Poverty Reduction through Energy Services: Challenges Towards Millennium Development Goals

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Abstract

This paper, based on global available evidences, analyses the linkages between energy services and various relevant targets of the Millennium Development Goals (MDGs). Energy services include heat for cooking, illumination for home or business use, mechanical power for pumping or grinding, communication, and cooling for refrigeration; and energy carriers include liquid fuels, electricity, water, wind etc. It is argued that energy services are essential to meet MDG targets, especially the targets of income poverty reduction (MDG target 1), eradication of hunger (MDG target 2), education (MDG target 3), gender equality and empowerment of women (MDG Goal 3 and target 4), health (MDG targets 5-8), and environmental sustainability (MDG target 9). In all possible cases, the paper provides empirical evidences, including those from relevant studies in Bangladesh. In addition, an attempt has been made to understand the extent of financial challenges associated with the realization of energy services need for MDG. And finally, it is argued that energy challenge to meet MDGs is attainable provided the rich countries meet their commitment to provide 0.7% of their GNP as ODA, and developing country governments place the issue of energy services at par with other MDGs in their national development strategies.

1. Introduction and Objectives

Energy services—including heat for cooking, illumination for home or business use, mechanical power for pumping or grinding, communication, and cooling for refrigeration—are not included as specific targets of Millennium Development

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Goals (with 8 goals and 18 targets). Therefore, the first logical question to raise would be: ***Are energy services necessary to expedite the Goals of MDG?*** If so, why, and what can be done to meet that necessity. This paper is a modest attempt to provide an analytical treatise on the issue. In doing so, both logical inferences and available empirical evidences have been explored. Keeping the above in view, the objectives of the paper are four fold:

1. To explore the linkages between energy services, in one hand, and income poverty reduction, eradication of hunger, education, gender equality and empowerment of women, health, and environmental sustainability (i.e, various goals and targets of MDG) on the other.
2. To provide argumentative empirical evidences (including those from Bangladesh) towards understanding the complex linkages between energy services and MDG.
3. To present an approximate estimation of financial means required to meet the energy challenges in meeting MDG.
4. To suggest possible means and ways to address energy challenges of MDG.

2. Energy is Essential to Meet MDG

Energy is not an explicit target of MDG. However, improved energy services, including expanded access to electricity and mechanical power, modern cooking fuels, improved cookstoves, and increased sustainable biomass production, are necessary for meeting all the MDGs (see Box 1).

Box 1: Energy Services – Meaning What?
Energy services include heat for cooking, illumination for home or business use, mechanical power for pumping or grinding, communication, and cooling for refrigeration. Energy services can be derived from a variety of energy carriers: illumination can be produced by fuels or by electricity; mechanical power can be produced from kinetic or potential energy or water, from kinetic energy of wind, from a liquid fuel, or from electricity. Energy carriers can be derived from a variety of primary energy sources; electricity for example can be generated from gas, hydropower, petroleum, solar, or wind energy. Important are the reliability, affordability, and accessibility of the energy service.
Source: Adapted from Modi et. al, 2006.

Electricity is crucial for providing basic social services, including education and health. In the sphere of basic social services the lack of energy often undermines sterilization, water supply and purification, sanitation, and refrigeration of essential medicines. Electricity can also power machines that support income-generating opportunities such as pumping water for irrigated agriculture, food processing, apparel production, and light manufacturing.

Cooking with fuelwood, crop residues, and dung is associated with a significantly higher disease burden than other forms of cooking. This is primarily due to indoor air pollution. Cleaner fuels and cookstoves that facilitate lower smoke exposures as well as improved ventilation of cooking areas, can reduce the disease burden from smoke, lower child mortality rates, and improve maternal health.

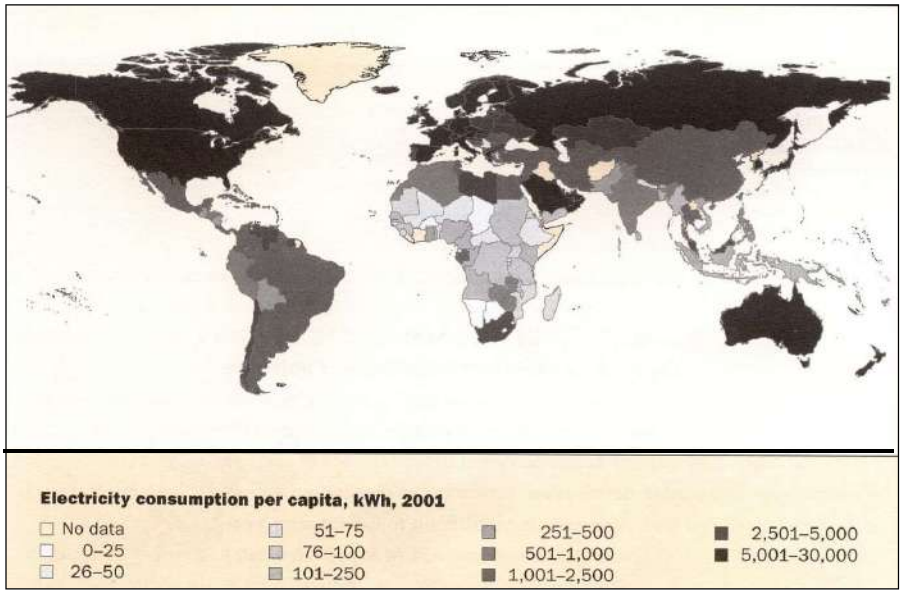
3. Energy Poor: Who and Where?

About 2.4 billion people in the world (40% of world population) today can be termed as poor (viewing from 2$ a day measure), and almost all of them are energy poor. Across the world, a large proportion of the population is unable to access modern energy services at all, and those who do have access often pay high for energy services of much lower quality. A substantial part of the population relies on bio-mass or dung for cooking fuel and heat; on kerosene lamps, batteries, or candles for lighting; and on human or animal energy-based mechanical power for tilling and weeding land, grinding and crushing, agro-processing, or transport. The poorest households spend a large part of their total income and human resources on energy because some forms of energy are absolutely essential to meet basic needs of cooked food and transport. Insufficient and unreliable power limits the ability of enterprises, limiting growth and job creation. The largest concentrations of the `energy poor', the people who are both poor and who also lack access to modern forms of energy (such as electricity), are situated in sub-Saharan Africa and South Asia (see Figure 1).

