Energy as a key variable in eradicating extreme poverty and hunger: A gender and energy perspective on empirical evidence on MDG #1

Discussion Paper

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Abstract

The Millennium Development Goals (MDGs) were adopted in 2000 at a United Nations Assembly summit as a set of time-bound, measurable goals and targets to be achieved by 2015. Although there is no MDG on energy, it has been identified as a critical input for the achievement of all MDGs. While many assumptions have been made about the linkages between energy and the MDGs, few empirical studies are available that provide convincing evidence for advocacy and policymaking. The present study is aimed at presenting empirical evidence – preferably quantitative data – on linkages among gender, energy and MDG 1: eradication of extreme poverty and hunger.

As regards how energy access could decrease *poverty and hunger*, there is good evidence for time and effort savings of 1 to 4 hours daily in cooking, fuel collection and food processing, when energy is made available for these tasks. There also seems to be a positive correlation between electricity and time spent on fuelwood collection, though this may be ascribed to other factors, as electricity is not used for cooking. There is little quantitative data on how women's freed-up time is utilized. Most data is anecdotal, pointing towards the fact that having more time available provides women more flexibility in their work, but few use this for resting more. Several studies also indicate that some of this time may be used for alternative home-based occupations such as sewing, handicrafts etc, but there is no information on the quantum of income increase brought about.

Women use biomass energy in their micro-enterprises, and use electricity to extend the working day for home industries and agriculture, but there is no quantitative data available on how much income improved fuels and lighting results in generating, and how much control women have in decisions on the use of increased incomes. Donor-supported projects have documented how energy enterprises can be successfully owned and operated by women, but typically, they have operated at small scale and their sustainability under market conditions is not known.

There is good evidence for reduction in household expenditures on energy of 20-50% with more efficient and lower cost cook stoves and lighting fuels; but it is not clear whether these savings are used to increase food consumption or are offset by increased energy use.

Keywords
Gender, poverty, energy, income, savings

1. Introduction

The Millennium Development Goals, adopted by the UN General Assembly in 2000, established a set of time bound and measurable goals for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women. Even though energy is not mentioned as a separate goal, it is being recognized that addressing the energy and poverty linkage is going to be a critical factor in the attainment of the Millennium Development Goals (MDGs). Energy services interface with people's lives in many different ways, starting from the basic survival activities to increasing productivity, and enriching the quality of life. Energy, a 'derived' demand, provides a wide range of 'services' that can have a range of positive impact including enhancing the livelihoods of people, reducing poverty, enhancing the quality of health, water and sanitation services.

This paper examines the hypothesis that improved energy services contribute towards the attainment of MDG1, which is targeted at *reducing extreme poverty and hunger*, specifically for women. The paper considers the various ways in which gender-and-energy interventions can contribute towards the achievement of MDG1 and examines available secondary literature to explore whether there is sufficient empirical evidence to support the hypothesis.

The paper is structured as follows. Section 1 is the introductory section, which outlines the objectives of the research, followed by methodology used and the challenges encountered in section 2. Section 3 presents a review of the current thinking on linkages between gender-and-energy and MDG1. The next section summarizes the findings of this research, i.e. empirical evidence linking gender-and-energy and MDG1. Some conclusions and priorities for research on gender, energy and MDG 1 are presented at the end of the paper. Detailed tables with the evidence and references for each indicator are annexed and a bibliography included.

2. Methodology and scope

The approach adopted for the study included a review of the existing literature on energy and the MDGs - especially which related to gender issues - in order to develop a set of likely indicators. Evidence was then sought from the literature, including library searches, journal databases and internet searches with key words. Major repositories of documents were covered, such as the libraries and resource centres at the United Nations and AIT at Bangkok; International Centre for Integrated Mountain Development (ICIMOD), Kathmandu; TERI (The Energy and Resources Institute), Indian Institute of Technology (IIT), United Nations Development Programme, and the World Bank at New Delhi; and Indira Gandhi Institute of Development Research (IGIDR), Mumbai. Country level materials were also collected through the ENERGIA network and the national focal points in the Asian countries. The primary focus of the study on gender and energy- MDG 1 linkage has been on Asia, though some references from other regions as available in literature has also been included. The study followed an iterative process, with a number of adjustments to the originally selected indicators throughout the review, according to the availability of evidence, and emerging clarity on the issues. The focus is on an objective presentation of empirical evidence, rather than on recommendations.

A number of challenges were encountered in the process. The literature proved far more extensive and difficult to access than anticipated originally, largely because quantitative data needed to be sought from studies in other fields rather than in "gender and energy" or even "energy" literature per se. Much literature had to be read only in order to find that it did not include the relevant information on impacts or disaggregated by gender. There were language problems, and material that had been produced in national languages could not be used, because of constraints of time and resource required for translations. There were considerable overlaps between MDGs, for example, evidence on indoor air pollution could feature in MDGs on child mortality and maternal health as well as that on environmental sustainability, and adjustments had to be made to avoid repetitions, while accommodating these overlaps.

3. The nexus between gender-and-energy and MDG 1

3.1 The energy and poverty linkage

Energy services are a key input in poverty eradication and in ensuring food security. Access to energy services can help the people living in poverty to remedy two of the pervasive problems that keep them in poverty - their low productivity and their limited range of productive options. Even though energy is not mentioned as a separate MDG, modern energy services are an essential element of developing the enabling conditions that can allow a country to meet the MDGs (Modi, 2005). The linkage between energy and MDG1 was first articulated in ***Energy for the poor***, a DFID paper (DFID, 2002), brought out prior to the World Summit on Sustainable Development (WSSD), which stated that "access to energy services facilitates economic development - micro-enterprise, livelihood activities beyond daylight hours, locally owned businesses, which will create employment - and assists in bridging the 'digital divide'", thereby contributing directly towards MDG 1 goal of halving extreme poverty.

Thereafter, the role of energy was emphasized at the WSSD in 2002, and a commitment was made "to improve access to reliable and affordable energy services for sustainable development sufficient to facilitate the achievement of the Millennium Development Goals, including the goal of halving the proportion of people in poverty by 2015, and as a means to generate other important services that mitigate poverty, bearing in mind that access to energy facilitates the eradication of poverty" (CSD, 2002).

The linkages between energy and MDG1 were conceptualized by the Global Village Energy Partnership (GVEP) Working Group on Impact Evaluation Methodology and Indicators Development (EDF-Access ADEME, 2003) as follows:

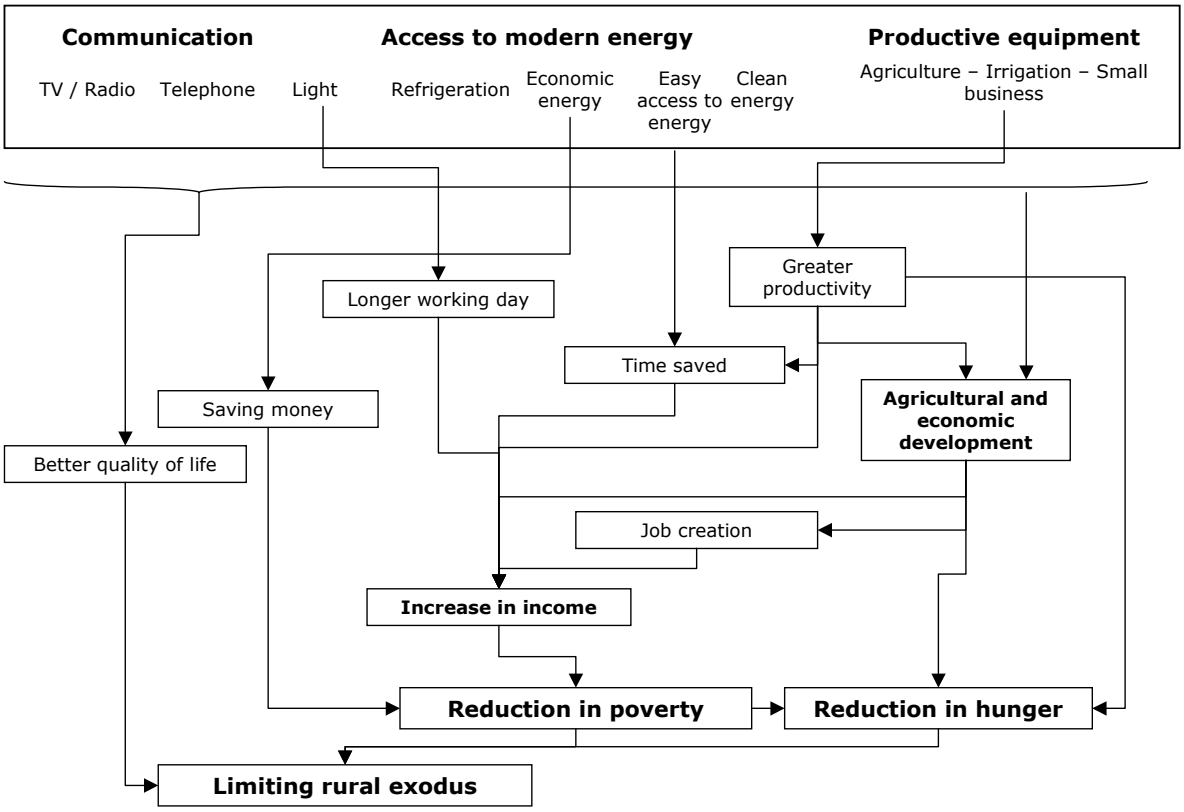


Figure 1. The linkage between energy and MDG1

More recently, under the Millennium project, ***Energy services for the poor*** (Modi, 2005)**,** a paper **c**ommissioned for the Millennium Project Task Force 1 contended that *poor access and lack of modern energy services have direct impact on opportunities for income generating productive activities and on health.* It further goes on to identify that at the household scale, some of the ways that modern energy services may directly contribute to economic growth and poverty reduction are by creating the possibility of small enterprises and by reducing unit costs. Indirect contributions to economic growth may come in the form of free time for other productive activities, improved health and education, improved access/supply of clean water, and reduced local environmental degradation). An ESMAP study on rural electrification in the Philippines has attempted to quantify, in monetary terms, the benefits of electricity access. The study, based on a survey of 2,000 households in four *barangays,* concluded that under the assumptions of the survey, the total net benefit of providing electricity to a typical, previously un-electrified rural Philippine household would be between US$81 and US$150 per month, depending on the household's number of wage earners and whether it runs a home-based business (ESMAP, 2002c).

3.2 Gender and poverty reduction: achieving MDG1

The gender aspect of MDG1 is rooted in the fact that of the approximately 1.3 billion people living in poverty, 70% are women. There is evidence that that, *in cases of similar access to resources and decision-making*, women and female-headed households are less poor than men and male-headed households (IFAD, 2005). In Niger, households headed by women represent 8% of all households. Of these, 55% are poor, against 64% among male-headed

families. Two possible reasons are put forth for this: (i) as heads of households, women are able to make their own decisions, achieve better access to resources than if they were married, and can use these resources more productively than do male heads of household; (ii) in cases where women are de facto heads of households, income transferred from husbands may raise the total household income. Among 19 countries examined in sub-Saharan Africa, the incidence of poverty in nine countries appears to be lower among female-headed households than among male-headed ones.

In general, when women have more control over the use of household income, expenditures tend to be more focused on meeting the basic needs of the family and of the children. In studies in seven sub-Saharan countries, the children in female-headed households with amounts of resources similar to those of male-headed households showed higher school enrolment rates and better completion rates. When women's control over household cash resources doubled in Côte d'Ivoire, the proportion of food expenditures to total income rose by 2 percentage points (directly contributing to MDG1), while expenditures for cigarettes and alcohol dropped by 26% and 14%, respectively. In the same country, another study found that, from 1987 to 1988, female-headed households with characteristics that were otherwise the same as those of male-headed households were able to maintain the household standard of living during a period when the mean decline in household incomes per person was 35 217 francs CFA (USD 117), in other words, when comparable male-headed households suffered substantial income declines (IFAD, 2005).

3.3 Gender, energy and MDG1

The linkage between gender-and-energy and MDG1 has its genesis in the fact that women and girls suffer more from energy poverty and hence stand to gain more from improved energy services. Why women are worst affected by energy scarcities can be linked to the following trends:

- In developing countries, energy consumption patterns are characterized by a high dependence on biomass, with cooking as the primary energy consuming end use. In West Sumatra, Indonesia, fuelwood supplies almost all of the cooking energy requirements (Polestico, 2002). In the Philippines, cooking and heating account for 90% of household energy use, and fuelwood provides 75% of the total energy used in rural areas and more than 25% in urban areas (ibid). 90% of rural households in Namibia use biomass energy to meet their energy needs (Wamukonya, 1999, quoted in Cecelski et al, 2002). As the responsibility for domestic energy rests squarely on the shoulders of the rural women, the depletion of traditional biomass-based energy sources affects women the most. Rough estimates of the proportion of rural women affected by fuel scarcity (based on estimates by the FAO of the percentage of household energy provided by fuel wood) are 60% in Africa, nearly 80% in Asia and nearly 40% in Latin America and the Caribbean (UNDP, 1995). Without access to mechanized equipment or motorized transport, women must walk longer distances and spend more time each day in gathering fuelwood and water.

- An increase in time spent in above activities implies that women have less time for other livelihood activities. In the end women often have little choice but to work more, cut down on the family living standard, and try to squeeze more output and income from degraded lands. A more serious and long term implication of fuel

shortage is that as the daily search for fuelwood, fodder and water becomes more difficult, children are taken off school and put to help their mothers. More often than not, it is the girls who are held back from school to look after younger siblings and assist their mothers, missing out on education and perpetuating the cycle of illiteracy and poverty. In the southern state of Tamil Nadu in India, a major reason for keeping girls of ages 10 to 12 is to help the mothers in collecting cowdung (Mencher, 1989).

- In rural areas, a large number of informal sector enterprises are operated by women. Despite this, the contribution of women entrepreneurs to national economies is not explicit in national statistics, leading to policies that do not deal with the specific barriers faced by women linked to their gender-defined roles. Women-headed enterprises are frequently located in the home, and these "cottage industries" tend to be overlooked by agencies because they are in the informal sector, and diffuse and difficult to reach. When women in rural areas do generate income, they have less access to financial resources, credit and equipment than do men, and less of a voice in household, or community-level decision making. In African countries, women still receive less than 10 percent of all credit reaching small farmers (Blackden and Bhanu, 1999). The types of enterprises that women are traditionally involved in are energy intensive and rely on biomass fuels.

When women gain access to energy services, it can have a marked effect on their lives, particularly with respect to freeing up their time by relieving some of the unending drudgery that characterizes the daily lives of poor families - gathering fuelwood, hauling water, milling grain; improving their health and well-being; and opening up opportunities by increasing the availability of information sources such as radio, television, and telephone. Many rural enterprises can become viable only when there is access to a reliable modern energy source: mechanical power, electricity, process heat, transport fuel. Productivity can also be increased by extending the working day with lighting and by mechanization for irrigation and processing crops and raw materials.

Energy-related development interventions and women's empowerment are both recognized as crucial to poverty reduction efforts and sustainable development. These elements have been independently recognized, but the case for gender and energy as a nexus in poverty alleviation is less developed and has only recently gained substantial attention. Specifically, there are three ways in which the synergy of gender and energy contributes to poverty reduction (Berthaud, 2004): (a) direct benefits from having access to improved energy services; (b) women benefiting from participation in the planning, design and implementation of energy projects; and (c) benefits from providing women with opportunities to gain technical knowledge and play a key role in commercial energy provision.

The gender and energy and MDG1 linkage was demonstrated by Havet in her article "Linking women and energy at the local level to global goals and targets" (Havet, 2003). She provides examples of the links between energy and each of the MDGs, using case study of the multifunctional platform in Mali. The installation of a multifunctional diesel engine combined with various mechanical devices in villages reduces the burden on women of exhausting and repetitive tasks, such as fetching water, collecting fuelwood and grinding cereals. It provides women with income-generating opportunities, community infrastructure management experience and an improved social status as their economic independence improves. The intervention, through provision of rural energy services through an innovative

community management model, has direct impacts on poverty reduction policies and strategies.

4. Framework of the study

The following table, which presents the overall framework for the study, outlines the various ways in which gender-and-energy interventions can contribute towards the achievement of MDG1. This is followed by a review of the available secondary literature to explore whether there is sufficient empirical data to support the hypothesis.

