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Access and Affordability of Electricity in Developing Countries

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Summary. — A key objective of developing countries is to provide affordable access to modern energy services in order to support economic and social development. The paper presents a number of arguments for why and in which way energy access and affordability can play a key role in national development programs and in achieving the Millennium Development Goals. Approaches for measuring accessibility and affordability are presented, drawing on case studies of Bangladesh, Brazil, and South Africa, countries with different rates of electrification. Affordability of using electricity is examined in relation to the energy expenditure burden for households and time consumption. Conclusions focus on lessons learned and recommendations for implementing policies, instruments, and regulatory measures to tackle the challenge of affordability.

Key words — access, affordability, electricity, Bangladesh, Brazil, South Africa

1. INTRODUCTION

A key objective of developing countries is to provide affordable access to modern energy services in order to support economic and social development of the society, the business sector, and individuals. Electrification is one important intervention to address energy poverty. Affordable access is not simply about connecting households to the grid. The extent to which energy services are actually used depends on their affordability.

The article presents a number of empirical results on energy access and affordability, drawing lessons based on the experience of three developing countries—Brazil, Bangladesh, and South Africa. The three countries are at different stages of electrification, ranging from those with very low levels of connection (Bangladesh), through those making rapid progress but still having significant portions of rural populations that are not electrified (South Africa) to those who have connected most households (Brazil). In these contexts, we examine the issue of affordability—both of access and affordability of use.

The principal methodology of this article is to draw on country studies, highlighting the twin issues of access and affordability. A proxy for affordability of use is the energy expenditure burden for households as a share of disposable income. The article considers lessons from implementing policies, instruments, and regulatory measures to tackle the challenge of affordability.

The article begins by setting the context of energy and development, and distinguishes the issues of access and affordability. Section 3 focuses on data from the three countries on access, with the following section presents case studies of policies to improve affordability. Lessons are drawn at the end of each section, and tied together in conclusions.

2. ENERGY AND DEVELOPMENT, ACCESS AND AFFORDABILITY

Electricity and other energy access are major factors in economic and social development. On the one hand, energy is a key productive asset in economic growth. Energy is a necessary input together with machinery, land, natural resources, human capital in the productive base of the economy.

On the other hand, access to clean and reliable energy is critical to human welfare and income generation possibilities seen from a household perspective. The literature includes several studies on energy and its role in development process, including work by Toman and Jemelkova (2002) about energy as a component in production functions and as a productivity-enhancing factor. Other studies have elaborated how energy together with other factors—such as income levels, education,

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health, and literacy rates—contributes to the welfare measured in relation to focal areas, such as health service, education, income generation, and leisure (Afrane-Okese, 2001; Cowan & Mohlakoana, 2005; Energy Sector Management Assistance Programme (ESMAP), 2003; Mehlwana & Qase, 1999; Spalding-Fecher, 2000). Toman's approach links macro and micro perspectives through factor analysis. He concludes that the following factors show how energy is related to economic development:

> Cleaner fuels resulting in health-related benefits, reduced smoke exposure, clean water and refrigeration, yielding direct benefits and higher productivity.
> Access to modern energy services allowing reallocation of household time (especially by women) from energy provision to improved education and income generation.
> Economics of scale in more industrial-type energy provision.
> Lighting providing greater flexibility in time allocation through the day and evening, as well as better conditions for education; and
> Lower transportation and communication costs, greater market size and access, more access to information (the combined result of energy and other infrastructure) (Toman & Jemelkova, 2002).

Overall, one can say that energy is a necessary condition for development, even though energy on its own is not sufficient. Extending access to affordable energy services is important to developing countries, enshrined for example in South Africa's energy policy (Department of Minerals and Energy (Department of Minerals, 1998). Brazil has codified access in a legal framework and pursued the implementation of electrification through several programs, notably Programa de Desenvolvimento Energético de Estados e Municípios (PRODEEM), Sérgio de Salvo Brito Reference Center on Aeolian and Solar Energy (Sérgio de Salvo Brito Reference Center on Aeolian, 2008), Luz no Campo (Avança Brasil., 2008) and Luz para Todos (Ministry of Mines and Energy (MME), 2008). Bangladesh has seen increases in electrification levels off a low base, and is actively pursuing an off-grid electricity program. Yet access in the sense of physical connection does not achieve anything, if the electricity is not affordable.

We define access and affordability as follows. By access, we mean that households and business in a given area can connect to electricity that is established either by grid or smaller non-grid connected supply. This assumes that individual households or businesses do not take decisions about investing in power supply or electricity grids.

Affordability is a politicized concept (Energy Sector Management Assistance Programme, 2003). Energy plays an important role as a basic household good; fuels for lighting and cooking are nearly impossible to live without. Strict quantitative definitions of affordability are difficult in this context. However, we seek to develop a working definition for this paper. A distinction can be drawn between the affordability of access (e.g., related to the costs of connection) and the affordability of using electricity. The most common approach to approximate affordability of use is to quantify the share of household income spent on energy. The further question is how high a share is 'unaffordable'.

A fuel poor household has been defined in the UK Department of Trade and Industry (DTI) as

> "A fuel poor household is one that cannot afford to keep adequately warm at reasonable cost. The most widely accepted definition of a fuel poor household is one which needs to spend more than 10% of its income on all fuel use and to heat its home to an adequate standard of warmth. This is generally defined as 21 °C in the living room and 18 °C in the other occupied rooms—the temperatures recommended by the World Health Organisation" (UK Department of Trade, 2001).

The threshold of 10% is somewhat arbitrary, but is also used elsewhere (Foster & Tre, 2000) and does reflect that a non-negligible share of energy in household budgets is devoted to energy. Applying such concepts for developing countries, however, one needs to take into account other factors. For example, a high share of energy expenditure could be due to a high level of consumption (as a result of large household size or high levels of discretionary use or low efficiency of use), more energy might be spent on cooking and lighting, or it could be due to high unit prices of energy, or it could be due to exceptionally low levels of income (Foster & Tre, 2000). To complete this approach, one should examine to what extent households are able to purchase enough energy for subsistence needs. Subsistence levels would vary across countries, not least due to climatic conditions, for example number of heating and cooling days. This shifts the discussion to definitions of subsistence and goes beyond the scope of this paper. The focus of this paper is not to refine the exact quantitative threshold at which 'affordability' is achieved, but to investigate how energy services can be made more affordable by policy interventions. Greater affordability of use would be achieved if the energy burden of households is reduced, or efficiency of use is improved.

Affordability in the context of electrification and use of electricity means whether households can afford to actually use electricity once they are connected to the grid. The price of electricity with which consumers are actually faced is assessed in relation to household incomes, purchasing power (opportunity costs of other goods), and relative price of electricity compared with other commodities. In countries with high proportions of poor, analysis should distinguish income groups *within* the poor (Prasad & Visagie, 2005). For the business sector, the affordability of electricity is assessed in relation to production costs and costs of other energy forms. From the perspective of halving energy poverty (McKinsey, 2004), actual electricity use by households is a priority (Spalding-Fecher, Winkler, & Mwakasonda, 2005).

3. ACCESS TO GRID ELECTRICITY

This article draws on experiences in three countries across different regions of the developing world, which also have different levels of access to grid electricity. About one-third of the Bangladeshi population was connected to grid electricity in 2005, up from about 3% in 1971. Although 71% of urban households have access, but only 20% in rural areas. South Africa has moved from one-third access in 1990 to approximately two-thirds by 2002. Again, urban levels are higher at 80% than rural ones (50%) [1]. The Brazilian population has relatively high levels of access, with more than 99% access in urban areas, and rural electrification rates at 77% in 2001 being comparable to the urban rates in the other two countries. The following section examines the patterns in each country in more detail.

