

Dark Homes and Smoky Hearths

Rural Electrification and Women

It is commonly argued by power utilities that rural electrification is commercially unviable and is responsible for the financial mess state electricity boards are in. This paper examines rural electrification from a socio-developmental perspective and argues that the direct and indirect benefits of rural electrification in reducing the burden on women, its positive impact on health, education and farm income, justifies the expense of network expansion for universal access. It also advocates multiple uses of electricity as this would enhance these benefits, have a beneficial effect on the environment, increase the viability of rural electrification and result in savings on household (total) energy expenditure.

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Based on a consensus reached at the chief ministers' conference in March 2001, the government of India set itself the ambitious target of electrifying every village in the country by 2007 and providing access to electric services to all rural households by 2012 under the Electricity For All (EFA) programme. As per estimates of the ministry of power, achieving EFA will require an investment of over Rs 8,00,000 crore [GoI 2004]. This paper is part of a larger project on the implications of this decision and its impact on social and economic development as well as on the state electricity boards (SLBs). This paper evaluates EFA from a gender perspective and discusses the impact of providing universal access to electricity on women, education and farm income and argues that the large direct and indirect social and developmental benefits of rural electrification (RE) justify this decision. We hope to analyse later the financial implications of such a massive network expansion and how EFA can be implemented.

The decision to provide EFA is in part, recognition of the importance of electricity in improving the quality of life. The National Human Development Report, 2001 [GoI 2002a] classifies access to electricity as a basic amenity in India, at par with other similar amenities like shelter, sanitation and drinking water. Moreover, electricity is also a critical input for economic activity – industrial, agricultural and commercial, and thus has a vital role to play in economic development and wealth generation. EFA is also acknowledgement of a political reality: excluding almost eight crore rural households and 1,20,000 villages from access to electricity is not politically sustainable.

There are contrary views on RE as well as scepticism about its efficacy in inducing industrial and commercial activities, economic growth and reducing poverty. Some policy-makers also believe that state sponsored electrification is being forced on the poorest of the poor who cannot afford electricity and have been living without it for decades. So why bother with EFA?

Electricity dramatically improves the quality of life, particularly for women. Household electrification reduces their everyday drudgery and frees up time for leading more balanced lives. It gives time for income generating activities like cottage industries (also providing energy where required), education (especially of the girl child and adult women) and leisure. Electricity also has an overall positive impact on household education, health and farm income. Some of these benefits have been quantified in monetary terms and we refer to them to buttress our arguments.

These benefits are enhanced with multiple usage of electricity. It is perhaps the cleanest energy option available in India and thus has a strong beneficial effect on the environment – in reducing both emissions and the pressure on forests.

Methodology and Layout

Available empirical findings and research show the positive impact of electrification on the economic and social development of households and particularly of women. We draw extensively from the findings of two field surveys on RE. The first was conducted by ORG Marg under the Canadian International Development Agency (CIDA) funded Energy Infrastructure Project (EISP), in the first quarter of 2001 in Madhya Pradesh (MP) (referred to as the EISP Survey in the paper). A sample of 1,080 households, 1,200 farmers and 690 small consumers from nine districts of MP, was selected adopting a two stage stratified random sampling procedure. The second, an Indian Rural Energy Study was funded by the World Bank and conducted by ORG Marg by interviewing over 5,000 women and 5,048 rural households from six states of India¹ in 1996 (referred to as the Energy Study). While access to this data was not available, we refer to several World Bank papers that present the survey findings.

In the next section, we discuss the general social and economic benefits of RE that justify EFA. Later, we evaluate the multiple benefits of electricity for rural women, health and the environment, and finally, we present findings of empirical studies that quantify the benefits of electricity on lighting, education and irrigation.

General Social and Economic Benefits of RE

Cost and benefit issues – a case of premature RE?: Admittedly, the costs of RE are very high. The obvious question then is, do the benefits justify the costs? Does electrification lead to a reduction of poverty, or an increase in economic activity, etc, that would justify the diversion of vast amounts of public funds? The important role that electricity plays in development is obvious. But what is not as clear is the relationship between electricity and poverty alleviation [World Bank 2000a]. The EISP Survey finds that poverty alleviation requires a wide range of initiatives that include electricity as a critical input, but that electricity alone cannot lead to poverty alleviation (except where it provides direct employment). In fact, Barnes mentions the “futility of premature

rural electrification” in the absence of other important inputs for economic development [World Bank 2001a].