Table 1. Possible linkages between gender and energy and MDG1

Contribution towards MDG 1	Possible gender and energy linkages
Time and effort saving	▪ Reallocation of time saved in fuelwood and cooking to engage in income generating activities, including food production ▪ Energy can reduce drudgery of arduous tasks, undertaken by women, such as agro-processing, grinding and milling, increase opportunity for enterprise and income generation.
Using energy services for income generation	a) Effect of modern energy sources on women's agricultural tasks and productivity ▪ Women are typically responsible for the high drudgery, low-technical input tasks like weeding, planting, and hoeing, in agriculture, which can be made easier through energy inputs. ▪ Energy inputs in irrigation can improve agricultural productivity and help in diversification of crop choices. ▪ Efficiency improvements in women's tasks can increase agricultural productivity ▪ Mechanized agro processing can increase food supply, with reduced effort ▪ Biogas slurry can help improve agricultural productivity.
	b) Effect on modern energy services on income generation in non agricultural activities ▪ Access to energy services facilitates emergence of new micro-enterprises, livelihood activities, and employment generation. ▪ Many of the informal sector enterprises are owned and operated by women, which can benefit from improved access to energy services ▪ More efficient fuel conversion technologies can reduce energy costs in rural industries. ▪ Lighting and thermal energy can enable rearing of piglets and chicks which require controlled but warm temperatures through out the night.
	c) Lighting can extend working hours in the evenings
Direct saving in household expenditures by using more efficient fuels	▪ Reduction in share of household income spent on cooking, lighting and heating by introducing clean, efficient fuels ▪ Reduction on expenditure in health related to biomass use (indoor air pollution)
Contribution towards improvements in social capital and quality of life	▪ Reduced time spent on household chores allows women to play greater roles in public domain. ▪ Radio, television and other communication technology powered by energy improves access to outside world. ▪ Girls, when freed from household chores like fuelwood collection can attend school. ▪ Street lighting improves women's safety ▪ As modern lifestyles become more rushed, women need more cooking and energy options to aid their work. ▪ Availability of efficient equipment for cooking, heating, water supply, lighting
Women as energy entrepreneurs	

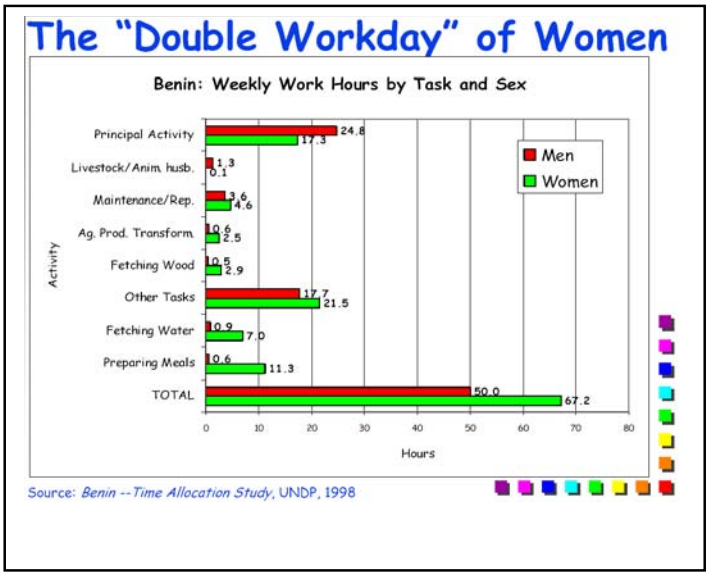
5. Empirical evidence on the linkage between gender and energy and MDG 1

5.1 Time and effort saving

This section focuses on the time savings brought about by improved energy services in the lives of women. It starts with a background of time burden faced by women, in light of the different tasks carried out by men and women, and then goes on to discuss the time they spend in energy related tasks such as fuelwood collection. This is followed by a summary of empirical evidence available on how modern energy services save women's time in fuelwood collection, cooking and agro-processing, and how this time is utilized.

5.1.1 Time burden of women

Studies that have explored the issue of time allocation between men and women (Tinker, 1990; Kumar and Hotchkiss, 1988; ILO, 1999; Bryson and Howe, 1993; UNDP, 1995; Horestein, 1989; Saksena et al 1995; Nathan, 1997; Barnes and Sen 2003; Biran 2004; UNDP 2004) show that lack of time is a serious constraint for women, especially rural women. In general, women shoulder a heavier and more diverse workload than men. They manage the housework; take care of the children; nurse the sick and the old; collect water, fodder, and fuelwood; take care of smaller livestock; work on crop fields; handle manual post-harvest operations; and when possible, undertake cash-earning activities to increase family income. Family work covers one third to one half of a woman's working day and includes, in addition to cooking, time-consuming and tiring tasks such as fetching water and fuel wood. Recent research estimates that for women in Burkina Faso and in Nigeria, the average working day is 14 hours, eight or nine of which are devoted to farm work, and the remainder to non-farm work; the corresponding figure for men is between eight and nine hours, seven of which in farm work, and the remainder in non-farming activities (Saito, 1994, quoted in IFAD, 2005). Refer to Annex1 for gender disaggregated data on time spent on various activities.



Source: Blackden and Canagarajah, 2003

Women's multiple roles limit their ability to benefit from poverty reduction strategy interventions unless women are especially targeted. Even where women have equal education and experience to men, their heavier domestic work burden reduces their opportunities for economic participation and income generation. When women are involved in productive work, their productive time and flexibility are much more constrained compared to men, often leading to trade-offs between their non-productive and productive roles (FAO, 2005). Time use studies demonstrate (Bamberger et al 2001, quoted in Zuckerman, 2002):

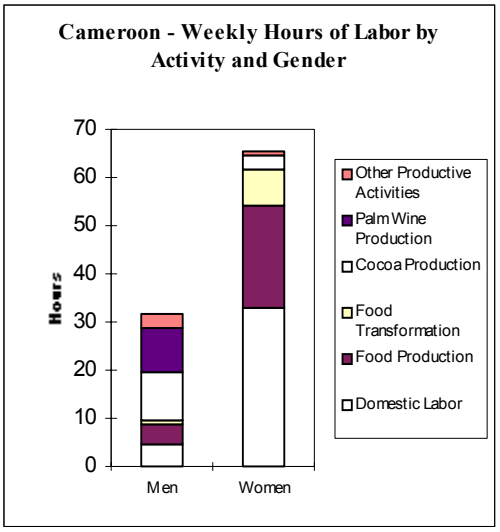
- In Uganda, women work 12-18 hours per day and men 8-10 hours per day.
- In Kenya, women work 50 percent more hours than do men on agricultural tasks.
- In Tanzania, women have two hours leisure per day while men have 4.5 hours leisure per day.

Children also are closely integrated into household production systems in poor households. Sometimes boys are disadvantaged but more often it is girls. While girls perform essential household tasks like carrying water, agricultural production and other economic tasks, boys usually go to school. Domestic chores, notably fetching water, are a major factor limiting

girls' access to schooling. African girls spend four times more time on productive tasks than do boys (Blackden, 2001).

The EnpoGen study in Sri Lanka (Masse and Samaranayake, 2002) revealed that women get up earlier and are awake for 16 hours or more, of which (excluding food and rest time) they spend more than 13 hours working, to be compared with 10 hours of work for men. Barnes and Sen (2004) report that in rural India, women spend about 40 minutes per day collecting fuel, almost one hour fetching water, almost three hours cooking and close to six hours on other housework. They spend almost two hours pursuing income-earning activities, about 30 minutes watching TV, 8.5 hours sleeping or engaging in other leisure activity and personal care, and about 40 minutes on miscellaneous activities. Ding (2002) reports that women in China spent an average of 44–50 hours per week on 'domestic' tasks and men between 15 and 31 hours. Women had the primary responsibility for cooking and washing. Further, women spent an average of 7-10 hours each week on pig feed preparation, while men only 1-3 hours.

Similar trends are seen in Africa as well. Data from World Bank studies shows that in Kenya, women are more active in agriculture than men, specifically in food crop production, marketing, and processing of agricultural products (90%). Women work 50 percent more hours than men on agricultural tasks (World Bank 1989, Horenstein 1989, quoted in Blackden, 2003). Women provide approximately 75% of total agricultural labor but they own only 1% of the land. Data compiled by IFPRI indicate that African women perform about 90 percent of the work of processing food crops and providing household water and fuelwood, 80 percent of the work of food storage and transport from farm to village, 90 percent of the work of hoeing and weeding, and 60 percent of the work of harvesting and marketing (Quisumbing et al. 1995, quoted in Blackden and R. Sudarshan Canagarajah 2003). In Uganda, women have work longer hours than men, between 12 and 18 hours per day, with a mean of 15 hours, compared with an average male working day of around 8-10 hours. In Cameroon, men's total weekly labor averages 32 hours, while women's is over 64 hours (see box). Much of this disparity results from differences in domestic labor hours—31 hours a week for women and 4 for men.

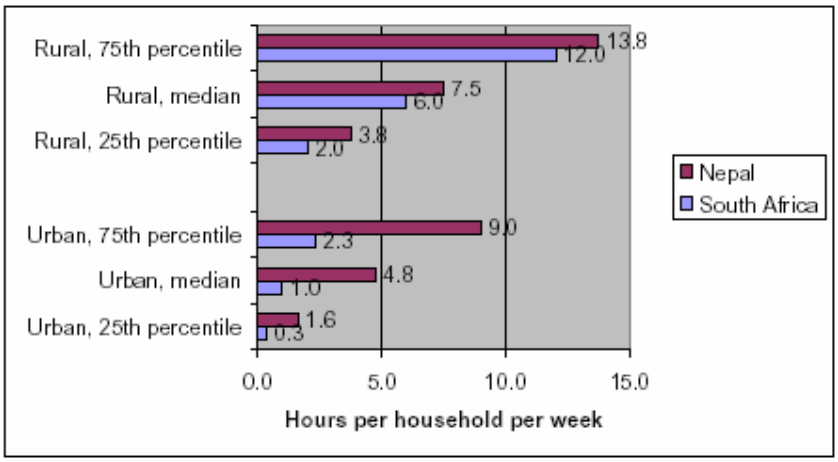


5.1.2 Time and effort spent on fuelwood collection

In most rural settings, collecting water and fuelwood is largely the responsibility of women. Villagers, mostly women and children, spend between 2-6 hours and travel from 4-8 km per day per household to collect, on an average, 10 kg of wood (quoted in Bloom and Zaidi undated). A field study in Kavre district in Nepal (Mahat, 2003) showed that almost 50% of the women respondents were spending 2 hours each day collecting fuelwood, and as many as 29% were spending more than 5 hours. Studies from South Indian villages show similar levels of time spent on fuelwood collection. In village Shusong village in Yunnan province in China, families estimate that women can collect two backloads of fuelwood per day, each

weighing 75 kgs, taking 3 hours to gather and carry home (Chuntao, 2002). The majority of the households in a recent study carried out in Rajasthan in India appeared to walk about 1-2 km for fuelwood collection. This amounts to almost 50 hours spent collecting fuel every month (Laxmi et al, 2003).

Surveys on firewood collection time collected in Nepal and South Africa showed that among wood collectors in rural Nepal, one-quarter of households spends more than 13.8 hours per week per household fetching wood, half spend more than 7.5 hours, and three quarters spend more than 3.8 hours; in rural South Africa, one-quarter of collectors spends more than 12 hours per week, half spend more than 6 hours, and three-quarters spend at least 2 hours (see figure below) (ESMAP, 2003).



With environmental degradation leading to depletion of biomass (the primary source of cooking fuel), and drying up of traditional water sources such as rivers, streams etc, it is primarily women's working day (already averaging 10-12 hours) that further gets lengthened. Data on rural India shows that time spent in fuel collection in fuel scarce areas can range from 1 to 5 hours per household per day (Agarwal, 1995). Kumar and Hotchkiss (1988), which reported on a study based on a year long survey of 120 households in three village districts of the Western development region in Nepal conducted in 1982/83, revealed that in the highlands, women were spending an average of 1.2 hours each day collecting fuelwood in the low deforestation villages, and 1.8 hours in degraded areas. The corresponding figures for lowlands were 1 and 1.6 hours respectively. As they walk long distances to collect fuelwood, women also suffer frequent falls, bone fractures, fatigue, and miscarriages, caused by carrying fuelwood often weighing 50-70 kg –almost equal to their own body weights. In Lao, where 97% of the households use wood or charcoal as fuel for cooking, a women who collects wood for a family of 5-6 must carry 120-150 woodloads per year, each load weighing 15-20 kg and uses 1-3 hours of walking and cutting time. Families with little extra income invest in handcarts which eases the work for women. Typically men and boys are involved in water and fuel collection when there is a handcart available (Lao Women's Union, 2001). Refer to Annex 2 for data on time spent and distance traveled to collect fuelwood in different countries.

Women's time burden increases further when men migrate in search of employment. In rural areas, the trend of men migrating to urban centres in search of livelihood is on the rise, resulting in a predominance of female-headed households. Data collected for 6 villages in lesser Himalayas and 3 in greater Himalayas (Bose, 2000) showed that out of 473 households, 186 (39.3%) have atleast one migrant. Data for the age group 18-35 years showed that 45.3% of the young males have migrated from these villages. Another comparative study showed that the mountain communities in Nepal had a migration rate of

20 %, while those in the plains had less than 2 %. In both cases, 85 % of the migrants were men (Gurung, 1998). In migrant families, women become in effect heads of households, but with only limited access to credit, agricultural extension, and other services. Women of migrant households also have to deal with other activities outside home, which adds to their work burden (Dutta, 2002) . One of the effects of the high level of female-headed households is increasing workload and responsibility for rural women. Human labor is the main form of energy used in the communal agricultural sector in Namibia, and women due to their preponderance in rural areas make up a large portion of farm labor. A government study in 1995 (Wamukonya, 1999, cited in Cecelski et al, 2002) found that rural women were performing many agricultural tasks previously characterized as male activities, adding to their time constraint.

5.1.3 Time saved by women in cooking and fuel collection with modern fuels and stoves

This section examines whether investments in improved energy services result in time saving in the daily lives of women or not. There is positive evidence that introduction of technologies such as biogas and improved cookstoves, bring about significant reductions in workload in collection and processing of fuelwood, as well as cooking and save time. Out of the 30 studies that dealt with improved stoves, biogas plants, LPG, kerosene and electricity, 18 reported time saved in fuelwood collection, as a result of modern cooking energy technologies. Refer to Annex 3 for detailed tables on time saved by women in cooking and fuel collection with modern fuels and stoves.

Technology/intervention	Number of studies reporting[2]	
	Time saved in fuelwood collection	Cooking
Improved stoves	4	10
Biogas plants	7	7
Kerosene	1	1
LPG	3	4
Electricity	2	2
Social forestry	1	

Only 10 of these studies however quantify the time savings and present the findings in number of minutes or hours per task, the rest are either in percentages or give a broad range. The range of time saved in fuelwood collection from use of ICs and biogas ranges from 40-50% (Chander and Tandon, 2004; Barnett et al 2002; Chuntao, 2002 and Dutta et al, 1997) to 100% (no fuelwood has to be collected after use of biogas plants, reported by Barnes and Sen, 2003).

Time savings in cooking seems to be the highest reported benefit from improved stoves. Cooking time is saved because of factors like the ability to use two pots at the same time, quick raising of temperature, higher heat-efficiency etc (Anderson, 1992; ESMAP, 2003; Liu, 1992). Opdam (1997), which conducted case studies on the Biogas Support programme of Nepal and Ratnayake (2000), reporting on the impact of biogas plants in Sri Lanka also reported time saved in cleaning, as a result of using biogas plants.

[2] Total number of studies on time savings in fuelwood collection and cooking: 30

Time saving has also been reported as an important benefit arising from micro hydro plants in Nepal (Mahat, 2004a), where the women reported a reduction in labour and time spent in processing activities, so that they have more time for rest and leisure. Time is also saved in filling up kerosene lanterns and lighting in each room. However, women's work has increased in the evenings and nights with the availability of electric light.

Even though electricity is not directly used for cooking, there seems to be a correlation between use of electricity and the time spent in fuelwood collection (Barnes and Sen 2003, Chakrabarti and Chakrabarti 2002, Masse and Samaranayake). Barnes and Sen reported that in rural India, at all levels of income, the time spent collecting fuel in households with electricity is lower than for those households without electricity. Households without electricity spend 0.9 hours in collecting fuel and 2.93 hours in cooking as against 0.53 hours and 2.58 hours spent by households with electricity for the same tasks.

Modern energy services, through use of electric or fuel-operated pumps, can make it easier to bring water supply closer to home. In Ghana, Tanzania, and Zambia, women account for two-thirds, and children—mostly girls—spend between 5 and 28 percent, of household time devoted to water and fuel collection (King and Alderman, 2001). Rosen and Vincent (2001) report that households (primarily women) spend an average of 134 minutes per day collecting water, and that the time saved by bringing water supplies closer to households is likely to dominate estimates of the benefits of improving rural water supplies. 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.

> Micro hydro plants installed under the REDP were instrumental in bringing down women's workload considerably. For instance, women used to wake up very early around 4 am in the morning and use *dhiki* and *janto* for at least two hours of grain processing which required their own physical energy. Now women spend only around half an hour on processing activities excluding travel and waiting times, which comprise around one hour. Since most of the energy related activities are carried out by women, this analysis focuses on women's work.
> Mahat, 2004

5.1.4 Time saved in food processing with modern energy sources

Women operate a variety of fuel-intensive small-scale industries in the informal food and beverage processing sector. In Namibia (Cecelski et al, 2002), these include processing of marula nut oil, fish smoking, bakeries, omalodu beer brewing, and pottery (where taboos exist for men). Men participate in sale of fuelwood and sometimes roast meat for sale. Fuelwood is the primary source of fuel for these small businesses, so the scarcity and high cost of fuelwood is a constraint and burden on their profitability. Food processing, especially grinding and milling form a major part of their daily domestic chores as well, especially in rural areas. In Housanxi village in Hubei province of China (IDS, 2001), households without an electric mill have to turn their stone mill by human power to grind corn, which takes an average of 8.4 hours by men and 7 hours by women a week in winter.

With electrification, the major time savings occurs in grinding and milling activities. Mahat from Nepal reported that after the installation of a micro hydro plant, the total time spent in milling and grinding came down, which includes the travel as well as waiting time. The waiting time was drastically reduced, because of the speedy processing activities unlike with the traditional water mill.