Energy poverty implies the lack of access and inability to cook with modern cooking fuels and the lack of a bare minimum of electric lighting to read, or for other household and productive activities after sunset. As suggested by Modi *et. al* (2006), these minimum needs correspond to about 50 kilograms of oil equivalent (kgoe) of annual commercial energy per capita, including approximately 40 kgoe per capita for cooking and 10 kgoe used as fuel for electricity. This represents just the most basic household energy needs for cooking and lighting; not included is energy consumption for agriculture, transport, community-level needs such as grinding, and social services or

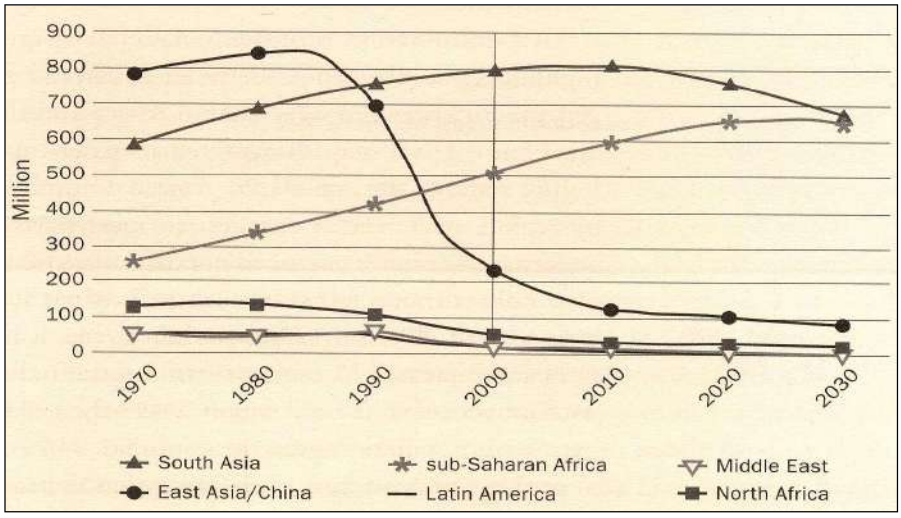
industrial, commercial, and government activities. As can be seen in Figure 1, in most developing countries, the per capita commercial energy consumption is low; in most cases, much lower than the minimum threshold of 50 kgoe reflects both income inequality and limited availability.

Figure 1 : World map of electricity use per capita by country



A close scrutiny of current national electricity consumption per capita depicts the differences between equatorial and non-equatorial regions in general, and between sub-Saharan Africa and the rest of the world in particular. Figure 2 shows the actual and projected number of people without electricity, by region, over several decades. In most parts of the world, investments in energy services have outpaced population growth. The steep fall in the number of people without access to electricity is particularly noticeable in East Asia during the 1980s and 1990s. In South Asia, it is expected that falling fertility rates and increased investments will, most likely, reduce the number of people without access. The only region where the expansion of services has not kept pace with population growth is sub-Saharan Africa. Therefore, the projected trend showing "people without electricity" is not encouraging for Sub-Saharan Africa and South Asia – the regions with high population concentration.

Figure 2 : Number of people (actual and projected) Without electricity, 1970-2030, by region



Source: IEA 2002b in Modi, et.al 2006.

The direct use of solid biomass – a variety of solid fuels such as charcoal, fuelwood, stalks and other farm waste or dung – is widespread in the poorest parts of the world. The lack of access to improved cooking fuels is most extreme in sub-Saharan Africa, followed by South Asia (Table 1).

Table 1: Number of people relying on traditional biomass for cooking and heating in developing countries, 2000

Region/country	Million	% of total population
China	706	56
Indonesia	155	74
Rest of East Asia	137	37
India	858	58
Rest of South Asia	128	41
Latin America	96	23
Sub-Saharan Africa	575	89
Total (Developing Countries)	2,390	52

Source: IEA 2002b

Is It Possible to Meet Energy Challenge?

Human deprivation, in terms of poor access to modern energy services, is still high. The progress towards expanded access to modern energy services has been slow. This is due to many interrelated reasons, including low income levels among the unserved population; lack of financial resources for service providers to build the necessary infrastructure and reduce first-cost barriers to access; weak institutional, financial, and legal structures to encourage private investment; and lack of vision and political commitment to scale up services. Following this, a logical question is : ***can these obstacles limiting access of the poor to modern energy services be overcome by 2015?*** It is most likely that this is attainable provided many committed concrete actions are taken. In considering the question of whether 2.4 billion people can make the transition from solid fuels to cleaner-burning fuels, it is worth noting that the proportion of Brazil's population using modern cooking fuels such as LPG increased from 16% in 1960 to 94% in 2005. Similarly, the 1.6 billion people worldwide who are without access to electricity may consider the examples set by Tunisia, where the electrification program expanded service from 6% of the population in 1976 to 95% in 2005. China's electrification rates reached 98% in 2005, credited to sustained political commitment, public funding that combined domestic resources and borrowings, and effective cost-recovery tariffs and mechanisms from users. These best indicate attainability of apparently hard targets associated with *making energy access work for the poor.*

It can be argued based on the analysis presented above that energy services should be treated as a key component of national strategies towards poverty reduction and attaining MDGs. Achieving all MDGs will require much greater energy inputs and access to energy services. Failure to include energy considerations in national development strategies and development planning frameworks will make it impossible to achieve the MDGs.

4. Linkages between Energy Services and MDG

Now, based on available evidence, I would like to argue that energy services are essential to meet MDGs. My arguments will rest upon the premises that energy services directly affect all dimensions of poverty – income, gender inequality, health, education, and poverty due to lack of infrastructure services.

5.1 Linkages between Energy Services and Income Poverty Reduction

The process of **income poverty reduction –** the **MDG target 1 –** can be directly accelerated using energy services. The pathway follows the fact that modern

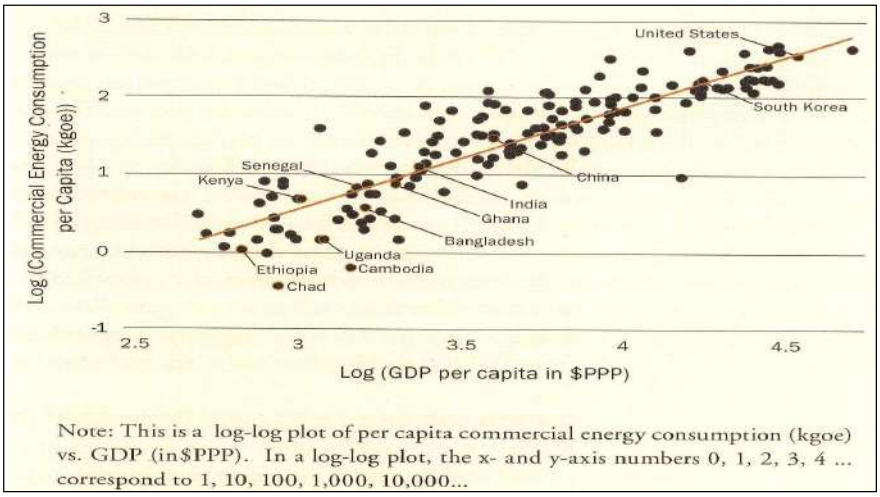
energy services promote economic growth by improving productivity and enabling local income generation. In addition, modern energy services are invaluable means of improving social equality.