There is also inadequate documentation of the productive uses of electricity, with some doubting its assumed level of benefits [Barnes et al 2002]. The World Bank points out that the economic returns of RE projects are often considerably lower than projected and a wide range of expected indirect benefits like spurring industrial growth or regional development do not materialise. It points out that evidence from Asia suggests that from a cost-benefit perspective, RE projects have performed poorly. The exception is agriculture, where RE has, as a part of a package with other inputs, contributed to the increase in irrigated farming. In the absence of other necessary conditions, electricity alone has not been able to stimulate growth and even demand for productive uses. Without agriculture, the rural demand for electricity has remained low [World Bank 2001b; OED].

Finally, there is also a point of view that the poorest of the poor cannot afford electricity and have been living without it for decades. Connecting them only traps them into availing a service they neither need nor can afford. Once connected, they are subject to harassment by corrupt and insensitive utility personnel. Moreover, the SEBs also have no incentive to divert scarce resources into this loss making sector. So why bother with EFA? *Direct and indirect benefits of RE:* An important finding of the EISP Survey in MP was that those excluded from access to electricity are the poorest of the poor. Hence any RE expansion programme essentially means increasing access for the poorest of the poor. This is important not only for the direct benefits that electricity brings, but also because electrification complements and facilitates the delivery of social and economic development programmes in education, health, sanitation and drinking water. EFA is also acknowledgement of a political reality: over 74 per cent of the population lives in rural India and excluding almost eight crore rural households and 1,20,000 villages from access to electricity is not politically sustainable in a democracy. The electricity riots in MP in 2003 and in Andhra Pradesh, Gujarat and more recently in Maharashtra in 2004, bear testimony not only to the extent to which electricity constitutes a vital part of daily life in rural India, but also that consumers have become aggressive and vociferous in demanding access to quality supply.

The objectives behind any mass electrification programme are essentially to improve the quality of life and enhance economic development. Electricity works in two parallel ways to achieve these objectives: the first as a substitute for traditional fuels (firewood, cow dung, crop residue, etc) used for lighting, cooking and heating. As discussed later in the paper, women are the major

beneficiaries of this substitution. This substitution saves the physical effort and time of collecting traditional fuels and consequently they have more time and opportunity for other productive activities. This substitution also has a significant positive impact on the health of women (in particular) and other members of the household, because electricity is a much cleaner fuel compared to any traditional fuel (and even kerosene). The other way in which electricity helps achieve development and welfare goals is by improving social and economic infrastructure. Electricity in schools would provide higher quality lighting and facilitate use of modern teaching and communication aids, particularly internet access. Electricity in the primary health centres would permit upgrading for services that can be provided – OT, X-ray, etc, and equally important, for stocking essential vaccines and medicines safely in refrigerators. Electricity in public buildings in the village would allow for access to modern communication media like TV and internet. Pumped water supply schemes, so essential for providing safe drinking water, becomes possible once a village is electrified. Street lighting in villages significantly improves health and safety. Overall, there is an evident and relatively quick improvement in the quality of life once a village or a household gets access to electricity.

The EISP Survey found that electricity is an important input for economic development and growth and can be seen as a necessity for significant poverty reduction. Electrified households are better off in term of income, assets and education, though the relationship between electricity and higher income was not established (we discuss this issue later). It also found that benefits from electricity include improved living standards, well-being and capabilities, a sense of security, higher productivity and increased commerce.

Table 1 reproduced from the *Energy And Development Report 2000* of the World Bank (2000b), summarises the direct and indirect benefits of energy services in alleviating poverty. It may be noted that energy services discussed in this report include electricity and other modern fuels like gas and kerosene. However, as we shall discuss later, in the Indian context electricity is the cheapest and cleanest energy source and hence, these benefits are particularly relevant for our discussion.

