularly in requiring metering, multi-annual regulation and requiring regulated third party access to large customers through the national transmission grid. Elsewhere central governments may have more control and may even use that wisely to press for effective reform, although progress appears to be slower than expected.

Perhaps the main leadership role that governments in the region could contribute would be to agree and enforce a regional energy charter to underwrite increased energy trade. Such steps have been effective in integrating the transition countries of Central Europe into the European Union, and stimulating FDI into the power sector, and might have similarly stimulative effects in South Asia, quite apart from creating profitable trade opportunities and increasing regional security of supply and greater resilience against external oil shocks. Opening access to industrial customers would help assure the financial viability of investments in cross-border infrastructure.

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Appendix: Data and analysis of energy supply and demand

Table 2. Energy Supply Indicators—South Asian Countries

	Fossil Fuel Proved Reserves			Fossil Fuel Production			Electric Generating Capacity (Million kilowatts)	Crude Oil Refining Capacity, (Thousand barrels per day)
	Crude Oil, (Million barrels)	Dry Natural Gas, (Trillion cubic feet)	Coal, (Billion short tons)	Petroleum* (Thousand barrels per day)	Dry Natural Gas (Trillion cubic feet)	Coal, (Million short tons)		
Bangladesh	56.0	10.6	0	5.0	.38	0	3.6	33
Bhutan	0	0	0	0	0	0.06	0.4	0
India	5,371.2	30.1	93.0	661.8	.88	392.6	120.3	2,135
Maldives	0	0	0	0	0	0.01	0.03	0
Nepal	0	0	0	0	0	0.01	0.4	0
Pakistan	288.7	26.8	2.5	60.9	.81	3.7	18.0	269
Sri Lanka	0	0	0	0	0	0	2.1	48
Total	5,715.9	67.5	95.5	727.7	2.07	396.4	144.8	2,485

** Includes crude oil, natural gas plant liquids, other liquids, and refinery processing gain.*
Sources: Crude Oil and Natural Gas Reserves: PennWell Publishing Co., Oil & Gas Journal, 12/22/03. Crude Oil Refining Capacity: PennWell Publishing Co., Oil & Gas Journal, 12/22/03. All Other Data: Energy Information Administration, International Energy Database, October 2004. Source: http://www.eia.doe.gov/emeu/cabs/nepal.html

The relationship between electricity consumption and GDP

Figure A1 shows the scatter plot of the 3-year average values of per capita annual electricity consumption against the corresponding 3-year average values of per capita GPD at constant 1995 $US, plotted on a double log scale, together with the regression line of best linear fit and the evolution of the annual per capita annual electricity consumption against the corresponding annual values of per capita GPD (US$1995) for selected S Asian countries, China and the USA. The value of R^2 is 0.8 and the slope coefficient is 0.98(s.e. = 0.03), not significantly different from 1, so that the income elasticity of demand for electricity is unity. The quadratic regression shown has a slightly higher R^2 of 0.81 and both GDPpc and GDPpc squared terms are significant at the 1% level, but if anything this regression line suggests that India and Pakistan are even more electricity intensive than might be expected.

Figure A2 repeats the exercise but using Real or PPP GDP per capita from the Penn World Tables which gives a slightly better fit (R^2 = 0.85) but a considerably higher PPP income elasticity of 1.63 (s.e. = 0.04), reflecting the higher ratios of Real to market GDP at lower income levels. The quadratic terms are not significant. The obvious reason for the higher elasticity is given by noting that a regression of ln(RGDP) on ln($GDP) has a coefficient of 0.6, i.e. ln(RGDP) = 3.84 + 0.6*ln($GDP), or $Y/L = (R/L)^{1.66}$ explaining the higher PPP elasticity exactly. The regression results are used to predicted S Asia consumption in Figure 2.