Increased economic growth is associated with productive uses of energy. Modern fuels and electricity help boost household income by providing lighting that extends livelihood activities beyond daylight hours. They power machines that save time and increase output and value added. By providing additional opportunities for employment, energy services also enable farmers to diversify their income sources, and thus mitigate the inherent risks associated with agriculture-dependent livelihoods.

Modern energy services contribute to economic growth by reducing unit costs. Due to the inefficiency of commonly used items such as batteries, candles, kerosene, and charcoal, the poor often pay higher unit costs for energy than do the rich. The use of more efficient fuels can reduce the large share of household income spent on cooking, lighting, and keeping warm, thus saving poor families' meagre income for food, education, health services, and other basic needs.

Commercial energy consumption levels across countries are primarily dictated by large disparities in income. Energy consumption is highly correlated with higher GDP per capita (Figure 3). It is also observed that low commercial energy use is also correlated with high infant mortality, illiteracy and fertility, and with low life expectancy (UNDP 2000).

Figure 3 : Commercial energy consumption and GDP, 2000

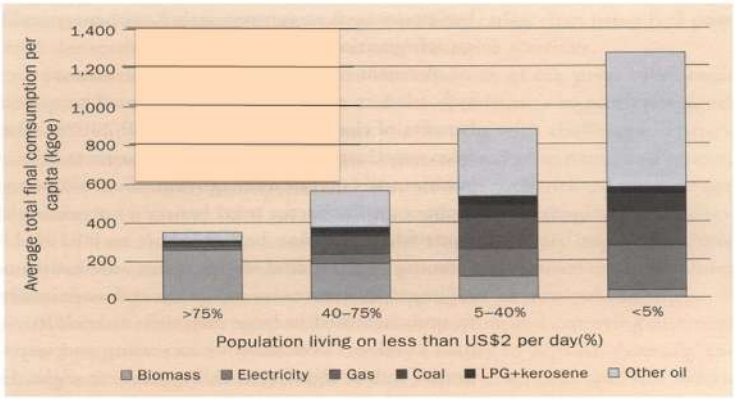


Source: Adopted from Modi et.al 2006 (in IEA 2002b)

Various relevant data and information available in HDR/UNDP, WDR/World Bank, and IEA indicate that increased energy consumption correlates closely with both income levels and economic growth. For example, an increase from 30 to 300 kgoe in primary commercial energy consumption has a strong association with dramatically improved living standards. Based on indepth analysis of relevant data, it is not unrealistic to associate per capita commercial energy consumption levels of about 500 kgoe with a substantial reduction in the number of poor for the poorest countries. It is worthwhile to note that the per capita commercial energy consumption in Bangladesh is only 82 kgoe, and that in India is 291 kgoe, and in Srilanka 156 kgoe (Barkat 2005a).

At the household level, modern energy services directly contribute to economic growth and poverty reduction. They create expanded opportunities for income

Figure 4 : The share of energy sources to the energy consumption of 100 developing and transition countries, by poverty levels and energy type



Source: Modi et.al 2006

generation, reduce unit costs, and enable increased income from irrigated agriculture (crop, non-crop, poultry, livestock, fisheries etc). Indirect contributions to economic growth may come in the form of freeing up time for other productive activities, improved health and education, improved access/supply of clean drinking water, and reduced local environmental degradation.

At the village, town, city and national scale, lack of reliable and affordable electricity supply can also become an impediment to income-generating

industrial, commercial, and service activities. In addition, increased productivity of human capital provided by energy services is evident worldwide. A recent effort to measure economic and social impacts of rural electrification in Bangladesh attempted to quantify the benefits of electricity access (Barkat 2005b). Based on survey data from rural communities in Bangladesh, the study reported the following notable impact:

1. The impact on employment is both direct and indirect. In agriculture, an estimated 1.1 million persons are directly involved in farmlands using rural-electricity connected irrigation equipment. Currently, 63,220 industries use rural electricity employing 983,829 persons; electrified industries, on average, generate 3.3 times more employment than non-electrified industries. Retail and wholesale shops using rural electricity employ 848,630 persons.
2. Women in the electrified households, compared to those in the non-electrified households, are involved more in income generation activities (IGA) and are better placed to re-allocating time for remunerative employment.
3. The relatively higher share of non-agricultural employment in the electrified households demonstrates the modernization effect of electricity on employment.
4. There has been an enormous spillover effect of rural electrification on employment in various support-services including shops, restaurants, banks, fax-email-photocopy facilities, schools and colleges, bus/tempo stoppages, diagnostic centres and clinics etc.
5. Both absolute and hardcore poverty are significantly less pronounced in the electrified than in the non-electrified households.
6. The average annual income of the electrified households (Tk. 92,963) is

Box 2: Impact of rural electricity on employment, Bangladesh

- Employment directly associated with rural electricity (RE), 2.95 million persons:
  Agriculture = 1.100 million (33% due to RE)
  Industry = 0.984 million (75% due to RE)
  Shops = 0.849 million (44% due to RE)
  PBS = 0.016 million (100% due to RE)
- RE's contribution 42%
- Enormous spill-over effect due to development of support services

much higher (65%) than that in the households of non-electrified villages (Tk.56,524). The annual income of the poor (landless category) in the electrified households (Tk. 58,864) was around 50% higher than that in the non-electrified households.

7. On average, 16.4% of the income of electrified households can be attributed to electricity. The corresponding figure for the non-electrified households in electrified villages was 12%, and for those in the non-electrified villages, only 3.6%.

8. Other things being the same, 100 percent electrification of rural households (currently about 20% rural households are electrified) might increase the annual rural income by Tk. 671 billion (equivalent to 26% of the current GDP), and as high as 43% of this incremental income can be attributed to electricity (Barkat et.al 2002).

9. The income-poverty reduction impact of rural electricity is evident in the fact that, irrespective of household electrification status, the relative share of household income attributable to electricity is consistently higher for the poor than that for the rich (Table 2).

10. The five year (1997-2002) increase in the average assets (measured in monetary terms) was 19.4% in the electrified households. The corresponding figure for households in the non-electrified villages was 10% and that for non-electrified households in electrified villages was only 2.4%.

11. Possession of electricity positively and significantly influences the shift of a household from poor to non-poor category; this shift is also influenced by the education status of the head of the household, which itself is influenced by electrification status.