Table 1 shows that the impact of RE increases with multiple uses of electricity. However, going strictly by a cost benefit approach, investments in rural electrification are commercially justified only when its emerging uses can generate sufficient demand to produce a reasonable return on the investment. Intuitively, one expects that electrification would lead to an increase in economic activity and therefore, demand. However, this

Table 1: Potential Benefits of Improved Energy Services in Alleviating Poverty

Direct Effects on Well-being	Direct Effects on Health	Direct Effects on Education	Direct Effects on Economic Opportunities for the Poor	Trickle-down Effect of Increased Productivity	Fiscal Space (Coupled with Pro-poor Policies)
Improved access to lighting, heat and refrigeration.	Improved indoor air quality through cleaner fuel.	Improved access to lighting allowing more time to study.	Easier establishment and greater productivity of businesses that employ the poor.	Easier establishment and greater productivity of businesses in general (including through positive impact on the environment).	Smaller fiscal burden and higher fiscal returns from more efficient services.
Savings in time and effort (due to reduced need to gather biomass and other fuels).	Reduced fire hazard. Improved quality of health services (through better lighting, equipment and refrigeration).	Savings in time and effort releasing time and energy to channel to education.	Creation of employment in infrastructure service delivery.		More benefits to the poor if government spending is effectively channelled to welfare enhancing services.
Improved access to information (through radio, TV and telecommunications)	Easier establishment of health centres. Better education.		Improved health and education and savings in time and effort increasing individual productivity.		Higher fiscal returns associated with higher growth coupled with pro-poor policies.

Reproduced from *Energy and Development Report 2000: Energy Services for the Poor, World Bank, 2000b.*

development is gradual and over a period of time, as did happen in the Philippines where electricity brought about an increase in household incomes through small enterprises like food stores [Barnes et al 2002]. Apart from inadequate generation, one explanation for the slow growth in demand for electricity in India could be the poor quality and reliability of supply that compels rural households to limit their use to lighting, fans or TV. SEBs have also been reluctant to extend access to what they consider, is a loss making consumer group. And finally, the fact that the number of households getting connected continues to grow years after a village is electrified, supports the argument that the benefits of RE should be evaluated from a long-term perspective [World Bank 2004]. Thus, a purely commercial criterion alone cannot be fully applied in appraising RE projects because the social obligations of the state far outweigh the return on investment criteria.

In the next two sections, we focus on specific areas that benefit substantially from electricity. We first discuss the enormous and wide ranging benefits that rural women derive from electrification. Then we cite work that has quantified the monetary benefits of electrification on lighting, education and agriculture.

Impact of Rural Electrification on Women

Women are possibly the greatest beneficiaries of rural electrification. Their traditional role in patriarchal societies casts upon them (and even girls) the entire burden and drudgery of household chores: collecting biomass fuel, cooking, fetching water, childcare and also helping in the fields. While these activities are critical for the survival of the family, they are largely non-monetary and lie outside the ambit of conventional national accounting. The UN Human Development Report finds that women do more than 50 per cent of the work in the world: in developing countries they do 53 per cent but get rewarded for only 34 per cent of their labour, while men do 47 per cent of the labour and get rewarded for 74 per cent [UN 1995]. Besides the physical strain and adverse impact on their health, these activities also leave no time for income generating activities, education, reading or leisure. Using electricity significantly frees up their time allowing women to lead healthier, more balanced (between work and leisure) and productive lives.

To see how electricity benefits women, it is useful to look at the time use pattern of women in rural houses with and without electricity. Table 2 reproduced from a 2004 World Bank report *The Impact of Energy on Women's Lives in Rural India*, shows how a sample of 5,000 women in the Energy Study spend their time.

Table 2 clearly shows that women in the sample spent over one-third of the full day doing household work: as a per cent of the waking hours, the proportion is almost double. This report has important findings from our perspective and we therefore summarise those relevant to our discussion. It may be noted that the results hold even after controlling for income, education levels, caste, occupation and access to village infrastructure:

- While women from all income levels benefited from electricity, those from the lowest income level households with electricity led more balanced lives than those from the highest income households without electricity.

- At all income levels, women living in houses with electricity spent significantly less time collecting fuel than those without access to electricity. Excluding 'other leisure' (essential personal activities), women in un-electrified households of the sample spent about 28 per cent of their waking hours collecting fuel and cooking as compared to 23 per cent when in houses with electricity and 21 per cent when they also had a TV. If we also

consider time spent in fetching water, the difference is even more marked.

