Energy as a key variable in achieving universal primary education: A gender and energy perspective on empirical evidence on MDG #2

Discussion Paper

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Girls in developing countries typically receive less education than do boys. This is particularly true for the poor developing countries, although there is considerable variation in overall levels of enrolment and in the girl/boy enrolment rate amongst poor countries. (Oxaal)

Although parents' education and income level influence children's schooling in general, girls are mostly affected by the combined effects of household poverty and gender concerns. Several studies indicated that the opportunity cost of schooling is higher for girls than for boys. Girls, more than boys, are responsible for reproductive tasks in the household, relieving their mothers of some of the burdensome tasks. So, households loose a greater number of hours worked when they send girls to school than when they send boys. (Mason and Khandker, Oxaal, Rose and Al-Samarrai, Soumaré)

Not only are the opportunity costs of girls' education higher, the return to the household are often also perceived to be less. Several reasons may account for this, including the expectation that daughters will leave the household upon marriage, a tradition that favours women remaining within the home, and the wage differentials between educated women and men. Another important constraint to girls' schooling are concerns about the safety of girls both at school -schools often lack separate toilet facilities for girls- and travelling between home and school. The latter becomes especially an issue at puberty, when parents may develop worries about their daughters becoming sexually active outside of social sanction. Since the poorest households are often furthest away from school, these safety issues are of particular concern to them (Oxaal).

It is further seen that "even girls in school have a relatively heavy work burden which they are expected to perform outside of school hours" (Rose and Al-Samarrai, 1997). Several reports indicate that having reproductive responsibilities contributes to a lower performance of girls in school, since girls have less time for doing homework than their brothers, and because girls are often tired and therefore less attentive in class. As a result, girls are often disadvantaged in terms of academic achievement. (see for example Levison and Moe, 1998; Rose and Al-Samarrai, 1997)

In literature on gender, energy and primary education, the most commonly recognised linkage is that access to modern energy services could free up time for girls to go to school, or to spend on homework. Another linkage generally assumed is that improved energy services at schools can create a more child-friendly environment in terms of improved water and sanitation facilities, lighting and space heating/cooling. Girls are more likely to benefit from better access to water and sanitation at school than boys given above-mentioned concerns for girls' safety at school. These, and other linkages from existing literature are given in the box below.

Linkages from existing literature between gender and energy and MDG 2 (primary education for all):

- Access to efficient fuel and technologies frees the time of children, who are often pulled out of school to help with survival activities. Girls are more likely to be taken out of school to help with domestic and agricultural chores than boys;
- Energy can create a child-friendly environment (acess to clean water, sanitation, lighting and space heating/cooling). Girls are more likely than boys to be affected by a lack of access to clean water and sanitation facilities, reducing their school attendance;
- Electricity in the household permits home study in good conditions beyond daylight hours, giving girls more opportunities for doing their homework;
- Lighting in school allows organisation of evening classes, making the timings for girls' schooling more flexible;
- Spending on schooling, especially for girls, increases with higher incomes for women.

Source: Havet (2003); DFID (2002); GVEP (2003)

Another linkage that could be made is that improved transport services (modern transportation, improved roads) would contribute to a higher enrolment and attainment of girls in school, as travelling between home and school becomes safer for them. Finally, improved energy services may result in girls being able to perform better at school, because they have been released from some of their responsibilities through improved energy services, or because improved lighting at home and/or at school has made their hours of study more flexible.

In the next section of the paper, we will look into the empirical evidence that can be found in studies done into the linkages mentioned above. Empirical evidence is not available for all linkages, however, while at the same time, some are better researched and documented than others.

Empirical Evidence

Increased school attendance by girls

As seen in the section above, improved energy services have the potential to increase the enrolment and attainment of girls in school. As investments in improved energy services result in time-saving of women and girls in their daily chores, it is thought that girls will thus have more time available for schooling.

Though various studies show that girls, more than boys, are responsible for assisting their mothers in reproductive tasks in the households, and that they do save time on their chores when they have access to improved energy services, the link with education is not very often made and not much empirical evidence is therefore available that would support this link. It is also seen that very little gender-disaggregated data is available on the subject. Though studies may disaggregate for data between men and women, when the discussion turns to children, the distinction between the two genders is more often than not abandoned, making it hard to find material that specifies the impact of certain energy services on girls, or on boys.

A study in which the connection between girls' involvement in work and chores and their time spent in school is made, is one by Levison and Moe (1998) in Peru. They quantified the amount of time girls between 5-19 years of age spend on paid work, unpaid work (other than chores), household chores, and school. They found that girls spend almost no time on paid work –under 5 hours per week for all except for 19-year olds, while unpaid work rarely exceeds 10 hours per week. More time is spent on household chores. Where 6-year olds already do almost 5 hours per week, time spent in household tasks increases steadily to over 20 hours per week for girls of 18 and 19. A particularly telling feature is that the unconditional hours in schooling and hours in chores cross at about age 12, when girls become increasingly useful in the household. The results show that where the hours spent on the three categories of work show an increase over time, the hours spent on school first rise, then fall as girls drop out of school.