An in-depth review of the Mali multifunctional platform[3] in Africa (UNDP, 2004) showed that the multifunctional platform has freed women's time and enabled them to rest. The aggregate time saved per women over a week in the processing of cereals amounts to an 8-hour working day. On an average, a multifunctional platform has freed 2 to 6 hours daily per woman depending on the services of the platform. The time saved can be interpreted in two ways: less time per task and/or less arduous tasks enabling other activities to be done. Four of the 12 studies that dealt with this aspect reported that the time saved was being used for income generating and entrepreneurial activities (Malmberg-calvo, 1994; Halim, 2004; Haque, undated; IDS, 2001), while Mahat's in-depth study (Mahat, 2004a) from Nepal, based on interviews with 487 households, reports that in spite of having more time, women do not have any time to spare as "there was always something to be done." Refer to Annex 4 for detailed data on time saved in food processing with modern energy sources.

> In the village of Noumoula, women compared hand production of shea butter with butter production using the multifunctional platform. They estimated that using the multifunctional platform increased daily production from 3 kg to 10 kg. The increased productivity results from time liberated by the mill and increased production through mechanical pressing (Diourté and Diallo, 1999).
> This finding was confirmed by another study that observed that production of shea butter with the multifunctional platform reduces work time from 8 hours to 4.5 hours per 10 kg of raw shea nuts and increases the yield from 35 percent to 45 percent (Diagana, 2001).
> Quoted in UNDP, 2004

5.1.5 How time saved by modern fuels and stoves is used by women

In two studies, the respondents said that the women were actually resting more, after modern fuels and stoves are introduced. A majority of the studies (12 out of 18) reported that the women were using freed time for some income generation activities, including handicrafts, sewing, other home based work and agriculture, and these are however not quantified. Only two studies (Laksono, 2001 and Ratnayake, 2000) presented some quantification of how much time was being spent in productive activities and what proportion of the respondents were using the freed-up time for income generation respectively. Only one study, a review of the multifunctional platforms in Africa (UNDP, 2004) reported on the productivity gains resulting from time savings, and estimated that using the multifunctional platform increased daily production of shea butter from 3 kg to 10 kg. Some women, especially those belonging to poorer households, also used the free time for wage labour (Barnes and Sen, 2003; Dutta et al, 1995; Rai, 2000). Refer to Annex 5 for empirical evidence on how time saved by modern fuels and stoves is used by women.

[3] The multifunctional platform consists of a source of mechanical and electrical energy, provided by a diesel engine of 8 to 12 horse power (hp), that is mounted on a chassis and to which a variety of end-use equipment can be added. The configuration of equipment modules – such as grinding mills, battery chargers, electric water pumps, vegetable or nut oil presses, welding machines, carpentry tools, and mini electricity grids for lighting – is flexible and can be adapted to the specific needs of each village.

There is some evidence that in situations, where there is a monetary opportunity cost for women's time, the adoption of energy saving devices is relatively easier (Nathan, 1997), and that the willingness for men to adjust to women's time schedule is higher. Women who have regular income generating work in Lao have started thinking of conserving firewood in order to save labour and time by using charcoal stove, saw dust stove, which have started appearing in the local markets (Lao Women's Union, 2001). In houses where women have income generating activities, families carry out planned wood collection and stockpiling so that they can cut and transport large quantities of wood at one time using carts or rented cars. In Viengsay when the work of harvesting rice is finished, villagers set aside time for planned fuel wood collection; they cannot waste time running back and forth to collect small quantities, they need to collect all at once so that women would be able to devote time to weaving. This trend started a decade ago when the sale of woven fabric became a regular source of income for the families. In PuDinDaeng and Lao Lum community in Viengsay, where women contribute significantly through embroidery and weaving, the division of labour in the family changes and the whole family is involved in fuelwood collection. The husband of the fastest weaver in the village had taken over all the household jobs. In Lao village in China, women's earning possibility went up very substantially with the commercialization of weaving, but there was no change in the earning possibility of men (Kelkar and Nathan, 2005). In this situation, along with the adoption of mechanical milling to reduce women's labour in non-earning activities, there was also some substitution of men's labour for women's labour in wood fuel collection. Men even took over some of the responsibility for childcare and, to a small extent, for cooking, in preparing food for themselves when their wives were busy.

Some researchers have expressed reservations that if electric light extends working hours into the evening, this adds to women's already long working day (Clancy 2000). Unfortunately, there are insufficient empirical data on what use is actually made of the lighting. One of the few detailed studies with gender-disaggregated data on rural electrification reported that women in rural Bangladesh felt that while electricity had not brought a real reduction in their workload it had given them greater flexibility (through lighting) in the organisation of their work patterns (Barkat et al 2002). Another impact assessment of solar home systems in Lampun province of the Philippines (Laksono et al 2003) showed that the use of SHS changes the pattern of individual activities. It enables the users to extend activities for longer hours at night. The SHS strengthens the domestic roles of women since they can conduct chores at night. Women's time allocation for productive activities increased 2.2 hours, but men's decreased 1.2 hours. In the households of SHS users there are 22.9% of women

Benefits to women from a micro-hydro scheme

In village Harichour, Baglung district, Nepal an enterprising MHP entrepreneur has been operating a 25kW micro-hydro plant for over 15 years. The mill serves about 380 households during the daytime and electricity is provided to 215 households in the evenings for about 5 hours. The accessibility to the electrically driven mill has provided a big difference to women's lives. While before, women had to walk about 1 hour to grind grains in the traditional water mill, it has been now reduced to a 5 minute one. Hira Gauchan, another user pointed out that they have more time now than before when they had to grind at least 4-8 kgs of grain every morning. The mill facility has also made it easier on poorer women who were hired to grind grains by the richer houses. According to these poorer women, this time saving has allowed them to work in other productive activities. Time is equated with money and often women preferred to work and earn rather than rest. Women also felt that the television has become an important medium for gaining access to information about political, social, cultural and economic issues. This has helped them widen their understanding particularly because they did not travel out of the village.

Rai 2000

working more than 9 hours everyday and 16.7% of men are in similar range. On the contrary, the non-SHS users have lower productive hours.

In Housanxi, a recently electrified village in Hubei province in China, the women thought that the biggest change after electrification was a reduction in time spent looking after pigs, with mechanization of pig fodder cutting and corn grinding (IDS, 2001). Women's resting time also increased substantially. However this was partly offset by an increase in the time spent working in the fields. This was partly because time saved on pig feeding being used for household agricultural work, partly because some men migrated, leaving their agricultural work to women. The women indicated that seeking work outside the village became a much more realistic income earning option with the arrival of electricity, as these enabled women to continue farming in the absence of male household members. Women in Housanxi were very enthusiastic about electrification, and said that it had improved their lives in a number of ways. Households could raise more pigs if they had access to powered fodder cutting machines; electric milling machines both allowed the production of potato flour for sale and freed time to work on the land or seek other sources of income; physical work was less arduous; but most importantly men could migrate and leave women to farm with the help of machines (IDS, 2001).

> Li Maimei lives in Duiwotai, a mountain village in Hubei province of central China. Her husband is mainly responsible for the work in the fields and fetching water, while she does most of the housework and works in the fields during the day, spending 3-4 hours on preparing three meals a day, washing (once every 2-3 days), collecting pig feed (1-2 hours once every two days), preparing pig feed every day (3 hours) and collecting fuelwood (2 hours each day). Women's working time extended following electrification. According to her," the benefits of electricity are that my son and husband can watch television in the evening and I myself can do housework more easily and conveniently at that time.
> Ding, 2002

In general however, it appears that when time-savings do take place because of introduction of energy saving devices, men are more likely to use these savings primarily for recreation and leisure, whereas women are more likely to redirect them to other household chores. On the whole, time-savings from electricity do not reduce the overall workload of women, although they make work easier. In Sri Lanka, women consider that lighting gives them about two extra hours of useful time, which are invested not only in better housework and care of the children, but also in time to rest, socialize, and watch television, and sometimes to develop income-generating activities (Matly, 2003).

Even though longer work hours do give women more flexibility in terms or organizing their domestic chores, the extent to which electricity can contribute significantly to poverty alleviation is not clear (Clancy, Skutsch and Batchelor, 2003). A study into the socioeconomic impacts of rural electrification in Namibia showed that women did stay up later than men, not working but socializing (Wamukonya and Davis, 1999, cited in Cecelski et al, 2002). More research needs to be done into what use is actually made of the lighting and electricity. Fuel savings in one area of drudgery can result in increased drudgery in another area (Clancy, Skutsch and Bachelor 2003). Jackson's (1997) study of women's involvement in water projects showed that some women deliberately adopted a nonparticipation strategy to avoid increasing their overall workload. In one case (Eastconsult, 2004), women had to spend more time fetching water after the installation of biogas plants. There can also be distinct gender aspects to the distribution of benefits from modern energy carriers. For example, the evaluation of a rural electrification project in Tamil Nadu showed that men benefited more than women since the electricity was used to run irrigation pumps substituting for oxen-drawn water (Rengasamy et al., 2001, cited in Clancy,

Skutsch and Batchelor 2003). The care of the oxen was traditionally a task for men. They gained more free time when the number of draft animals decreased, and they used this time for involvement in politics and improving their agricultural methods, thereby increasing their social and human capital. However, electricity did not substitute for any of the tasks of women, and hence their strategic needs were not addressed.

5.2 Using energy services for income generation

Access to energy can potentially improve livelihoods in a number of ways: energy inputs in irrigation can improve agricultural productivity and diversify crop choices; lighting permits income generation beyond daylight hours, agricultural productivity can be improved through efficiency improvements in women's tasks in agriculture, thereby increasing incomes, access to reliable energy improves income from enterprises, many of which are owned and operated by women. Energy inputs, by freeing up women's time earlier used for chores such as fuelwood and water collection enables them to engage in income generating activities. Most of these benefits however accrue at the household level and difficult to segregate by gender, based on available data.

5.2.1 Effect of modern energy sources on women's agricultural tasks and productivity

In his paper, "Energy services for the poor", a commissioned paper for the Millennium Project Task Force 1, Modi identifies a number of ways in which use of improved energy services can contribute towards agricultural productivity (MOdi 2005).

- Use of modern fuels or improved stoves can allow a greater proportion of biomass (in form of crop residues and manure) to be returned back to the soil. This allows nutrient replenishment directly as well as indirectly by providing additional soil carbon that in turn can reduce leaching of soils.
- Modern cooking fuels could indirectly increase farm productivity by freeing up women's time and ensuring that the physical effort of biomass collection by child-bearing women is not detrimental to their health.
- Electrical power could help raise agricultural productivity and income of smallholder farms by enabling them the use of information and communication infrastructure for weather and market information and pumps to lift water collected through rainwater harvesting.
- High transport costs due to inadequate road network density and poor road conditions can lead to high costs of agricultural inputs, affecting farmers' incomes. Lowering of transport costs can significantly lower the cost of transporting fuel.

An assessment of the rural electrification programme of Bangladesh revealed that in agriculture, an estimated 1.1 million persons are directly involved in farmlands using rural electricity connected irrigation equipment. Currently, 63,220 industries using rural electricity employ 983,829 persons; and electrified industries, on an average, generate 11 times more employment than the non-electrified industries. Rural and wholesale shops using rural electricity employ 848,630 persons. There has been direct employment of 16,223 persons in the PBSs (Barkat, Khan etal, 2002). This data however is not segregated by gender.

The data available shows that there are two areas in which modern energy services have contributed to agricultural productivity:

- By freeing up women's time which they use in agriculture: Women in developing countries provide the bulk of agricultural labour, up to as much as 60%. In Africa for example, women perform about 90% of processing food crops and providing water and fuelwood, 80% of food storage and transportation from farm to village, 90% of hoeing and weeding and 60% of harvesting and marketing. A World Bank study pointed out that women provide about 70% of total agricultural labour in sub-Saharan Africa (Blackden and Bhanu, 1998, quoted in FAO 2005). Statistical data for Ghana show that women account for about half of the agricultural labour force and produce around 70% of Ghana's food crops (FAO 2005). The converse was borne out by a study in Nepal which showed that increased fuel wood collection time corresponded directly with decreased time worked in agriculture and a higher overall workload for women (Kumar and Hotchkiss, 1988). In this review, four of the 12 studies that touch upon agricultural productivity (Barnett et al, 2002; Ding, 2002; IDS, 2001; UNDP, 2004) report that women use freed up time for increasing agricultural production.

- By using biogas slurry as a nutrient-rich fertilizer, used for farming and for growing vegetables (Chuntao, 2001; Dutta et al, 1997; Eastconsult, 2004; Keyun, 1995).

In one case, electricity also helped in raising the productivity of livestock rearing (Wilkinson 2002).
For detailed data on how women's agricultural activities are positively impacted by modern energy sources, refer to Annex 6.

5.2.2 Effect on modern energy services on income generation in non agricultural activities

The effect of modern energy services on non-agricultural income generation has been analyzed under two categories: (a) direct impact on income generation activities, and (b) extension of working/business hours through lighting.

(a) Direct impact on income generation activities

Non-agricultural activities in the village that take advantage of electricity are generally small trades like carpentry, blacksmithy etc. for local markets and services (such as repair centers, battery charging centers, restaurants, and shops). Electricity favors the development of home activities in particular (but not only) for women (Matly, 2003), including handicrafts and textiles, embroidery and garments, food processing, such as *tahu* (bean cakes), and wooden sandals in Indonesia, clove nut processing, wrapping local cigarettes *(beedies*), making joysticks ("magic" candles made locally for children's birthdays), and weaving in Sri Lanka. 12 out of the 15 studies that covered this aspect reported that women had undertaken small income generating activities such as poultry, fish farming, handicrafts, as a result of improved energy services. Refer to Annex 7 for empirical evidence on the effect on modern energy services on income generation in non agricultural activities.

In Kavre district in Nepal, after the installation of a micro hydro plant, men recognized the possibility of income generating activities through establishing saw mills and poultry farms, using hydro power. In some cases, women and men were engaged in handicraft work at

night, such as weaving baskets, mattresses etc (Mahat, 2004). After the Muana micro hydro plant, women have developed small businesses such as cold storage facility for seafood and other foodstuff (Sauturaga, 2004). In a preliminary community assessment conducted in Cambodia in October 2001, it was learned that in some villages, battery-powered lanterns are used not only for everyday lighting in the home, but also outdoors for frog hunting—a significant source of income. (Cecelski, 2002)

Four studies (Barkat et al, 2002; Nathan, 1997; Ramani, 2002; Dutta et al, 1995) showed that improved energy services enable women to make use of available employment opportunities, including wage labour. In Bangladesh, electricity has increased the employment opportunities for women in electrified households, which translates in greater control over their incomes (Barkat et al 2002). The same study showed that the women in the electrified compared to those in the non-electrified households are involved more in household level income-generation activities and depict better re-allocation of time for remunerative employment.

Only a small proportion of households directly employ electricity in home-based micro-enterprises. Among them, poor households use it the least for such use because of the lack of capacity to acquire productive use appliances. Income from village enterprises and businesses depends on the quantity of electricity supply, the time lag since electrification, investment capacity, and access to markets. On an average, income from enterprises and businesses that use electricity is double that of un-electrified enterprises and businesses (Ramani and Heijndermans, 2003).

> In one village in Lao, most of the houses who adopted solar home systems immediately moved their weaving looms upstairs. The teenagers were very happy to contribute extra income weaving in the evenings. This income paid back the cost of the solar panel and weaving materials after which there was additional money for the family. In the same village, the solar lights had helped incomes by allowing net mending to take place at night, and also by allowing charging of batteries used for fishing and for hunting frogs at night.
> OPS 2004

(b) Extension of working/business hours through lighting

The most widely experienced benefit of lighting in terms of income generation is the extension of working hours and keeping shops and businesses open until late at night (IDS, 2001; Khan, 2001; Madon and Gardiner, 2002; Wilkinson 2002). In Sagardweep island in India, where a SPV power plant is supplying electricity to households for lighting, the cultivators, cultivating betel leaf, have benefited from the power supply as a significant part of their work like arrangement of leaf for supply, watering in the field etc, can be done at night. The supply of power has also helped the commercial establishments to continue their activities at night for a longer period and to provide more services to the people. The production works like weaving, sewing etc., have also been carried out at night with the help of electric light (Barkat, Khan et al 2002; Bryce and Soo, 2004; Chakrabarti and Chakrabarti, 2002; Khan, 2001). The supply of solar power has also helped, though on a small scale, to run video hall, battery charging centre etc (Chakrabatri and Chakrabarti 2002). Refer to annex 8 for empirical evidence on how lighting helps extend working/business hours.

5.3 Direct saving in household expenditures by using efficient fuels

Improved energy services including cooking energy technologies as well as electricity (grid electricity, SPV and hydro power) are known to have brought about savings in expenditure at the household level, the empirical evidence collected as part of this study is summarized in the table below. Refer to Annex 9 for empirical evidence on direct saving in household expenditures by using efficient fuels.