- Houses with electricity are more likely to use an electric or kerosene stove.

- Household electrification frees up women's time allowing them, particularly those with a lower education level, to engage in income generation.

- Reading requires good quality light and time. 90 per cent of the women who did some reading during a typical day lived in electrified houses. Clearly, electricity has an important role to play in the education of the girl child and adult women.

- More than 40 per cent of electrified houses had a TV: it was the most popular use of electricity after lighting and space cooling. Besides entertainment, TV also provides a very strong medium of communication and a link with the rest of the world. Messages relating to important development and social issues like health, childcare, hygiene, sanitation and social justice, women's rights, etc, are effectively conveyed through it. Both reading and watching TV are important for raising awareness levels and educating rural women.

These findings clearly show that electrification reduces the time women spend on household chores, particularly on the back-breaking drudgery of collecting fuels. They are able to use the time saved on earning income, building awareness, childcare or leisure. It is important for women to have the freedom to work because of the beneficial impact of women's income on the well-being of the family. Studies have shown that a woman's income is more likely to be spent on the household as compared to a man's income. In fact, it is well recognised that the health, educational level, awareness and ability to contribute to the family income have a positive and definite impact on the status of women (see for example, Dixon 1978). Hence, from a social perspective, access to electrification is highly desirable because of the high opportunity costs of women's time. We submit that this time saving, derived only from a limited use of electricity for lighting, cooling and TV, alone justifies EFA. If we also consider multiple usage of electricity for cooking and piped water supply, to name just two, not only are these benefits enhanced (through greater time saving and reduction in drudgery), but other equally important and socially desirable consequences follow.

We now discuss one of these other uses of electricity - even if it may seem a distant dream at this point of time - namely, as an energy source for cooking. The above account clearly shows (not surprisingly) that cooking and collecting fuel take up the bulk of the time of rural women. This is because traditional

Table 2: Electricity and Women's Time Allocation, Rural India 1996

Activities	Mean Time Spent (hours)		
	Households Without Electricity N = 2,012	Households With Electricity	
		All N = 3,036	With TV N = 1,249
Collecting fuel	0.90	0.53	0.32
Fetching water	1.00	0.88	0.71
Cooking	2.93	2.58	2.53
Other housework	5.75	5.83	6.01
Earning income	1.86	1.93	1.38
Reading	0.03	0.20	0.32
Watching TV	0.06	0.76	1.63
Other leisure (includes sleeping)	10.49	10.46	10.42
Miscellaneous	0.52	0.72	0.60

Note: The women surveyed were the primary cooks in the house. They were asked how they spent their time the previous day. Hence, the results may not capture activities not undertaken daily.

Reproduced from *The Impact of Energy on Women's Lives in Rural India*, World Bank, 2004.

biomass fuels continue to be the fuel of choice for cooking in India. Table 3 shows that over 80 per cent of rural households in India use firewood, crop residue and cow dung cakes.

The use of biomass fuels poses a number of serious problems, particularly for women. The first is the time spent collecting these fuels and the accompanying drudgery. A number of studies document that women (and girls) spend 2-4 valuable daylight hours walking between 3-10 kms to collect fuels. The exact amount depends upon the geographical location and the extent of forest degradation in the area [Agarwal 1986]. Moreover, both time and effort have been increasing as the pressures of increasing population lead to greater degradation. This is crucial because of the high opportunity cost of this time. Second, biomass fuels are highly polluting and pose a major health hazard to the cook – invariably women and girls. Cooking indoors and on open fires exposes women to obstructive pulmonary disease [World Bank 2004; Parikh and Laxmi 2000]. Price reports that about 4,00,000 people in India die prematurely on account of indoor air pollution [World Bank 2000]. This health hazard thus has a huge social and economic costs [Goldemberg et al 2004]. Third, these fuels have low calorific value, which means longer cooking hours, greater consumption of fuel and more exposure to toxic emissions. And finally, the longer cooking time could also lead to changes in cooking styles – cooking only once a day and/or under cooking; both of these could have an impact on the nutritional status of family members, particularly women. Unfortunately, there is a common perception that traditional fuels are ‘free’. This view not only ignores the time value of women’s labour and its opportunity costs, but also the adverse impact of using fuel wood (the major category used) on the environment – in terms of forest degradation as well as the emissions. The sight of a typical village at dusk with a pall of smoke from the fires does appear picturesque, but that haze is toxic.

