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The Effects of Power Sector Reform on Energy Services for the Poor

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Note

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ABBREVIATIONS

AC	**ALTERNATING CURRENT**
BEA	**BUREAU OF ECONOMIC ANALYSIS**
BHEL	**BHARAT HEAVY ELECTRICALS, LTD.**
BPA	**BONNEVILLE POWER ADMINISTRATION**
CESC	**CALCUTTA ELECTRIC SUPPLY CORPORATION**
CFE	**COMISION FEDERAL DE ELEKTRICIDAD**
CO_2	**CARBON DIOXIDE**
CRE	**COMISION REGULADORA DE ENERGIA**
GDP	**GROSS DOMESTIC PRODUCT**
DOC	**U.S. DEPARTMENT OF COMMERCE**
DRC	**DEVELOPMENT RESEARCH CENTER**
EIA	**ENERGY INFORMATION ADMINISTRATION**
EJ	**EXAJOULE, 10^{18} JOULES**
EPRI	**ELECTRIC POWER RESEARCH INSTITUTE**
ESKOM	**ELECTRICITY UTILITY OF SOUTH AFRICA**
ESMAP	**ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAM**
FAO	**FOOD AND AGRICULTURE ORGANIZATION**
GWH	**GIGAWATT HOUR, 10^9 WATT HOUR**
IEA	**INTERNATIONAL ENERGY AGENCY**
IIASA ANALYSIS	**INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS**
IPCC	**INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE**
IPPS	**INDEPENDENT POWER PRODUCERS**
KM	**KILOMETRES**

LFC	**LUZ Y FUERZA DEL CENTRO**
MDGS	**MILLENNIUM DEVELOPMENT GOALS**
MIT	**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**
MW	**MEGAWATT, 10^6 WATT**
NO_X	**OXIDES OF NITROGEN**
PEMEX	**PETRÓLEOS MEXICANOS'**
PFC	**POWER FINANCE CORPORATION**
PPAS	**POWER PURCHASE AGREEMENTS**
PPP	**PURCHASING POWER PARITY**
PRI	**PARTIDO REVOLUCIONARIO INSTITUCIONAL**
REC	**RURAL ELECTRIFICATION CORPORATION**
R^2	**COEFFICIENT OF DETERMINATION**
SEBS	**STATE ELECTRICITY BOARDS**
SOES	**STATE-OWNED ENTERPRISES**
SPC	**STATE POWER CORPORATION**
TVA	**TENNESSEE VALLEY AUTHORITY**
TVES	**TOWNSHIP AND VILLAGE ENTERPRISES**
USAID	**U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT**
WB	**WORLD BANK**
WEC	**WORLD ENERGY COUNCIL**
WRI	**WORLD RESOURCES INSTITUTE**
WSSD	**WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT**

EXECUTIVE SUMMARY

In the effort to combat extreme poverty and improve human welfare, in recent decades policy makers have adopted a variety of measures to provide electricity and other modern energy services to low-income households. By subsidizing access to and consumption of electric services, policy makers have attempted to remove impediments to economic growth and allow households to devote scarce income to other purchases. Policy makers have also hoped that programs to provide electricity could help to cut indoor air pollution, fires, poisonings and other hazards commonly associated with some of the fuels that electricity often replaces.

The actual record of these programs is mixed, but it is unmistakable that electricity plays a crucial role in economic modernization. For some particular energy services, such as the powering of radios, television, lighting, cellphone chargers, and refrigeration, electricity has few if any rivals. Broadly, consumption of electricity is correlated closely with economic development. To the extent that electric consumption *causes* economic development, successful electrification programs could play important roles in catalyzing broader development.

The Millennium Development Goals (MDGs) have refocused attention on the need to identify and implement effective development policies. While there are no MDGs specific to electricity and energy, in practice electricity is intimately related to nearly every aspect of human development.

In parallel with this growing attention to the role of electric services in development, over the last two decades many countries have also sought to reform their electric power systems. Triggered by investment crises and by concern that the state-owned enterprises (SOEs) that have traditionally dominated the power sector in most countries were wasteful and inefficient, these reformers have sought to introduce the discipline of market forces. While the exact plan followed has varied widely, most reformers have been guided by a standard "textbook" for reform. They have attempted to unbundled the integrated SOEs into separate companies that generate, transmit and distribute electricity; they have sought to privatize these unbundled firms; and finally they have aimed to introduce market competition where possible. In addition to these structural reforms, they have also established new institutions, notably independent regulators vested with the authority to oversee these new markets.

This report examines the connections, if any, between the efforts to enhance development through electrification of the world's poorest households with the parallel efforts to introduce market forces in the power sector. Advocates for equitable economic development have rightly signaled many concerns about the process of electricity reform. Their fears range from the higher prices that often accompany reform to the concern that private firms motivated for profits will not have an incentive to provide public services. Some of these fears have been articulated by implying the existence of a "golden era" when state owned firms dominated the power sector and provided energy services equitably across societies; in fact, that golden era never existed in most countries. Public utilities traditionally have been highly politicized; in many countries they have concentrated their services on urban elites and often neglected the poorest populations.

The report finds no inherent connection between the promotion of improved welfare for the poorest households and the reforming of energy markets. It finds that while electricity and development are correlated, detailed studies have not clearly separated cause and effect. Insofar as policy makers invest in electrification programs for the purpose of promoting economic development, in fact there is not yet a robust theory and practice to identify when such strategies are a superior investment when compared with the alternative development strategies. The report also finds that, in practice, very few countries have actually implemented substantial reforms of their power sectors. Rather than the "textbook" model of reform, they have implemented a variety of half measures that have left SOEs in dominant roles with private firms operating at the margins. These "reforms" have not much altered the industrial organization of the electric power sector. Given these two weak signals—the ambiguous link between overt electrification and development, and the lack of much real reform in developing country power markets—it is not surprising that the reform processes observed so far have not had much effect on the welfare of the poorest households.

Critics of power sector reform have particularly focused on the price of power and sounded alarm that higher prices will disadvantage the poor. This study suggests that much of the increase in power prices that often coincides with reform is rooted in other factors and is not inherent to market-based organization in the power sector. Rising prices often reflects efforts to undo the historical practice of under-charging for electric services—a practice that has bankrupted electric supply organizations (whether state controlled or privately owned) and led to severe misallocations of capital and excessive use of electricity. Such drains on public finances and the misallocation of resources are often the main driving forces for market reforms—they create such a thicket of troubles that market reforms are seen as the only way to impose a sense of fiscal discipline and financial solvency. Rising prices also often reflect the end of an era, evident worldwide, in which the cost of building and operating power plants has been declining steadily. In most countries, new power supplies are more costly than the old plants that dominated power systems until the late 1980s. These two factors are probably, in most settings, much more important than the impact of markets per se.

Where market disciplines do exist, public service programs have not disappeared. The study focuses on two reasons for this. First, in a few cases, market reforms have led to significant improvements in the financial solvency of firms in the sector; those cases are few, perhaps, because market reforms have not advanced far in most countries. Healthier firms have generally provided improved power quality, shorter waiting times, and had the resources needed to conduct public service programs with vigor. Second, every country examined in this study has included public service obligations alongside its market reforms. Programs that used to be conducted by SOEs as arms of the government have been shifted to the government itself. The cost of these programs was previously buried inside the fiscal accounts of the SOEs; reformers have made them more explicit, often with the creation of overt government subsidies. Special rules have been devised to create incentives for private firms to provide some of the public services that the SOEs used to deliver. Private distributors, for example, have been required to provide electric services at concessionary rates within their service area. In general, the fear that private firms would shirk public service obligations has not been realized because independent regulators, established as part of the power sector reforms, have exercised their mandate to ensure that public service obligations are actually met.

The study includes a review of the literature on the links between energy services and development and a detailed overview of the process of market-oriented reform in the power sector. It examines the issues generally and includes more in-depth analysis of the reforms in Argentina, Brazil, Chile, China, India, Kenya, Malaysia, Mexico, The Philippines, and Senegal.

I. INTRODUCTION

At the 2002 World Summit on Sustainable Development (WSSD) the members of the United Nations reaffirmed the "Millennium Development Goals (MDGs)," which are the UN system's guide the elimination of poverty and the improvement of the human condition over the coming decade. While the achievement of these goals depends on progress in many areas, improvements in essential infrastructure services such as water, sanitation and energy will aid the attainment of most MDGs. This report focuses on electricity, which has played a central role in modern economic development. Electricity carries energy for pumping water in agriculture, refrigerating vaccines, illumination at night, and sundry other services essential to human welfare, particularly for the poorest populations. For a growing array of services—such as providing power for cellphones, computer servers, and television—electricity is unique in its properties. Electricity is a clean energy carrier and thus can play a role in helping to reduce the pollution that arises indoors and outside as dirty energy sources are burned for power. The WSSD never adopted any MDGs explicit to energy and electricity, but electricity is pervasive in the global project to achieve the MDGs.

About 1.6 billion people (one quarter of the global population) presently have no access to electricity. Although that number has declined in absolute value and also as a fraction of the world's population since 1970, by 2030 it is expected that 1.4 billion people will still lack electricity (IEA, 2002). Even the very poor who have access to electricity tend to use other (less costly) energy forms for the bulk of their energy needs; electricity, which is costly, is reserved only for those applications for which electrons have no substitutes. Indeed, some 2.4 billion people rely on traditional biomass—such as crop residues, dung and firewood—for cooking and heating. Indicators of rudimentary energy services—such as lack of access to electricity and reliance upon traditional fuels—correlate closely with most measures of poverty. At present, most of the people without electricity live in rural areas in developing countries where the challenges of economic development remain particularly severe (notably in South Asia and sub-Saharan Africa).

At the same time that governments have redoubled their awareness of the critical roles that electric services can play in promoting human development, many countries have attempted substantial reforms in how they organize their electric power sector. In general, these countries have attempted to shift from a state-dominated power system, financed by state funds, to one where the role of private ownership and market forces play a larger role (Victor and Heller, eds., 2006; World Bank, 2002b; Rufin et al., 2003). This shift to markets has raised many concerns about whether firms responding to market signals will also adequately supply services for the poor (e.g., Dubash, 2002a; Powell and Starks, 2000; Goldemberg et al., 2004; Clark et al., 2005).

Under the old state-dominated system, many governments created special tariffs that subsidized low-income households; governments also directed state enterprises to provide energy services for poor households. Perhaps, some analysts have worried, such arrangements will be more difficult to sustain when private firms and market forces dominate the power sector. Under the state system, the state's monopoly on capital and investment allowed for the provision of services that would be risky or unprofitable for

private companies to supply—for example, by building costly extensions of the grid to poor rural areas. And the transition to markets has, in many countries, required raising user tariffs so that they better reflect the real cost of supplying new electric services; such increases can be unaffordable and disruptive to those, including the very poor, who have become accustomed to cheap power. Many of the world's poorest operate through informal arrangements such as barter rather than cash that could make it additionally difficult for these populations to obtain electric services that are supplied by private companies that require formal incomes (e.g., USAID, 2004).

This essay examines the linkages between power sector reform and the provision of electric services for the poorest segments of the population. We begin with a review of the context in which this question arises—namely, the critical role of electricity in development and the industrial organization of the power sector. Then we examine the practice of power sector reform in developing countries. Finally, we examine the impact of power sector reform on the actual provision of electric services.

The argument in this report is that there is no simple relationship between power sector reform and energy services for the world's poor. Many of the supposed harms of power sector reform are, in fact, byproducts of other forces at work. For example, the rise in tariffs that usually accompanies power sector reform in developing countries is often, fundamentally, a reflection of the historical practice in state-dominated systems to under-charge for their services. Reform makes transparent the extent of that subsidy. In some countries, the financial distress on utilities caused by excessively low tariffs is what triggers the need for reform in the first place (Victor and Heller, eds., 2006). In some countries that financial distress has undermined efforts to provide energy services for low-income households (e.g., Powell and Starks, 2000).

One observation suffuses this report: there is no inherent conflict between exposing power systems market forces and supplying energy services (even on a concessionary basis) to help catalyze economic development. The analysis here suggests three particular implications for policy.

First, the policy instruments that governments use to advance energy services for the poor will change as governments restructure the power sector, and governments must be prepared to embrace these new policy instruments alongside market reforms. For example, in state-dominated power systems the government has advanced policy by directly controlling the supply of capital and the management of state enterprises; in a market-oriented system, if government seeks some outcome other than the one supplied by the market it will need to adopt special market correction measures, such as overt subsidies or income transfers to the poor. These new policies are often politically difficult to adopt precisely for the reasons they are often attractive to reformers: they impose transparency and accountability. In this report we review the wide array of policies that governments have adopted with the goal of benefiting the poorest segments of the population.

Second, the process of transition to a greater role for markets has not actually advanced far in most countries. Creating the institutional context needed for the

proper functioning of a market—including competitive sources of capital, the closing of "soft" budget constraints that allow state enterprises to operate without true financial discipline, legal institutions for the enforcement of contracts, and sundry other arrangements such as truly independent regulators—are difficult for most governments. Compounding these difficulties is the fact that power sector reform is often initiated in the context of crisis—when the lights are already flickering, capital is not readily at hand for expanding power systems, and governments have few options. This context for reform may help to explain why so many governments appear to have inadequate plans for sustaining and expanding service in low-income areas while simultaneously reforming the power sector.

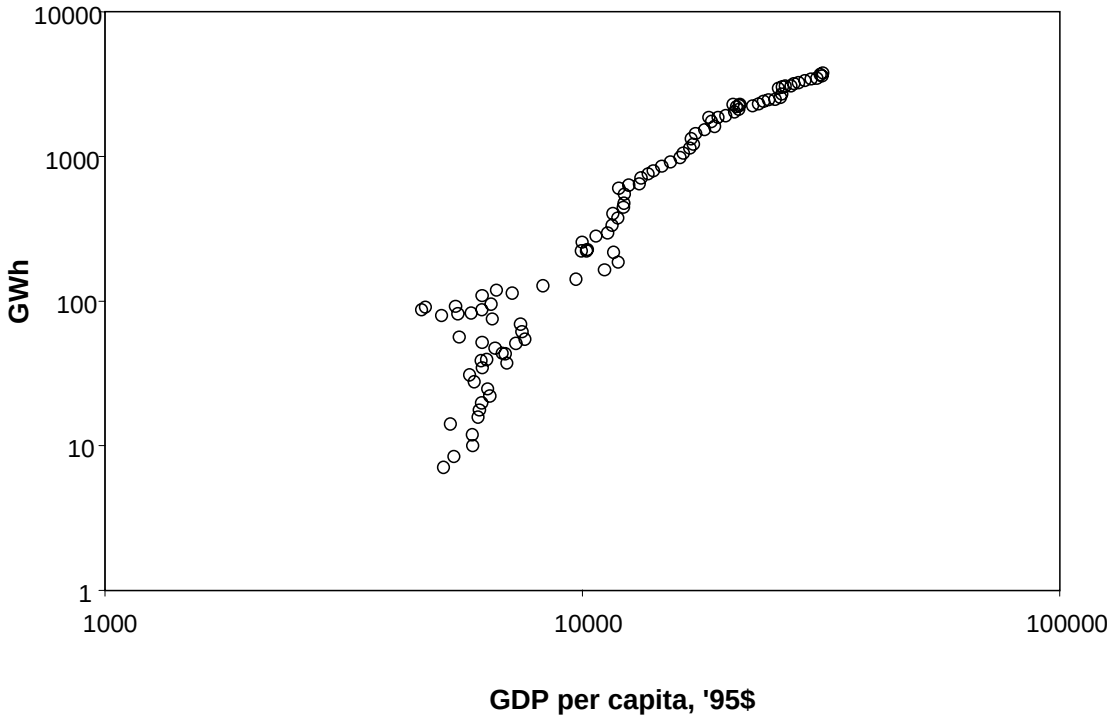
Third, insofar as governments are pursuing policies that promote electric services for the poor as a strategy for accelerating development, it is important to compare such the cost of such policies with alternative development strategies such as investing in female literacy or health programs. It does not appear that such policy comparisons are actually conducted in a rigorous fashion, and thus it is unclear how well electrification stands as a development strategy.

II. CONTEXT: ELECTRICITY AND ITS INDUSTRIAL ORGANIZATION

A. The relationship between electric services and economic growth

There is no simple relationship between electric services and economic growth and the improvement of human welfare. The relationship between electricity consumption and the size of the economy is tight—as shown in data over time (figure 1, for the United States over time) and across countries (figure 2, for nearly all countries today).

Figure 1. USA Electricity Net Generation versus GDP per capita, 1902-2000 in logarithmic scale. Data Source: Mitchell (1998), EIA (2004).



In general, as the economy grows power consumption also rises, but studies that have looked beyond correlation at the causal linkage between electricity and economic output have not yielded crisp conclusions. In figure 2, for example, it is clear that economies with relatively low output have demonstrated a wide dispersion in their consumption of power because their economic strategies vary enormously. Countries that rely on heavy industry—especially electric-intensive industries such as aluminum and other metals production—can demonstrate high electric requirements even if the average income of the population is low (e.g., China , Brazil, Venezuela, India and former communist-bloc countries). Similarly, countries with concentrated and wealthy populations that rely heavily on services can yield high economic output even though the electric power consumed within their borders is relatively low (e.g., Luxembourg). International trade in goods and services that embody these different amounts of electricity equalizes the differences; however, there are no reliable data on the electricity embodied in traded products and services.

Nearly all experts envision that the role of electric services will continue to expand. Historically, at low levels of economic development nearly all primary energy (e.g., biomass, coal, oil and natural gas) is consumed directly for energy. With development, economies usually become more dependent on energy carriers—mainly electricity—to "carry" the energy in clean and flexible form from the point where primary energy burned (i.e., the power plant) to the final user. Figure 3 shows this pattern for the U.S., for which the historical data are unusually good and thus the pattern is particularly evident over time. In the early 1900s very little of U.S. primary energy was converted to electricity before consumption. There is no sign that this trend toward electrification is saturating even at today's high level of 40%. So far, transportation services—except by train—have not been amenable to widespread cost-effective electrification, so complete conversion of the non-transport parts of the energy system may represent an upper bound on electrification with presently viable technologies.

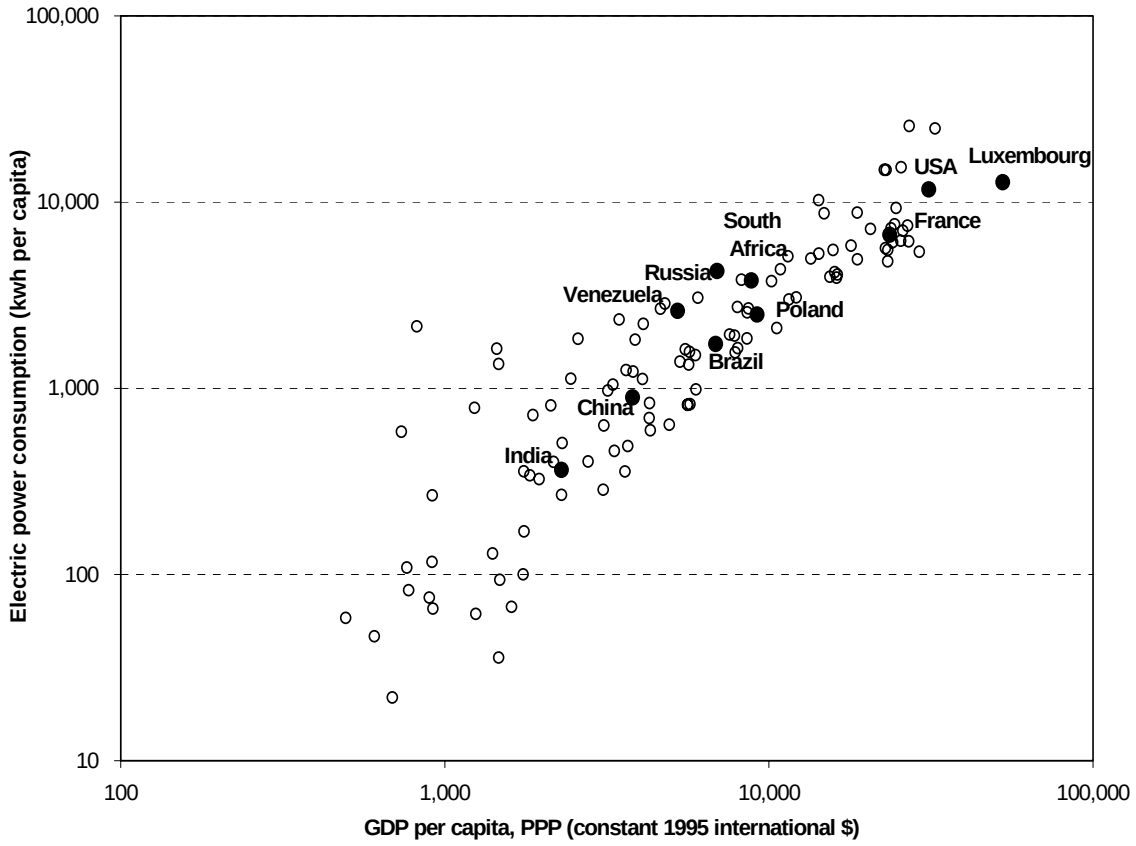


Figure 2. Electricity per capita versus GDP per capita for nearly all countries (2001) in logarithmic scale. Note that GDP figures are adjusted (World Bank method) for differences in purchasing power—so-called purchasing power parities (PPP). Such an approach is commonly used when making economic comparisons across countries at sharply different levels of economic development since internal prices in developing countries typically do not equilibrate with world prices for many goods and services; moreover, the PPP arrangement also helps to ease comparisons in the wake of sharp changes in official exchange rates. Data Source: World Bank (2004).

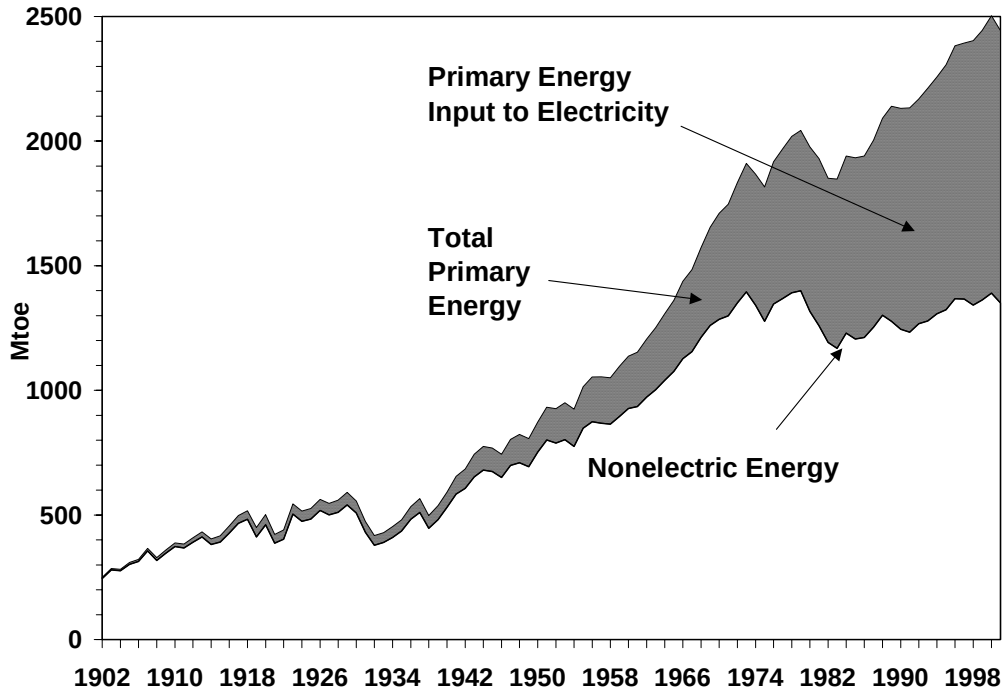


Figure 3. U.S. fraction of primary energy converted to electricity before consumption, 1902 to 2001. Today, looking across a large sample of countries, a similar pattern is evident—as shown in figure 4. In general, at low levels of economic development a country converts only a small fraction of their energy to electricity; at higher levels the economy becomes much more fully electrified. For most countries, the degree of electrification at today's level of economic development is usually higher than it was for the U.S. (or other leading industrialized nations) at the same level of economic development. For example, as shown on figure 4, China converts about 10% of primary energy to electricity at an average level of economic development of $4000 per capita. The U.S. reached that same level of economic achievement at the beginning of the 20th century when less than 2% of primary energy was electric. Such differences reflect improvements in electric technologies and also the more rapid diffusion of ideas, technologies and practices to countries that are trailing in the development process. Data Sources: Mitchell (1998), DOC (1976), IEA (2000), EIA (2001).