Where studies show evidence of improved energy services impacting on girls' time in school, most of the evidence relates to time saved by girls on fetching water through improved water facilities. King and Alderman (2001) in rural Morocco found that the probability of both girls and boys to enrol in school increases with having wells or piped water. It was found, however, that the impact on girls is considerably larger, as they are responsible for collecting water. Another study in Morocco shows that where electrification increases school attendance of both boys and girls, higher school attainment for girls is achieved by investing in clean water, as this improves the efficiency of time use at home, especially for girls. Boys' schooling, on the other hand, benefits more from investment in irrigation and advanced crop technology. (Khandker et al., 1994)

Levison and Moe (1998) found that having water in the dwelling decreases the hours in chores for girls by over 90 minutes per week, where running water increases the likelihood of them attending school, raising the hours in school by almost 80 minutes per week.

The clear link with improved water facilities is also found in a study into the impacts of the Multifunctional Platform in rural Mali. The multifunctional platform has a simple diesel engine that can power a number of tools, like a cereal miller, husker, and/or battery charger. The engine can also generate electricity for lighting and refrigeration and to pump water (Brew-Hammond and Crole-Rees, 2004). One of the sample villages in the study had a water pump

installed with its platform and, though girl-to-boy ratios in primary school increased in all the villages with platforms installed, this village showed one of the more dramatic increases. Considering the fact that fetching water is a highly time-consuming tasks, mostly performed by girls, this is not surprising. (Porcaro, 2005)

As said, also without the water pumping service, the platforms saved time and released both women and girls from burdensome tasks. This led, not only to increased attendance of girls in primary schools, but also to their improved school performance. (Brew-Hammond and Crole-Rees, 2004; Porcaro, 2005)

Access to electricity can also result in increased school attendance of girls. A study into the rural electrification efforts in Tunisia found schools asserting that the rate of enrolment for girls caught up with that of boys after electrification not only of households, but also of schools and public streets. Public lighting was found to reduce the risks of travelling to school, which was an important concern, especially for families with girls. (Chaieb and Ounalli, 2001)

In Morocco, the presence of a paved road in the community influences the schooling outcomes of rural children. Thus, in the absence of a paved road, 21% of rural girls as compared to 58% of rural boys ever attend school. If a paved road exists, the school participation rate increases to 48% for girls and 76% for boys. The survival rate by grade also varies by gender in the presence of a paved road: girls drop out in larger proportions than boys even before completing the primary cycle in the absence of a paved road in the community. However, the presence of a paved road increases girls' survival rate only at the primary level. (Khandker et al, 1994)

In Bangladesh's coed schools, the availability of separate toilet facilities has helped raise girls' enrolment and attainment. (King and Alderman, 2001) Also in Bangladesh, it was seen that the higher school attendance of girls in electrified villages is associated with the availability of electricity in the schools and provisioning of fans for comfort (Barkat et al, 2002). Girls' attendance varied markedly with the availability/non-availability of electricity in the village: attendance was 85-86% in the electrified villages and about 80% in the non-electrified villages. In electrified villages girls' attendance was even reported higher than boys', whereas in non-electrified villages the opposite was true.

About 20% of the electrified households have reported incidence of drop out of school going children, while the corresponding reporting was 25% for the non-electrified households in electrified villages and 28% for the households in the non-electrified villages. As for these three sample categories boys' dropout was reported by 16% to 22% households, and girls dropout by 8% to 11% households. Thus, drop out decreases with the availability of electricity in the household.

Though linkages are assumed to exist between an increase in income and an increase in girls' schooling, there is very little evidence to substantiate this. Glick and Sahn (1999) have found in their study in West Africa that increases in household income lead to greater investment in girls' schooling, but they have no significant impact on the schooling of boys. In Bangladesh, Barkat et al found that the per capita annual household expenditure on education in electrified households was Tk. 1,964 with Tk. 2,344 for male and Tk. 1,502 for females. The corresponding expenditure in households of non-electrified villages were much less at Tk. 1,300 (both), Tk. 1,505 (male) and Tk. 1,069 (female). In all categories of household, the per capita education expenditure for females was less than that of the boys. This is mostly likely largely due to the existence of the female secondary education stipend program in rural Bangladesh.

Further, Levison and Moe (1998) found that having a telephone in the household, taken as a proxy for wealth, decreases the hours spent in chores by almost 140 minutes per week and increases the likelihood of school attendance. Other than that, there are some incidental reports of women spending their income on sending their daughters/children to school (see for example box 1).

BOX 1 - Income earning enables Ms Yesu to send her sisters to school

Meshet Yesu (25) who began carrying wood as a fuelwood carrier in Addis Ababa, Ethiopia at the age of nine, together with her mother, after whose death she was left responsible along with her day labourer father for raising 3 younger sisters. Through help of AFWFC she is now weaving. "Today I earn a decent income as a weaver," says Ms Yesu. I'm also able to send my 3 sisters to school and care for my father."