LPG or kerosene are undoubtedly safer and cleaner fuels for cooking and would also reduce women’s drudgery and free up time for them. Although the problems associated with substituting traditional fuels by cleaner fuels are daunting, even at a global level, ‘shifting to clean fuels (LPG/natural gas/electricity) over 10-15 years is a goal within reach’ [Goldemberg et al 2004]. However, the lack of an extensive rural supply network in India has constrained the growth in LPG use. Besides, the subsidy on kerosene (that makes it a viable fuel) is available only for a limited quantity that is just adequate for lighting (while the exact amounts of both quantity and subsidy vary across states, the principle holds). In addition, kerosene lighting is of very poor quality, so the impact on education is lost. Improved chullahs do reduce pollution and cooking time, but they still use biomass. And finally, there are no cost-effective substitutes for electricity to provide for refrigeration, fans, TV, and provide Internet access, etc. Electricity alone has the flexibility to serve these multiple needs. This is the crux of our argument for the multi-usage of electricity.

In the Indian context, electricity is the cleanest and optimal energy source. Hence, a graduation up the energy ladder by substituting electricity for traditional biomass fuels for cooking, heating and lighting will significantly reduce the burden of women and release time that they can use for more productive and socially beneficial activities. This would also have an equally desirable outcomes on women’s and household health and the environment. It may be noted that even today, electricity is used, though in a very small numbers, for cooking, as seen from the preceding table.² But because the system is not planned for this load, the quality of supply suffers. Multiple uses would also boost consumption, leading to economies of scale in generation and supply.

This would lower connection and consumption expenses for consumers. It is also likely to lead to a reduction in the total energy expenditure of the household, an issue we turn to in the next section.

Quantifying Benefits of RE

Quantifying the benefits of electrification is important. It would help in a cost-benefit analysis of RE that could incorporate the social benefits discussed above. It would also permit prioritising and even selecting the optimum RE project. Unfortunately, evidence of the monetary benefits of rural electrification is difficult to come by. In part, this may be because of the inadequacy of available measurement techniques, but the diverse and pervasive social benefits of RE also render their measurement difficult. Applying econometric techniques developed by the World Bank to data collected by the Energy Study, Barnes et al attempt to quantify the monetary benefits of RE with reference to lighting, education and irrigation [Barnes 2002]. While these findings appear intuitive, their value lies in the objective quantification of benefits that are ‘presumed’ to exist. Being able to assign a money value gives a better appreciation of the value of electricity and is therefore a useful input for pricing and subsidy policies. *Lighting:* Kerosene continues to be the fuel of choice for lighting in rural areas. Table 4 shows that at an all India level while 43 per cent households use kerosene, in rural areas almost 56 per cent use kerosene as the source of lighting.

Barnes et al derive the monetary benefit of electric lighting from an estimate of the difference between the amount households are willing to pay and what they actually have to pay (this is the consumer surplus generated from using electricity). The largest surplus is generated in the transition from an improved kerosene lamp to incandescent lighting. They found that across the entire sample, this change resulted in a phenomenal 95 per cent reduction in lighting price (from Rs 2.65 to Rs 0.13 per kilo lumen hour; lumens is a measure of light). It also increased the consumption of lighting by 40 times. They conclude that rural electrification generates a consumer surplus between Rs 15-20 per kilowatt-hour (kWh), an amount far in excess of the existing subsidised domestic tariff rate. While these numbers will vary across states, the more important findings do not: that the benefits of lighting far exceed what domestic consumers actually pay for electricity and, that while the consumer surplus for higher income households is greater in absolute terms, as a percentage of household income, it is much lower than poor households. In other words, the poor benefit more from gaining access to electrification. This is particularly significant for policy decisions on tariff subsidy. It would appear that there is a case for a long run phasing out of tariff subsidies, provided the investment and

Table 3: Fuels Used for Cooking
(In per cent)

	All-India Total	Rural	Urban
Total households	100	100	100
(Number of households)	(191,963,935)	(138,271,559)	(53,692,376)
Firewood	52.5	64.1	22.7
Crop residue	10.0	13.1	2.1
Cow dung cake	9.8	12.8	2.0
Coal, lignite, charcoal	2.0	1.1	4.6
Kerosene oil	6.5	1.6	19.2
LPG	17.5	5.7	48.0
Electricity	0.2	0.1	0.3
Biogas	0.4	0.5	0.4
Other	0.6	0.8	0.2
No cooking	0.3	0.2	0.6

Source: Table H-11, *All-India Census, 2001*.

operating costs can be lowered – a policy approach that we strongly advocate and discuss in our later work.