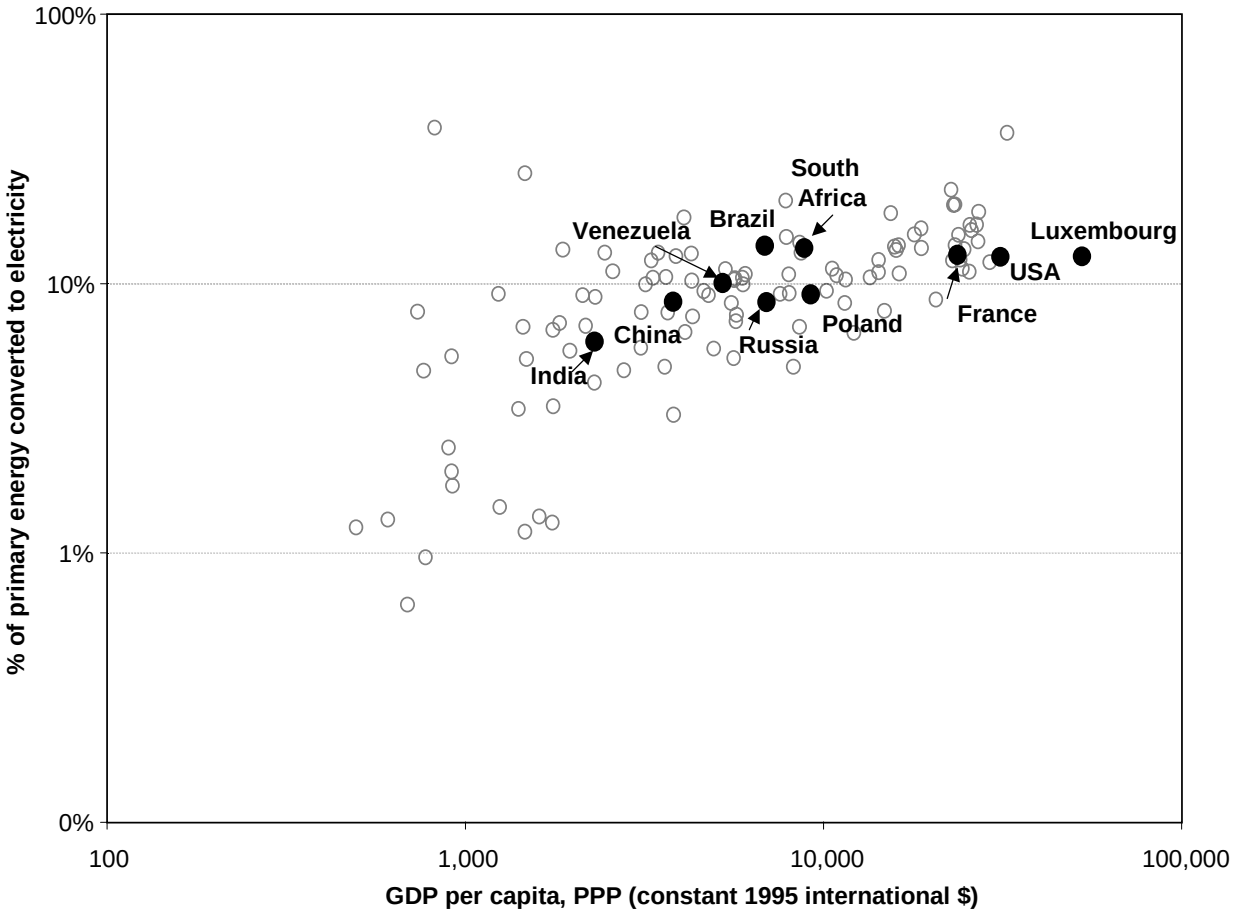


Figure 4. Share of Electricity in Primary Energy Consumption versus GDP per capita for nearly all countries, 2001 (double logarithmic scale). GDP is adjusted for purchasing power, as discussed in the caption to figure 2. Data Source: World Bank (2004).

While there are many differences among the energization patterns of different economies—as evident in the scatter in figure 4—the dominant pattern is electrification. In 1998 the Intergovernmental Panel on Climate Change (IPCC) convened a sample of energy experts and modelers to make projections for the world's future energy system. That group was particularly interested in the implications for emissions of CO_2 and other greenhouse gases linked to global warming, but the results of their models also included information about electrification, as shown in figure 5. All of the modelers anticipated that electrification will expand, and the central projections envision that electrification will rise from about 10% of the world energy system today to perhaps 30% by 2100.

These patterns indicate the importance of electricity in the overall process of economic growth. They do not indicate whether electricity leads the process of development or vice-versa. Nor do they suggest that electricity necessarily has a special role in advancing economic development for the poorest populations. We address those topics in more depth later.

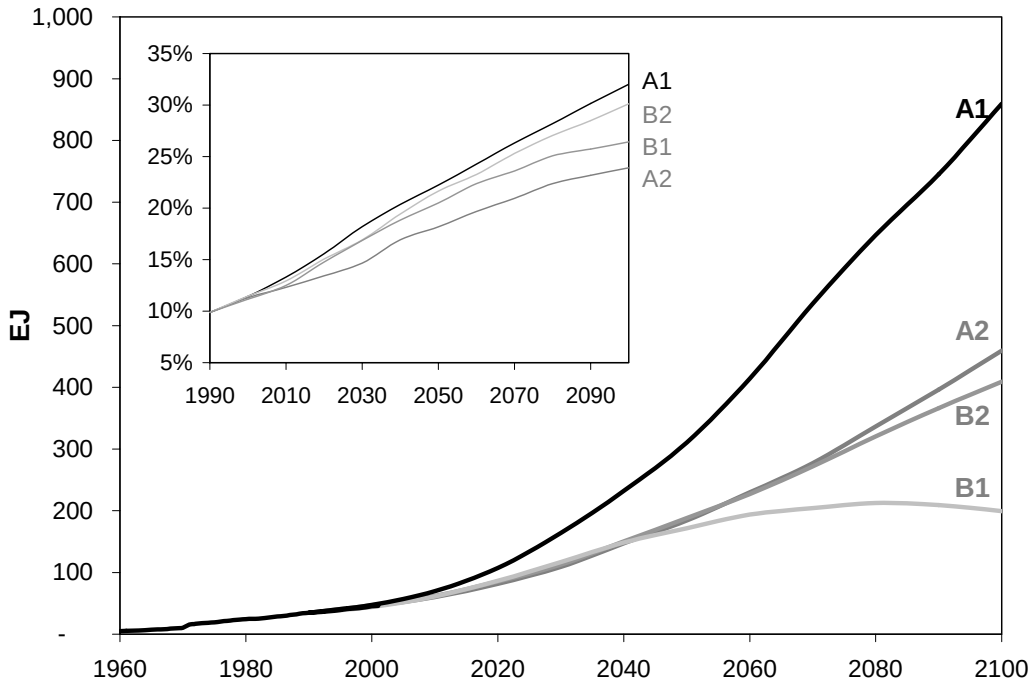


Figure 5. Electrification of the world energy system. Large figure shows historical data (1960 to 1990) and then model projections for the quantity of primary energy consumed as electricity (in Exajoules, or 10^{18} Joules) as projected for the Intergovernmental Panel on Climate Change (IPCC) by researchers at the International Institute for Applied Systems Analysis (IIASA). The inset shows the projections for fraction of total primary energy converted to electricity before final use. The A1 storyline is a case of rapid economic development, strong commitment to market-based solutions, high rates of investment and innovation and international mobility of people, ideas, and technology. The A2 scenario is characterized by lower trade flows, relatively slow capital stock turnover, and slower technological change; it emphasizes self-reliance in terms of resources as well as reduced economic, social, and cultural interactions between regions; economic growth is uneven and the income gap between now-industrialized and developing parts of the world does not narrow, unlike in the A1 and B1 scenario families. The B1 storyline is characterized by rapid change in economic structures toward a service and information economy, with the introduction of clean and resource-efficient technologies and high level of environmental and social consciousness combined with a globally coherent approach to a more sustainable development. The B2 world is one of increased concern for environmental and social sustainability, with a trend toward local self-reliance and stronger communities, and intermediate levels of economic development. Data sources: IPCC (2000), World Bank (2004).

B. The organization of the electric power sector: from the 19th century to the 1980s

Viewed in the broadest historical sense, the organization of the electric power sector is coming full circle. Electricity is perhaps the first global technology in that the arrival of electric services in the territories of today's developing countries occurred at nearly the same time that the nascent power grids in the advanced industrialized world were formed. Nearly everywhere the development of the electric power industry followed a similar industrial organization: private companies supplied power to private users who could pay for the luxury and special services of electric current. Where regulation existed at all it took the form of exclusive franchises—a private company was awarded a franchise area for service, and usually there was a close relationship between the users of electricity and the suppliers. That relationship, backed by the franchise award, prevented excess charges and created isolated pockets of electrification around the world.[1]

For example, electricity generation in India began under British Rule with a demonstration on 24 July, 1879; by 1897 the Government of Bengal had granted an exclusive 21-year license for electricity to illuminate and power the area of Calcutta, covering an urban area 5.64 square miles (Tongia, 2006). The Calcutta Electric Supply Corporation (CESC) Limited, registered in London, commissioned India's first power station in 1899 and sold power at the equivalent tariff as the one that prevailed in London—one rupee per kWh (CESC Limited, 2001). Electricity was quickly adopted for lighting and fans, and for some commercial purposes. Bombay (now Mumbai) was the second city in India to electrify, and soon a number of private companies built urban power supply systems under franchises that allowed for reasonable rates of return and included regulatory oversight to prevent monopolistic abuse. India was at the world frontier of electric technology; in 1902, the world's then longest transmission line was erected from Shivasamudram to the Kolar Gold Fields in Karnataka (Sankar and Ramachandra, 2000).

In the earliest days of Thomas Edison's Pearl Street electric power station in New York, regulation was neither contemplated nor readily available. Electricity competed with other energy carriers—for example, town gas for illumination—which made the business competitive.

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[1] This paragraph and the following two paragraphs rely heavily on Victor and Heller, eds. (2006). The particular origins of franchise regulation vary by country and with the legal powers of the territory awarding the franchise—complicated issues that are not addressed in more detail here. For example, in the United States franchises were first sought by power companies not because they (or the locality they were to serve) wanted regulation but, rather, because the franchise award allowed the power company to use powers of eminent domain to obtain rights of way that were essential for stringing transmission wires, crossing public roads, and building other elements of an economically efficient electric system (Priest, 1993).

As these early power systems—small, isolated, and targeting to a special class of customers—grew in size and interconnected they gave rise to the problem of natural monopoly. Electric service became cheaper to supply as power networks grew in size. Such "economies of scale" allowed the cost of the network to be spread over a larger number of users and a greater volume of service, and thus each new ("marginal") service was cheaper to supply than the average. In such situations, it is always more efficient for a single firm with an integrated network to supply the entire electric service for an area. Competition becomes impossible, and if the firm is unchecked in its behavior it will exploit the lack of competition to raise profits at the expense of consumers.[2] By about 1900 the best generators and transmission systems had these properties.

Moreover, a series of innovations in the methods of transforming and transmitting power gave a strong advantage to power grids that operated with alternating current (AC). (By contrast, Edison favored DC and famously lobbied to thwart AC technologies; some early power grids were built as DC systems.) AC further enhanced the natural monopoly status of electricity by requiring that all parts of the system be synchronized, which gave a prized position to dispatchers who controlled the power grid—a function known as "system operation" today. Essentially all of these early power suppliers were integrated in form—generation, transmission and distribution of power, along with the control (dispatch) of power plants and the grid were all performed by a single enterprise.

In most of the world—including nearly all developing countries—the problem of monopoly and the ever-expanding scale of power grids led the government to take control over the power system. From roughly the 1920s to 1930s governments began to assert greater regulatory control and squeezed private investors; as those investors fled (or simply refused to sink more capital into expanding their systems) the state assumed greater ownership and control. Unlike in the oil industry—where outright nationalizations became commonplace—governments generally did not nationalize but rather pressured and squeezed the private sector through tariff orders, restrictions on market access, and license conditions that made additional investment by private firms unattractive. At the same time, governments and later multilateral banks often channeled public funds into newly created state enterprises.

The timescales for change varied with the exact method and strategy. In Brazil, Mexico and South Africa, for example, the state worked mainly by constraining the private incumbents and channeling funds to new state entrants; as the for-profit business became increasingly unattractive the state was able to sweep up the remaining private firms,

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[2] The technical definition of a natural monopoly is slightly more complex—known as the principle of subadditivity—but for our purposes the simple and commonsense definition in this text will suffice. The critical factor is the economy of scale that arises from integrated power networks and ever-larger generators. For more see Viscusi et al., 2001, chapter 11.

usually at discount prices. It took about one turnover of the capital stock (about thirty years) for control to shift from predominately private to predominantly state-owned enterprises (SOEs). In China and India, the shift to public control unfolded more rapidly when governments combined their squeeze on private enterprise with partial nationalizations in the 1940s.

Governments around the world used similar arguments to explain their construction of state-owned enterprises and the assumption of electric services as a national duty. They branded competition as wasteful and dangerous. They argued that electricity had evolved from a luxury good and a specialized input to a few industries, such as mining, to become an essential catalyst for modern economic growth. It was too important, they claimed, to leave in the hands of profiteers outside state control. They saw government monopoly as the best way to improve service through economies of scale and scope, and as power systems grew in size the logic for state control propagated itself through fear of privately owned monopoly. State control also coincided with the realization that power projects, such as building dams, offered the opportunity for boosting employment, which delivered tangible political benefits. Such enterprises were particularly attractive flagship elements of socialist development policies that signaled the arrival of government at the commanding heights in much of the world economy.

Only a few countries in the world, such as the United States, left the power sector largely in private hands. Even in those instances, the state attempted to thwart profiteering with rules that vested special regulatory commissions with the power to manage the behavior of the monopolists for the benefit of the public. Very few other governments tolerated such private ownership; among the other exceptions were Hong Kong and a few parts of India (notably Mumbai) where private firms operated key parts of the power supply and distribution system. Even in the U.S.—the paragon of private ownership—the government built some large power enterprises of its own, such as the Tennessee Valley Authority (TVA), the Bonneville Power Administration (BPA) and a few others that owned and operated large dam and public works projects (Roberts and Bluhm, 1981, ch. 4; World Bank, 1995). In addition, the U.S. encouraged collective power producers that functioned like local government institutions and were the main agents for rural electrification; in rural America, power collectives remain the dominant mode of organizing power service today.

For countries that embraced the state-dominated system, the model seemed to work from the 1920s until the 1980s. Then the confluence of five trends imposed severe pressure on state owners and led to various efforts at reform. The details of reform efforts are the subject of the next section; here we focus on the causes.

First, technologically, the achievement of ever-large economies of scale through larger power stations began to slow. Worldwide, the cost of electricity had declined over most of the 20th century due to these economies of scale, and thus whatever inefficiencies existed in the state-controlled model of power could be obscured by declining total costs. Consumers expected that tariffs would decline in tandem. Technology reached the limits of scale in the late 1960s—as shown in figure 6. No longer could it be assumed that the next generation of power plants would be cheaper to build and operate than the current

generation, which put pressure on the assumption that electricity prices would continue declining.

In every country and technological setting, the details and timing of this exhaustion of technological potential were different. In some countries where nuclear power played a large role the shock of higher power costs arrived quickly as reactors proved difficult to scale up in size—especially in the U.S. where regulated enterprises were too quick to order ever-larger reactors before the technology was commercially proven and the practice of tailor-designing and –regulating each reactor made the technology prone to delays that were especially costly in the high interest rate environment of the 1970s.

In developing countries, in general, the exhaustion of economies of scale arrived later because import-substitution philosophies of economic development raised severe barriers against imported equipment and thus generation equipment usually operated far from the world best. In most countries, those rules were lifted (at least partially) in the context of broader economic reforms. In India in the early 1990s, for example, a reformist government changed the tariffs to make it easier to import equipment that would compete with the Indian incumbent Bharat Heavy Electricals, Ltd. (BHEL). The result was that new plants in India were often much more efficient than the incumbents and India quickly caught up to the world standard (Shukla et al., 2004). In many countries, the onset of higher tariffs was delayed by policies that shifted rising costs to private owners of power plants or to the government.

Second, the oil and macroeconomic shocks of the 1970s and 1980s dramatically changed the conditions for power sector investments. As the world economy slowed (and as high prices promoted efficiency) most countries nonetheless did not slow expansion in their investment in electric infrastructure. The result, in general, was over-investment followed by high capital charges for under-utilized infrastructure.

The cost of servicing these expenditures created severe stress for state-owned power companies, but the overhang of excess capacity meant that these companies did not face the immediate need for new investment. Even where power systems were generally well-managed this problem of over-investment arose—for example, in South Africa, where inattention to the risks of overbuilding led to a glut in power capacity and rising power prices as the state-owned power enterprise sought to cover its costs (Eberhard, 2006). Similar over-building was evident in Brazil and Mexico, although in many developing countries the over-building was not as large as in the advanced industrialized countries. The timing of efforts to launch market reforms typically coincided with the exhaustion of excess capacity from the overbuilding of the 1970s.

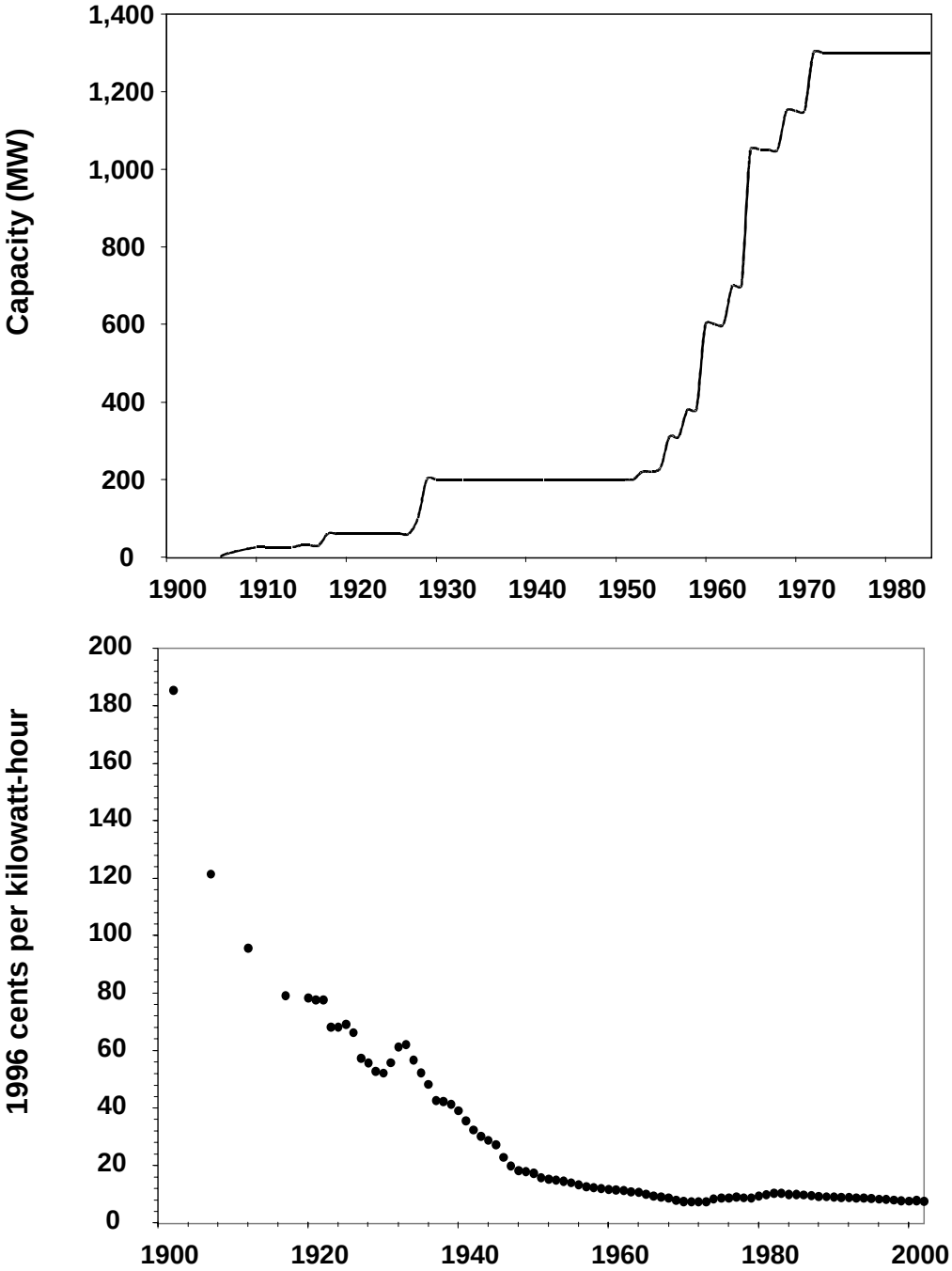

Figure 6: Technological Exhaustion of the Economies of Scale—example from the U.S. By around 1970 the size of the largest generator (an indicator of potential economies of scale) had peaked with the demonstration of coal-fired super-critical steam turbines (top panel). At roughly the same time—and causally connected, in part—the steady decline in electricity prices (bottom panel) had leveled as well (bottom panel). Sources: top redrawn from Schurr et al. (1990) and Victor (2002b). Bottom computed from U.S. Department of Commerce (1975) and EIA (2000), converted to constant prices using deflators from BEA (2001) and reported in Victor (2002b).

Third, as electricity became more pervasive in society it also became more politicized. In general, the tariff structure reflected the political priorities of government. In Mexico, for example, the system of political control embodied in the party that ruled the country for seventy years (PRI) tended to focus on a wide array of public programs that benefited the urban middle class—electricity was no different, with urban tariffs set at below the cost of service and cross-subsidy supplied by commercial users and the state budget. In India, Prime Minister Indira Gandhi created a tariff in the early 1970s that provided nearly free electricity to farmers—a very large and politically powerful voting block. Low cost electricity became entrenched as an expectation and in the structure of the economy—once offered free electricity, farmers also installed inefficient pump sets and chose thirsty crops (e.g., cotton), which compounded the political difficulty of rolling back free power for farmers in India. Today, perhaps more than one-third of electricity in India is used for agriculture (Tongia, 2006). In China, by contrast, power for farmers has been costly and farmers account for only a tiny fraction of total electric power consumption (Zhang and Heller, 2006).

Fourth, the "idea" of markets took hold from the early 1980s. In part, the focus on markets for power reflected a new thinking about ways to organize the power sector so that it did not fully have the attributes of a natural monopoly (e.g., Joskow and Schmalensee, 1983). In part, the idea of markets was made possible by a change in the larger context of economic governance—macroeconomic shock of the oil crises in the 1970s, the "lost" decade of the 1980s and the related debt crises exposed the weaknesses and rigidity of planned economies. These events refocused minds on the need for widespread economic reforms; they created the political and ideological vacuum that became filled by the idea of market organization and the practical policy machinery designed by technocrats trained in market economics. In many areas of economic policy in developing countries, that space was also filled with conditions and mandates pushed by multilateral development banks; although viewed with controversy, then and now, the World Bank notably played a leading role in advancing a coherent program for market reform in infrastructure industries—roads, ports, telecommunications, water and electricity (World Bank, 1993; World Bank, 2002b).

Fifth, and perhaps most importantly, in most countries the electricity supply sector performed poorly under state control. State managers ran state-owned enterprises (SOEs) as bastions of political patronage (e.g., in creating jobs) and were not properly attentive to investment choices that affected the efficiency of the sector. Such problems, along with state ownership, made it difficult or impossible for them to mobilize private capital. And as public budgets became squeezed—partly tue to large subsidies being paid for power—state sources of capital finance were unable to keep pace.

III. THE PRACTICE OF POWER SECTOR REFORM IN DEVELOPING COUNTRIES

A. MODEL FOR MARKET REFORM

These four trends—technological change, macroeconomic shock, politicization of tariffs, and the logic of markets—combined in different ways to yield pressure for power sector reform. The earliest reform efforts—in Chile (1983) and then England & Wales (1985)—were animated mainly by the idea of markets and implemented by governments that had seized a political mandate for market reform (e.g., Surrey, 1996; Green and Newberry, 1998). Advocates for market reform pointed to the pervasive inefficiencies of state-controlled corporations, such as their indifference to customers, their propensity to over-build, and the lack of accountability in their decisions. High tariffs were the most visible manifestation of these failures of state companies.[3]

Those experiences, especially in England & Wales, became the models for power sector reform worldwide. In this approach, which we will call the "textbook model" or "standard model," integrated power companies were unbundled into separate entities and sold to private owners; competition was allowed in all parts of this new industry where it was feasible. Wholesale generation of electric power and service to large power users were the areas particularly amenable to market competition; most "textbook" reforms initiated competition particularly in these areas. Table 1 summarizes the main elements of this "textbook model."

Table 1: The Standard "Textbook" Model for Market Reform

Source: adapted from Bacon (1999)

1	Corporatization of the State Enterprise(s)
2	Enactment of a framework energy law
3	Creation of an independent regulator
4	Restructuring (unbundling) of the core enterprise(s)

[3] Indeed, in the U.S., the states with the most costly power were generally those that went first with market reforms intended to reduce power prices (Joskow, 1998).

5	Attract greenfield private investment
6	Privatization of state enterprise(s)
7	Competition for wholesale supply of electricity
8	Retail competition

By the late 1990s more than 70 developing countries had pursued some elements of power sector reform (Bacon, 1999). Much of the move toward markets was concentrated in Latin America—in part because the debt crisis of the 1980s had forced these nations to be among the first to confront the need for private investment in the power sector. Asian countries, in general, have been slower to pursue reforms—The Philippines and Thailand are among the exceptions. The two largest Asian nations, China and India, created provisions for private investors in generation during the 1990s, but broader reforms have been much slower. In Africa, attempts at reform have been still fewer. Figure 7 provides a useful snapshot of the effect of reforms by measuring the flow of private capital into electricity infrastructure projects in different regions of the world.