Source: Tadesse, 2002

Table 2.1: Increased school attendance girls through energy interventions

Reference	Location	Sample Size	Energy Intervention	Results	Notes
Brew-Hammond and Crole-Rees, 2004	Mali		Multifunctional Platform	The Platforms release girls from domestic chores such as cereal grinding, which they generally perform from the age of 8 and even earlier for water carrying. The results have been an increased level of girls' attendance in primary school.	The positive impacts on girls' education are among the most visible, appreciated, and profound impacts the multifunctional platforms have produced thus far.
Khandker et al, 1994	Morocco	The data used in this report is taken from the 1990-91 Morocco Living Standards Survey (MLSS). The sample included 3360 households with almost 20,000 individuals. From this sample 2224 households nationally were included in a Literacy Survey.	Electrification	Increase in school attendance of both boys and girls.	Public investment in clean water improves the efficiency of time use, especially for girls, at home and thus reduce the transactions cost of schooling, leading to higher school attainment.
			Irrigation	Increased school attendance boys.	
			Improved water supply	Increased school attendance especially for girls.	
Porcaro, 2005	Mali	Field data from 12 villages with MFP. In each village 10-11 women were interviewed.	Multifunctional Platform	There is a clear improvement in the girl-to-boy ratio after the installation of the platform in almost every sample village.	
			Multifunctional Platform with water pump	Balanfina, the only sample village that installed a water pump along with its platform, had one of the more dramatic increases in the girl-to-boy ratio.	The results from Balanfina are not surprising considering the fact that fetching water is a time-consuming task typically performed by girls.
Levison and Moe, 1998	Peru	2,387 girls, age 10-19	Improved water supply	Water in the dwelling decreases the hours in chores for girls by over 90 minutes per week; running water increases the likelihood of girls attending school and raises the hours in school by almost 80 minutes per week.	
			Telephone (used as a proxy for wealth)	Having a telephone in the household, a proxy for wealth, decreases the hours spent in chores by almost 140 minutes	

				per week and increases the likelihood of school attendance.	
Chaieb and Ounalli, 2001	Tunisia		Electrification	Schools assert that the rate of enrolment by girls has caught up with that of boys, after the electrification of households, schools and public roads.	
Barkat et al, 2002	Bangladesh		Electrification	Comparing non-electrified with electrified households, it is seen that per capita annual household expenditure on education increases from Tk.1,300 to Tk.1,964 with electrification for both sexes. For boys spending went up from Tk.1,505 to Tk.2,344, and for girls from Tk.1,069 to Tk.1,502.	In all categories of household, the per capita education expenditure for females was less than that of the boys. This is mostly likely largely due to the existence of the female secondary education stipend program in rural Bangladesh.
Barkat et al, 2002	Bangladesh		Electrification	Girls' attendance was 85-86% in electrified villages and about 80% in non-electrified villages. In electrified villages, girls' attendance rate was reported higher than the boys, but in non-electrified the opposite was true.	The higher school attendance of girls in the electrified villages is associated with the availability of electricity in the schools and provisioning of fans for comfort.
Barkat et al, 2002	Bangladesh		Electrification	About 20% of electrified households have reported drop out of school going children. The corresponding reporting was 25% for the non-electrified households in electrified villages and 28% for households in non-electrified villages. As for these three sample categories boys' drop out was reported by 16% to 22% households, and girls' drop out by 8% to 11% households.	
IRC	India		Improved school sanitation and hygiene education (SSHE)	In Alwar, where 1,667 schools combined good classroom practices and SSHE, 78% more girls and 38% more boys have enrolled.	

Increased hours of study

Evidence exists that links access to electricity (especially at home) to increased hours of study and reading, either at night or in the morning (see table). Most studies do not provide disaggregated information for boys and girls, but rather treat children as a homogeneous group. It is however safe to assume that school-going girls will also reap the benefits of the positive influence of electricity on study/reading hours, though it cannot be concluded that boys and girls would benefit in the same way, or as much from electricity.

In West Bengal, India, about half of the sample households indicated that the supply of power has helped children significantly in their studies. Children get an extra 2.25 hours per day for study, as power supply has helped them to continue their study at night. (Chakrabarti, 2000) In the Philippines data reveals that having access to electricity is associated with an average of 3.4 more years of education (Porcaro, 2005), while in Bangladesh, providing better light for their children to study at night was an incentive for parents to purchase battery lamps. (Khan, 2001b)

Madon (2003), for the EnPoGen study in Indonesia, found that high percentages of electrified respondents say that children devote the additional time made available by electricity to reading either in the morning (51 percent) or even more in the evening (71 percent); more than a third say that children use it for their homework in the evening. A large majority (more than 70 percent) feels that electricity contributes to children's education through information from television or radio, and an even larger one (79 percent) credits studying at home at night.

The EnPoGen study in Sri Lanka came with similar results, with schooling having globally improved because children can work in better lighting conditions and longer at night. Electricity in the household provided children with an estimated average of half an hour of extra time, which was mainly used for studying (according to 74.5 percent of the electrified households). However, 17.6 percent of these households feel children spend less time studying since obtaining electricity, the major cause being thought the fact that the majority of the children also spend extra time watching TV. Schooling seems to be improved as children increase knowledge in relevant subject matters and can learn from TV programs at night.