Table 2 : Rural electricity and income-poverty reduction Bangladesh

Households by electrification status	Rich	Poor
Household with electricity	15.2	17.2
	(Tk. 220,986)	(Tk.54,864)
Household without electricity in electrified village	8.6	14.3
	(Tk. 68,237)	(Tk. 38,989)
Household in non-electrified village	3.8	6.1
	(Tk. 195,165)	(Tk. 38989

Note: *Parentheses show annual household income (net; in Tk). 'Poor' means those having<50 decimals landownership; 'rich' means those having landownership 750 decimals and above.*

Box 3: Impact of rural electricity on economic poverty reduction, Bangladesh
Consumption pattern – food-non-food:
Urban pattern for electrified HH
Rural pattern for non-electrified HH
Education expenses:
Higher for electrified than non-electrified
Much less gender disparity in electrified
Much higher for female in electrified than non-electrified
Health expenses: Similar progressive pattern as in education
Potential cost savings on Kerosene fuel if switched to 100% RE: Annual Tk. 7361 million (2.2% import bill)

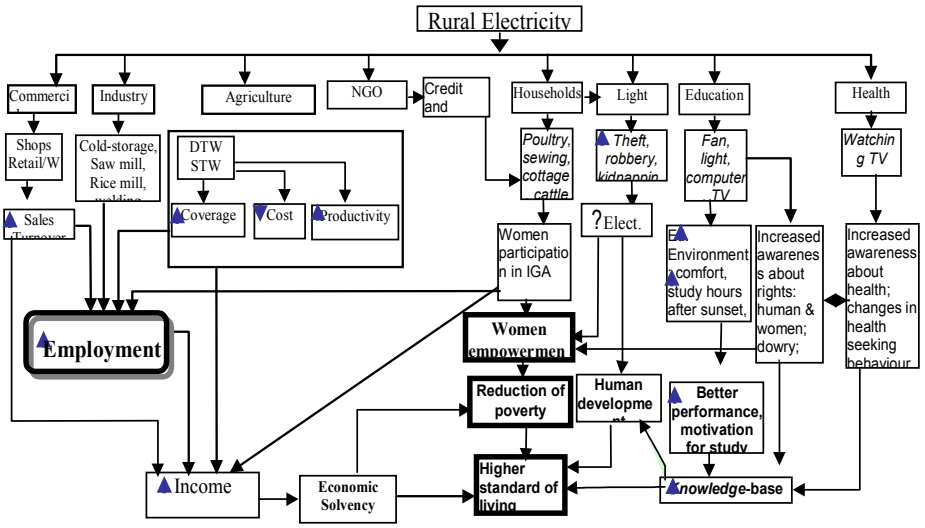
12. An electrified household uses, on average, 2 liter less kerosene per month as domestic fuel than the non-electrified households do. With 100 percent access to electricity of the rural households, about 410 million liters of kerosene use can be saved annually in rural Bangladesh. This saving is equivalent to 2.2% of the annual import bill of Bangladesh.

The Bangladesh study clearly shows that rural electricity accelerates the process of generation of resources in the rural areas through the promotion of inter-subsectoral linkages which creates more job opportunities for the people most of who are poor and were unemployed for a large part of the year before electrification (Barkat *et.al* 2003). The mechanism of rural electrification's multidimensional impact is complex, which is depicted in the following impact flow diagram (Figure 5).

Considering the unquestionable impact of energy in accelerating growth and poverty reduction, securing the supply of primary energy and securing the demand to sustained services is paramount to achieving the MDGs. A rapid increase in oil price, as brought about by a sudden disruption in supply, uncertainty within the oil markets, or by strong demand, has important implications for energy security, macroeconomic growth, and poverty reduction. Such price hikes highly disproportionately affect the net oil importers. For net oil importing developing countries, a rapid rise in oil prices weakens economic growth and exacerbates poverty. The direct effect on an economy is felt through a worsening balance of payments and the subsequent contraction of the economy or increased external borrowing required to restore the balance of payment equilibrium. For example, it is estimated that a sustained US$10 a barrel price increase would amount to a 1.5% loss in GDP among the world's poorest

countries (ESMAP 2005b; IEA 2002a). Price hikes in primary energy sources also mean increases in consumer prices for essential products such as kerosene used for cooking and lighting by many poor people and a considerable increase in transportation costs, beyond what the poor can afford. This, in turn, leads the poor to go back down the energy ladder, for example, switching from kerosene to charcoal or fuelwood and putting more pressure on forestry and land resources; returning to walking rather than using fuel-powered transport; and spending less time on productive activities.

Figure 5 : Flow diagram showing rural electricity impact on employment generation, poverty reduction and women's employment, Bangladesh



Therefore, energy security is tantamount to a country's ability to expand, diversify, and optimize its energy resource portfolio and a level of services that will sustain economic growth and poverty reduction. It is in this light that energy security should become a key focus of energy policy.

5.2 Linkages between Energy Services and Eradication of HUNGER

Eradication of hunger is the second target of MDG (under Goal 1). Energy as form of heat is required to cook 95% of the basic staple foods that form the basis of human nutrition. Most cooked food also requires water, which must be pumped and transported. Growing food crops also requires energy inputs. And women

bear the primary responsibility for cooking. Therefore, the availability and use of both traditional and modern cooking fuels have important linkages to hunger. The amount of energy needed for household cooking needs is commonly estimated at 1 gigajoul (GJ) `into the pot' per capita per year, which can rise as high as 10 GJ per capita per year once efficiency of cooking methods such as biomass burning over a three-stone fire are accounted for (Modi *et.al* 2006).

The urban poor devote a high share of their incomes to obtaining cooking fuels, therefore, they are vulnerable to changes in the price of energy carriers. For example, rising costs of imported fuels or charcoal can lead to a higher incidence of hunger since such increases prevent the poor from adequate cooking and processing their food. The poorest families typically dedicate 80% of total household energy expenditure to fuels for cooking and heat and only 20% for fuels and batteries to produce light. This is primarily because there is little choice whether or not to meet basic subsistence needs (Reddy 1999).

For rural households who rely heavily on biomass fuels, farm waste (in the form of crop residues and manure) can be an important part of the energy supply. Use of modern fuels or improved stoves can allow a greater proportion of farm waste to be returned to the soil. Modern cooking fuels can also indirectly increase farm productivity by freeing up women's time and effort, in particular by reducing the work required for biomass collection, which is particularly detrimental to the health of childbearing women and adolescent girls.

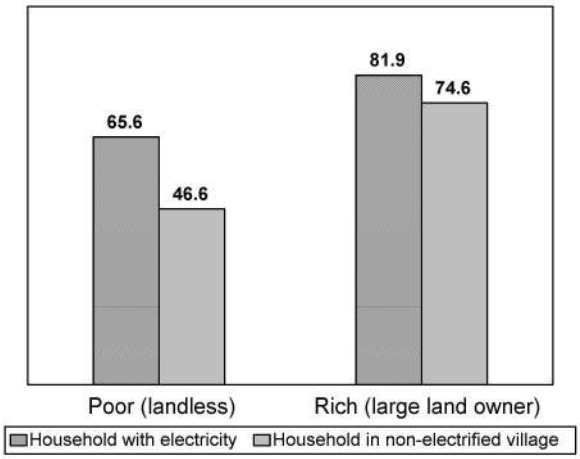
5.3 Linkages between Energy and Education

Attaining the MDG targets on education (MDG target 3) depends decisively on energy services. Particularly for school-age girls, improved access to modern energy services can free time for going to school and for after-school study. Energy scarcity creates time pressure on children to collect fuel, to fetch water, and to participate in agricultural work, and contributes to low school enrollment and high dropout. King and Alderman (2001) show that investment in infrastructure saves time spent collecting water and fuelwood and benefits all household members; in particular, such infrastructure investments result in fewer interruptions to women's paid work and to girls' schooling. The positive correlation between improved access to modern energy services especially that of electricity and educational achievements has been found in Bangladesh study (Barkat *et. al* 2002, Barkat 2004, 2005b).