Technology/energy source	Number of studies reporting savings from use of
Improved stoves	9
Biogas plants	5
Electricity (including SPV and hydro)	8
LPG	1

Mrs. Veal Hour is a food shop owner in Chamkarmon district, Phonm Penh. At present there are 4 charcoal burning stoves for cooking and an LPG cooker for serving instant foods. 2 of the stoves are traditional bucket stoves and 2 are NLBS stoves, in which she invested 2 years back. The main reason for the changeover was that, traditional stoves emit smoke which causes discomfort for her customers and consume a lot of charcoal. On using the NLBS stove the amount of charcoal consumed came down form 3.5 to 2 Kg per day resulting in an annual saving of 540 kg (243,000 Riel). Mrs. Hour feels that even though her investment was much higher than traditional stove, her monetary saving from charcocal saving would more than offset the high investment cost (15,000 riel as against 5,000 riel for traditional stove)

(Case study on savings from new LAO bucket stove in restaurant (growing popularity of NLBS utilization in food shops, No author, Green fire, Quarterly Bulletin, Issue 007, Feb 2004, published by Wood Energy Network of Cambodia, Phnom Penh)

Savings in expenditure through fuelwood savings resulting from use of improved cokstoves and biogas plants has been reported in many studies, and savings between 20-50% are reported (Anderson, 1992; Ali, 2002; Barnett et al, 2002; Dang, 1998; Dutta et al, 1997; ESMAP, 2003; HLF, 2001; Halim, 2004; IDS, 2001; Maharjan, 2005; Shailaja, 2000). In Rwanda and Kenya, monetary savings brought about from reduced fuel wood consumption after improved cookstoves was in the range of $8.41 to $15.3 (Barnes et al, 1994). In Nepal, fuelwood use decreased in the biogas households was in the range of 15.68 kg in summer and 19.56 kg in winter per household. The corresponding figures for the Hills are 6.28 kg and 7.32 kg both in summer and winter. The decrease of kerosene consumption per household per day in *Terai* has been 64 ml in summer and 70.77 ml in winter. Likewise, the figures for the Hills are 17.83 ml and 13.57 ml in summer and in winter, respectively (Eastconsult, 2004). Another study, in Nuwakote district of Nepal, the use of biogas plants brought about a saving of 63% (Keizer, 1993). It is however important to note that most of the surveys that have reported these savings are based on the recall method (asking the user how much fuelwood the household uses since a biogas plant has been adopted, and how much was being used earlier), and not on measurements. The few studies that are based on measurements are typically conducted in laboratories and the variations in these results as compared to field data could be quite significant.

Getting electricity is also a significant way to save money, through reduction in expenditure on traditional energy sources such as kerosene lighting, dry batteries for sound equipment, and car batteries for televisions (HLF, 2001; Bryce and Soo, 2004; Laksono, 2003; Masse and Samaranayake, 2002; Sauturaga, 2004). The EnPoGen study in Sri Lanka reported savings equivalent to 1-3 days salary. Newly electrified households in Sri Lanka may cut their monthly energy bills in half, and in Indonesia up to 70 percent. Cash savings of 30–40

percent are derived in pre-electrification expenditures on electricity substitutes, such as kerosene and candles (Ramani and Heijndermans, 2003). In Bangladesh, the monthly expenses on kerosene in electrified households were only Tk. 28.3, while it was around Tk.65 in the non-electrified households (Barkat, Khan et al 2002). Calculations from a household survey conducted in South Africa (Annecke, 2005) showed that some households saved money through using electricity, but the introduction of free basic electricity (FBE) skews the calculation. Some said that FBE means they are able to do things such as reading and watching television for longer. The focus groups thought that electricity saves money. The savings could be greater if efficient appliances, such as compact fluorescent lamps (CFLs), were used. However, over time, these savings are offset by increased electricity consumption from greater appliance use.

> A 33k W MHP was installed in 1999 in Kalinga north of the cordillera Mountain region in Northern Luzon in the Philippines. An improtrant economic outcome is the savings made from the kerosene and pine pithwood traditionally used for light. The households spent an average of 38 pesos on kerosene and 79 pesos on pine pithwood per month before the installation of the MHP, against the current MHP tariff of 30 pesos.
> Approtech-Asia, 2005

The Philippines Rural electrification study made an attempt to quantify the monetary benefits of electrification, which are summarized in the table below (ESMAP, 2002c).

Summary of electrification benefits for rural households, 1998

Benefit category	Benefit value	Unit	Total per month (millions)
Less expensive and higher levels of lighting	$36.75	Per household per month	$147.5
Less expensive and higher levels of radio and television use	$19.60	Per household per month	$77.5
Adult education and electricity wage income returns	$37.07	Per wage earner per month	$296.6
Time savings for household chores	$24.50	Per household per month	$97.5
Improved productivity for home business	$34(existing home business), $75(new home business)	Per business per month	$24.7
Improved health	None	NA	NA
Improved agricultural productivity resulting in increased irrigation	None	NA	NA
Feeling of security	Not quantified in monetary terms	NA	NA
Public good benefits	Not quantified	NA	NA

Source: ESMAP, 2002c.

5.4 Contribution towards improvements in social capital and quality of life

According to these studies, electricity brings about improvement in social capital in a number of ways, including improved health through reduction in exposure to indoor air pollution, literacy/ children's education, television, safety, more time for leisure, childcare, convenience through use of appliances, reduction in fires and accidents and confidence building and participation in community activities, a summary of which is presented below. Annex **10** presents details of these studies.

Benefit	Number of studies reporting

	benefit from access to improved energy source
Health improvement[4]	4
Access to television	6
Literacy	6
Safety for women	3
Extra time for leisure, recreation and childcare	11
Convenience through use of appliances	4
Reduction in fires and accidents	5
Participation in community activities and confidence building	5
LPG	1

In Sri Lanka, women consider that lighting gives them about two extra hours of useful time, which are invested not only in better housework and care of the children, but also in time to rest, socialize, and watch television, and sometimes to develop income-generating activities. For the first time, women get full control of part of their daily schedule (Matly, 2003). Biogas digesters provide time and labour savings. In some areas, they have become a necessary prerequisite for marriage. Girls want them as part of their dowries, or they may ask their future husband's families to build them as part of the marriage agreement. Biogas digesters are considered "priceless assets" (Keyun, 1995). In some cases, social benefits were noticed. In Kerala India, the adoption of solar home systems led to a decrease in the drinking problem in the villages due to the ability to undertake productive activities during the evenings (Khuller, 2002).

Access to television and media seems to be the most appreciated benefit (Barkat Khan et al 2002; Everts and Shulte 1997; Mukhopadhyay 2004). Electricity, especially through freeing people from social isolation (socializing in the evenings, safety for women through streetlights) is considered a major benefit. It also permits women to be involved in community level activities (ESMAP, 2004; Wilkinson 2002).

Among the most significant findings in relation to the benefits of electrification were those that related to reading and watching television. In a study on rural electrification in Bangladesh (Berthaud, 2004), As high as 64 percent of those women having knowledge in the electrified households reported TV as the main source of knowledge, the corresponding figure for TV was 34 percent in the non-electrified households and 19.1 percent in the non-electrified villages." The study also found that the gender divide in health and education has decreased: "in the electrified households, the annual average health expenditure for the males was 22 percent higher than the females, the corresponding health expenses were…116 percent higher for males than females in the households of non-electrified villages.… the male- female gap in literacy in electrified households has been reduced from about 25 percent to 16 percent." In another study by ITDG in Sri Lanka, it was reported that 12 percent of the beneficiary families are now reading newspapers, after the advent of electricity. A survey of 5000 households in India revealed that ninety percent of the women who spent some time reading resided in homes with electricity. About 90 percent of the women who pursue some reading during a typical day are in households with electricity,

[4] Health improvements have been covered separately in studies on MDGs 4, 5 and 6.

compared to 2 percent in households without electricity (Barnes and Sen, 2004). In Nepal, an assessment of the impact of the Gandruk hydro plant suggested that the advent of television had a significant 'cultural impact' in that women said they could see that they "don't have to remain as second class citizens" (Joshua Thumin 1999, quoted in Barnett 2000). A recent study by Annecke (Annecke, 2005) in the Khayelitsha township in South Africa revealed that while all respondents make the point that electricity has afforded them or their children more time to study or do homework and watch television, television also has disadvantages. For parents living in dangerous areas (which most slums are), television is a necessity to keep children at home, but they worry about what children see and learn from it.

In migration from electricity

A new phenomenon of in-migration into the electrified village has been reported. Many have said that, because of electricity, new economic activities have emerged, which has created more employment opportunities, and that, in turn, gave impetus for people in the non-electrified villages toward electrified villages for work. The occupational pattern has changed in the electrified villages. In addition, due to the availability of improved educational and health facilities people are also attracted toward electrified villages. Electrified villages have better agricultural facilities due to electricity-driven equipments for land preparations, irrigation, threshing, husking and demand for labour during harvesting has increased. All these have been instrumental in reducing out-migration for job from electrified villages, and in increasing immigration (both temporary/seasonal and permanent) to electrified from non-electrified villages. Because of the combined effect of all these factors mediated through rural electrification a tendency has been developed among people to shift their residence from non-electrified to electrified villages. As a result, the price of land in the electrified villages has increased.

Source: Barkat et al 2002

Electricity is known to bring about *lifestyle changes* in the lives of people (Ramani and Heijndermans 2003). It enables households to go in for labour saving devices such as electric kettles, electric drills, freezers etc (Bryce and Soo 2004, Madon and Gardiner 2002). Using electricity is safer than using kerosene wick-lamps, candles and lanterns (Ratnayake, 2000; Madon and Gardiner, 2002).

Electricity is generally believed to make villages more attractive and prosperous. In Sri Lanka, electric fencing appears to be of major interest to farmers, so as to reduce crop damage by animals, including elephants (Matly, 2003).

5.5 Women as energy entrepreneurs

There are quite a few examples of "energy enterprises" operated by women, where women manufacture energy equipment or control energy-producing assets that are the basis of a business In general, women are ideal candidates to become renewable energy entrepreneurs for household and small-scale industry because

- They are users of these devices, so they may be more sensitive to customers' desires.
- They are effective entrepreneurs with a good credit record. In 1996, 94% of Grameen Bank borrowers were women, with a 98% repayment rate.
- They can more effectively market to women.

Most common energy enterprise run by women seems to be the manufacture and sale of stoves (Bhogle, 2003; Haque, undated; Njenga, 2001). Some of the other positive examples

of women taking up energy technologies that have contributed to increasing their incomes are as follows:

- In Mali, the multifunctional platforms are run by women's associations, and the business is led by and works for the women who operate it. The association elects management committee members, schedule work, distribute benefits arising out of the platform operation, and develop a mechanism to address any potential confrontations that may arise. Members of women's associations are trained in managerial and entrepreneurial skills to ensure the technical and economic viability of the platform. The multifunctional platform is used for productive activities such as rice de-hulling or shea nut grinding. In addition, the multifunctional platform provides employment (and new income opportunities) for women operating the multifunctional platform (UNDP, 2004).
- The Vietnam Women's Union has been active in the promotion of solar home systems in rural areas through its extensive network of 11 million members. VWU is in charge of marketing; motivating households; developing material on basic maintenance; and conducting solar home demonstrations. It is also responsible for reporting problem areas that require troubleshooting, seeking support of government bodies, and identifying new project implementation sites. VWU operates through its commune offices, allowing it to respond better to consumer needs. Its presence instills confidence in rural customers. Many of the local technicians responsible for installing the solar home systems are women (Dutta and Sam, 2005).
- A FAO/UNDP post-harvest programme at Kawanda Research Station in Uganda recommended small-scale solar dryers for long-term storage and house- hold consumption of fruit and vegetables. However, it soon found that rural groups were more interested in solar dryers for income generation than for food security. In 1992, the Fruits of the Nile company was formed to exploit this commercial interest by linking rural producers with the market for dried fruit in Europe. It continued the work of developing and promoting small-scale dryers with women's groups and businesses. For an investment of US$100, a group became a supplier of the company and received a simple improved solar dryer with instructions for its use. Within three years, more than fifty groups had taken up the technology. In 1995, the company exported more than 40 tonnes of dried fruit. The dried pineapples, bananas, and mangoes produced by the rural women's groups are transported to a central collection point in Kampala. An example of such a group is the Matinyani Women's Development Group. The Matinyani Women's Development Group uses solar dryers to dry mangoes. In thirteen weeks each of the women in the group earned 6,000 Kshs to supplement their income. Fruit was sold to Nairobi and Mombasa, and 3 tonnes were shipped last season. Not only are the women's groups generating significant incomes for themselves, the original food security concerns are also being addressed, because, when they are not drying for profit, the women are drying vegetables and fruits for home storage and consumption (UNDP, 2000).
- In Sonora, Mexico, a group of women from one of the poorest neighborhoods, calling themselves Mujeres Activas, was looking for a micro-enterprise that could help support their families. They had already started using solar ovens in their families, so with assistance from an outside NGO, Mujeres Activas built large commercial-size solar ovens and established a bakery business that provides them with income to buy

shoes and clothes for their children and send them to school (Stone, 1998, cited in Cecelski, 2000b).

- Prokaushali Sangsad Limited (PSL) is promoting a rural women's micro-enterprise in Bangladesh. The project is located at Char Montaz, an island in southern Bangladesh, a five-hour motorboat journey from the nearest commercial centre. Electric grid extension to this area will not be economically viable within at least the next 20 years, and therefore there is a high demand for alternative modern lighting (UNDP, 2001).

Through a micro-enterprise, rural women are engaged in the construction and sale of fluorescent lamps that use direct current (DC) and rechargeable batteries. The women involved in the project run the manufacturing plant that produces the lamps, and are certified by the local government to run their business as a cooperative. Besides lamp construction, women are also learning about quality control, business development and marketing. If a woman constructs and sells two lamps a day, her daily income increases by 100 Taka (approximately US$2). This is equivalent to the daily wages of a skilled labourer, and thus raises both her income and her social status.

The project advertised the lamps by organizing public meetings, distributing handbills, setting up billboards and posters and demonstrating at several locations. A detailed marketing plan was developed by the women covering factors such as business location, customer characteristics, target markets, competition, electricity demand, marketing goals and strategies, and budget considerations. About one thousand rural households are using these lamps today in the remote islands of Bangladesh.

Refer to Annex 11 for examples of women as energy entrepreneurs.

6. Summary of findings on the linkage between gender-and-energy and MDG1

Reducing poverty and hunger is linked to women's ability to have the time and effort available to participate in development. There is good evidence that women can save time and effort from improved access to energy for their traditional responsibilities of cooking, water fetching and food processing. Modern cooking fuels but also electricity reduce the time that women spend on drudgerous tasks. How this time is allocated depends though on many factors, especially market and income-earning opportunities. A summary of the findings from this review are presented below:

Time and effort saving

- *Time saved by modern fuels and stoves:* Modern energy services save time and effort expended by women on subsistence activities, by making domestic chores less drudgerous. There is sufficient empirical evidence to show that improved cookstoves and biogas plants, by saving fuelwood, reduce the time that women have to spend on fuelwood collection, processing and cooking. The range of time saved in fuelwood collection from use of ICs and biogas ranges from 40-50% to 100%. There also seems to be some correlation between electricity and time spent on fuelwood collection, though this may be ascribed more to other factors such as income than electricity, as electricity is not used for cooking.

- *Time saved in food processing:* There is sufficient data to show that electricity saves women's time in domestic food processing, which is traditionally done manually. However, data on micro and small scale industries operated by women and energy's role in them is almost non-existent.
- *Use of time saved:* Majority of the studies reviewed showed that women used freed time for some income generation activities, including handicrafts, sewing, other home based work and agriculture. There is some evidence that in situations, where there is a monetary opportunity cost for women's time, people are more eager to adopting energy saving devices and making adjustments within the family to share the burden of fuelwood collection. There is however little quantification of what proportion of time was being used for productive activities and what are the productivity gains resulting from additional time available. In general, it appears that when time-savings do take place because of introduction of energy saving devices, men are more likely to use these savings primarily for recreation and leisure, whereas women are more likely to redirect them to other household chores. On the whole, time-savings from electricity do not reduce the overall workload of women, although they make work easier.

Using energy services for income generation

Modern energy services contribute to agricultural productivity primarily by freeing up women's time in subsistence activities which they use in agriculture. As such, women in developing countries provide the bulk of agricultural labour, up to as much as 60%. Studies on biogas plants report that productivity gains are observed when slurry from biogas plants is used as a nutrient-rich fertilizer, used for farming and for growing vegetables.

In the non-agricultural sector, modern energy services directly impact income generation activities. Non-agricultural activities in the village that take advantage of electricity are generally small trades like carpentry, blacksmithy etc. for local markets and services (such as repair centers, battery charging centers, restaurants, and shops). Electricity favors the development of home activities in particular (but not only) for women, including handicrafts and textiles, embroidery and garments, food processing. Improved energy services also enable women to make use of available employment opportunities, including wage labour. Only a small proportion of households directly employ electricity in home-based micro-enterprises. The most widely experienced benefit of lighting in terms of income generation is the extension of working hours and keeping shops and businesses open until late at night. Production works like weaving, sewing etc., are carried out at night with the help of electric light.

Direct saving in household expenditures by using more efficient fuels

Biogas plants and improved cookstoves have been known to bring about reduction in household expenditure on cooking energy down by 20-50%. A number of studies also showed that electricity brings about reduction in expenditure on kerosene, batteries etc. though total energy expenditures may increase due to higher consumption.

Contribution towards improvements in social capital and quality of life

According to these studies, electricity brings about improvement in social capital in a number of ways, including improved health through reduction in exposure to indoor air pollution, literacy/ children's education, television, safety, more time for leisure, childcare, convenience through use of appliances, reduction in fires and accidents and confidence building and participation in community activities. A significant benefit offered by electricity is television, greatly appreciated by women and the feeling of freedom from social isolation. The percentage of women reading is consistently higher in households with televisions.

Women as energy entrepreneurs

There are a handful of experiences with women's energy enterprises, and all of these had been promoted as part of donor-funded projects, so in a sense, they all operated under 'special conditions'. No studies were found that discussed experiences of women entrepreneurs set up and operating under free market conditions. The relative contributions of energy and other complementary inputs from the projects) is not clear.