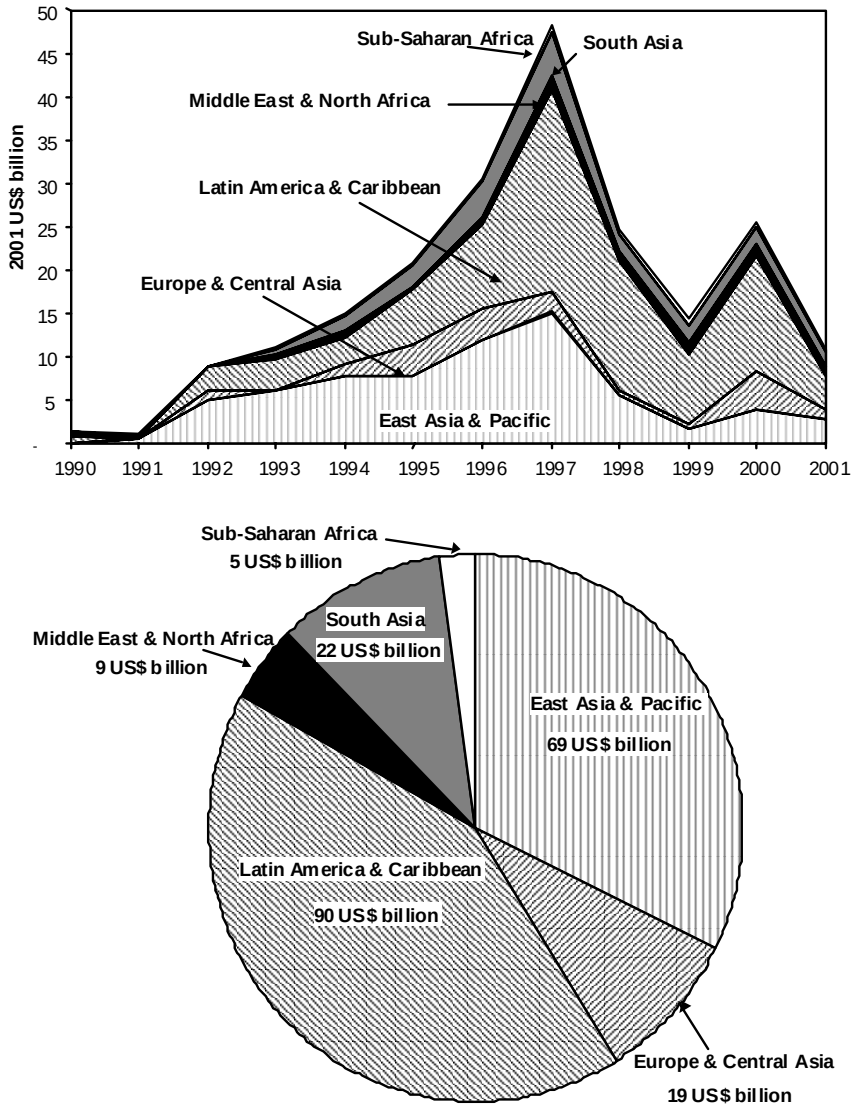

Figure 7. Annual Investment in Electricity Projects with Private Participation in Developing Countries by Region, 1990-2001 (top panel) and detail for the year 2001 (bottom panel). Data source: World Bank (2002b and 2002c).

B. Reform: Rhetoric and Reality

While a few developing countries adopted nearly all elements of the standard textbook model, most have attempted only partial reforms. Some countries have sought to sell distribution companies and other prized assets in an effort to raise cash for state budgets while not taking subsequent steps toward fuller competition. And the vast majority of countries that have attempted power sector reform have focused on just parts of the industry, notably electric power generators.

The boxes that follow provide more detail on the reform efforts in different countries. Here we examine just the main points.

Most striking in the reform experience is the disconnection between the bold "textbook" model and actual practice on the ground. Power sector reformers around the world claim that they are following a plan for comprehensive reform when, in most cases, very little progress has been made toward that goal. In part, this gap between rhetoric and reality simply reflects a shortage of time. Attempts at reform began only around 1990, and serious reform efforts require putting into place many complementary reforms, which has proved difficult. The rhetoric also reflects the overly bold visions of reformers. A whole community of experts in power reform has arisen since the early 1990s, and like any professional community its members embrace and enforce a common paradigm. That rhetoric, in practice, has become something more akin to a compass than a strict plan for achievement—it points the process in a direction and provides messages that can be conveyed to policy makers, but in the real world the process of following that compass is much more complicated.

Argentina[4]

Argentina reformed its power sector in the context of an economy-wide reform effort launched in 1989 under the leadership of newly elected President Carlos Menem. The goal was to revitalize an economy that had grown at an average rate of 1% per year since the 1970s while not increasing the burden on the already debt-laden public budget. The late 1980s and early 1990s were a period of sustained crisis in the country, characterized by an inability to ensure monetary stability. Inflation during the 1980s was regularly between 300-600%, and peaked at 3000% in 1990.

Reformers focused on privatization of state owned infrastructure and utilities as a way to both improve efficiency and increase public revenues through the sale of these state assets. In retrospect, the privatization of telecommunications and transport infrastructures has been viewed poorly by experts. Argentina's privatization of the electricity sector, on the other hand, was a success widely admired in the developing world—at least until the Argentine economy suffered a severe macroeconomic shock in 2001, leading to widespread job loss, abandonment of its currency peg, and default on its external debt. The political and institutional fabric of the Argentine state underwent drastic upheaval as it cycled through four presidents in a matter of months; earlier successes with market reforms stalled and reversed.

Until the early 1990s, Argentina faced a chronic lack of investment in its electricity industry, high demand growth (over 7% per annum) and frequent supply interruptions. The industry was entirely owned by the government, with the exception of several small electricity cooperatives. Four large federally-owned utilities controlled close to 88% of the generation and transmission in the country, with the rest shared among 19 small

[4] This box draws heavily on Woodhouse (2005c).

provincial utilities and two dam joint-ventures with Paraguay and Uruguay. Distribution outside of Buenos Aires was largely in the hands of provincial authorities.

The Electricity Act of 1992 established an independent regulator (ENRE) to oversee the sector, and unbundled the electricity industry into three sectors—generation, transmission and distribution—allowing private participation in each sector. In the process of unbundling, the major electric utilities were corporatized. The resulting market organization included competitive generation markets, and transmission and distribution sectors organized into regional monopolies privatized via concession to the private sector.

During this time, Argentina also established a legal framework to encourage foreign direct investment. The *Bilateral Investment Treaty of 1992* signed with the United States guaranteed to American companies the privilege to invest in terms no less favorable than those applied to domestic companies. Additionally, *Decree # 1853 of 1993* removed all restrictions on foreign investment, enabling 100% participation in privatized entities and full repatriation of profits.

These two events—reform of the electricity sector and the adoption of rules encouraging foreign investors—laid the foundation for a highly competitive process of privatization. Today, the generation sector is almost entirely private and loosely regulated as a competitive market. Except for the bi-national hydroelectric projects (*Yaciretá* and *Salto Grande*), the commercial nuclear enterprise (ENASA), and minor plants owned by provincial utilities and co-operatives, most generation in the country is in private hands. The privatization effort, combined with greenfield investment succeeded in increasing capacity from 15 GW to 20 GW in 10 years, while the number of generators increased from 14 to 45 (of which 40 are private).[5]

The generation sector is organized on a competitive basis, with IPPs selling their electricity to distribution companies and large users in the competitive Wholesale Electricity Market—either through supply contracts or in the spot market. The transmission sector is largely private, but closely regulated as regional monopolies. Similarly, the distribution sector is also largely private, although closely regulated—as is normal for natural monopolies. All federal distribution assets have been privatized, although many provincial distributors are still owned by local governments. As in transmission, private investors enter the market by winning a concession for a particular area.

The gains from restructuring arrived rapidly and decisively. The post-privatization spot price for electricity in Argentina decreased from US$41/megawatt-hour in 1992 to

[5] Foreign investors hold a major ownership stake in these units (primarily from the U.S. and Chile). However, most small capacity generation facilities were purchased by domestic companies, not for selling into the national wholesale market, but rather for self-supply.

US$36/megawatt-hour in 1997, while thermal power plant availability improved from 48 percent to nearly 70 percent and distribution losses were reduced by almost half over the same period. Increased reliability of electricity service has been substantial in some cases. For example, the northern Buenos Aires distribution company reduced outages from 22 hours per year in 1992 to 6 hours per year in 1995. Meanwhile, the southern Buenos Aires distribution company cut outages from 39 hours per year to 6 hours per year over the same period. The gains from private operations of utilities in Argentina exceeded 1 percent of GDP per year, as a result of efficiency improvements, labor productivity gains, and investments. These gains eased the efforts of distribution companies to invest in additional services for low-income households and to improve the quality of power delivered to such users (Powell and Starks, 2000).

The effects of the macroeconomic crisis are still not yet fully measured. Investors were hit badly when their contracts (originally valued in US Dollars) were converted at parity to pesos that rapidly lost value. The Argentine population also suffered badly in the crisis. It is telling, however, that most investors have remained in the country and sought to restructure their contracts to reflect the nation's new realities.

The differences in the reform process between telecom and electricity are striking, especially since most countries have seen exactly the opposite experience: telecommunications reform has generally seen success while electricity restructuring has proved more problematic. Through its telcom reform the Argentine government focused on generating revenue for a cash-strapped government rather than on improving the economic efficiency of the sector. As a result, the government did not undertake the politically difficult task of restructuring state telecommunications companies nor did it establish a regulatory framework prior to selling its assets (Manzetti, 1997). In contrast, in the electricity sector the government proceeded more carefully, undertaking the politically difficult task of shedding excess labor and raising tariffs to self-sufficient levels in the state-owned electric company. It also created an independent regulator with competence and authority. Importantly, all of these steps were taken prior to selling the state assets and creating an industry dominated by private owners. In telecommunications the government frequently changed policies—such as allowable rates of return, monopoly rights, concession lengths, pricing, auction rules, and regulatory powers—in response to various pressures from investors or the public. In electricity the government was able to adopt a credible framework for investors—one that held until tested to the breaking point by the macroeconomic crisis.

In large part, the absence of comprehensive reform reflects that the goals of power sector reformers in developing countries generally have been quite different from those that animated the comprehensive reforms in England & Wales. The cases of Argentina, Chile and Colombia—all countries that have implemented somewhat comprehensive textbook reforms—are actually quite rare. In all three countries, strong market-oriented governments backed by an abundance of highly qualified experts pushed through sophisticated, comprehensive reforms during relatively brief periods of time. And, even in those cases, markets have not strictly followed the textbook. In Argentina, state enterprises continue to play a large role. All three markets remain dominated by cost-

based contracts rather than truly open bid-based wholesale markets that some experts see as the ideal market model. Chile's market, for example, relies heavily on contracts between a limited number of suppliers, and in none of these three countries has there been much experience with reform in distribution—except in the case of extremely large consumers and in some cities. The most important of these reform experiences is Argentina where reforms stalled and then reversed in the wake of broader financial troubles.

In most countries, the rhetoric of reform has been dominated by the ideas of market economics, but actual progress toward reform has been paced by the ability of the power sector to attain financial solvency and to muster the massive amounts of capital needed to expand capacity. This pacing factor explains the three dominant features of the reform process.

First, some countries have been drawn to privatization as a first step in reform—not simply because private firms hold the promise of better management, but because privatization was an urgent and convenient way to raise capital for cash-constrained governments. Governments that found themselves the most strapped—especially in Latin America—generally were the most enamored of privatization. Indeed, as shown in figure 8, a sizeable fraction of the private investment that went to energy infrastructure was devoted to the acquisition of existing assets—so-called "brownfield" investments. In some countries, the early stages of reform were dominated by the goal of obtaining the highest prices for these assets. Brazil, for example, adopted rules as part of its reform effort that made existing distribution companies and hydroelectric dams look attractive to outside investors so that the Brazilian government would obtain the most money for these assets. Indeed, market reforms often introduce uncertainties that can devalue the prices obtained through privatization and discourage new investment—facts that pull governments away from the textbook plan.

As privatizations took hold and investors built business strategies around entering these electric markets through the acquisition of existing assets, prices soared and still more investors were drawn in. Over a period of about five years a bubble of electricity assets swelled in size and then burst in two stages. In Asia it burst in 1998 in the wake of the Asian financial crisis; in Latin America it burst starting in 2000 with macroeconomic troubles and a loss of confidence. Some of the frustration with market reform, especially in Latin America (where the electricity bubble bloated the most), is rooted in the irrational exuberance of investors who imagined that these markets had only upside potential.

These privatizations have proved problematic in many cases. For the host country, new private owners were politically attractive targets, especially when private investors demanded tariffs that would allow them to recover a high rate of return. The investors saw these rates as normal in risky markets; the largest investors typically bought a portfolio of assets, sought high returns for all, and assumed that some of the investments would go sour. The hosts saw high rates as exploitation—being forced to pay for the risk that others would default. These deals became easy political targets because governments could externalize political anger to entities other than the state (which was

particularly attractive if the private owners were foreign). Among the common strategies for putting pressure on private investors were restrictions on dividends, rules that made it difficult to cut excessive costs, and unfavorable tariff rulings. In the Philippines, public outrage at high tariffs became focused on IPPs (which accounted for half the nation's power supply—the highest fraction in any major country); the government responded by renegotiating all the contracts with IPPs in a way that managed the public concerns while also not alienating most investors (Woodhouse, 2005a). In some extreme cases the privatized assets were returned to state control—for example, in Senegal.

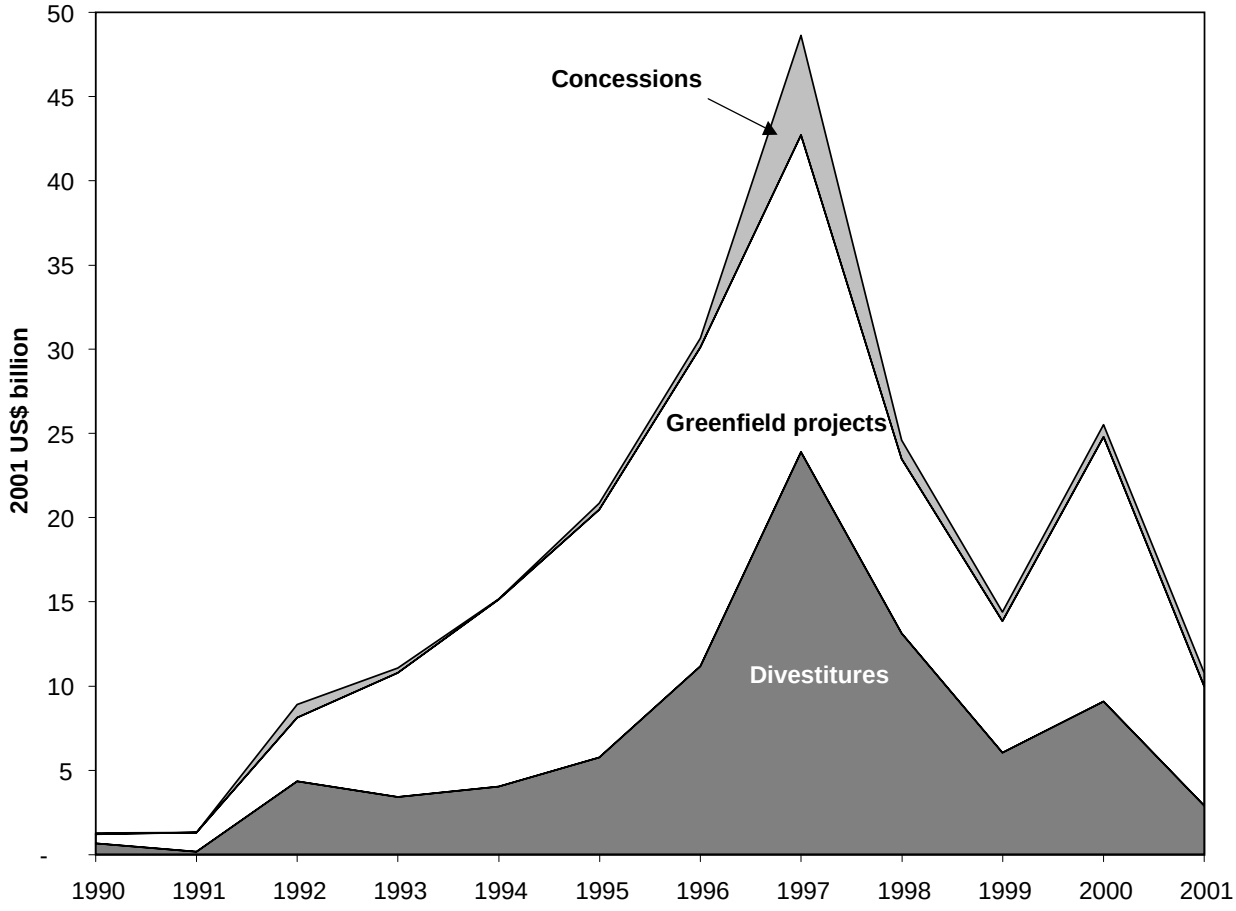

Figure 8: Private investment in the electricity sector by purpose. Data sources: World Bank (2002b and 2002c).

Second, in most countries the first foray into power sector reform has not come by pursuing policies that lead promptly to the end-state of the electricity market textbook: competitive generation and retail choice. Rather, governments have focused almost exclusively on how to finance new capacity and have focused on that mission. In the majority of cases they have turned to a special vehicle: greenfield independent power producers (IPPs). These arrangements carve out a space in the power sector for a private investor to build a power plant or a transmission line (or both) and operate them as an

entity independent of the (usually state-owned and operated) incumbent utility. In some countries, such as in India or Mexico, the initial effort at IPPs bypassed completely the early steps of power market reform shown on table 1 by leaving the existing state-owned enterprises completely intact while encouraging IPPs at the margin. In China, the first efforts at reform in the middle 1980s focused on IPP-like investments as a way to alleviate a shortage in power generation capacity. The actual record for IPP investors and hosts has been mixed, but for many countries the embrace of IPPs has occurred at a time when the lights were already flickering and there were few other options (Woodhouse, 2005b).

Typically, IPPs are financed and built on the basis of long-term contracts known as power purchase agreements (PPAs) between generators and the offtaker of power (usually state-owned distribution companies). Often, the PPA for power is synchronized with similar contracts for fuel. (IPPs are disproportionately gas-fired, but some use coal, hydro, biomass and wind for primary energy.) In a few countries IPPs have been stepping stones that have led to broader markets for power, but that transition has been quite uneven and risky for the investor. For example, in Brazil a program for gas-fired IPPs has been particularly disastrous for the owners of those plants that bet on the emergence of a lucrative merchant market because demand for power collapsed, gas became scarce, and the regulatory rules changed just as the plants came online (see box; de Oliveira, 2006). In most cases, however, the binding fixed long-term contracts have actually created rigidities that make it difficult to encourage competition and fuller market reform after the investments have been made. Having fixed a contract investors are generally wary of a change in context—especially in markets where there is a large availability of existing low-cost power and IPPs are more expensive to operate. In such markets, conditions of glut can make it difficult for IPPs to get dispatched. China, for example, created a limited experiment with small wholesale markets in six provinces during a period of power glut in the late 1990s with exactly that result: higher-cost recent power projects (notably those built by private investors) were unable to compete with incumbent low-cost coal projects. Some analysts have argued that those limited market experiments were mainly convenient ways to squeeze recent high cost power procurements rather than true first steps toward a competitive market (Zhang and Heller, 2006). Indeed, when demand for power in China soared and supply remained tight Chinese officials suspended the market and returned to a system of administered prices (see box).

IPPs offer the prospect of some competition, notably at the time of initial bidding. Indeed, if the system for original bidding is managed properly, the outcome can be economically efficient and (in principle) can reduce the need for regulation.[6] The best

[6] Indeed, among the early economic studies challenging regulation of the electricity industry were studies based on Demsetz (1968) that argued, in theory, that original term bidding—known as "franchise bidding"—could produce incentives for low-cost bidding that could eliminate the tendency for owners of power systems to exploit their monopoly

practice in greenfield IPP policy calls for open bidding, and many countries have followed this advice. However, in practice it has proved difficult to apply. In some cases, regulators and government decision-makers have limited information on the credibility of bids. In other cases, decision-makers are keenly focused on the need for additional power capacity (or they believe that they must have such capacity—often, governments overstate the amount of capacity that their economies actually need). In such settings, governments adopt rules that favor the investor because they value expensive power over no power at all. In still other cases, systems of federal control make it difficult for any single government agent to act as strategic decision-maker. All these forces combined in the most infamous failed greenfield IPP: Enron's Dabhol project in India. That project was built under special "fast track" rules adopted by the Indian government in the wake of a financial crisis in the early 1990s; bidding was secret; estimated costs were inflated by the investors; estimates of power demand were inflated by an overly optimistic government planning office; and division of responsibilities between the federal and state systems in India allowed the state to make some decisions (and then reverse itself) while the federal government bore a significant part of the financial risk (Lamb, 2005). The context encouraged a "perfect storm" on political controversy, default and litigation.

Greenfield and brownfield IPPs alike have always faced the problem identified long ago by Ray Vernon (1971): once capital is sunk the original legal terms of the contract can be difficult to sustain because the investor is no longer able to move his assets if circumstances turn unfavorable. Traditionally, legal systems are used to enforce contracts that allow investors and hosts alike to adopt a long-term perspective; for investors, especially, such contracts are essential to reducing the risk of exploitation. But legal contracts are not available if legal systems are politicized or inefficient. Investors and hosts alike have tried to apply various mechanisms to manage these structural problems that impeded investment. Investors, for example, have used special information and resources to leverage to the disadvantage of the host (Wells, 1998). Thus investors try to embed their projects into larger activities that the host country is keen not to upset—for example, funding from multilateral development banks and their affiliates. Usually, investors partner with local hosts so that their political connections can substitute for weakness in the enforceability of contracts. In some instances, the investor has been able to select technologies that are less immobile, preserving the option of exit—for example, barge-mounted power plants. On the other side, the host country has a myriad of ways to strengthen their hand. Even seemingly "bombproof" PPAs have fallen in the face of sustained efforts to rewrite the original deal—for example, offshore arbitration is seen as a paragon of enforceability, but in practice it has been difficult to trigger arbitration provisions, and the delays in such arrangements make it difficult to preserve the financial viability of a sunk investment.

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power. That arrangement worked well in theory but has proved politically and technically difficult to administer.

Third, there are in-built reasons why reformers, in practice, have not been able to realize the full textbook model. A recent study at Stanford University, with collaborating partners in five major developing countries, found that early in the reform process a special class of firms and enterprises emerges to play a dominant role in reform strategy. These organizations, which the Stanford group calls "dual firms," are marked by their strong interest in *avoiding* full-blown reform, for they thrive in the murky middle ground between the old state-dominated system and a fully open private marketplace (Victor and Heller, eds., 2006).

Dual firms are distinctive because they are governed to perform two tasks simultaneously. On the one hand, they are able to mobilize the political connections needed to get plants financed, sited and dispatched and to obtain the subsidies and payment guarantees that are necessary for profitable infrastructure investments. On the other hand, these firms are efficiently managed so that the resources they obtain are not squandered through poor operations, bloated payrolls and the like. Performing both these tasks is exceptionally difficult; some of the organizations that do it have arisen originally as state owned firms while a few trace their origins to private enterprise. Power sector reform has not proceeded fully to the textbook model not simply because it is technically difficult to create such private markets. Rather, these dual firms thrive in the partially reformed world and have a strong incentive to prevent full blown restructuring of the sector.

This third observation is important because it implies that a special kind of enterprise will dominate the landscape in partially reformed power systems. It is unclear what effects this form of industrial organization will have on electrification of low-income households, but there are reasons to think that they will be positive. Dual firms excel at politically difficult tasks such as securing government subsidies needed to cover the cost of unprofitable services, which may lead to electrification programs that are financially more sustainable (from the firm's perspective) than in cases where the needed subsidy is ephemeral and where the enterprises that supply electric services are poorly managed. However, if the presence of such firms prevents the entry of any others—for example, through the holding of exclusive franchises or other obstacles to competitive services—then the effects could be harmful for electrification, especially in rural areas, since there is accumulating evidence that for-profit business models can play a substantial role in rural electrification (Zerriffi and Victor, forthcoming).

Aside from these general patterns in the early stages of reform efforts, developing country reformers have routinely faced a handful of particular problems to which we now turn.

BRAZIL

Brazil restructured its power sector in the context of broad economic reforms aimed at revitalizing its flagging economy. Brazil's power system, like most in the world, was dominated by a single state-owned enterprise: Electrobras. The firm was created through acquisitions and state projects beginning in the 1930s and was responsible for most aspects of providing bulk power in Brazil—from strategic investment planning to operation of most generation and transmission. Electrobras also controlled some distributors, but in Brazil's federal system most power distribution was left to the individual state governments. [7]

The root of Brazil's troubles with the electric sector lay in the government's responses to the energy shocks of the 1970s. A spiral of inflation, devaluation of the Brazilian currency and fiscal deficit wreaked havoc on the country's macroeconomic fundamentals (Carneiro and Modiano, 1990). In the context of these troubles, power consumption fell far below forecasts of the early 1970s; generators ordered in the early 1970s sat idle and capital charges escalated. Yet the Ministry of Finance, more worried about inflation, mandated low tariffs that eroded the cash flow of power companies just as their debt servicing obligations escalated. This triggered a series of creative (but fiscally disastrous) efforts by state companies to delay payments to generators. The financial accounts of the power system became a shell game of arrears and special debts. These problems, and the economy's larger troubles, created the window of political opportunity for reforms.

By 1995 macroeconomic stability had been established, and restructuring of the power sector gained momentum around the mission of privatization. The Finance Ministry sought to obtain the maximum price for privatized industries with the hope that these resources could help the government's balance sheet. The privatization program moved pidly and was largely successful. By 1998, sixteen distribution companies, with a total annual service of 160 TWh, had been sold, along with 9.2 GW of capacity in four generation companies. Licenses for new power hydropower plants and transmission lines were sold in public auctions by the regulator at premium prices. The average annual capacity additions rose from a low of 1.080 GW per year in the early 1990s to 2.800 GW per year from 1995 to 2000. The flow of funds to the power industry, one of the main objectives of the reform, was back. Moreover, the newly privatized companies demonstrated better economic performance. The number of employees per customer—a key measure of productivity—was decreasing; most privatized distributors also saw a decline in the number and duration of power outages (Aneel, 2003). The share of consumers with access to power was also improving—increasing to about 95%. Crucially, the cost per MW of new hydropower installed capacity declined sharply due to

[7] This box relies heavily on de Oliveira (2006).

improved control of construction and financial costs.

