ACHIEVING THE MILLENNIUM DEVELOPMENT GOALS :

THE ROLE OF ENERGY SERVICES

Case studies from Brazil, Mali and the Philippines

United Nations Development Programme

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ACHIEVING THE MILLENNIUM DEVELOPMENT GOALS: THE ROLE OF ENERGY SERVICES

CASE STUDIES FROM BRAZIL, MALI AND THE PHILIPPINES

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FOREWORD

Over the past few decades the number of people impoverished by a lack of modern energy services has remained unchanged. Today, almost 1.6 billion people in developing countries live without electricity in their homes, while nearly 2 billion people depend on dung, firewood, and agricultural residues for cooking and heating. The availability of energy services has a distinct impact on the lives of poor people, in particular women. For women and their families, dependence on traditional fuels and fuel technologies barely allows fulfilment of the basic human needs of nutrition, warmth and lighting, let alone the opportunity for more productive activities.

The Millennium Development Goals (MDGs), which were agreed at United Nations General Assembly Millennium Summit in 2000, address challenges in poverty reduction, hunger, health, gender equality, education, and environmental sustainability. There is no MDG related to energy, despite the fact that reaching any of the MDGs will require a much greater quality and quantity of energy services in developing countries.

At the World Summit for Sustainable Development (WSSD), which was held in 2002, agreement was reached to significantly advance the attention given to energy; particularly the issue of access to energy services. In an effort to ensure that a lack of energy services does not become an impediment to development, the United Nations Development Programme (UNDP) has made a commitment to enhancing the visibility of energy within broader development strategies.

This publication, *Achieving the Millennium Development Goals: The Role of Energy Services, Case Studies from Brazil, Mali and the Philippines*, is one concrete contribution to addressing the linkages between energy and development. As the 2005 review of the MDGs approaches, the UNDP hopes that this publication will help draw attention to the relationship between energy service availability and the economic and social dimensions of the MDG framework. This is particularly important given that one of the themes for the 2006/2007 cycle of the Commission on Sustainable Development will be energy for sustainable development.

This publication is the culmination of a joint graduate research project between the UNDP and Columbia University's School of International and Public Affairs (SIPA). I congratulate the editors, case study authors and all the staff involved in this collaboration. I sincerely hope that energy practitioners, government officials, civil society and those working in the field of international development find the material presented here useful in supporting efforts to overcome poverty.

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EXECUTIVE SUMMARY

Energy services are an essential input into each of the economic, social and environmental dimensions of human development. They help to facilitate economic development by underpinning industrial growth, enhancing productivity, and providing access to global markets and trade. Modern energy services contribute to social development by helping to fulfil the basic human needs of nutrition, warmth, and lighting, in addition to education and public health. Energy services can also protect the local and global environment by helping to curb deforestation and by reducing emissions. Energy's crucial role in enabling development makes the provision of adequate, affordable, and reliable energy services absolutely necessary in order to achieve the Millennium Development Goals (MDGs).

This study quantifies the impact energy services have on the achievement of the MDGs by analyzing the developmental impacts of energy-related interventions in Brazil, Mali, and the Philippines. The study's findings point to several key conclusions, which are directly relevant to national strategies, aimed at achieving the MDGs.

First, motive power – energy services that can be used for agricultural, manufacturing, transport, and other livelihood activities – is a particularly important service for the poor. It helps free up women's time and enables local income generation through enhanced agricultural productivity and the formation of micro-enterprises. A study of Mali shows that the provision of mechanized agricultural services – such as girding, milling, etc. – has enabled women to increase their income from agricultural activities by an average of US$ 0.32/day (PPP1993). An increase in income of this magnitude constitutes a significant contribution to poverty reduction when considering that Mali's estimated poverty gap ratio is US$ 0.37/day (PPP1993). The potential contribution to poverty reduction is even larger when also considering that somewhere between one and one and a half million women (8-11 percent of Mali's total population or 11-15 percent of people living on less than US$ 1/day) could benefit similarly if motive power were made available at a national scale. Energy services are an indispensable part of stimulating development at the local level.

Second, improvements in energy infrastructure – particularly electricity – are associated with industrialization and reductions in poverty. In Brazil's northeast state of Ceará, a twofold increase in the number of electrified households during the past decade has coincided with the largest improvement in any Brazilian state's Human Development Index (HDI) ranking. This kind of distinct relationship between growth in electricity access and development is common to many countries, with the causal direction working both ways. Energy services are undeniably tied to economic development at the macro level.

Third, energy services also play a critical role in improving education and gender equality. A study of rural Mali shows that the provision of time and labor-saving energy services can help dramatically improve girl-to-boy ratios in primary school, close to doubling the ratio in some cases. A statistical analysis of 15,000 barangays in the Philippines indicates that the odds of being literate are far greater for individuals with electricity than those without. Modern lighting

and improved telecommunications enable people to study during evening hours and help attract and retain better qualified teachers. While there is clearly a strong relationship between access to energy services and certain measures of education, it does not always yield equal benefits for both men and women. In rural areas, energy services that reduce the drudgery of daily chores like fetching water and collecting fuelwood are often more effective at increasing girls' opportunities for schooling as well as for after-school study.

Fourth, equally important is the impact energy services have on health. Child mortality and maternal health are two examples of health-related issues that are closely linked to energy services and the fuels and fuel technologies that make them possible. In the Philippines, the odds of giving birth with the assistance of a doctor are far greater for women who have electricity than for those who do not. In certain rural regions of Mali it is access to time and labor-saving energy services that enable women to take better advantage of prenatal health care. The use of solid biomass fuels for cooking also has significant health implications for women – including the health of their children – as women are exposed to a disproportionately higher share of indoor air pollution.

In order for countries to meet their development goals, key development issues – economic productivity, education, health, and gender equality – need to be addressed simultaneously. Energy is an essential component to all of these issues, bringing about multiple and synergetic development impacts. To ensure energy considerations are properly addressed in broader development strategies, more must be done to quantify the linkages between energy and development. Moving beyond an intuitive understanding of how energy and development are related will enable policy makers to better recognize the costs and benefits of scaling up energy services. It is imperative that policy makers understand the importance of energy services versus growth in other inputs as a means of stimulating development. This will undoubtedly require greater awareness among non-energy specialists as to the role energy services can play in other development sectors, as well improving the quality and quantity of energy-related data available to those who continue to explore the linkages between energy and development.

1. INTRODUCTION

1.1 Motivation and Objectives

Adopted unanimously by the international community in 2000, the Millennium Development Goals (MDGs) are a list of development objectives to be achieved by 2015. While energy is not explicitly mentioned in any of the MDGs, there is a growing understanding that energy services play a crucial role in underpinning efforts to achieve the MDGs and in improving the lives of poor people across the world. Lack of access to affordable, reliable, and environmentally-benign energy is a severe constraint on development. Recognition of the importance of energy in development has been the impetus for a growing effort to better understand the linkages between energy and the MDGs. While an understanding of these linkages is beginning to emerge, efforts to quantify the impact energy services can have on development are still very new.

The objective of this study is to help establish a better quantitative understanding of how the provision of energy services can lead to development outcomes that aid the achievement of the MDGs. To accomplish such an objective, even within the limited scope of this study, should provide better quantitative support for expanding the role of energy services within broader development strategies. Addressing this issue has important implications for public policy; especially for policy makers who face the challenge of allocating scarce resources across competing development strategies.

1.2 Methodology

Trying to quantify all the potential linkages between energy and development is beyond the scope of this study. This study instead relies on three country case studies to illustrate how the provision of energy services has affected people's lives in Brazil, Mali, and the Philippines. These three countries represent regions of the world with different geographic, socio-economic, and development characteristics. They also represent countries for which at least the minimum amount of data required to conduct an analytical study of this kind is available.

All three country case studies are similar in that they all evaluate the development impacts of a particular national, regional or local energy intervention. The Brazilian case study examines the impacts of a national rural electrification initiative on the northeast state of Ceará. The Mali case study investigates the development of local micro-enterprises in which women's associations purchase and manage diesel-powered multifunctional platforms. The Philippines case study examines a national electrification initiative.

Each country case study evaluates its respective intervention and its impact on development in two stages. The first stage involves quantifying what impact the intervention has had on local-level development. The second stage involves using the local-level analysis as the basis for addressing how energy services can contribute to the achievement of the MDGs at the national level. With the exception of sharing this general methodological framework, the three country

case studies differ in their scope and the extent to which they rely on analytical analyzes to quantify energy-development linkages.

Each country case study uses the data available to it to evaluate only those linkages it can. The scope of each study is primarily limited to analyzing the impact energy services have on: (1) poverty reduction; (2) education; (3) gender equality; and (4) health. These four broadly-defined categories are meant to correspond with MDGs 1 through 5 (note that health includes both MDG 4 - Reduce Child Mortality and MDG 5 - Improve Maternal Health).

Since data availability varies from one country to another, each country case study relies on a slightly different methodology. The Brazil case study relies on the most basic analytical tool – i.e., the correlation test – and thus represents the first and lowest level of analysis. The Philippines case study relies on a slightly more sophisticated analytical tool – i.e., the regression model – and thus represents the second and intermediate level of analysis. The Mali case study relies on actual field data and thus represents the third and highest level of analysis. The analytic portion of each country case study is based primarily on publicly available data and desktop reviews of existing studies. With the exception of the Mali case study, where some field level data has been gathered, no field level investigations have been performed as part of this study.

1.3 The Millennium Development Goals

In September 2000, heads of state and representatives of the governments of 191 countries met at the United Nations (UN) and adopted the Millennium Declaration. The Declaration outlines the central concerns of the global community – peace, security, development, environmental sustainability, human rights and democracy – and articulates a set of inter-connected and mutually reinforcing goals for sustainable development. These, the MDGs, are based on the major goals and targets agreed upon at the UN conferences of the 1990s, which have been synthesized into a global agenda for development.

The Millennium Declaration commits the international community and member states of the UN to the achievement of eight major goals (i.e., the MDGs):

1. Eradicate Extreme Poverty and Hunger
2. Achieve Universal Primary Education
3. Promote Gender Equality and Empower Women
4. Reduce Child Mortality
5. Improve Maternal Health
6. Combat HIV/AIDS, Malaria, and other Diseases
7. Ensure Environmental Sustainability
8. Develop a Global Partnership for Development

Quantitative targets have been defined for each MDG, most of which are to be achieved by 2015. Indicators have been selected to monitor progress on each of the targets. A list of 18 targets and 48 indicators has been agreed upon to ensure comparability across countries and

facilitate tracking of progress at global, regional, and national levels. Table 1.1 shows the targets and indicators for MDGs 1 to 5.

Table 1.1: Millennium Development Goals (MDGs 1 thru 5)

Goal and Target	Indicator
GOAL 1 - ERADICATE EXTREME POVERTY AND HUNGER • Target 1 - Halve the proportion of people with income < US$1/day between 1990 and 2015	1) Proportion of population < US$1(PPP)/day 2) Poverty gap ratio 3) Share of poorest quintile in national consumption
• Target 2 - Halve the proportion of people who suffer from hunger between 1990 and 2015	4) Prevalence of under-weight children under five years old 5) Prop. of pop. below min. level of dietary energy consumption
GOAL 2 - ACHIEVE UNIVERSAL PRIMARY EDUCATION • Target 3 - Ensure that by 2015 children will be able to complete a full course of study	6) Net enrollment ratio in primary education 7) Proportion of pupils starting grade 1 who reach grade 5 8) Literacy rate of 15-24 year olds
GOAL 3 - PROMOTE GENDER EQUALITY AND EMPOWER WOMEN • Target 4 - Eliminate gender disparity in primary and secondary education by 2005 and to all levels by 2015	9) Girl-to-boy ratio in primary, secondary and tertiary education 10) Ratio of literate women to men 15-24 years old 11) Share of women in wage employment 12) Proportion of seats held by women in national parliament
GOAL 4 - REDUCE CHILD MORTALITY • Target 5 - Reduce the under-five mortality rate by two-thirds between 1990 and 2015	13) Under-five mortality rate 14) Infant mortality rate 15) Prop. of one-year old children immunized against measles
GOAL 5 - IMPROVE MATERNAL HEALTH • Target 6 - Reduce the maternal mortality ratio by two-thirds between 1990 and 2015	16) Maternal mortality ratio 17) Proportion of births attended by skilled health personnel

1.4 Energy and the Millennium Development Goals

Energy services can play a variety of roles in helping to achieve the MDGs. At a local level, energy services – i.e., cooking, water heating, lighting, refrigeration, water pumping, transport, and communications – can facilitate sustainable livelihoods, improve health and education, and significantly reduce poverty. At a national level, energy services can help to facilitate economic development by underpinning industrial growth, attracting foreign direct investment, and providing access to global markets and trade via transport and communications[1]. Table 1.2 summarizes the importance of energy services to achieving the MDGs.

[1] DFID. 2002. Energy for the Poor: Underpinning the MDGs. Department for International Development.

Table 1.2: Matrix of Energy-MDG Linkages (MDGs 1 thru 5)

Goal and Target	Importance of Energy to Achieving the Goal
GOAL 1 - ERADICATE EXTREME POVERTY AND HUNGER • Target 1 - Halve the proportion of people with income < US$ 1/day between 1990 and 2015 • Target 2 - Halve the proportion of people who suffer from hunger between 1990 and 2015	• Access to energy services enables enterprise development • Lighting permits income generation beyond daylight hours • Machinery increases productivity • Local energy supplies can often be provided by small scale locally-owned businesses creating employment in local energy service provision and maintenance • Privatization of energy services can help free up government funds for social welfare investment • Clean, efficient fuels reduce the large share of household income spent on cooking, lighting and keeping warm • The majority of staple foods need cooking before they can be eaten and need water for cooking • Energy for irrigation helps increase food production
GOAL 2 - ACHIEVE UNIVERSAL PRIMARY EDUCATION • Target 3 - Ensure that by 2015 children will be able to complete a full course of study	• Lighting in schools helps retain teachers, especially if their accommodation has electricity • Electricity enables access to educational media and communications in schools and at home that increase education opportunities and allow distance learning • Availability of modern energy services frees children's and especially girls' time from helping with survival activities
GOAL 3 - PROMOTE GENDER EQUALITY AND EMPOWER WOMEN • Target 4 - Eliminate gender disparity in primary and secondary education by 2005 and to all levels by 2015	• Availability of modern energy services frees girls' and young women's time from survival activities • Clean cooking fuels and equipment reduces exposure to indoor air pollution and improve health • Good quality lighting permits home study and allows evening classes • Street lighting improves women's safety • Affordable and reliable energy services offer scope for women's enterprises
GOAL 4 - REDUCE CHILD MORTALITY • Target 5 - Reduce the under-five mortality rate by two-thirds between 1990 and 2015	• Indoor air pollution contributes to respiratory infections • Gathering and preparing traditional fuels exposes young children to health risks and reduces time spent on child care • Provision of nutritious cooked food, space heating, and boiled water contributes towards better health • Electricity enables pumped clean water and purification
GOAL 5 - IMPROVE MATERNAL HEALTH • Target 6 - Reduce the maternal mortality ratio by two-thirds between 1990 and 2015	• Energy services are needed to provide access to better medical facilities for maternal care, including medicine refrigeration, equipment sterilization, and operating theatres • Excessive workload and heavy manual labor (carrying heavy loads of fuelwood and water) may affect a pregnant woman's general health and well being

Source: DFID. 2002. Energy for the Poor: Underpinning the MDGs. Department for International Development.

1.5 Methodological Challenges

Several methodological challenges arise when attempting to determine the precise relationship between energy services and development. In one way or another, the following methodological issues made it difficult to either validate or quantify the relationship between energy and development:

- *Interdependencies*. One of the main methodological challenges when attempting to quantify energy-MDG linkages is the interdependency between MDGs. To illustrate this challenge consider the following: Energy services that reduce the time and labor that women must devote to daily chores often enables children to engage in other productive activities such as education. This opportunity in itself is a benefit to both women and young girls. MDGs 2 and 3 track this kind of progress. Education is also an investment, however. Better-educated girls are more likely to make better business and health decisions later in life. These benefits are of interest to MDGs 1, 4, and 5. The existence of these spillover effects suggests that costing one target at a time may overestimate the cost by unknown magnitudes. That is, there is a danger of double-counting.

- *Causality*. The fact that expanded availability and use of energy services is strongly associated with socio-economic development still leaves open how important energy is as a causal factor in development. Development involves a number of other steps besides those associated with energy, notably, the evolution of education and labor markets, financial institutions to support capital investment, modernization of agriculture, and provision of infrastructure for water, sanitation, and communications. Keeping these kinds of variables constant is virtually impossible when trying to isolate and quantify energy's impact on development.

- *Accounting for Direct Benefits*. Development is quite often the result of synergies between different local level initiatives. The provision of modern energy services is one such initiative. The evolution of education and labor markets, financial institutions to support capital investment, modernization of agriculture, and provision of infrastructure for water, sanitation, and communications are examples of others. It is for this reason many development impacts associated with energy services are indirect in nature. It is only when energy services are coupled with other initiatives – such as the construction of schools, health clinics, etc – that together they make an impact on development. This makes quantifying energy's impact on development difficult, as it often requires evaluating such impacts within the context of other initiatives.

- *Socio-Economic Differences*. The extent to which energy services benefit the poor is often dependent upon the underlying socio-economic characteristics of those who use them. Income and access to productive resources are key determinants of how energy services ultimately enhance people's lives. These endowments are unevenly distributed among the world's poor. This makes generalizing the benefits of energy services quite difficult. Energy services might greatly enhance development in one community but not necessarily in another.

2. BRAZIL COUNTRY CASE STUDY

2.1 Summary

This study examines the relationship between rural electrification in Brazil's northeast state of Ceará and development outcomes that aid the achievement of the Millennium Development Goals (MDGs). In addition to providing analytical insights into energy-development linkages, the study also assesses the relevance of small-scale rural electrification initiatives to the Brazilian National Program for Rural Electrification, also abbreviated to *"Luz no Campo"*. The findings from this study suggest that rural electrification can make important contributions to the livelihood of the rural poor. Within the context of Ceará's experience with electrification, access to electricity has been associated with economic development and improved education. It is anticipated that increased rural electricity services will help reduce rural-to-urban migration, as well as the pressure on government resources for increased urban infrastructure and social services.