The most notable and critical findings of the Bangladesh rural electricity study showing inextricable linkages between electricity-energy and education-poverty reduction (MDG Goal 2) are as follows:

1. The overall literacy rate in the electrified households (71%) is 26 % higher than that in the non-electrified households. And for female the rate is 31% higher.
2. The rich-poor gap in literacy is 20% in the electrified households, but it is as high as 60% in the households of non-electrified village.
3. The literacy rate among the poor in the electrified (66%) is about 41% higher than that of the poor in the non-electrified villages.
4. The average annual household expenditure on education is 87% higher in the electrified (Tk.3,260) compared to that in the non-electrified villages (Tk. 1,746).
5. In electrified household, not only the availability of more time for study (average 30-45 minutes more after sunset as compared to non-electrified), but also the quality of that time due to sufficient lighting and fan for comfort plays determining role in the improvement in quality of children's education. Thus, household access to electricity should be seen as one of the major strategies to reduce knowledge-poverty (Barkat 2005b).

Figure 6 : Rich-poor divide in overall literacy rate by household electrification status, Bangladesh



Another important dimension to the provision of efficient education services is the availability of qualified teachers. One of the most often cited factors affecting teachers' retention in rural areas is the lack of access to modern energy services, in particular lighting and power that enable a minimum quality of life and connectivity. Energy and ICT in schools can also enable access to educational material, distance learning, and continuing education for teachers. All these linkages are critical in supporting the achievement of universal primary education as well as the equal participation of boys and girls in education at large.

5.4 Linkages between Energy and Gender Equality

Studies show clear linkages between energy services and gender equality (which is MDG target 4). Access to energy services affects men and women differently, and the specific energy services used by men and women differ based on the economic and social division of labor in the workplace and at home.

Most poor women in developing countries spend one or more hours every day gathering biomass – wood, agricultural residues, and dung. The disproportionate amount of daily time and effort women and young girls spend gathering solid fuels and water for household chores could be used for other income-producing activities, family subsistence, or education. The time spent gathering biomass varies with geographic location, land ownership, the time of the year, climatic events, and loss of control over local resources (Modi *et.al. 2006)*.

Women spent much time and efforts in fetching water and carrying supplies and products to and from markets. Frequently water is fetched by girls and women in plastic containers that are either head-loaded or carried strapped on the back, from a water source (river, spring, or a stream) likely to be at a lower elevation or lifted from a well. Mechanical power-perhaps from a windmill, a diesel generator, or an electric motor-can provide the means to lift the water to a storage tank. Electric or fuel-operated pumps can make it easier to bring water supply closer to home. Rosen and Vincent (1999) report that households (primarily women) spend an average 134 minutes per day collecting water and that the time saved by bringing water supplies closer to households is likely to generate huge benefits.

The time spent collecting fuelwood also reduces the proportion of day-light hours otherwise available. These hours may be critical to other income-generating activities such as commercial foods vending, which is facilitated by improved heating and lighting; agricultural processing using mechanical power; and many trading activities. The cost of energy inputs into those business are high and the

lack of more-affordable alternatives limits the income-generating opportunities faced by women.

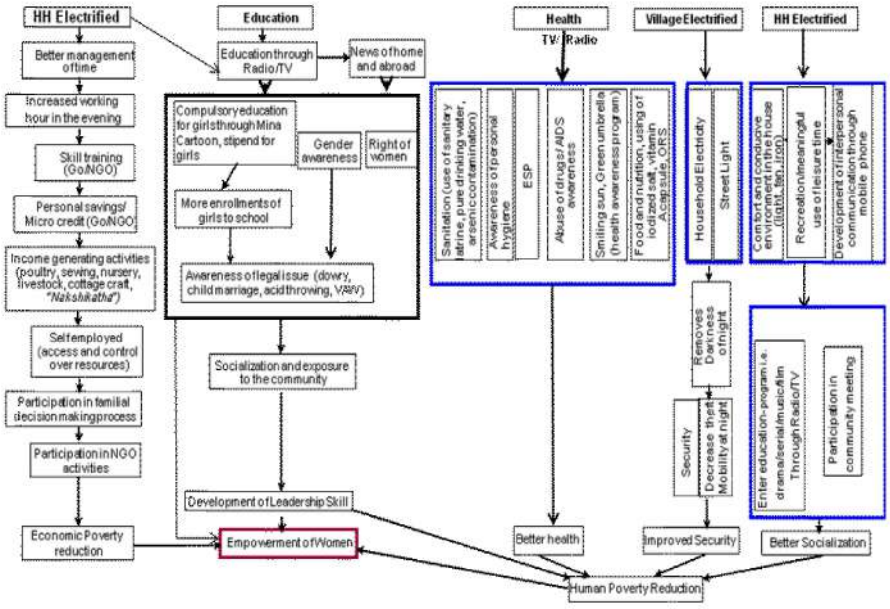
Energy services accelerate the whole process of gender equality and empowerment of women. The Bangladesh rural electricity study illustrates this pathway of generation of relevant impact (Figure 7). Electricity has profound impact on women's mobility, on participation in IGAs, on decision making freedom in using income and savings, on better utilization of credit, on making household work plan according to convenience, on changes in attitude in terms of reducing healthcare, on the increase in overall years of schooling for both boys and girls, on the preference of sending girls to schools, on awareness of gender equality issues, and on awareness of the negative impact of dowry. Electricity mediated TV viewing contributes spectacularly to knowledge-building about gender equality.

Electricity enables all members in electrified households to avail more time (average 60 minutes more) after sunset, in comparison with those in the non-electrified. Socio-culture development is the most prominent activity after sunset for electrified households. Watching TV/ listening radio is the major activity for senior members both male and female followed by socialization. Both the activities facilitated through electricity also signify spillover effect of electrification for female members in non-electrified households in the electrified villages. Thus, provisioning of electricity at the household level is crucial to ensure better standard of living as the effective use of time shapes up the life style for each individual concerned. The better use of additional time attributed to electricity has facilitated the electrified household members to explore new range of activities as well as extended time period for the old ones. Comparison of the pre and post electrification time allocation pattern for electrified household members, revealed increased time allocation for income generating activities or watching TV, which address income as well as human poverty. In the electrified household, reduced household chore for female members and reduced gender gap in terms of daily average time for studying is clearly indicative of improved gender status.