7. Conclusion and priorities for future research

In the past, energy policies and international donor agencies have sought to increase the supply of energy, assuming this would propel economic development without considering demand or the local level context. This focus on economic growth patterns has accentuated the oversight of gender agendas in energy planning, because women's unpaid labor contribution to the gross domestic product is often inadequately accounted for. Energy supply interventions target all households and are gender neutral, and no effort is made to provide any special benefits to poor or marginalized groups, such as female-headed households. In most of these, there is little or no evidence of participatory methods or gender analyses. Given this history/ background of energy projects and initiatives, most of which did not recognize the existence of gender issues in energy, looking for and establishing the gender, energy and poverty linkage does not seem entirely appropriate. There have however been technologies that have specifically focused on areas that are considered women's domain such as cooking, and here the gender and energy linkages are far more visible.

- An area that has good empirical evidence is the time and effort saving brought about by energy technologies, especially in fuelwood collection and cooking. However, most data available on the use of this freed-up time is anecdotal. More research needs to be done into how women actually use lighting and electricity and the extended work hours.
- There is a need to measure the quantum of income increase brought about by extension of work and business hours, enabled by lighting.
- The poverty impacts of electricity on agriculture, and small-scale industries etc. is well established, but very little information is available on women-operated enterprises and the role of energy (and other complementary inputs) in their sustainability.
- Women's energy enterprises is another un-researched area, as most operations are in a project mode, and relatively recent. There is a need to research into what inputs are required to make them replicable on a large scale, and sustainable.

Annex1. Time burden of women

1. Women's time allocation in Rural Areas (Hours of activity for the previous 24 hours) (Barnes and Sen 2003)

Work activities	All households			Only households pursuing activities	
	Mean	SD	% of all	Mean time	SD
Collecting fuel	0.67	1.21	32.7	2.06	1.27
Fetching water	0.93	0.63	93.1	1.00	0.60
Income production	1.90	1.96	63.9	2.98	1.67
Cooking and serving	2.72	1.20	96.9	2.81	1.12
Household work	5.80	1.96	100.0	5.80	1.96
Food processing	*1.79*	*1.10*	*88.9*	*2.02*	*0.95*
Cleaning, dishes, house	*2.17*	*0.93*	*98.6*	*2.21*	*0.90*
Childcare	*1.23*	*1.00*	*73.1*	*1.67*	*0.77*
Shopping	*0.62*	*0.96*	*40.8*	*1.52*	*0.93*
Watching TV	0.48	0.92	26.7	1.79	0.91
Reading	0.14	0.48	10.8	1.27	0.82
Other leisure activity	10.47	2.00	100.0	10.58	1.70
Taking meals	*0.65*	*0.31*	*99.0*	*0.66*	*0.31*
Bathing	*0.54*	*0.33*	*99.1*	*0.54*	*0.33*
Leisure	*0.87*	*1.09*	*52.4*	*1.66*	*0.98*
Sleep	*8.42*	*1.49*	*100.0*	*8.51*	*1.22*
Miscellaneous	0.64	1.18	29.7	2.17	1.18

2. Women's Workload (Nathan, 1997)

Activity		Number of hours spent in activity per day			
		Indonesia	Burkina Faso	India	Nepal
Firewood collection	Women	0.09	0.10	0.65	2.37*
	Men	0.21	0.03	0.65	0.83*
Water hauling	Women	0	0.63	1.23	0.67
	Men	0	0	0.04	0.07
Food processing	Women	2.72	2.02	1.42	0.70
	Men	0.10	0.17	0.27	0.20
Cooking	Women	-*	2.35	3.65	2.10
	Men	-*	0.01	0.03	0.38
Average total work per day	Women	11.02	9.08	9.07	11.88
	Men	8.07	7.05	5.07	6.53

For Nepal, firewood collection includes grass and leaf fodder collection, for Indonesia, cooking is included in food processing

3. Time spent on non-income earning activities each week: Hubei village, winter (IDS 2001)

Activity	Xiaozhu		Duiwotai		Housanxi	
	Men	Women	Men	Women	Men	Women
Cooking	2.7	18.6	1.1	20.2	0.6	23.9
Fuel gathering	8.0	5.6	5.4	9.2	6.4	5.2
Fetching water	5.7	2.0	3.7	2.4	4.8	1.6
Washing	1.1	3.9	0.4	2.2	0.4	3.5
Grinding/Milling	4.9	3.7	0.7	1.6	1.2	0.3
Prepare food for pigs	2.3	8.6	0.6	7.3	2.5	9.7
Prepare food for cattle	0.3	0.5	1.3	1.8	0.3	0.1
Grazing cattle	5.0	0.5	1.9	4.8	6.8	0.4
Collect compost straw	0.0	0.0	0.0	0.0	0.9	3.0
Other	1.0	0.9	0.0	0.0	0.0	0.0
Total	30.9	44.2	15.2	49.5	23.7	47.7

4. Daytime activity budgets of Masai women and girls (Biran 2004)

Activity	Mean minutes per day women(n=52)	Mean minutes per day girls (n=17)
Animal care/milking	36	48
Child care	174	96
Domestic cleaning/maintenance	42	30
Food preparation/eating	108	108
Resting/socializing	168	300
Snuff making	6	0
Trips to town	66	0
Water collection	54	36
Wood collection	10	30
Total	664	648

5. Time spent on daily activities of women and men in Madjoari, Burkina Faso (UNDP 2004)

	Women		Men	
	Rainy season	Dry season	Rainy season	Dry season
Total time	17 h 30 m	16 h 30m	16 h	17 h 30 m
Milling, grinding and de-hulling	3 h (17%)	2 h (12%)		
Other domestic activities (water, wood, meals preparation, etc)	7 h 30 m (43%)	4 h (12%)		
Agricultural work on household collective field	4 h (23%)		10 h 50 m (68%)	
Agricultural work on private field	30 m (3%)			
Training in reading and writing		6 h 30 m (40%)		
Livestock reading			45 m (5%)	2 h 20 m (14%)
Housing, construction				7 h 40 m (45%)
Petty trade		2 h (12%)		

Rest and leisure	2 h 30 m (14%)	2 h (12%)	4 h 25 m (28%)	7 h (41%)

Source: PAICB/LCB 2001

6. Time (number of hours) allocated to various tasks by women and men (Saksena et al 1995 (based on a study conducted in three villages in Garhwal Himalayas in North India))

	Women			Men		
	M	W	S	M	W	S
Agriculture						
Fields	0	4	5.1	1	1.4	6.6
Kitchen garden			1.3		1	2.4
Fuel/fodder						
Collecting wood	3.3	2.3	.5			
Collecting fodder	3.1	2.3	3.9			
Attending/ grazing cattle				5.2	5.8	4.6
Domestic						
Cooking	4.4	5.1	4			
Preparing tea	.6	.6	.5			
Washing vessels	.7	1	1.2			
Washing clothes	.7	.6	.7			
Cleaning house	.5	.5	.6			
Milking cows	.6	.5	.5			
Cleaning cowshed	.5	.5	.5			
Fetching water	.5	.5	.5			
Caring for children	1.8	2.4	1			
Employment						
Travel to work				1.1	1.3	1.1
At work				6.7	7.3	6.8
Leisure (+ market)	5.2	6.3	2.4	10.2	8.4	7.6
Sleep	7.1	7.7	6.5	7.6	8.3	7.0
Other	2	4.5	13.5	1.6		

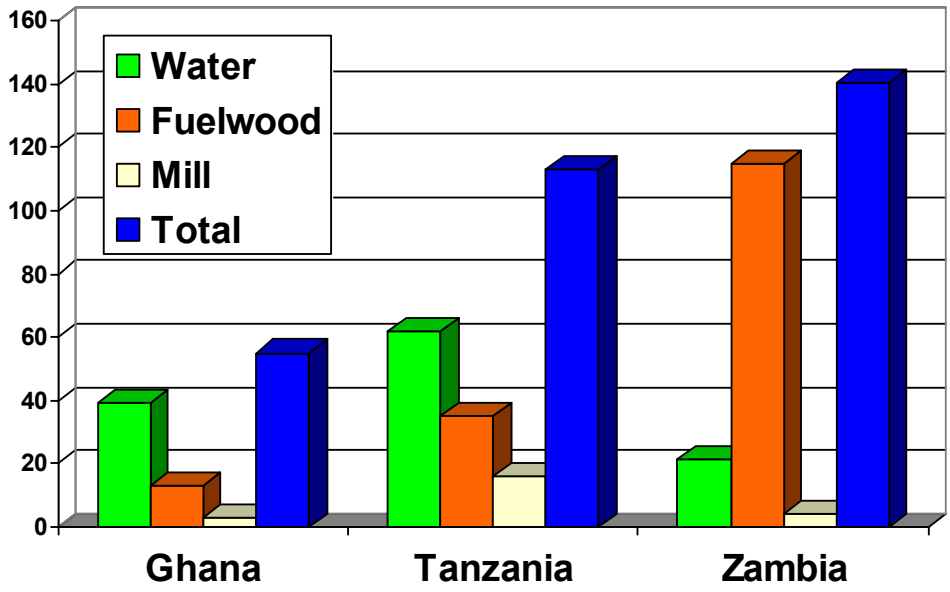
S: Summer, M: Monsoon, W: Winter

7. Time allocation for various tasks (hours per person per day) (Kumar and Hotchkiss 1988) (The study is based on a year long survey of 120 households in three village districts of the Western development region in Nepal conducted in 1982/83)).

	Men	Women	Children
1. Agricultural work			
(a) Household farm	3.1	2.75	
(b) Employment	.8	.13	
Sub total	3.9	2.88	
2. Support activities			
(a) Fuelwood collection	.13	1.15	.13
(b) Water collection	.1	1.15	.23
(c) Grass collection	.35	.98	.28
(d) Leaf fodder collection	.1	.35	0

(e) Grazing			1.8
3. Food processing	.2	.7	
(a) Cooking	.38	2.1	…
Sub total	1.26	6.43	2.44
Total	5.16	9.31	2.49

8. Women's Minutes/Day by Task (Malmburg-Calvo, 1994)



9. **Average Daily Time Spent on Reproductive Work by Women in Ghana**
(http://www.unu.edu/unupress/unupbooks/80964e/80964E0f.htm)

Activity	Wet season	Dry season

	1984	1991	1984	1991
	(N = 250)	(N = 226)	(N = 250)	(N = 226)
Household maintenance				
Cooking	1.5	1.7	2.3	2.0
Child care	1.6	1.2	1.4	1.1
Water collection	1.4	1.1	1.9	1.2
Cleaning/washing	1.1	0.6	0.8	0.8
Total housework	5.6	4.6	6.4	5.1
Kitchen gardening	1.5	1.4	0.6	0.4
Total	7.1	6.0	7.0	5.5

Source: Fieldwork, 1984 and 1991.

Total Average Daily Time Use of Women in Zorse, 1984 and 1991 (hrs/day)

Activity	Wet season		Dry season	
	1984	1991	1984	1991
Reproductive work	7.1	6.0	7.0	5.5
Household maintenance	5.6	4.6	6.4	5.1
Kitchen gardening**	1.5	1.4	0.6	0.4
Social duties	0.9	0.5	2.4	1.7
Productive work	3.3	4.1	2.3	5.2
Total time use	11.3	10.6	11.7	12.4

Source: Fieldwork, Awumbila, 1984 and 1991.

**Each married woman cultivates a garden on the land directly behind her hut, growing mainly vegetables for the family's meals.

According to Awumbila, “cooking, including food preparation, is the most time consuming domestic chore and also the most gender specific task”. Up to 72% of the 180 married women living with their husbands cooked themselves and the remainder had some help, mainly from daughters. Reduction in the number of meals seems to be a function of food scarcity (no explicit mention of fuelwood scarcity in the study) and hence more meals were cooked in the dry season when food is more plentiful.

Water collection	
Time 1 hour/day	1 hour/day
Distance to source (well and dam)	About 6.4km
Weight of water carried	About 25kg when full
Number of trips per day	Not recorded
Firewood collection	(Twigs, granches, dried millet and sorghum stalks)
Other comments	About 1 hour (1.2 hrs in wet season, 0.7hrs in dry season) In times of scarcity women walk longer distances, sometimes to neighbouring Burkina Faso once a week, with 30Kg loads per trip “intensive use of millet stalks gathered from the grain fields leaves the soil bare and exposes it to sheet and gully erosion” – Threat to food security “As household incomes fall with deteriorating environmental conditions and economic restructuring, women are making more use of the dry season to generate additional income, thus increasing their workloads”.

Women’s daily activity in Sampara, Mali, Percentages

	Dry season	Rainy season
Total time worked	0600 - 2300	0600 -02100
Water fetching	6	7
Preparation of meals and washing up	35	16
Cereals grinding and de-hulling	15	30
Meals	6	13
Cotton spinning	20	10
Private (washing, praying)	5	4
Entertainment	13	0

Source : Sahel Consult 2000

Annex 2. Time and effort spent on fuelwood collection

State / Region/country	Year of Data	Firewood collection*			Data source	Comments
1. India						
		Time taken	Distance travelled			* firewood collected mainly by women and children @average computed from information given in the study NA information not available Source: data compiled from Agarwal 1995
Bihar (plains)	c.1972 1980	NA NA	1-2 km/day 8-10 km/day		Bhaduri and Surin (1980)	
Gujarat (plains) (a) Forested (b) Depleted (c) Severely depleted	 1980	 Once every 4 days Once every 2 days 4-5 hr/day	 NA 4-5 km NA		Nagbrahman and Sambrani (1983)	
Karnataka (plains)	NA	1 hr/day	5.4 km/trip		Batliwala (1983)	
Madhya Pradesh (plains)	1980	1-2 times/week	5 km		Chand and Bezboruah (1980)	
Rajasthan Alwar plains Ajmer plains (average of all seasons)	 1986 1970s 1990s	 5 hr/day(winter) 2 hr/journey 2 hr/journey	 4 km 1.9 km 2.1 km		 Author's observation in 1998 Survey by author in 1993 Survey by author in 1993	
Uttar Pradesh Chamoli (hills) (a) Dwing (b) Pakhi Garhwal (hills) Kumaon (hills) Kumaon (hills) (average all seasons)	 1992 1992 NA 1982 1970s 1990s	 5 hr/day@ 4 hr/day 5 hr/day 3 days/week 1.6 hr/journey 3.4 hr/journey	 Over 5 km 10 km 5-7 km 1.6 km 4.5 km		 Swaminathan (1984) Agarwal (1983) Folger and Dewan (1983) Survey by author 1993 Survey by author 1993	
2. Kavre district, Nepal	2002	48% respondents spent 2 hours, 43% between 3 and 6 hours and 10% more than 6 hours per day	NA		Mahat 2003	
3. Jodhpur, Kota and Sawai Madhopur districts of Rajasthan, India	2002	49.9 hours spent per month per household (15.6 trips)	Distance traveled	% of hh	Laxmi et al 2003	Based on a survey that covered 1,989 households and 11,955 individuals.
			Upto 1 km	29		
			1-2 km	30		
			2-3 km	23		
			More than 3 km	18		

4. India					Agarwal 2001	situation in early 1990, data based on field-visits by Madhu Sarin
a.West Bengal						
i.Kamardanga		5 days/wk and 1.5-2 hrs per headload				
ii. Bhadli		0.5 km/headload	NA			Have to 'steal' from other's forest, hefty fines if caught
b. Gujarat						
i. Vena (Panchmahals district)		0.5 hr/headload, 1 wk.month				Harassment and abuse by FD staff and residents of other villages when women go to unprotected forest further away
ii. Chari (Panchmahals district)		1 hr, daily for one month/yr	NA			Abuse by residents of other villages; fear of being beaten by own men
iii. Malekpur (Sabarkantha district)		1-2 hrs	NA			
5. India	2000				Parikh and Laxmi 2000	based on a survey conducted in rural Tamil Nadu covering 5028 households from 30 villages and 4 districts
			Villages collecting			
			0-1 km	1-2 km	5km and more	
a. Chengulpet		22.4 hrs/month/hh	3	3	1	
b. Coimbatore		20.8 hrs/month/hh	3	-	1	
c. Trichy		18.4 hrs/month/hh	4	1	-	
d. Tirunelvalli		17.6 hrs/month/hh	3	3	-	
6. Africa					Biran 2004	The present paper brings together data collected during two separate studies at contrasting study sites. In both communities the collection of wood is the responsibility of women and girls. In the Malawi study, men and boys were never observed collecting wood for domestic use. In the Maasai community, of the 114 loads of wood which were observed being brought to

						houses, 54 were brought by women, 57 by girls, and two by boys. Masai men were never observed collecting wood.
a. Lake Malawi	1996, 1999,1999	63 min/day		2.1 km (1.8-2.5 km)		Farming and fishing community living in a national park on the shores of Lake Malawi. The Malawian girls assist their mothers on wood collection trips from about the age of 10 years.
b. Simanjiro Plains of Tanzania	1996	10 mins (30 mins when girls collect)		1.1 km (0.9-1.3 km)		A community of Maasai agro-pastoralists living on the Simanjiro Plains. Of the 114 loads of wood which were observed being brought to houses, 54 were brought by women, 57 by girls, and two by boys. Maasai men were never observed collecting wood.
7. Nepal	1982/83				Kumar and Hotchkiss 1988	The study is based on a year long survey of 120 households in three village districts of the Western development region in Nepal.
		Low deforestation	High deforestation			
a. Lowland hrs/person/day		0.5	0.8			
b. Highland hrs/person/day		0.7	1			
8. Multi-country					Nathan 1997	
		Women	men			
a. Indonesia		0.09	0.21			For Indonesia, cooking is included in food processing
b. Burkina Faso		0.1	0.03			
c. India		0.65	0.65			
d. Nepal		2.37	0.83			For Nepal, firewood collection includes grass and leaf fodder collection.