(a) *Brazil*

Access to the energy supplied by electricity in Brazil has evolved, if measured as household coverage, from 89% in 1992, to 96% in 2001, as shown in Figure 1.

Table 1 shows the different levels of access in urban and rural settings in 2000. It can clearly be seen that most problems of lack of access to electricity in Brazil are to be found in the

rural environment. According to the Brazilian Institute of Geography and Statistics IBGE, in the year 2000 Brazil had a population of 168 million living in permanent private households. Out of this total, 157 million have access to electricity and around 11 million people do not.

The 2000 census shows that 64% of households without access to electric lighting have a family income under two minimum wages.[2] If the households that reported no income and those with income less than three minimum wages are included, the figure increases to 89%. Data on access by small farmers are given by the 1996 Agricultural Census (Brazilian Institute of Geography, 1996), with some three million Brazilian farms without access to electricity. The recent evolution of electrification in Brazil is shown by the Brazilian Institute of Geography and Statistics (Brazilian Institute of Geography, 2001) (see Table 2).

The connection fee charged to customers was around US$ 995 (2002 values). This had increased from the 1994 levels of about US$810, prior to the reforms (see Table 8).

(b) *South Africa*

At the beginning of the 1990s, about one-third of all households were connected to the electricity grid. By the end of the decade, this had increased to about two-thirds. The National Electrification Programme connected more than 3.4 million households between 1994 and 2001. The Government continues the program with the intent to electrify 300,000 homes annually. It is interesting to note that the cost of connection was declining during the program (to around US$ 50, see below), although this decline is not expected to continue as electrification moves to more marginalized areas (see Table 3).

The total investment in the electrification program was about R7 billion (US$ 1.2 million), all of which was domestically financed. Without this subsidy, electrification would not be viable (Borchers *et al.*, 2001). As electrification is taken over by government, direct government subsidies will be required. Estimates are that a capital subsidy of R840 million (US$ 140 million) per year would be required from the government to regional electricity distributors for the first 5 years and R560 million (US$ 93 million) per year thereafter (PriceWaterhouseCoopers, 2000). This would amount to a subsidy of R2,800 (US$ 467) per connection.

The trends in costs of connecting households to the grid are shown in Figure 2. Changes in connection costs are reported in constant Rand (R6,000 was about US$ 1,000), and total connections and capital expenditure per connection are also shown. The average cost of urban electrification increased by

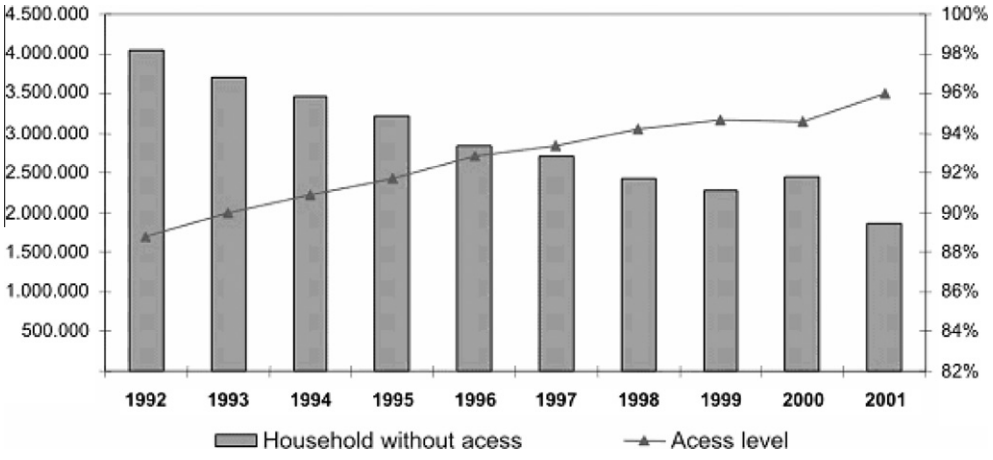

Figure 1. *Trends in access to electricity in Brazil, 1992–2001. Source: Rovere et al. (2004).*

Table 1. *Household and population figures in urban and rural Brazil (millions, 2000)*

	Permanent private households			Permanent population		
	Total	Urban	Rural	Total	Urban	Rural
Total	44.8	37.4	7.4	168	137	31
With electric lighting	42.3	37.0	5.3	157	136	21.7
Without electric lighting	2.5	0.4	2.1	11	1	9.3
Electrification level (%)	94.5	99	71	93	99	69

Source: Demographic Census (2000), Brazilian Institute of Geography and Statistics (IBGE) (2001).

Table 2. *Brazilian electrification levels (%)*

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
National	88.5	90.5	91	92	93	93.5	94.5	95	94.7	96
Rural	57	58	60	62	67	69	73	75	71	77
Urban	97.5	98	98.3	98.6	99	99.1	99.2	99.3	99.1	99.3

Source: Ministry of Mines and Energy (MME) (2005).

Table 3. *South African electrification rates*

	1990 (%)	1995 (%)	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)
Rural		21	27	38	43	48	46	49	50
Urban		76	79	74	77	80	74	77	80
Total	31	50	55	60	63	66	63	66	68

Source: National Electricity Regulator (NER) (2002, 2001, 1995).

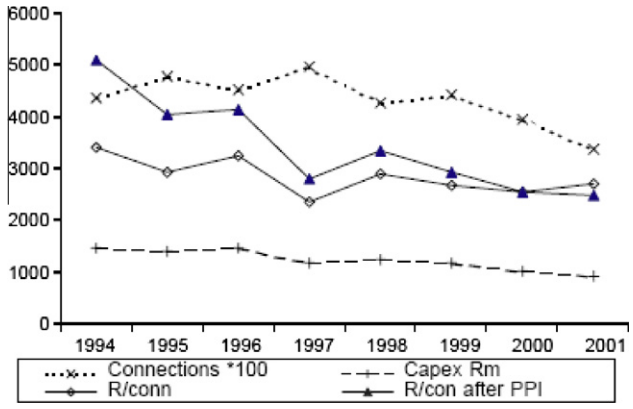

Figure 2. *Cost per connection in South Africa, 1994–2001. Source: Gaunt (2005).*

about 15% in nominal terms, although it decreased by 20% after allowing for inflation (Gaunt, 2005).

The *affordability of access* is better approximated, however, by the connection fee charged to households. An evaluation of the South African electrification program found that connection costs of around R300 (~US$ 50) were not widely affordable (Borchers, 2001). In the Western Cape, the electrification agent found that many families could not afford even the nominal connection charges of R150, and thus allowed them to pay this charge off over time, with apparent success. Other distributors explored the use of less expensive infrastructure, and some provided current-limited supplies as an option for those households who cannot afford to pay connection fees but are able to pay the costs for basic consumption. Non-technical losses were found to be high, and could only partially be addressed by technical means (e.g., pre-payment meters), with a more complete solution need to address cultural issues and requiring greater community involvement (Borchers, 2001).

In spite of the major achievements—such as being self-financed by the country—of the electrification program, nationally about 30% of the population is yet to be electrified (20% urban and 50% rural), mostly the poor. Some efforts were made to use photovoltaic panels in homes, schools, and clinics. Initial schools and clinics program, as well as an Eskom–Shell joint venture in the Eastern Cape, made some early connections. During 2002, 338,572 homes, 974 school, and 49 clinics were grid-electrified, and 5,321 solar home systems (SHS) installed (Mlambo-Ngcuka, 2003).