International trends in the electric power sector—in particular, the model of reform adopted in England and Wales—helped guide the reform process. International experts crafted all the major elements of the "standard model" of reform—continued privatization, open access to the grid, and competition in generation and in retailing—into a strategy tailored for Brazil. In practice, restructuring has been much more difficult to implement than implied in the standard model. The privatization-for-cash approach to reform generated early income for the government but did not remove key obstacles to making the power business a profitable and reliable enterprise. Through much of this period the architects of reform focused on profitability and investment; a drought in 2001, however, underscored the need also to focus on reliability. It also revealed that the restructured power system reflected mainly the interests of the incumbents (notably hydro dam owners, as they supplied 95% of power) and socialized the risk that the system would not deliver power as expected.

The central problem with Brazil's reforms lies in the credibility of the rules adopted. At first, rules were adopted to reduce risk for investors—thus making assets slated for privatization fetch the highest price. Thus Brazil adopted, for a while, a price cap regime modeled on the system for regulating electricity distributors in England and Wales. Tariffs would be reviewed each year; the tariff baseline would be revised every five years, and the operator could request a special review if unusual circumstances prevented it from earning a fair return. This system would work only insofar as the regulator, created in 1996, was allowed to do its job. The regulator is financially and administratively independent from the government and funded by charges levied on generators and distributors (plus any fines it collects from companies that don't comply with quality-of-service standards). It regulates tariffs, licenses, and controls power concessions; it serves as arbiter of disputes between the power companies and the government. (However, as steward of concessions, Aneel also serves as the government´s representative in the disputes.) During the power crisis of 2001 a special government committee superseded the regulator's authority with emergency powers. A new government elected in 2002 has set a new direction for the power system that is reasserting a larger role for government.

The market relies heavily on contracts. Distributors are required to sign bilateral contracts for essentially all of their expected power from generators; in addition, those generators are also free to sign bilateral contracts with "free" consumers (large power users whose peak demand exceeds 3 MW). At this writing, essentially all large users have left the distribution companies and have negotiated their own electric service contracts. A thin spot market rectifies imbalances between the contracts and actual power supply and demand.

The contracts with distributors arise out of two sets of auctions. On set, under way since late 2004, concerns "old" power—existing plants whose contracts with distributors are expiring. The auctions for "new" power are set to begin in late 2005 and will award twenty-year contracts that investors can use to finance new hydro, coal, biomass or other power supplies. These auctions have been separated in an effort to keep prices low—part

of the government's anti-inflation strategy. "Old" power is assumed to be much less costly than new sources. It is still unclear what will happen if adequate supplies are not bid in the "new" auction or if prices rise to a level that inflation-fighters abhor. Another challenge has been to arrange to environmental permits needed for new hydro dams.

Brazilian policy makers have been mindful that privatization and a shift to greater market orientation would require policies to ensure the provision of energy services for low-income users. Thus contemporary with power sector reform have been a series of public programs focused on energy use by the poor (Goldemberg et al., 2004). In addition, the government has required private distributors to provide low-income energy services; the distributors, themselves, have had an incentive to engage in such programs in part because they can obtain special funds for that purpose and in part because such programs can help to cut power theft by creating a more normal commercial relationship with their customers (USAID, 2004). Such programs include both grid-connected services as well as, in rural areas, special off-grid energy services such as biomass gasifiers, diesel mini-grids, and photovoltaic systems.

C. Tariff Reform

Perhaps the most difficult task for reformers has been the management of tariffs. For users, tariffs and power quality are the most visible attributes of the power system. Indeed, reform efforts have been judged by these metrics, and since power quality is often poorly measured (or not measured at all, except anecdotally), the focal point for consumer assessments of reforms is the tariff. Across the industrialized world, successful power sector reforms has, in nearly every case, caused a reduction in tariffs. California famously legislated a 10% reduction in final user tariffs—to ensure that the public saw a tangible benefit from restructuring.[8] In England and Wales tariffs for users who could shop for electricity declined sharply in the first years of restructuring—in part because competition drove down prices in a market noted for its excess capacity and in part because contemporaneous reforms in coal mining drove down the price of fuel (Green and Newberry, 1998).

Across the developing world the experience has been notably different. The history of state-owned enterprises supplying power in developing countries is, generally, one of setting prices at levels below the cost of supply. This pattern of under-pricing has been

[8] For the first two years of the California power experiment the market, itself, produced lower prices; in the third year, 2000, generators found a way to use their market power to drive up prices. The legislated 10% reduction in prices, while not the root cause of California's power crisis, exacerbated these high prices by blunting the ability of households to see real energy prices and respond. Wolak (2003).

particularly evident in democratic countries because electricity usually becomes a political good, and governments use the tariff as an instrument of political patronage and control. Thus nearly every democracy that has sought reform of its power sector has had to confront the fact that existing tariffs are usually inadequate to cover the cost of new supplies.

The problem of under-recovery of costs is particularly severe in India and Mexico. In the former case, this problem is now widely known and has visibly led all of India's State Electricity Boards (SEBs), the entities that distribute electricity to most Indians, to be formally bankrupt. (As state companies the SEBs never actually declare bankruptcy; rather, they survive on a constant infusion of state support and various accounting shell games, discussed by Tongia, 2003 and Tongia, 2006.) In Mexico the problem is less well known because a special financing scheme puts the liability for costly new power onto the state itself—out of sight, yet accumulating to perhaps 5% of GDP today (Carreon et al., 2006).

Under-pricing has created enormous political difficulties for reformers, who must take on the task of getting prices right (itself quite difficult) while also not undermining the public support needed for market-oriented policy reforms. That's because in most countries power sector reforms have occurred at the same time as other political reforms designed to create greater democratic accountability. The cost and availability of electric services are highly visible and often politicized, which makes raising prices particularly difficult. The difficulties are particularly acute for those who take market economics most seriously, as the proper way to price power is at marginal cost. SOEs built on subsidized capital with inexpensive technologies, few pollution controls, and fully amortized costs have a large legacy of extremely inexpensive power; new plants built by private enterprises, by contrast, must comply with hard budget constraints and thus fully service their debt, pay the full costs of operation and maintenance, and provide a return for equity investors. Thus it is not uncommon for "new" power to carry a tariff several times that of amortized "old" power. (Enron's Dabhol power project was built with a PPA that, originally, called for a tariff that would have been five times the cost of "old" power.) Some countries, such as Brazil, have actually created segmented markets for "old" and "new" power, which inevitably leads politically connected groups to demand service from the inexpensive "old" supply even though power is a homogenous good and economic principles suggest that all power should be priced at the marginal cost of supply (de Oliveira, 2006). Such arrangements are understandable political compromises. Yet they create distortions that are evident, mainly, in excess consumption of (under-priced) power and inadequate incentives for self-sustaining investments.

There is a striking contrast in the experiences of the two largest developing countries: China and India. In India, power has become a highly politicized good, with notably low tariffs for farmers—a politically well-organized group. Not surprisingly, a large fraction (perhaps two-fifths) of all electricity is consumed by agriculture (Tongia, 2006). In China, rural farmers have been much less well organized as a political force, and planning in the power sector is controlled by a central planning apparatus that has valued industrial output. Thus electricity prices in rural agricultural areas are much higher than in India (though may still not fully cover the cost of supply as it is costly to build

infrastructures that provide small quantities of power to highly dispersed populations). Indeed, Chinese electricity prices everywhere are generally higher—closer to the level required for a financially self-sustaining power sector. When India sought to attract private greenfield IPPs every project was forced to grapple with the large difference between incumbent and new power; in China, those differences have been less severe and some IPPs actually delivered new power at prices lower than the incumbents. The constituency for low power prices was unable to mobilize as strongly in China as in India. In part, this reflects that large industrial power consumers in China were usually state firms that did not respond to normal price signals and in part this reflects the particularly active form of Indian democracy (Tongia, 2006; Zhang and Heller, 2006).

There are some notable exceptions to the thesis that democracies under-charge for electric power. Ever since its power sector reforms of the early 1980s the Chilean government has charged the full cost of electricity—perhaps because Chile was able to create the context for a market-based power system during a period of military rule, with transition to democracy coming only later after difficult decisions had been implemented. Democratic South Africa has a power system that is essentially self-sufficient—although some distributors in low-income areas lose money on their power sales. South Africa's power system has been blessed by abundant cheap coal and has the lowest electric power prices of any large country. However, South Africa is beginning to encounter political resistance as the incumbent utility seeks to raise tariffs to cover higher costs and to prepare for the construction of new capacity (Eberhard, 2006). The Brazilian power system, as a whole, covers its costs. In Brazil's case, however, a severe drought in 2001 underscored that hydroelectric systems may generally under-price power because the pricing scheme often does not factor in the risk of inadequate supply in times of drought; in the midst of that crisis government undertook politically difficult tasks of forcing conservation and raising tariffs. Brazilian users do not remember those measures fondly, and a weak government would have faced enormous difficulty in imposing such changes. Today, power prices in Brazil are set to rise so that new power projects are solvent, and a government weakened by scandal and focused on taming inflation confronts severe difficulties in allowing tariffs to rise as needed (de Oliveira, 2006). All told, the exceptions to the "democratic under-charging" thesis are the easy cases where power is already relatively inexpensive—notably systems based on cheap coal and hydroelectricity.

The experience in Argentina reveals the "best practice" for power reform and tariffs. Argentina, like most developing countries, had historically under-charged for power. When the government contemplated power sector reform in the early 1990s it knew that private owners would find it unattractive to participate in a system whose tariffs fell far short of the cost of new power supply. Thus the government incurred the political cost of raising tariffs before it privatized the industry. This outcome reflects the important (and accurate) conventional wisdom of contracting: in any deal the risks should be allocated to the party that is most able to bear them. In this case, the political risks surrounding tariff reform (i.e., tariff increases) were assumed by the government, which was much more able to manage this challenge in the larger context of Argentinean politics than could a private player, especially foreign owned companies that were vulnerable to

becoming political lightning rods. That system worked well until other macroeconomic shocks roiled Argentina in 2001 (see box).

D. Complementary Reforms

Perhaps the most striking finding from the experience with power sector reform over the past fifteen years is that outcomes depend critically on activities that lie outside the power sector. These external reforms are often themselves complicated and contentious. The interlocking nature of these distinct efforts helps to explain why the overall process of reform has been so halting and fine-tuned to local circumstances.

State Enterprise Budgets

First and foremost, the ability to impose market discipline on the electricity sector depends on whether the operations of key firms in the power sector are subjected to "hard" budget constraints—that is, whether they face the real cost of capital and will be held accountable for losses (Kornai, 2001). Imposing hard budget constraints on state enterprises has proved extremely difficult in industrialized and developing countries alike. In Europe, power sector reform has been partly stymied by the ability of some state enterprises to continue to draw financial infusions from their state parents. In the United States state enterprises such as TVA have, at times, been under fire for not being held accountable to the same standards of corporate governance as private firms (e.g., for an overview see Roberts and Bluhm, 1981, ch.4). (Private firms, themselves, have not had an unblemished record—evident, for example, in the Enron fiasco.) In Japan the process of reforming the economy has yet to fully grapple with imposing an arms length relationship between government and state enterprises, including hard budget constraints. Across Eastern Europe one of the mantras of economic reformers after the fall of the Berlin wall was the need to impose a hard budget constraint (Kornai, 2001). It is not surprising, then, that imposing hard constraints, transparent accounting and truly independent governance have proved very difficult in the process of reforming power markets in the developing world.

Where governments have applied hard budget constraints on the state agencies that control the electric power business, progress in improving efficiency of these enterprises has usually followed quickly. In Brazil, the financial crisis of the late 1980s forced the most indebted state governments to cover gaping holes in their balance sheets, which required the sale of some local generators and distributors to private owners. That privatization forced state governments to observe hard budget caps that, previously, did not exist; it also forced the new enterprises to meet similar caps long applied by private managers (de Oliveira, 2006).

In most countries subsidized state-directed capital has flowed via many complicated channels, and one of the most demanding tasks for reformers has been to untangle this web of soft finance. Brazil largely shut off the flow of subsidized capital to its power industry because Brazil's power industry reforms began in the context of broader reforms

triggered by the severe crisis in public finance, and reformers had a firm grip on the public purse. South Africa went the furthest in completely imposing a hard budget constraint on its power system because it had the least to do—it removed public debt guarantees for Eskom in 1983, and since then Eskom has conveniently demanded little state investment (Eberhard, 2006). Nonetheless, some South African distributors remain subsidized. In China, much of the effort in power sector reform, in fact, has been set through the central government's control over capital. When the central government has not allocated sufficient capital to the sector other investors have filled in at the margins; when central capital has been abundant (either through the state budget or, more recently, through the state banking system) the central government has exerted more direct control (Zhang et al., 2005; Zhang and Heller, 2006).

In practice, though, it has proved extremely difficult to tame soft financing because the subsidy that is removed from one part of the power system often metastasizes to a new location. For example, some countries have imposed hard budget constraints on generators because they believed that generators could be easily separated from the rest of the power system and their performance measured against known alternatives. But fixing generation tariffs (usually at levels higher than in the past) merely shifted the point of subsidy. Systems for transmitting and delivering power remain a favorite locus of the soft budget constraint because their activities are usually retained by the state or strictly regulated as natural monopolies; it is easier to construct a politically sustainable argument for subsidizing enterprises that have close contact with politically organized power users. (As the owners of distributors in Orissa, Rio and São Paulo—among other cities—have learned, soft budgets that kept the enterprise alive when it was in state hands can disappear when a private owner is holding the reins.)

Partially imposed hard budget constraints move the locus of insolvency in the power system to the point where it is politically easiest to sustain the loss. The details vary across countries, and in recent years there has been much flux in accounting rules in the power sector in developing countries in part because the search mechanism is still "looking" for a politically sustainable way to locate subsidies. In India, for example, recent accounting rules have attempted to concentrate insolvency (and thus subsidy) in the transmission companies. In some Indian states—notably Andhra Pradesh—this arrangement has proved politically sustainable because the government has been willing to provide the needed subsidy; where this falters, however, transmission companies will be unable to sustain their operations and a new solution will be needed (Lamb, 2005). Until reforms began in 1991, all elements of the power system—generation, transmission and distribution—were lumped together into State Electricity Boards (SEBs) that co-mingled their losses and would be bankrupt if forced to comply with standard accounting practices and a hard budget constraint.[9] As reforms have led the central government to

[9] The only part of the Indian power system not under SEB control were federal power plants—coal-fired unites owned by the state-owned National Thermal Power Corporation (NTPC) and similar arrangements for federal hydro and nuclear facilities. NTPC, notably, received a special tariff arrangement that that even though the SEBs (which

apply hard budget constraints on the states, the states have been forced to struggle with applying such constraints to their own operations; absent a credible strategic plan for reform (which is particularly difficulty in divided federal systems) the application of hard budget constraints to only parts of the system triggers a sometimes long and politically contentious process of finding the entity that can be left holding the deficit.

Independent Regulators and the Judiciary

A second area of activity outside the electricity sector that has important implications for power sector reform is oversight. The keystone for the reform process is the creation of a new independent authority—the regulator—with powers to make decisions within policy criteria set by government. In the integrated state-centered system, all relevant decisions about power supply and cost are made by government agents who assumedly act according to public interest and thus require no independent oversight. In the market-centered system, by contrast, an independent regulator is essential, as private investors seek protection from the whims of the state and consumers seek shelter from monopoly powers.

Whether regulators have been able to exercise their delegated powers has depended on the efficiency, independence and attitudes of the courts. When a regulator makes an unfavorable ruling the challenges usually proceed to the courts. Analysts have noted that China, for example, has fared poorly in establishing an independent regulator partly due to the lack of legal reforms that would empower an independent and authoritative judiciary—in effect, a rule of law (Zhang and Heller, 2006). Among the countries where the creation of truly independent and relevant regulators has been highly successful is India, where the judiciary has a durable and proud reputation for independence. After a 2002 Indian Supreme Court decision reaffirmed the validity of regulatory decisions, the influence of India's regulators has risen. A new electricity law in 2003 further clarified the wide scope of authority delegated to regulators.

Where the judiciary has not provided the rock-solid support needed for a truly independent regulator, regulatory bodies have nonetheless sometimes been able to function effectively—usually when the government itself replaces the judiciary in endowing the regulator's authority. In Brazil and Mexico, reform-minded politicians in the federal government made the creation of independent regulatory bodies a high priority and granted them substantial powers. Pro-reform politicians and civil servants enlisted entrepreneurial heads for these new regulatory agencies and gave them the resources to hire competent staff and constitute independent and well-qualified boards.[10]

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bought all of NTPC's power) were bankrupt the NTPC still received a healthy financial return on its power sales.

[10] In neither Brazil nor Mexico was it clear how the courts would rule if they had been fully empowered to review regulatory decisions. In Mexico, especially, an independent

As long as pro-reform governments backed the regulator, the regulator could pretend to be truly independent. When circumstances changed, regulators fell into disarray, as illustrated by the fragility of the authorities vested in Brazil's energy regulator. During Brazil's electric power crisis in 2001—brought on by drought—the government found it convenient to suspend the regulatory authority's powers. Two years later, a new government with quite different ideological orientation visibly reinforced the need for regulatory "independence" when it was convenient but suspended key powers when the regulator tried to impose a politically unpopular rise in tariffs. Brazil's regulator has faced other difficulties such as rules that impede the hiring and retaining of experienced staff and budget provisions that have kept the regulator from spending money earmarked for its use (Brown and de Paula, 2004).

Even in India, where the foundations for regulatory independence are strongest, there has been substantial variation across the individual Indian states. A special law on regulatory commissions in 1998 created the legislative basis for a central regulatory commission, and some states constituted state commissions even earlier. Still, organized interest groups that felt disadvantaged by regulatory decisions could delay implementation by challenging them in court, where access was easy and the legal basis for regulatory delegation had not been tested. Regulatory commissions already suffering due to thin staffing found themselves tied up in legal proceedings and unable to issue firm orders. In the states where governments have been most keen to advance reform officials boosted the powers of the regulator by agreeing to honor any decisions. The regulatory commission in Andhra Pradesh, for example, earned a reputation for competence and authority because it antiseptically applied agreed upon rules to politically sensitive issues such as computation of subsidies, and a supportive state government complied with all of the regulator's main decisions. But that experience is not proof of regulatory independence because the interests of government happened to coincide with the powers of the regulator. In May, 2004 a new party—populist in orientation and more wary of market reforms—took power. Its first act was delivery on a campaign promise to supply free power to farmers, which will exacerbate the cost of subsidy and strain the regulator's authority. How the system will survive this test is still unknown.

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judiciary was just beginning to test its autonomy in the late 1990s after decades of suppression, and several high profile cases suggested that key judges were actually hostile to electricity reform, which they viewed as a violation of the Constitutional requirement that electric power be organized as a public service and owned by public institutions. Similarly, in the Mexican telecommuications sector the judiciary routinely forestalled regulators' decisions on formalistic ground such as inadequate explicit delegation. The creation of an independent judiciary, as the Mexican experience shows, does not automatically reinforce the authority of regulators. In Brazil, a series of court cases under way at this writing, threaten to overturn PPAs that had been blessed by regulators.

Around 1990—when the wave of power sector reforms began to move through the developing world—there were essentially no independent regulators in developing country electricity systems. The reasons were simple: with an integrated state-dominated power system there was no perceived need for regulators. The state, it was assumed, acted in the public interest, and a state controlled power sector was automatically assumed able to guide itself to meet its own policy goals. Since 1990 there has been a striking rise in the number of power sector regulators worldwide. Even countries that have done little to restructure their power markets have made considerable progress in establishing regulators.

Perhaps most striking about the rise of independent electricity regulators across the developing world is that the functions they perform are often quite different from those of their counterparts in the industrialized world. A small industry for regulatory training in the developing world has arisen, animated by the belief that the regulatory experiences in the industrialized world are directly relevant to those in the developing world. That assumption is not necessarily valid. In jurisdictions where rate-of-return regulation is dominant—notably much of the United States—the task of regulators is to elicit information about costs and allowable returns. In jurisdictions where competition prevails, the job of regulators is to oversee the market, spotting anti-competitive practices and ensuring that conditions for competition prevail.

INDIA[11]

India's power sector has grown tremendously since the country achieved independence from Britain in 1947. Installed capacity has grown at 8% annually to more than 107,000 MW by 2003. Despite this eighty-fold growth, the per capita consumption of electricity, estimated at 350 kWh per annum, is far below the world average of over 2,000 kWh. Indians often compare their economic performance with China; the latter had a lower level of development two decades ago, but today has more than double the per capita electricity consumption (and GDP) of India.

Until recently, in all parts of India except for a few cities and private industrial plants electricity has been a state-dominated activity. Like most state enterprises, India's State Electricity Boards (SEBs) survive in an environment of "soft" budgets. The problems with this approach to industrial organization were evident already by the 1970s, with widespread blackouts due to inadequate generation capacity. To solve this problem, the Indian central government created a new layer of state-owned corporations for power generation and transmission; those national companies, notably the National Thermal Power Company (NTPC), have grown to account for more than one quarter of the country's generation and more than one-third of all transmission capacity. The SEBs, which are controlled by the states in India's system of federal government, remain the primary institutions for delivering power to final customers; but the SEBs are all loss-

[11] This box is based heavily on Tongia (2006).

making enterprises, which has constrained their growth.

By the end of the 1980s, state budgets could no longer manage the losses of the SEBs; at the same time, the federal government faced financial collapse. The system was ripe for change. In 1991, a new central government, reacting to a balance of payment crisis, ushered in economic liberalization that included power sector reforms.

The first efforts at reform in India focused on increasing investment in power generation. The calculus was simple. India's goal of sustaining 8% annual economic growth, which based on historical experience would require a growth in power capacity of 1.5 times that rate, implied the need for billions of dollars of investment – money that was unavailable through the Indian governments or public savings. The remedy for the government, which traveled with the moniker "India Means Business," was to attract foreign investment to independent power producers (IPPs). The government promised attractive rates of return and offered "fast track" status with accelerated approvals and sovereign repayment guarantees to eight showcase projects. Several projects were abandoned. A few actually saw commission, although those projects might have been built even without the special fast track provisions. GVK Industries' 235 MW gas-based Jegurupadu project and Spectrum Power's 208 MW gas-based Kakinada Project have been commissioned (in July 1996 and January 1998, respectively, both in Andhra Pradesh), as has the first phase (740 MW) of Enron's Dabhol project in Maharashtra state (May 1999). (The Dabhol complex has since slipped into bankruptcy and mothballs due to a festering dispute with the Maharashtra State Electricity Board over tariffs.) In total, these IPPs contributed little to the total power generation portfolio and imposed further burdens on the fundamentally unsound SEBs, whose losses mounted as they sold ever more power for prices that were lower than cost.

While the effort to promote IPPs proved wrongheaded, fuller structural reforms followed later in the 1990s. The unlikely front-runner for structural reform of the power sector was the state of Orissa, one of India's poorest. There, the World Bank withdrew support for a pending hydropower project in 1991 and made renewal of assistance conditional upon the state reforming its power sector. The government of Orissa responded by unbundling its SEB and eventually privatizing its distribution companies. Other states subsequently reformed the structure of their SEBs but were generally wary about selling the enterprises responsible for distribution. This wariness was rooted, in part, in early disappointing results from Orissa, where the newly privately owned firms experienced higher losses after reforms—in part because the lack of proper accounting prior to reforms masked the true extent of losses and in part because remedies for losses, such as crackdowns on theft, proved politically impossible to implement. Reformers also faced political opposition from farmers, who use enormous amounts of subsidized power, and labor unions representing workers who feared losing their jobs if the bloated SEBs were privatized.

As part of these structural reforms the Indian central government also encouraged the establishment of independent electricity regulatory commissions (ERCs). A primary motivation for creating independent regulators was to slice through the Gordian Knot of tariffs. The SEBs were organs of the state, and had the authority to set their own tariffs, but the tariff-setting process was highly politicized. The voting masses (farmers and domestic consumers) secured low tariffs for themselves, which forced the SEBs to try to

offset their losses by raising tariffs on industrial and commercial users. In turn, the more lucrative users have reduced their grid purchases and build their own on-site ("captive") power, which is further deteriorating SEB revenues.

At present, the central government is institutionalizing these returns across the country—aided, in part, by 2003 comprehensive legislation. One major impetus for these reforms is extraordinarily high losses in transmission and distribution (T&D), estimated at nearly 30%. This figure is several times higher than in the U.S., in part because of high technical losses but also because of rampant theft. The solutions to such problems involve upgrading the distribution and monitoring systems, requiring significant investments.

This new phase of institutionalized reforms has included fresh efforts to shift distribution of electricity to private management. The city of Delhi has been at the forefront of the effort, unbundling and privatizing distribution in June 2002. Despite being an urban area with virtually no agriculture, Delhi suffered from T&D losses as high as 40-45% prior to reform. The Delhi model was designed to avoid the mistakes made in Orissa; rather than asking private investors to bid on the distributor's assets, in Delhi the bidding focuses on commitments to reduce losses. The winning bidders are awarded 16% on their equity if they meet their bid; if they beat the targets they keep half the extra savings due to the reduced losses (the rest of the benefit accrues to consumers via lower tariffs).