Annex 3: Time saved by women in cooking and fuel collection with modern fuels and stoves

Study	Location	Sample size	Type of stove/fuel	Total time saved
Ali 2002	Kalampur (Dhamrai Thana) and Kaliakor Thana where government provided improved cookstoves.	198 women, 78 from the ICS program areas and 120 from nearby the ICS program areas were interviewed through a structured questionnaire.	Improved cookstove	73% respondents mentioned "less time required" in cooking.
Anderson 1992	Two mining villages in Nicaragua.	60 stoves	Improved cookstove	The new stoves save time as they cook faster and stove has space for 2 pots.
Barnes and Sen 2003	Six states of India	Household energy survey of more than 5,000 households in 180 villages	Improved cookstove	Use of ICs reduces cooking time by 0.13 hours and fuel collection time by 0.16 hours.
Barnes and Sen 2003	Same as above		Biogas plants	Women spend more time cooking and practically no time collecting fuel.
Barnes and Sen 2003	Same as above		Kerosene	Fuelwood collection time reduced from 0.76 hours/day for households using biomass only to 0.39 hours for those using kerosene.
Barnes and Sen 2003	Same as above		LPG (sample: 518 users and 4528 non users)	Cooking time reduced from 2.74 hours/day for households using biomass only to 2.3 hours for those using LPG. Fuelwood collection time reduced from 0.76 hours for households using biomass only to 0.52 hours for those using LPG.
Barnes and Sen 2003	Same as above		Electricity (sample: 2012 households without electricity and 3036 households with electricity)	The time spent collecting fuel is related both to having electricity and to household income. At all levels of income, the time spent collecting fuel in households with electricity is lower than for those households without electricity. Households without electricity spend 0.9 hours in collecting fuel and 2.93 hours in cooking as against 0.53 hours and 2.58 hours spent by households with electricity for the same tasks.
Barnett et al 2002	Baima Snow Mt. Nature Reserve, Yunnan Province, in South West China.	Interviews with key individuals and a limited number (6) case studies of users	Integrated biogas systems with pig production and latrine	Electricity reduced time and labour by women and children to gather fuelwood (not quantified). A farmer in Shusong (Mr A qi) estimated that his demand had dropped from one 70 kg bag per day, which took his wife 3 hours to collect) to no firewood required in summer, and one every week in winter – that is more than a 50% decrease. The extra time made available was used to tend fruit trees, vegetables and winter wheat crops.
Chakrabarti and Chakrabarti 2002	Sagardweep island in the Bay of Bengal in	Based on a sample survey of 150	SPV power plant for lighting	38 per cent respondents reported that, on an average, the use of power has helped to save cooking time at night by 1.5 hours.

	India	households using SPV power for lighting (out of a total of 475)		
Chander and Tandon 2004	Lag valley of Kullu district, Himachal Pradesh, India	Not indicated	LPG	Fuelwood collection has reduced from 7 trips a week to 1 to 4 trips, varying between 2 and 6 hours (depending on the distance of the forest). In 9 cases, the collection frequency is down to 1 to 4 trip per month. Daily cooking time is down by 1 to 2 hours for most women. However, only in a few cases was the saved time devoted to income generating activities.
Conroy 1991	Panchmahal district of Gujarat, India	Not mentioned	Social forestry	The social forestry project led to self sufficiency in fuelwood. An earlier study in the same region found that people (primarily women and children) used to have to spend 6-8 hours every two or three days to collect 20 kg of fuelwood: mainly from forest lands as much as 10 km away.
Chuntao 2002	Baima Snow Mt. Nature Reserve, Yunnan province, China	Not mentioned	Biogas plants	By using biogas plants, the women users reported that they now use half as much as wood before, and save half the time spent earlier on fuelwood collection.
Dang 1998	Langson province in Vietnam.	Not mentioned	Improved cookstoves	By use of improved stoves, 30-50% fuel savings reported, cooking time reduced by 30-40%.
Dutta et al, 1997	8 states in India	In-depth case study of 12 NGOs implementing biogas programme, including physical inspection of biogas plants, semi-structured interviews with user and non-user families and in-depth discussions. Sample size: 482 biogas users	Biogas plants	The women reported 40-50% time savings on wood collection from use of biogas plants. Village Pingot reported a time saving of almost 70%. Cooking time has also reduced by about 50%. Time saving enables productive use of their time, in terms of wage labour.
Eastconsult 2004	10 districts of Hill and Terai of Nepal	A total of 200 households (100 with Biogas and 100 without Biogas) were surveyed.	Biogas plants	Time spent in collecting fuel wood source after biogas installation is less by 63.1 min/day in Terai region and 33.05 min/day in hills for men. For women, the respective figures are 111 min/day in Terai and 58.97 min/day in the hills.
ESMAP (2003)	Nicaragua		Improved cookstove	50% reported time saved in cooking from use of improved stoves.

Central America Gender and Sustainable Energy Project				Women are saving between 30-60 minutes per meal. Particularly useful the possibility of cooking two meals at the same time (from Nicaragua pilot projects impact assessments)..
ESMAP 2002a	Andhra Pradesh, India	134 LPG users, 18 gas agencies and other villages level groups in 6 districts	LPG under Deepam scheme (a one time subsidy of Rs 1000 to acquire LPG connection for poor households)	97% of the respondents stated that using LPG saved time for cooking
Kaizer 1993	Nepal	50 female biogas users in Nuwakote were interviewed using structured questionnaire, using stratified random sampling.	Biogas plants	Biogas reduced the time spent on daily activities by 2 hours 30 minutes per household. Households are using other fuels along with biogas. The average time saving in cooking on biogas per household was 1 hr and 16 min per day.
Keyun 1995	China	Not based on a survey	Improved cookstoves and biogas plants	The introduction of improved stoves and biogas plants in China helped reduce the amount of time women spend gathering fuelwood, lightening their burden.
Liu 1992	Hunan province in southern China.	An investigation of these stoves was carried out in 1990. Results based on surveys. Sample size not mentioned	Improved stoves	Cooking time is reduced by using firewood-saving stoves, because of advantages like quick raising of temperature, higher heat-efficiency as well as being more convenient to use.
Maharjan 2005	Nepal	Methodology not mentioned	Biogas plants	Saving of at least 3-hours a day reported
Mahat 2004	Kavre district, Nepal	Household surveys were conducted in both project (273 households) and non-project areas (205 households) and were integrated with participatory research methods, in areas where Rural Energy Development Program (REDP) was implemented.	Biogas plants, improved cookstoves and micro hydro	There was a change in women's workloads after having access to biogas plants and micro-hydro mills. The average cooking time per meal after using biogas stoves and ICS, has been reduced from 1.08 hours to .75 hours. Similarly, cooking time for morning and afternoon snacks has been reduced from .85 hours to .59 hours.

Masse and Samaranayake 2002	Sri Lanka	A qualitative study was conducted in four sample areas. A quantitative surveys were conducted in six Provinces (10 Districts, 35 villages). 1,820 respondents, including households, commercial and service establishments and non-beneficiary households.	Electricity	Having electricity at home results in having more time. Women gain by saving time on now unnecessary travel and through tasks being made easier with electric appliances, providing them with an extra hour and a half each day.
Opdam 1997	Nepal	Based on case studies on the Nepal Biogas Support Programme (BSP)	Biogas plants	In four households in the village of Madan Pokhara, the net time savings varied from 2 hours 20 minutes, to 1 hour 15 minutes per day (Van Vliet, 1993[5]). Most of these savings were due to less time spent on cooking (1 to 2 hours) and cleaning (1 hour). In the village of Puthuwa, Keizer (1994[6]), found total net time savings of more than 3 hours per day for women. In Rupandehi, where fuelwood is scarce, the average time saved in collecting fuelwood was as high as 5.6 hours per day (Van Vliet, 1993). If one adds to this the time saved in cooking and cleaning, the average time savings in fuelwood collection, cooking and cleaning may amount to 6 to 7 hours per day.
Oza 1993	Gujarat, India	Not mentioned	Biogas plants	Time spent in kitchen work has come down by 1-2 hr per day by use of biogas plants.
Rajakutty	Andhra Pradesh, India	Primary data was collected through FGDs with 66 SHGs and interviews with 134 Deepam beneficiaries.	LPG	49% respondents reported time saving in cooking from LPG, 30% of who further linked this to additional labour time, 9% reported increased social status, 88% reported cleanliness of cooking gas the most important benefit while 45% cited absence of smoke as a primary reason. 97% reported time saving in cooking as the most significant benefit and 45% in reduction in time in fuel wood collection.

[5] Marieke van Vliet and Wim J. van Nes, E*ffect of biogas on the workload of women in Rupandehi-district in Nepal*, Biogas Forum, No. 53, 1993 pp. 12-16

[6] Cecilia Keizer, *Effect of biogas on the workload of women from a gender perspective. Pithuwa village, Chitwan District, Nepal*, SNV-Nepal, April 1994, 57 pp.+ annexes

Ratnayake 2000	Sri Lanka	225 respondents (125 project beneficiaries and 86 non-beneficiaries)	Biogas plants	69% of the women in the beneficiary group mentioned a reduction in cooking time by 30 - 60 minutes, mainly in preparation activities. Housewives reported a time saving of 135 minutes per day in cooking by using biogas plants. Further, cleaning of pots and pans is easy when a biogas flame is used and helps to cut down at least 50 percent of cleaning time. 18% of women highlighted the fact that they engage in some form of housework while cooking, a task which was not that feasible when they used firewood. This is now possible since the flame of the burners can be maintained at a constant level unlike when using firewood. Altogether, women save about 2.5 hours a day as a result of biogas use. Time spent on collection of fuel wood almost stopped and this helped to save about eight hours monthly.
Shailaja 2000	Karnataka, India	Based on literature review	Improved cookstove	In Karnataka 81-93 % housewives reported reduction in cooking time. Measurements of cooking time with stoves in Karnataka showed reduction of 25-36%. In Pura, Karnataka, a community biogas plant supplies electricity for lifting water and supplying to household through pipelines. This has saved the women the drudgery of fetching two pots of water per trip from a stream 2 km away.
Tedd et al	5 districts in the northern Bangladesh, namely Bogra, Joipurhat, Rangpur, Gaibandha and Kishorgonj.	A sample was selected of a total of 112 biomass stove users (27 male and 85 female), who had received training on stove construction	Improved cookstove	All the 100 users were of the opinion that less time is required for cooking while using an improved stove compared to what was required with the traditional stove. As for the extent of less time use, 61 respondents claimed that they have 30-40 percent less time requirement with the IS, followed by 23 respondents (41+ %).

Annex 4. Time saved in food processing with modern energy sources

Study	Location	Sample size	Time saved and other benefits
Approtech Asia 2005	A 33k W MHP in Kalinga north of the cordillera Mountain region in Northern Luzon in the Philippines.	Semi-structured interviews and focus group discussions (FGD)	In Tulgao village, women are freed from the daily labor of pounding rice, one among the daily toil and drudgery endured by women farmers in upland agriculture.
Christine Malmberg Calvo			Introduction of maize mills led to time savings. Women improved the roads so that their produce could be sold to motor vehicle-borne traders; they piped water from small streams into tanks to provide for water in the dry season; built communities houses for their gatherings; engaged in soap making; attended literacy classes; fenced their farms; set up cooperative shops; spent more time with children. (From: O'Kelly, E., 1973)
Christine Malmberg Calvo			The installation of improved ovens for fish smoking reduced smoking time by one third. Thus, women were able to do three smoking cycles in a day instead of one. Most women preferred to reinvest their time in the smoking activity and consequently increase their income. The improved smoking technology also required less tending and the women were able to simultaneously perform various activities around their homes.
Ding 2002	3 villages of Hubei province of central China	36 In-depth interviews with women in three villages.	With electrification, the major time savings occur in grinding and milling activities. In Housanxi, households without an electric mill have to turn their stone mill by human power to grind corn, which takes an average of 8.4 hours by men and 7 hours by women per week. However, in households with an electric mill, the task is mainly undertaken by men, spending about one hour per week on it. The biggest change for women following electrification was a reduction in the time spent looking after pigs, with the mechanization of pig fodder preparation and corn grinding.
Halim 2004	Bangladesh	Interviews with 3700 households and establishments, residential, industrial, commercial and agricultural.	Existence of mechanized mills has reduced the workload of women in households with electricity, allowing them time for other income generating activities. They have more leisure time to watch TV, listen to radio, which contributes to widening their horizons.
Haque undated	Sylhet, Bangladesh	Not stated	Women spend more time in productive work and income generating activities
IDS 2001	Gansu and Hubei. Provinces of China	36 in depth interviews	In Housanxi, a recently electrified village, women said that it had improved their lives in a number of ways. Households could raise more pigs if they had access to powered fodder cutting machines; electric milling machines both allowed the production of potato flour for sale and freed time to work on the land or seek other sources of income; physical work was less arduous. Men could migrate and leave women to farm with the help of machines.

Mahat 2004	Kavre district, Nepal	Household surveys were conducted in both project (273 households) and non-project areas (205 households) and were integrated with participatory research methods, in areas where Rural Energy Development Program (REDP) was implemented.	There has been a significant reduction in average processing times, which used to be 4.31 hours (for hulling and grinding 30 kgs. of grain) with traditional processing techniques like dhiki and janto. This has come down to 1.09 hours with micro hydro milling, which includes the travel as well as waiting time. The waiting time was mentioned to be very short, because of the speedy processing activities unlike with the traditional water mill. However, an interesting thing is that women never seemed to have free time for any other social and economic (income generating) activities. *There was always something for women to do.*
Mahat 2004b	Nepal	GAM carried out with groups of men and women using micro-hydro, biogas, solar cookers and ICs	MMHPs have reduced the labour and time spent by women in processing activities, so that they have more time for rest and leisure.
Rai 2000	Nepal	Not indicated	Before the micro hydro plant, women had to walk about 1 hour to grind grains in the traditional water mill, it has been now reduced to a 5 minute one. The mill facility has also made it easier on poorer women who were hired to grind grains by the richer houses.
UNDP 2004	Mali and Burkina Faso	Desk review, interview with project beneficiaries, detailed case studies of 3 villages	The multifunctional platform has freed women's time and enabled them to rest. The aggregate time saved per women over a week in the processing of cereals amounts to an 8-hour working day. On an average, a multifunctional platform has freed 2 to 6 hours daily per woman depending on the services of the platform. 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.
Weingart 2005	Mali	Not mentioned	Using the MFP, the accumulated time saved in a week by a woman for cereal processing (millet, sorghum and maize) is equivalent to an eight hour work day.

Annex 5. How time saved by modern fuels and stoves is used by women

Study	Location	Sample size	Type of stove/fuel	Total time saved	How time saved is used					
					Leisure	Reading	Child care	Agriculture	Income generation	Others
Barnes and Sen 2003	Six states of India	Household energy survey of more than 5,000 households in 180 villages in six states in India	Electricity						Income generation[7]	Reading and watching television. Ninety percent of the women who spent some time reading resided in homes with electricity. About 90 percent of the women who pursue some reading during a typical day are in households with electricity, compared to 2 percent in households without electricity.
Christine Malmberg Calvo – Case study on the role of women in rural transport	Lesotho	Case study	Improved access to water		Resting					Participating in social activities
Chakrabarti and Chakrabarti 2002	Sagardweep island in the Bay of Bengal in India	Based on a sample survey of 150 households using SPV power for lighting (out of a total of 475)	SPV power plant for lighting						Running a tea stall, sewing	
Dang 1998	Vietnam	Not mentioned	Improved cookstoves					Farming		Attending to old people and children, particularly in winter
Ding 2002	3 villages of Hubei	Three mountain villages, in three	Electricity		Resting[8]			Agriculture		

[7] Especially for women with lower levels of education.

[8] By introduction of rural electrification, women's resting time increased substantially, but this was partly offset by an increase in the time spent working in the fields. In some households , women's working time even increased with the arrival of electricity, as electricity made it possible for women to move some of the 'domestic' activities into the evening period so that they could work longer in the fields during the day.

	province of central China	state-defined poverty-level counties, were selected: one without electricity (Xiaozhu), one with microhydro electricity (Duiwotai), and one with grid connection (Housanxi). 36 In-depth interviews with women were conducted in each village.								
Dutta et al 1995	8 states in India	In-depth case study of 12 NGOs implementing biogas programme, including physical inspection of biogas plants, semi-structured interviews with user and non-user families and in-depth discussions. Sample size: 482 biogas users	Biogas plants						Wage labour	
ESMAP 2002a	Andhra Padesh, India	134 LPG users, 18 gas agencies and other villages level groups in 6 districts	LPG						30% of LPG users reported time available for more labor	
Eastconsult 2004	Hill and terai districts of Nepal	A total of 200 households (100 with Biogas and 100 without Biogas) were surveyed covering 10 low penetration – high penetration districts of Hill and Terai.	Biogas plants				Child care			36% and 49% the respondents in Hill and Terai regions respectively reported that women had to spend more time fetching water after the installation of biogas plants.
Haque undated	Sylhet, Bangladesh	Not stated	Improved cookstoves						Productive work	
Laksono et al 2003	Lampung province of the Philippines	Purposive sampling with 100, 97 and 95 respondents in the baseline, first and second rounds of	Solar home systems						Women's time allocation for productive activities increased 2.2 hours, but men's decreased 1.2 hours. In the households	Recreation time has increased 1.2 hours for both men and women.

		interviews.							of SHS users there are 22.9% of women working more than 9 hours everyday and 16.7% of men are in similar range. On the contrary, the non-SHS users have lower productive hours.	
Madon and Gardiner2002	Provinces of Banten, West Java, and South Sulawesi in indonesia	Survey covered 1800 respondents in 19 villages, including electrified (1300) and non-electrified (400) households, and small business users (100).	Electricity						Income generation	Additional domestic tasks, socialization and entertainment
Maharjan 2005	Nepal	Methodology not mentioned	Biogas plants				Childcare		Income generation	Tending to sick family members and to their own health
Mahat 2004b	Nepal	GAM carried out with groups of men and women using micro-hydro, biogas, solar cookers and ICs	Solar lighting						handicraft work, weaving baskets, mattresses etc.	
Masse and Samaranayake 2002	Sri Lanka	A qualitative study was conducted in four sample areas. A quantitative surveys were conducted in six Provinces (10 Districts, 35 villages). 1,820 respondents, including households, commercial and service establishments and non-beneficiary households.	Electricity		Leisure					Watching TV (2 hours per day). Twenty-nine per cent of the women said that the time they saved was spent on extra housework, while less than 5% reported using it for productive activities
Nathan 1997	China	Not based on a survey	Improved cookstoves						Village-level industry and commercial production of livestock and vegetables	

Ratnayake 2000	Sri Lanka	A total of 225 respondents were covered (125 project beneficiaries and 86 non-beneficiaries) using questionnaires.	Electricity						43% of beneficiary families utilize extra hours for some income earning activities such as mat weaving, retail trading & spice packeting.[9]	
Rajakutty	Andhra Pradesh, India	Primary data was collected through FGDs with 66 SHGs and interviews with 134 Deepam beneficiaries.							49% reported time saving in cooking, 30% of who further linked this to additional labour time	
Rai 2000	Nepal	Not indicated	Hydro power						According to poorer women, time saving from milling has allowed them to work in other productive activities.	