5.5 Linkages between Energy Services and Health

Health related goals of MDG are reflected in four targets (MDG Targets 5-8). The close linkages between health issues and energy use, and between the quality of health services and the availability of quality energy services are obvious. There is increasing evidence that the burning of solid biomass fuels for cooking in

Figure 7 : Mechanism of women's empowerment in electrified village, Bangladesh



indoor environments, especially using traditional stoves in inadequately ventilated spaces, can lead to an increased disease burden. WHO estimates show that the impact of indoor air pollution on morbidity and premature deaths of women and children is the number one public health concern in many developing countries, particularly for the poorest segments of the population. Women–including mothers with young children – who carry out a disproportionate amount of cooking activity – are also likely to share a disproportionate disease burden.

Recent studies have detailed the relationships among three variables – fuel type, kitchen type (indoor versus outdoor), and kitchen ventilation – and exposure to particulate matter experienced by those within household cooking and living areas (ESMAP 2002c, 2003, 2004b). The studies note that two factors – use of solid fuel and lack of ventilation – were associated with the highest particulate matter levels, addition that women responsible for cooking experienced the highest exposure.

Combustion of solid fuels produces smoke containing a number of pollutants such as particulates, and formaldehyde. Exposure to small particulates (less than 10 microns in diameter) is believed to be a risk factor for acute respiratory infections

(ARI) and acute lower respiratory infections (ALRI). Such exposure also appears to be associated with chronic bronchitis and chronic obstructive pulmonary disease, particularly among women. Smith *et al* (2003) report evidence from China that exposure to coal smoke in the home markedly increases the risk of lung cancer, also particularly in women. Though tentative, evidence is accumulating that indoor air pollution is associated with other important child and adult health problems, such as low birth weight babies and blindness in adults (Mishra *et al*. 1999). It is estimated that 1.6 million deaths per year (of which 60% are female) in developing countries are associated with the inhalation of indoor air smoke from the use of solid fuels. This makes indoor air pollution the fourth leading cause of premature death in developing countries (Bruce *et al.* 2000).

Health care infrastructure even in the smallest clinics and health centers relies on refrigeration for vaccines and sterilization. Illumination for patient care after dark, for operating theaters, and for public safety surrounding hospitals increases the health systems' ability to serve poor populations. Improved lighting and hygiene from clean water would help reduce women's mortality rate at childbirth. Modern fuels and/or electricity are essential for these functions. Electricity is essential for many medical instruments, illumination, medical record keeping, communications facilities for reporting medically significant events, and medical training.

The global HIV/AIDS pandemic has many direct and indirect linkages to energy services. Global evidence suggests that education and awareness campaigns, including those using radio and television, which require electricity, are essential to educate at-risk populations about prevention and treatment options in the most affected areas. Another key linkage is the role energy services can play in substituting for labor in areas where labor shortages exist as a result of HIV/AIDS (Modi *et.al* 2006).

The Bangladesh rural electricity study provides ample testimony of high positive impact of electricity in improving people's health (Barkat *et.al* 2002b, 2003; Barkat 2004,2005b). Population survival rate is higher in the electrified than in the non-electrified villages; this is evident from the relatively low infant mortality rates (IMR) in the electrified villages, 42.7/1000 live births against 57.8/1000 live births in the non-electrified villages. Estimates show that if access to electricity were 100% in the rural households, and if those households maintained the same IMR as the current electrified households, the annual number of infant deaths that could be prevented would be around 36,818, an average savings of 101 infant deaths every day. Further, rural electricity's immense role in improving people's

health status is especially true for those in the electrified households, and more so for the poor, the women, and the children. The electrified households are much better off than the non-electrified households in the electrified villages and significantly better off than the households in the non-electrified villages in terms of the following health indicators: awareness of crucial public health issues (Figure 8), seeking treatment by a medically competent person while sick (Figure 9), and seeking treatment by a medically competent person in maternal morbidity (Figure 10), to cite a few. In all of these indicators, not only is the rich-poor divide less pronounced in the electrified than in the non-electrified households, but also the poor (landless) in electrified households show much better health outcomes than their counterparts in the non-electrified villages. Also, in many instances, the poor in the electrified households are better off than even the rich in non-electrified villages in terms of health outcomes: The mechanism of health poverty reduction using electricity is clearly evident in the Bangladesh study (Figure 11).

Figure 8 : Rich-poor divide in public health knowledge by hh electrification status (overall knowledge coefficient), Bangladesh

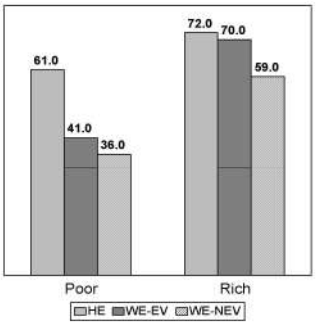


Figure 9: Rich-poor divide in seeking treatment fro medically comp0etent person (proportion sought treatment from MCP), Bangladesh.

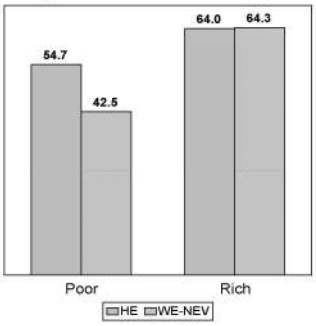
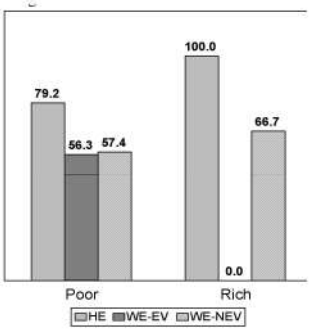


Figure 10: Rich-poor divide in seeking treatment from MCP while sick with) maternal morbidity (% sought treatment from MCP), Bangladesh.

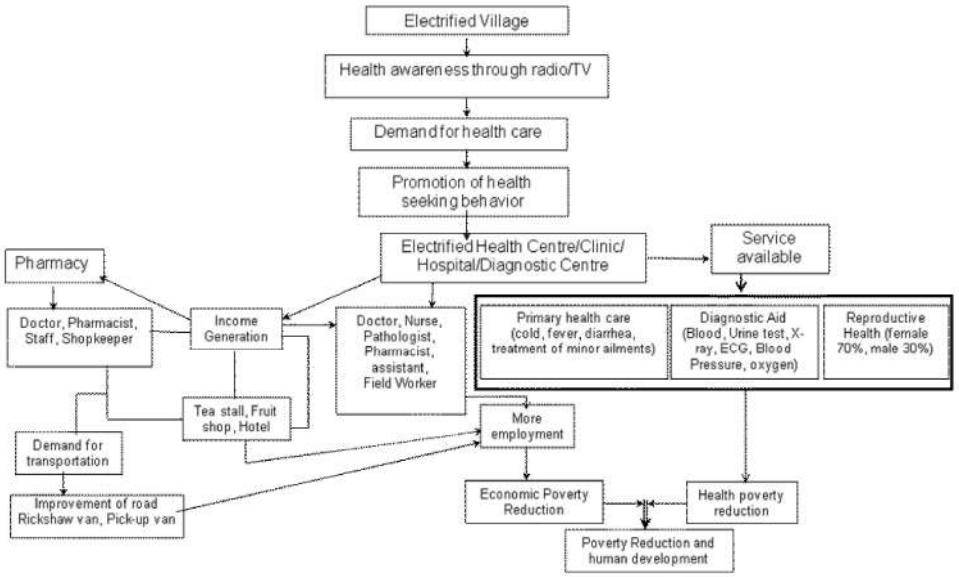


Note: HE= Electrified household; WE-EV= Non-electrified household in electrified village; WE-NEV=Household in non-electrified village.