A larger-scale off-grid electrification program than the initial joint venture was launched in March 1999, aimed at providing 350,000 SHSs in seven concession areas. However, this was later revised to five concession areas, and a sixth was recently awarded by the Government. Under this program, the government provides a subsidy of R3,500 (about US$ 575[3]) to the concessionaire for each installation and the users pay a monthly service fee of R58 (US$ 9.50) for maintenance. The system provided is of 50 W peak capacity, which can power four lights, a radio and a black and white TV, estimated to consume about 6 kW h/month. However, the implementation of the program has encountered many operational problems. The opportunity costs of spending such large amounts on electricity are high for poor households. Studies have shown that at such effective electricity prices, alternatives like LPG for cooking become attractive (Energy and Development Research Centre (Energy, 2003), given relative efficiencies (Cowan, 2005).

(c) *Bangladesh*

It is encouraging that households' access to electricity increased in the decade up to 2001. In 1991 only about 14% households had access to electricity, but by 2001 it increased to about 32%. The rate of increase in the last decade stands at 120%. The percentage of households having electric connection was only 4.57% for rural areas and 58.06% for urban areas in 1991 which has increased to about 20% and about 71%, respectively, in 2001(Bangladesh Bureau of Statistics (BBS), 2007).

Over the last decade, an off-grid electricity program is also gathering momentum through supportive policy of the government and innovative financing mechanism by large non-government organizations in the country. Grameen Shakti bank has installed more than 40,000 photovoltaic (PV) panels with a total capacity of 2 MW to provide electricity services. There are other organizations both in the government and non-government sectors also promoting off-grid electricity services in the rural areas (see Figure 3)

The average connection cost per household including cost of house-wiring was found to be Taka 2800 (40 USD). The connection cost is found reasonable by 53% of the new customers while it is considered high by the remaining 47% of the consumers (Mainuddin, 2006).

(d) *Lessons learned*

(i) *Brazil*

Historically, electrification levels have been steadily growing in Brazil. The pace of increase of electricity supply in

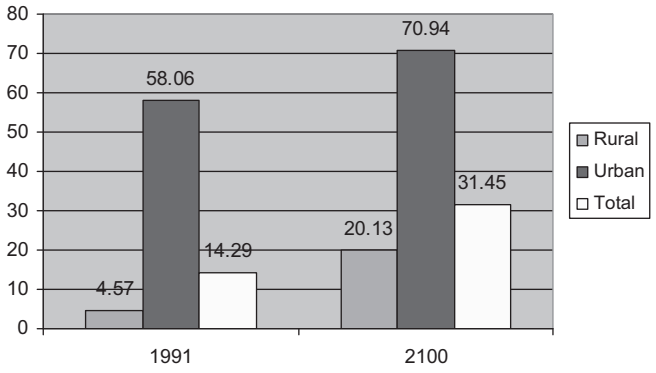

Figure 3. *Access to grid electricity in Bangladesh, 1991 and 2001. Source: Bangladesh Bureau of Statistics (BBS) (2007).*

cities has coped with the high urbanization rates. In rural areas, however, electrification rate has been slow, due to the insufficiency of investment efforts by utilities, in view of the low profitability of grid extension to reach small and dispersed consumers.

The difficulties related to servicing the low-income households are inherent to a low consumption per unit, significantly increasing payback time for initial investments, aggravated in highly dispersed rural markets. This situation has become even more serious due to a privatization process that intended to maximize the value of assets to be sold and to minimize obligations to future concessionaires. Once private distribution companies were in place, a number of flaws in the power reform framework became evident: there was lack of incentives and obligations to implement rural electrification programs, to improve supply to low-income consumers, and to sustain existing off-grid projects.

The need of a comprehensive national strategy for granting universal access was felt and new laws and regulations on this issue emerged in the last few years. In summary, the electrification programs implemented in Brazil were PRODEEM, Luz no Campo, and Luz para Todos. These programs have been described in detail elsewhere (Goldemberg, 2004) and only some key lessons on each are reported here.

The PRODEEM[4] (Energy Development of States and Municipalities Program)—was a government-sponsored off-grid electrification program, aiming to promote the off-grid electrification of villages. It was established by a Presidential Decree in December 1994. Some key lessons on servicing low-income markets were learned in PRODEEM, and mainly that a top-down approach, with installations generally made in unskilled and unorganized communities, was not effective. In the absence of cost recovery, there were insufficient funds for maintenance, resulting in unreliable service. Problems were exacerbated by the lack of responsibility given to local communities and states for the equipment, not promoting a sense of ownership of the program.

The problems with *PRODEEM* led the Executive and Legislative branches of Federal Government to jointly start initiatives to create incentives and obligations for the new concessionaires to invest in rural electrification and to supply such services to low-income consumers. A state-owned holding of most regional and state generation utilities, under the coordination of the Ministry of Mines and Energy (MME), launched in December 1999 an ambitious program, *Luz no Campo* (Light in the Countryside), to finance the electrification of one million new rural consumers over a three year period and to focus exclusively on grid extension.

Luz no Campo aimed to provide until 2007 electricity to 5 million people living in 1 million rural households, with sectoral funding of R$ 1.77 billion (US$ 650 million). Half of the resources should be allocated to programs for rural electrification, energy efficiency, and electrical power for low-income users. In the same year, a further law (No. 9427) made concessionaires responsible for the cost of providing services to new customers. Customers only have to meet tariffs. As of September 2002, 480,000 connections had been made, and other 125,000 were in progress, through *Luz no Campo* program.

While Luz no Campo had the potential to assist with universal access, the program fell short of its ambitious targets. The income loss from non-payment of energy bills is one the main concerns of distributors, and hampers the achievement of targets. Another lesson learned was that power sector restructuring did not contribute to access to energy services, due to the lack of incentives to do low-cost grid connections or off-grid projects except for a couple of specific projects (in Minas Gerais, Bahia and Amazonas). As financial resources allocated to *Luz no Campo* are scarce and face competition for other uses (Associação Brasileira de Grandes Consumidores Industriais de Energia e de Consumidores Livres, 2009), the program prospects are uncertain.

A crucial step to increase access to electricity in Brazil was the approval in 2002 of a new Law (Law 10,438/2002[5]) that acknowledged the right of all citizens to have access to electricity supply, as a public service.[6] The most immediate and important challenge to ensure the expansion of electricity service for low-income and rural areas was the new legislation. This was done in 2003 by Agencia Nacional de Energia Electrica (ANEEL), the Federal Power Regulatory Board, through the definition of targets and deadlines for full coverage, regulating the allocation of resources for concession and permission holders, consolidation of the possibility of awarding permission within concession areas, and creation of instruments to make these new agents sustainable. ANEEL has issued in 2003 a Resolution[7] that established targets and deadlines for universal access to electricity in Brazil. Expenses related to the connection to the grid will be borne by utilities, and not by the consumers. All utilities are to submit to ANEEL within determined deadlines their programs to expand access to electricity. Targets were defined in order to reach full coverage of consumer connections within a term set from 2004 to 2015 according to current levels of electrification. Targets were established for the areas serviced by each utility and for municipalities (the closest target prevails in case of conflict). Utilities started on January 2004 to implement their plans to provide electricity supply to all households in 2,400 municipalities without 100% access (out of a total number of 5,507). However, 336 municipalities mainly located in the North and North-eastern regions may have to wait until 2015 to be supplied. Two million Brazilians may have to wait until 2005 to have full access to electricity, if ANEEL targets are met.