[9] 68% of such activities are performed by female members of these families while a majority of males (76%) use their spare time either for some form of entertainment like watching TV or for resting.

Annex 6 Effect of modern energy sources on women's agricultural tasks and productivity

Study	Location	Sample size	Energy source	Effect on agricultural productivity
Barnett et al 2002	Baima Snow Mt. Nature Reserve, Yunnan Province, in South West China	Interviews with key individuals and a limited number (6) case studies of users	Integrated biogas systems with pig production and latrine	Extra time made available was used to tend fruit trees, vegetables and winter wheat crops.
Conroy 1991	Panchmahal district of Gujarat, India	Not mentioned	Social forestry	The large amount of dung that is no longer used as fuel is used as fertilizer instead—a positive externality (environmental and agricultural) arising from the social forestry programme.
Chuntao 2001	Baima Snow Mt. Nature Reserve, Yunnan province	Not mentioned	Biogas plants	Women have been pioneers in using biogas slurry as fertilizer.
Ding 2002	3 villages of Hubei province of central China	36 In-depth interviews with women were conducted in 3 villages.	Electricity	Electricity made it possible for women to move some of the 'domestic' activities into the evening period so that they could work longer in the fields during the day.
Dutta et al, 1997	India	482 biogas users	Biogas plants	23% of the respondents reported a reduction of commercial fertilizer use in their fields after using biogas slurry, saving money.
Eastconsult 2004	10 districts of Hill and Terai of Nepal	A total of 200 households (100 with Biogas and 100 without Biogas) were surveyed.	Biogas plants	Majority of the biogas users reported increased yield responses in paddy (39.83%), maize (48.31%), potato (62.71%) and vegetable (57.63%). The biogas household could manage kitchen garden of 1.5 time bigger size than that of non-biogas household.
IDS 2001	Gansu and Hubei. Provinces of China	36 in depth interviews	Electricity	In Housanxi, women could raise more pigs if they had access to powered fodder cutting machines; electric milling machines both allowed the production of potato flour for sale and freed time to work on the land or seek other sources of income; physical work was less arduous. Men could migrate and leave women to farm with the help of machines.
Keyun 1995	China	Not mentioned	Biogas	The biogas system combines biogas production, poultry or pig breeding, vegetable and fruit production, and fertilizer collection in a single plot. Women are able to develop productive agricultural businesses.
Liu 1992	Hunan province in southern China.	An investigation of these stoves was carried out in 1990. Results based on surveys. Sample size not mentioned	Improved stoves	Stoves promote the development of agriculture and animal husbandry. Grass and wheat straw and corncobs were saved by the improved stoves and used as fodder for raising livestock or as organic fertilizer for farm land. Consequently stoves promoted the improvement of food and livestock.
UNDP 2004	Mali and Burkina	Desk review,	Multi	Introduction of a multifunctional platform helps community members deal with

	Faso	interview with project beneficiaries, detailed case studies of 3 villages	functional platform	seasonal stresses and shocks. In the short term, it alleviates the time bottleneck in the rainy season, when agricultural workload is highest, by making it possible for women to spend more time in the field during this critical period without threatening food production (95 percent of rural household income in southern Mali comes from agriculture).
Wilkinson 2002	Pinthali project, Nepal and Tungu-Kabire project, Kenya	Not mentioned	Micro hydro	In the Pinthali micro hydro project, there has been a positive impacts on the livelihoods. Additional irrigation water, a by product of the project promoted a significant increase in agricultural production. From 649 kg garlic sales have risen to 864 kg per annum. Provision of electric light has enabled better livestock rearing. Sale of buffalo milk has risen from 800 to 1037 litres per household per annum.

Annex 7 Effect of modern energy sources on women's income generation activities (exclusive of lighting)

Study	Location	Sample size/methodology	Energy source	Income/activity
Barua 2002	Bangladesh	Not mentioned	Solar home systems	Women are involved in income generating activities such as fish farming, poultry etc.
Christine Malmberg Calvo – Case study on the role of women in rural transport				Women allocated their time savings from improved access to water to income-generating craft work. The earnings were invested in a grinding mill, which saved them more time, which they used to enroll in literacy classes. (From: Unifem, Kwaho Water Project file)
Barkat et al 2002	Bangladesh			Electricity in rural areas has increased the employment opportunities for women in electrified households, which translates in greater control over their incomes.
Ding 2002	3 villages of Hubei province of central China	Three mountain villages, in three state-defined poverty-level counties, were selected: one without electricity (Xiaozhu), one with microhydro electricity (Duiwotai), and one with grid connection (Housanxi). 36 In-depth interviews with women were conducted in each village.	Electricity	With electrification, the major time savings occur in grinding and milling activities. In Housanxi, households without an electric mill have to turn their stone mill by human power to grind corn, which takes an average of 8.4 hours by men and 7 hours by women a week in winter. However, in households with an electric mill, the task is mainly undertaken by men, spending about one hour a week on it. The biggest change for women following electrification was a reduction in the time spent looking after pigs, with the mechanization of pig fodder preparation and corn grinding. The biggest change for men was a reduction in time spent on 'domestic' activities and a corresponding increase in resting time. Women's resting time also increased substantially, but this was partly offset by an increase in the time spent working in the fields.
Dutta et al 1995	India	482 biogas users	Biogas plants	Time saved enables productive use of their time, in terms of wage labour.
ESMAP 2002c	Luzon, Philippines	Energy survey involving 2,000 electrified and non-electrified households selected from four rural electric cooperatives.	Electricity	Electrified households have a larger variety of home businesses. Close to 25% of electrified and 14.8% of non-electrified households run a home business. Thus, it appears that households with electricity are more likely to have some form of home-based business. Of the four provinces, Camarines Sur has the largest proportion of households with home businesses-more than 33% of the province's electrified households and 18% of its non-electrified households. Compared to households without access, households that use electricity directly in their businesses spend about four hours more per day running

				their businesses. Assuming that households with home-based businesses operate 24 days per month (6 days per week, 4 weeks per month), the increased time spent per month equals 96 hours for households who use electricity directly in their businesses and 48 hours for those who use electricity indirectly.
IDS 2001	Gansu and Hubei. Provinces of China	36 in depth interviews	Electricity	The major impact of electricity on livelihoods arose from its capacity to reduce general workloads and lengthen the working day, thereby increasing the possibilities for diversification of activities. Electricity was used for smaller domestic equipment and viewed mainly as a consumption item.
Mahat 2004	Kavre district, Nepal	Household surveys were conducted in both project (273 households) and non-project areas (205 households) and were integrated with participatory research methods, in areas where Rural Energy Development Program (REDP) was implemented.	Biogas plants, improved cookstoves and micro hydro	MMHPs have reduced the labour and time spent by women in processing activities. Some income generating activities such as incense making has become possible for women. Men recognized the possibility of income generating activities through establishing saw mills and poultry farms, using hydro power. In some cases, women and men were engaged in handicraft work at night, such as weaving baskets, mattresses etc.
Nathan 1997	China	Not based on a survey	Improved cookstoves	In China, the successful improved stove programmes have a high level of village-level industry and commercial production of livestock and vegetables. In these income-earning activities, there is substantial participation by women. Hence, there is a drive to economize on women's labour in fuel collection and use, resulting in the high rate of adoption of unsubsidized improved stoves.
OPS 2004	Lao PDR	Based on field visit reports, sample size not mentioned	Solar home systems	Solar lights had helped incomes by allowing net mending to take place at night, and also by allowing charging of batteries used for fishing and for hunting frogs at night. In one village with hydro supply, the electric light has increased their incomes significantly. Many of the families make small baskets for sale to tourists. Now that the extra hours of good quality light are available from the hydro, they are making significant extra income (one estimate was higher than 300,000 kip per month).
Ramani 2002	India	Not mentioned		85% of the borrowers turned out to be women. In all 36 energy intensive micr project resulted in an average income growth of 124% in the households. In s community enterprises were able to offer employment to other households in borrowers proved to be enterprising, innovative and credit worthy.

Sauturaga 2004	Muana microhydro project, Fiji	Not mentioned	Hydro power	After the micro hydro plant, women have developed small businesses such as cold storage facility for seafood and other foodstuff.
UNDP 2004	Mali and Burkina Faso	Desk review, interview with project beneficiaries, detailed case studies of 3 villages	Multi functional platform	Village case studies clearly indicate that the platform has positive cash flows from the first day after installation. Moreover, the annual income per woman increases when the freed time is used for income-generating activities and when the multifunctional platform is used for productive activities such as rice de-hulling or shea nut grinding. In addition, the multifunctional platform provides employment (and new income opportunities) for women operating the multifunctional platform. In the village of Noumoula, women compared hand production of shea butter with butter production using the multifunctional platform. They estimated that using the multifunctional platform increased daily production from 3 kg to 10 kg.The increased productivity results from time liberated by the mill and increased production through mechanical pressing.
Weingart 2005	Mali	Not mentioned	Multi functional platforms	Using the MFP, the husking of 28 kg of paddy is accomplished in about an hour instead of 48 hours by hand. This has resulted in an annual average production increase from 250-300 kg to 600 kg of paddy per woman, and the generation of additional income of 50,000 CFA per season.

Annex 8 Extension of working/business hours through lighting

Study	Location	Sample size	Results
Approtech Asia 2005	PV-battery charging station in Malitbog, Southern Leyte, Philippines	Semi structured interviews and focus group discussions	Women in the two barangays have more time to do weaving, sewing and other activities. In some cases, they venture into making blankets to cater to certain demands.
Barkat, Khan et al 2002	Bangaldesh	The total sample for quantitative survey was 3718: household (2491), irrigation equipment (523), industry (176) and commercial (528), following appropriate statistical formula. The assessment was carried out using *`with-without'* (electricity) scenario to gauge the impact of REP on different categories of customers through a quantitative survey and qualitative discussions (27 Focus Group Discussions	Women in the electrified compared to those in the non-electrified households are involved more in household level income-generation activities and depict better re-allocation of time for remunerative employment; Considering income-generating activities for female household heads/senior female members sewing appeared as the one entirely attributable to electricity. The difference in terms of average time spent for sewing in electrified households is 978.6% higher than households in non electrified villages respectively
Bryce and Soo 2004	Bulelavata, a small village in Western Solomons	Not mentioned	Many women are engaged in sewing and weaving, which they do together at night.
Chakrabarti and Chakrabarti 2002	Sagardweep island in the Bay of Bengal in India	Based on a sample survey of 150 households using SPV power for lighting (out of a total of 475)	Power supply from the SPV power plant has enabled women to do household work at night. Production works like weaving, sewing etc., have also been carried out at night with the help of electric light. Some women have got engaged in other work, like running a tea stall, sewing etc
IDS 2001	Gansu and Hubei. Provinces of China	36 in depth interviews	The major impact of electricity on livelihoods arose from its capacity to reduce general workloads and lengthen the working day. In Xiapai, electricity allowed women to do tasks in the evening, allowing children to do their homework and read and providing access to television.
Khan 2001	Char montaz island, Bangladesh	Not mentioned	Among the women who purchased batteries with credit, six out of 30 used the lights for extending their business hours in the evenings. Women with tailoring businesses at home worked an additional four hours, which increased

			revenue by 30 per cent. Some women let their husbands use the lantern in retail shops in the market, giving them three extra hours of sales.
Laksono et al, 2003	Lampung province of the Philippines	Purposive sampling with 100, 97 and 95 respondents in the baseline, first and second rounds of interviews.	The use of SHS changes the pattern of individual activities. It enables the users to extend activities for longer hours at night. The SHS strengthens the domestic roles of women since they can conduct chores at night. Women (56.2%) feel that the advantage of having SHS is to support them do their housework. In terms of the production activities, the survey findings indicate that women's productive activities in the households of the SHS users are 10.1 hours in average, while men spend 8.0 hours everyday. Compared to the base line survey, women's time allocation for this category increases 2.2 hours, but men's decreases 1.2 hours in average. In the households of SHS users there are 22.9% of women working more than 9 hours everyday and 16.7% of men are in similar range. On the contrary, the non-SHS users have lower productive hours. Women activities are 8.0 hours and men are 7.3 hours everyday in average.
Madon and Gardiner 2002	Provinces of Banten, West Java, and South Sulawesi in indonesia	Survey covered 1800 respondents in 19 villages, including electrified (1300) and non-electrified (400) households, and small business users (100).	The useful length of the day increases over time with electrification, and this extension is generally used to perform additional domestic tasks or to undertake income-generating activities. Especially in the morning, electricity gives women more time to prepare food and clean their houses. Overall, it is not clear if the workload of women has increased or reduced as the result of electrification
OPS 2004	Lao PDR	Based on field visit reports, sample size not mentioned	Villagers in Laos are quick to use small electricity supply for income generation. In one village taking SHS, most of the houses immediately moved their weaving looms upstairs. The teenagers were very happy to contribute extra income weaving in the evenings. This income paid back the cost of the solar panel and weaving materials after which there was additional money for the family. In the same village, the solar lights had helped incomes by allowing net mending to take place at night, and also by allowing charging of batteries used for fishing and for hunting frogs at night. In one village with hydro supply, the electric light has increased their incomes significantly. Many of the families make small baskets for sale to tourists. Now that the extra hours of good quality light are available from the hydro, they are making significant extra incomes (one estimate was higher than 300,000 kip per month).
Wilkinson 2002	Pinthali project, Nepal and Tungu-Kabire project, Kenya	Not mentioned	The project has allowed village shops to develop, opening for longer hours. Community and group meetings and cultural events can take place in the evenings ensuring better attendance.

