

The Case for Meeting the Millennium Development Goals Through Access to Clean Electricity



November, 2008

Peter Meisen
President, Global Energy Network Institute (GENI)
www.geni.org
peter@geni.org (619)595-0139

Irem Akin
Research Associate, Global Energy Network Institute (GENI)
iremakin85@hotmail.com

Table of Contents

Abstract

1. Introduction

1.1 Current Situation

1.2 Energy Poor Africa

2. Impact of Clean Electricity on Achieving the UN Millennium Development Goals

2.1 Background

2.2 MDG #1: Eradicate extreme poverty and hunger

2.3 MDG #2 Achieve Universal Primary Education

2.4 MDG #3 Promote Gender Equality and Empower Women

2.5 MDG #4 Reduce Child Mortality

2.6 MDG #5 Improve Maternal Health

2.7 MDG #7 Ensure environmental sustainability

3. Best Examples

3.1 Rural Electrification Project in Tunisia

3.2 Electrification of China

Conclusion

Abstract

Access to affordable clean electricity is fundamental to daily life and any level of socio-economic development. Because it is central to all aspects of our lives - lighting, heating, pumping and purification of water, agricultural productivity, refrigeration of food and medicines, sterilization of equipment and many others - there is an essential correlation between access to electricity and quality of life.

Surveys and studies in the 1990's confirmed that the threshold for developing countries to achieve sustainable socio-economic growth could be measured in terms of energy consumption. Below 1000 kWh annual per capita consumption of electricity, indicators such as literacy rate and access to potable water remain below 50 and 40% respectively. When per capita consumption reaches 2000 kWh, the same indicators rise to 85 and 90%. The same correlation has also been established with regard to infant mortality and life expectancy.¹ Therefore, access to electricity is clearly a determinant either of poverty or development.

Based on this relationship, we assert that achieving the Millennium Development Goals can be accelerated through the provision of clean electricity and the requisite energy policies because only then will socio-economic sustainable development be secured. Enabling access to clean electricity makes it possible to achieve the MDGs by meeting the energy needs of poor people and serves as a solution to help the poorest countries break out of the poverty trap. We contend that achieving of the MDGs can be accelerated with increased access to clean energy services.

1. Introduction

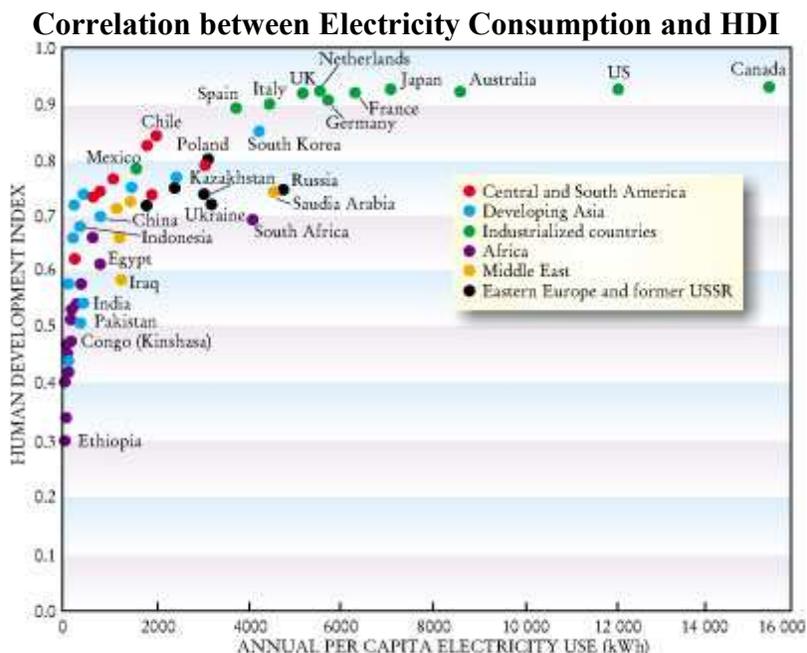
When it was introduced in the 1880s, electricity was used almost solely for lighting. Today, it is used for many functions from lighting and heating-cooling to powering televisions and computers. In the developed world, electricity usage has displaced earlier sources of fuel for home lighting, such as oil and coal. Nonetheless, in the developing world, the majority of people still do not have access to electricity in their homes. The places where electricity is universally installed are in North America, Europe, Japan, several Asian-Pacific countries, and a few other nations. However, even in some of these countries, the adoption of electricity in the household has been a recent, slow and gradual process.