Trying to anticipate the achievement of universal access to electricity, the Brazilian Government has announced in November 2003, the *Luz para Todos* program (Light for All). This Program is today the main government instrument to supply electricity to nearly 12 million people by 2008 throughout Brazil, as yet unconnected to any transmission grid. Besides accelerating the universalization of access to electric energy in Brazil, *Luz para Todos* will allow for the generation of indirect and direct jobs. In accordance with the Federal Government, the main objective of *Luz para Todos* is social inclusion, through access to electricity supply service. In fact, the relationship between no access to electric energy and poverty is clear in Brazil, as 90% of households without access have an income lower than three minimum wages.

Since its start-up in 2003, and up to September 2005, the Light for All Program in Brazil has created around 53,000 new jobs, according to a survey by the Ministry of Mines and Energy (Ministry of Mines, 2008). The creation of jobs is a positive economic impact of the program, which has made electricity connections possible for 40 thousand households per month. Despite these positive results, the program is still far from meeting its ambitious goal. Up to September 2005 the program has reached 1.3 million people (375 thousand households). By 2008 the Light for All Program expects to spend US$ 4.07 billion (9.5 billion reais), US$ 2.91 billion (6.8 billion reais) of which will be paid directly by the federal government. The rest will come from state governments and private electricity companies.

(ii) *South Africa*

The grid electrification program has targeted mainly rural households, with little changes in the share of electrified urban areas (Figure 4).

A lesson from the South African electrification program is that consumption levels remained lower than planned. For several years after electrification, households consumed on average between 100 and 150 kW h/month (Borchers, 2001) well below the planning estimate of 350 kW h. Electricity is limited to use of certain services, usually lighting, some entertainment and limited cooking. In other words, this reflects problems of affordability despite the 'low' tariffs, as shown by the South African research which suggests that many electrified households continue to use traditional, highly polluting fuels (Mehlwana & Qase, 1998; Thom, 2000). Electricity is not used for the full range of domestic needs, including all cooking, space heating, and water heating—poor households clearly find this unaffordable. There are also a variety of social and cultural reasons why people may still choose to use non-electric fuels (Mehlwana, 1999). High cut-off rates and community protests against cut-offs epitomize the affordability problem.

Multiple fuel use continued after electrification. The concept of an energy transition has been described by some as a "universal trend" whereby households move from traditional fuel, consisting of wood, dung, and bagasse, through transitional energy sources (coal, paraffin and LPG) to 'modern energy services'—electricity (Energy Research Institute, 2001). While some shifts in fuels occur, questions have been asked whether this process is happening in a linear fashion, and whether it takes adequate account of persistent multiple fuel use (Yamba *et al.,* 2002) which continues for several years after households receive electricity services (Mehlwana, 1998). In this context, the involvement of local communities—the beneficiaries—in designing electrification programs is important (Gaunt, 2005). Without a sense of local ownership, benefits will not be realized.

The program contributed to the welfare of the communities by providing improved health care in clinics and evening adult education in schools. Computers and photocopiers where schools could afford them benefited education (Energy Research Centre (ERC), 2004). Fires in homes were reduced because kerosene for lighting and candles were substituted by electricity (Borchers, 2001). The benefits from cooking and heating with electricity were lower than expected because many poor can only afford to pay for electricity for lighting and media, using appliances with much lower capacity than electric stoves, for example. Poorer households appear to make a choice that electric cooking is not the most economic option. For economic development to take off, electricity on its own is insufficient. Finance has to be made available for productive use of energy and access to markets is needed to sell the goods produced. However, small enterprises benefited, with retailers and workshops able to open for longer hours in the evening (Energy Research Centre, 2004).

The South African program was centrally coordinated through the utility, Eskom together with municipal distributors. A National Electrification Programme from 1994 to 1999 exceeded its target of 2.5 million connections. Even though electrification is not financially viable in itself, the program was financed domestically to the tune of R7 billion (over US$ 1 billion) (Borchers, 2001). A key lesson is that successful electrification requires as much focus on meeting community needs as on technical and financial issues, and targets that are set not only in terms of numbers of connections, but also the wider benefits, for example lighting improving conditions for learners, or electricity enabling the use of appliances.

(iii) *Bangladesh*

The Rural Electrification Program in Bangladesh started in 1978 with the aim of providing electricity outside urban areas. It was conducted primarily with the technical assistance of the National Rural Electrification Cooperative Association (NRECA) of the United States of America. The economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh (Barkat *et al.,* 2002) revealed that the average annual income of households with electricity is 64.5% higher than that in the households of non-electrified villages, and 126.1% higher than that in the households without electricity of the electrified villages. The study also mentioned that 16.4% of the annual income of the electrified households can be attributed to electricity. Electrification and income

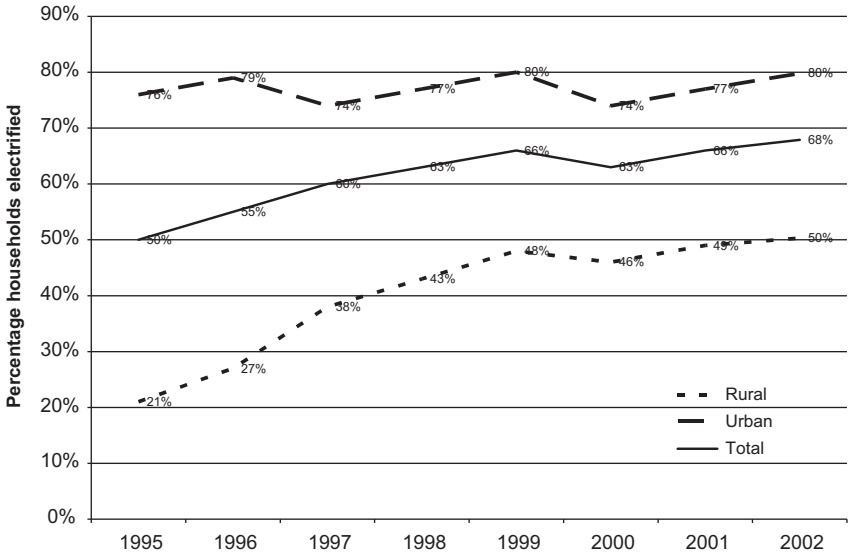

Figure 4. *Trends in electrification of households in SA, 1995–2002 (The drop in urban electrification rates from 1999 to 2000 is explained by changes in the numbers of households reported in the 1996 census to new data. As a result, the number of households for statistical purposes increased markedly from 1999 to 2000 (National Electricity Regulator, 2001). Source: NER (2001, 2002).*

appear correlated, although the connection may be in both directions.

The study cited above also revealed that overall literacy rate was found to be much higher at 70.8% in the electrified households, compared to that in the non-electrified with 54.3% in the electrified villages and 56.4% in the non-electrified villages. Compared to the non-electrified households, the overall literacy rates for both male and female in the electrified were significantly higher, especially due to the household's access to electricity which has contributed much both in economic terms as well as in raising awareness about the value of education. The rich-poor divide in literacy was also less pronounced in the electrified than in the non-electrified households.

The Strategic Planning and Management (SPM) study carried out by the Power Cell of the Ministry of Energy and Mineral Resources (Power Cell., 2004) identified a number of barriers to the expected economic development of the rural area of which lack of entrepreneurs, lack of capital, load shedding, lack of infrastructure, and lack of industries are key reported by both connected to grid and non-connected households. However, barriers vary due to location specificity and are associated with social and economic situation of an area. Consideration of location specificity, social and economic situation is necessary for future planning of electrification. The study makes clear that electrification policy on its own is not sufficient for rural development, but that policies promoting other economic activities are needed as well.