The most difficult attribute of Indian power sector reform is the raising of tariffs—especially in agriculture, where tariffs are nearly zero. In addition to low tariffs, the small charges that are applied are based on the nameplate horsepower of pumps. (Most electricity for agriculture is used for pumping water; originally, the logic for a low tariff was to set the price of pumped water at a level comparable with gravity-fed water.) The result of this scheme is that farmers understate their capacity, which in turn yields drops in electric voltage, causing frequent transformer overloads and motor burnouts. Installing meters is politically challenging (and logistically-given 14 million pumpsets), with linemen fearing for their lives at times. Water is over-used, leading to erosion and water saturation; farmers have selected water-intensive crops where arid crops would be more appropriate; water tables have declined, leading to the need to pump even deeper (which requires still more electricity). A spiral of inefficient investment and design has resulted, and no single entity has the capacity to break the cycle. There is some evidence that farmers would be willing to pay more if higher quality power were available. One World Bank study, based on several states, indicates electricity-based irrigation (including an implicit burden of roughly 50 paise/kWh from motor burnouts due to bad quality power, downtime, etc.) to cost around 1/3 of gross farm income (World Bank, 2001). There are indications that policy makers recognize this, but politicians cater to larger landowners as they are key swing voters, patriarchs who bring with them their entire community (Lal, 2003).

In the developing world the tasks of regulators have been quite different in at least three ways. First, regulation is a much more fragile and political activity; regulatory institutions are young and often not firmly established in practice or expectation. Often those harmed by regulation levy political attacks on the regulatory institution itself, and thus successful regulators may require even greater sensitivity to the limits of their authority than those who operate where regulation is a more firmly established feature of the landscape. This is particularly evident in Brazil, where a sophisticated regulatory system has emerged yet regulators today are mindful that inconvenient decisions could weaken their authority. In China, a formal regulatory body exists but exerts no influence on the operation of the electric power system; complex tariff orders are unlikely to be among that regulator's first tasks. In Africa a number of proposals are now emerging to limit the discretionary power of regulators (Eberhard, 2005).

Second, the targets of regulators are quite different in developing countries. In most systems, independent regulators oversee a landscape that is dominated by state enterprises or "hybrid" firms that occupy a middle space between purely independent private and state ownership. These are enterprises that have their own political assets and political masters; yet regulators are often able to exert some influence on their behavior. In Mexico, for example, the independent regulator, CRE, is influential in the siting of new power plants, transmission lines and other energy-related infrastructure—yet two state-owned companies (*Comisión Federal de Electricidad Compañía*, CFE and *de Luz y Fuerza del Centro*, LFC) completely dominate the electric power supply industry. (CRE has no control over tariffs, which are left to another arm of government, the Ministry of Finance.)

Third, given the different political and organizational environment for independent regulators it is not surprising that the tasks of regulators are often quite different. In India, notably, the most active state regulators are occupied by the task of computing subsidies. Their mission is not to dismantle the bankrupt State Electricity Boards or to serve as stewards of market competition; rather, their purpose is to create transparency in the power system. They compute the subsidy that is needed to create solvency for the system—making the true cost of under-pricing in the power system clear. In the most successful instances, such as in the state of Andhra Pradesh, the government pays the requested subsidy and the accountability afforded by this system offers key first steps toward a more rational pricing system. (Indeed, in this system the regulator has actually fought efforts to open the power sector to full competition because it fears that lucrative customers will simply exit the electric system by generating their own power rather than participating in the public scheme with its larger political goals.) The core of these regulatory functions involves overseeing state enterprises; at the margin regulators engage in other activities, such as reviewing and approving tariffs for private power plants. In countries where the power sector is more fully restructured and ownership is dominated by private firms, exactly the opposite occurs: the dominant activity of regulators is overseeing private companies, with state actions filling the margins.

Regulators in these environments usually face acute problems of asymmetrical information. They do not have the authority needed to acquire the accurate information (e.g., on costs and technological options) necessary to perform the function of a powerful

and impartial independent regulator. The underlying problem is that the electric power system in each country is dominated by state enterprise monopolies that emerged in an era marked by strong incentives to keep accounting systems closed to external scrutiny. Analysts have noted that the internal operations of state enterprises were a jumble of politically useful duties, soft budgets, uncollected accounts, cross-subsidies, and padded payrolls and other expenses (Victor and Heller, eds., 2006). No one demanded real accounting, and political choices were often easier to manage in these shadows. Such problems of accountability have existed even when state enterprises faced formal requirements to post accounts and attain financial benchmarks. In India, government utilities must earn a declared rate of return. Thus nearly all of the State Electricity Boards (the state-level enterprises that control most of India's power distribution system) post an official 3% return on investment on their books even though all are actually severely bankrupt. Official books are meaningless (Tongia, 2006). In Mexico, even if the regulatory authority had the power to set tariffs it would be unable to perform the task since the state enterprise (CFE) does not have an audited record of expenditure.

The lack of transparency helps to explain why regulators have often been enthusiastic advocates of private investment in greenfield projects. Not only are regulators often trained in the paradigm of competitive markets and thus inclined to favor private enterprise for its efficiency, but they also believe that such firms will be able to supply a benchmark for judging performance of the state system. (A similar logic led the U.S. federal government to build its own utilities—such as the Tennessee Valley Authority in the 1930s; see McCraw, 1971.) The wildly inaccurate information available about the actual performance of state enterprises was revealed during the privatization in Orissa, when the state government (with expert advice from the World Bank) made assumptions about levels of theft and costs that were far from of the actual values discovered when the new owners took control and applied true standards of accounting. Where information is highly contested there is enormous room for political mischief as all sides exploit uncertainties in key data—such as on the cost of electricity production—to advance their particular cause.

Factor Markets

Power sector reform in developing countries has also depended on events in factor markets—notably labor and fuel. This outcome should not be surprising in light of the experience in the advanced industrialized countries. In the England & Wales market reforms in coal markets account for a large part of the reduction in prices achieved during the first few years of operation of the power pool. In the United States, the removal of restrictions on the consumption of gas for power in the 1980s made it possible a decade later for market-sensitive power generators to select gas as the fuel of choice for new generating capacity. (A sharp rise in gas prices since 2001 has inspired some utilities and their regulators to shift back to coal.)

For integrated utilities, labor is among the largest expenses; state owned enterprises are typically managed as a substrate for public employment and job patronage. Managers of reformed enterprises forced to meet a hard budget constraint have demanded the ability to limit labor costs, which has often required a change in

legislation and politically accepted practice. While some managers have made significant progress toward solvency by cutting the labor force, this route to economic efficiency is often self-limiting due to the political fallout from large layoffs.

During the 1990s in India no utility cut its staff by more than half, and pacts made during the process of reform have averted further cuts. Even as most stories about Indian power reform today focus on theft of electricity and the very low tariffs charged to farmers—both of which are severe (and intertwined) problems—few places in India have yet to address nearly the full potential for leverage on labor costs. Indeed, labor in India remains highly regulated by the federal and state governments alike—through some 47 federal laws and over 170 state statutes. Many rules in force are a century old; many key labor decisions are rooted in the Industrial Disputes Act of 1947, which, for example, requires government permission before companies above a certain size can lay off employees or close down plants, and such permission is virtually never given (Rao, 2001).

The SEB staff have typically viewed their jobs as lifetime employment, with concomitant poor records in performance and accountability. Prime Minister Rajiv Gandhi jokingly referred to SEBs as the "State Employment Boards" (Ruet, 2003). Not surprisingly, labor productivity is quite low in the Indian electric power sector. While improving from an all-India average of 4.6 employees per million kWh in 1992-93 to an estimated 2.82 in 2000-01 (Planning Commission, 2002), this is still well below global norms, regularly below 0.5 employees per MkWh. The state of Uttar Pradesh, for example, had over 120,000 employees a decade ago. This figure fell to 90,000 and now 70,000. However, those employees are responsible for producing little more than that the state of Connecticut, which has only a few thousand employees (Tongia, 2006). Problems of over-employment are compounded by rising wages as India's central government accepted the recommendations of the Fifth Pay Commission. While they raised salaries even higher than the Pay Commission advised (in the face of competition from the private sector), they ignored recommendations to reduce government employment by 30% over 10 years (Srinivasan, 2001).[12]

Announcements of power sector reforms were often met with strikes by the utility's employees. Invariably, the compromise reached guaranteed job security for the employees, extending even beyond corporatization to privatization. When a private owner took over two of Delhi's distribution circles in 2002, it acquired 1.6 million customers and 13,000 employees. Such deals hamper the benefits of privatization, as they limit not only state efficiency but also growth in productivity over time as bloated workforces have few incentives to embrace new technology and practices. In

[12] Labor reform in the Indian power system must also confront the particular difficulties that arise because of a prized role for layoffs as a means of cutting costs. In addition, labor reform affects mobility of skilled workers, and it affects the ability to appoint senior managers other than officials from India's civil service, which is noted for its very high labor quality but a system of appointment shuffling that creates generalists rather than specialists and favors projects with short time horizons.

comparison, Mumbai, where the same company has long operated a private concession, they have 2.2 million customers and 4,500 employees (Tongia, 2006).

Difficult provisions for shedding labor are also often cited as a reason for the rampant problems of theft in many developing countries' power systems. In Rio, for example, the privately owned power distributor shed many redundant engineers only to find that they had established small private businesses making illegal power connections. Efforts to cut theft in the favelas have required careful attention to hiring collection employees from the local area to ensure that the community sees local benefits from participating in legal electrification (USAID, 2004).

Fuel markets are also important. Politically, events in fuel markets often drive technological and economic choices in the power sector. In Mexico, oil was sold by the state petroleum corporation (PEMEX) to the state electric generators at below-market prices, shifting resources from the state (which otherwise could have sold the oil on the world market) to the politically connected users of electricity, and allowing both the oil and electric monopolies to reinforce each others' economic and political positions. In Brazil, a water law adopted in 1934 that conferred authority over falling water to the State allowed the government to build up a vast enterprise of hydroelectric dams that it operated as a single organism—dams downstream on a cascade were dispatched in coordination with those upstream and with dam cascades on other river catchments. Even when some individual dams have been privatized the system continued to function as one and payment rules, in effect, have continued to bar non-hydro sources from the market. In China, India and South Africa local coal is king because it is an inexpensive source of primary energy, and competitors face many barriers.[13]

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[13] Even where it is cost-effective to import coal, importers often face political currents that flow against economic logic. In parts of southern China and western India, for example, imported coal is less costly (adjusted for quality) than locally available sources, but the levels of imports are still much less than would be suggested by a straight economic analysis. In some areas, artificially low internal transportation tariffs have given local coal an advantage and also explain why few coal users bother to seek pre-washed coal. (Washing removes most ash and thus eases the task of transportation—in the low-quality coals that are prevalent in both China and India, ash can account for 25% to 40% of the total volume of the coal moved.) In India, coal freight tariffs are profitable for the railroads but used to cross-subsidize the politically visible services of passenger transport, with the result that the railroads overall are not financially viable. The resulting poor service makes rail an unreliable means of delivering coal to consumers. As the impoverished Indian railroads falter in their payments to the electric generators who supply the electrons for traction, the generators, in turn, delay payment to the coal mines. The cycle of nonpayment binds all units together into a community of debt whose political fates are intertwined.

Barriers to entry and distortions in incumbent fuel markets partly explain the fuel and technology choices made by private investors. Where distortions are systemic the new entrant builds generators that obtain the same advantages as the incumbents. Thus private investors in Brazil have disproportionately favored hydro generators because the entire dispatch system favors those who produce within the hydro paradigm. Those that have invested outside that paradigm—notably in gas—have generally lost money except where they have been able to exit their investments and leave other firms nursing the loss (de Oliveira, 2006). Around the world the issues related to the introduction of gas have proved to be particularly important. Gas is much cleaner than the fossil fuels that it replaces—notably coal—but is usually more costly than coal and fuel markets do not automatically reflect the environmental consequences of dirty fuels.

E. Final observations about the Reform Experience

Looking across the last fifteen years of efforts in developing countries to restructure electric power systems, no single model for reform has emerged. In the early 1990s reformers echoed a similar core set of unified ideas and looked to external experiences, notably in England & Wales, for guidance. With time and experience, the actual practice of reform has lagged behind ambitious plans of the early 1990s and deviated from the standard textbook model as policy makers tuned their efforts to local conditions. Although the general terms of "market reform" and "restructuring" remain, no longer do they have a single meaning.

The deviation between bold visions and reality reflects, in part, the impracticality of the original vision—reformers, themselves, have noted in retrospect that it was probably impractical to make such dramatic reforms in light of the large number of complicated and politically difficult complementary changes in government and industrial structure that would be needed. In addition, a certain degree of path dependence arose in the reform process. Since most reformers focused, initially, on solving problems of inadequate investment in the generation of electric power they began with efforts to lock investors into long-term investments in capital-intensive generators. That initial focus may, ironically, have slowed the broader process of reform because it focused attention on the need for stability and assured high rates of return for investors—goals that militate stability, aversion to policy experimentation, and assurances for the offtake of electric supply.

Perhaps the greatest affliction for power sector reform efforts is that they are judged against outcomes in other areas of infrastructure reform—notably in telecommunications. The same forces that led governments to embrace a larger role for private ownership and competition in electric power also led to similar efforts in most other areas of infrastructure. Ports, roads, water distribution systems, and telephone networks were all sold in large numbers in developing countries (World Bank, 2002b). And telecommunications, in particular, became a darling for investors during the 1990s; just as private resources flooded into telecommunications, the quality of service improved

dramatically in nearly all markets. (Figure 9 shows the destination of capital investments for all major infrastructure areas, led by telecommunications, in developing countries.)

The reasons, fundamentally, are rooted in wireless telephone technology. Wireless networks offered a ready and rapid competition for incumbent wire-based systems and were less prone to the scale effects that create natural monopolies and thus thwart competition. Faced with intense competition and a rapidly improving technological frontier, wire-based and wireless both improved sharply. Wireless also offered a much less costly way to connect users that previously had no access to service.

By nearly all metrics that are used to judge service—numbers of users with access, cost per connection, cost per minute, and waiting times for service—telecommunications reform has been a dramatic success almost everywhere. (Ironically, among the least successful telecommunication reforms is in Argentina, a country that had been most successful in the more difficult task of power sector reform.) There is no similar innovation in electric power (nor in any other infrastructure industry), and thus telecommunications is widely seen as a sprinter for reform while other industries lag behind.

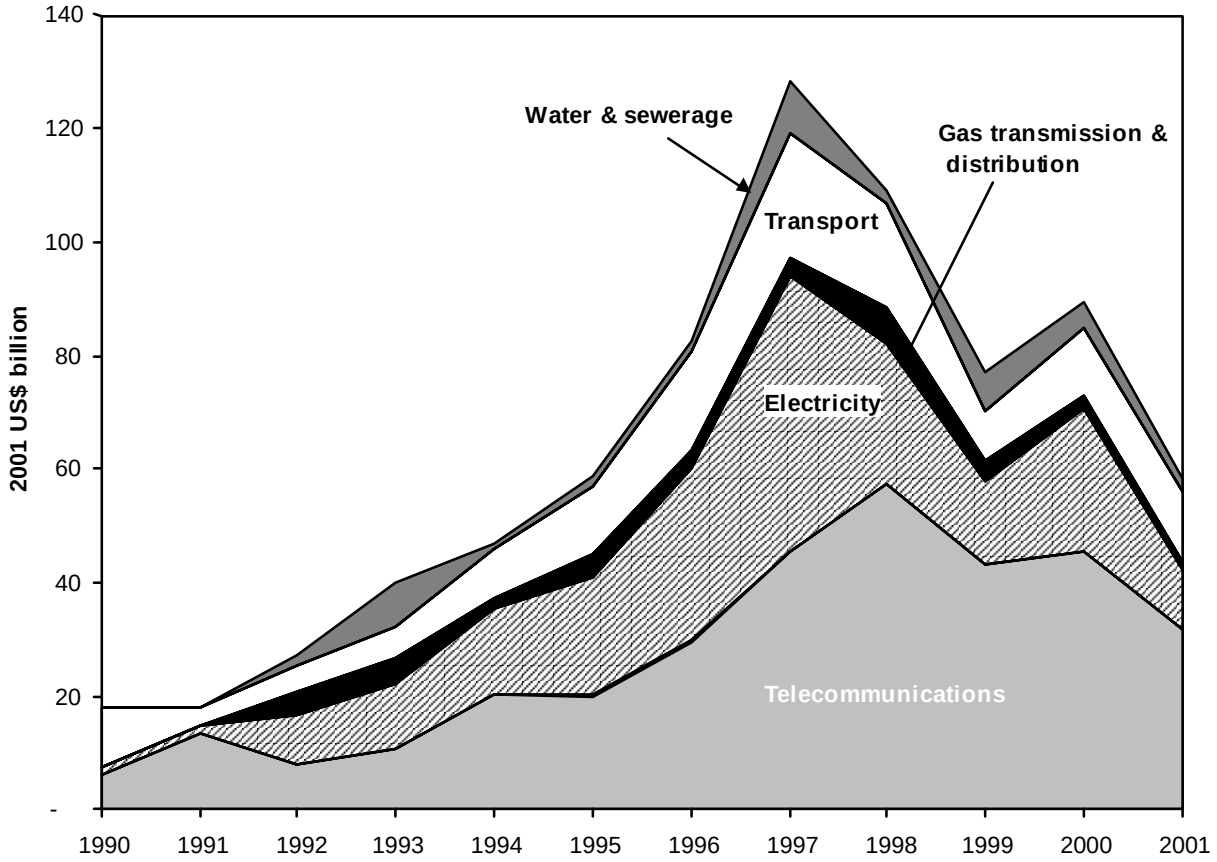

Figure 9. Annual Investment in Infrastructure Projects with Private Participation in Developing Countries by Sector, 1990-2001. Data sources: World Bank (2002b and 2002c).

Finally, the measured pace of reform also reflects a backlash against markets that has had several dimensions. Part of the backlash has focused on the purveyors of reform ideas, such as the World Bank and international consultants. In some countries, the World Bank made electricity sector reform a condition of lending—a factor that explains why the state of Orissa in India (one of the nation's poorest) was one of the first locations in the developing world to implement a broad reform package that included unbundling and privatization of distribution companies and elements of competition in the bidding for those assets. The Orissa experience is widely seen as a disaster because reform was attempted without the necessary institutional conditions in place. Notably, no accounting systems were present so that the buyers of the assets could know, in advance, the true extent of losses in the systems they were purchasing and their basic financial status. Just as experiences such as Orissa have become symbols for the multilateral institutions' errors in advice, other experiences such as in Argentina (which was widely seen as a success until the country as a whole suffered a financial meltdown after 2001) are positive experiences. The World Bank and other multilateral institutions have generally become more nuanced in their advice and visions for power sector reform as they have gained experience—a recognition of the very difficult political and institutional obstacles to serious reform (World Bank, 2004).

CHILE

Chile witnessed two rounds of sweeping policies aimed at the privatization of state assets and the introduction of competition: 1974-1979 and 1985-1989. The first round coincided with a period that started with one deep recession (1975) and ended in another that was possibly worse (1982-83). The Pinochet regime responded to these recessions with economic policies that emphasized the reduction of fiscal expenditures, liberalization of financial and other markets (including reform of trade tariffs), and privatization. These policies were aimed not only at promoting economic efficiency but were also intended to break traditional patronage networks of the political parties and the power of traditional vested interests—such as the unions and business organizations that relied on controlling access to government resources. The authoritarian regime could carry out these policies without significant resistance from traditional business groups or civil society. The Pinochet government followed strategies such as the sale of public stock to private citizens ("popular capitalism") and to workers, employees and managers of the company ("labor capitalism") as overt efforts to lure middle-class and working-class people away from traditional patrons—labor, left-wing, and Christian democratic parties.

Chile's first round of privatization is generally considered a case of mixed success. Some public enterprises were sold to private owners; the remaining "strategic" public companies—including Endesa, the Chilean state electricity company—were reformed through corporatization and the imposition of hard budget constraints that forced them to control costs, notably though the shedding of extra labor. These changes improved financial performance as well as operational efficiency and were critical in the successful subsequent sale of these companies to private investors. However, the dominant method of privatization was direct sale of controlling stock to investors, the creation of holding companies with high debt leverages and highly concentrated ownership (particularly in the form of institutional investors, the pension funds, AFPs).[14] The recession of the early 1980s forced these new enterprises deeper into debt, which in turn worsened the situation for already insolvent banks—ultimately compelling the government to take over some of the holding companies.

The second round of privatization tackled the problem of concentrated ownership directly by starting with privatization of the pension funds (AFPs) and by strengthening the domestic capital markets. The second round also involved the privatization of the remaining "strategic" public companies—including Endesa. Endesa was privatized by the initial sale of stock to workers and employees (actually a swap of severance payments for stock) then later to the general public and institutional investors. Chile's privatization resulted in two generation companies that were primarily focused on hydro-generation (Endesa and Colbun) and a third generation company, Gener, focused on thermal.

[14] For a more detailed discussion of the privatization methods used in Chile, see Hachette and Lüders, 1993.

Unlike in Argentina, Chile's regulatory framework did not bar companies from holding cross-ownership in the different sectors of the electricity industry. Not surprisingly, this vertical integration has led to monopoly rents: even though privatization resulted in a significant reduction in distribution losses, the benefits did not lead to a reduction in regulated consumer rates. As a result, profits soared for regulated companies (where rates of return have been about 30%) whereas competitive companies have seen more modest returns on investment (15%). (In Chile, the regulatory regime distinguishes between competitive companies, which compete for large customers with whom they can freely negotiate contracts, and regulated companies, which are subject to rate regulation.)

The powerful semi-monopoly positions frustrated subsequent efforts to establish an independent regulatory framework that would be sufficiently powerful to countervail the economic interests of the newly privatized industries. Moreover, the various responsibilities that are normally combined in one regulator—such as tariff-setting, market oversight and dispute settlement—are instead fragmented across different regulatory institutions in Chile. For example, the National Electricity Commission (Comision Nacional de Energia, CNE) which calculates tariff-setting rules, is not an independent body, but is an advisory organ to the Economics Ministry, which retains the final authority to set tariffs. The Superintendent of Electricity and Fuels (SEC) is charged with oversight and compliance of the law and regulations, handling of complaints between consumers and suppliers, and the preparation of information for CNE's price-setting process. Yet the systems have not performed well under stress—evident, for example, in the poor management of conflicts over water and transmission rights that erupted between Endesa and Colbun during the power crisis that followed the 1998 hydro-shortage.

The combined effect of allowing vertical integration, insufficient competition, grandfathered water rights, and weak regulatory governance is an industry climate that is inherently risky for new investors. Not surprisingly, with the exception of Spain's Endesa—which has specialized in investing across Latin America's power markets—there have been no major new investors in Chile's electricity industry. On the other hand, Enersis and Chilgener are among the most profitable companies in Chile. On the basis of their retained earnings, they have become the biggest investors in electricity supply in the region (Manzetti, 1997, p.6).

A second source of backlash is rooted in the politicization of tariffs. The higher tariffs required for financial solvency are an obvious source of political resistance, especially for groups that have become accustomed to paying nearly nothing for power. However, the electric sector has generally not suffered the backlash evident in water infrastructure where opponents of reform have argued, with influence, that water is a gift of nature and thus should not be owned or priced.

These latent sources of opposition help to explain the inordinate influence of the power sector debacle in California. Prior to the California experience there was no widely accepted example of what could go wrong. Orissa was seen as a special case, even in India. Blackouts in New Zealand (1998) and Chile (1998-1999) were known regionally

but not globally, and seen as byproducts of special local circumstances. Most other power sector reforms were either seen as a success (notably England & Wales) or were too early in the reform effort for an assessment. California's blackouts changed all that and focused the rhetoric of opposition. At the same time, a growing number of policy makers in developing countries have started to question whether market competition will produce economic benefits; those questions have been particularly concentrated on competitive electricity trading and partly explain why very few developing countries are making serious plans for this last and most complicated step of the textbook reform.

IV. ELECTRICITY RESTRUCTURING AND SUSTAINABLE DEVELOPMENT: CONFLICTS OR COMPLEMENTS?[15]

A. Context

At the same time that nations have undertaken electricity sector reforms they have also been focused on the role of energy services in advancing sustainable development. The decade of summits—beginning with the UN Conference on Environment and Development in Rio in 1992 and ending with the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002—set goals for development and included sustained attention to the many ways that energy services contribute to economic and social development. At the UN's 2000 Millennium Summit a set of specific goals for development were adopted, which were then reaffirmed at the 2002 WSSD. While none of these goals pertained particularly to energy, in practice energy services must play a significant role in nearly every aspect of development.

In this section we examine what is known about the role of energy services in economic development and the particular role of electricity. Next, we examine the record of access to electric services. Finally, we attempt to draw linkages between the record of providing electric services to low-income households and the attempts at reform in the power sector.

[15] This section based on a literature review by Elias and Victor (2005).

B. Energy for Development: The Role of Electricity

Viewed from the broad sweep of history, the types of energy services that humans utilize have evolved with other major indicators of human development, notably the size of the population, urbanization and economic output.

Before the advent of organized agriculture, energy was used sporadically for cooking and heating when biomass could be foraged locally. Around 10,000 years ago, the Neolithic revolution ushered in a transformation in energy technology that facilitated the shift from hunting and gathering food to organized agriculture (Snooks, 1994; Diamond, 1999). As time was freed from gathering food and fuelwood, the organization of society shifted from isolated, small and self-sufficient groups to larger settlements of specialized, interdependent producers (Seabright, 2004). A class of non-food producers—tradesmen, craft specialists, merchants and soldiers—emerged; the egalitarianism of hunter-gatherer groups gave way to increasing stratification and centralization of power (Hassan, 1979). Continuous improvements in agricultural tools and techniques increased surplus crop production and allowed a sharp rise in global population and settlement in larger communities (Childe, 1942; Hassan, 1979). Agriculture offered not only a standing source of food, but a ready source of biomass energy (crop waste). The role of biomass in energy budgets rose, along with the motive power of domesticated animals—which in turn allowed for more intense cultivation of crops (Landes, 1998).