While three-quarters of the world's population take electricity for granted, 1.6 billion people have limited or no access to electricity. This unequal distribution of energy has the largest impact on the vulnerable poor, especially poor women and children in rural areas. Inadequate access to modern energy is both a determinant and a manifestation of poverty and unequal gender relations. Rural women spend much of their income on acquiring energy which amounts to more than a third of household expenditures in some countries. They also use a large portion of another valuable asset, their time, on energy-related activities - for example, women and young girls spend almost 6 hours a day gathering fuel

¹ Gaillard, Roger M., "Regional Integration of Power Systems: A Tool to Reduce Energy Poverty and to Accelerate Economic Growth," Workshop on Energy Poverty in Africa 9-10th of June 2008 Abuja Nigeria, pp. 2.

wood and water, cooking and farming. They walk long distances, averaging 4-5 miles per day, risking their own and their children's health and safety. In Sub-Saharan Africa, only 8 percent of the rural population has access to electricity while 90 percent of the population still relies on traditional fuels for cooking. Women in rural sub-Saharan Africa are the most vulnerable population due to the lack of access to energy and are in strong need of cleaner, more efficient fuels.

Today, coal is still the primary energy source, supplying 41% of the world's electricity. Negative global environmental impacts of the current energy production and usage threaten the health and well-being of current and future generations. Its immense impact on global warming by its greenhouse gas production argues for phasing out coal and aggressive development of clean, renewable energy resources. Clean energy sources can be harnessed to produce electricity, process heat, fuel and valuable chemicals with less impact on the environment. Countries like China, Brazil and South Africa have electrified rural parts of their territories using renewable options for electricity generation such as mini-hydro, domestic solar hot water and drying systems, and small scale wind.² To enable sustainable socio-economic development for the world's population, a major change in the energy system is required worldwide. Continuing along the current path of energy development is incompatible with sustainable development objectives and the MDGs.³ Breaking the chains of poverty requires increased access to energy, while at the same time, aiming for sustainable development demands clean energy.



Higher electricity use per capita correlates with a higher score on the HDI

Source: Human Development Report 1999, United Nations Development Programme

² “Poverty Reduction: Can Renewable Energy Make a Real Contribution?” GNESD.
<http://www.gnesd.org/Downloadables/PovertyReductionSPM.pdf>

³ World Energy Assessment Overview 2004 Update,
<http://www.energyandenvironment.undp.org/undp/indexAction.cfm?module=Library&action=GetFile&DocumentAttachmentID=1010>, September 12 2008.

Electricity is the key to improving the lives of billions of people in a relatively short period of time. It is access to renewable energy services, not energy supply that matters. Electricity makes possible energy services such as lighting, heating, cooking, motive power, mechanical power, transportation and telecommunications. Furthermore, electricity contributes to income and employment generation. It increases household productivity and income generating potential, and therefore, helps to break the cycle of poverty. All these benefits are essential for socio-economic development. Increased access to electricity impacts both short and long term improvements in people's quality of life.

Choosing the appropriate technology for electrification is determined by cost effectiveness and environmental impact. One possibility for providing access to clean energy for rural and remote areas is to extend the electric grid and linking to various forms of renewable energy. The ability to transmit electricity over long distances allows for the use of low-carbon renewable resources. If grid extension were an affordable option for a village, it could bring benefits of access to lighting, modern telecommunications, clean water and other basic services to the community. However, connecting small villages with high voltage transmission lines has serious financial and technical constraints. Grid electrification is extremely expensive (approximately \$1 million/mile in the U.S.) due to the high cost of materials, land development and construction.