Education: Intuitively, we expect that electricity would make a significant impact on education and several studies have established that household electrification has a positive impact on children's school enrolment and leads to a decline in school drop-out rates [Sen et al 2004]. Electric light facilitates and encourages studying in the evening and night because it is of significantly higher quality than light from kerosene lamps. Any policy initiative for education would therefore be complemented by household electrification.

Barnes et al explore the relationship between electricity use, education and non-farm income (all household income excluding from farming and animal husbandry) statistically. For the sample of households with non-farm income in the Energy Study, the average annual non-farm income was Rs 17,350 (in 1996) and the average education was 7.3 years. They found that the probability of household electrification appeared likely to increase with the level of education and income. The impact of electricity and education on non-farm income together is much greater than either variable taken separately. Domestic electrification seems to increase labour productivity (as measured by non-farm income) of each additional year of education. In quantitative terms, for the sample of households with non-farm income, on average, electrification increased the returns to an additional year of education by 3.1 per cent (2.2 per cent without electricity and 5.3 per cent with electricity). In monetary terms, electrification led to a 25 per cent (or Rs 4,350) increase in household annual non-farm income.

Besides the economic impact, there is also a human aspect to the relationship between electricity and education in India. With kerosene in widespread use in rural areas, the bulk of rural children are forced to study in poor quality light. With more children entering the formal education system, competition has increased. Parents and children are both equally worried about performance in key board examinations, which determine future career opportunities. In such tough – even cut-throat – competition, denying a child access to electricity is tantamount to denying an equal opportunity to compete. Parents and children are increasingly aware of this. The widespread public agitations across MP, especially the riots in Bhind district in May 2003 were a protest against evening power cuts during examination time. Hence, an education programme with electricity is, therefore, likely to be significantly more effective than one without it.

Irrigation: The positive impact of irrigation in general and electrification in particular on farm income is well documented. In fact, it is widely acknowledged that the greatest success of the rural electrification programme in India has been its significant contribution to agricultural growth [Barnes et al 2002]. Irrigation increases productivity, agricultural yields, the number and pattern of crops that can be harvested and consequently farm income. Irrigation is essential for high yielding varieties of seed and has become a critical agricultural input for the past 40 years since the launch of the green revolution. In a White Paper on the Status of the Power Sector released in 2003, the government of MP acknowledged the impact that the increased use of electricity in irrigation had on higher agricultural production, particularly of oilseeds and cotton. The impact of irrigation on production and productivity can be seen from Table 5.

While the contribution of other factors cannot be undermined, irrigation through electric pumps has played a major role in the tremendous increases in yields and productivity. Pump irrigation, particularly using electricity, has been widely encouraged by the government, as can be seen from the phenomenal growth in

pumps energised. As on March 31, 2004, 1,40,00,000 pumps were connected, as compared to about 1,50,000 in 1970, an almost tenfold increase. This growth is reflected in an increase in electricity sales to agriculture, from 26 per cent to 29 per cent of all sales by SEBs between 1989-90 and 2001-02 [GoI 2002b].

Once electricity is available, it becomes the energy of choice for irrigation, presumably because of its low cost and ease of operation. The primary driver of cost appears to be the highly subsidised agricultural tariff. This large tariff subsidy probably accounts for farmers choosing electric pumps over diesel operated ones.