Key lessons on access from the Bangladeshi experience are:

° Electrification is a necessary, but not a sufficient condition for rural development.

° Electrification, in the sense of connections to the grid, primarily reaches higher- and middle income households.

° Electricity is a significant contributor to income for the electrified households.

° Social indicators such as literacy are also higher in the electrified households, although this may be due to income factors as much as electrification.

(e) *Conclusions on access*

Electrification is a necessary, but not a sufficient condition for development for poor communities in urban and rural areas. While electrification may not be viable on strict financial terms, it is an important social investment. This implies that electrification should not necessarily be assessed on financial costs and benefits alone. In calculating financial returns, estimates are made of consumption levels for newly connected households. Multiple fuel use typically persists, and care needs to be taken that consumption levels are not over-estimated, to avoid over investment in supply that may not be taken up.

Successful electrification requires as much focus on meeting community needs as on technical and financial issues. Involvement of local communities is important in shaping *how* electrification programs are implemented for maximum benefit. Electrification planners should set targets not only in terms of numbers of connections, but also for the wider benefits, for example those related to health, education, and productive use. Indicators could include literacy or health benefits, although care must be taken with attribution.

Legal and institutional frameworks were found to be important in promoting access. A clear legislative framework in Brazil followed by detailed regulations enforced by the Federal Regulatory Board (ANEEL's resolution 223/2003) made a clear difference.

Cost recovery, at least to fund maintenance, is important if a reliable service is to be provided. Systems require minimum maintenance if they are to provide a reliable service to communities. At the same time, governments seek to keep connections affordable for consumers, through low connection fees, use of low-cost infrastructure or current-limited supply. The imperatives of cost recovery and affordability of access require careful balance.

Finally, access to electricity is not everything. The affordability of using electricity for a wide range of needs is key to unlocking the full potential benefits. The benefits of access to electricity may be limited by the indirect costs, for example the costs of appliances. Poorer households often lack the purchasing power to buy appliances. The indirect investment requirements become a barrier to realizing the full economic benefits of electrification. These questions bring us to the issue of affordability. Across the three countries, the issue of affordability gains more prominence as the issue of physical access is resolved.

4. AFFORDABILITY—LESSONS FROM EXPERIENCE WITH POLICIES

The review of experiences with access to electricity has highlighted affordability of use as a key issue. In Section 1, affordability of use was quantified in terms of the share of household income spent on energy. Table 4 shows data on the energy burden.

However, such data need to be interpreted with caution. Use of 'free' fuels such as collected biomass might reduce the share of money spent, but the opportunity costs of women collecting wood would not be reflected. Complete absence of access would reduce expenditure and hence provide a low share of budgets—but not indicate affordability. Finally, national averages—particularly in societies with high inequality, such as Brazil and South Africa—tend to obscure differences within the population. More detailed analysis from individual countries is presented in this section.

Before reporting on interesting policy experiments in each country, Table 5 summarizes the different residential fuel shares in each country. It also reports the costs of fuels used by households in Brazil, Bangladesh, and South Africa.

Table 5 shows that the expenditure on electricity consumption in South African households is much higher than that in Brazil. Despite Brazil's much higher level of electrification, the largest cost burden still derives from wood, and another large share from wood. In Bangladesh, wood or biomass accounts for a similar share of expenditure as in Brazil, but the electricity burden is lower. The estimates for biomass use in South Africa suffer from data uncertainty and the costs of biomass are also not well known (Winkler, Howells, & Alfstad, 2005).

Fuel prices—all reflected in US$/MJ for comparative purposes, but also reported in the local currency and units of the actual fuel consumed—vary across the countries as shown in Table 5. Electricity tariffs for Bangladesh are the highest of the three countries; tariffs in South Africa are known to be relatively low, without counting the external costs of coal-fired electricity (Spalding-Fecher & Matibe, 2003; Van Horen,

Table 4. *Average share of household income spent on energy*

Country	Urban (%)	Rural (%)	Total (%)
Brazil	3.4	3.2	3.4
South Africa	3.7	5.9	4.7
Bangladesh	11	5	8

Source: Energy Sector Management Assistance Programme (ESMAP) (2003), BBS (2003a, 2003b, 2007).

Table 5. *Residential fuel shares and costs in Bangladesh, Brazil, and South Africa*[a]

Approximate share of total residential energy use	Electricity	Coal	Gas	Paraffin	LPG	Wood	Candles	Other
Fuel shares								
Bangladesh (Share of expenditure)	23%	0.2%	8%	12%		24%		32%[b]
Brazil	30%	2%	1%	0.3%	30%	37%	–	
South Africa	62%	9%		12%	2%	12%	2%	
Fuel prices								
South Africa								
GDP *per capita* US$ 11,290 [c]	8.7 ZA c/kW h	7.0 ZAR/kg		14.5 ZAR/liter	14.0 ZAR/kg	1.5 ZAR/kg	75 ZA c/candle	
Cost of energy sources in local units & currency in upper row and US$ in lower row (c/kW h, c/liter of kerosene, etc) [d]	1.4 US c/kW h	1.14 US$/kg		2.4 US$/liter	2.29 US$/kg	0.245 US$/kg	12 US c/candle	
Cost/MJ (for comparison, in USc per MJ)	0.4 US c/MJ	3.9 US c/MJ		6.3 US c/MJ	6.7 US c/MJ	1.6 US c/MJ	0.3 US c/MJ	
Brazil								
Cost of energy sources in local units & currency in upper row and US$ in lower row (c/kW h, c/liter of kerosene, etc) [d]	R$ 0.22/kW h	R$ 0.05	R$ 0.32/m3		R$ 1.63/kg	R$ 14.52/m^3 (native wood) R$27.72/$m^3$ (wood from deforestation)		
	US$ 0.1 /kW h	US$ 0.025 /kg	US$ 0.14 /m3		US$ 0.74/kg	US$ 12.6/m^3 (wood from reforestation)		
Cost/MJ (for comparison)	US c 3/MJ	US c 0.2/MJ	US c 0.9 /MJ		US c 3/MJ	US c 0.13 /MJ (native wood) US c 0.25/MJ (wood from reforestation)		
Bangladesh								
Cost of energy sources in local units & currency in upper row and US$ in lower row (c/kW h, c/liter of kerosene, etc) [d]	3.42 Tk/kW h	5 Tk/kg	130 Tk/mcf	35 Tk/liter	66.7 Tk/kg (800 Tk/12 liter cylinder)	4 Tk/kg		
	5 US c/kW h	7.5 US c/kg	1.94 US$/mcf	52 US c/liter	1 US$/kg	6 US c/kg		
Cost/MJ (for comparison)	1.4 US c/MJ	218 US c/MJ	179 US c/MJ	1.4 US c/MJ	3 US c/MJ	0.4 US c/MJ		

Source: Bangladesh Bureau of Statistics (BBS) (2007), Ministry of Mines and Energy (MME) (2003a, 2004), Department of Minerals and Energy (DME) (2003), Energy Research Institute (ERI) (2001).

[a] For comparison, exchange rates to the dollar are used, with US$ 1 equivalent to Bangladeshi Taka 67, Brazilian Reais 2.2 and South African Rand 6.1.

[b] Mainly cow-dung, jute stick, fuel from agriculture.

[c] GDP *per capita*, ppp in US$ 2001 (United Nations Development Programme (UNDP), 2008).

[d] January 2006 retail prices for all energy sources except electricity.