Rural electrification is associated with a number of development outcomes. In 1991 the proportion of Ceará's rural population living below R$ 75.50 (1/2 minimum wage) was roughly 85 percent. By 2000 this proportion had decreased to 74 percent. Poverty reduction during this time period coincided with a significant improvement in access to electricity. The findings from this study suggest that these two accomplishments are, in fact, related. Rural electrification is associated with economic development across both time and geography. The findings from this study also suggest that rural electrification is associated with a number of educational improvements. These include higher literacy rates and school enrollment ratios.

Rural electrification programs like *"Luz no Campo"* have important implications for macro-development and the achievement of Brazil's MDGs. *"Luz no Campo"* will almost certainly facilitate development via improvements in income and education. It is less likely to facilitate development in areas such as health and gender equality. This is because electricity is not an energy service itself, but rather an energy carrier that is often linked to the kinds of services that bypass survival activities such as cooking and heating. The findings from this study also suggest that households with lower productive potential may have less to gain – at least from a monetary perspective – from *"Luz no Campo"* than those who already enjoy higher levels of income.

All of these findings seem to suggest that in order for rural electrification to make a larger impact on people's lives – particularly with regards to rural-to-urban migration – policy makers must remain sensitive to the differential impact that electricity has on development. Access to electricity, while certainly a prerequisite of development at the national level, does not necessarily result in a broad range of local level development outcomes.

2.2 Country Profile

2.2.1 Overview

Figure 2.1: Map of Brazil

Brazil is the largest country in South America, covering an area of 8.5 million km^2, and bordered by the Atlantic Ocean and all South American countries except Ecuador and Chile. The country's topography is quite diverse, combining the Amazon basin in the north and west and the Brazilian Highlands in the southeast. Almost all of Brazil is humid and has either a tropical or subtropical climate. Two of Brazil's most prominent geographic features are its vast rainforests and the Amazon River.

Brazil has a population of nearly 175 million and an annual growth rate of about 1 percent. Although the country has experienced considerable rural-to-urban migration, nearly 40 million people still live in the countryside, and another 10 million live in towns with a population under 20,000. Population densities vary between the densely-populated southeast and south, the sparsely-populated north and center-west, and intermediate population levels in the northeast. On average, the country's population density is roughly 21 inhabitants per square kilometer.

Brazil accounts for almost half of Central and South America's economic output. It has large and well-developed agricultural, industrial, and service sectors. Agriculture accounts for 9 percent of the country's Gross Domestic Product (GDP), employs about 20 percent of its labor force, and provides about 41 percent of the country's exports[2]. The country is the world's largest producer of sugar cane, coffee, and tropical fruits, and has the world's largest commercial cattle inventory. Brazil is a major producer and exporter of cocoa, soybeans, tobacco, wood products, poultry, pork, corn, cotton, and tobacco. Brazil's industrial sector accounts for nearly one-third of the country's GDP and includes industries ranging from automobiles and parts, steel, textiles, shoes, cement, lumber, iron ore, tin, and petrochemicals, to computers, aircraft, and consumer durables. Brazil also has a diverse and sophisticated service industry. Mail and telecommunications are the largest service sub-sectors, followed by banking, energy, commerce, and computing.

Brazil is divided into 27 administrative regions or states. This study focuses on the state of Ceará, located in the northeastern region of the country. Ceará's climate is semi-arid and its 146,350 km^2 encompass a wild and often remote coastline. Ceará faces periodic droughts as it is the only Brazilian state without reliable water resources. The state's population is roughly 7.4

[2] Agribusiness, taken as a whole, accounts for about one-third of Brazil's GDP.

million. The majority of the state's populace lives in urban areas like those found in and around the capital city of Fortaleza. Despite high rural-to-urban migration, roughly 28 percent of the state's populace lives in the countryside. Ceará's three largest employment sectors include services (46%), agriculture (40%), and industry (14%). Their contribution to the state's GDP is 54, 6, and 40 percent, respectively.

2.2.2 Development Context

Brazil has made remarkable progress toward development within the last 30 years. In 1975, Brazil ranked near the bottom on the Human Development Index (HDI). By 2003, Brazil had moved up 16 places to rank 65th out of 175 countries on the HDI[3]. Much of this development can be attributed to improvements in the country's educational system. Improvements in life expectancy and income, on the other hand, have been limited. Brazil falls only within the world average in terms of income and life expectancy, and is still below the Latin American average on both indicators. Development in Brazil is characterized by a growing standard of living coupled with extreme socio-economic inequality, increasing health threats from a high AIDS infection rate, and environmental degradation.

In contrast to the more developed states in southern Brazil, the portrait of rural northeast Brazil exhibits conditions similar to the world's poorest countries. Ceará exemplifies this picture. Despite having gone through massive reforms in the late 1980s and 1990s, during which time the state's educational and health systems began to improve, Ceará remains one of Brazil's poorest states. In 2000, Ceará ranked 19 out of 27 on the national HDI. Development in Ceará is characterized by above average income inequality[4] and unreliable environmental resources.

Brazil's development strategy is defined in the government's Multiyear Plan (Plano Pluriannual, or PPA). According to the 2004-2007 PPA, a number of development challenges warrant particular attention given their severity and importance to the country's future. A few of these challenges include:

- *High Socio-Economic Inequality*. Despite its recent economic progress, Brazil has gained international notoriety for its extraordinary socio-economic inequality. The "income share of the richest 20% of the population is equal to 33 times the corresponding share of the poorest 20%"[5]. Indeed, a Gini coefficient of 60.7[6] supports this assessment and highlights the extreme income disparities across the country. In 2003, only four other countries had a higher Gini coefficient than Brazil[7].

[3] UNDP. 2003. "Human Development Report 2003". New York: Oxford University Press.
[4] In 2000, Ceará had the highest Gini coefficient in the northeast. World Bank (2004). "Growth and Poverty Reduction in Rio Grand do Norte. A State Economic Memorandum", Washington: The World Bank, p.11.
[5] World Bank. 2003. "Brazil. Inequality and Economic Development". Washington D.C.: The World Bank.
[6] UNDP. 2003. "Human Development Report 2003". New York: Oxford University Press.
[7] These countries were Botswana (63.0), Sierra Leone (62.9), Central African Republic (61.3), and Swaziland (60.9). See UNDP. 2003. "Human Development Report 2003". New York: Oxford University Press.

Inequality is especially acute in the state of Ceará. Ceará suffers from extreme income inequality which is reflected by a regional Gini coefficient of 68.0[8]. This supersedes the national average and is the highest in the northeast.

- *Rural Poverty*. Roughly 9.8 million Brazilians live in rural poverty[9]. Unlike those affected by urban poverty, the rural poor generally have less access to services and live in remote, agriculturally-dominated areas. Brazil's deepest pockets of rural poverty are located in the northeast and southeast regions. In these regions, the proportion of the population living below the poverty line is 49 and 24 percent, respectively.

  One state in northeastern Brazil most affected by rural poverty is Ceará. In regions like Ceará, the contrast between urban and rural access to services is reflected by the fact that 95 percent of the urban population has access to improved water sources compared to 53 percent of the rural population. In northeast Brazil, only 24 percent of the rural population has piped water access. The same applies to access to electricity and income-generating opportunities. The problems of service access are exacerbated by the fact that 85 percent (8.3 million people) of all poor in the northeast and southeast regions live in remote farming communities. The bulk of farmers receive over 70 percent of their income from agricultural-related activities. Non-agricultural workers are consistently better off than farm labor workers, with public pensions serving as the main source of non-labor income[10].

- *Rural-to-Urban Migration*. Approximately 53 percent of the Brazilian population living below the poverty line lives in urban areas. Urban areas are often characterized by extreme overcrowding and so called "favelas" or slums[11]. This is a result of Brazil's extremely high rate of rural-to-urban migration. Many poor rural farmers migrate to urban areas expecting to find greater job opportunities. Because of high land values and the enormous demand for space, the poor are often forced into squatter settlements with little to no access to public services.

  Rural-to-urban migration is a particularly important issue for Ceará. In times of water shortage the large proportion of Ceará's rural population that engages in low-scale, rain-fed agriculture is often faced with issues of hunger, unemployment and dislocation. As a result, many people migrate to urban areas hoping to find better job opportunities in the cities. From 1999 to 2002, Ceará's rural population decreased by 20 percent, while the total state population grew roughly 8 percent[12].

Brazil's human development outlook can be contextualized further by examining the country's performance against the development indicators shown in Table 2.1:

[8] Atlas of Human Development in Brazil.
[9] World Bank. 2003. "Rural Poverty Alleviation in Brazil: Towards an Integrated Strategy". Washington D.C.: The World Bank, pg 2.
[10] World Bank. 2003. pg 10.
[11] Ibid, pg 11.
[12] Atlas of Human Development in Brazil.

Table 2.1: Selected Development Indicators [a]

MDG	Indicator (2000 except where noted)	Brazil	Developing Regions [d]
1	Proportion of Population Living < US$ 1/day (PPP) [b]	12	23.2 [e f]
	Poverty Gap Ratio	3.9	6.9 [e g]
	Share of Poorest Quintile in National Consumption	22.0%	2% [e h]
	Prevalence of Underweight Children < 5 Years of Age	10% [c]	28%
2	Net Enrollment Ratio in Primary School	93.0	82.1
	Proportion of Pupils Starting Grade 1 Who Reach Grade 5	NA	NA
	Literacy Rate of 15-24 Year-Olds	95.6	84.4
3	Ratio of Girls to Boys in Primary Education	0.93	0.87
	Ratio of Literate Women to Men, 15-24 Years-Old	1.03	0.91
4	Under-Five Mortality Rate (per 1,000 live births)	35	90 [i]
	Prop. of Children < 1 Year-Old Immunized Against Measles	97.0%	70% [i]
5	Maternal Mortality Ratio (per 100,000 live births)	160	440
	Proportion of Births Attended by Skilled Health Personnel	97%	52%

[a] This table includes only selected MDGs and MDG indicators. [b] Brazil has not yet defined an official national poverty line. [c] 2002 data. [d] As defined by the United Nations. [e] Low and middle income countries (as defined by the World Bank). [f] 1999 data. g 1998 data. [h] 1993 data. [i] 2001 data.
Source:

Brazil has made significant progress toward achieving the MDGs but remains challenged in regards to a number of social issues. Brazil continues to make progress with regards to eradicating extreme poverty and hunger but also confronts severe income inequality. With respect to achieving universal primary education, Brazil appears on track. With a net enrollment ratio of 93 percent, Brazil is close to achieving the objective of 100 percent enrollment by 2015. With regards to promoting gender equality, Brazil is moving in the right direction. Presently, females outnumber boys in primary and secondary education and have a slightly higher literacy rate[13]. Brazil has also made significant progress with health-related issues. The measles immunization rate is close to 100 percent, and the under-five mortality rate, as well as the infant mortality rate, has been reduced by 40 percent since 1990.

Disaggregated data for Ceará's performance on the MDGs is not available. Instead, UNDP Brazil, the Ministry of Planning's Applied Economic Research Institute (IPEA) and the João Pinheiro Foundation make available HDI data at the municipality level. In 2000, Ceará ranked 19 out of 27 on the national HDI. In contrast to the more developed states in southern Brazil – which are classified as high development states – Ceará is considered a medium development state[14]. Despite its low national ranking, Ceará has moved up four places since 1991. No other state has achieved a comparable improvement of its overall HDI ranking during this time period.

[13] UNDP. 2003. "Human Development Report 2003". New York: Oxford University Press.
[14] Atlas of Human Development in Brazil.

2.2.3 Energy Context

Brazil is the largest energy consumer in South America (consuming 8.78 quadrillion Btu of commercial energy in 2001), and the third largest in the western hemisphere, behind the United States and Canada. While total energy consumption statistics place the country as prominent in the region, Brazil's per capita energy consumption is comparable to the average per capita energy consumption for all of Central and South America. Energy consumption is estimated to increase to approximately 11.5 quads by 2010 and to 16.0 quads by 2020, at a rate of increase of 3.3 percent per year.

Brazil is heavily reliant on hydroelectric power. In 1999, Brazil produced roughly 52 percent of its energy from hydroelectric plants and was the second largest producer of hydroelectric power in the world (behind Canada). After hydroelectric power, Brazil relies most heavily upon oil to produce its energy.

The energy profile of Ceará is rather different from the energy profiles of states found in the more developed regions of southern Brazil. While little is known about specific energy consumption and production trends, it is safe to say that Ceará represents a region of Brazil with poor access to modern fuels and unreliable energy services.

From an energy perspective, Ceará's most important challenge is:

- *Rural Energy Poverty*. Ceará's rural population has far less access to modern energy services than the state's urban population. Despite the fact that electrification rates in rural Ceará have increased from roughly 39 percent in 1991 to 76 percent in 2000, a large portion of the state's rural population still has no access to modern fuels. Roughly 79 percent of all households use wood almost exclusively for cooking, which underlines the state's dependency on biomass for basic survival activities[15].

2.3 Project Description

2.3.1 Overview

No one particular project or program is the focus of this study. Instead this study examines the general relationship between rural electrification and development outcomes in the northeast state of Ceará. The study also assesses the relevance of Ceará's experience to the Brazilian National Program for Rural Electrification, or *"Luz no Campo"*. In lieu of leaving the "Project Description" section blank – given that the study is not based on any particular project – this section will be devoted to discussing *"Luz no Campo"*.

In late 1999, "*Luz no Campo*" was launched by the federal government in an effort to improve the overall standard of living in rural portions of the country. The objective of the

[15] Eletrobras, "*Luz no Campo"*, ex-ante household survey, 2002, and team analysis.

project is to extend the electricity grid to rural areas in order to reduce rural-to-urban migration, improve the quality of life of Brazil's rural population, increase productivity, generate jobs, and improve the average income of rural families and thereby increase tax revenues. In 2003, *"Luz no Campo"* was complemented by the *"Luz para Todos"* project. Its aim was to provide decentralized renewable energy options to those areas that were too remote to be served by the grid extension.

2.3.2 Scope and Cost of Project

Aimed at connecting nearly a million rural households – benefiting roughly five million people – in the three-year period from 1999-2002, *"Luz no Campo"* is the single largest rural electrification program implemented in Brazil (Table 2.2). As of September 2002, 480,000 connections had been made, and another 125,000 were in process. A total of 823,000 new customers had signed contracts. So far, no off-grid connections have been made under the program, even though this option was considered.

Table 2.2: Project Summary

Project Name:	Brazilian National Program for Rural Electrification, or "Luz no Campo"
Objective:	Bring electricity to one million rural households
Status:	As of 2002, 480,000 connections had been mae, and another 125,000 were in progress
Start Date:	1999
Finish Date:	2003
Total Project Cost:	US$ 1.0 billion

The project finances the implementation of rural electrification infrastructure using the "Global Reserve Fund" (GRF), which is constituted by a "levy" charged on power utilities' revenues. Such preferred finance conditions foster a huge number of rural electrification projects implemented by rural cooperatives, power utilities, and other qualified agencies. Initial estimates forecasted an investment of around US$ 1 billion dollars; that is, nearly US$ 1,000 per new consumer. Rural consumers are typically expected to pay the full costs of the connection, albeit spread over a number of years. *"Luz no Campo"* lends 75 percent of the investment to concessionaires at a 6 percent rate of interest, with a two-year grace period, and a five- to ten-year repayment period. Concessionaires finance rural consumers on similar terms, but in some cases the state governments provide partial subsidies, assuming the consumer's contribution.

2.4 Methodology

2.4.1 Methodological Framework

The objective of this study is to establish a better quantitative understanding of the relationship between rural electrification and development outcomes that aid the achievement of the Brazil's MDGs. Given Brazil's size, a detailed study of the entire country is not feasible. Instead, this study focuses on evaluating the impact of electrification on rural municipalities within the state of Ceará. Having given consideration to the resources available to the study, the

quality and availability of data (see Section 2.4.3), and the development context in which rural electrification is being evaluated, the scope of this study has been limited to analyzing rural electrification's impact on: (1) poverty reduction; (2) education; and (3) health. These three broadly-defined categories are meant to correspond with MDGs 1, 2, 4, and 5 (note that health includes both MDG 4 - Reduce Child Mortality and MDG 5 - Improve Maternal Health).

The study relies on both cross-sectional and time series data from 98 municipalities in Ceará to construct a series of correlation tests. Trends in income, literacy rates, school enrollment, mortality rates, and life expectancy are compared with trends in access to electricity across municipalities and over time. Correlations between varying degrees of access to electricity and the development indicators are established. In some instances where more complicated analyses are permitted, simple regression analyses are conducted.

2.4.2 Data

The analytical portion of this study is based on two data sets. The first is the annual "Atlas of Human Development in Brazil". UNDP Brazil, in conjunction with IPEA and the João Pinheiro Foundation, has been producing an annual Atlas since 1997. The data set provides detailed disaggregated data for all of Brazil. The Atlas has now developed into an electronic databank presenting human development indicators for all 5,506 Brazilian municipalities[16].

The Atlas does not distinguish between rural and urban municipalities. In order to assess the project's impacts on rural Ceará, a criterion to select data for rural Ceará was defined. With data for total and rural population in each municipality, the proportion of rural population for each municipality was calculated. All municipalities with a proportion equal to, or higher than, 50 percent were identified as rural. In order to obtain a unique value for "rural Ceará" for each indicator, the contribution of each "rural municipality" to "rural Ceará" according to their population was estimated. The indicators were then adjusted for each municipality according to the mentioned weights and summed up to get the overall "rural Ceará" indicators. Despite its flaws, this methodology does provide a reasonable indication of the rural population in Ceará.