5.6 Linkages between Energy Services and Environmental Sustainability

Environmental sustainability is the 9th target of MDG. The way energy is produced, distributed, and consumed affects the local, regional, and global environment through land degradation, local air pollution, acidification of water and soils, or greenhouse gas emissions. Fossil fuel use, exploration, transportation, transformation, and distribution will have some unavoidable detrimental effects on the environment. The strong linkages between the

Figure 11 : Mechanism of human poverty reduction in health in electrified village



production and use of all energy forms are central to the climate change debate, particularly the long-term impact on, and risks for, developing countries, with the likelihood that the poorest populations are increasingly vulnerable.

In considering the environmental impact of energy use, greenhouse gas (GHG) emissions are a key concern. It is essential to draw a distinction between fossil fuel use in the poorest LDCs where energy consumption and GHG emissions are low both per capita and in aggregate and where the primary concern is the local environment, and fossil fuel use in industrialized and rapidly industrializing counties, where per capita emissions and aggregate emissions are much greater and therefore more significant on a global scale. This distinction is the basis for the principle of common but differentiated responsibilities for emissions mitigation and reduction which is at the heart of global accords on climate change.

6. Investment Requirement for Energy Services towards Meeting MDGs

Estimation of investment required for energy services to address the relevant MDG targets is not easy. The approximate estimated amount of financial resources needed for the purpose depends on many dynamic assumptions. According to the International Energy Association, the estimated amount of

investment required in the energy sector during 2003-2030 would be US$ 16 trillion, of which $9.6 trillion (60%) for electricity, $3 trillion (19%) for oil, $3 trillion (19%) for gas, and $0.4 trillion (2%) for coal (IEA 2004). The broad distribution of the $9.6 trillion electricity sector investment requirement during 2003-2030 would be as follows: $3.9 trillion for OECD countries, $0.65 trillion for Transition Economies, and $5.2 trillion for Developing countries. It is also estimated that in order to ensure access to safe, clean and reliable electricity to 3.5 billion people an amount of around $600 billion per year will be required. And to attain MDG goal, the additional cumulative investment requirement for electricity sector for 2003-2015 would be $ 202 billion, which in other words comes to about $16 billion per year. The pertinent practical question is how to mobilize this annual $16 billion investment in generation, transmission and distribution of electricity, which is absolutely necessary to attain the relevant MDG targets through provisioning of electricity. One of the most practical answers would be to vigorously pursue the MDG Goal 8, in which the rich countries have committed to provide annually 0.7% of their GNP as ODA, which amounts to $175 billion per year, but so far they have provided only 0.2% (i.e. annually $ 53 billion). Therefore, the commitment of the rich countries in funding MDG needs to be materialized to expand the base of the 'Millennium Challenge Account' from the current around $50 billion to $175 billion annually. At the same time the commitment of the national governments of the developing countries towards expansion of energy services shall be displayed in full swing.

7. Some Concluding Remarks

It is clear that energy services have an impact on all of the MDGs and associated poverty reduction and development targets. Access to energy services facilitates the achievement of these targets. Failure to consider the role of energy in supporting efforts to reach MDGs will undermine the success of the development options pursued, the poverty reduction targets, as well as the cost effectiveness of the resources invested.

Achieving all of the MDGs will require much greater energy inputs and access to energy services. Failure to include energy considerations in the development philosophy behind MDG as well as in national MDG strategies and development planning will severely limit the ability to achieve the MDGs. Therefore, based on the analysis presented in this paper, it would be appropriate to conclude that **Energizing MDG** is both necessary and possible. Transforming this possibility into reality will require *informed-energized actions* on three fronts, simultaneously:

1. At the level of the United Nations – in congruence with the spirit of UN Millennium Declaration to meet the energy challenges – the issue of *"modern energy services* for the poor, marginalized, women, and excluded people" *should be placed at per with other MDGs. (An issue of philosophical principle).*

2. The rich countries – in congruence with the spirit of MDG Goal 8, *"develop a global partnership for development"* – should be pursued to keep and respect their commitments towards Millennium Declaration and accordingly *allocate 0.7% of their GDP annually as ODA* to facilitate realize MDGs. *(An issue of keeping commitment towards global development).*

3. The national governments in the developing countries should be encouraged to adopt and implement the following, among others: broaden the base of energy services by adopting relevant policy frameworks; ensure expanded energy access for poor household, economic, and human development sectors; incorporate the cost of energy service delivery needed to support the attainment of MDGs into national development strategies; and develop and rapidly scale up energy services, improve human capital through energy-related education, training, research and learning. *(An issue of implementation where most people live).*

Annex Table : Critical linkages between energy services and the Millennium Development Goals

Goal 1: Eradicate extreme poverty and hunger

Importance of energy to achieving the Goal

- Access to affordable energy services from gaseous and liquid fuels and electricity enables enterprise development
- Lighting permits income generation beyond daylight hours
- Machinery increases productivity
- Local energy supplies can often be provided by small-scale, locally owned businesses creating employment in local energy service provision and maintenance, fuel crops, etc
- Privatization of energy services can help free up government funds for social welfare investment
- Clean, efficient fuels reduce the large share of household income spent on cooking, lighting, and keeping warm (equity issue – poor people pay proportionately more for basic services)
- The majority (95 percent) of staple foods need cooking before they can be eaten and need water for cooking
- Post-harvest losses are reduced through better preservation (for example, drying and smoking) and chilling/freezing
- Energy for irrigation helps increase food production and access to nutrition

Goal 2: Achieve universal primary education

Importance of energy to achieving the Goal

- Energy can help create a more child-friendly environment (access to clean water, sanitation, lighting, and space heating / cooling), thus improving attendance at school and reducing drop-out rates
- Lighting in schools helps retain teachers, especially if their accommodation has electricity
- Electricity enables access to educational media and communications in schools and at home that increase education opportunities and allow distance learning
- Access to energy provides the opportunity to use equipment for teaching (overhead projector, computer, printer, photocopier, science equipment)
- Modern energy systems and efficient building design reduce heating/ cooling costs

Goal 3: Promote gender equality and empower women

Importance of energy to achieving the Goal

- Availability of modern energy services frees girls' and young women's tie from survival activities (gathering firewood, fetching water, cooking inefficiently, crop processing by hand, manual farming work)
- Clean cooking fuels and equipment reduces exposure to indoor air pollution and improves health
- Good quality lighting permits home study and allows evening classes
- Street lighting improves women's safety
- Affordable and reliable energy services offer scope for women's enterprises

Goal 4: Reduce child mortality

Importance of energy to achieving the Goal

- Indoor air pollution contributes to respiratory infections that account for up to 20 percent of the 11 million child deaths each year (WHO 2002, based on 1999 data)
- Gathering and preparing traditional fuels exposes young children to health risks and reduces time spent on child care
- Provision of nutritious cooked food, space heating, and boiled water contributes towards better health
- Electricity enables pumped clean water and purification

Goal 5: Improve maternal health

Importance of energy to achieving the Goal

- Energy services are needed to provide access to better medical facilities for maternal care, including medicine refrigeration, equipment sterilization, and operating theatres
- Excessive workload and heavy manual labor (carrying heavy loads of fuelwood and water) may affect a pregnant women's general health and wellbeing.