Table 6. *Impact of poverty tariff on poor household energy burden, South Africa*

Expenditure on	Before subsidy	After subsidy	Difference	
Electricity (R/month)	38	31	7	18%
Fuels excluding electricity (R/month)	70	59	11	16%
Energy as% of household expenditure	18%	12%	6%	

Source: Prasad and Ranninger (2003).

1996). Coal is cheap compared to other fuels in Brazil, but very expensive in Bangladesh. The costs of LPG per MJ of energy consumed are fairly similar across the three countries. In these diverse situations, the three countries have each sought to address the challenge of affordability in different ways.

(a) *SA poverty tariff*

In an attempt to address the question of affordability, the South African government committed itself to implementing a free supply of electricity for basic needs (Department of Minerals, 2004). The 'poverty tariff' [8] stipulates a uniform electricity basic support services tariff (EBSST) of 50 kW h/month at zero cost to all grid-connected poor customers. This is considered sufficient for lighting, ironing, water heating, TV, and radio (National Treasury, 2003) and could make cooking and heating more attractive. By subsidizing the use of electricity for some basic needs, the government is seeking to increase the social benefits of electrification (Gaunt, 2003).

The extent to which the policy alleviates poverty can be illustrated by the extent to which it increases affordability. In Section 1, some definitions of affordability suggested 10% of total household expenditure as an 'affordable' share of household expenditure on energy. Work in South Africa shows that such shares differ widely by income group *within* 'the poor', divided into quintiles. Generally, households spent more on energy as the incomes rose. But poor households spent a higher proportion of their monthly income on energy. For rural households in Limpopo, the energy burden ranged from 19% (first quintile) to 6%; for urban Khayelitsha, the range was from 14% to 3% of household income spent on energy (Prasad & Visagie, 2005).

What impact could the poverty tariff have on energy burdens at such a level? The results of survey work examining the effects of the poverty tariff are reflected in Table 6, which shows the mean household expenditure on energy as a share of total household expenditure before and after implementation.

From Table 5 above, the energy burden of poor households in remote rural villages can be up to 18% of the total household budget, according to data from a case study reported in (Prasad & Ranninger, 2003) see also (University of Cape Town (UCT), 2002). The 50 kW h provided by the poverty tariff would reduce the energy burden by one-third (6% points). Monthly expenditure on electricity and other fuels decline by 18% and 16%, respectively, due to the poverty tariff. After an allocation of 50 kW h free basic electricity the energy burden reduced to 12% of the total household budget. The energy burden is still above the 10% threshold, and not 'affordable' if one takes this threshold as definitive. There can, however, be little doubt that the poverty tariff has *increased* affordability and makes a major difference to poor households.

A recent study in the poor areas of Cape Town showed that monthly electricity consumption has risen by 30–35 kW h/month per customer since the introduction of poverty tariff, a substantial rise against an average consumption ranging from 100 to 150 kW h/month (Borchers, 2001). This rise is less than the full 50 kW h/month, suggesting that households both make greater use of electricity, and also value some saving on their energy bills (Cowan & Mohlakoana, 2005). Often further services would focus on lighting or other relatively low-power appliances (e.g., radios, TVs, extended lighting periods). However, the subsidy support is typically not sufficient for all cooking needs or productive uses. The remaining savings are spent either on other energy or other goods with a lower opportunity cost (Mwakasonda & Davidson, 2004).

Beyond income, the 'poverty tariff' has shown positive signs in providing access to more services. In some communities, it has been reported that about 30% of the households have added lights in the previously non-electrified rooms. It is also reported that some households started using appliances they owned but were not able to use before the program was implemented.

The main objectives of the EBSST were to help in the alleviation of poverty, but yet some key questions came to light on whether such objectives were realized by the intervention. Some of these questions included:

Who are the poor the EBSST intended to reach with an electricity subsidy?

What contribution can electricity make to the alleviation of poverty?

Is access to electricity a basic right? Can EBSST, in conjunction with an electrification program, make meaningful progress toward the reduction of poverty and the improvement of living conditions?

Although the EBSST was intended for poor households of an income of R800 or less per month, targeting such households proved to be difficult. Several approaches were thus suggested, including extending the support to all households and using a self-targeting approach whereby the subsidy would apply only to those willing to accept a restricted supply of electricity. It was acknowledged that with whichever approach used, there would be many households excluded from the support because of various reasons, including those not connected to electricity or those that were disconnected because of nonpayment.

Considered from the perspective of electricity distributors, there has been some concern about the financial implications of providing free electricity. However, distributors are not collecting data on the impact of the EBSST, probably for two reasons—they are required to provide this service by central government and the impending restructuring into Regional Electricity Distributors has much larger implications (Eberhard, 2003).

From a climate change perspective, increased use of coal-fired electricity would increase emissions. Under the assumption that all the free electricity would be additional to existing energy use, a study showed that the poverty tariff might at most increase emissions by 0.146 $MtCO_2$ per year (University of Cape Town, 2002). This upper-bound estimate represents 0.04% of total GHG emissions, but about 2% of residential sector emissions in 1994. In practice, it is likely that electricity might displace the existing use of paraffin, coal, wood, candles, batteries, and other fuels to some extent. Future studies might examine the net effect with displaced fuel use. A more recent study modeling options for CDM credits in rural households found that options with the widest range of benefits were non-electrical renewable energy supplies (solar) along with oil-based energy (LPG) (Howells, Alfstad, Victor, Goldstein, & Remme, 2005).

Table 7. *Discounted tariff structure in Brazil*

Monthly household consumption (kW h/HH/month)	Discount (% reduction compared to overall tariff)
30 kW h	−65%
100 kW h	−40%
Regional limit defined by ANEEL	−10%
100–220 kW h	Discount declining [a] [b]

Ministry of Mines and Energy (MME) (2008).
[a] With the Social Tariff, families of (proved) low income with consumption between 80 and 220 kW h/month, have automatic discount that can reduce light bills by 50%.
[b] Beginning from 40% (for 100 kW h consumers), and reaching zero for those consuming more than 220 kW h/month.

(b) *Brazil's progressive tariff*

The Brazilian experience has thrown up lessons on the impact of energy reform on the electricity consumption levels of the poor urban and rural households. Brazilian electricity tariff structures have some peculiarities. Higher-income domestic and commercial customers cross-subsidize rural consumers, public lighting, and low-income consumers. High voltage industrial consumers are heavily subsidized by the other classes of consumption, and even industrial consumers supplied at 2.3 kV pay substantially less (55%) than the residential, commercial, and industrial consumers supplied at a lower voltage.

Within the residential sector, the tariff is discounted according to the household consumption level, so that those consuming up to 30 kW h/month pay only 35% of the overall tariff, those consuming up to 100 kW h/month pay only 60% of the overall tariff, with the discount declining to zero for those consuming more than 220 kW h/month. This is the so-called progressive or stepped-block tariff. The third class of discount is around 10%, and benefits those consuming up to a regional limit defined by ANEEL, and still classified as low-income consumers. The overall tariff and regional limit vary from concession to concession (see Table 7).

In fact, the precise definition of low-income consumers was made clear only with the Law 10438/2002, and included all households under a monthly consumption of 80 kW h, supplied by one-phase system, and those between 80 and 220 kW h/month, also supplied by one-phase system, registered to social programs, and under a regional limit defined by ANEEL. This limit coincides with the 220 kW h per household per month threshold in some cases. Discounts are also allowed for households that can prove income at half the minimum wage.