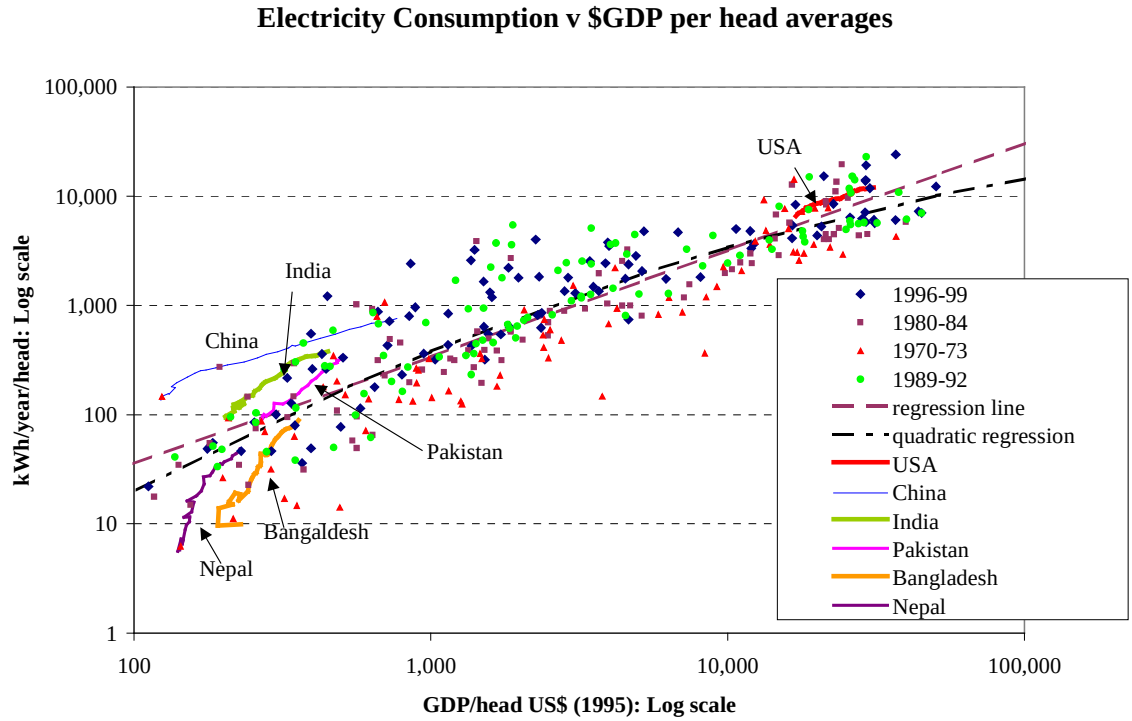

Figure A1 Electricity demand as a function of US$ GDP/head

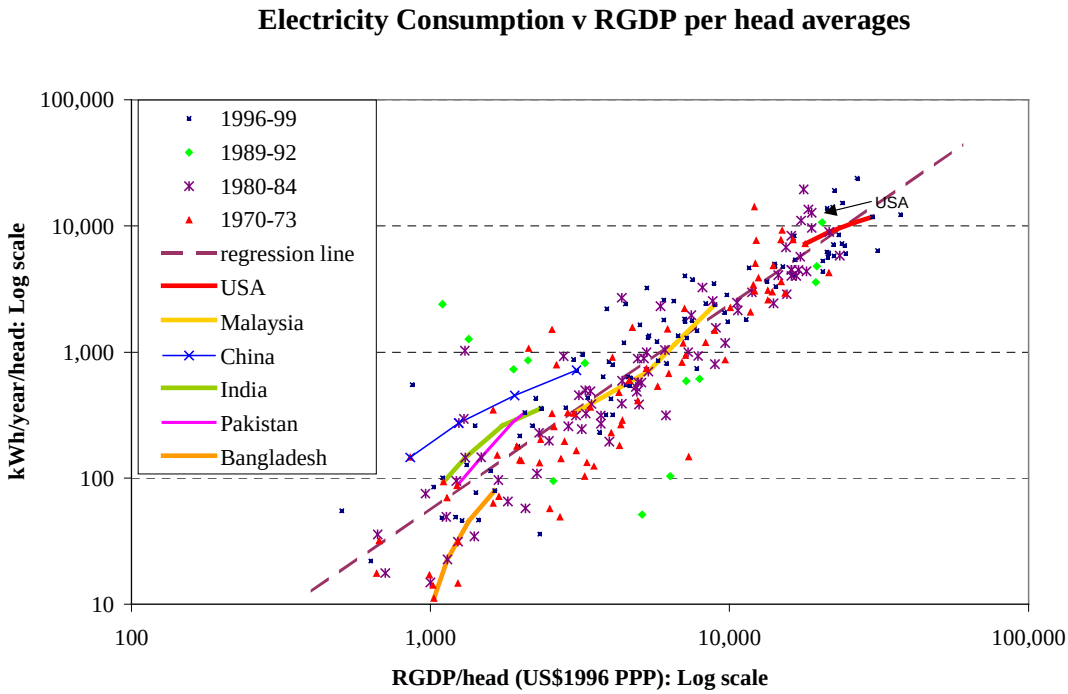

Figure A2 Electricity demand as a function of Real GDP/head

Figure A3 shows the importance of price in influencing electricity demand. The cross country partial regression has R^2 = 0.9 and a price