Until the Industrial Revolution, nearly every society obtained nearly all of its energy from local resources. Biomass was burned for light and heat, and animate sources of power—humans and draft animals—supplied most mechanical energy, supplemented increasingly with wind and water power (Grübler, 1998). Nearly all biomass was converted for final use in inefficient devices nearby, such as open and stone-ringed fireplaces. Some specialty applications such as kilns for pottery making and the casting of bronze used large quantities of primary energy—and some of these devices were highly efficient—but most energy went for tending crops and for cooking and heating dwellings.[16] Dwellings helped to contain the heat, but also the pollution.

Human society is now in the midst of another transition in energy systems—away from traditional fuels to the energy sources and carriers associated with the industrial revolution. The Industrial Revolution, which dates to the late-18th century and has spread throughout the West, signaled a series of changes in the way humans quarry and consume energy. In this new energy transition, fossil fuels have come to dominate primary energy supply. Fossil fuels, first coal, offered much higher energy densities and more flexibility than the bulky and site-specific resources that dominated the pre-industrial era (Grübler, 1998). Steam created from fossil fuels was particularly important to mining (coal, copper

[16] An example of efficient energy use by industry was coke-fueled smelting of pig iron in blast furnaces, which consumed only one-tenth of the energy per mass of finished product of charcoal-based production (Smil, 1994).

and lead) and to powering the factories that drove the boom in Britain's textile industry (Mokyr, 1990). Britain, birthplace of the Industrial Revolution, saw a succession of innovations in the use of steam power between 1770 and 1870 (Landes, 1998).

While much of this energy revolution occurred within industrial firms—in part because economic activity concentrated at ever-larger scales and in part because large energy systems required scale for efficient operation—the modern energy transition has also affected households. Coal supplanted wood and agricultural wastes for interior heating—either directly or as steam supplied in district heat schemes. In cities, gas manufactured from coal supplied lighting and other services. Later, new fossil fuels—oil and natural gas—supplanted coal, preferred for their higher energy densities, ease of transport and relative cleanliness (Mitchell, 1998). As noted earlier, industrialization has also accompanied a shift to clean energy carriers, notably electricity.

While there is a broad correlative relationship between the commercialization of energy systems and economic growth, the direction of causation is less established. Is the modernization of energy systems a source of economic growth and the improvement of human welfare? Or does the causal arrow run in the opposite direction, with economic growth allowing society to invest in new energy systems? At the broadest macro level, today's experts on economic growth are focusing on factors other than energy—in particular, the institutions of governance, fiscal control, and openness to trade and competition (Easterley, 2002). Energy prices are often included as a factor in the models that are used to explain economic growth, but rarely have growth economists given much attention to energy services as an independent source of growth. The wellspring of economic activity, it is thought, is found elsewhere.

A similar conundrum arises when examining energy services for low-income households. Energy services in these households are dominated by traditional fuels—especially for cooking and heating, which account for the bulk of the total energy consumed by a typical low-income household. One school holds that the provision of modern energy services can liberate time and provide motive power for productive purposes—thus helping a household (or, more often, a village, since commercial energy services require an infrastructure that is usually larger than a household) overcome poverty. Therefore, these scholars tend to focus on "energy poverty" as a source of broader economic poverty.

Another school sees the sources of economic growth as rooted elsewhere, such as in the availability of institutions for providing capital—the "microfinance revolution," for example, is rooted in this idea. If the conditions for microfinance lending are in place then households and villages will be able to mobilize the capital needed to invest in their own economic growth—including energy capital investments such as small generators, distribution lines, solar panels and the like. By this logic, the critical original condition is the presence of institutions such as microfinance—once in place, those facilitate the emergence of energy systems and other aspects of the local economy.

Most likely, the causal arrows run in both directions. There is some evidence that energy-focused policies have helped to alleviate poverty. Yet evidence also exists that

poverty alleviation programs that are not particularly focused on energy nonetheless have had an effect on energy purchases. And the normal process of economic development—excluding overt policies to promote development—also has a bicausal relationship with energy services.

This complicated logic is extremely important for the core task of this paper: to explore the interactions (if any) between power sector reform and the prospects for achieving broader development goals. The reason is that electricity is not the only source of useful energy for households and small firms that typically lie at the center of the development challenge. These entities, especially households, make use of multiple fuels simultaneously (Masera et al., 2000; Liewen and O'Neil, 2003; ESMAP, 2003; Pachuari and Spreng, 2003; Heltberg, 2005). Such patterns in multiple fuel use arise for several reasons. First, households often have significant capital invested in "traditional" technologies (e.g., wood-burning stoves) and may not have the spare capital to purchase new energy-consuming appliances immediately upon gaining access to new energy sources (Saghir, 2004). Second, modern energy sources are usually expensive and thus applied sparingly and for unique services (such as radios and television for entertainment) rather than simply supplanting an existing energy carrier that already supplies a service adequately (Thom, 2000). Thus, traditional fuels and technologies tend to exit more slowly than new ones arrive; modern transistor radios exist alongside primitive cookstoves. And the largest energy users in the household—cooking and heating—are the last to be replaced by modern fuels. Finally, multiple fuels can provide a sense of energy security. Complete dependence on commercially-traded fuels leaves households vulnerable to variable prices and often-unreliable service. In Hyderabad, India, for example, electricity reliability is so low that households experience an average of two or three power cuts each day (ESMAP, 1999).

Although households deploy many fuels and technologies simultaneously, they appear to follow a hierarchy in the energy *services* that they demand. Almost always, cooking and heating are the first functions fulfilled, followed by lighting and entertainment. For the poorest people in developing countries, cooking (and space heating in particularly cold climes) can account for upwards of 90% of the total volume of energy consumed; lighting accounts for the majority of the remaining share (Victor, 2002a). The operation of appliances such as electric irons, refrigeration devices and water heaters arrive in household energy budgets only after core heating, cooking and lighting services are satisfied (Victor, 2002a).

Figure 10 shows results from household energy surveys in Brazil, Kenya and India that illustrate the relative shift from traditional to cleaner fuels as incomes rise and the energy services afforded by households expand. The data from Brazil reveal a phenomenon often evident in energy services for the poor: when incomes rise, total energy demand can fall (if temporarily) because wealthier households can afford more efficient conversion technologies that reduce the amount of primary energy needed even as demand for energy services grows (WEC/FAO, 1999). These patterns reveal that *electricity* occupies only specialized niches in household energy budgets. The first few kilowatt hours of electricity acquired by households are commonly used for lighting, entertainment and communication services, while many households continue to cook and

heat the home with traditional fuels long after modern energy enters the household (IEA, 2002; WEC/FAO, 1999). The sparing use of electricity reflects straightforward economic calculations by the household: electricity is usually much more expensive than its rivals.[17]

[17] Some of this reluctance to shift to electricity may also be due to taste preferences and the familiarity of cooking with traditional fuels and technologies. In India, for example, many wealthy households retain a biomass stove for baking traditional breads (Malhotra et al., 2000). And in certain regions of Mexico even high-income households cook tortillas over an open wood fire rather than using an LPG stove because they prefer the taste and texture provided by woodfuel cooking (Masera et al., 2000; Saatkamp, 2000).

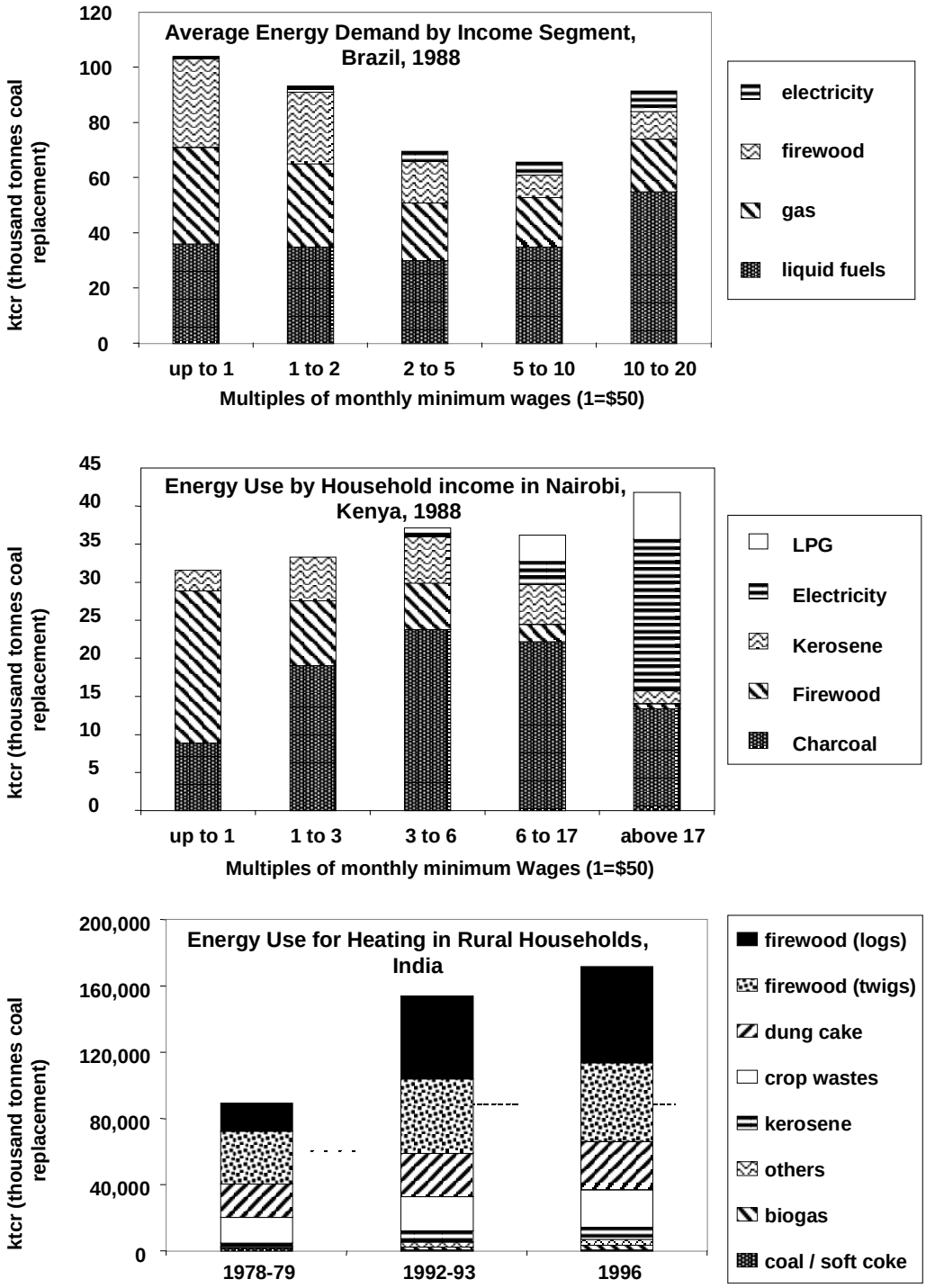

Figure 10. Household energy surveys in Brazil (top), Kenya (middle) and India (bottom) showing the shift from traditional to cleaner energy sources with rising incomes (Brazil, Kenya) and over time (India). Some surveys have given particular attention to electricity, which arrives in the household energy budget along with other clean fuels but typically in very small quantities because electricity is expensive relative to its rivals. Sources for Brazil: de Almeida and de Oliveira (1995). Sources for Kenya: O'Keefe et al (1984), Leach (1992). Sources for India: Natarajan (1998).

Although costly, electricity provides benefits that are difficult or impossible to attain with other energy sources. In providing illumination, electricity is safe and without fumes—unlike traditional wick lamps or even pressurized kerosene lamps. In providing power

for radio, television and other appliances (e.g., cellphones), electricity has no rivals. Thus even at extremely low income levels households have been willing to spend large amounts of money for small quantities of electric power. In a subsidized rural electrification program in Western China the cost to villagers for electricity is about US$.50 per kilowatt hour (and the total cost perhaps above US$1 per kilowatt hour). Solar panel programs have been successful even when they supply power at US$.50 per kilowatt hour. Schemes to supply power to rural areas through the central and remote recharging of lead acid batteries also cost similar amounts, and are economic. (For more on power pricing see cost data in Hu, 2005).

At least three implications follow from the observations that electricity arrives in the household energy budget as a niche energy carrier and households are willing to pay extremely high tariffs for small quantities of power. First, much of electrification for the very poor should not be viewed simply through the lens of government policy—as a service that must be supplied below cost. The solar photovoltaic program in Kenya, though begun with subsidy, is now a self-sufficient and highly competitive market (Duke et al., 2002). Most of the success with rural electrification in China has been achieved through small hydro plants whose cost has been paid through local funds and private investment for self-supply as well as formal governmental programs. In much of the world electricity arrives to a rural area in the form of small diesel generators, many of which are not subsidized although often diesel fuel receives a subsidy that is actually targeted for transportation services. These facts do not mean that public policies for electrification are not often important, but they do mean that economic settings where communities are able to mobilize capital on their own could provide similar levels of service as overt public policies to promote electrification. Even if power market restructuring were to undercut the ability of governments to provide direct grid service for the poor (a hypothesis we will challenge in the next section), that may not matter for the benefits that households typically obtain from initial electrification. Indeed, households are already willing to spend handsomely for a niche of electric service.

Second, it is crucially important that electrification not be equated with benefits of energy services. Electricity provides its own important (often unrivaled) benefits to households, but the bulk of primary energy obtained by the household comes in other forms. Some governments have given excessive attention to electric services for the poor at the expense of broader "energization" strategies (see, for e.g., Howells et al., 2006). India's unbalanced electricity policy, for example, has focused excessively on providing power for farmers who use it for irrigation at nearly zero cost; yet welfare would be enhanced with an alternative strategy that gave more attention to other complements, such as the pricing of water, energy efficiency, and even more costly power that could lead to better-run electric utilities that supply higher power quality (World Bank, 2001). And the most adverse health effects—such as smoke from wood or dung stoves—are typically not extinguished by the arrival of electricity. There is an extensive record of experience with such cookstove programs (e.g., WEC/FAO, 1999 reviews the literature).

Third, progress with electrification is usually measured at the level of individual households. For urban areas this measuring is probably apt because households are densely arranged, they are located near commercial and industrial users that are profitable

to serve, and (relative to rural areas) are wealthier and able to afford larger quantities of electricity. These factors make it generally less costly per connection for utilities to provide urban electrification, although in practice many urban areas are still quite costly for power utilities to supply (e.g., de Oliveira, 2005). In rural areas the situation is quite different and the proper measure of electrification is not simply the household. Families benefit not only from having electric service within their homes but also through the various small enterprises, co-operatives, and other so-called "productive" uses of electricity. Often these productive activities are the anchor customers for rural electrification. Because these ventures make cash earnings, in many settings they make viable even non-subsidized electric service. In the Chinese history of electrification, for example, profitable township and village enterprises (TVEs) partly provided the commercial impetus and finance needed for some electrification programs (Pan, 2002). As household incomes rise, these productive electrification programs can spread to individual households.

C. The Global Record: Access to Electricity

Before turning to the particular policies that have been adopted in an effort to promote electrification, we first look at the global record of electrification. While 1.6 billion people today lack power, that number has declined from about 2 billion in 1970. And the proportion of the world population that lacks access to electricity has declined sharply—from perhaps half in 1970 to less than one-quarter today (IEA, 2002). Figure 11 reports these numbers and proportions and also offers the IEA's projection (by region) for the year 2030.

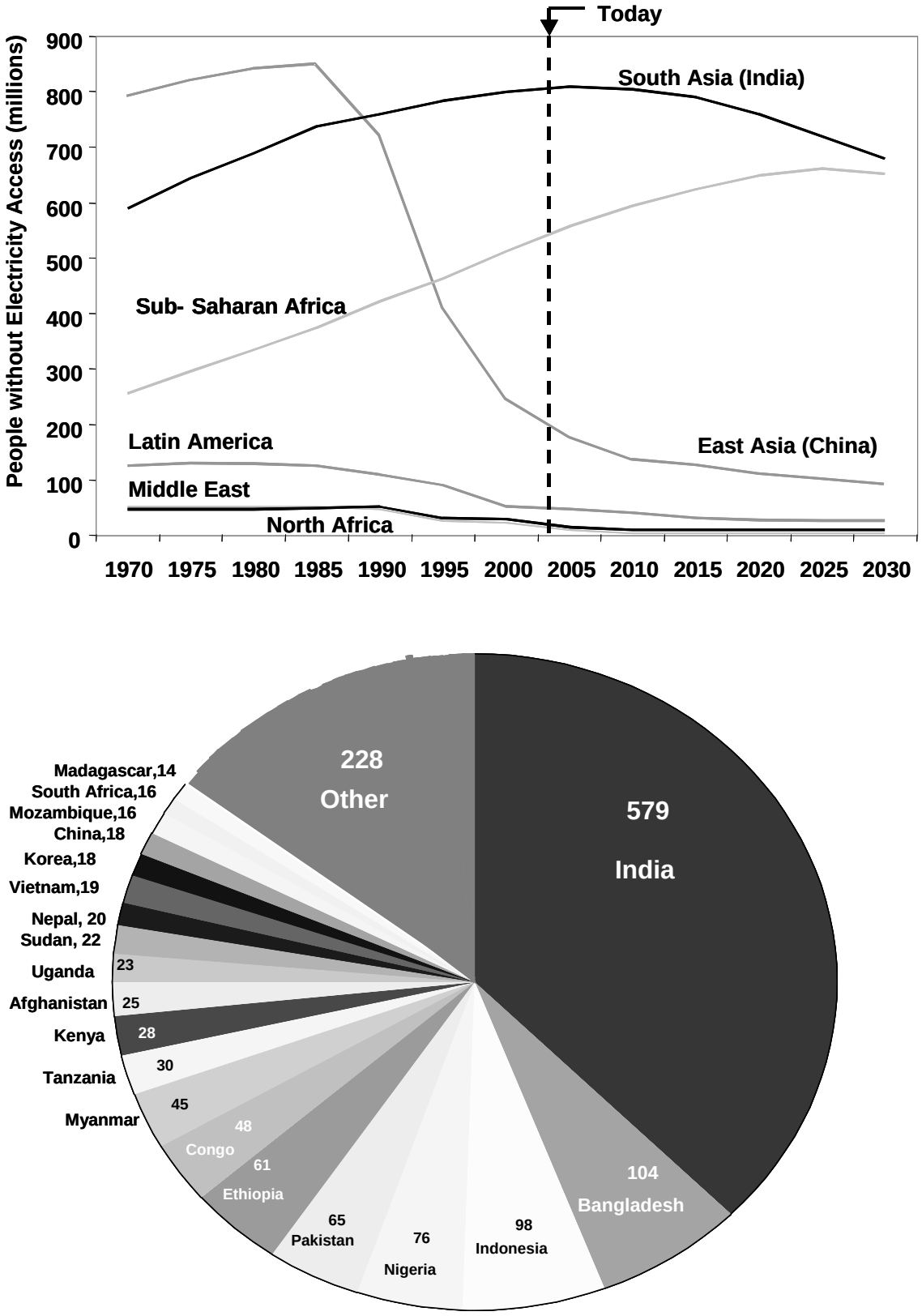

Figure 11. Population without Access to Electricity over time (top) and for 2001 (bottom), in millions. "Access" is measured at the household level. Data Source: IEA (2002).

The variation in outcomes across countries and regions is particularly striking. Analysts do not agree what accounts for these differences, although the dominant effect is probably income. Latin America has had high levels electrification because of achievements in economic development prior to 1980, although the lost decade of development during the 1980s caused some of that progress to stall. The continued persistence of large unelectrified populations in India reflects the difficulties that country has had with rural development. India remains as the largest remaining challenge for electrification in terms of sheer numbers of unelectrified households. (In terms of electrified villages, India is doing well, but village measures reveal only the availability of electricity in the proximity of village dwellers and nothing about truly remote households.) As a fraction of the population, sub-Saharan Africa remains the least electrified region of the world, and while the population without access to electricity in South Asia (India, Pakistan and Bangladesh) is peaking at the moment and on the cusp of declining, in Africa the numbers are still rising steadily. Again, that outcome reflects mainly the difficulties of economic development and the fact that populations in Africa (despite a declining birth rate) are still growing more rapidly than the tentacles of economic prosperity can spread. However, it is important to underscore that the data used to make current assessments and projections are incomplete and flawed in many ways and thus the actual availability of electricity may be quite different, especially in areas (notably Africa and South Asia) where measurement efforts have been historically poor.

It is also clear, however, that each country and region has its own story, and the details matter. The most dramatic story of electrification in the last three decades is in China, where a series of factors coincided to electrify about 600 million people over a period just two decades, from the early 1980s to the present. One factor is certainly the economic development that began in earnest after a large reorganization of the Chinese economy starting in 1979. That development included, in the first 10-15 years, a heavy emphasis on small enterprises such as the "Township and Village Enterprises (TVEs)". The TVEs and similar modes of development shifted some of the rise in purchasing power that accompanied China's surge to rural areas—which both lifted incomes and created investment in electric (and other) infrastructure. At the same time, the central government created some financial incentives for rural electrification activities, although most such activities were actually undertaken by provincial and local government enterprises. (Exact ownership and control over these electric infrastructures is difficult to determine because the Chinese economy, then and now, has not made clean allocations of property for enterprises that serve public purposes.) Essentially all of China's success with electrification in the last three decades has come through small mostly hydro systems—more than 90,000 today—rather than through extension of the integrated power grid. Small hydro systems are easier to scale for local uses and, where hydro resources are available, often much cheaper than grid services (Pan, 2002; Leiwen and O'Neill, 2003).

A detailed study of electric services in Mexico has shown that electrification is most closely correlated with economic growth and urbanization (themselves related phenomena—in most economies, the wealthiest population tends to be the most urbanized) (Carreon et al., 2006). They report data for the country as a whole (figure 12)

and then examine the correlations for the sample of all Mexican states. Access to electricity more than doubled from 1970 to 1990. Residential and agricultural tariffs declined in the 1970s, which aided electrification, but progress in electrification has continued even through the flat and rising tariffs of the 1980s. Even as the sector has experienced enormous financial difficulties in the 1990s, electrification continued apace. By 1997, 94.7% of the Mexican population had access to electric power. Today, penetration has reached 96%, despite the country's complicated geography and remoteness of small settlements in diverse rural areas. Despite this achievement in aggregate, some states have lagged markedly—notably, Oaxaca, Chiapas, and San Luis Potosi where there is a high percentage of indigenous communities living in remote rural areas where the cost of service is high (Carreon et al., 2006).

The correlation with electrification is highest for GDP (R^2=0.81) and urbanization (R^2=0.99). Urbanization is, itself, strongly affected by income growth. Similar results are evident for water services, but in telecommunications the correlations are much less robust—suggesting that public policies promoting access have been more important for telecommunications or, perhaps, the cost of telecommunications has declined so sharply that factors such as urban concentration and income have a less intense effect than in the public services where costly fixed infrastructures remain central. The story of successful electrification in Mexico is similar in many respects to that of China—factors outside the electric sector have spilled over to create dramatic progress in electrification. This history is quite unlike that of South Africa, where success in electrification in the 1990s is the direct consequence of an active government policy to promote electric connections (Eberhard, 2006).

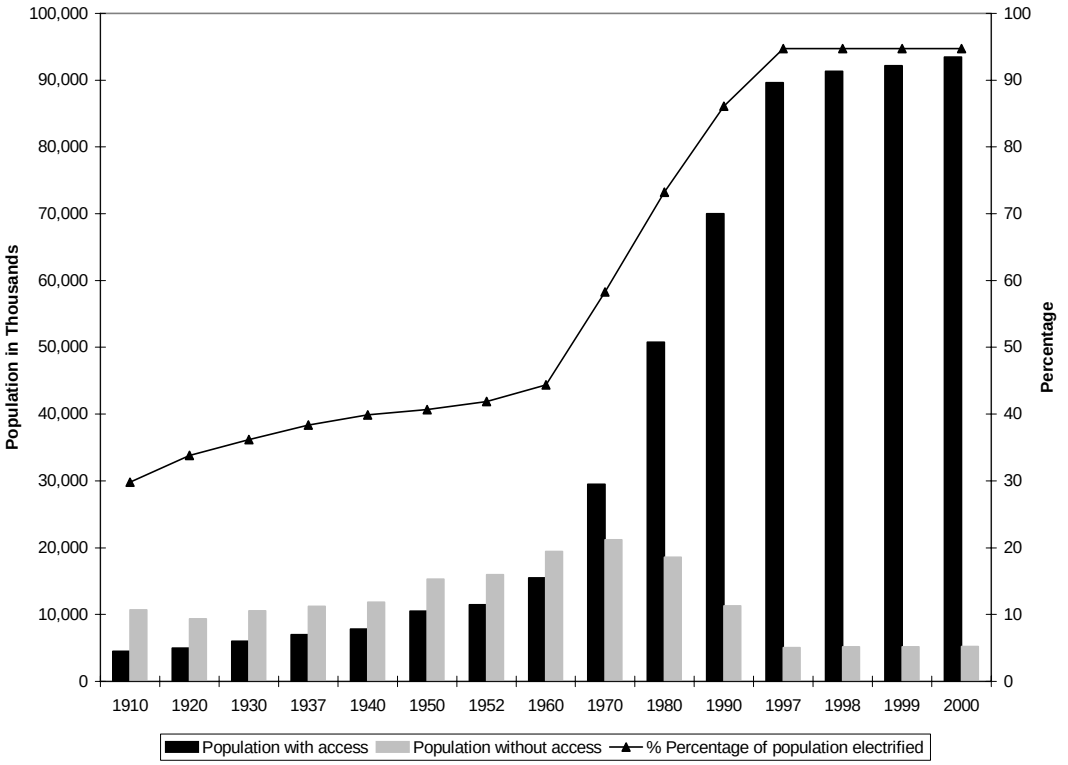

Figure 12. The progress of electrification in Mexico. Data source: from CFE analyzed by Carreon et al. (2006).