The second data set is a national household sample survey known as PNAD. The survey is managed by IBGE (Brazilian Census Bureau) and has been conducted since 1973. PNAD contains extensive data on personal and household information. Household data includes characteristics of the household such as quality of building materials (roof, walls, and floors), utility services (water supply, sewage disposal, and electricity), domestic utensils (radio, stove, fridge, etc.), and rural or urban condition, among others.

In addition to the Atlas and the PNAD, an additional household survey, related specifically to the *"Luz no Campo"* project, was available as background information. This ex-ante survey was undertaken by Eletrobras in 2001 and provides a social and economic profile of rural Ceará. The survey was of 440 households.

[16] The whole data set can be downloaded at http://www.pnud.org.br/index.php?lay=inst&id=atl3.

2.4.3 Analytical Limitations

There are a number of issues related to the quality and availability of data that have, in one way or another, limited the analytical scope of this study. The most important issues to keep in mind while evaluating the study's findings are the following:

- *Low Explanatory Power*. As mentioned earlier, this study is based on a set of simple correlation tests. This study does not control for other non-electricity-related variables that might influence development (i.e., macroeconomic growth or educational/health reforms). As a result, the study's analysis is limited in its explanatory power and its ability to address issues of causality.

- *Assumptions*. The methodology used to derive what is a "rural municipality" may have influenced the outcomes of the correlations. The methodology assumes that certain urban sections of a municipality are rural and therefore the real rural population may not be represented. In addition, it is not clear how this "rural" population compares to the rural population from the PNAD data for 1999-2002.

2.5 Findings

2.5.1 Overview

The findings from this study suggest that rural electrification can make important contributions to improving the livelihood of the rural poor. Within the context of Ceará's experience with electrification, access to electricity is associated with, if not a prerequisite for, economic development and improved education. It is anticipated that increased rural electricity services will help reduce rural-to-urban migration, as well as the pressure on government resources for increased urban infrastructure and social services; which in turn can free up more development resources to rural areas, traditionally poor, and home to almost a third of the Brazilian population.

2.5.2 Poverty Reduction (MDG 1)

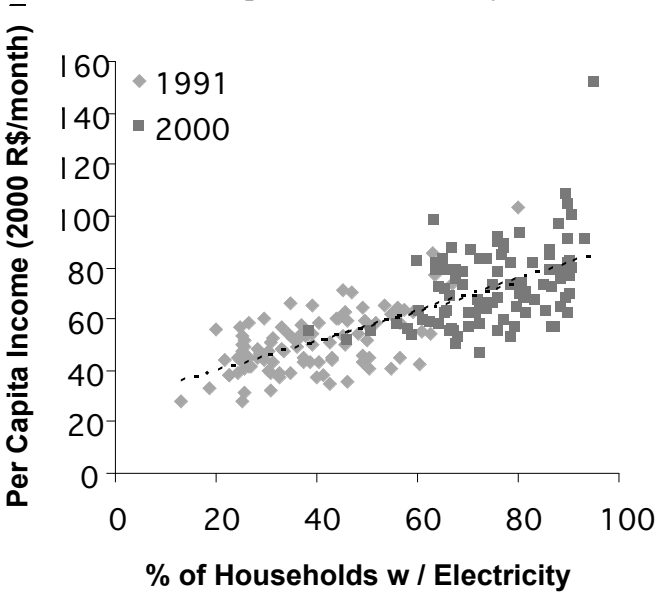
Using 1991 and 2000 data from 98 rural municipalities in Ceará, correlations between access to grid electricity and income indicators were estimated. The results in Table 2.3 show that most income indicators in 1991 have a high correlation with access to electricity, running between 0.44 and 0.64 (absolute value). This is not surprising given what is intuitively understood about the relationship between access to electricity and economic development. What is more interesting to note is that the correlation between average income per capita (IPC) and access to electricity seems to decrease across lower, and lower income, quintiles.

Table 2.3: Income Correlation Coefficients

	Access to Electricity	
Income Indicator	**1991**	**2000**
Income per Capita (IPC)	0.61	0.45
Avg. IPC, 5th (richest) quintile	0.55	0.39
Avg. IPC, 4th quintile	0.59	0.43
Avg. IPC, 3rd quintile	0.54	0.45
Avg. IPC, 2nd quintile	0.48	0.39
Avg. IPC, 1st (poorest) quintile	0.44	0.36
% Pop. w/IPC < R$ 75.50	-0.64	-0.48
% Pop. w/IPC < R$ 37.75	0.58	-0.49

Source: Team Analysis

Figure 2.2: Relationship between Electricity and Income



The results for 2000 are similar to those found in 1991, with the exception that for most indicators, the estimated correlations have lower absolute values. This suggests that as the number of households with electricity increases, the relationship between electrification and income weakens. Another point worth noting is that, unlike in 1991, the correlations between average income per capita and access to electricity in 2000 do not decrease across lower income quintiles.

With the help of a regression model, an analysis was conducted in order to better understand why the relationship between rural electrification and income seems to weaken over time. Using an interactive term called "Time*Elec" – which only appears when two conditions are met: (1) year = 2000; and (2) electrification rate > 75% – the impact of being electrified on IPC was estimated while controlling for time (1991 vs. 2000). The results of the model show a statistically insignificant interaction between electrification and time. This suggests that the

interaction between what year it is and the percentage of households that have electricity does not explain per capita incomes. It might just be that there is no statistically significant difference between the 1991 and 2000 correlation coefficients.

2.5.3 Education (MDG 2)

Increases in access to electricity are also associated with improvements in education indicators. Using 1991 and 2000 data from 98 rural municipalities in Ceará, correlations between access to electricity and education indicators were estimated. The results in Table 2.4 show that all education indicators in 1991 have a positive correlation with access to electricity. The correlation between access to electricity and literacy rates ranks among the highest (0.67) while correlations between access to electricity and the percentage attending elementary school ranks among the lowest (0.37).

Table 2.4: Education Correlation Coefficients

	Access to Electricity	
Education Indicator	**1991**	**2000**
Literacy Rate	0.67	0.67
% Literacy Rate, age 18 to 24	0.60	0.61
% Literacy Rate, age 15 to 17	0.58	0.53
Gross Enrollment Ratio	0.41	0.27
% Access to Elementary School, age 7 to 14	0.37	0.31

Source: Team Analysis

Figure 2.3: Relationship between Electricity and Literacy

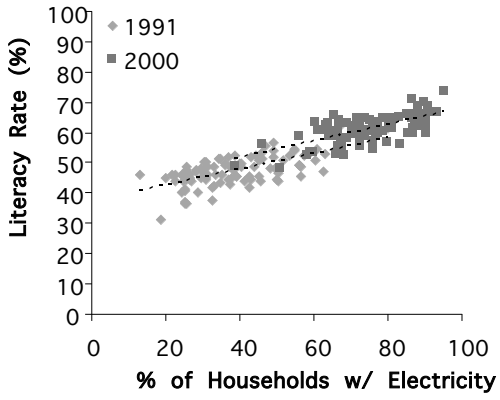
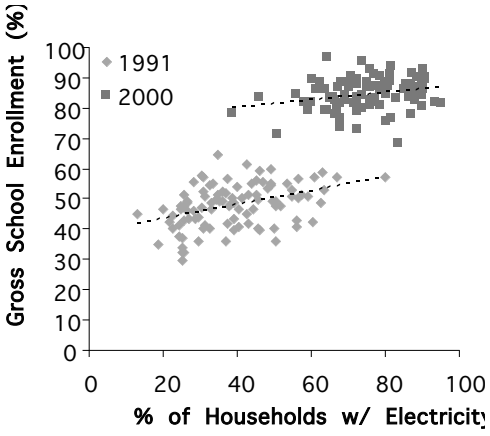


Figure 2.4: Relationship between Electricity and School Enrollment



The results for 2000 are similar to those found in 1991. Unlike the income indicators, which showed lower correlations with access to electricity in 2000 than in 1991, correlations for education do not change significantly from 1991 to 2000 – with the exception of the gross enrollment indicator which decreases. It should also be noted that access to electricity and

educational indicators move together over time (or at least between 1991 and 2000), suggesting that the association between both measures is not limited to cross-sectional data.

2.5.4 Health (MDGs 4 and 5)

Using 1991 and 2000 data from 98 rural municipalities in Ceará, correlations between access to electricity and health indicators were estimated. The results in Table 2.5 show that all health indicators in 1991 have weak, if not insignificant, correlations with access to electricity. The indicator with the highest correlation is life expectancy. What is striking are the results for "Resident Doctors per 100 Inhabitants". In 1991, there is a negative correlation, which seems counterintuitive since it seems reasonable to expect a higher number of doctors being attracted to areas that offer higher living standards. The correlation becomes positive in 2000, which seems to make more sense, but is still a very low number, which does not suggest a significant correlation. The rest of the indicators change only slightly, with the exception of the fertility rate whose correlation becomes more significant, yet still low.

Table 2.5: Health Correlation Coefficients

	Access to Electricity	
Health Indicator	**1991**	**2000**
Life Expectancy when Born	0.17	0.12
Mortality Rate < age 1	-0.16	-0.11
Fertility Rate	-0.04	-0.23
Resident Doctors per 1,000 Inhabitants	-0.08	0.07

Source: Team Analysis

Figure 2.5: Relationship between Electricity and Mortality Rate

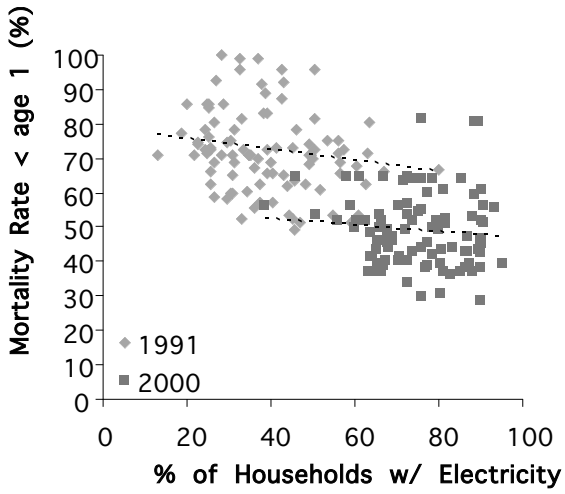
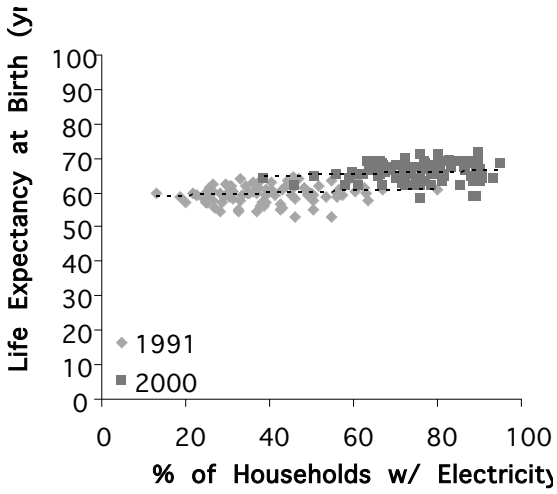


Figure 2.6: Relationship between Electricity and Life Expectancy



From the coefficients presented in Table 2.5, it is difficult to illustrate any relationship between access to electricity and improvements in health. The only significant relationship between the two measures is found when looking at temporal trends. As illustrated by Figures 2.5 and 2.6, mortality rates and life expectancy seem to move together with improvements in access to electricity.

2.6 Contribution to Macro-Development and the Achievement of the MDGs

At the local level, access to electricity can alleviate poverty and help improve education by providing individuals with energy services such as lighting, mechanization, refrigeration, and telecommunications. These services in turn help improve productivity, encourage new business formation, increase the number of productive hours in a day, and attract higher-qualified teachers. At the national level, access to electricity services can help to facilitate development by underpinning industrial growth, attracting foreign direct investment, and providing access to global markets and trade via transport and communications. These energy-development linkages suggest that access to electricity may have played an important role in reducing poverty and improving education in rural Ceará.

Due to a lack of data, this study is unable to determine to what extent enhanced access to electricity was accompanied by the kind of energy services described above or how exactly these services induced development between 1991 and 2000. What is known, however, is that between 1991 and 2000, the increase in access to electricity was accompanied by an almost three-fold increase in the percentage of households with refrigerators, televisions, and telephones, and a substantial improvement in the number of households with running water. The emergence of services like televisions and telephones suggests that they were almost certainly accompanied by improvements in lighting services.

These kinds of findings have important implications for macro-development and the achievement of Brazil's MDGs. They suggest that large-scale rural electrification programs like *"Luz no Campo"* might facilitate development in ways very different than energy interventions targeted at survival activities such as cooking or heating. Given what is known about the relationship between access to electricity and development, *"Luz no Campo"* will almost certainly facilitate development via improvements in income and education. It is less likely to facilitate development in areas such as health or gender equality, however. This is because electricity is not an energy service itself, but rather an energy carrier that is used very differently than traditional energy sources such as biomass or liquid and gaseous fuels. The energy requirements for cooking and heating services, for example, are primarily met by fuel sources such as wood and charcoal. When given access to electricity, most households forgo using it for cooking or heating applications, and instead use it for services such as lighting, televisions, radios, and agriculture. This suggests that access to electricity may not be an appropriate policy tool for addressing issues such as indoor air pollution or the drudgery of woman's labor, as it does not really affect the activities associated with them.

"Luz no Campo" will not only facilitate development in ways different to other energy interventions, but may also have differential impacts within development areas depending upon the socio-economic characteristics of those the program serves. This study suggests, for example, that the relationship between rural electrification and income may weaken as lower income households are provided with access to electricity. This finding has important implications for macro-development and the achievement of Brazil's MDGs, as it suggests that households with lower productive potential have less to gain from being electrified.

2.7 Conclusion

This study has examined the relationship between rural electrification and development outcomes in northeast Brazil. The study's findings suggest that rural electrification can make important contributions to improving the livelihood of the rural poor. Access to electricity is associated with economic development and improvements in education.

As the findings from this study suggest, there are a number of lessons to be learned regarding the role electricity services play in rural development. The following is a list of the most important policy messages derived from this study:

- *Increase the role of rural energy services within macro-scale/national poverty reduction strategies*. Compared to industry, agriculture has been steadily dropping in importance in terms of the dynamics of the Brazilian economy. The industrialization drive helps explain Brazil's rural exodus, as well as shortfalls in energy supplies outside the country's major cities. As agriculture slumps, job opportunities in rural areas become more scarce, causing the rural labor force to move into more urban areas. As the Brazilian experience suggests, events like these are often followed by government policies targeted at the development challenges of urban areas like those found in the southeast of the country. These policies are certainly warranted, however they often overlook the development challenges of the rural population. As this study suggests, rural electrification programs can be associated with a number of development outcomes that aid the achievement of the MDGs; namely those related to poverty reduction and education. This finding suggests that there is much to be gained – especially with regards to curbing rural-to-urban migration – by linking rural energy interventions with policy formulation at the macro level. It is for this reason that more needs to be done to encourage policy makers to integrate the potential impact energy services can have rural development into their macro-level decision-making process.

- *Remain sensitive to the differential impacts that access to electricity can have on populations with different socio-economic backgrounds*. By now it is clear that the provision of electricity can be have a number of impacts on socio-economic development. Experience suggests that one of the most significant impacts that access to electricity can have is helping to generate revenue for those who use its services. The Brazilian experience suggests, however, that access to electricity may have differential impacts on income generation, depending on the wealth and productive potential of those who are given access to it. As a result, rural electrification does not always result in extensive use of electricity. For those who cannot

afford its services, electricity is often used for lighting, radio, and television services, while most other energy needs – namely cooking and heating – continue to be met with other energy carriers. As such, policy makers must continue to be sensitive to the fact that access to electricity does not always provide the poor with access to the kind of energy services that reduce poverty and hunger.

3. MALI COUNTRY CASE STUDY

3.1 Summary

This study reviews experiences of the multifunctional platform project (the "project") in Mali and documents how modern energy services affect people's lives. The study assesses the relevance of the project concept to larger national development policies and the achievement of Mali's Millennium Development Goals (MDGs). The study's findings suggest that modern energy services – particularly motive power – play an important role across a wide spectrum of development initiatives. By reducing the drudgery of basic survival activities, a multifunctional platform can help women and girls re-allocate their time to productive activities and thus can serve as a powerful engine for rural development.

The energy services provided by the multifunctional platform are associated with a number of development outcomes. The study's findings indicate that a platform can reduce the time women spend on daily chores by an average of 2.5 hours per day and can help increase per capita incomes by an average of US$ 0.32/day (PPP_{1993}). By enhancing agricultural productivity, a platform enables women to increase their food production capacity and, ultimately, the amount of food their families can consume. A platform can also provide alternative means for villagers to handle tasks that would otherwise be handled by girls, and thus can reduce the opportunity cost of sending young girls to school. For women who don't have enough time and/or money to devote to their health needs, access to a platform's time- and labor-saving services is particularly important.

Replicating the project concept on a larger scale would have important implications for macro-development and the achievement of Mali's MDGs. In a country where the poverty gap ratio is US$ 0.37/day (PPP_{1993}) an increase in income of US$ 0.32/day (PPP_{1993}) constitutes a significant contribution to income poverty reduction; especially when considering that somewhere between one and one and a half million women (8-11 percent of Mali's total population or 11-15 percent of people living on less than US$ 1/day) could benefit similarly if motive power were made available at a national scale. Scaling up the project concept could also increase the girl-to-boy ratio in primary school to at least 74 percent, and would almost assure that the cohort survival rate reaches 100 percent. Health-related benefits might include improved maternal health and a reduction in child malnutrition.

Despite the potential to bring about multiple and immediate development benefits for the poor, scaling up rural energy services remains a challenge. Increasing investment, promoting local energy entrepreneurs, building capacity among rural communities, and strengthening policies and regulatory systems which address decentralized energy needs remain the country's most important challenges. To tackle these challenges, more needs to be done to link micro-scale experiences with policy formulation at the macro level. A well-designed community-level intervention like the multifunctional platform project should inform the development of national policies and strategies.