An alternative solution in rural areas is "off-grid electrification" which can provide power for many low-demand users for less expense. Even low demand can provide for domestic uses (lighting, cooling, TV, radio, communication), productive uses (water pumping, cooling, crop milling, sewing machines) and public uses (schools, health clinics, police stations).⁴ Rural electrification through renewable technologies such as PV, wind and biomass systems can provide an economical and environmentally sustainable option for meeting the energy needs of rural households without high operational costs or dependence on imported fuels. Building an off-grid electrification system requires a determination of which resources exist and which system would be best: i.e. wind turbine to generate electricity from wind or photovoltaic systems to generate electricity from sunlight. Small scale renewable energy is often the most economical way to electrify the rural areas of developing countries.

In this respect, rural electrification, first and foremost bringing clean electricity to remote areas, plays a major role in poverty alleviation. Even a small amount of energy supply can minimize the time spent on fetching water and fuel, extend working hours, enable storage of food and medicine and many other benefits. Access to energy, especially in the form of clean and affordable electricity, can help meet development needs. Even though no MDG refers to energy explicitly, increased access to electricity would accelerate meeting all the Goals.

This research argues that access to clean electricity is a prerequisite for reducing poverty and for meeting the Millennium Development Goals. It first describes the current situation of the world's unequal energy service distribution. The paper outlines the link between

⁴ Reiche, Kilian. Covarrubias, Alvaro. Martinot, Eri. "Expanding Electricity Access to Remote Areas: Off-Grid Rural Electrification in Developing Countries," http://www.martinot.info/Reiche_et_al_WP2000.pdf, Oct 24, 2008

access to electricity and MDGs 1, 2, 3, 4, 5 and 7 which focus on poverty reduction facilitated by income generation, improved health, universal primary education, women's empowerment, gender equality and environmental sustainability. Best examples (China and Tunisia) are given which lay out great achievements in electrification and helping large numbers of people overcome poverty.

1.1 Current Situation

“What human beings want is not oil or coal, or even gasoline or electricity per se, but the services that those energy sources provide.”

*World Energy Assessment Report:
Energy and the Challenge of Sustainability*

According to the International Energy Agency (IEA) of the Organization for Economic Cooperation and Development (OECD), nearly 1.6 billion people (one-quarter of the world population) have no access to electricity. So we can say that electricity is not yet universally accessible. Over the next three decades, the investment needed for new power generation capacity in developing countries will reach \$2.1 trillion. Even if this investment is secured, in the absence of effective policies and equitable distribution, the IEA projects 1.4 billion people will still lack electricity in 2030. IEA estimates that four out of five people without electricity live in rural areas of the developing world, mainly in South Asia and sub-Saharan Africa. However, the concentration of energy deprivation is likely to change. If current trends continue, 95% of the increase in population in the next three decades will occur in urban areas. Today, 2.4 billion people rely on traditional biomass (wood, agricultural residues and dung) for cooking and heating. That number will increase to 2.6 billion by 2030. In developing countries, biomass use will still represent over half of residential energy consumption by 2030. In sub-Saharan Africa, people spend up to five hours per day gathering fuel wood. So the traditional fuels used by poor people come at a high cost in time, labor and the environment.

Failure to meet the energy needs of the poor intensifies poverty, aggravates the delivery of social services, limits opportunities for women and erodes environmental sustainability at the local, national and global levels. Women and children spend several hours daily gathering fuel wood and water, often from considerable distances, for household needs. Because of these demands on their time and energy, women are denied opportunities for other endeavors such as economic activities, and children are denied school attendance. They also suffer considerable damage to their health, especially respiratory diseases from inhaling toxic fumes from cooking indoors on poorly vented stoves. Poor urban people spend a much greater share of their household income on energy than do higher income urban groups as they have smaller and less predictable incomes than higher income groups. Their appliances also use fuels much less efficiently. Global evidence shows that poor people's highest expenditure for energy services is on fuels for cooking, while the remainder is spent on fuels or batteries for light. In general, fuel wood provides heating and cooking for the urban poor at a higher cost than Liquefied Petroleum Gas (LPG) used by higher income groups. Likewise, kerosene provides lighting for the urban poor at a higher cost than electricity used by higher income groups. The poor's cost of acquiring

energy is increased by having to buy their fuel wood, charcoal and kerosene in small amounts, because they lack cash resources needed to buy these fuels in larger quantities.⁵



The difference of electrification between Europe and Africa is clearly seen in this photo taken by NASA. Africa with 955 million people is poorly lit overall, and the brightest areas are the most urbanized, not necessarily the most populated.