D. Power Sector Reform and Electrification

Now we turn to the links, if any, between power sector reform and energy services for the poor and unelectrified. It is clear that the provision of services for the poor depends on many factors. Moreover, the most important factors—economic development, in most cases—lie largely beyond the leverage of power sector reformers. Indeed, because of the dominant role of economic development in both, there may be some positive correlation between power sector reform and energy services for the poor. Developing countries that have achieved the highest levels of economic development have generally pursued the most elaborate power sector reforms because the same pressures that lead to economic reform (and growth) usually also lead to power sector reform. Argentina, Brazil, and Chile are the economic powerhouses of Latin America and also among the most active reformers of the power sector (along with Columbia). In Asia, India's power sector reforms have been contemporary with broader economic reform that has multiplied growth rates. China is an anomaly in its sustenance of exceedingly rapid rates of economic growth (itself partially a result of market reforms) and yet a lack of much reform in electricity. To some degree this is simply the result of the enormous accumulation of capital in China, which the government has been able to direct toward

power investments rather than attempting reforms in a sector that is viewed as more strategically important. In general, countries that have achieved the highest levels of economic development have also systematically achieved the highest levels of electrification, although clearly the relationship is not iron-clad (see figures 2 and 4, for example). In this section we explore what countries have done (or not) to advance the goal of electrification.

Governments have been acutely aware that reorganization of the power sector could frustrate efforts to extend service to low-income households. In response, they have adopted a wide array of policies aimed at electrification at the same time that they have sought, often haltingly, to reform their power sectors. Various analysts and advocates for such public benefits have articulated the need for such policies (e.g., Dubash, 2001, de Oliveira, 2005). Under the old system, such policies would have been simply parts of the state system and thus perhaps less visible; more overt policies have been needed as those state enterprises were unbundled, exposed to new accounting methods, subjected to hard budget constraints, and restructured to respond to new incentives. We examine three broad clusters of policies and also an important fourth area of activity (private enterprise) that has had a large effect in some settings where public policy allows or even encourages its operation.

CHINA[18]

As in so many countries, the Chinese power system began as a scattered series of local systems with both private and public investors. After the founding of the People's Republic of China in 1949, the new communist regime nationalized the entire industry and placed it under the control of the central government. In time, the industry developed trademark syndromes of central planning: chronic shortage and lack of incentives to perform. The government initiated sweeping reforms of the entire economy beginning in 1979; with time those influences have spread (albeit only partly) to the electricity sector.

Chinese electric reforms have been notable for their apparent changes to structure yet the lack of implementation of much reform in practice. The first reform in the electricity industry started in 1986 with the implementation of a scheme designed to raise investment funding for industry expansion. The rise in power demand associated with double-digit growth in the Chinese economy from the early 1980s dwarfed the inadequate financial capability of the central government – the sole operator of the electric power industry at that time. The reforms included the abandonment by the central government of its exclusive right to invest in new power plants. Under the reformed system, central planners retained control over the approval of large projects (>50 MW) and projects with foreign investors, but smaller projects were left to provincial authorities. Private investors were also allowed to build some plants. In addition to decentralized control, the central government adopted a new "cost plus" rule that offered generous rates of return and accelerated capital repayment schedules (usually 10 years). By the end of the 1990s power plants other than those controlled by the central government accounted for 54 percent of the national total installed capacity.

This first wave of capital-oriented reforms also included the creation of a new national tax (RMB 2 cents per kilowatt hour) that funded new electricity projects and was shared between the central and provincial governments; a wide range of special fees and charges were further collected by state and local governments to finance various projects such as Three Gorges hydro project construction. These measures increased electricity costs to all end-users, including in rural areas that served low-income users, but they achieved the goal of attracting new investment.

A second stage of reform began in the late 1990s, aimed at separating government administration from business operation of electricity supply. These reforms included elimination of the Ministry of Electricity Industry and the creation of a separate corporation with its own board of directors: the State Power Corporation (SPC). These reforms had little practical effect on efficiency as the SPC's board and management are government appointees. A few years later, in 2002, the SPC iteslef has disbanded into five separate generation companies and two grid companies—all owned by the state.

[18] This box is based heavily on Zhang and Heller (2006).

(The southern grid company is shared ownership with the province of Guangdong.)

The reforms of the late 1990s also included experimentation with wholesale market competition among generators on a very limited basis in six provinces in 1999 (Liaoning, Jilin, Heilongjing, Zhejiang, Shanghai and Shandong). The experiment was associated with the unexpected turn around of the power market from chronic shortage to a wide-spread surplus that arrived when the Asian financial crisis created a macroeconomic shock that suppressed demand. Even power companies with PPAs were forced to reduce their contracted off-take hours. When the glut disappeared these market experiments were suspended.

The government's aims in breaking up the SPC monopoly include the eventual creation of a competitive power market, improvements in economic efficiency, and optimization of resources through national grid interconnections. These reforms have also included the creation of a regulatory commission; so far, however, the commission has not been vested with any significant powers.

At the same time, the government has been concerned about the lack of economic development in rural areas and has introduced special funding programs and lower end-user tariffs for rural power projects. Rural electrification has long lagged behind electricity development in urban areas due to a central planning strategy that favored manufacturing industries. For a long time the central government focused investment capital and power output on industries in urban areas. In contrast, large rural areas—with over 70 percent of the nation's population—were left to follow the government policy of "self-construction, self-management, and self-consumption" since the early 1960s (Wu, 2003). With little government support, rural communes and villages slowly developed small, predominantly hydro, power stations during the 1960s and 1970s. By 1979, about 90,000 small hydropower stations had been built, with a total capacity of 6.33 GW (Smil, 1988, p.64). These stations had an average size of 70.3 kW capacity, were unreliable due to seasonal changes in water flow and lack of connection to main grids. They were also highly inefficient, with line losses as high as 30 percent. The slow development of rural electricity left 245 million people—or 31 percent of the rural population—with no access to electricity in 1979. Rural electrification has since improved significantly. Installed capacity, power generation and access to electric services have all increased rapidly. Power consumption by agriculture doubled over two decades; meanwhile, 217 million new rural residents gained access to electricity. Per capita rural residential consumption of electricity rose to 64.13 kWh in 1998—though remained only 1/8 that of their urban counterparts.

Several factors have contributed to rural electrification in the past twenty years. Economic development in rural areas—such as through small industrial "township and village enterprises"—have increased the demand for electricity and also brought in new capital for investment in electricity infrastructure. These facilities, especially, have favored coal and diesel power, which are more reliable than run-of-the-river hydro stations. The central government implemented several programs to increase rural electricity development during this period, with programs such as "400 Rural Electrification Counties", "Sending Electricity to Villages" and "Replacing Firewood

with Electricity". These programs supplied technology, training, and capital; the most successful of these provided resources but relied on provincial and local authorities to orchestrate construction and operation. In addition to these activities specific to rural areas, the overall rapid economic development of the country during this period also played a role. On balance, the electricity reform elements have probably helped to accelerate rural access to power because they have decentralized control over capital investment.

Subsidized access

The most visible means of extending electric service to low-income areas has been via a direct subsidy for extending the grid (or providing alternatives to the grid) and even the initial appliances and wiring inside the house needed to utilize newly available power. Nearly all countries have programs of this type. Many point to the experience with the U.S. Rural Electrification Administration, which extended the grid from cities to nearly all rural areas in the U.S. from the 1930s through the 1950s, and to other public enterprises (e.g., TVA) with similar mandates. Despite the current wave of enthusiasm for private ownership and market competition, supporters of such programs note that these were state enterprises funded by government. Indeed, in the U.S. today most power in rural areas is supplied by semi-governmental cooperatives—not the privately owned utilities that dominate in urban markets.

Other countries have also funded governmental and quasi-governmental ("public-private partnerships") of this type. Examples include the special funding provisions, mentioned earlier, for the building of small hydro facilities in China. Those programs generally paid the capital cost for the small turbines, generators and power lines but have left local communities to fund the operation and maintenance of the facilities.

South Africa has had perhaps the most dramatic of such programs that promote electrification by subsidizing the initial access lines. Starting in the late 1980s the state-owned integrated utility (Eskom) subsidized connections, first in urban areas (starting with the politically visible township of Soweto, outside Johannesburg) and later extending the electrification program to rural areas. The rise of this program, which is now electrifying several hundred thousand homes per year (see figure 13) reflects the high priority put on electrification and other infrastructure services by the country's new black leadership (whose eventual control was obvious by the late 1980s, with formal control being handed over in 1994). Traditionally, infrastructure services had been the province of an elite minority; the new government made a visible public commitment to extend such services to all (Eberhard and van Horen, 1995). During the 1990s the electrification program moved from an activity of Eskom to a somewhat market-oriented program orchestrated and paid for by the government. The government sought bids for electrification services, and while Eskom won most of those bids, an array of dedicated electrification enterprises also arose to provide these services. Particularly interesting is RAPS, a private organization that provides solar-based technologies in rural areas with

government subsidy. During the 1990s South Africa's electrification program also shifted from "easy" electrification targets (dense and relatively affluent urban populations) to the much harder task of electrification in remote rural areas. Despite this shift, the cost per connection continues to decline through experience. The concept of "learning by doing" that has attracted much scholarly attention in mainstream areas of technological change—such as in the building of ships, aircraft and windmills—also applies to low-income electrification. South Africa's electrification program has been aided by low-cost (coal) power and by a keen interest in avoiding other rival fuels, such as kerosene that is linked to the poisoning of an estimated 10,000 children annually (Eberhard and Van Horen, 1995). Some countries have created separate rural electrification enterprises even though the power sector is dominated by state companies. Among the reasons for such an organizational situation is that the arms-length enterprise can be an attractive vehicle for external funding—as evident in Kenya's experience (see box).

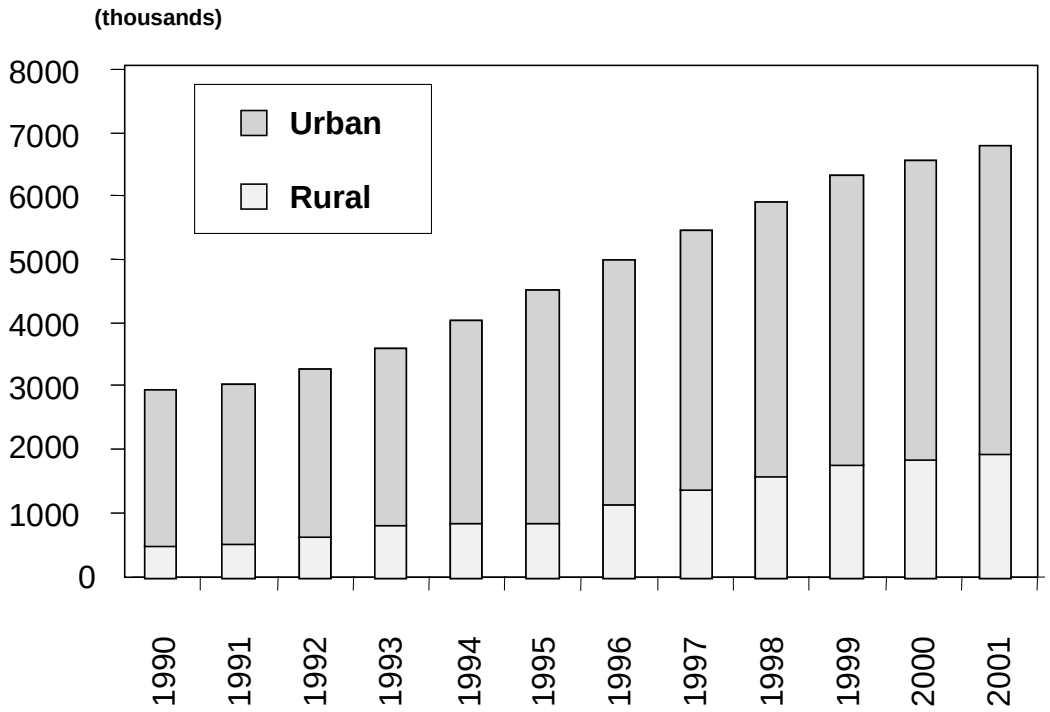

Figure 13. South Africa's experience with electrification (thousands of households electrified per year). Data sources: from Wendy Poulton (Eskom) and Trevor Gaunt (Univ. of Cape Town).

In India, an elaborate array of special funding mechanisms has arisen to advance the goal of electrification, with mixed results. Some power sector financing came from intermediaries such as the Rural Electrification Corporation (REC) and, later, the Power Finance Corporation (PFC), both state enterprises that raise money from government,

outside donors, and the bond market. REC was established in 1969, after the famines of the 1960s, with the mission to "facilitate availability of electricity for accelerated growth and for enrichment of quality of life of rural and semi-urban population." Unlike its counterpart in the U.S. (which was a partial model), REC funds more than just rural electrification. Loans are provided only to utilities, not end-users, at or just below market rates. Effectively, REC transfers and consolidates risk, since it takes outside loans (both from the government and the market) itself. PFC was established in 1986 with the goal of becoming the primary financial institution for the development of power projects. Its funds are meant to be in addition to the on-budget expenditures envisioned under India's system of central planning. Most loans are given at attractive rates (lower than bank lending rates by several percent). Despite its strong performance, PFC can only meet a small fraction of the needs of the system, and the bulk of PFC's resources go into the general system (which in turn also benefits electrification, although most electrons go to established users). The compass for these electrification efforts is in India is a government policy to provide "Electricity for All" by 2012. The government is presently advancing its timetable for full electrification, but few analysts believe that the target of full electrification is achievable in the coming few years.

MALAYSIA[19]

State-owned Tenaga Nasional Berhad (Tenaga) is the dominant electric utility in Malaysia. Tenaga owns roughly half of all Malaysia's generation assets and holds a monopoly over transmission and distribution in all of Peninsular Malaysia; in eastern Malaysia two much smaller utilities provide power to the provinces of Sabah and Sarawak. The rest of generation capacity is owned primarily by independent power producers (IPPs), the result of a law initiated in 1990 designed to attract private investment into the sector.

Malaysia was one of the earliest Asian countries to proceed with a privatization program. Under the 1990 Act the government power authority, National Electricity Board (NEB), was corporatized into Tenaga and then partially privatized through the selling of non-controlling shares on the Kuala Lumpur Stock Exchange, where today Tenaga is one of the two largest capitalized stocks.

All aspects of policy in the energy sector are overseen by the Prime Minister's office; the Energy Commission (EC), a division of the Ministry of Energy, Water, and Communications, is the principle electricity sector regulator and is responsible for implementing the sector's governing statute, the Electricity Supply Act 1990 (amended in 2001). The regulator sets tariffs and advises the government on power policies.

As in most other countries that privatized state power companies and introduced IPPs during the 1990s, the goal was to reduce government involvement in commercial activities and lighten the burden on the treasury that would have resulted from the need to double capacity—from 6,645 MW in 1992 to an estimated 12,000 MW by 2000 and to 30,000 MW by 2020. Malaysia's economic expansion during the 1990s created a surging need for power, and electricity was viewed as a key bottleneck for continued economic growth and industrialization generally. A massive two-day blackout in 1992 shut down factories, computers and traffic lights, prompting a fierce public outcry and threats of lawsuits against Tenaga. An inquiry cleared Tenaga of negligence, but the incident severely damaged its reputation (*Asiaweek*, July 12, 1996).

In response to the blackout, the Malaysian government dismantled Tenaga's monopoly on generation and aggressively pushed forward an IPP program to restore an adequate margin of capacity and to ensure that the country could meet its anticipated power needs. In addition to concerns about financing and the competence of Tenaga's management, IPPs were viewed by the government as particularly attractive vehicles for foreign direct investment. However, all the winners in the bidding for IPPs have been consortia dominated by Malaysian enterprises. (Some of these companies were new to the power sector, which may have made it difficult to get lending from financial institutions. These

[19] This box is based heavily on Rector (2005).

firms had good political connections but little knowledge of building and running power plants.)

As is commonly seen in IPP programs, the contracts had take or pay PPAs or fixed capacity charges such that Tenaga would have payment obligations regardless of whether it actually needed the power. These new power supplies were significantly more costly then production by Tenaga-owned facilities. The first IPPs were all gas fueled, sourced from domestic natural gas resources and supplied solely by Petronas, the state owned oil and gas company.

Malaysia had visions of broader reforms that would introduce a competitive power pool, full privatization of Tenga, and the removal of restrictions on IPPs that required them to transmit their power through Tenga's power lines. But the California power crisis put an end to those plans, lending to arguments that stability is far more important than theoretical efficiency gains that might result by injecting competition throughout the value chain. The Asian financial crisis of 1997-1998 and subsequent difficulties in the Malaysian economy dampened the expected rise in demand for power, which in turn has lightened pressure for reform.

Concessionary tariffs

Nearly every country pursues its political aims, in part, through the electricity tariff. Almost always, the tariff structure reflects the goal of providing electric services at below cost to low-income users, especially in rural areas. Even in countries where the price of electricity is high in rural areas—such as in China—the tariff structure includes some built-in subsidy that overcharges users who are wealthier, less able to oppose high tariffs, or are not politically favored. As the central government in China has become increasingly worried about failures of economic development in rural areas it has reduced tariffs for rural users even as tariffs in the rest of the country have risen (and are poised at this writing to rise even further). (Thus most left-leaning governments tend to target industry—often small industrial users who are large in number and not well organized on this issue. See, for example, the discussion of Mexico in the box.) India is an extreme example of this phenomenon, where low-income agricultural users pay almost nothing (though get low quality power in return), as described in more detail in the box.

MEXICO[20]

The Mexican power system arose as a series of privately owned, vertically integrated local and regional monopolies located mainly in mining and industrial areas as well as in the largest cities. With the political consolidation following the period of the Mexican Revolution (1910-1917), foreign investment waned to a trickle. Into this void stepped government, whose actions over several decades brought the power system under complete control of the state. The *Comisión Federal de Electricidad* (CFE) came to dominate all investment in new capacity; CFE, and a smaller state-owned enterprise, *Compañía de Luz y Fuerza del Centro* (LFC), which serves the areas around Mexico City dominate the Mexican power system today. These state enterprises retain their control through Article 27 of the Mexican constitution, which gives government "exclusive responsibility" for generating, transmitting, transforming, and distributing electricity. This constitutional provision reflects longstanding populist appeal to sovereign state ownership of vital infrastructures. CFE and LFC operate through a system of "soft budget" state financing and wield enormous political power directly and through labor unions.

Mexico is an oil exporter, and when oil prices crashed in the early 1980s, a deep financial problem created both the urgent need and a political opportunity for reformers that sought to make the power sector more efficient while reducing the burden on the state to supply all new capacity. Those reforms started slowly and cautiously; successive financing crises have created additional pressure for reform. Reforms proceeded relatively swiftly in other economic sectors (e.g., banking, telecommunications), but it has proved difficult to muster the momentum for electric reform, in part because a democratic restructuring in the late 1990s has opened Mexican politics to an array of competing political parties. Fragmentation has impeded efforts by successive presidents to implement power sector reforms as there is enormous disagreement on the best track.

In 1993 Mexico created an independent regulator, the Energy Regulatory Commission (CRE), with limited powers—such as review and approval for new power projects. However, the setting of tariffs has not shifted to the regulator; instead, tariffs have long been controlled by the *Secretaría de Hacienda* (Ministry of Finance), which views tariffs as an extension of the development strategy that the government pursues at any given moment.

The macroeconomic crisis of the early 1990s included a negotiated settlement with Mexico's creditors that limited the ability of state-owned enterprises to incur additional debt. For the power sector, this did not seem a substantial concession—the economy was expected to tip into recession and thus demand for power would be sluggish, and considerable excess capacity was available from the years of over-building. Reality

[20] This box based heavily on Carreon et al. (2006) and Nuñez-Luna (2005).

proved to be quite different. Integration with the U.S. fueled rapid economic expansion in Mexico and power demand rose at a much higher rate than expected. The government response followed the pattern in most other rapidly growing developing countries: independent power projects (IPPs) that would sell power to CFE under long term contracts. The first IPP (Mérida III) entered into service in 2000; since then, 3,495 MW of capacity have been added through IPPs, which has contributed considerably to restoring the sector's reserve margin. In recent years, one-third to one-half of all new capacity has come from IPPs, and a sizeable segment of that has taken the form of self-generation and cogeneration facilities located at industrial sites outside the direct control of CFE and LFC. Barely one-third of the new capacity from 2000 to 2002 came from the traditional CFE and LFC-dominated model of power plant construction.

IPPs have solved some problems, but others remain. Maintenance at state-owned enterprises is falling short. IPPs are financed through a scheme known as PIDIREGAS that shifts the true size of the liability for long-term contracts off the government's books; but those contracts could prove costly, especially in the wake of a currency devaluation (all the contracts are denominated in U.S. dollars, not in local currency). And the power sector is still the beneficiary of a large net subsidy totaling about US$5 billion a year, principally because of residential and agricultural tariffs are set way below cost—the subsidy associated with residential tariffs alone could be as high as 3% of GDP. (The distributional effects of this subsidy are enormous; total tax collection, outside the oil sector, is only 10% of GDP.) In 2000, residential consumers received 64.1% of the total subsidy; the industrial sector 17.9%; the agriculture sector 11%; and the commercial sector 5.3%. As a consequence of this policy, residential consumers face a tariff that is among the lowest in the world. A new 31-category tariff scheme adopted at the end of 2000 marks a further step at rationalization; still, residential tariffs remain below cost—implying a subsidy for 98% of users.

Politically it has proved extremely difficult, if not impossible, to raise residential and agricultural tariffs. Most analysts conclude that the only practical way to make the sector financially sound is to reduce costs—yet that, too, is politically challenging as it requires confronting the powerful unions that embedded in CFE and, especially, in LFC.

Since the early 1990s there have been repeated efforts to adopt reforms that go beyond comprehensive the creation of an independent regulator and provisions for IPPs. The keystones of those efforts have been constitutional reform and transparency in the setting of tariffs. These two efforts would go hand-in-hand. Constitutional reform would make it possible to have non-state players in the power sector (outside the highly restricted form of IPPs with long-term contracts); in turn, market competition would impose scrutiny of costs. In addition to promising electricity at lower cost, a shift to competition would make it possible to remove key operational decisions in the sector from the grip of state enterprises and their unions. The theoretical appeal of these arguments, however, has run aground on the power of particular vested interest and the inability, despite at least two major efforts (one in 1999 and the other around 2003) to assemble a viable coalition for electricity reform. Throughout the period of attempted reform, Mexico has continued to extend electric services to low-income households—in part due to special tariffs and in part due to growth in incomes. Mexico is already highly electrified, except

in the poorest and most rural areas (notably the south).

Many economists have opposed these subsidy structures because they are not efficient; nor is it sustainable to charge much less than the cost of supplying a good. Under-charging leads to over-use, scarcity and misallocation of resources. Mindful of such arguments, it is important to note that tariff structures that deviate from cost of service are not completely inconsistent with economic theory. If tariffs are raised for those who are relatively indifferent ("inelastic") to price and set lower (near the marginal cost of supply) for the price-sensitive then the power system is able to recover not just its operating costs but also its fixed costs in a way that does not impose undue costs on welfare. Such approaches are known to economists as "Ramsey pricing" and are an attractive second-best policy when it is politically difficult to create the most rational tariff structure: a two-tier (or multi-tier) scheme in which users pay fixed costs in lump sum payments and then pay for the marginal cost through the tariff. Such a system is also often called a "block tariff" in which the first unit of service (the connection) is charged at a very high rate and then lower tariffs apply to higher volumes—increasingly, telecommunications is charged in this fashion, but these arrangements have proved politically difficult to apply in the case of electricity.

Many countries do have block tariffs that operate in the reverse from the purely economic solution. The first block of consumption is charged at a low rate—also known as a "lifeline" tariff as it is supposed to represent the minimum amount of power that is necessary for the household to operate at an agreed standard of basic welfare. Consumption above that "lifeline" level is charged at a higher rate. (Consumption at much higher levels, such as in industrial and commercial facilities, is usually handled in a different tariff schedule from households and often charged at lower rates.)

Some countries are now implementing zero tariffs for the lifeline level. South Africa is presently implementing a zero-cost tariff for the first 50 kwh of electricity consumed by households per month. The experience with this program sounds a caution about such schemes, which are politically attractive but engender difficulties in time. One of the political problems is that the size of the zero-tariff block can become politicized—thus some politicians in South Africa are already jawboning a 100 kwh/household block even as the 50 kwh block is just taking effect. As these political dynamics unfold a power system can easily find itself in the quandary that afflicts India, where an essentially unlimited block of power is available to special classes of users (notably farmers). A second problem is that free power can cause severe distortions in household energy budgets as rational households will invest in appliances that use the low-cost (or free) power even though alternatives could be socially more optimal. In South Africa evidence is mounting that households are now cooking with electricity (up to the 50 kwh free block) even though the cost per unit of energy delivered to the bottom of a pan would be lower if those same households would use LPG; similarly, electric hot water heating is spreading, although in some areas solar hot water heaters would be socially less costly (e.g., Howells et al., 2005).

GHANA[21]

Ghana's power sector has been undergoing some reform since 1995 with the aim of increasing private sector participation and also boosting the performance of state-owned enterprises. Nearly all the country's electricity comes from two large hydroelectric projects (Akosombo and Kpong) and Takordi thermal power station, all owned and operated by the state enterprise, the Volta River Authority (VRA). Beginning with its first power sector loan to Ghana in 1961, the World Bank became the most important external source of financing for power projects, and thus VRA has been particularly sensitive to the Bank's influence. VRA also owns and operates the country's transmission grid; distribution of electricity to final users is controlled by the state-owned Electricity Company of Ghana (ECG). Until reforms the Ministry of Energy controlled the sector—providing both the functions of a regulator and policy strategist.