3.2 Country Profile

3.2.1 Overview

Figure 3.1: Map of Mali

The Republic of Mali is a landlocked economy situated in the middle of sub-Saharan West Africa, covering an area of 1.24 million km^2, and bordered by Algeria, Burkina Faso, Guinea, Côte d'Ivoire, Mauritania, Niger, and Senegal. The country is subdivided into three main climatic regions, ranging from subtropical in the south to a large expanse of arid desert in the north. Mali's most important geographic feature is the Niger River, which traverses both the Sahel and the southeastern section of the country, including the capital city of Bamako.

Mali has a population of approximately 11.7 million inhabitants (2001 estimate)[17]. The population growth rate, although slightly declining, remains high at 3.0 percent[18]. Despite a high growth rate and high mobility between rural areas and towns, Mali's population is still fundamentally rural: roughly 70 percent of the populace lives in rural areas and engages in subsistence agriculture[19]. Population densities vary considerably throughout the country but on the whole remain quite low.

The vast majority of Malians are employed in farming, herding, or fishing. Agricultural activities occupy 80 percent of Mali's labor force, provide roughly 40 percent of the country's Gross Domestic Product (GDP) and make up approximately 75 percent of export revenues[20]. Cotton and peanuts are the country's only significant cash crops; with rice, corn, sorghum, millet, and cassava being the major food crops. Gold, phosphate, salt, and limestone are mined, and the country has extensive unexploited mineral resources, including bauxite, manganese, iron ore, lithium, uranium, tin, copper, and diamonds.

3.2.2 Development Context

Poverty in Mali is endemic and widespread, making Mali among the poorest countries in the world. Nearly two-thirds of the total population lacks access to basic social services (i.e., education, health, housing, drinking water, etc.), and nearly a third lives in extreme poverty[21].

[17] United Nations Population Division, Department of Economic and Social Affairs. 2002.
[18] Ibid. (2001 estimates)
[19] Ibid. (2001 estimates)
[20] Data are averages from: Toulmin, C. et al. 2000. Mali Poverty Profile. IIED Drylands Programme, and Ministry of Economy and Finance. 2002. Poverty Reduction Strategy Paper (PRSP), Government of Mali.
[21] Ministry of Economy and Finance. 2002. Poverty Reduction Strategy Paper (PRSP), Government of Mali.

Poverty in Mali is also characterized by multi-dimensional forms of deprivation, including illiteracy, malnutrition, low life expectancy, unemployment, poor physical infrastructure, unreliable environmental resources, and an increasing rate of rural-to-urban migration. These are but a few reasons why Mali consistently ranks among the lowest countries on the Human Development Index (HDI) and is considered a Least Developed Country (LDC).

The incidence and nature of poverty in Mali differs between the various regions of the country. The incidence of poverty is the highest in the northern and the more isolated central regions of the country, such as Kidal. The lowest rates of poverty are found in the southern and westernmost regions of the country, including the district of Bamako, where precipitation is also most reliable and abundant.

Mali's development strategy is defined in the government's Poverty Reduction Strategy Paper (PRSP). According to the 2002 PRSP, a number of development challenges warrant particular attention given their severity and importance to the country's future. These challenges include:

- *Rural Poverty*. Poverty in Mali is widespread and most severe in rural areas. According to estimates from the Malian government, roughly 88 percent of the poor population lives in rural areas[22]. The incidence of poverty is 75.9 percent in rural areas compared with 30.1 percent in urban areas[23]. The bleak development outlook in rural parts of the country has stimulated high levels of rural-to-urban migration, which in turn has put pressure on the country's food production capacity.

- *Poor Education*. The Malian education system is among the least impressive in the world. Almost 70 percent of the economically-active population has no access to education[24]. This is primarily because of the high cost of schooling (both actual and opportunity costs), the negative perception of the usefulness of school, and public expenditure trends. For those who do have access to schooling, the quality of education tends to be very low. Teachers are more often than not under-qualified, while dropout and repletion rates remain high.

- *Underdeveloped Infrastructure*. Mali's transport infrastructure is among the least developed in the world. It is generally inadequate and in poor condition. Isolation and difficulties in accessing basic social services and socio-economic infrastructure (markets in particular) have been identified as the major constraints in poor and extremely poor regions (in particular in the Timbuktu, Gao and Kidal regions, but also in Kayes). The lack of transport infrastructure considerably reduces the mobility of travelers and goods, and raises the prices of the goods transported.

[22] Ministry of Economy and Finance. 2002. Poverty Reduction Strategy Paper (PRSP), Government of Mali.
[23] Ibid.
[24] Ibid.

- *High Susceptibility to External Shocks*. The high volatility in the price of cotton makes Mali's economy vulnerable to external shocks. Rainfall, which varies significantly from year to year, can have drastic effects on the country's economy by reducing earnings from cotton and increasing the bill for food imports in drought years.

Mali's human development outlook can be contextualized further by examining the country's performance against the development indicators shown in Table 3.1:

Table 3.1: Selected Development Indicators [a]

MDG	Indicator (2000 except where noted)	Mali	Developing Regions [e]
1	Proportion of Population Living < US$ 1/day (PPP) [b]	73	23.2 [fg]
	Poverty Gap Ratio	37.4	6.9 [fk]
	Share of Poorest Quintile in National Consumption	4.6%	2% [fi]
	Prevalence of Underweight Children < 5 Years of Age	43% [c]	28%
2	Net Enrollment Ratio in Primary School	43 [d]	82.1
	Proportion of Pupils Starting Grade 1 who Reach Grade 5	95	NA
	Literacy Rate of 15-24 Year-Olds	37.1	84.4
3	Ratio of Girls to Boys in Primary School	0.71	0.87
	Ratio of Literate Women to Men, 15-24 Year-Old	0.54	0.91
4	Under-Five Mortality Rate (per 1,000 live births)	231	90 [j]
	Prop. Of Children < 1 Year-Old Immunized Against Measles	37%	70% [j]
5	Maternal Mortality Ratio (per 100,000 live births)	630	440
	Proportion of Births Attended by Skilled Health Personnel	24%	52%

[a] This table includes only selected MDGs and MDG indicators. [b] Mali has not yet defined an income based poverty line. [c] Data is an 1995-2002 average. [d] Data refer to the 1998/99 school year. [e] As defined by the United Nations. [f] Low and middle income countries (as defined by the World Bank). [g] 1999 data. [h] 1998 data. [i] 1993 data. [j] 2001 data.

Source: United Nations Human Development Report 2003, United Nations Population Fund, United Nations Millennium Development Indicators Database

There is relatively little information regarding Mali's progress toward the MDGs. What is known, however, does suggest the country has much to accomplish in order to achieve many of its goals. For example, Mali is far behind in meeting the goal of reducing the proportion of undernourished people and the prevalence of underweight children. It is also far behind in meeting the goal of improving its net primary school enrollment ratio and under-five mortality. Areas in which Mali is making progress include the percentage of children that reach grade five and the girl-to-boy ratio in primary school. Despite these improvements, Mali remains a top priority country for many of the goals.

3.2.3 Energy Context

Data on energy production and consumption in Mali is sparse. In general, Mali has a low level of energy consumption compared to most countries in the world. In 2001, Mali consumed approximately 0.011 quads of energy, of which roughly 85 percent was consumed by households, ten percent by the transportation sector, and the remaining portion by industry. Traditional fuels, particularly fuelwood and charcoal, provide the bulk of all energy consumed in the country; particularly in rural areas. In urban areas, energy needs are met by a combination of charcoal and the central electricity grid.

Mali produces all of its electricity domestically, primarily from hydro-power (58.3%) and fossil fuel (41.7%) sources[25]. Between 1998 and 2001, electricity use increased by 36 percent from 288 million kW to 447 million kW[26]. Despite recent increases in electricity use, somewhere between 90 and 95 percent of Mali's population still lacks access to electricity[27].

From an energy perspective, Mali's most important challenges include:

- *Rural Energy Poverty*. Because the majority of Mali's population lives in small and dispersed rural villages, rural grid electrification is practically non-existent, leaving decentralized mechanical and electrical energy supply the only viable option. At this point, however, there is still no clear energy policy for bringing decentralized power to rural areas. As a result, the majority of Malians still do not have access to basic provisions of modern energy.

- *Deforestation*. Due to a high reliance on traditional fuels to meet domestic energy needs, Malians –particularly those who live near urban centers – are rapidly depleting forests for household fuels. In the process, they are creating corridors of deforestation along access roads and exacerbating problems with soil erosion and desertification. Deforestation is one of Mali's most predominant environmental issues associated with energy consumption.

- *Under Investment in Production Capacity*. Development of Mali's energy resources, whether for processing, transport, or direct use, has come up against considerable financial constraints. Large dams require substantial investments, which would be difficult for the country to shoulder under current economic and financial circumstances. Decentralized power production is a potential alternative; but most rural collectives are not in a position to purchase decentralized energy generators on their own.

[25] CIA World Factbook, 2000 and 2003
[26] Ibid.
[27] The range reported is based on estimates from the United Nations Educational, Scientific and Cultural Organization and the Global Environment Facility.

3.3 Project Description

3.3.1 Overview

In 1997, the United Nations Development Programme (UNDP) in Mali and the government of Mali collaborated to create the multifunctional platform project as a vehicle to promote women's development and poverty alleviation in rural Mali. The project consists of the development of energy service micro-enterprises, owned and operated by women's associations. The platform consists of a small diesel engine mounted on a chassis, to which a variety of end use equipment can be attached, including grinding mills, battery chargers, vegetable or nut oil presses, welding machines, and carpentry tools. It can also support a mini grid for lighting (150-200 bulbs) and electric pumps for a small water distribution network or irrigation system.

One of the primary objectives of the project is to promote poverty alleviation among women in rural areas. The project has been designed to increase women's productivity, alleviate the drudgery of women's labor, and increase income-generating opportunities by providing villages with energy services that replace traditionally time- and labor-intensive activities. Another key objective of the project is to provide new business opportunities and a source of income for the women who own, operate, and manage the platforms. By allowing women's associations to purchase the platform, choose which modules to install, and collect fees for its use, the project is intended to empower women while also providing services demanded by the community.

3.3.2 Scope and Cost of Project

The project began with a small pilot phase from 1993 to 1995, during which time four platforms were installed in villages in the Sikasso region. By the end of 1999, there were a total of 48 platforms installed, and the multifunctional platform initiative had become a national project, run and administered by the Malian Department of Industry and Commerce (with ongoing support from the UNDP). As of March 2004, the project was responsible for the installation of 394 platforms, serving roughly 80,000 women – mostly concentrated in the southern regions of Sikasso, Segou, and Mopti – and had reached a total cost of approximately US$ 10 million (Table 3.2). The ultimate goal of the project is to install, by the end of 2004, 450 platforms serving ten percent of Mali's rural population.

Table 3.2: Project Summary

Project Name:	Mali Multifunctional Platform Project
Objective:	Provide decentralized energy services to 10% of Mali's rural population (450 platforms)
Status:	394 platforms installed as of March 2004 (serving roughly 80,000 individuals)
Start Date:	Pilot began in 1993
Finish Date:	2004
Total Project Cost:	US$ 10 million

A basic multifunction platform – including the engine, mill, de-husker, alternator, battery charger, and housing – costs roughly US$ 4,300. The women's associations that purchase the platforms finance between 40 to 60 percent of the platform's total equipment costs and pay for all the maintenance and operation costs. The project subsidizes the remaining cost of the platforms including all feasibility studies performed ahead of time.

The number of individuals that any given platform can serve in a village is by and large a function of how many individuals live in the village. Among the communities that already have access to a platform, the average size of a village is roughly 1,100 individuals. Of these 1,100 individuals, on average 620 of them are women. Of these 620 women, is has been estimated that on average 205 women per village are "economically active" and therefore likely to use the platform's services.

3.4 Methodology

3.4.1 Methodological Framework

The objective of this study is to establish a better quantitative understanding of how energy services provided by multifunctional platforms have led to development outcomes that aid the achievement of Mali's MDGs. Having given consideration to the resources available to this study, the quality and availability of data (see Section 3.4.3.), and the development context in which the project has been implemented, the scope of this study has been limited to analyzing the impact energy services have on: (1) poverty reduction; (2) education; (3) gender equality; and (4) health. These four broadly-defined categories are meant to correspond with MDGs 1 through 5 (note that health includes both MDG 4 - Reduce Child Mortality and MDG 5 - Improve Maternal Health).

Within each broad category, a number of development indicators are evaluated both before and after the implementation of the project. The purpose of the comparison is to identify which project outcomes have helped aid the achievement of the country's MDGs. Some development indicators are part of the MDGs and Targets, while others are proxies for MDG indicators for which data is not available.

Regardless of which type of indicator is being analyzed, attributing improvements in any of the indicators to the platform's services is a complicated task. In an effort to help clarify issues of attribution, the study's findings (i.e., how each development indicator faired before and after the multifunctional platform project) are categorized as either a direct or indirect result of the platform's services. This categorization is meant to differentiate energy services that have had a direct impact on people's lives from those that required additional interventions in order facilitate development.

3.4.2 Data

The analytical portion of this study is based on field data from 12 different villages with multifunctional platforms. All 12 villages are from central and southern Mali. Ten of the sample villages are in the Sikasso region (semi-tropical) and two are in the Mopti region (the Niger River valley). Within each village roughly 10 or 11 women were interviewed. Each woman was asked to provide information/data regarding the following development indicators for both pre- and post-multifunctional platform conditions[28].

- *Time Use*. The average time spent on food processing (namely milling cereals and de-husking rice) both before and after the introduction of the multifunctional platforms was estimated for each woman interviewed. Since many Malian women do not have a western sense of time, major events in their daily lives – including sunrise, call to prayer, and the start and end of classes – were used to gauge time use.

- *Revenue*. The amount of revenue generated – from the sale of foodstuffs such as rice, shea butter, and milk – both before and after introduction of the multifunctional platforms was estimated for each respondent. Revenues were estimated on an annual basis and were based on the amount of foodstuffs each respondent sold, and on their respective market prices.

- *Production and Consumption of Foodstuffs*. The amount of rice, shea butter, and peanuts produced and consumed was estimated for each respondent. The data is based primarily on rice, describing kilograms produced and consumed both before and after the installation of the platforms[29].

- *Education*. Pre- and post-multifunctional platform data on: (1) girl-to-boy ratios in primary school; (2) the proportion of school children completing primary education; and (3) dropout rates; was estimated for eight villages with schools. The quality and consistency of data varies from one village to another, as some schools have bi-annual enrolment schedules and no examination until the final year (i.e., no repetition of school years,) while other schools were established after the project.

- *Health*. How many women sought prenatal care, and the number of vomiting and diarrhea cases, were estimated before and after the installation of the multifunctional platforms. Similar to the data on education, the quality and consistency of the data varies from one village to another. This is because some health clinics were established after the project.

[28] Since all interviews were conducted after the installation of the multifunctional platforms, data for pre-multifunctional platform development indicators are to be considered estimates.

[29] For shea butter and peanuts, the data most often states that before the platform "all production was auto-consumed".

3.4.3 Analytical Limitations

The analytical limitations of this study are a function of both data quality and availability. As alluded to in the prior section, there are a number of issues related to the quality and availability of data that have in one way or another limited the analytical scope of the study. The most important issues to keep in mind while evaluating the study's findings are the following:

- *Small Sample Size*. The study's analysis is based on data from 12 villages (roughly 127 women interviewed). This constitutes a relatively small sample size, as the total number of platforms in operation to date is 394 (serving roughly 80,000 women). Caution, therefore, must be taken when trying to extrapolate the findings of the study onto the country as a whole.

- *No Control Group*. As mentioned earlier, the study is based on data from 12 villages with multifunctional platforms. This study does not, however, control for the overall development trends of villages without access to multifunctional platforms.
- *Unrepresentative Sample*. The villages from which data was collected are concentrated primarily in one region of the country (the Sikasso Cercle of the Sikasso region). There are significant differences between regions with respect to primary economic activity, access to land, irrigation, roads, and access to markets. These differences make it difficult to generalize the study's findings.

- *Low Explanatory Power:* As mentioned earlier, the study is based on a comparison of pre- and post-multifunctional platform development conditions. The study does not control for other non-platform-related variables that might influence development (i.e., educational/health reforms)

3.5 Findings

3.5.1 Overview

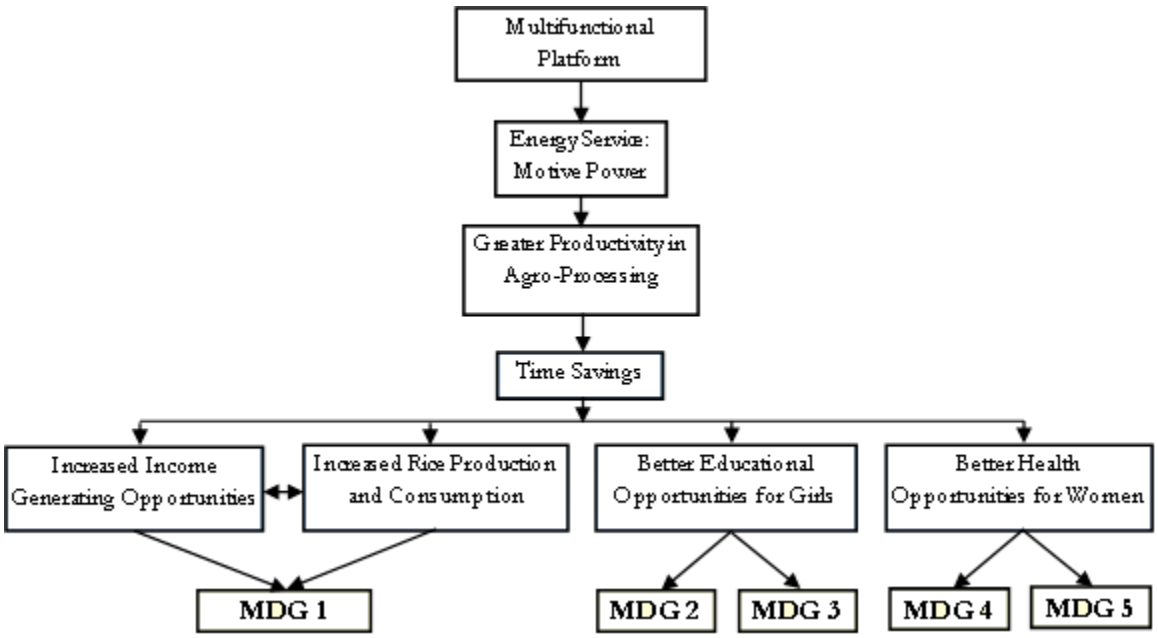
The energy services provided by the multifunctional platforms have both direct and indirect effects on people's lives. With the exception of one instance, all development indicators were found to have improved after the implementation of the project (Table 3.3).