elasticity of –1.2 (s.e. = 0.11). Figure A4 shows that this relationship continues to hold for non-industrial consumption (R^2 = 0.83, and a price elasticity of –1.04, s.e. = 0.15).

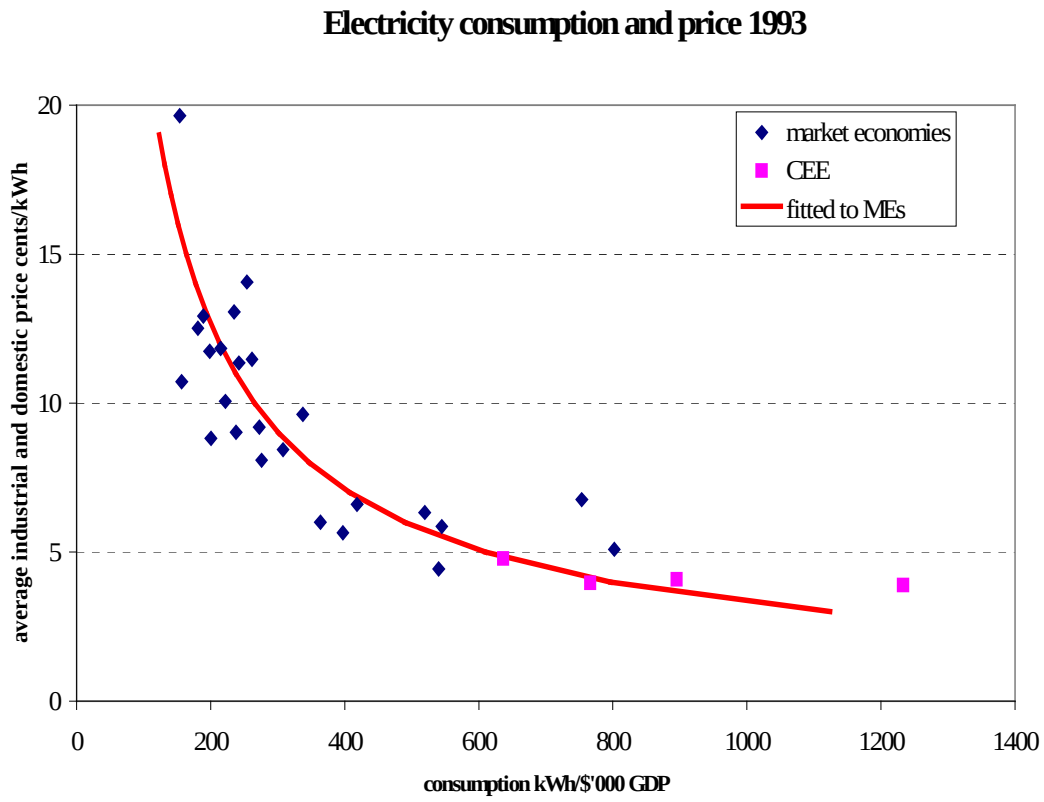

Figure A3 The relationship between price and electricity consumption for developed market economies and transitional countries