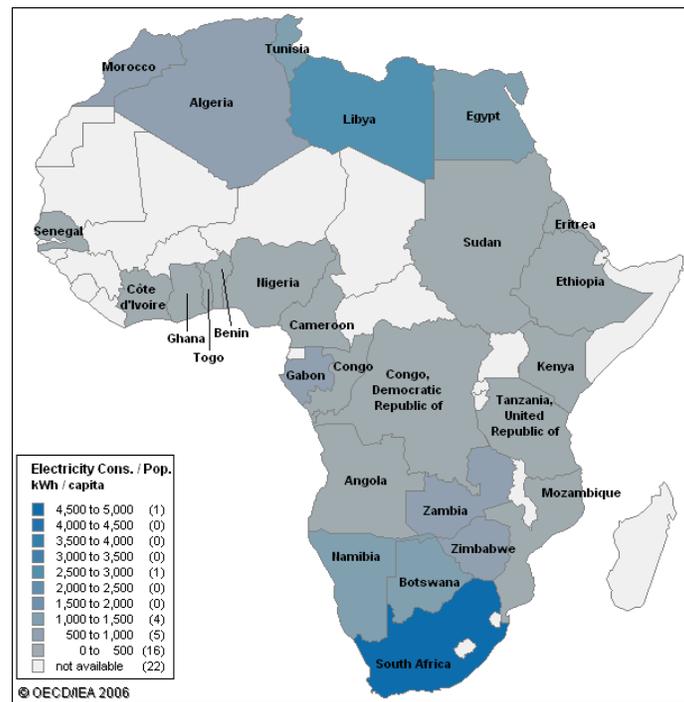
According to the World Bank, nearly 75 percent of Sub-Saharan Africans, or 716 million people, do not have access to electricity. In South Asia, some 50 percent, or 700 million people, lack access. About 90 percent of those without access in South Asia live in rural areas. The International Energy Agency estimates 1.4 billion people will still lack access to electricity in 2030 unless new approaches and policies are adopted. Hence a major expansion of electricity supply is needed in both the urban and rural areas of these regions.

The energy sources that the poor use are inefficient, unhealthy, pollute and destroy the environment. They use only a little energy, and they use it inefficiently. Consequently, they pay higher prices (for items such as batteries, battery recharging, candles, kerosene and charcoal) than the rich and spend enormous time collecting wood and fuel. The majority use kerosene rather than electricity for lighting, and they are exposed to carbon monoxide and carcinogenic gases. The dependence on fossil fuels by both developed and developing nations poses a global environmental threat, and the deprivation of millions of people from energy threatens global security.

⁵ Information taken directly from UN Energy Paper June 22, 2005

1.2 Energy Poor Africa

Most regions of Africa are extremely poorly served with electricity, and the energy demand of most of the countries is currently not being met. Several nations on the continent – even including oil-producing countries - are facing serious deficiencies in energy supply in all its various forms. Ironically, although energy is desperately needed for economic growth and poverty reduction, Africa is an exporter of commercial energy. Africa produces 7% of the world's commercial energy, but consumes only 3% of it. During the decade 1990 to 2000, the per capita consumption in sub-Saharan Africa declined.⁶ As there is direct correlation between the growth of the GDP and the consumption of energy, this is a deteriorating situation for the well-being of the African population.



The World Bank estimates that about 716 million people in sub-Saharan Africa are without access to electricity.