Also children from unelectrified households may see an increase in reading/studying hours in an electrified environment. In Ghana, for example, it was seen that children from these households would use the streetlights for studying and reading, though mostly boys would make use of streetlights. (Mensah-Kutin, 2002)

Barkat et al found that electricity matters in improving the quality of education. This quality improvement in the electrified households works through very many channels:

- more time available for study after sunset
- the quality of that time due to sufficient light and fan for comfort
- strengthening the knowledge-base due to access to TV (which in turn increases the appetite for learning)
- parents (especially mothers/other elder female members) devote more time in assisting children's education compared to before electricity

The average amount of time spent on study after sunset (6 p.m.) was 126 minutes in electrified households. It was 16% less in the households of non-electrified villages (109 minutes) and 22% less in the non-electrified households of electrified villages. Further,

around 51% women reported that they now give, on average, 37 minutes more time in assisting children's study as compared to before electricity. (Barkat et al, 2002)

…… Before solar was installed in this household, my three children (one girl and two boys) rarely read at night. For my little girl, her academics were on God's mercies. She never had time to read at home. When she would be free, paraffin will be over. These days, after doing the domestic work, she goes to the sitting room and starts reading even if her brothers are
already asleep. Last term she surprised me, she won the whole class even my boys performed better in their respective classes…….

Source: Sengendo, 2005

Table 2.2 Increased hours of study after electrification

Reference	Location	Sample Size	Results
Rose Mensah-Kutin, 2002	Ghana	Sample population: 300; 55% male. 110 participated in in-depth interviews and 4 focus group discussions were held in each location.	Lighting gives children the opportunity to study at night, even where their own households do not have electricity. Children sit to study under street lights, but mostly boys.
Halim, 2004	Bangladesh	3700 households and establishments, residential, industrial, commercial, and agricultural.	Electricity has enhanced the quality of education for children, both by extending the time in which they can study and by creating a comfortable learning environment through electrical appliances.
Sauturaga, 2004	Fiji		School childen have an improved ability to study and work during evening hours and they have access to televised educational programmes. It was noted that in one village there was a marked improvement in student's exam results.
Bryce and Soo, 2004	Bulelavata, Solomon Islands		With house lights, children can do homework and the school principal says Bulelavata children already have better marks at school.
Khuller (2002)	Pavur, Kerala, India		The PV lights have turned out to be an ideal solution to children's inability to study in the evenings.
Khan (2001 b)	Bangladesh		Families with school age children show significant interest in purchasing battery lamps so that their children have better light for studying.
Madon (2003)	Indonesia		18% of the respondents rank more time for children's education first as an advantage of electricity, while more than one third of respondents rank it as second.
Madon (2003)	Indonesia	1,300 electrified respondents	High percentages of the respondents say children devote the additional time made available by electricity to reading either in the morning (51%) or even more in the evening (71%); more than a third say that children use it for their homework in the evening. A large majority (79%) says electricity contributes to studying at home at night.
Massé (2003)	Sri Lanka		74.5% of electrified households feel that children use their extra time (estimated average of half an hour) mainly for studying. However, 17.6% of these households feel children spend less time studying since obtaining electricity. This is probably because 77.6% of children also spend extra time watching TV.
Berthaud (2004)	Bangladesh		The positive secondary effects of the fluorescent lamps are increased security, increased reading hours for the children and adults, and increased time spent helping children with homework.
Chakrabarti (2000)	Sagar Dweep, West Bengal, India		According to about 47% of the sample households the supply of power has helped children significantly in their studies. On average they are now getting an extra 2.25 hour per day for study.
Porcaro (2005)	The Philippines	Based on data from Demographic and Health Surveys (DHS). DHS reports are nationally	Some 32% of the survey group said that well-lit rooms provided improved study conditions for their children. The most basic analysis of data reveals that having access to electricity is associated with an

		representative surveys, two of which have been conducted in the Philippines (1993 and 1998).	average of 3.4 more years of education.
Barkat et al, 2002	Bangladesh		The average amount of time spent on study after sunset (6 p.m.) was 126 minutes in electrified households. It was 16% less in households of non-electrified villages (109 minutes) and 22% less in non-electrified households of electrified villages.
Sengendo, 2005	Uganda		Most of the beneficiaries of solar lighting at night were the female pupils/students. Before, female pupils/students would be helping their mothers with household chores. By the time they would be through with this, it would be approaching time for sleeping or the lamps have run out of fuel. In the meantime, their fellow male counterparts would be with their father in the sitting room doing their homework or relaxing. After solar installation, the girls got a chance of proceeding with doing their homework after the domestic activities.

Improved school performance

Access to electricity may also result in improved school performance of children. After the introduction of the multifunctional platform in Mali it was seen that the total number of students who passed the yearly exam of entry to secondary education increased. The proportion of students entering secondary school also increased slightly after the introduction of the platform. The proportion of girls entering secondary education increased from roughly 31 to 38 percent. (Porcaro and Takada, 2005)

In Tunisia as well, an increase in graduation rates (60 to 70 percent) was found in those rural areas that were electrified. A contributing factor was electric lighting at school, improving conditions in the classroom, especially during the dark hours of winter, when previously each student was supposed to bring their own candle to school. (Chaieb and Ounalli, 2001)

On Solomon Islands, children can do their homework with electric light at home, which results in better marks at school. (Bryce and Soo, 2004) On Fiji as well, electrification led to more hours of study and work in the evening hours, but also to access to educational programmes on TV. In one village this resulted in marked improvement in students' exam results. (Sauturaga, 2004)

In Bangladesh, both boys and girls in the electrified households reported to be better-off than their counterparts, in all the classes. (Barkat et al, 2002)

In Ghana, energy poverty was found to have an indirect negative impact on education. Women would have to fetch wood in the morning to prepare breakfast. This takes a long time, which means that children have to go to school either late or with empty stomachs which affects their work and ability to follow lessons. (Denton, 2005)

Marie Ngum from the village of Gadiag testifies: "in the morning I have to prepare breakfast. Consequently my children arrive late for school. Sometimes they leave without breakfast and they are not able to follow what the teacher is saying. These are precisely the factors that affect their academic achievement."