The MP EISP Survey shows that poor farmers usually own one three or five HP electric pumps. Sharing pumps mitigates the high capital costs. Non-users own diesel pumps irrespective of whether they are poor or not. The reason for owning a diesel pump is the inability to get connected to the grid, usually due to distance. Diesel pumps are reported to have higher capital and running costs than electric pumps. The survey found that the difference in operating costs was about Rs 1 per kwh. The impact on farm income from using electricity can be seen from Table 6, that shows cost-revenue data for agriculture collected in the survey. The data includes all seasons and all crops combined and both electricity and non-electricity users. Non-users include rain fed farmers, canal, diesel pumps and water purchasers.

Based on 2001 level tariffs, the cost of irrigation represented about 20 per cent of total costs or 3.5 per cent of the crop value and gave a net income that was more than double than that without irrigation.

The World Bank Energy Study also found that the cost of operating a diesel pump is higher than an electric one with the difference, in aggregate, being of the order of about Rs 2.30/ kwh. It found that irrigating with electricity adds about Rs 20,000 to income compared to un-irrigated farming, with large farmers getting a larger increase (though irrigating with diesel or canal

Table 4: Fuel Used For Lighting in India
(In Per cent)

	Total	Rural	Urban
Total in per cent	100	100	100
(Household numbers)	(191,963,935)	(138,271,559)	(53,692,376)
Electricity	55.8	43.5	87.6
Kerosene oil	43.3	55.6	11.6
Solar	0.3	0.3	0.2
Other oil	0.1	0.1	0.1
Any other	0.2	0.2	0.1
No light	0.3	0.3	0.4

Source: Table H-9, All India Census, 2001.

Table 5: Impact of Irrigation on Agricultural Production in India

S No	Irrigated area (000 Ha)	1950-51	1993-94	Percentage Change
1	Net area sown	118746	142095	20
2	Total cropped area	131891	186420	41
3	Area sown more than once (2-1)	13147	44352	237
4	Net irrigated area	20853	51452	147
5	Gross irrigated area	22563	68367	203
6	Area irrigated more than once (5-4)	1710	16915	889
<i>Principal crop production (million tonnes)</i>				
7	Foodgrains	50.82	184.26	263
8	Oilseeds	5.16	21.5	317
9	Sugarcane	57.05	229.6	302
<i>Principal crop productivity (kg/ha)</i>				
10	Foodgrains	522	1501	188
11	Oilseeds	481	799	66
12	Sugarcane	33363	67152	101

Source: Government of India, Planning Commission, Data and Statistics, September 22, 2004. <http://planningcommission.nic.in/data/dataf.htm>

also increased income significantly). Using both diesel and electricity gave the highest increase. These results are also confirmed after controlling other factors that may account for an increase in income in the regression. As in the EISP study, the poorest farmers (small and marginal) do not benefit sufficiently to cover capital costs and therefore, probably do not have pump irrigation.

To sum up then, empirical evidence from both surveys clearly shows that irrigation increases farm income and that electricity is the cheapest, most convenient and cleanest source of energy for irrigation. All but the poorest small and marginal farmers have an increase in income by using electricity for pumping. Moreover, the gain is considerably more than what is spent on electricity. Hence, as in domestic rates, there is clearly a case for tariff rationalisation for agricultural consumers. And finally, because a significant number of agricultural operations – particularly those involving hard labour (transplanting paddy for example) – are done by women, they would also benefit from the reduced drudgery, as increased yields and income are likely to lead to greater mechanisation (as in Punjab, for instance).

Conclusion

In this paper, we have tried to show the strong positive spin-offs for women and rural households that could result the use of electricity. Electrification reduces the drudgery and burden of women and saves time that they can use for more productive purposes, thereby improving their status in the family. There are also significant benefits in education, health, household incomes and farm productivity. These benefits complement the entire spectrum of gender and rural development and poverty alleviation programmes, and therefore, justify the costs of expanding rural electrification. We presented findings that quantify the benefits of using electricity for lighting, education and irrigation. The results indicate that not only does electricity significantly improve the quality of life for rural women, it also leads to a saving in household energy expenditure.