Prior to attempting structural reforms in the sector, Ghana made an effort to improve the efficiency of the sector by setting performance contracts for VRA, ECG and other state-owned enterprises; it is unclear whether these contracts had much impact on behavior.

At the same time that the government began to grapple with power sector reforms it also focused attention on the problem of extremely low electrification of the country—a reflection of the very low income levels in Ghana (in 1990 GDP per capita was US$343; in 1999 about 79% of people were living on less than $2 a day) and the poor performance of state enterprises. By 1993, only 24 percent of the population was served by electricity. In 1989, the government instituted a National Electrification Scheme aimed at expanding access to the entire population by 2020; it is too early to assess progress toward that target, but electrification remains extremely low – 55 percent of population remains without electricity). Even as Ghana's power sector posted poor performance, demand for power rose sharply. Between 1985 and 1993, internal demand for power grew 10.8 percent per year as the economy rebounded from an economic crisis of the early 1980s and the needs of the National Electrification Scheme were realized. Ghana had long been an exporter of electricity to Côte d'Ivoire; in 1994 that trade pattern reversed. At the same time, Ghana had binding export obligations to Togo and Benin and still needed to serve the needs of its own consumers. Investment in new generation and transmission capacity was urgent.

In 1993, a new World Bank policy of "commitment lending" required sectoral reform as a precondition for further loans. With the World Bank's pressure, a series of reforms followed. In February 1997 the Electricity Company of Ghana was formed to hold the assets of the Electricity Corporation of Ghana and corporatised—a first step to eventual privatization. Also in 1997 the government created the legal basis for an independent regulatory commission, and the next year the commission ("PURC") took over the function of setting tariffs and announced a rise in tariffs of all categories of consumers—

[21] This discussion of Ghana's reforms is based heavily on Dubash, N.K., ed. (2002a),

part of an effort to create financial solvency in the power sector.

In practice, it has not proved to be inordinately difficult to implement cross-subsidy schemes while also exposing the power sector to the disciplines of private ownership and market forces. Governments have kept authority over final tariffs and have been able to adjust them as needed for public electrification programs. Usually regulators are assigned responsibility for tariffs, but the rules governing their choices typically provide room for concessionary tariffs for such purposes. Moreover, distribution franchises can be awarded with requirements for private owners to provide electrification services. In Brazil, for example, all distributors are required to extend electric service to their entire concession area; the practical implications of that requirement are negotiated with Brazil's regulator who looks at a wide range of factors affecting electric service and the distributor's financial performance.

Tolerance of theft

Very briefly, we note that in many countries a major "strategy" for electrification appears to be tolerance of theft. Most governments do not overtly express this as an electrification strategy, and there has been no rigorous analysis done by experts. As a strategy it is fraught with problems, of course. Theft-based energy services engender criminality; it is dangerous for those who make the connections; it undermines efforts to assure stability of power grids and can cause system damage such as transformer burnouts and voltage drops; it is also selective for those who have the political connections to get electric connections. All that noted, in many power systems theft is one of (often *the*) largest sources of low-income connections. Indeed, theft often exchanges with legal electrification. In Rio, a program to "normalize" energy services in shantytowns (*favelas*) sought less to make new connections than to replace illegal connections with safer wiring, meters and actual payment (at reduced rates) (USAID, 2004; see also the detailed study of one shantytown in de Oliveira and de Melo, 2005).

So far we have focused on policies that tend to be applied to grid-based electric services, in part because these are politically the most visible and in part because the institutions that provide these services are usually controlled by the state enterprises that also run the grid system. But for extremely remote households the grid may not be efficient (e.g., Goldemberg et al., 2004). In countries where the grid is poorly managed and unreliable there are alternative schemes that are more attractive.

Many countries have created special schemes for off-grid energy services. They include China's programs for small-hydro and South Africa's electrification program (which includes some subsidies for rural solar home systems). Many analysts have focused on

renewable power—such as biogas digesters connected to generators and photovoltaics—as especially attractive sources of rural electric power. Such energy systems do not require outside fuel sources and are therefore often viewed as especially "sustainable." Among the notable successes with these programs are the efforts to provide solar home systems to poor rural areas in Bangladesh.

Private sector electrification

It is important to note that all aspects of low-income electrification are not the product of charity, concessionary lending, or public programs. Indeed, there are interesting prospects for a substantial private sector (i.e., for profit) industry in electric services. Indeed, in most low-income households the provision of energy services is already, at least partly, served by self-sustaining private markets. For example, very poor rural households typically provide the bulk of their energy services from self-collected fuels that require zero cash expenditure by the household. (The only opportunity cost is labor, often accounting for several hours per day, but the cash benefit from averting that labor expense is low or zero if there are no other wage opportunities.) Even so, some energy services—for example, extra fuel needed in emergency or specialized services—are commercial activities in some settings, with cash or barter as currency. And households whose energy budgets are dominated by traditional fuels may nonetheless purchase energy conversion technologies (notably stoves, as cooking and heating—often provided simultaneously by a stove—are typically the main uses for bulk energy in low-income households). Advanced cookstove markets exist in some countries, based on cash sales—often catalyzed by government programs—and have led to noticeable improvements in human health when compared with traditional, highly polluting stoves (e.g., three stone fireplaces).

In urban areas, self-collected fuels are less available as forests and caches of crop residues are more distant, and thus households typically make greater use of private markets for energy services. Cash incomes are also typically higher in urban areas where jobs are proximate, and thus efficient fuel markets can arise.

Similar arguments apply to electric services. Concessionary and government programs typically attract the most attention because they are the most visible and generate, on their own, the richest track record. But there is evidence of private sector electric programs as well. In China, some small hydro electrification has arisen entirely with locally-collected resources and operates akin to a private enterprise. Electrification of small villages with local diesel generators can arise entirely through private transactions—private firms as vendors of the technology and fuel, and local companies through self-interest as purchasers. Kenya's highly competitive market for photovoltaic panels and services arose with some subsidy but for two decades has been a market populated almost entirely by private enterprise (see box). For-profit business models for rural electrification exist in many countries; in India, for example, reforms adopted in 2003 were aimed, in part, at unleashing private sector investment in such electrification (Zerriffi and Victor, forthcoming).

KENYA[22]

Like most countries examined in this study, Kenya's power system began as a small privately owned scheme oriented to serve special users. A state owned company was established in the 1950s to transmit bulk power from Uganda, and by 1970 the Kenyan government had integrated power services into a single enterprise—the Kenya Power and Lighting Company Limited (KPLC)—in which it had a controlling interest.

Today, Kenya's power system is dominated by two state-owned enterprises. Most generation is controlled by state-owned Kenya Electricity Generating Company Limited (KenGen). KPLC also controls transmission and distribution and is 51% owned by the Kenyan government, with the balance held by private investors. Lacking its own prodigious sources of fossil fuels, Kenya relies heavily on hydropower; in 1992 hydropower accounted for 87 percent of total power generated, but since then the absolute quantity of hydropower and the share have declined. To offset this loss, Kenya has made greater use of geothermal power (12.4% of the total in 2001) and fossil fuels (diesel engines run on fuel oils, and gas turbines run on kerosene or gas condensate).

Traditionally, Kenya had relied on bilateral donors and funding from multilateral development banks to finance power projects—notably dams. A general aid embargo against Kenya in the early and middle 1990s—the byproduct of strict one-party rule, allegations of corruption, and long history of Kenyan unresponsiveness to conditions placed on external aid—largely eliminated donor funding as a source of system expansion. Kenya remained unattractive for private investment for reasons similar to the donor exit, and thus contracted for a series of small IPPs, some on extremely short terms (e.g., one year PPAs), in the context of power emergencies that included frequent blackouts. Today, the Kenyan system remains dominated by state companies, but the few IPPs that operate are the legacy of this unusual policy history.

Since the early 1970s the Kenyan government (and outside donors) has focused on the need to supply energy services to rural and low-income areas. In 1973 the Kenyan government initiated the Rural Electrification Program (REP) to extend the grid to rural areas. In 1997 the government expanded its effort with a special 5% levy on all power consumption that is used to fund the Rural Electrification Programme Fund (REF). In addition to these grid extension services, which have played a role but always been hampered by the larger difficulties with KPLC's administration, Kenya is famously the locale of one of the world's most successful experiences with off-grid electrification. Begun in the early 1980s with limited subsidies from the World Bank, the system has evolved to a completely self-sustaining and highly competitive industry. Firms supply solar panels, batteries and appliances; a service industry has also arisen (Duke et al,

[22] This box based heavily on Gratwick and Eberhard (2005).

2002).

The separation between generation on the one hand and transmission & distribution on the other is one product of legislation in 1997 that de-integrated and corporatized the Kenyan power system. At the same time, the Kenyan government created the framework for an independent regulator—the Electricity Regulatory Board (ERB). The ERB is charged with setting tariffs and overseeing the industry and operates in the context of a policy set by the government. ERB has a reputation for operating independently, but its six member body has suffered from extremely high turnover. In principle, the government can overturn ERB decisions, but so far that has not happened.

During the 1990s the Kenyan government and the ERB gradually raised tariffs with the goal of making the electric power sector more self-sufficient—a condition that the World Bank imposed on further lending. A tariff adjustment in 1994 raised rates to 53% of Long Run Marginal Cost (LRMC); in 1996 they rose to 75%, and further tariff increases occurred in 1999. These tariff increases affected all users and contributed to a steep decline in power consumption.[23] Other factors that contributed to the decline were drought and an economic recession (itself a partial byproduct of the drought conditions that affected farming). Despite higher tariffs, KPLC posted losses starting in 1999 due a long drought; only in 2004 did it post a profit. The tariff structure includes some cross-subsidy, as REP users (who are costly to serve) pay only about 20% more than the largest industrial consumers (who have the lowest tariff, which is consistent with their highly concentrated consumption of large power volumes). The highest tariffs are paid by small and medium commercial users and government (for street lighting).

At this writing, the gradual privatization of state enterprises is expected to continue, with 30% of KenGen to be sold, perhaps, in 2005. The separation of transmission services from KPLC is also expected in the next two years with the formation of an independent transmission company. These actions are expected to continue laying the framework for truly open competition at least in the bidding and siting of new power plants and, eventually, at the retail level.

These markets are widely viewed as niche activities, but with 1.6 billion people still lacking electricity (and a much larger number with power consumption well below the 1000 kwh/capita that some analysts have argued is a reasonable goal for basic

[23] For more on electricity reforms and the poor and the implications of higher tariffs see Nyoike (2004).

electrification) this "niche" could be very large.[24] Successful firms in these enterprises will probably be nimble, small firms that understand the markets and tastes that prevail in different local conditions. They will be able to keep costs extremely low while tailoring services around the very small quantities of electricity that low-income users are typically able to afford. Successful firms in this area are also likely to combine the provision of energy services with innovative financing schemes—such as microfinance (allowing the household to make the capital purchase of a PV or other system directly) or various kinds of leasing or service-based arrangements.

E. Electricity Reform and Environmental Protection

In addition to electrification of the poor and pricing of electric services, reform could also affect the achievement of development goals through possible impacts on environmental quality. Again, the links are very difficult to determine because many factors affect the environmental impact of the electric power system. For example, countries that are growing rapidly require large quantities of electric power; all else equal, that expansion will probably take a toll on the environment. Indeed, reform of the power sector since the early 1990s has correlated highly with expansions of the power sector, and in turn with higher total emissions of some pollutants (e.g., Shukla et al., 2004; Zhang et al., 2005). On the ledger of sustainable development, however, should such sector expansion be counted as a debit (due to higher emissions) or a credit (due to welfare-improving expansions of service)?

The best way to examine the impact of reform on the environment is to focus on the implications for choice of fuel and technology. The case studies presented in the boxes throughout this text reveal a wide range of impacts. The most common story is that power sector reform creates closer attention to costs—especially capital costs. In coal-dominated countries that fact has systematically favored natural gas-fired power plants over incumbent coal technologies—at least in settings where gas is available and priced competitively. (In Brazil, for example, when gas was abundantly available reform was assumed to favor construction of gas plants; today, with regulatory rules that discourage gas-for-power contracts and a shortage of gas, the Brazilian market is looking to more hydro, biomass and even coal. See de Oliveira, 2006.) IPPs, in particular, have often favored gas because of short construction times and modularity, which allow the IPP to be nimble in responding to changing conditions.[25] Developing countries offer essentially

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[24] The 1000 kwh/capita/year target has not been scrutinized rigorously, but for a presentation and discussion of the key issues see EPRI (2003) and Victor (2002a); for a discussion of sustainable electricity consumption over time see Spreng (2005).

[25] IPPs are disproportionately gas-fired—even in countries, such as China and India, where other fuels are dominant (Woodhouse, 2005).

no experience with bid-based open power pools, but in places that have such systems—for example, England & Wales—gas has also gained favor for similar reasons. (In England & Wales, the case for gas was strengthened by the arrival of abundant gas from the North Sea and by a particularly high cost structure in indigenous coal mines.) All else equal, gas is environmentally much less harmful than coal—emissions of essentially all pollutants are much lower.

Some power sector reforms have created incentives to build hydro facilities. In Brazil power sector reform has seen the privatization of many existing dams and incentives to build a small number of greenfield dams. In Turkey, the country's IPP scheme has seen the construction of one new dam. Hydro facilities have essentially no atmospheric emissions (although highly controversial new evidence suggests that some dammed reservoirs emit prodigious quantities of greenhouse gases), but they do impose other ecological costs such as ecosystem disruption (usually due to flooding) and humanitarian costs such as displacement of nearby human settlements.[26]

No developing country has yet exposed existing or new nuclear power plants to market competition, so it is unclear what effect reform will have on their construction and operation. In the advanced industrialized world the experience has generally been that market competition has created strong incentives to operate nuclear reactors with shorter and fewer downtimes—leading to a greater role for nuclear power (MIT, 2003). So far, however, competitive power markets have not created strong incentives to build new nuclear plants. Like hydro, nuclear power has essentially zero atmospheric emissions but other ecological (and security) liabilities that are highly controversial.

Power sector reforms have usually coincided with other economic reforms that have also generally rewarded efficiency. In India, for example, reforms in the early 1990s made it possible to import heavy electrical equipment and build world-class power generators that, in turn, had much lower emissions than their Indian-made competitors (see box). That competition has since spurred better performance by Indian equipment suppliers, and the environment has been a beneficiary.

Reform of the power sector is also often correlated with growing attention to all matters ecological. In Mexico, the electricity sector is subjected to increasingly strict regulation concerning siting and effluents. The relevant norms are under renewed consideration at present as Mexico considers the possibility for even stricter rules based on improved state-of-the-art technology. The government is in the midst of designing a credit trading system for regulating large sources of sulfur dioxide—including power plants as well as the many facilities of PEMEX. In Brazil, the growing power of environmental regulators has forced closer scrutiny of new power projects—notably

[26] For a particularly high estimate of greenhouse gas emissions from large hydro plants see Fearnside (2002).

SENEGAL

Senegal's power system is dominated by state-owned SENELEC. In the mid-1990s the World Bank made further loans to the power sector conditional upon reform of SENELEC. The government resisted strongly, seeing SENELEC as vital to the country's economic model. Under intense World Bank and IMF pressure the government relented and sold the enterprise to the French-Canadian group, Elyo Hydro-Quebec (EHQ). (The government used a timely blackout to muster the political will to sideline union leaders that opposed the privatization.) Private ownership, however, did not resolve the fundamental problems in Senegal's power sector. Power outages increased, which contributed to the country's further economic slowdown; the private owners were accused of transferring profits abroad, enlisting too many external consultants, and discriminating against Senegalese employees in pay structures.

The controversy over SENELEC's privatization contributed to a change of government in 2000, after which the state took back control and reinstated the union leaders. The utility has improved since, and power outages have declined by more than 50 percent relative to 2000, but pressure to privatize is again building.

A second attempt at privatization undertaken in Senegal in 2001-2002 shows how difficult it is to bring the private sector into this type of partnership with the State. Two failed privatizations demonstrated the unattractiveness of small markets to the private sector. The Senegal experience shows that privatization is not necessarily the solution to the power sector's problems.

Privatization was part of a larger vision for power sector reform that included the possible creation of a power pool, provisions for independent power producers (IPPs) and third party access to the power grid. That large vision has never been realized, however, because of difficulties in the first step in Senegal's strategy—large scale privatization of the incumbent enterprise. Of the other parts of the larger reform vision, Senegal has had success in shifting some regulatory functions from government (which retains the policy-setting role) to a new independent regulator. The government has also created a Senegalese Agency for Rural Electrification (ASER), to guarantee cooperation between electric companies and private interests, particularly in the provision of technical and financial assistance related to rural electrification projects.

dams, for which it has proved very difficult to get environmental licenses.

Power sector reform has not been unalloyed good news for the environment. Perhaps the most striking example is in China where rapidly growing demand for power and the lack of central control over the building of small (<50 MW) power plants has led to a profusion of small and inefficient units that burn generally low-quality diesel fuel. Emissions are extremely high, and compared with alternatives (e.g., centralized large coal- or gas-fired units) this outcome is certainly less ecologically or economically favorable (Zhang et al., 2005). Whether the favored ecological outcome is feasible is

hotly debated; more likely is that power simply would not be available, which would impose severe economic costs.

The Chinese power system has been growing so rapidly that it has proven difficult to embrace systematic ecological planning. Until the 1980s, the choice of generation technologies was determined by domestic technological capability and foreign assistance. During the Cold War embargo, China received technical assistance mainly from former Soviet Union and Eastern Europe, with the result that its plants were smaller and less efficient and usually had much higher emissions profiles than those in the West (Xu, 2002).

Rapid expansion of predominantly coal based capacity and power generation started to have a serious environmental impact and economic damages. By 1998, the power sector used 450 million tons of coal (25 percent of national coal consumption), emitted 6.97 million tons of SO_2, (30 percent of the national total) and 228.5 million tons of CO_2 , or one-quarter of the national total (Zhu et al., 1999). It was also responsible for 80 percent of national NO_X emissions (DRC, 2002, p.71).

Pollution emissions from power generation have caused huge environmental damage and socioeconomic costs. SO_2 is the most damaging source because of lax emission controls and the sheer scale of annual emissions. Studies conducted by the Chinese estimate that SO_2 cost the country between US$7 and US$13 billion in the mid 1990s.[27] Environmental protection has become a growing challenge to sustainable electricity development in China (Economy, 2005).

Chinese policy makers have long been aware of the environmental problems associated with electric power production, and a number of environmental protection laws and regulations have been established in the past twenty years to help protect the environment[28] Various efforts have also been made to either directly address environmental problems or, more often, to solve other industry problems with ancillary environmental benefits. For example, the recent long-term policy change to diversity sources of energy to increase capacity has also assumed growing importance in controlling environmental pollution from power generation. More large hydropower, long distance transmission, nuclear power, as well as the West-East gas pipeline and gas-fired power plants have been planned. Renewable energy, especially wind power, has been encouraged. Moreover, the central government's effort, initiated in the late 1990s, to shut down small old thermal power plants in order to reduce power surplus has also contributed to environmental protection. According to the State Power Corporation (SPC)

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[27] See DRC (2002) Chapter 3 for the source of literature. See also McElroy (1997), World Bank (1997).

[28] China's Air Pollution Control Law was promulgated in 1987. It has since been amended several times to tighten the control. The Electric Power Law of 1995 also provided for environmental protection in electricity development.

data, a total of 10 GW of small thermal capacity was eliminated between 1996 and 2000. An additional 14.2 GW is scheduled to be replaced by new power plants with better technology during the 10th Five-year period (SPC, 2002).

In general, environmental considerations have not been the driving forces in power sector reforms. While critics have complained about IPP projects on environmental grounds (and even filed lawsuits, notably in India, to stop such projects on environmental basis), it is a fact that modern plants are better designed and have lower emissions than vintage plants (Shukla et al., 2004).

V. CONCLUSIONS AND IMPLICATIONS FOR POLICY

The history of power sector reform in developing countries, while complicated and varied, reveals two general lessons. First, very few developing countries have actually implemented much reform. Many have advanced bold visions for reform, but actual practice has been slow, halting and generally carefully. I have argued that the key causes of this are the larger and complicated institutional infrastructure that is essential for reform; reforms in the power sector in depend on the pace of reform in areas quite far outside the electricity. Those other ancillary areas include government budgets, capital markets, the judiciary, labor and fuel markets. Indeed, it is interesting to note that the developing countries that have gone the furthest to implement power sector reforms have not embraced the full textbook of reforms; they have generally not moved to bid-based open wholesale markets but have stopped short with various cost-based systems that are much easier to administer. While bid-based systems may be the holy grail of a competitive market, without adequate conditions and supervision they can also go horribly wrong—as evident in California. They may be particularly prone to go wrong where the demand for power is rising rapidly and thus it is likely that scarcities may arise—conditions that describe those in the developing countries that have been most keen to embrace reform programs.

The second lesson from history is that power sector reforms coincide with many other changes in the organization of industry and government. It can be extremely difficult to disentangle cause from effect, as we have shown when probing the particular impacts of power sector reform on sustainable development—notably the provision of electric services for the very poor and the impact of electricity on the environment.

Mindful of these two general lessons, we close with a few implications of this study for further analysis and for policy.

For analysts, the implications lie in areas where scholars so far have devoted almost no attention. One area where analysis is weak is in measures of electrification beyond simply access to power. The world is making steady—though still inadequate—progress toward making power available to all. The real questions surround power prices and quality. Yet so far most measures of progress still focus on access. A shift in the way that progress is measured will make it easier for analysts to see the very large potential—

and perhaps real—market in for-profit low-income electric power (and energy) services. Excessive attention to just connections has, perhaps, led analysts and policy makers to pay too much attention to stringing wires and not enough to the role of electricity in the household and local economy where the poorest people live.

A second area for further analysis is in the complex linkages between reform and low-income energy services. We have shown that crucially important policy issues arise in the midst of reform, and there is a wide array of experience with such policies and their varied outcomes. Sophisticated analysis of the cause-effect linkages could lead to much better insights into how electric markets for the poor really operate and how policy makers can exert leverage on outcomes for the benefit of the poor.

A third area that requires research is on the broader linkages between "globalization" and power services for the poor. It does not appear that openness to market forces and electrification are zero-sum ventures. Similarly, it does not appear that, on balance, the exposure of electric power services (and equipment suppliers) to competition has been bad news for the quality of the environment—indeed, the bulk of the experience suggests the opposite. Yet exact linkages remain elusive and detailed case studies on such issues are scarce.

For policy, the analysis in this essay also suggests some key lessons. First, policy makers must pay particular attention to the root causes of poor access to electric power. Where the failures lie in a market failure—for example, the inability of a local community to obtain technology or expertise, or the lack of financial institutions to help households clear a large capital hurdle for acquiring new technology—then the potential role for government policy is clear. Where the failures lie fully with low purchasing power then electrification is, in essence, a development policy and must be evaluated alongside other development options that require the same fiscal resources.

Second, policy makers have at their disposal a wide array of policy tools for advancing electrification. In this report we have suggested the range of options, but the full universe of experiences is exceedingly broad. Policy makers may be right to fear that exposure to market forces will make it more difficult to pursue electrification programs within traditional state-dominated enterprises, but they would be wrong not to adopt one or more of the many ancillary policies available to ensure that this objective is achieved.

Third, the institutional context for reform has an enormous effect on outcomes. Thus, policy makers must be sure to design policies that are appropriate for the setting in which they are applied. For example, in India state regulators are now required to create transparency in financial accounting. That policy that has led to improvements in the performance of state enterprises, while not undercutting the incentives to provide reduced cost power to farmers in the states where governments have been willing to cover subsidies with additional budget resources. In states that have not been willing to keep the system solvent such a policy is bound to lead to quite different outcomes.

Another important contextual issue is the provision of capital. Where capital is available—for example, through microfinance—households are much more likely to be

able to participate in electrification schemes (and other beneficial energy programs) than in cases where the household must rely entirely on its own resources.

Fourth, it is important for policy to tap, where available, for-profit services that can serve the poor. The gains from market discipline and the much deeper base of capital that is typically available to the private sector must be tapped. For example, since 2003 India has "delicensed" rural energy services, which has eased (in principle) entry of private firms into this line of business. Policy makers should also compare notes on which pro-business policies seem to work best, while avoiding fads. At the moment, public-private partnerships have received much attention; it is not clear, however, whether this new industrial model is actually much different from long-standing efforts by government to encourage and shape private activity.

Fifth, policy makers must realize that the markets in developing countries are quite different from those that have emerged in much of the industrialized world. Among the many implications of this are those related to training. Workshops organized by regulators in the advanced industrialized world may have little to offer regulators who operate in completely different institutional settings and address quite distinct political, legal and regulatory challenges.

To close, there are no intrinsic conflicts between electricity sector reform and attaining human development goals. To the extent that electricity sector reforms lead to a more efficient and financially sustainable power industry they may contribute to additional investment and improved service. Cogent concerns about power sector reform undermining the incentive to serve poor users have been raised; in practice, nearly all governments have sought to address these issues with special rules and arrangements that accompany power sector reform, such as tariff rules and concession requirements that are designed to serve the poor. Nonetheless, it has proved very difficult to identify clear causal links between power sector reform and development because such reforms have often been much less modest than originally envisioned and have arrived at a time of profound economic and political change. Indeed, power sector reforms usually ride in the coattails of much larger reforms that have a more substantial effect on the level and distribution of national income and a much more direct impact on human development.

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