Table 3.3: Summary of Findings

Indicator	Trend Since the Implementation of the MFP Project
Time Women Spend Milling Cereals and Du-husking Rice	⇩
Revenue Women Generate Through the Sale of Agricultural Goods and Foodstuffs	⇧
Amount of Rice Women Produce and Consume	⇧
Total Proportion of School Children Completing Primary School	⇧
- Girls	⇧
- Boys	⇔
Girl-to-Boy Ratio in Primary School	⇧
Dropout Rates	⇩
Number of Prenatal Visits Women make to Health Clinics	⇧
Number of Vomiting and Diarrhea Cases	⇩

With the exception of the reduction in time women spent milling cereals and de-husking rice, which is an effect that can be directly attributed to the platform's services, the improvements in almost all of the other development indicators are best explained by the indirect effect that the platform's services have on development vis-à-vis time savings (Figure 3.2).

Figure 3.2: The Significance of Time Savings



Since most of the project's outcomes are in one way or another linked to time savings, this section will begin by first summarizing the study's findings regarding time savings, and then proceed to other development outcomes associated with poverty reduction, education, gender equality, and health.

3.5.2 Time Use

One of the most important impacts that the multifunctional platform has brought to women is time savings. By mechanizing what are traditionally time- and labor-intensive activities – such as milling cereal and de-husking rice – a multifunctional platform's services can dramatically reduce the time women and girls have to devote to daily chores. As illustrated by Table 3.4, a platform's services can save a woman anywhere between 1.0 to 3.3 hours of grinding per day.

When taking into account the number of women that are involved in grinding per family, the time savings for a given family can reach upwards of 50 hours per day. In the village of Bogotiere, for example, where families are quite large and there are many mouths to feed, typically 16 women engage in grinding cereals for the family's daily consumption. With access to the platform's services, a woman can drop a bag of grain off at the platform and pick it up later the same day. Each woman in Bogotiere, therefore, can save herself nearly two hours so that the 28.3 combined hours per family previously spent grinding can be devoted to other activities.

Table 3.4: Time Saved Grinding Cereals

Village	Potential Time Savings w/ MFP [a] [hrs/woman/day]	Avg. # of Women per Family Engaged in Grinding Cereals	Potential Time Savings w/ MFP [hrs/family/day]
N'Gorona	1.3	1.6	2.1
Banzana	2.6	2.0	5.2
Lobougoula	1.8	2.4	4.3
Kolango	1.0	3.3	3.3
Sabenebougou	2.9	3.7	10.7
Tendely	2.1	3.9	8.2
Zoumana D	2.5	4.5	11.3
Manaco	2.6	5.0	13.0
Balanfina	1.0	5.5	5.5
M'Pegnesso	1.3	9.0	11.7
Bogotiere	1.8	15.7	28.3
Kolayerebougou	3.3	16.7	55.1
Average	*2.0*	*6.1*	*13.2*

[a] Values are derived from data on the number of hours spent milling cereals per day without the MFP (e.g. a MFP enables a woman to save all of the time she would have spent grinding cereals manually).

As illustrated by Table 3.5, the platform's services have also reduced the time women devote to de-husking rice. Unlike millet and other daily cereals, rice is consumed primarily on special occasions. When the time does come to process rice, however, it can take roughly 12 hours (active time) to process 28 kg of rice paddy[30]. This equates to a productivity of roughly 2.3 kg of rice per hour. With the help of the platform's services, this chore can performed almost effortlessly.

Table 3.5: Time Saved Dehusking Rice

Village	Avg. Pre-MFP Rice Production [kg/family/yr]	Potential Time Savings w/ MFP [a] [hrs/woman/day]
Kolango	102	0.1
Lobougoula	336	0.4
Kolayerebougou	167	0.2
N'Gorona	541	0.6
M'Pegnesso	205	0.2
Bogotiere	655	0.8
Sabenebougou	655	0.8
Zoumana D	195	0.2
Banzana	545	0.6
Balanfina	268	0.3
Average	*367*	*0.4*

[a] Assuming: (1) one woman per family is responsible for de-husking rice manually; and (2) de-husking rice manually requires roughly 12 hours (active time) per 28 kgs of rice.

When taking into account the combined time savings for both chores, women can save on average 2.5 hours per day. This estimate corresponds quite well with other studies' estimates of time savings[31].

3.5.3 Poverty Reduction (MDG 1)

- *Increased Revenue Generation*. The second most significant finding of this study is that women were found to have made more money after the introduction of the multifunctional platforms. Of the 127 women interviewed, 89 (70%) reported an increase in revenues, 29 (23%) reported no change, and 9 (7%) experienced a decrease in revenue. The sample's average annual revenue increase was 37,400 CFAF (US$ 68) per woman[32]. In rural Mali,

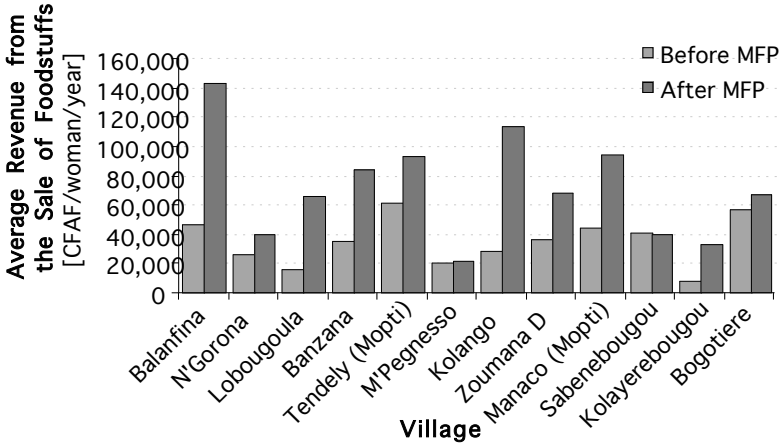
[30] Diagana, M. 2001. Impact Study of the Multifunctional Platforms on the Living Conditions of Women. United Nations Development Programme.
[31] Brew-Hammond, A. & Crole-Rees, A. 2004. Reducing Rural Poverty through Increased Access to Energy Services: A Review of the Multifunctional Platform Project in Mali. Mali: United Nations Development Programme.
[32] Since 1 January 1999, the CFAF has been pegged to the euro at rate of 656 CFAF per euro. At the time of this study the exchange rate between the euro and the US dollar was on average: 1 euro = US$ 1.20

where the implied per capita income in agriculture is a mere US$ 122[33], this additional revenue constitutes a significant increase in women's income.

The increase in revenue can be interpreted in three ways: (1) greater productivity in agro-processing enabled woman to produce and sell more products; (2) better quality products enabled households to fetch higher prices; and/or, (3) time savings enabled woman to devote more time to other income-generating activities. Any one or combination of these interpretations might explain the increase in revenue generation among women who use the platform's services. Based on anecdotal evidence from the field, however, it appears as though – at least within the villages surveyed as part of this study – the increase in revenue is partially explained by increased rice production, but best explained by the re-allocation of women's time to other income-generating activities. These activities include maintaining their individual farms, increasing and diversifying their farm production, and developing small trade through the purchase and resale of agricultural, fishery products, and the preparation and resale of various condiments[34].

The average increase in revenue only explains so much. There is a high degree of variation in the change in revenue across villages and even within villages. For example, some women's revenues increased by a factor of ten while a minority experienced little or no change. Figure 3.3 illustrates the average revenue generated by women in each village before and after the implementation of the project. The village with the largest growth in revenues is clearly Balanfina; which coincidentally was the first to receive its multifunctional platform in 1996, along with a water pump. The remaining villages received their multifunctional platforms either in 2000 or 2001. Although some women in a village may have experienced reductions in revenue, on average there was positive growth across all villages.

Figure 3.3: Revenue Generation by Village



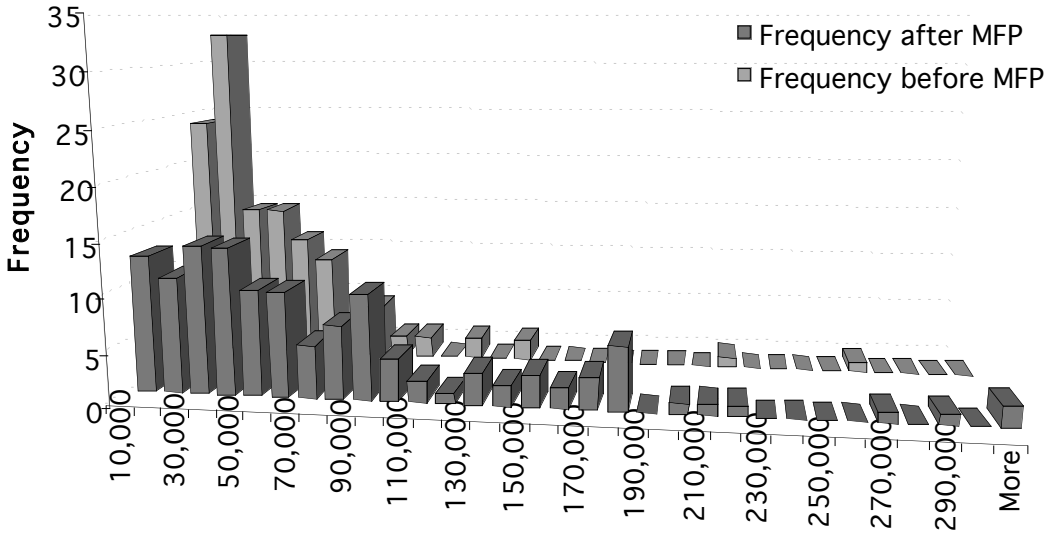
[33] Crole-Ress, A. 2002. Rural Household Strategies in Southern Mali: Determinants and Contribution of Income Diversification to Income Level and Distribution. Swiss Federal Institute of Technology, Zurich.

[34] Diagana, M. 2001. Impact Study of the Multifunctional Platforms on the Living Conditions of Women. United Nations Development Programme.

Based on anecdotal evidence from the field, the reasons why some women are more successful at translating time savings into increased revenue generation than others are best explained by: (1) how much land a head of household owns, and what portion of that land he gives to his wife; (2) how much "manpower" a woman has at her disposal (usually her daughters) to help in her agricultural work; and, (3) her husbands' assets/resources (i.e., how much farm equipment he owns and/or his ability to hire a worker – which translates into less work forced onto his wife). These reasons all boil down to suggest that: (1) the wealth of her husband; and (2) the size of her family; are key determinants of how much revenue a woman can raise.

Not only did a village's average revenue change (increase) after the implementation of the multifunctional platform project, but also the distribution of revenues. As illustrated by Figure 3.4, the distribution of revenues shifted from being heavily skewed toward the low end of the revenue spectrum before the implementation of the project to being more normally distributed after. This suggests that the platform's services did not just have an impact on a handful of women, but enabled a number of women to generate additional income.

Figure 3.4: Revenue Generation by Respondent



Another notable change in the distribution of revenues has to do with the range of revenues women earned. Before the project, women earned revenues which, on the whole, did not exceed 150,000 CFAF per year. After the project, the number of women who earned revenues in excess of this amount increased by a factor of ten.

- *Increased Production and Consumption of Foodstuffs.* In the Sikasso region, rice is a female-cultivated foodstuff. Of the 108 women interviewed regarding rice production, 60 (56%) reported an increase in production, 39 (36%) reported no change, and 9 (8%) experienced a decrease in production. Looking at the results at the village level, the findings suggest that

eight out of the ten villages experienced growth in rice production after the introduction of the multifunctional platform. As Table 3.6 illustrates, this growth was particularly dramatic in the Kolango village, and more than doubled in the Kolayerebougou and N'Gorona villages.

The results for rice consumption are similar (Table 3.6). Of the 108 women interviewed, 51 (47%) reported an increase in consumption, 46 (42%) reported no change, and 11 (10%) experienced a decrease in consumption. Looking at the results at the village level, the findings suggest that six out of the ten villages experienced growth in rice consumption after the introduction of the multifunctional platform. The villages that experienced the largest rates of growth in rice consumption were Kolango, Lobougoula and N'Gonona.

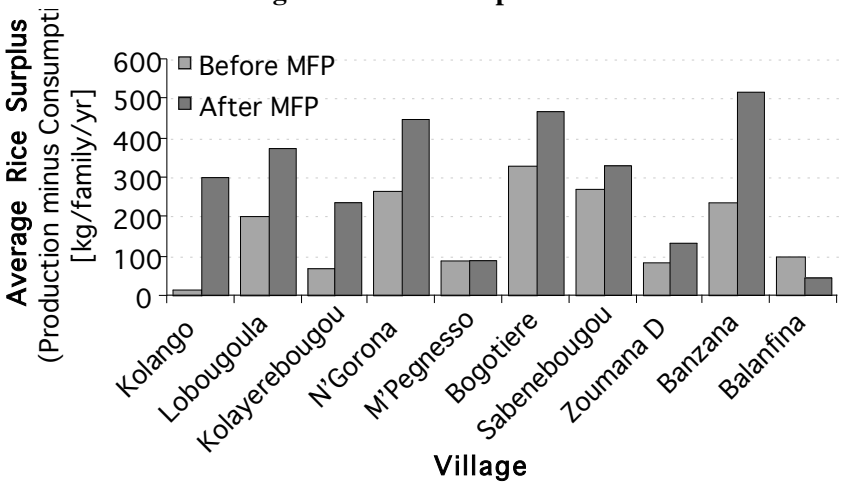
Table 3.6: Rice Production and Consumption

	Average Percent Change in Rice	
	Production w/ MFP	**Consumption w/ MFP**
Village	[% change/family]	[% change/family]
Kolango	518	270
Lobougoula	94	118
Kolayerebougou	155	67
N'Gorona	124	97
M'Pegnesso	0	0
Bogotiere	68	79
Sabenebougou	0	-7
Zoumana D	11	-1
Banzana	75	34
Balanfina	15	0

Source: Project Data

It is difficult to say with any degree of certainty what exactly caused rice production and consumption to increase. It is not intuitively surprising, however, that villages with access to energy services which improve the productivity of food processing – among a variety of other activities – would be associated with increased food production. As mentioned earlier, women often used the time saved by the platform's milling or grinding services to increase and diversify their farm production. Since the majority of Malians engage in subsistence farming, it is also not surprising that increased food production might lead to increased food consumption.

Figure 3.5: Rice Surplus



By looking at the relative change in rice production and consumption for each village another important trend can be identified. As illustrated by Figure 3.5, the average rice surplus (defined as the difference between what the family produces and consumes) increased in almost every village after the implementation of the project. Assuming exogenous factors such as climate did not play a significant role in increasing food production, this suggests that not only are families consuming more rice, but they may be producing enough of it to sell their increasing surplus.

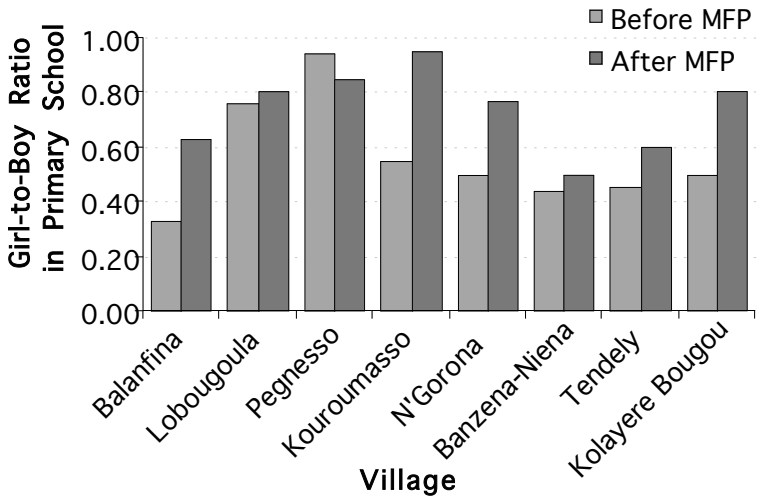
3.5.4 Education (MDG 2) and Gender Equality (MDG 3)

In rural Mali, the responsibility of children – primarily girls – to assist their mothers in domestic activities often prevents them from regularly attending school. The findings from this study suggest that the provision of time- and labor-saving energy services can reverse this trend. After analyzing data from eight villages, as well as anecdotal evidence from the field, this study concludes that the girl-to-boy ratio in primary school, dropout rates, and the proportion of school children (especially girls) completing primary education all improved after the implementation of the project.

- *Higher Girl-to-Boy Ratios in Primary School*. Through data gathered on the number of boys and girls enrolled in school in each class level[35], this study has been able to determine the girl-to-boy ratio in primary school. As illustrated by Figure 3.6 there is a clear improvement in the girl-to-boy ratio after the installation of the platform in almost every sample village[36].

[35] Mali's primary education system, like the former French system, runs for six years: Cours preparatoire (CP) 1 and 2, Cours elementaire (CE) 1 and 2, and Cours moyen (CM) 1 and 2.
[36] The data available was of sufficient quality and homogeneity for only eight of the villages surveyed.