Annex 9. Direct saving in household expenditures by using efficient fuels

Reference	Location	Sample size	Results
Anderson 1992	Two mining villages in Nicaragua.	60 stoves	50% fuel saving reported, after introduction of improved kitchens and stoves.
Ali 2002	Bangladesh	198 women, 78 from the ICS program areas and 120 from nearby the ICS program areas were interviewed through a structured questionnaire survey	63% of the respondents mentioned "less fuel required",
Barkat, Khan et al 2002	Bangaldesh	The total sample for quantitative survey was 3718: household (2491), irrigation equipment (523), industry (176) and commercial (528), following appropriate statistical formula. The assessment was carried out using *`with-without'* (electricity) scenario to gauge the impact of REP on different categories of customers through a quantitative survey and qualitative discussions (27 Focus Group Discussions	Electrified households monthly expenses on kerosene was only Tk. 28.3, while it was around Tk.65 in the non-electrified households.
Barnes et al 1994	A comparative international review of stoves programmes		Improved stoves help urban families save money. In Niamey, Niger, an improved stove uses about 0.42 kilograms (kg) per person per day, as opposed to the 0.57 kg per person per day consumed by the typical traditional stove used in Niger. Total family savings for a year amount to about 335 kg of wood, valued at 5,360 CFA ($15.3). In Rwanda, the savings with improved charcoal stoves are even greater. There, consumption of charcoal dropped to 0.33 kg per person per day from 0.51 kg per person per day. This means that in a year a family could save about 394 kg of charcoal worth 6,310 Rwanda Francs ($84.1). In Kenya, average daily charcoal consumption with an improved stove fell to 0.39 kg per person per day from the 0.67 kg per person per day devoured by the traditional stove. This adds up to a total yearly savings of 613 kg per family, with a value of about 1,170 Kenya shillings ($64.7).
Barnett et al 2002	Baima Snow Mt. Nature Reserve, Yunnan Province, in South West China.	Interviews with key individuals and a limited number (6) case studies of users	A 50% reduction in fuelwood consumption reported from use of biogas plants. However, firm data on the actual fuelwood savings are not available. Estimates range from about 50% saving to around 20%. The higher estimate would imply a saving of approximately 9 tonnes per household per year. An average reduction of 1,000 Yuan in firewood purchases for each family (buying firewood is quite common in some village where they do not have access to a sufficient area of

			mountain to collect firewood).
Bryce and Soo 2004	Bulelavata, a small village in Western Solomons	Not mentioned	After electrification through a micro hydro plant, the women reported fuels savings, as electricity is cheaper than kerosene and batteries.
Chandar and Tandon 2004	Lag valley of Kullu district, Himachal Pradesh, India	Not indicated	There was unanimity among the women that LPG is cheaper. This is important coming from poor women. None mentioned about any money problem to get the re-fills.
Dang 1998	Langson province in Vietnam.	Not mentioned	30-50% fuel savings reported after use of improved cookstoves
Dutta et al 1997	8 states in India	In-depth case study of 12 NGOs implementing biogas, including physical inspection of biogas plants, semi-structured interviews. Sample size: 482 biogas users	wood savings between 25-40% resulted from biogas plants
ESMAP 2003	Nicaragua		91.7% women reported to savings in wood consumption by using improved stoves. Families save $35 per month on buying wood (from Nicaragua pilot projects impact assessments).
Eastconsult 2004	10 districts of Hill and Terai of Nepal	A total of 200 households (100 with Biogas and 100 without Biogas) were surveyed.	Fuelwood use saving in the biogas households was in the range of 15.68 kg in summer and 19.56 kg in winter per household. [10]
HLF 2001	Nepal	Not mentioned	The villagers do not have to buy expensive kerosene oil, atleast Rs 75 per month on kerosene and Rs 100 per month on battery charging are saved.
Keizer 1993	Nepal	50 female biogas users in Nuwakote were interviewed using structured questionnaire, using stratified random sampling.	On an average 128,550 Kg of wood was saved in the sample households using biogas plants, reducing the wood consumption by 63%. For households that purchased (and did not collect) fuelwood earlier, biogas meant a saving of money.
Laksono et al, 2003	Lampung province of the Philippines	Purposive sampling with 100, 97 and 95 respondents in the baseline, first and second rounds of interviews.	SHS houses record a significant reduction of the SHS user's expenditure for energy. The use of SHS has eventually reduced the expenses on dry cell batteries and kerosene as well as the cost of recharging car batteries. Here, the reduction of the expenditure for kerosene is the most significant. The average consumption of kerosene amongst the SHS users steeply declined from 25.88 liters to 14.05 liters per month (45.71% deduction). The monthly average of recharging car batteries done by the SHS users go down from 3.86 to become 2.50 times per month (35.23% deduction), which is lower than what is done by the non-SHS users (2.97 times per month).
Liu 1992	Hunan province in southern China.	An investigation of these stoves was carried out in 1990. Results	According to the kitchen process testing results and questionnaire of 60 rural households in 6 counties, 2,327 kg of firewood and 142 kg of coal were saved on

[10] The decrease of kerosene consumption per household per day in Terai has been 64 ml in summer and 70.77 ml in winter. Likewise, the figures for the Hills are 17.83 ml and 13.57 ml in summer and in winter, respectively

		based on surveys. Sample size not mentioned	average in each household per year.
Maharjan 2005	Nepal	Methodology not mentioned	A biogas plant enables annual savings of at least 18 liters of Kerosene and 2,700 of firewood, and saving of $37 annually per household Increased agricultural output. 10% increase in maize, 18% in cabbage and similar amounts in others.
Masse and Samaranayake 2002	Sri Lanka	A qualitative study was conducted in four sample areas. A quantitative surveys were conducted in six Provinces (10 Districts, 35 villages). 1,820 respondents, including households, commercial and service establishments and non-beneficiary households.	Electrification has led to financial savings on regular expenses, such as kerosene oil for lighting and car batteries to run television sets. The savings amount to Rs.150 to 350 per household per month, equivalent to one to three days salary.
Mukhopadhyay 2004	Chottomollakhali island of Sundarbans, in India	A field survey covering 101 households based on direct interviews was conducted	There have been several economic benefits. There has been a complete elimination of inefficient use of diesel generator sets. There has also been a decline in the use of kerosene. The cost of diesel used per unit of power generation has reduced from US$0.49 to US$0.09. 70% of the commercial units reported an increase in the business hours an increase in sales. The demand for lighting appliances has also increased. Consumers are saving on an average US$2.67 per month in the post gasifier period. The diesel consumption (80 compared to 1280 litres per day) of the gasifier plant is much lower than the DG set and the emissions of CO2 (212 compared to 3392 kg per day) and SO2 (6.72 compared to 107.5 gm per day) are much lower.
Norbu and Giri 2004	Tsirang district in Bhutan	Not mentioned	The majority of the improved cookstove users claim reduction in fuelwood consumption by at least 50 percent, with a few even reporting reduction as high as 75 percent. If Tsirang's average per capita fuelwood consumption is assumed to be 1.25 tonnes per annum and rural household size (conservatively) six people, then individual household consumption works out to 7.5 tonnes per annum. Half this amount – 3.75 tonnes – is what is saved per household.
Sauturaga 2004	Muana micro hydro plant, Fiji	PRA methods	Since the micro hydro plant, the households do not have to purchase benzene and kerosene for lighting.
Suprenant 2000	Lao, Vietnam, Cambodia	Not mentioned	In Vietnam, increased awareness level was reflected in households being able to understand their electricity bills and read their meters. Many are voluntarily reducing household energy consumption. After training in Hai Pong Vietnam, women were so sure that they could immediately implemented the strategies suggested by the motivator that they drew up ' conservation contracts' committing their households to achieve as much as $8 savings in their monthly bills.

Shailaja 2000	Karnataka, India	Based on literature review	Studies conducted on fuel savings by measurement method on various improved stoves show wood savings ranging from 25 – 153 kg per capita per year. Fuel wood saving is also expected to reduce time and drudgery involved in fuel gathering.
Tedd et al undated	5 districts in the northern Bangladesh, namely Bogra, Joipurhat, Rangpur, Gaibandha and Kishorgonj.	A sample was selected of a total of 112 biomass stove users (27 male and 85 female), who had received training on stove construction	In Bangladesh, a survey after a year of a training course on biomass stoves reported users of improved reporting wood savings: the amount of twigs used earlier for the traditional stoves was 586.0 maunds, which came down to 302 maunds for the improved stoves. Correspondingly, the cost of twigs incurred also decreased by more than a half (51.53%).

Annex 10. Improvement in social capital and quality of life

Study	Location	Sample size, methodology	Type of stove/fuel					
				Less smoke	Television	Literacy	Safety	Others
Barkat, Khan et al 2002	Bangaldesh	The total sample for quantitative survey was 3718: household (2491), irrigation equipment (523), industry (176) and commercial (528), following appropriate statistical formula. The assessment was carried out using *`with-without'* (electricity) scenario to gauge the impact of REP on different categories of customers through a quantitative survey and qualitative discussions (27 Focus Group Discussions	Electricity			The overall literacy rate in the electrified households (70.8%) is 26% higher than that in the non-electrified households	98% agreed that protective security has increased	56% of those having knowledge in the electrified households reported TV as the main source of knowledge, the corresponding figure for TV was 28% in the non-electrified households in electrified villages, and 17% in the non-electrified villages.
Barnes and Sen 2003	Six states in India	Household energy survey of more than 5,000 households in 180 villages in six states in India	LPG					Women with LPG have a more balanced life between onerous tasks and leisure compared to women who use biomass fuels
			Electricity		90 percent of the women who pursue some reading are in households with electricity, compared to 2 percent in households without electricity.			
Bryce and Soo 2004	Bulelavata, a small village in Western Solomons	Not mentioned	Hydro power					some people in the village have electric kettles, radios, videos, electric drills, there are also two freezers, which are extremely convenient and labour saving
Dang 1998	Langson province in Vietnam.	Not mentioned						Reduction of fire hazards

Ding 2002	3 villages of Hubei province of central China	Three mountain villages: one without electricity (Xiaozhu), one with microhydro electricity (Duiwotai), and one with grid connection (Housanxi). 36 In-depth interviews with women were conducted in each village.	Hydro power					A reduction in the time spent looking after pigs, with the mechanization of pig fodder preparation and corn grinding.
Dhanapala 1998	Sri Lanka	Results based on the findings of a survey conducted on ITDG implemented micro-hydro plants (sample size not mentioned).	Hydro power			Improvements in children's schoolwork	Enhanced safety for children (when compared to using flammable bottle lamps)	Increased leisure
Dutta et al 1997	8 states in India	In-depth case study of 12 NGOs implementing biogas, including physical inspection of biogas plants, semi-structured interviews. Sample size: 482 biogas users	Biogas plants					
ESMAp 2003, Central America Gender and Sustainable Energy Project	Nicaragua	Pilot projects impact assessments; no. of women unknown; pilot project improved stoves	Improved cookstoves	All respondents reported smoke removal				Reduced risk of burns. 58.3% of women users surveyed never had burns with new stove and 29.2% reported having burned only at beginning of using it. Through training, women improved communication skills and are willing to voice their opinion in public.
ESMAP 2003 Central America Gender and Sustainable Energy Project	Panama	Same as above	Improved cookstoves					Reduction of accidents and burns[11]
ESMAp 2004	Char Montaz, an isolated	Not mentioned	Battery-operated direct		Increased access to mass media		Increased women's safety	Increased time for social/cultural and other networking events.

[11] People tend to associate fire related accidents with economic losses in terms of transport cost of getting the sick person to the health centre ($40) and medication. In more dramatic examples, interviewees reported to have known of more than three people who had their house burned while cooking.

	rural island off the southwestern coast of Bangladesh		current (DC) lamps		information (radio, television)			
ESMAP 2002a	Andhra Padesh, India	134 LPG users, 18 gas agencies and other villages level groups in 6 districts	LPG					
Eastconsult 2004	10 districts of Hill and Terai of Nepal	A total of 200 households (100 with Biogas and 100 without Biogas) were surveyed.	Biogas plants					Women have more time for child care. [12]
Everts and Schulte 1997	Vietnam	Based on superficial observations during TOOLConsult's visit to the project area	Solar home systems		TV and radio provide better access to information			Better light in the evenings can ease women's housework,
Go Kerala 2000	Kerala, India	Documents the anticipated outcomes of the Kerala power sector reforms on quality of life, economic growth and development, public services, accessibility, poverty reduction and gender impacts.	Electricity					Women from all groups felt that after electricity reforms, they would benefit from better street lighting and public services, but women from poorer groups are more dependent on them, since they cannot pay for alternative facilities
HLF 2001	Nepal	Not mentioned	Soalr home systems					
Halim 2004	Bangladesh	Interviews with 3700 households and establishments, residential, industrial, commercial and agricultural.	Electricity		Time available to watch TV			Electricity has helped women to organize work according to their convenience
IDS 2001	Gansu and Hubei provinces of China.	Case studies. In each village the survey teams selected 36 households for interview.	Electricity		Provides access to television.	Allows children to do their homework and read		Allows women to do tasks in the evening, allowing more time for rest. Time spent in looking after pigs decreased substantially (by 55%) because of mechanization of pig fodder cutting and corn grinding. the marriage-ability of rural men

[12] 36% and 49% the respondents in Hill and Terai regions respectively reported that women had to spend more time fetching water after the installation of biogas plants.

								is significantly affected by lack of electricity
Kaizer 1993	Nuwakote, Nepal	50 female biogas users were interviewed using structured questionnaire, using stratified random sampling.	Biogas	Smoke removal				Ease of cooking and no soot
Keyun 1995	China	The paper discusses various renewable energy technologies and their impacts						Time and labour savings
Khuller 2002	Kerala, India	Not mentioned	Solar home systems			More women are putting their children into schools, paying the fees themselves.		The drinking problem in the village has reduced due to the ability to undertake productive activities during the evenings
Laksono et al, 2003	Lampung province in the Philippines	Purposive sampling with 100, 97 and 95 respondents in the baseline, first and second rounds of interviews.	Solar home systems					Strengthens the domestic roles of women since they can conduct chores at night. More time for recreation: On an average, men of the SHS users spend 6.5 hours and women 7.1 hours for recreations. Their recreation time has increased 1.2 hours for both men and women. In the households of the SHS users 41.7% of the men and 47.9% of the women spend their time for recreation for more than 6 hours per day.
Liu 1992	Hunan province, China	Results based on surveys, sample size not mentioned	Improved cookstoves					The incidence of eye diseases in women decreased from 30% in 1985 when they were using traditional stoves to 13% in 1989 using firewood-saving stoves; respiratory tract infections

								decreased by 11.2%
Madon and Gardiner 2002	Provinces of Banten, West Java, and South Sulawesi in indonesia	Survey covered 1800 respondents in 19 villages, including electrified (1300) and non-electrified (400) households, and small business users (100).	Electricity					The use of domestic appliances eases housework.[13] The absence of fear of fires from kerosene lamps or candles, and the feeling of safety at night
Mahat 2004b	Nepal	GAM carried out with groups of men and women using micro-hydro, biogas, solar cookers and ICs	Solar lighting			Children can study at night		More time for rest and leisure
Mukhopadhyay 2004	Sundarbans in India	A field survey covering 101 households based on direct interviews was conducted	Biomass gasifier for power generation		Night time activities such as TV			
Masse and Samaranayake 2002	Sri Lanka	A qualitative study was conducted in four sample areas. A quantitative surveys were conducted in six Provinces (10 Districts, 35 villages). 1,820 respondents, including households, commercial and service establishments and non-beneficiary households.	Electricity				Women, appreciate increased security and health benefits that come with village electrification	Saving time on now unnecessary travel and through tasks being made easier with electric appliances, providing them with an extra hour and a half each day.
Norbu and Giri 2004	Tsirang district in Bhutan	Not mentioned	Improved cookstoves					Cleaner kitchens and utensils The ability to keep food warm longer
Oza 1993	Gujarat, India	Not mentioned	Biogas plants					additional rest for the overburdened women, spending more time with the children, quick cooking for guests
Rai 2000	Nepal	Not indicated	Hydro power					Replacement of unhealthy kerosene lamps. The health centre for women had benefited largely with lights as emergency cases in the evenings could be treated well.
Rajakutty	Andhra Pradesh,	Primary data was collected through FGDs with 66 SHGs and interviews	LPG					9% reported increased social status

[13] When women head a household, more importance is given to the purchase of domestic appliances such as water pumps, refrigerators, and small domestic appliances blenders, juicers, dispensers, etc.) than in male-headed households.

	India	with 134 Deepam beneficiaries.						
Ramani 2002	India	Not mentioned						Social benefits included reduction in women's labour for household activities and in existing enterprises, freeing time for childcare
Ratnayake 2000	Sri Lanka	A total of 225 respondents were covered (125 project beneficiaries and 86 non-beneficiaries) using questionnaires.	Electricity			12 percent of the beneficiary families are now reading newspapers		The accidents that happened due to kerosene bottle lamps were completely stopped due to the use of electricity
Wilkinson 2002	Nepal and Kenya	Not mentioned	Micro hydro					The project management committee has boosted community confidence; promoted mobilization and increased solidarity of purpose. Women are taking a role in the formal decision making process. Community and group meetings and cultural events can take place in the evenings ensuring better attendance

Annex 11. Women as energy entrepreneurs

Study	Location	Energy enterprise	Benefits to producers
Bhogle 2003	Karnataka, India	Women trained as stove entrepreneurs	As the construction of one stove took only two hours, women were able to combine stove construction with their work as agricultural labourers. The six women were together able to earn Rs. 3800 in addition to their other earnings in the five months.
ESMAP 2004	Char montaz island, Bangladesh	Manufacture of DC lamps	Production of DC lamps by a women's cooperative has doubled income of the women entrepreneurs and increased their socio-economic status. The off-grid power provided by these lamps and solar panels has enhanced the productivity and income by 30 percent.
Everts and Shulte1997	Vietnam	Vietnam Women's Union has been marketing solar home systems through its communes.	The women of the VWU are doing the marketing of the SHSs, new households are constantly signing up for purchasing SHSs. Probably because the "saleswomen" of VWU know the energy needs of women best, they are very effective marketers.
Haque undated	Sylhet Bangladesh	Women were trained in manufacture and marketing of improved cookstoves	Women, who are trained in ICs production, spend more time in productive work and income generating activities, and their technological skills have improved.
Khan 2001	Char montaz island, Bangladesh	Manufacture of DC lamps	Improved employment prospects for women If a woman constructs and sells two lamps a day, her daily household income increases by 100 Taka (US $2), equivalent of the daily wages of a skilled labourer.
Njenga 2001	Kenya	A total of eight producer groups, or at least 50 women, were trained to produce, install and market the upesi stove.	On average, stove producers devoted two to three days a week to stove production. Every active group member could sell 510 stove liners and earn KShs 15,300 in a year, or KShs. 1,275 per month. If producers sold directly to the users, then they could make an extra KShs. 50 per stove for installation. Stove promoters made an average of KShs. 15,000 per year. With increased income, women are able to help support their families and pay for children's school fees, thus reducing school dropout rates.
Okalebo and Hankins 1997	Uganda	Adoption of solar dryers for fruits and vegetables by women's group	For an investment of $100, a group becomes a supplier of the company and receives a simple improved solar dryer with instructions for its use. Within three years more than fifty groups had taken up the technology. In 1995, the company exported more than 40 tonnes of dried fruit. Not only are the women's groups generating significant incomes for themselves, the original food security concerns are also being addressed because, when they are not drying for profit, the women are drying vegetables and fruits for home storage and consumption.
Mabona 2001	Malawi	Women were trained to manufacture and market briquettes made of waste paper, agri-residues and saw dust	The group generates a profit of about USD 5.30 to USD 6.60 per week, which is shared equally by the members. The women also have control over the decision on how to use this money.

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