Sub-Saharan Africa depends largely on inefficient traditional fuels. The dominant fuel for cooking or lighting in low-income African homes is wood or other biomass, such as dung and crop wastes, which accounts for over 80% of primary energy demand. Kerosene is widely used. The population is scattered, and there is no electricity grid linking the remote locations to power generation. Thus, the percentage of households which have access to modern energy services is very low. It is estimated that no more than 20 percent and in some countries only 5 percent, of the population in Africa (excluding South Africa and Egypt) has direct access to electricity. The percentage falls to 2 percent in rural areas. Demand is expected to grow by 5 percent annually over the next 20 years.

⁶ Gaillard, Regional Integration...pp. 2.

Access to sustainable energy is a key factor for promoting social progress and economic growth both of which are closely linked to sustainable reduction of poverty. Lack of access to affordable, reliable, safe and environmentally friendly energy is a serious barrier to sustainable development. This has serious implications for Africa which displays the lowest per capita consumption of electricity with an average of approximately 400 kWh per capita per year in the Sub-Saharan region.⁷

More than five trillion cubic meters of water is available on the continent, but only 4% is being tapped for irrigation, food production, and hydroelectricity. Africa's exploitable hydroelectric potential is estimated at approximately 1.4 million GWh/year. This would be sufficient to supply electricity for the entire continent, yet, only 3% of this hydroelectric potential is used.⁸ The travesty here is that because hydro power is not harvested for development, the proportion of people in Africa dependent on inefficient traditional energy sources is higher than on any other continent.

In spite of the abundant energy resource potential in Africa, many countries have not been able to attract investment in the development of the energy sector. For example, in Southern Africa most of the rural areas remain unconnected despite the electrification efforts in the past. In these isolated areas, hybrid electricity* and solar home systems provide opportunities. In 2004, Universal Access goal, aiming for 100% of the household to be electrified, was accepted. This goal seems difficult to reach due to financial and capacity constraints.

Today, Africa is the least interconnected region in the world. More than any part of the world, renewable energy must play a part to bring light and power to the continent. Solar energy use in photovoltaic generators (PV) can be the remedy for Africa. The continent receives high levels of solar radiation; thus, solar home systems to electrify every household could be supplied at a lower cost than national grid distribution. The use of solar home systems could replace kerosene lamps and batteries. Kenya has made a huge step in making use of the sun and has created the most active solar home system market in the developing world. Kenya's successful experience should be expanded to other African countries which are abundant in renewable energy and at the same time in urgent energy deficit. For the rural poor living in these areas, renewable energy is the cheapest option. In brief, Africa is blessed with renewable energy potential, has enormous unmet demand and could accelerate this development for the benefit of all Africans.

⁷ Ibid., pp.3.

⁸ Blyden, Bai K., Aikwumi, Fenda A. "Unrealized Potential in Africa," IEEE Power&Energy, Volume 6, Number 4. July/August 2008, pg 53

* Hybrid electricity systems make use of two or more electricity generating options, i.e. a diesel-powered generator coupled with a solar photovoltaic generator, or a combination of a wind and solar system. (Source: Desert Research Foundation of Namibia website http://www.drfn.org.na/htm/energy_desk/energy_hybrid_electricity.htm)

2. Impact of Clean Electricity on Achieving the UN Millennium Development Goals

2.1 Background

It is clear that access to electricity makes a fundamental difference to poor people's lives and has an impact on achieving the MDGs. Electricity can do the following:

- enhance agricultural productivity (pumping water for agriculture, food processing)
- make clean drinking water possible
- provide refrigeration for vaccines -light schools and health clinics
- change the form of cooking and reduce diseases from toxic indoor fumes
- power machines that provide income-generating opportunities
- protect the environment by reducing the use of fuel wood and dung
- reduce the time and transport burden of women and young girls who collect biomass, thereby increasing opportunities for education and income-generating work
- lower child mortality rate and improve maternal health with access to clinics with refrigeration and lighting.

Lighting is essential to meet the needs of poor people for their household activities, trade and schooling.