Figure 3.6: Girl-to-Boy Ratio in Primary School



In fact, in four of the villages, the girl-to-boy ratio was found to have surpassed the national average of 0.71 girls for every boy in primary school[37]. Balanfina, the only sample village that installed a water pump along with its multifunctional platform, had one of the more dramatic increases in the girl-to-boy ratio. This is not surprising considering that fetching water is a time-consuming task typically performed by girls.

- *Lower Drop-Out Rates*. The study also includes detailed school enrolment data for the village of Balafina. Despite not being able to determine enrolment rates – because the total numbers of boy and girl residents in the village was unknown – the study was able to calculate dropout rates for the school. Drop-out rates were analyzed using two methods: (1) by cohort, following one group of students through their six years of primary school; and, (2) by class, looking at differences in dropout rates for each class level. As illustrated by Figures 3.7 and 3.8, both methods show a decline in the dropout rate after the introduction of the multifunctional platform.

[37] UNDP. 2003. "Human Development Report 2003". New York: Oxford University Press.

Figure 3.7: Change in Cohort Size, Balanfina

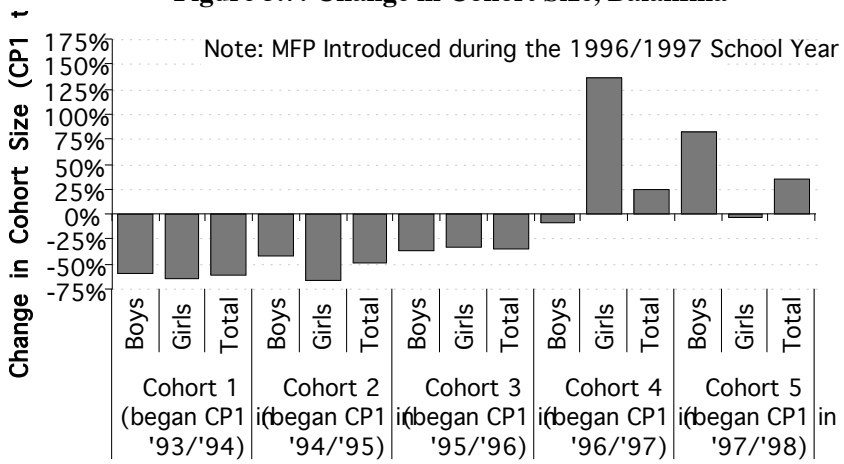
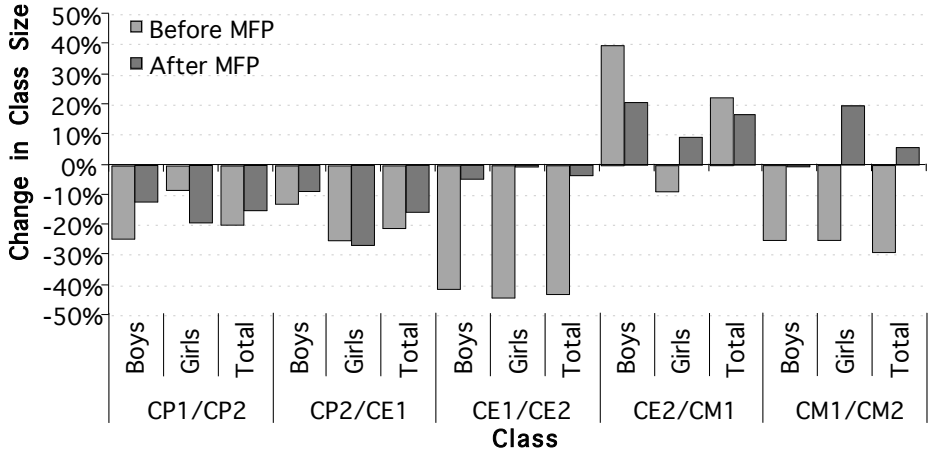


Figure 3.8: Change in Class Size, Balanfina



The sharp change in drop-out rates in classes CE1 and CE2 also suggests that a platform's time- and labor-saving services do not benefit children until they are old enough to help their mothers at home. Another way of interpreting this finding is as follows: The opportunity cost of sending children (especially girls) to school increases as they grow older, but decreases dramatically when energy services provided by the platform can enhance the productivity of either the mother's or her child's labour. Another interesting finding to note is that, at least within the context of Balafina's experience with the project, the decline in drop-out rates is not just associated with girls. The drop-out rate for boys, in fact, falls dramatically for each class and cohort. This is somewhat surprising given that girls are predominantly the ones responsible for helping their mothers at home, and therefore have the most to benefit by greater access to time- and labor-saving services.

- *Greater Proportion of Children Entering Secondary School*. Five villages provided data on the number of children who passed the yearly exam of entry to secondary education. This information is used as a proxy for the number of children who finished primary education. CM2 is the final year of primary education in Malian schools. Table 3.7 shows the proportion of students in CM2 that passed the exam before and after the installation of platforms in the five sample villages.

Table 3.7: Completion of Primary School

	# of Children in CM2 that Passed the Exam		# of Children Entering Secondary School		Proportion of Children Entering Secondary School	
	before MFP	after MFP	before MFP	after MFP	before MFP	after MFP
Boys	415	474	147	164	35%	35%
Girls	183	245	57	92	31%	38%
Total	598	719	204	256	34%	36%

[a] Data is from five sample villages. [b] CM2 is the final year of primary education in Malian schools.

[c] Assuming that only those children in CM2 that pass the exam to enter secondary school are eligible to begin secondary school.

Source: Project Data

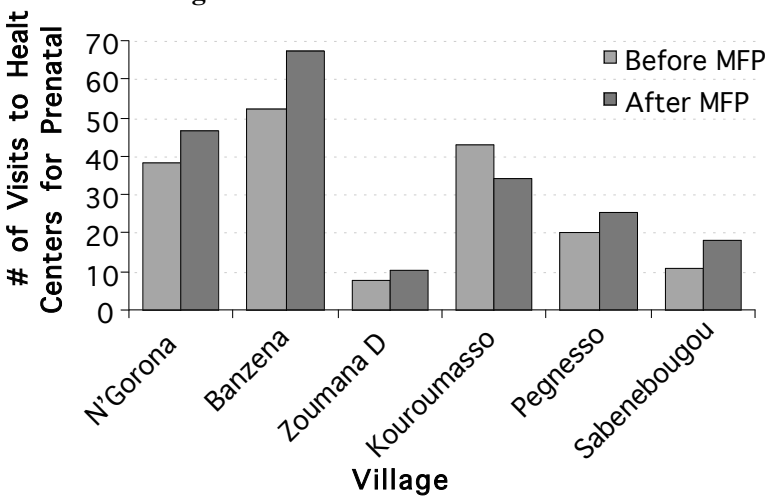
After the introduction of the platform, the total number of children in CM2 and the total number of students who passed the exam increased. The proportion of students entering secondary school also increased slightly after the introduction of the multifunctional platform; the proportion of girls entering secondary education increased from roughly 31 to 38 percent.

Attributing the improvement in educational indicators to the multifunctional platform's services is not a straightforward task. Many factors may have contributed to these results. From an intuitive perspective, however, these results are not surprising. The relationship between providing women and children with access to motive power and time savings is well documented. It is not surprising therefore to learn that with additional time savings mothers are allowing their children – especially girls – to take better advantage of educational opportunities.

3.5.5 Health (MDGs 4 and 5)

- *Higher Number of Prenatal Visits to Health Clinics*. Data on prenatal health care, and supporting information gathered from women and health care staff, suggests that the multifunctional platform can facilitate health care by giving women and children more time and money to take care of themselves. Figure 3.9 illustrates this finding by showing the number of visits to health clinics for prenatal care both before and after the implementation of the multifunctional platform project. Not surprisingly, five out of six villages with health clinics saw a rise in the number of prenatal visits after the introduction of the multifunctional platform.

Figure 3.9: Prenatal Health Care



In addition to data on prenatal health care, the study also includes anecdotal information regarding diarrhea and vomiting. In Balanfina, where the multifunctional platform provides a water network, the study documented a drastic reduction in the number of consultations for diarrhea and vomiting.

3.6 Contribution to Macro-Development and the Achievement of the MDGs

The local level development outcomes associated with the multifunctional platform's services have important implications for macro-development and the achievement of Mali's MDGs. They suggest that the provision of rural energy services is an important means of alleviating extreme poverty and hunger, helping achieve universal primary education, promoting gender equality, and enhancing overall health.

The current goal of the multifunctional platform project is to provide decentralized rural energy services to roughly ten percent of the country's population by the end of 2004. This will require the construction of roughly 450 multifunctional platforms. To date, there are roughly 400 multifunctional platforms in operation. Assuming each of the 205 economically-active woman per village who use a platform's services save on average 2.5 hours from grinding and milling chores per day, it can be estimated that almost 75 million hours of time savings are currently being made available to women per year. These hours are being used for resting, generating additional income, educating children, and tending to health needs.

This is only one example of the impact that multifunctional platforms are having at the national level. A similar kind of estimation can be made for other benefits, such as increased monetisation of the economy. Assuming the cost of procuring a platform's services averages 320 CFAF per woman per visit, and that each economically-active woman visits a platform three to

four times a month, the cost of using a platform averages roughly 36 CFAF per day[38]. If each woman generates on average 102 CFAF (US$ 0.19) a day in additional revenue by using a platform's services, the net additional income generated per woman is estimated at 66 CFAF (US$ 0.12) per day. This suggests that roughly 2 billion CFAF (almost US$ 3.6 million) of supplementary income is being made available to women per year.

These estimations are impressive given the limited number of individuals that multifunctional platforms currently serve. But what if with a wide-scale implementation of the multifunctional platform concept, every village in Mali had access to a multifunctional platform?[39] What would be the likely benefits of scaling up such services?

Table 3.8: Implications of Scaling-up the Multifunctional Platform Project

Field	MDG	Selected Indicator	Value in 2000	What if Every Village in Mali had Access to a Multifunctional Platform? [a]
Poverty	1	Proportion of People with an Income < US$ 1/day	73%	Somewhere between one and one and a half million women (11-15% percent of people living on less than US$ 1/day) could earn an additional US$ 0.32/day (PPP)
Education	2	Cohort Survival Rate	95%	Drop out rates for boys and girls will decline, putting Mali in a very good position to achieve 100% cohort survival.
Gender	3	Girl-to-Boy Ratio in Primary School	71%	The girl-to-boy ratio in primary school might rise an additional 3 percentage points above baseline trends within a matter of years.
Health	4 &5	Maternal Mortality Ratio	0.63%	Infant and child malnutrition and the incidence of water-born diseases will decrease along with the affordability of women's healthcare.

[a] This assumes that somewhere between 4,500 and 6,500 additional villages recieve MFPs. Ranges correspond to the lower and upper bounds of this assumption.

If every village in Mali receives a platform and if each platform serves roughly 205 economically-active women, somewhere between one and one and a half million women (8-11 percent of Mali's total population or 11-15 percent of people living on less than US$ 1/day) will benefit from scaling up the multifunctional platform concept. Assuming that scaling up the project concept does not dramatically diminish its benefits, the financial gains on the part of direct users, alone, could amount to somewhere between US$ 41 and US$ 59 million per year. On a purchasing power parity (PPP_{1993}) basis this equates to each individual earning an additional US$ 0.32/day. This is almost equivalent to the country's poverty gap ratio (US$ 0.37/day (PPP)). Despite being based on a number of assumptions, this rough estimation provides a good sense of how large an impact a wide-scale implementation of the multifunctional platform concept might make on income poverty.

[38] Assumptions are based findings from: Brew-Hammond, A. and Crole-Rees, A. 2004. Reducing Rural Poverty through Increased Access to Energy Services: A Review of the Multifunctional Platform Project in Mali. Mali: United Nations Development Programme. pg. 28.

[39] In 2001, Alpha Oumar Konaré, then the president of Mali, formally declared his intent to provide an MFP for every Malian village as part of his sustainable development policy.

Replicating the multifunctional platform concept on a larger scale would also have important implications for education and gender equality. For example, in 1990, the average girl-to-boy ratio in primary school in Mali was roughly 59 percent. By 2000, the ratio had increased by 12 percent to approximately 71 percent. The average girl-to-boy ratio in primary school among the villages surveyed as part of this study was approximately 56 percent in 2000, well below the 1990 national average. In the course of less then five years – the time between this study and the beginning of the multifunctional platform project – the average girl-to-boy ratio among the villages sampled grew to 74 percent; an increase of roughly 18 percent. In comparing the two trends, it is obvious that the average annual increase in the girl-to-boy ratio in primary school is almost three times larger for villages with access to multifunctional platforms than for those villages representative of the country as a whole. Using the most conservative estimates, this suggests that if the multifunctional platform concept were to be replicated at the national scale, there is a good chance that the national girl-to-boy ratio in primary school would increase to at least 74 percent.

Maternal and child health are two other areas in which scaling up the project concept would also have an impact. Quantifying these impacts at the macro-level is difficult, however. Turning to a literature review, instead, uncovers some important energy-health linkages that illustrate how a multifunctional platform's services can impact both maternal and child health. The findings from this literature review are as follows:

In 2000, the Initiative for Equality in Mali conducted a study of the health services offered in the community of Sikasso and circle of Bla[40]. The study found that lack of money was one of three key reasons why people interviewed did not seek medical treatment for a fever, accounting for 33 percent of responses. The other reasons included a preference for home treatment (40%) and the expectation that the fever would pass (17%). The study also found that "those in the highest income quintile were found to be 1.94 times more likely to use health services compared to the lowest income quintile for fever treatment"[41]. This upper quintile is also 1.58 times more likely to receive post-natal care. These findings suggest that a multifunctional platform can improve the use of health facilities via improvements in revenue generation.

According to an analysis of the Demographic and Health Survey (DHS) of Mali for 2001, "the causes of (child) malnutrition are multiple and include poor socio-economic conditions, inadequate prenatal care, maternal malnutrition, short spacing between births, high fertility, large numbers of young children, ignorance about feeding, repeated infections, and lack of access to health services"[42]. This study's findings suggest that the freeing up of women's time due to the multifunctional platform's services will lead to improvements in infant and child nutrition. Data

[40] Gamble K., et al. 2000. Rapport d'etude sur la demande, l'ofre et la qualite des soins de sante de base dans la commune de Sikasso et cercle de Bla. L'Initiative pour l'equalite au Mali; Partnership for Health Reform.
[41] Hutton, G., 2002. User Fees and other Determinants of Health Utilization in Africa. Switzerland: Swiss Tropical Institute.
[42] Castle, S., et al. 2001. Introducing Complementary Foods to Infants in Central Mali. Demographic and Health Survey, Mali.

from three studies of Mali detail how a woman's busy work schedule explains the prevalence of undernourishment among young children and infants.

Masters and Sanogo (2002) show that in Mali, infant malnutrition is worst up to two years of age. After two years, the nutritional status improves, but the early experience of malnutrition can lead to lasting detrimental health effects[43]. Tefft et al. (2003) state: "Work and child care demands compete for a women's time. Within four weeks after child birth, 58% of mothers resumed their normal work because existing social systems failed to provide adequate support for accomplishing household tasks, taking care of other children, and supplying agricultural labor."[44] The DHS report reveals similar findings; "…it became clear that women frequently employed surrogate caretakers when they were occupied with household tasks or engaged in cultivation or trading". As if to underscore the potential benefits of the multifunctional platform's services regarding health, Tefft et al. specifically note, "demands on women's time are compounded by the lack of functioning bore wells and cereal mills".

These time constraints from a heavy workload aggravate problems that lead to child malnutrition. The World Health Organization recommends that infants be exclusively breast-fed until six months of age. Tefft et al. found that women do not follow these recommendations in part due to their work schedules "that make it difficult to meet demanding infant feeding schedules". The DHS survey documented these findings: "Few children were exclusively breast-fed and most were given water or other liquids from birth. These other liquids are likely to be sources of contamination and lead to a risk of diarrhea and ultimately to growth faltering."

These findings suggest that the benefits of scaling up the multifunctional platform project can be measured in orders of magnitude. The analysis also suggests that given the appropriate conditions (i.e., access to schools or health clinics in villages), the benefits of increasing access to rural energy services may impact a broad range of development fronts. This is important because it suggests that the provision of relatively inexpensive small-scale decentralized energy services can help the country achieve its MDGs.

3.7 Conclusion

This study has reviewed experiences of the multifunctional platform project in Mali and documents how modern energy services affect people's lives. The study's findings suggest that modern energy services can make significant contributions to improving the livelihood of the rural poor. Energy services are a powerful engine for local level development and play a critical role across a wide spectrum of development initiatives. Areas in which access to energy services were found to have made a contribution to development include: (1) poverty alleviation; (2) education; (3) gender equality; and (4) health.

[43] Masters, W. and Diakalia S., 2002. Welfare Gains from Quality Certification of Infant Foods: Result from a Market Experiment in Mali. American Journal of Agricultural Economics, 84 (4), November, 2002: 974-989.
[44] Teft, J. et al. 2003. Linkages between Child Nutrition and Agricultural Growth in Mali. USAID Policy Synthesis Number 64, United States Agency for International Development.

The findings from this study also suggest there are a number of lessons to be learned regarding the role that energy services can play in Mali's development. The following is list of the most important policy messages derived from this study:

- *Increase the role of rural energy services within macro-scale/national poverty reduction strategies*. As the evidence from Mali suggests, there is a positive correlation between the provision of energy services and the achievement of MDGs related to poverty reduction, education, gender equality, and health. As the Malian experience suggests, however, governments often lack the appropriate policies or institutional framework required to bring decentralized energy services to rural areas. Linking micro-scale energy interventions with policy formulation at the macro level still remains a challenge to Mali. It is for this reason that more needs to be done to encourage policy makers to integrate the impact energy services can have on human development into their macro-level decision making process.