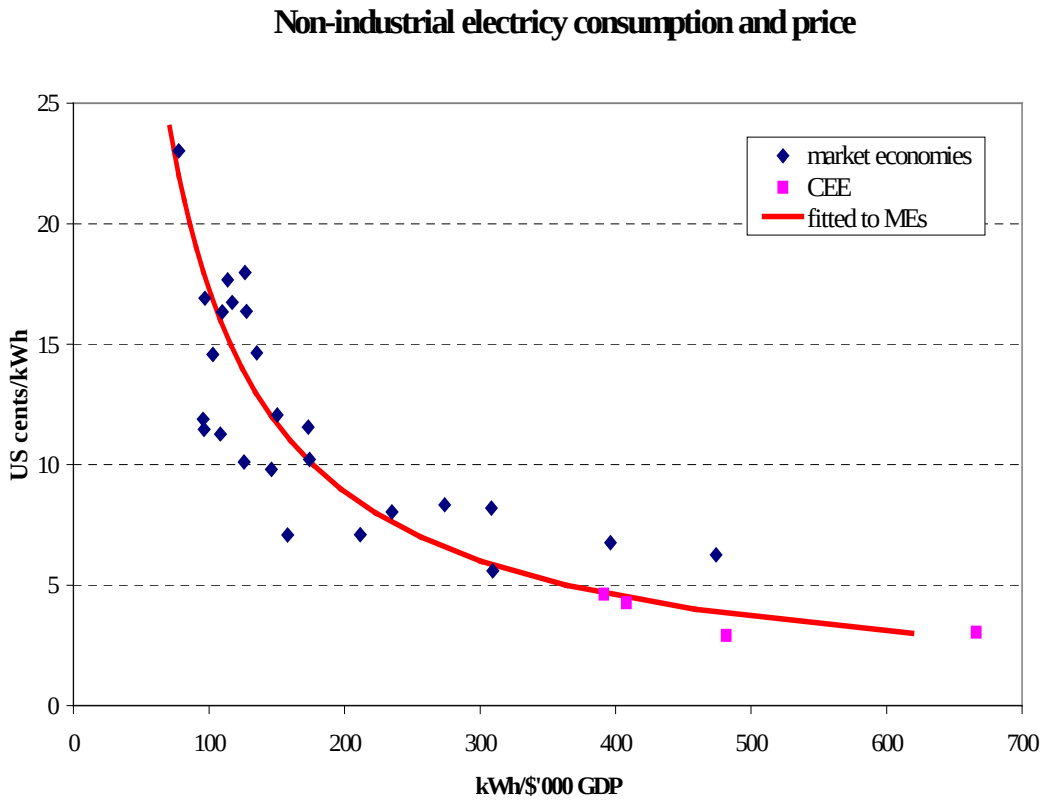

Figure A4 The relationship between non-industial electricity consumption and price

Good electricity price data is not readily available but if effective retail prices should be raised by 50% to address losses and under-pricing of wholesale power, then demand might (eventually) fall by about 50%, and would return India and Pakistan to the regression line in figure A1.

Note that both Bangladesh and Nepal fall considerably below either regression line, even though there is no reason to believe that pricing is higher in those countries than in India and Pakistan. The obvious explanation is that electricity penetration is considerably lower than in those two countries, and the movement towards the regression line probably reflects increasing coverage of the population.