According to ANEEL, [9] the average price of electricity has increased 102.4% from January 1995 to October 2001, or 13.5% above inflation in the period. [10] In the same period the residential consumer had an average price rise of 30.5% above inflation. The situation has worsened after 1999, when a 70% maxi-devaluation of Brazilian currency took place. [11] These increases of electricity prices caused a heavy burden on the budgets of low-income households. Besides, high prices of electricity and liquefied petroleum gas (*LPG*) have strong negative environmental side effects, since the poorer population switches to the use of cheaper options for their energy needs, leading to additional use of wood fuels, instead of *LPG*. Connection fees appear relatively higher in Brazil than the other two countries considered here, possibly due to higher prices as electrification reaches closer to 100% and includes more expensive connections, also over great distances (see Table 8).

Table 8. *Comparative analysis: pre and post-reforms of the Brazilian power sector*

Indicator	1994—Pre-reform Year	2000—Post-reform Year
National electrification levels		
Total electrification levels, national (%)	92	95
Rural	68	74
Urban	98,5	99,2
Electricity consumption (kW h/year)		
National average *per capita* electricity consumption (kW h/person/year)	442[a]	499[b]
Average *per capita* electricity consumption by the rural population	390[a]	440[b]
Average *per capita* electricity consumption by the urban population	560[a]	576[b]
Electricity tariffs		
Average tariffs (US$/kW h)	0.098[c]	0.179[b]
Connection fees & charges (US$/connection)	810 (1994)	970 (2002)

Source: Agencia Nacional de Energia Electrica (ANEEL) (2003) Eletrobrás (2003) Ministry of Mines (2003a, 2003b).
[a] Residential sector.
[b] Residential sector in 2000.
[c] Residential sector in 1996.

Table 9. *Electricity prices at different consumption levels for households in Bangladesh*

Consumption level (kW h)	Per unit price (BDT/kW h) 2002	Per unit price (US c/kW h) 2002	Per unit price (BDT/kW h) 2004	Per unit price (US c/kW h) 2004
100	2.15	3.12	2.50	3.62
101–300	2.30	3.33		
101–400			3.00	4.35
301–500	3.45	5.00		
>400				7.25
>500	4.50	6.52		

Source: Power Cell (2004).

Table 10. *Share of household expenditure on fuel and lighting in Bangladesh*

Year	Urban (%)	Rural (%)	National (%)
1991–92	6.20	5.47	5.62
1995–96	4.63	5.98	5.59
2000	6.00	7.19	6.81

Source: Bangladesh Bureau of Statistics (BBS) (2003a).

The *per capita* consumption levels are national averages and hide the inequality in energy consumption of different income groups. Poor households consume some 80 kW h/month, or about 275 kW h/person/year for the average household of 3–4 people. That is just over half of the national average. National average figures are of limited usefulness in situations of high inequality. It may be useful to distinguish even with the broad category of 'the poor'.

Key lessons on affordability drawn from the Brazilian experience include:

- There have been concerns that the progressive tariff might impact negatively on the financial health of (smaller) distributors, this problem was mainly experienced during the power shortage in 2001.
- A bigger impact than the tapering of the tariff seems to have been the setting of tariffs more closely approximating the marginal costs of new plants.
- The increase of tariffs during power sector reform probably had a stronger effect in limiting the *use* of electricity than the policy of the progressive tariff. Higher tariffs make the use of electricity unaffordable, in spite of the high percentage of households physically connected to the grid, even in rural areas of Brazil.

(c) *Bangladesh creative financing*

Supply of electricity to all citizens of the country is a constitutional obligation of the government and electricity supply has been increased to meet growing demand. In order to meet this commitment, government is installing more generation plants in the country. Over the decades generation and distribution of electricity has increased, reflected in increasing *per capita* consumption of electricity. Consumption of electricity per person has increased from 44.0 kW h in 1991 to 122 kW h in 2002–03.

There is no explicit policy to increase affordability of use of electricity in Bangladesh. However, the government has different pricing policies for different sectors. For household consumption it has four major blocks that indirectly support low electricity consumers. The different prices for different levels of consumption are as follows (see Table 9).

The cost of fuel for generating electricity and price of fuel for other energy uses is increasing in Bangladesh. Cost of fuel for generating electricity has increased over time and varies by fuel types. For example, generation of electricity using gas fired turbines has increased from 1.026 taka (US 1.49 cents) in 2001–02 to 1.216 taka (US 1.83 cents) in 2002–03.

The share of household expenditure on fuel and lighting has also increased at a national level from 5.62% in 1991 to 6.18% in 2000. At the same time, rural households' share of expenditure increased from 5.47% to 7.19%. It is also revealed from the household income and expenditure survey 2000 that the lower income group is paying more in terms of percentage compared to the well off households. For example, monthly expenditure on energy is about 11% for the household monthly expenditure is less than 750 Tk (US$ 10.86) while monthly expenditure on energy is about 5% for the household who is spending 15–20 thousand per month (US$ 218–290) (Bangladesh Bureau of Statistics, 2007).

Expenditure has increased both for lower and higher income groups but increasing expenditure on energy by lower income group represents an increasing burden on household budgets. Expenditure on energy by higher income group reflects increasing use of appliances and levels of consumption. Table 10 shows the share of household income spent on fuel and lighting.

Rural households are increasingly provided with electricity services through photovoltaic technology, assisted by micro credit from non-government organization including Grameen Shakti. Policy support from government is critical in making this possible for low and medium income households. Grameen Shakit and Bangladesh Centre for Advanced Studies (BCAS) are also working together to bring international financing under Clean Development Mechanism (CDM) for increasing affordability of the rural households.

As in South Africa, there are disconnections from the grid, giving some indication that electricity use has become unaffordable. In Bangladesh, about 10–15% of consumers under RE system remain disconnected on an on-going basis. The number of disconnected consumers stood at 0.78 million (13%) out of 6.0 million consumers in 2005. This was about 1.5% higher than the disconnected consumers which had been 11.5% 2 years earlier in 2003. In some areas, disconnection levels were as high as 20% (Mainuddin, 2006).

(d) *Theory of life-line tariffs*

All three countries have used tariffs in addressing the challenge of affordability. Brazil's progressive block tariff, pricing policy in Bangladesh, and South Africa's poverty tariff all explicitly or implicitly favor poorer communities. The social benefits of a poverty tariff are clear, and the level of such a tariff can be justified in using economic theory. This section provides some theoretical background to the concept that shows two demand curves AB and GH, representative of lower (I_1) and higher (I_2) income households; the poverty tariff P_T over the minimum consumption block from 0 to Q_{min}. If the economic tariff based on the long-run marginal cost is at P_E, the higher-income households will be consuming the optimal level Q_2, but the poorer households will not be able to afford the service (Munasinghe, 1992) (see Figure 5).