Source: Denton, 2005

Table 2.3 Improved energy services at schools improve school performance

Reference	Location	Sample Size	Energy Intervention	Results	Notes
Chaieb and Ounalli, 2001	Tunisia		Rural electrification	The first benefit cited by households with school-age children is improving homework and school performance.	
Chaieb and Ounalli, 2001	Tunisia		Rural electrification	Within schools electric lighting has improved conditions, especially during the dark hours of winter, when previously each student had to bring their own candle. All this is believed to have contributed to the increased rate of graduation (60-70%) in these rural areas.	
Sauturaga, 2004	Fiji		Microhydro	Children work during evening hours and have access to televised educational programmes. In one village there was a marked improvement in students' exam results.	
Bryce and Soo, 2004	Bulelavata, Solomon Islands		Microhydro	The school principal claims that Bulelavata children have better marks at school.	
Porcaro (2005)	Mali	Field data from 12 villages with MFP. In each village 10-11 women were interviewed.	Multifunctional platform	The total number of students who passed the exam increased. The proportion of girls entering secondary education also increased from roughly 31 to 38%.	
Sengendo, 2005	Uganda		Rural electrification	In each classroom, a solar bulb had been installed. Increased classroom lighting had led to increased school academic performance at primary seven. It shows that especially the number of girls passing in first grade had increased tremendously.	
IRC	India		School sanitation and hygiene education	In Alwar, where 1,667 schools combined good classroom practices and SSHE learning achievements are significantly higher.	
Brew-Hammond and Crole-Rees, 2004	Mali		Multifunctional Platform	Releasing girls from domestic chores, the multifunctional platforms have led to improved school performance for girls.	The positive impacts on girls' education are among the most visible, appreciated, and profound impacts the multifunctional platforms have produced thus far.

Table 2.4. Income-generating activities women through improved energy services increases spending on schooling children, especially girls

Reference	Year of study/ intervention	Location and intervention type	Research methods (anecdotal/ survey), sample size	Results	Comment on research conclusions/ methodology
White Ron D., 2002, p7		Pavur village, India. Winrock & Don Bosco with USAID support created a revolving fund to finance PV systems on a commercial credit basis. Women used the light for weaving baskets		Average household income increased from $19.50 to $32.15 per month with some portion of that increase being used to pay school fees for an increase in enrollment.	Also see: article Anita Khuller in EN, August 2002, special issue on Asia. Article in special issue on gender and special issue on VP2000 of Winrock newsletters
Tedd, L et al (ITDG street foods project)		Bangladesh: Dhaka and Bogra	Case studies done in baseline study of street food project	Case study of Saleha in food business who has been able to give her three children some education with her earnings.	Use for case in a text box. Not to be included in the final table.
ESMAP (2003) Central America Gender and Sustainable Energy Project	June 2001-December 2003	Nicaragua	Pilot projects impact assessments; no. of women unknown; pilot project improved stoves	Families save $35 per month on buying wood. 79.2% spend this on food. Women complement the family diet with eggs , milk, and cheese 4 times a week, or clothes and material for children's school. Women referred to money saved in medicines.	
Khuller (2002)	Journal article	Pavur, Kerala, India. Don Bosco project Solar Basket Fund, which could be used to finance PV systems on a commercial credit basis. No special efforts were made to involve women.		More women are putting their children into school. The women themselves pay the fees which was never done before, indicating that the women have attained significant new financial independence.	
Khamati-Njenga (2001 b)	Journal article	Upesi rural stoves project in Kenya started in 1995. women were targeted as the immediate beneficiaries. Project beneficiaries were involved from the beginning in the design, development, selection and field testing of the stoves. Every revision of the marketing strategy	Final project evaluation	With increased income, women are able to help support their families and pay for children's school fees, thus reducing school dropout rates.	