- *Couple the provision of energy services with productive activities in order to enhance income generation in rural areas*. An important insight into how energy interventions can enhance income generation lies in the synergistic relationship between energy services and productive activities (especially those associated with agriculture). As the multifunctional platform project suggests, increased income generation among villages with access to multifunctional platforms is closely tied to enhanced productivity and expanded economic activity. With the additional time and labor saved by the multifunctional platform's services, households are able to produce larger quantities of, and better quality, agricultural products.

- *Reduce the gender bias of rural energy poverty*. Despite its relative success, preliminary findings from the multifunctional platform project in Mali suggest that the extent to which the provision of energy services (particularly mechanization) is capable of increasing revenue generation among women is dependent upon the socio-economic and/or cultural environment in which they live in. In order to assure rural energy projects are equitable to both men and women, policy makers must first recognize the gender dynamics of household energy management. To assure these dynamics do not continue to exacerbate the gender bias of rural energy poverty, more attention must be placed on reducing the drudgery of women's labor and ensuring women are empowered to make choices about energy.

- *Focus on modernizing energy services needed for food processing, agriculture, cooking and rural enterprises in order to maximize the impact energy interventions can have on the least developed and remote rural countries*. As the Malian experience suggests, energy interventions targeted at reducing the time and effort that households must spend on informal activities such as food processing (i.e., rice production and milling cereals) can help improve the probability that women and children will take advantage of better educational, health, and income-generating opportunities. Despite the potential to bring about multiple and immediate development benefits for the poor, this aspect of rural energy development currently receives little support from external agencies as compared with rural electrification, for example. This suggests that in Mali, where cooking or other time-intensive informal activities continue to

exacerbate the drudgery of women and children's labor, a more balanced approach to rural energy development must be taken.

4. PHILIPPINES COUNTRY CASE STUDY

4.1 Summary

This study examines what impact the 'Philippines National Electrification Program has had on development outcomes that aid the achievement of the Millennium Development Goals (MDGs). Since the mid-1980's, growth in the provision of electricity in the Philippines has coincided with positive trends along many of the country's major developments fronts. This correlation is borne out "descriptively" by observing the trends in many of the poverty-, health-, and educational-related MDG indicators. The relationship is also validated by the analytical work presented in this study. The study's findings suggest that access to electricity can have important contributions to improving the livelihood of the poor.

Overall, this study finds a strong correlation between access to electricity and development, and can isolate electricity's positive relationship with education and health while controlling for other non-energy related factors. The study's findings suggest that individuals with access to electricity have roughly a 25 to 30 percent higher probability of being literate and having completed primary school compared to those without electricity, and women with access to electricity have a 10 to 17 percent higher probability of giving birth to a child with the assistance of a health professional than those without electricity. These kinds of quantitative findings are validated by anecdotal evidence from the field.

Field studies show that access to electricity can facilitate improvements in education and health by stimulating local income generation, decreasing the burden of housework, and improving study conditions for children. According to a Manila Electric Company (Meralco) Rural Electrification Project survey, nine percent of respondents reported "increased income and/or savings" as a result of electrification. Some residents in newly-electrified barangays began selling ice cream and chilled drinks, and others started selling water obtained using electric pumps. In other cases, store owners were able to keep their stores open at night expanding their revenue-generating potential. The survey also showed that roughly 15 percent of survey participants noted savings in time spent on housework. The addition of appliances such as electric irons, refrigerators, water pumps, and washing machines, all helped lightened the workload of women. The survey showed that the dinnertime and bedtime of respondents shifted back by one to three hours with electrification. This increased opportunities for education, piecework, and entertainment. Ssome 32 percent of the survey group said that well-lit rooms provided improved study conditions for their children.

The success of the National Electrification Program in facilitating macro-development can be attributed, at least in part, to the Philippines' Rural Electric Cooperative (REC) model. The REC model has been successful at maintaining a high rate of household electrification, and thus has enabled a large segment of the country's population to benefit from electricity. A well-designed cooperative like the REC may serve as a good electrification model for other developing countries.

4.2 Country Profile

4.2.1 Overview

The Philippine archipelago is made up of over 7,000 islands extending over 1,600 km from north to south. The country is situated between the South China Sea, the Philippines Sea, and the Pacific Ocean. Eleven of its islands account for 94 percent of the total land area and much of the population. The terrain is mountainous, with large coastal plains, and the climate is tropical, with heavy rainfall and dense rainforests.

Figure 4.1: Map of the Philippines

At year-end 2003, the Philippines had a population of roughly 83 million people. While the population growth rate through the 1990s averaged only slightly more than 2 percent, the country's population density of 258 people/km^2 is well above the levels of its southeast Asian peers. Despite being a densely-populated country, roughly 50 percent of the country's population still lives in rural areas.

The Philippines is a predominantly agricultural country, with 47 percent of total land area (about 13 million hectares) devoted to the practice. In terms of employment, the agricultural sector accounts for about half of the total labor force and roughly 18 percent of Gross Domestic Product (GDP). Rice and maize are the two principal food crops. Other major cash crops include coconuts, sugar, bananas, pineapples, and coffee. Industry is another important sector of the Philippine economy; particularly textiles and garments, electronics, and automobile parts. Most industries are concentrated in the urban areas around metropolitan Manila. Manufacturing accounts for 32 percent of GDP and employs 9 percent of the work force. The country's service sector (commerce, finance, transportation, and a host of private and public services) accounts for the remaining 50 percent of the country's GDP and 40 percent of the work force. The country possesses significant reserves of chromite, nickel, and copper. Forestry and fishing are two other important natural resources of the Philippines.

4.2.2 Development Context

The Philippines has made significant progress toward development during the last decade. Indicators that track development in poverty, education, gender equality, children's health, maternal health, and elimination of diseases have been generally positive. Despite improvements in these areas, measures of income and wealth equality and environmental sustainability have not been encouraging.

The country's Human Development Index (HDI) rank has steadily improved over the years, having gained seven notches since 1990. The Philippines ranks 85th out of 175 countries on the 2003 United Nations HDI, placing it in the medium human development category. All in all, development in the Philippines is characterized by rapid industrialization, a crippling fiscal deficit and diminished investor confidence, deteriorating environmental resources, high levels of poverty (one in three Filipinos survives on less than US $1 per day), and extreme gaps in income.

The Philippines' medium-term policy agenda for reducing poverty is defined in the government's Medium-Term Philippines Development Plan (MTPDP). According to the 2001-2004 MTPDP, a number of development challenges warrant particular attention given their severity and importance to the country's future. A few of these challenges include:

- *Rural Poverty*. In the Philippines, poverty is a rural phenomenon. The gap between urban and rural poverty has been increasing. Poverty incidence in rural areas is more than twice that in urban areas. In 2000, almost one-half of the total families living in rural areas were deemed poor.

- *Environmental Degradation*. A number of environmental problems have plagued the country in recent years, including; forest resources depletion, coastal and marine resources degradation, loss of biodiversity and habitat destruction, soil erosion, land-use conversion, water and air pollution, waste disposal, urban congestion, and water scarcity. Among these problems, the country faces three broad environmental challenges: urban air and water pollution, solid waste generation, and the declining quality and availability of water resources.

- *High Population Growth*. The 2000 Social and Structural Review pointed out that higher population growth is constraining increases in per capita incomes and concluded that curbing population growth will make the poverty reduction task much easier. The Philippines has a high fertility rate by Asian standards (3.5), despite its decline in recent years. As a result, population growth (2.1 percent in 2000) remains one of the highest in the region, which puts a higher burden on economic growth to reduce poverty. According to the population projections conducted for the review, if the current trend continues, population will increase to about 95 million in 2010 from about 78.6 million in 2000. This has implications for delivery of basic services (i.e., food, health, education) and especially maternal and infant health care and health insurance systems, and on the need to enhance growth of incomes in rural areas, especially in impoverished regions.

- *Corruption*. Lack of transparency and corruption constrain performance at all levels of the executive branch, the legislature, and the judiciary. Systemic and structural weaknesses allow corruption to flourish, inhibiting the development of competitive markets, deterring foreign investors, and severely limiting the government's ability to raise revenue. Uneven distribution of the benefits of economic growth has disproportionately excluded the Muslim minority, strengthening the resolve of armed separatist groups in the Mindanao region. The ongoing

conflict feeds the cycle of poor economic performance by scaring off private investors, halting tourism, and draining fiscal coffers of funds needed for infrastructure and education.

- *High Government Debt*. Despite revived economic growth since the Asian financial crisis, the government incurred a record budget deficit in 2002 of US$ 4.1 billion, or 5.3 percent of GDP, which left the country with public sector debt equal to more than 100 percent of GDP. Current government debt is estimated at nearly US$ 60 billion, half of which is denominated in foreign currencies. There is growing concern that rising debt levels are eating up an increasing share of the government budget. Interest on external debt accounts for about a third of government spending.

The Philippines' human development outlook can be contextualized further by examining the country's performance against the development indicators shown in Table 4.1:

Table 4.1: Selected Development Indicators [a]

MDG	Indicator (2000 except where noted)	Philippines	Developing Regions [c]
1	Proportion of Population Living < National Poverty Line [b]	34	23.2 [d e]
	Poverty Gap Ratio	8.4	6.9 [d f]
	Share of Poorest Quintile in National Consumption	5.6%	2% [d g]
	Prevalence of Underweight Children < 5 Years of Age	31%	28%
2	Net Enrollment Ratio in Primary School	96.4	82.1
	Proportion of Pupils Starting Grade 1 who Reach Grade 5	67.2	NA
	Literacy Rate of 15-24 Year-Olds	98.7	84.4
3	Ratio of Girls to Boys in Primary School	1.0	0.87
	Ratio of Literate Women to Men, 15-24 Year-Old	1.0	0.91
4	Under-Five Mortality Rate (per 1,000 live births)	40	90 [h]
	Prop. Of Children < 1 Year-Old Immunized Against Measles	86.5%	70% [h]
5	Maternal Mortality Ratio (per 100,000 live births)	200	440
	Proportion of Births Attended by Skilled Health Personnel	69%	52%

[a] This table includes only selected MDGs and MDG indicators. [b] National Poverty Line = PhP 11,388/capita/yr [1997] or US$ 315/capita/yr. [c] As defined by the United Nations [d] Low and middle income countries (as defined by the World Bank). [e] 1999 data. [f] 1998 data. [g] 1993 data. [h] 2001 data.

Source: National Statistical Coordination Board and UNICEF

The Philippines made good progress in reducing the number of poor living under US$ 1/day until 1997, as the share of the population living on less than US$ 1/day fell from 19.1 percent in 1990 to 12.1 percent in 1997, but progress has stagnated since then. An analysis based on the country's official national poverty line (the Philippines derives its national poverty line on a 2,000 calorie per day basis) is not as encouraging. The proportion of the population living below the national poverty line was reduced from 45 percent in 1991 to 33 percent in 1997, but has yet to fall further.

The Philippines has made significant progress with regards to achieving universal primary education. In 2000, the country's net primary school enrollment ratio was 96.4 percent. Elementary enrollment is almost equal between boys and girls, while secondary enrollment is slightly higher for girls. Despite being close to meeting its enrollment target, the Philippines still has a long way to go in improving primary education completion rates.

Under-five mortality rates and infant mortality rates have shown steady declines over the 12 years through 2002. Despite being in a good position to meet its under-five mortality rate target, reducing the infant mortality rate remains a challenge. The government's target is to bring the infant mortality rate down to 35/1,000 by end 2004. The maternal mortality rate has shown a consistent improvement over the ten years through 2000. In order to meet the target set forth by MDG 5 (Improve Maternal Health), maternal mortality will need to fall from 200 – where it was in 2000 – to roughly 52 by 2015. Given that the ratio declined by only 18 percent between 1990 and 1998, the outlook for meeting the target is not encouraging.

4.2.3 Energy Context

The Philippines has witnessed steady growth in primary energy demand over the past 20 years, following a period of relatively flat growth during the 1970s and the first half of the 1980s. Compounded annual growth in energy consumption between 1980 and 1990 was 2.4 percent, while growth for the ten-year period through 2000 was more than double that at 5.6 percent. On a per capita basis, consumption was flat over the ten years through 1990, but picked up to 3.3 percent compounded annual growth over the following ten years. This rising trend in energy demand that began in 1986 coincided with an economic reform program implemented following the departure of the Marcos regime.

The Philippines is highly dependent on imports for its energy supply. Imported oil and coal contributed 57 percent to the demand mix in 2000. Biomass (wood, charcoal, bagasse, and organic waste) made up a significant 28 percent of consumption, while geothermal and hydropower provided eight and five percent of supply, respectively. The country possesses a huge potential for geothermal energy; it is the second-largest producer in the world behind the United States. However, the country is currently utilizing only a small portion of potential geothermal capacity, since much of the untapped geothermal resources are smaller capacity, more geographically dispersed, and/or far from energy demand centers.

Power generation consumes roughly 30 percent of total primary energy demand in the Philippines, with the balance consumed by the commercial, industrial, and transportation sectors. In 2000, the Philippines had over 12,000 MW of installed electric power capacity. This level represents an eight percent compounded annual growth in capacity over the 1992 to 2000 period. Growth in power-generating capacity began to rise sharply in the 1970s and 1980s when government policy called for a dramatic expansion in national electrification. This growth trend in power capacity correlates quite well with improvements along many of the MDG indicators in the Philippines over the past ten to fifteen years.

From an energy perspective, the Philippines' most important challenges include:

- *Conservation and Efficiency*. Accelerating economic and population growth in the Manila region continues to put pressure on the country's energy supply, which in turn is putting upward pressure on the country's already high electricity prices. Since the power crisis in 1990, the country has done much to increase generation capacity, but has done relatively little with regards to conservation and efficiency. In 1990, for example, the country's energy intensity was roughly 129 mtoe/million US$ 1995 in purchasing power parity (PPP). By 1999, the country's energy intensity had increased to 147 mtoe/million US$ 1995 PPP.

- *Air Pollution*. Deteriorating air quality is impairing the health and welfare of a large portion of the Philippine population, in particular that of the 20 million residents in Metro Manila and its surrounding air shed. The concentration of several dangerous pollutants has reached critical levels that are well above those that commonly affect human health. The primary causes of air pollution – vehicles, industry and electric utilities – continue to expand rapidly. If not addressed, the detrimental effects of air pollution will significantly erode the gains of economic and social development.

4.3 Project Description

4.3.1 Overview

What impact energy services provided by the National Electrification Program have had on the achievement of the country's MDGs is the focus of this study. The Philippine government first established total electrification as a national policy objective in 1960, and created the Electrification Administration (EA) to oversee its implementation. In 1969, the government determined that RECs would serve as the primary business model for national electricity distribution. The National Electrification Administration (NEA) was established that year (replacing the EA) and charged with implementation of a national REC program.

In 1990, major steps were taken to de-politicize and reorganize the REC program. The NEA introduced a number of reforms including stricter financial accountability for RECs. In more recent years, a number of programs have been initiated that focused on poverty alleviation and social development through the expansion of rural power access. These programs included: (1) the Accelerated Barangay Electrification Program (ABEP), which was initiated in 1999; (2) the O'Ilaw ("Let There Be Light") Program, which was operational from early 2000 rthough early 2003; and (3) the Expanded Rural (ER) Electrification Team, which was established in April 2003.

The O'Ilaw Program unified the electrification efforts of agencies including the Department of Energy (DOE), the NEA, the National Power Corporation (NPC), and the Philippine National Oil Company-Energy Development Corporation (PNOC-EDC). Each of these organizations had responsibilities for specified barangay electrification programs, as part of the overall electrification goals. The O'Ilaw Program also encouraged the participation of the private sector

in expanding power provision. The ER Team effectively replaced the O'Ilaw. Its objectives are: (1) to further encourage public/private partnerships in electrification; (2) to promote unconventional and renewable energy for power provision in remote and unviable regions; (3) to achieve 100% barangay electrification by 2006; and (4) to coordinate various parties and efforts to the overall rural electrification process.

The Meralco Rural Electrification Project was established as a part of the National Electrification Program. The project objective was to provide electricity to rural areas within the company's franchise region, wherever access to electricity service was either limited or non-existent, and thereby improve the living standard of the residents and contribute to rural development. The project was initiated in mid-1991 and was completed in late 1999, at which point almost 100 percent of all barangays in Meralco's franchise areas had been connected to the power grid.

While electrification programs have been ongoing for decades, this study limits the "project" to only encompass efforts since the early 1990s. It was at this time that the government began to seriously address many of the failings of previous efforts in the REC programs, and began to emphasize and encourage greater private investment into the sector. This time period also coincides nicely with the starting point of the MDGs.

4.3.2 Scope and Cost of Project

The rate of increase in barangay electrification has accelerated over time. By 1980, some 120 RECs had been established across the country, supported by roughly US$ 100 million in loans –primarily from the United States Agency for International Development, but also with lending from France and the World Bank. At that point, the country had achieved an electrification rate of just over 25 percent of the country's 42,000 barangays. By 1990, the rate had grown to approximately 60 percent, and by 2000, it reached 80 percent. Table 4.2 shows that within the first three years of the O'Ilaw Program (through year-end 2002), some 4,300 barangays received electricity and the overall barangay electrification rate reached 87 percent. At present roughly 4,000 barangays remain unconnected.

Table 4.2: Barangay Electrification Program

	1999	2000	2001	2002	2003 F	2004 F	2005 F	2006 F
Target	900	1,621	1,353	1,636	1,619	1,258	1,304	1,228
Actual	755	1,366	1,244	1.699				
Remaining	9,731	8,352	7,108	5,409	3,790	2,532	1,228	0
Cumulative	32,281	33,647	34,891	36,590	38,209	39,467	40,771	41,999
Rate (%)	77%	80%	83%	83%	91%	94%	97%	100%

Under the Meralco Rural Electrification Project, 189,567 households in six provinces (Bulacon, Rizal, Laguna, Quezon, Batangas, Cavite) were electrified. The beneficiary households accounted for over 11 percent of the total number of electrified households in the target provinces by the completion of the project. The project was funded by Japanese Official

Development Assistance (ODA) lending via the Japan Bank for International Cooperation (JBIC). The project cost amounted to 12,722 million yen (roughly US$ 110 million;), 58 percent of which was covered by the Japanese ODA loan.