Goal 6: Combat HIV/AIDS, malaria, and other major diseases

Importance of energy to achieving the Goal

- Electricity in health centers enables night availability, helps retain qualified

staff, and allows equipment use (for example, sterilization, medicine refrigeration)

- Energy for refrigeration allows vaccination and medicine storage for the prevention and treatment of diseases and infections
- Safe disposal of used hypodermic syringes by incineration prevents re-use and the potential further spread of HIV/AIDS
- Energy is needed to develop, manufacture, and distribute drugs, medicines, and vaccinations
- Electricity enables access to health education media through information and communications technologies (ICTs)

Goal 7: Ensure environmental sustainability

Importance of energy to achieving the Goal

- Increased agricultural productivity is enabled through the use of machinery and irrigation, which in turn reduces the need to expand quality of land under cultivation, reducing pressure of ecosystem conversion
- Traditional fuel use contributes to erosion, reduced soil fertility, and desertification. Fuel substitution, improved efficiency, and energy crops can make exploitation of natural resources more sustainable
- Using cleaner, more efficient fuels will reduce greenhouse gas emissions, which are a major contributor to climate change
- Clean energy production can encourage better natural resource management, including improved water quality.
- **Energy can be used to purify water or pump clean ground water locally, reducing time spent collecting it and reducing drudgery.**

Source: DFID 2002

References

Barkat Abul. 2005a. *Energy Security for South Asia.* Regional Energy Security Study for SARI/Energy Countries. Delhi (8-9 April 2005).

Barkat Abul. 2005b. *Access to Electricity in Rural Bangladesh: Some Empirical Evidence of Socio-Economic Impact*. Asian Institute of Technology, Thailand: Pathumthani.

Barkat, Abul. 2004. *Rural Electrification and Poverty Reduction: The Case of Bangladesh,* in Social Science Review, Vol.21, No.1, June 2004, Dhaka University.

Barkat, A., Khan, SH., Haque, M., Ara, R., Zaman, S., and Poddar, A., 2003. *Impact Study of Rural Electrification Project : Mechanism of Poverty Alleviation Fostered by Rural Electrification,* Human Development Research Centre (HDRC), Prepared for Japan Bank for International Cooperation, Dhaka.

Barkat, A., Khan, SH., Rahman, M., Zaman, S., Poddar, A., Halim S., Ratna, NN., Majid, M., Maksud, A.K.M., Karim, A., and Islam, S., 2002. *Economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh,* Human Development Research Centre (HDRC), undertaken for NRECA International Ltd., partners with the Rural Electrification Board of Bangladesh and USAID for the Rural Power for Poverty Reduction (RPPR) Program.

Bruce, Nigel, Rogelio Perez-Padilla and Rachel Albalak. 2000. *The Health Effects of Indoor Air Pollution Exposure in Developing Countries.* World Health Organization: Geneva Available at .

DFID (Department for International Development, UK). 2002. *Energy for the poor: Underpinning the Millennium Development Goals*. August. Available at .

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2005a. *Advancing Bioenergy for Sustainable Development: Guideline for Policymakers and Investors*. Report 300/05. World Bank: Washington, DC, USA.

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2005b. *The Impact of Higher Oil Prices on Low Income Countries and on the Poor.* World Bank: Washington, DC, USA.

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2004a. *The Impact of Energy on Women's Lives in Rural India.* World Bank: Washington, DC, USA. Available at .

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2004b. *Indoor Air Pollution Associated with Household Fuel Use in India: An Exposure Assessment and Modeling Exercise in Rural Districts of Andhra Pradesh, India*. World Bank: Washington, DC, USA.

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2003. India: *Access of the Poor to Clean Household Fuels.* World Bank: Washington, DC, USA.

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2002a. *ESMAP Business Plan, 2002-2004.* World Bank: Washington, DC, USA. Available at .

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2002b. *Energy Strategies for Rural India: Evidence from Six States.* World Bank: Washington, DC, USA. Available at .

ESMAP (UNDP/World Bank Energy Sector Management Assistance Programme). 2002c. *Household Energy, Indoor Air Pollution, and Health.* World Bank: Washington, DC, USA.

IEA (International Energy Agency). 2004. *World Energy Outlook 2004*. IEA: Paris, France.

IEA (International Energy Agency). 2002a. *Analysis of the Impact of High Oil Prices on the Global Economy.* Organization for Economic Co-operation and Development (OECD)/IEA: Paris, France.

IEA (International Energy Agency). 2002b. World Energy Outlook 2002. Chapter 10, Energy and Development. Organization for Economic Co-operation and Development (OECD)/IEA: Paris, France.

King, E. M. and H. Alderman. 2001 Education. Brief No. 6 in Quisumbing, A. R., and R. S. Meinzen-Dick (eds). *2020 Focus 6: Empowering Women to Achieve Food Security.* International Food Policy Research Institute (IFPRI): Washington, DC, USA. Available at .

Mishra, Vinod K., Robert D. Retherford and Kirk R. Smith. 1999. Biomass cooking fuels and prevalence of blindness in India. *Journal of Environmental Medicine 1:* 189-199. Available at .

Modi, V., S. Medade, D. Lallemant, and J. Saghir-2006 – *Energy Services for the Millennium Development Goals.* New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium project, and World Bank.

Reddy, A.K.N. 1999. Goals, strategies, and policies for rural energy. *Economic and Political Weekly* 34 (49): 3435-45.

Rosen, S. and J. R. Vincent. 1999. *Household Water Resources and Rural Productivity in sub-Saharan Africa: A Review of the Evidence.* Harvard Institute for International Development Paper DDP No. 673. Available at .

Smith, K.R., S. Mehta and M. Feuz. 2003. Indoor smoke from household solid fuels. In: Ezzati, M., A. D. Rodgers, A.D. Lopez and C.J.L. Murray (eds) *Comparative Qualaification of Health Risks: Global and Regional Burden of Disease due to Selected Major Risk Factors,* 3 volumes. World Health Organization: Geneva, Switzerland.

UNDP (United Nations Development Programme). 2000. *World Energy Assessment: Energy and the Challenge of Sustainability.* UNDP: New York, USA. Available at.