		was done in consultation with the women groups and the women came up with the content of promotional materials including posters and radio advertisements.			
Bradley (1991)	Book, volume 1	This volume develops an approach philosophy to the fuelwood issue, an integrated package of methods designed to service this approach and the practical results obtained in 3 districts in Kenya.	Agroforestry survey in Kakamega, Kisii, and Murang'a districts in Kenya	Woodlots of Eucalyptus saligna (male owned) play a role as living banks. There is little doubt that the woodlots come to represent a vital source of school fees for the children.	
Berthaud (2004)	Case study report	Bangladesh	Case study; interviews	A cooperative member indicated that she and her husband opened a savings account in which they deposit money every month. The couple plans to use the money for their only daughter's education.	
Brew-Hammond and Crole-Rees (2004)	Report	Mali, review of the multifunctional platform project		Women who had been trained by the project to read, count and manage perceive the benefit of increased learning and in turn encourage their daugters to attend school.	
Tadesse (2002)	Journal article	Addis Ababa, Ethiopia.	Cases of former women fuelwood carriers. The Association of Former Women Fuelwood Carriers (AFWFC) is supporting former women fuelwood carriers in finding another living	Meshet Yesu (25) began carrying wood at the age of nine, together with her mother, after whose death she was left responsible along with her day labourer father for raising 3 younger sisters. Through help of AFWFC she is now weaving. "Today I earn a decent income as a weaver," says Ms Yesu. I'm also able to send my 3 sisters to school and care for my father." Ayeletch Demisse (56-year-old widow with 5 children) has been able to send all her children to school with her earnings as a weaver.	Use for case in a text box. Not to be included in the final table.
Khuller (2002)	Journal article	Pavur, Kerala, India. Don Bosco project Solar Basket Fund, which could be used to finance PV systems on a commercial credit basis. No special efforts were made to involve women.		More women are putting their children into school. The women themselves pay the fees which was never done before, indicating that the women have attained significant new financial independence.	
Modi (2005)	Report			Glick and Sahn argue that an increase in	In: Glick, P. and D.E. Sahn,

				incomes is also an important factor since even when electricity access is available in urban areas domestic work obligations continue to limit female schooling for the very poor.	February 1999. "Schooling of girls and boys in a West African country: the effects of parental education, income, and household structure" (Economics of Education Review 19 (1).)
Glick and Sahn (1999)	Journal article (only abstract available)		This paper investigates gender differences in the determinants of several schooling indicators –grade attainment, current enrollment, and withdrawal from school- in a poor urban environment in West Africa, using ordered and binary probit models incorporating household-level random effects.	Increases in household income lead to greater investments in girls' schooling, but have no significant impact on schooling of boys.	
Levison and Moe (1998)		Peru		Having a telephone in the household, a proxy for wealth, decreases the hours spent in chores by almost 140 minutes per week and increases the likelihood of school attendance.	

Table 2.5. Household chores detain girls from going to school

Reference	Year of study/ intervention	Location and intervention type	Research methods (anecdotal/ survey), sample size	Results	Comment on research conclusions/ methodology
Fleuret			Hypotheses tested against empirical evidence	*Fuelwood shortage and consequent increased labour demands may lead to the reallocation of collection responsibility to others, particularly children.* To date, however, there is no conclusive evidence that children's energy balance, access to food or educational opportunities are being adversely affected by additions to their workload occasioned by increasing time inputs to fuelwood collection.	
Fuuna	1997	Uganda	134 respondents: 64 women, 60 participants in Focal Group Discussions; 7 Rural Resource Managers; and 3 members of the Uganda Electricity Board	All household members are responsible for carrying produce to the market. The proceedings from the weekly market are pooled to enable the household survive for the next week. Since the weekly markets are held on Mondays in the study area, school children are absent from school to help their parents. For girls, household responsibilities account for their late enrollment and early dropout.	
Modi (2005)	Report			Schultz also suggests that girls are constrained in their schooling in part by the demands placed on their time and suggest that the use of electricity and refrigeration could reduce households' dependence on the labour of girls. Glick and Sahn argue that an increase in incomes is also an important factor since even when electricity access is available in urban areas domestic work obligations continue to limit female schooling for the very poor.	In: Schultz, T. Paul, June 1990, "Returns to Women's Education" Yale University Economic Growth Center Discussion Paper No.603. In: Glick, P. and D.E. Sahn, February 1999. "Schooling of girls and boys in a West African country: the effects of parental education, income, and household structure" (Economics of Education Review 19 (1).)
Brew-Hammond and Crole-Rees (2004)	Report	Mali, review of the multifunctional platform project		Girls handle domestic chores (cereal grinding) generally from the age of 8 and even earlier for water carrying. Platforms have provided alternative means for the villagers to handle the tasks that would otherwise be handled by the girls and thus have released them from burdensome tasks. The results have been an increased level of	

				girls' attendance in primary school and improved school performance. The positive impacts on girls' education are among the most visible, appreciated, and profound impacts the multifunctional platforms have produced thus far.	
King and Alderman (2001)	Journal article		Review of literature on gender and education	In rural Morocco having wells or piped water increases the probability that both girls and boys will enroll in school. But the impact is considerably larger for girls, who are responsible for collecting water. These investments mean fewer interruptions to women's paid work and to girls' schooling.	
Glick and Sahn (1999)	Journal article (only abstract available)		This paper investigates gender differences in the determinants of several schooling indicators –grade attainment, current enrollment, and withdrawal from school- in a poor urban environment in West Africa, using ordered and binary probit models incorporating household-level random effects.	Domestic responsibilities, represented for example by the number of very young siblings, impinge strongly on girls' education, but not on boys'.	
Khandker et al (1994)	Paper	Morocco	This paper, using data from the Morocco Living Standard Survey (MLSS), explores the relative effectiveness of both supply- and demand-side factors in determining educational outcomes. The supply-side explanatory variables include both school access and quality. On the demand side both household and market demand	Investment in electricity, irrigation, and new crops increases the returns to education and hence the demand for education. Rural electrification increases the school attendance of both boys and girls, while investment in irrigation and advanced crop technology increase the school attendance of boys. In contrast, public investment in clean water improves the efficiency of time use, especially for girls, at home and thus reduce the transactions cost of schooling leading to higher school attainment.	