Table 4.3: Project Summary

Project Name:	National Electrification Program
Objective:	To achieve 100 percent baranagay electrification by 2006
Status:	As of 2003, 91 percent of all baranagay had been electrified
Start Date:	1990
Finish Date:	2006
Total Project Cost:	Unknown

4.4 Methodology

4.4.1 Methodological Framework

The objective of this study is to establish a better quantitative understanding of how energy services provided by the National Electrification Program have led to development outcomes that aid the achievement of the Philippines' MDGs. Having given consideration to the resources available to the study, the quality and availability of data (see Section 4.4.3), and the development context in which the National Electrification Program has been implemented, the scope of this study has been limited to analyzing the impact that energy services have on: (1) education; and (2) health. These two broadly-defined categories are meant to correspond with MDGs 2, 4 and 5 (note that health includes both MDG 4 - Reduce Child Mortality and MDG 5 - Improve Maternal Health).

This study uses a set of regression models to help in quantifying the impact that access to electricity has on development. The objective of such an approach is to help isolate electricity's impact on development while holding other non-energy related variables constant. The analysis includes both Ordinary Least Squares (OLS) and probit regression models. As illustrated by Table 4.4, each model controls for a slightly different combination of independent variables. Note that "floor quality"[45] is used as a proxy for income, since income data is not available.

[45]The following "floor quality" classifications correlate well with income: (1) earth, sand; (2) wood planks; (3) palm, bamboo; (4) parquet, polished wood; (5) vinyl, asphalt strips; (6) ceramic tiles; and (7) cement carpet.

Table 4.4: Regression Models

		Independent Variable						
Mode	Dependent Variable	Access to Electricity	Respondent's Age	Respondent's Age^2	Residence Type	Muslim	Years of Education	Floor Quality
1	Literacy (probit)	X	X		X			X
2	Years of Education	X	X	X	X			X
3	Completed Prim. School (probit)	X	X		X			X
4	Completed Sec. School (probit)	X	X		X			X
5	Educational Attainment	X	X	X	X			X
6	Birth Assisted by Doctor (probit)	X			X	X	X	X
7	Birth Assisted by Nurse (probit)	X			X	X	X	
8	Received BCG (probit)	X			X		X	X

4.4.2 Data

The analytical portion of this study is based on data from Demographic and Health Surveys (DHS). DHS reports are nationally representative surveys designed to provide information on population, health, and nutrition of women in developing countries. Two surveys have been conducted in the Philippines – one in 1993 and one in 1998. The household questionnaire employed is divided into two parts: a household questionnaire and women's questionnaire. The women who are interviewed range from 15- to 49-years-old.

4.4.3 Analytical Limitations

The analytical limitations of this study are a function of both data quality and availability. As alluded to in the prior section, there are a number of issues related to the quality and availability of data that have, in one way or another, limited the analytical scope of this case study. The most important issues to keep in mind while evaluating the case study's findings are the following:

- *Narrowly Defined Statistics*. A major constraint of this analysis is that the only energy-related indicator included in DHS reports is a yes/no question regarding whether or not a household has access to electricity. The study does not have available any data on other sources of energy used by households and individuals, nor does it have data on the types of energy services that people avail themselves to with these energy sources.

- *Lack of Income Data*. The study's analysis is constrained further by the fact that it cannot control for income, as this kind of data is not available in the DHS reports. The study used occupation as a proxy for income, but occupation was shown to be statistically insignificant. The study's second attempt at controlling for income with the use of floor quality proved to be more successful.

- *Lack of Disaggregated Data on Gender*. The study is unable to control for gender because of a lack of data. This may not be as large an effect, since the Philippines tend to show more gender equality, but the study can not state this with certainty.

- *Lack of Time-Series Data*. The study is unable to address differences in results between 1993 and 1998, or the impact of the increased barangay electrification rate over the intervening period. There are two key reasons for this. First, the survey results for the two time periods are not panel data. The sample groups are different in the two studies, and so a time-series analysis could not be performed. Even if panel data were available, the study would not be able to present more than simple statements of correlation. This is because the surveys have not been designed with this objective in mind.

4.5 Findings

4.5.1 Overview

Overall, this study finds a strong correlation between access to electricity and development, and can isolate electricity's positive relationship with education and health when controlling for factors such as residence type (urban, rural), housing characteristics (proxy for income), age, and religion. Table 4.5 summarizes the results of the regression analysis.

Table 4.5: Summary of Findings

Indicator	The Odds of an Individual having…with Electricity as Compared to an Individual without Electricity
Completed Primary School	⇧
A Higher Level of Literacy	⇧
Given Birth Assisted by a Doctor	⇧
Given Birth Assisted by a Nurse	⇧
Received a BCG Test	⇧

4.5.2 Education (MDG 2)

The findings from the study suggest that having access to electricity is associated with overall improvements in education. The most basic analysis of the 1998 data reveals that having access to electricity is associated with an average of 3.4 more years of education. This is a significant increase since it is approximately one standard deviation. The situation is very similar for 1993, where the difference in years of education between someone with and someone without access to electricity is approximately 3.2 years; which is again more than one standard deviation.

Table 4.6: Descriptive Statistics for Education

Year		Number of Individuals	Mean Level of Education (yrs)	Std. Dev.
1993	Electricity	10,185	9.6	3.2
	No Electricity	4,741	6.4	3.2
1998	Electricity	9,702	9.7	3.1
	No Electricity	3,981	6.3	3.3

Source: Team Analysis

Figures 4.2 and 4.3 illustrate this finding in further detail. Figure 4.2 illustrates the relationship between access to electricity and various educational attainment levels, while Figure 4.3 illustrates the relationship between access to electricity and different forms of literacy. Both figures support the hypothesis that access to electricity is associated with overall improvements in education.

Figure 4.2: Relationship between Electricity and Level of Education, 1998

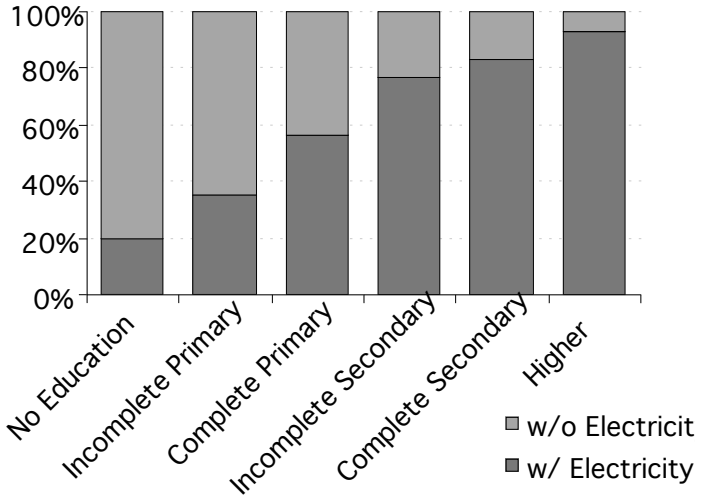
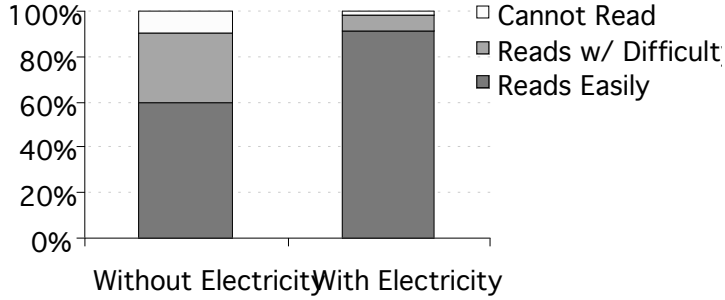


Figure 4.3: Relationship between Electricity and Literacy, 1998



A regression analysis of the data confirms the importance of electricity to educational attainment. According to model 2 (see Table 4.4) a person with access to electricity has, on average, three more years of education than a person without access to electricity. This is holding age, type of residence (urban, rural), and a proxy for income (floor quality) constant. According to probit models 1 and 3, having access to electricity is also associated with a higher probability of completing primary school and being literate.

Table 4.7: Regression Results for Education

		Probability				
MDG	**Indicator**	**w/Elec.**	**w/o Elec.**	**Odds Ratio**	**Pseudo R^2**	**Controlling for**
2	Completed Primary School - 1998	91%	64%	1.4	0.18	Respondent's age, rural, floor quality
2	Completed Primary School - 1993	92%	67%	1.4	0.16	Respondent's age, rural, floor quality
2	Being Literate -1998	88%	60%	1.5	0.17	Respondent's age, rural, floor quality
2	Being Literate -1993	87%	58%	1.5	0.16	Respondent's age, rural, floor quality

Source: Team Analysis

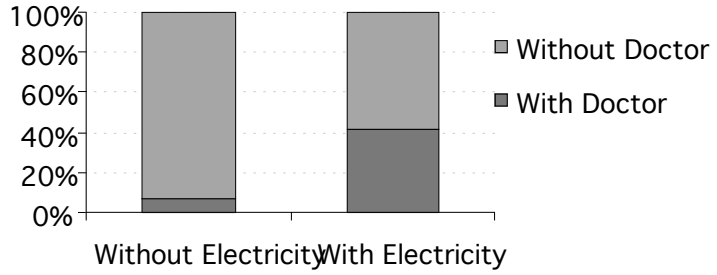
In 1998, a person with a mean age of 29, living in a rural area, with average floor quality (4.81 - vinyl, asphalt strip), had a 64 percent probability of completing primary schooling when without access to electricity whereas the same person with access to electricity had a 91 percent probability. The same person with access to electricity also had a 27 percent higher chance of literacy than a person without access to electricity.

The findings for 1993 show the same trend. A person with a mean age of 29, living in a rural area, with average floor quality (4.57 - vinyl, asphalt strip), had a 67 percent probability of completing primary school when without access to electricity whereas the same person with access to electricity had a 92 percent probability. The same person with access to electricity also had a 28 percent higher chance of literacy then a person without access to electricity.

4.5.3 Health (MDGs 4 and 5)

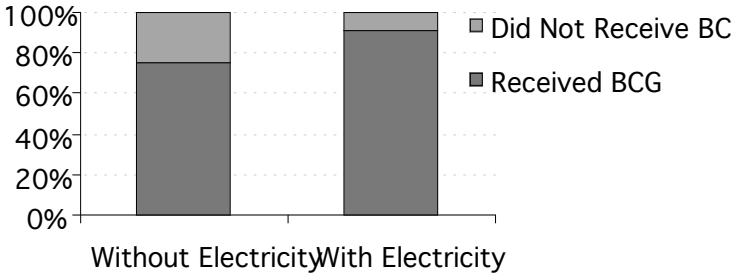
Figure 4.4 illustrates the relationship between access to electricity and births attended by a skilled health personnel. It shows that only 7 percent of those without access to electricity have doctor-assisted births and that the number rises to 42 percent for those with electricity access.

Figure 4.4: Relationship between Electricity and Births Attended by a Doctor, 1998



To calculate the effect of having access to electricity on the prevalence of tuberculosis, the study used a proxy variable of whether or not individuals have received a BCG test (Figure 4.5). Even though the difference between individuals with and without access to electricity is not large, the percentage of individuals that have received a BCG test is higher for those with access electricity in both 1993 and 1998.

Figure 4.5: Relationship between Electricity and BCG Tests, 1998



As illustrated by Table 4.8, having access to electricity is also associated with a number of other health-related indictors. The study has found that having access to electricity explains over 15 percent of the improvements in births assisted by doctors, and over 10 percent of the improvements in births assisted by nurses.

Table 4.8: Regression Results for Health

MDG	Indicator	Probability w/Elec.	Probability w/o Elec.	Odds Ratio	Pseudo R^2	Controlling for
5	Birth Assisted by Doctor - 1998	27%	10%	2.7	0.23	Religion, education, rural, floor quality
5	Birth Assisted by Doctor - 1993	23%	9%	2.6	0.22	Religion, education, rural, floor quality
5	Birth Assisted by Nurse - 1998	17%	7%	2.4	0.17	Religion, education, rural, floor quality
5	Birth Assisted by Nurse - 1993	14%	5%	2.8	0.17	Religion, education, rural, floor quality
5	BCG Tested -1998	87%	78%	2.7	0.08	Education, rural (insignificant), floor quality
5	BCG Tested -1993	84%	79%	2.6	0.06	Education, rural (insignificant), floor quality

Source: Team Analysis

There is a positive relationship between having electricity and births attended by a skilled health personnel. An analysis of the 1998 data shows that a non-Muslim, living in a rural area with average education (8.7 years of schooling), and with average floor quality has a 10 percent probability of giving birth assisted by a doctor if she does not have access to electricity. A person with the same characteristics but with access to electricity has a probability of approximately 27 percent. The findings for 1993 are very similar.

Births assisted by a nurse increase when comparing individuals with access to electricity to those without. The 1998 data shows that an average aged, non-Muslim, and average educated person in a rural area without access to electricity has a probability of approximately 7 percent of a birth assisted by a nurse; whereas a person with the same characteristic but with access to electricity has a probability of approximately 17 percent. The relationship is similar for 1993. Holding floor quality, religion, and education constant, an average person without access to with electricity has a probability of approximately 5 percent of a birth assisted by a nurse whereas a person with access to electricity has a probability of 14 percent.

As mentioned earlier, to calculate the prevalence for tuberculosis, the study used a proxy variable of whether or not an individual received a BCG test. The 1998 data suggests that the average person with access to electricity had a 9 percent higher probability of having had a BCG test as compared to an individual without access to electricity. In 1993, the difference was slightly lower, at 4 percent. There is a positive relationship between electricity and the probability of BCG tests, but the pseudo R^2 is only 6 percent and therefore the model does not explain the relationship very well.

4.6 Contribution to Macro-Development and the Achievement of the MDGs

Since the mid-1980s, growth in the provision of electricity in the Philippines has coincided with positive trends along many of the country's major development fronts. This correlation is born out "descriptively" by observing the trends in many of the poverty-, health- and educational-related MDG indicators. The relationship is also validated by the analytical work presented in this study. The study finds a strong correlation between access to electricity and development, and can isolate electricity's positive relationship with education and health when controlling for non-energy related factors. This suggests that the provision of electricity may have had an important impact on macro-development and the country's progress toward the MDGs.

The study's findings are validated by anecdotal evidence gathered from previous studies. One such study is the post Meraclo Rural Electrification Project survey. After the completion of the Rural Electrification Project in 2001, the company conducted a survey designed to ascertain the benefits of electrification to newly-connected households. The survey was carried out in six barangays (two in each of the provinces of Bulacan, Rizal, and Laguna) and consisted of 108 answers. The survey presented a series of questions that looked at the same set of individuals pre- and post-electrification. The survey's most relevant results to this study's findings are summarized below.

According to the survey, nine percent of respondents reported "increased income and/or savings" and three percent reported an "increase in job opportunities" as a result of access to electrification. Some residents in newly-electrified barangays began selling ice cream and chilled drinks, and others started selling water obtained using electric pumps. In other cases, store owners were able to keep their stores open at night, expanding their revenue-generating potential. Some beneficiaries were able to do piecework at home, even into the night. The results also showed that roughly 15 percent of survey participants noted savings in time spent on housework. The addition of appliances such as electric irons, refrigerators, water pumps, and washing machines, helped lighten the workload of women. The survey also showed that the dinnertime and bedtime of respondents shifted back by one to three hours with electrification. This increased opportunities for education, piecework, and entertainment. Some 32 percent of the survey group said that well-lit rooms provided improved study conditions for their children.

4.7 Conclusion

This study has examined the relationship between electrification and development outcomes in the Philippines. The study's findings suggest that electrification can make important contributions to improving the livelihood of the rural poor. Access to electricity is associated with, if not a prerequisite for, improvements in education and health. As the findings from this study suggest, there are a number of lessons to be learned regarding the role that electricity services play in the Philippine's development. The following is the most important policy message derived from this case study:

- *Consider using the Philippine REC model as a best practice model*. If one the objectives of an electrification program is to increase the rate of household electrification relative to village electrification, then the Philippines REC model should be considered a "best practice". In 1999, for example, 82 percent of all barangays in the Philippines were electrified as compared to 73 percent of households. The gap between the two levels of analysis is far larger in India, for example, where village electrification is roughly 85 percent while household electrification is only 27 percent.

CONCLUSION

Countries throughout the world are becoming more involved in the poverty reduction strategy process, which requires all countries to identify their development priorities in individual poverty reduction strategy papers (PRSPs). Which areas of development are given priority, and the amount of resources dedicated to them, often determines the direction and rate of progress a country makes toward achieving the Millennium Development Goals (MDGs). Despite their importance to a number of MDGs, more often than not, energy services are not explicitly mentioned in PRSPs. This is because the links between energy and development are not easily quantifiable, nor are they always direct in nature. As a result, small-scale energy interventions, however successful they might be at a local level, are rarely coordinated with other development initiatives, or replicated at sufficient enough scales in order to impact national or regional development. This often leads to an understatement of energy's importance in development strategies, and a situation where underinvestment in energy services becomes a bottleneck to development.

To ensure energy considerations are properly addressed in broader development strategies, more must be done to quantify the links between energy and development outcomes that aid the achievement of the MDGs. Moving beyond an intuitive understanding of how energy and development are related will enable policy makers to better understand the costs and benefits of scaling up energy interventions. It is no longer sufficient to think of energy demand as being driven by economic development. For those who are concerned with meeting the MDGs, it is imperative that they understand the importance of energy services versus growth in other inputs as a means of stimulating development. This will undoubtedly require greater awareness among non-energy specialists as to the role that energy services can play in helping achieve goals in their respective sectors, as well as improving the quality and quantity of energy-related data available to those who continue to explore the linkages between energy and development.

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