These benefits are significantly enhanced by the multi-usage of electricity. For example, substituting electricity for biomass fuels for cooking not only frees up more time for women, it also has positive implications for family health and the environment. There is also evidence that this substitution has already started. Multiple use would also increase rural demand and consequently, the commercial justification for RE. It would also reduce the total energy bill of a household, thereby increasing the ability to pay for the energy consumed. This, in turn, would further increase the viability of the investment. Thus while estimating the network and capacity expansion for EFA, there is clearly a case for planning for a higher demand to provide for multiple uses of electricity. In terms of EFA, this would mean an even broader definition of household electrification and setting a more realistic time frame for achieving the target because at the present rate of rural electrification, it is unlikely that universal access can

Table 6: Average Farm Income With and Without Electricity in MP

	Electric Pump Users (Rs)	Non-Electric (Rs)
Average value of production reported/acre	5446	3401.6
Average cost (expenditure) reported/acre (excluding irrigation)	1568	1442.7
Average cost (expenditure) of irrigation reported/acre	304	300.1
Average net income/acre	3574	1658.8

Source: MP EISP Survey, Agriculture, 2001.

be provided by 2012. Of course, EFA comes with a huge cost. In a later work, we address the issue of how EFA is to be funded and implemented. [97]

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Notes

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- 1 AP, HP, Maharastra, Punjab, Rajasthan and West Bengal.
- 2 There is considerable anecdotal evidence for multiple usage. For instance, throughout the year, the daily demand curve in MP has 2 peaks-one in the early morning (5-9 am) and the other in the evening, suggesting that water supply schemes and domestic cooking significantly add to the demand. It has been seen that the majority of urban and some rural Single Light Point consumers, who get free supply, use electricity for cooking and other uses.

References

- Agarwal, Bina (1986): *Cold Hearths and Barren Slopes: The Fuelwood Crisis in the Developing World*, Allied Publishers, New Delhi.
- Barnes, Douglas, F, Kevin B Fitzgerald and Henry M Pskin (2002): 'The Benefits of Rural Electrification in India: Implications for Education, Household Lighting, and Irrigation', mimeo, World Bank, Washington, DC.
- Dixon, Ruth B (1978): *Rural Women at Work: Strategies for Development in South Asia, Resources for the Future*, Johns Hopkins University Press, Baltimore.
- Goldemberg, José, Thomas B Johansson, K N Amulya Reddy, Robert H Williams (2004): 'A Global Clean Cooking Fuel Initiative', *Energy for Sustainable Development*, Volume VIII, No 3, September 2004, Ravi Graphics, Bangalore, India, <http://ieglobal.org/ESDVol8No3/cookinginitiative.pdf>
- Government of India (2002a): *National Human Development Report 2001*, Planning Commission. March, New Delhi.
- (2002b): *Annual Report on Working of SEBs*, Planning Commission, New Delhi.
- (2004): *Annual Report, 2003-2004*, ministry of power, New Delhi.
- Parikh, Jyoti and Vijay Laxmi (2000): 'Biofuels, Pollution and Health Linkages: A Survey of Rural Tamil Nadu', *Economic and Political Weekly*, 47.
- Sen, Mitali and Sonalde Desai (2004): 'Household Electrification, Child Labour and Education in India', Annual Meeting Programme, Population Association of America, April 1-3. <http://paa2004.princeton.edu/download.asp?submissionID=41930>.
- United Nations (1995): 'In Defence of Women and Children: A Vision of Hope', *The United Nations: The Last 50 Years – The Next 50 Years*, The Regency Corporation Ltd Publications, London.
- World Bank (2000a): 'Reaching the Poor in the Age of Energy Reform' written for the *Energy and Development Report 2000: Energy Services for the Poor*, Energy Unit of the Infrastructure Group and the Energy Sector Management Assistance Programme, World Bank, Washington, DC.
- (2000b): 'Better Energy Services, Better Energy Sectors – and Links with the Poor' written for the *Energy and Development Report 2000: Energy Services for the Poor*, Energy Unit of the Infrastructure Group and the Energy Sector Management Assistance Programme, World Bank, Washington, DC.
- (2001a): 'Rural Electrification: How India Diverges from Best Practices', Background Paper, World Bank, Washington, DC.
- (2001b): 'A Hard Look at Costs and Benefits', OED, World Bank, September 20, 2004. <http://Inweb18.worldbank.org/oed/oeddoctlib.nsf/DocUNIDViewForJavaSearch/2F800655A86FE9B5852567F5005D895D?opendocument>
- (2004): *The Impact of Energy on Women's Lives in Rural India*, January, Washington, DC.