			variables are included.		
Porcaro (2005)	Case study report	Cases from Brazil, Mali and The Philippines	The objective of this study is to help establish a better quantitative understanding of how the provision of energy services can lead to development outcomes that aid the achievement of the MDGs. The 3 country studies evaluate the development impacts of a particular national, regional, or local energy intervention. The Brazilian case examines the impacts of a national rural electrification initiative in the northeast state of Ceará. The Mali case investigates the development of local micro-enterprises (MFPs). The Philippines case examines a national electrification initiative.	**Mali:** In rural Mali, the responsibility of children – primarily girls- to assist their mothers in domestic activities often prevents them from regularly attending school. The findings from this study suggest that the provision of time- and labour-saving energy services can reverse this trend. The study concludes that the girl-to-boy ratio in primary school, dropout rates, and the proportion of school children (especially girls) completing primary education all imrpoved after the implementation of the project. There is a clear improvement in the girl-to-boy ration after the installation of the platform in almost every sample village. Balanfina, the only sample village that installed a water pump along with its MFP, had one of the more drmatic increases in the girl-to-boy ratio. This is not surprising considering the fact that fetching water is a time-consuming task typically performed by girls.	
Levison and Moe (1998)	Journal Article			Having water in the dwelling decreases the hours in chores by over 90 minutes per week; running water increases the likelihood of attending school and raises the hours in school by almost 80 minutes per week. Having a telephone in the household, a proxy for wealth, decreases the hours spent in chores by almost 140 minutes per week and increases the likelihood of school attendance. Research in Peru shows that on average, girls spend almost no time in paid work: under 5 hours per week on average for all but the 19-year olds. Unpaid nonchores	See: Figure 2 (p. 343) – weekly hours of activity, girls 5-19, peru 1985

				work rarely exceeds 10 hours per week. Girls are spending quite a few hours per week doing household chores. Even 6-year olds do almost 5 hours per week, and time spent in household tasks increases steadily to over 20 hours per week for girls ages 18 and 19. A particularly telling feature is that the lines representing unconditional hours in schooling and hours in chores cross at about age 12, when girls become increasingly useful in the household.	
Chaieb and Ounalli, 2001	Journal article	Describes the rural electrification efforts in Tunisia and its results.	Period: 1976-2000 Rural electrification was the third pillar of the national rural development drive. First two: improve health and education programmes.	Schools assert that the rate of enrolment by girls has caught up with that of boys, after the electrification not only of households, but also of schools and public streets.	

Table 2.6.: Increased school attendance children through energy interventions

White, 2002	Pavur village, India		Revolving fund to finance PV systems on a commercial credit basis	Women used the lights to weave baskets. The average household income increased from $19.50 to $32.15 per month with some portion of that increase being used to pay school fees, leading to an increase in enrolment.	
Khuller, 2002	Pavur village, India		Revolving fund to finance PV systems on a commercial credit basis	More women are putting their children into school. The women themselves pay the schoolfees.	Women had never paid for school fees before, indicating that the women have attained significant new financial independence.
Khamati-Njenga, 2001	Kenya		Improved stove production, as an income-generating activity for women	With increased income, women are able to help support their families and pay for children's school fees, thus reducing school dropout rates.	
Bradley, 1991	Kakamega, Kisii, and Murang'a districts, Kenya		Establishment of woodlots of Eucalyptus Saligna (to be used for firewood)	The woodlots (male owned) play a role as living banks. There is little doubt that the woodlots come to represent a vital source of school fees for the children.	
Khan, 2001 b	Bangladesh		Fluorescent lamps that use direct current and rechargeable batteries.	Adults living in households with electric light are found to encourage higher education for their children.	
Porcaro, 2005	The Philippines		Electrification	The most basic analysis of data reveals that having access to electricity is associated with an average of 3.4 more years of education.	
Barkat et al, 2002	Bangladesh		Electrification	The gross enrolment ratio was high at 63% in the electrified households, followed by 55% in the non-electrified households in electrified villages, and 54% in the non-electrified village. This estimated 18% higher gross enrolment ratio in the electrified households compared to that in the households of nonelectrified villages could be attributed to electricity via increased income, enhanced awareness about value of education etc.	

Conclusions and recommendations

The evidence above indicates that improved energy services can have a positive impact on girls' schooling. The evidence is most strongly presented for increased school attendance by girls following an energy intervention and for the increased hours of study that electricity brings to school-going children. Studies into the latter linkage, make little distinction, however, between boys and girls, but rather look at children as a homogeneous group. It is therefore difficult to draw conclusions on what the impacts of electrification are on the study and reading hours of each gender. Though it is safe to assume that both genders will enjoy the benefits of improved lighting, it cannot be concluded that boys and girls would benefit in the same way, or as much from electricity.

Evidence further suggests a linkage between improved energy services and improved performance at school by girls, even if it is only meager evidence that is presented here. It would be worthwhile to study this linkage more extensively.

Another linkage worth more study would be that as the income of women rises, more money is spent on schooling of children, and especially girls. Very little information is available here, and no empirical evidence was found to confirm this linkage.