The government attaches weight to social benefits to poor households, so the consumer surplus ABF is increased. Although A lies below P_E, the weighted distance OA could be greater than the marginal cost of supply. Adopting the poverty tariff P_T for the first block, followed by P_E, allows the capture of the weighted consumer surplus. The richer households still consume close to optimum, apart from the slight change due to their reduced expenditure for the first block. A means of identifying the magnitude of Q_{min} should be based on criteria for identifying 'lower-income' groups, and establishment of consumption levels. In developing countries, it is typically around 50 kW h/month (Munasinghe, 1992). A simple welfare model suggests that

$$P_T = \text{LRMC} \times \text{s(poor persons' income/critical income)}$$

where critical income is a nationally established poverty line (Munasinghe, 1992). In South Africa, Q_{min} has been set at 50 kW h, but the tariff has been set at zero. In Brazil, under a progressive tariff approach, Q_{min} has been set at 30–80 kW h per household per month, priced at 35–60% of the full tariff,

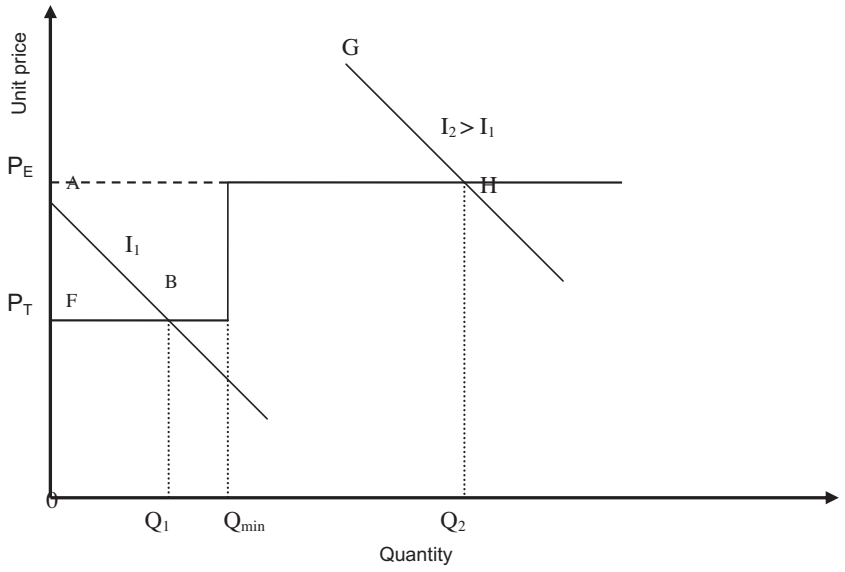

Figure 5. *Welfare economic basis for poverty tariff. Source: Adapted from Munasinghe (1992).*

and allowing for inclusion of households consuming up to 220 kW h/month if enrolled on governmental social programs (according to maximum incime level requirements).

There is some basis in economic theory for life-line tariffs as an instrument to address affordability. The following section draws together the lessons from the practical experience in the three countries.

(e) *Lessons on affordability*

Specific lessons on affordability can be drawn from the experiences of Brazil, Bangladesh, and South Africa. All three countries experimented with tariffs, although in the Bangladeshi case, pricing policy was not explicitly aimed at affordability. This is also the country with the lowest levels of access among the three. Innovative financing solutions, using the Grameen Bank and CDM, were explored in that country.

Life-line tariffs, which have a basis in economic theory, were found to assist in reducing household expenditure on energy. In the two countries with higher levels of access, more formal policies to address affordability were introduced. In South Africa, monthly expenditure on electricity and other fuels declined by 18% and 16%, respectively, due to the poverty tariff. In Brazil, progressive tariffs have substantially contributed to narrowing the gap between electricity consumption levels in rural and urban households (10% under national average against 15% above). In Bangladesh, without an explicit adjustment, household expenditure on fuel and lighting has increased as a share of total household expenditure, reflecting increasing consumption levels among higher-income households. The energy burden (i.e. the energy expenditure as a share of the total household budget) increased. Poverty or progressive tariffs have the ability to reduce this burden.

Reduced tariffs had the effect of poorer households using additional services. The effect of free or very low-cost electricity appears to be in part an increase in electricity consumption, but also a saving on energy bills for poor households often beginning with lighting. Other relatively low-power appliances (e.g., radios, TVs, extended lighting periods) were also found to be used more. However, the subsidy support is typically not sufficient for all cooking needs or productive uses.

From the utility point of view, there have been concerns that life-line tariffs might impact on the financial health of distributors. Only initial findings are available on this matter, but it does appear that other factors have a larger impact. Much depends on who foots the bill for the life-line tariff. In the case of Brazil, default of payment of electricity bills (from rich consumers also) is far more relevant to the financial health of distributors, and progressive tariffs may help to counter this problem. Increased competitive pressures in the context of power sector reform might drive prices up more than a tariff, as would the need for investment in new electricity generation capacity. In both Brazil and South Africa, expectations are that residential customers would face higher tariffs as new plants are built and the sector is opened to competition, making investments into end-use efficiency important.

5. CONCLUSIONS

The paper has presented a number of arguments for why and in which way energy access and affordability can play a key role in national development programs. The focus has been not only on access to electricity, but also on affordability of using energy services. Lessons were drawn from country studies of Bangladesh, Brazil, and South Africa.

Access to a grid connection does not guarantee *use* of electricity for all end uses, in particular by poor households. Experience with increased access to electricity has shown that consumption levels in newly connected households remain lower than expected for some time. Affordability—to enable greater use of electricity—requires specific policy interventions.

From the three countries, it seems that affordability gained greater prominence as a policy issue as electrification levels increased. In Bangladesh, with the lowest levels of grid connection, the issue is least explicitly addressed. A hypothesis worth testing across a larger sample of countries would be that affordability increases in importance as electrification levels increase.

Examining policy initiatives with South Africa's poverty tariffs, Brazil's progressive tariff and innovative financing solutions in Bangladesh provides some insights. The policy interventions did increase the supply of energy services

primarily for less energy-intensive end-uses, such as lighting, entertainment, but less so for cooking and productive use.

Factors beyond policy on electrification, access, and affordability play an important role. Changes of tariffs due to the need to construct new generation capacity (in South Africa and Brazil) may increase electricity prices to the extent that the reduction by the lifeline tariff is outweighed.

NOTES

1. There have been many connections in urban areas, but also most of the growth in household numbers, so that the *share* of urban households with grid-connection has not increased much over the last decade. Most of the increase in electrification levels has been in the rural areas of South Africa.

2. Minimum wage was R$300 (US$133 a month) in April 2003.

3. For comparison, exchange rates to the dollar are used, with US$ 1 equivalent to Bangladeshi Taka 67, Brazilian Reais 2.2 and South African Rand 6.1.

4. In fact, PRODEEM was not a part of the reform process. This program was a previous effort done by the Federal Government to foster the use of renewables, and PV cells in particular, to supply areas not covered by the grid.

5. The Law 10,438 (April 26, 2002) established an incentive program for renewable energy called PROINFA (*Programa de Incentivo a Fontes Alternativas de Energia Elétrica*), under which the government would purchase electricity from biomass, wind and small hydropower under favorable conditions. Total capacity to be contracted was 3,300 MW, which was divided equally among the three sources. However, out of 1,100 MW allowed for biomass, only 2 projects with total 685.24 MW of the capacity managed to sign the power purchase agreement with Electrobras due to the difficulties involved with implementing the PROINFA.

6. Law 10,438/2002.

7. Resolution ANEEL 223, May 2003, regulating aspects of Law 10438/2002 on the extension of access to electricity to all municipalities (Agencia Nacional de Energia Electrica, 2009).

8. Official names include electricity basic support services tariff (EBSST). The national policy indicates 50 kWh, although some municipal distributors are providing lower amounts, 20–50 kWh/household/month. Households in Eskom distribution areas receive 50 kWh.

9. Agencia Nacional de Energia Electrica (2009). National Electricity Agency www.aneel.gov.br.

10. 78.3% by IPCA, the extended prices index to consumer. IPCA is the official Brazilian government index developed to evaluate the inflation targets, contracted with the International Monetary Fund, after July 1999.

11. The maxi devaluation also made even more expensive the price of imported capital goods and fuels, such as the Bolivian natural gas supplied under a take or pay contract in dollars.

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