Another conclusion to be drawn is that it is important that gender disaggregation of data takes place. Children are not a homogeneous group impacted equally by improved energy services. One of the factors that differentiates children is gender. Some studies have shown this, but much more data are needed to be able to make firm conclusions on how energy services can improve girls' schooling. It is striking to see that even a gender, poverty, and energy study like EnPoGen fails to collect gender disaggregated information when it comes to impacts electrification has had on children's education.

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Case Studies

Household Work as a Deterrent to Schooling: An Analysis of Adolescent Girls in Peru
Levison and Moe, 1998

The authors analyse the determinants of hours spent in chores and in school for adolescent girls in Peru. They use the 1985-1986 Peru Living Standard Survey (PLSS) data on hours spent in paid work, unpaid work, household chores, and school. It was seen that on average, girls spend almost no time in paid work. They are spending quite a few hours per week doing household chores. From the age of 12 onwards, girls become increasingly useful in the household and their school hours are seen to decrease.

The results of this study show that there are a number of factors that influence schooling of girls, such as living in an urban area increasing the hours spent in chores and decreasing the hours spent in school, and having a mother present in the household reducing the hours of school attendance, though increasing the likelihood that the girl will be enrolled in school.

With regards to having improved energy services in the household, it was seen that having water in the dwelling decreased the hours spent in chores by 90 minutes a week. Having running water on the other hand even raised the hours in school by almost 80 minutes per week. Having a telephone in the household was taken as a proxy for wealth in this study and this resulted in a reduction in the hours spent in chores by almost 140 minutes per week and increased the likelihood of girls attending school.

Schooling and Cognitive Achievements of Children in Morocco: Can the Government Improve Outcomes?
Khandker, Lavy and Filmer, 1994

This paper, using data from the Morocco Living Standard Survey (MLSS), explores the relative effectiveness of both supply- and demand-side factors in determining educational outcomes. On the supply-side, variables include both school access (accessibility of schools and presence of roads) and quality (teachers' education and highest class offered by the school), while on the demand-side both household (parents' education and assets and availability of clean drinking water) and market demand variables (availability of electricity, irrigation and new crop varieties) are included.

Focusing on the effects that the availability of roads, water, and electricitry have on children's schooling, the results show that investment in electricity and irrigation increases school attendance of children. Where electricity increases school attendance of both boys and girls, irrigation mainly effects the school attendance of boys. On the other hand, having clean water improved the efficiency in time use, especially of girls, at home and thus lead to higher school attainment.

The presence of a paved road mostly effects the schooling outcomes of rural children. Existence of a paved road increases the school participation rate for girls from 21 to 48 percent, and for boys from 58 to 76 percent. Having a paved road also

influences the survival rate by grade, reducing the probability of girls dropping out by 5 percents, and of boys by 36 percent. The presence of a paved road increases girls' survival rate only at the primary level, however. It is thus seen that though public investments in water, roads and electricity are gender-neutral, the benefits of these public investments are not.

A Review of the Impacts of the Multifunctional Platform Project in Mali on Girls' Education
Brew-Hammond and Crole-Rees, 2004

This report reviews experiences of the multifunctional platform project in Mali and documents how modern energy services affect people's lives. With regards to the effects of the multifunctional platform on the schooling of girls, it was seen that the platforms have provided alternative means to the people to handle tasks that would otherwise be handled by girls, which has released the girls from burdensome tasks. As a result, girls' attendance in p[rimary school has increased and their school performance has improved. It is stated that these "positive impacts in girls' education are among the most visible, appreciated, and profound impacts the multifunctional platforms have produced so far".

Another positive effect of the platform is that the women who have been trained by the project to read, count and manage the multifunctional platform, now see the benefit of increased learning and in turn encourage their daughters to attend school. Members of the Water Management Committee in Sampara are quoted to say: "We prefer to pump water than to take our daughters away from school".

Rural Electrification and Girls' Schooling in Bangladesh
Barkat et al, 2002

Though the gross enrolment ratio for primary school is high in Bangladesh – primary education is free, and all girls in rural areas receive stipends at the secondary level of education – electrified households do have an 18 percent higher gross enrolment ration than non-electrified households. It is thought that electricity contributes to this higher enrolment rate through increased income, enhanced awareness about the value of education, etc.

The study found that for both electrified and non-electrified households, the spending for girls' education was lower than that for boys', the reason most likely being that girls receive the stipend at the secondary school level. Both boys and girls in electrified households get better marks than their counterparts in non-electrified households.

When looking at the school attendance rate, it was found that girls' attendance varied notably with the availability of electricity in the village. The higher school attendance of girls in electrified villages is probably linked to the availability of electricity in the schools and the provisioning of fans for comfort. These findings were substantiated by school level observations by the study teams. Related to this, it was found that the dropout rates declined with the introduction of electricity, both for boys and girls.

More time was further spent on studying after sunset. Improved electric light further improved the quality of this study time, while parents also are seen to assist their children more with their study than they used to before electrification.

Electrification thus improves the quality of education. This is realised through a number of channels, the most important of which are:

- More time available for study after sunset
- More quality study time through electric light and the availability of fans.
- A better knowledge base due to the TV, which was also seen to increase the appetite for learning
- Parents spend more time in helping children with their school work.