The lack of stable and sustainable energy services correlates closely with many poverty indicators. Where there is no electricity, people must use other energy sources that are more expensive, more toxic and polluting and require more time to collect (wood and biofuel) and are more damaging to the environment. As a result, people are left with virtually no time for school or to study or engage in income generating activities. This is a major hindrance to achieving the MDGs.

Providing clean, sustainable energy is not only vital to alleviate poverty but also for fighting environmental problems such as global warming, the seventh UN Millennium Development Goal. There is a strong relationship between lack of clean electricity and environmental damage. To meet their basic cooking and heating energy needs, the poor use, amongst other things, unsustainable wood supplies. Cutting down trees for fuel causes deforestation and land degradation which in turn can destroy the watershed and also contribute to desertification.

As the *raison d'être* of the MDGs is reducing extreme poverty in its various dimensions, including income poverty, hunger, disease, promoting gender equality, education, health, and environmental sustainability by 2015, increased provision of electricity should take a leading role. Today, it is clear that the goals will not be met unless access to renewable and clean energy services is available for the dark parts of the world.

Table 1: Energy and the MDGs Linkage

<p>1. Eradicate extreme poverty and hunger</p>	<p>Increased modern energy is essential to generate jobs, industrial activities, transportation, and modernized agriculture. Staple foods need processing, preservation and cooking, and these require modern energy for a reasonable quality of life.</p>
<p>2. Achieve universal primary education</p>	<p>Good educational facilities need electricity for teaching aids and homes need light for students and parents. Many children, especially girls, do not attend school in order to satisfy family subsistence needs.</p>
<p>3. Promote gender equality and empower women</p>	<p>Lack of access to modern fuels and electricity affects women and leads to gender inequality. Household activities mostly done by women could be made easier and save time with modern energy. Time saved could be used for income generating activities.</p>
<p>4. Reduce child mortality</p>	<p>Diseases caused by contaminated water and respiratory illness caused by indoor air pollution from traditional fuels and stoves directly contribute to infant and child mortality. Clinics lacking electricity can not adequately treat sick children.</p>
<p>5. Improved maternal health</p>	<p>Women are disproportionately affected by indoor air pollution and water- and food-borne illnesses. Lack of electricity in health clinics, poor illumination in night deliveries and daily household chores all contribute to poor maternal health, especially in rural areas.</p>
<p>6. Combat HIV/AIDS, malaria and other diseases</p>	<p>Electricity for communication (radio and television) is needed to spread important public health information to combat deadly diseases. Also, electricity is needed for illumination, refrigeration and sterilization for effective health services.</p>
<p>7 Ensure environmental sustainability</p>	<p>Energy production, distribution and consumption in Africa has many adverse effects on the local, regional and global environment including indoor air pollution and land degradation. Cleaner energy systems are needed to address environmental sustainability.</p>
<p>8 Develop a global partnership for development</p>	<p>The World Summit for Sustainable Development called for partnerships between public entities, development agencies, civil society and the private sector to support sustainable development, including delivery of affordable, reliable and environmentally sustainable energy services.</p>

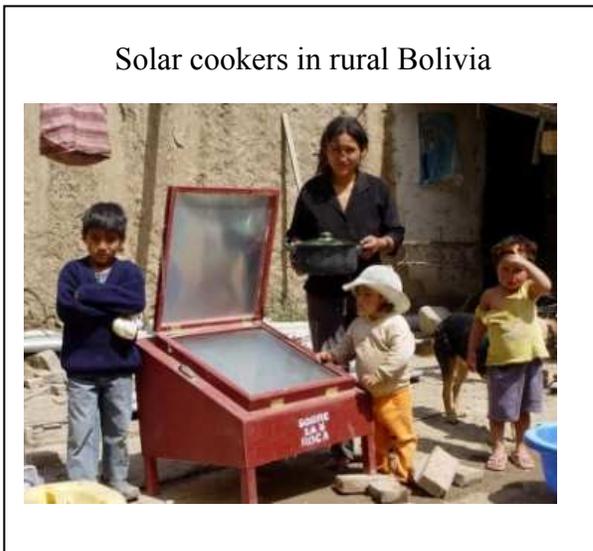
Source: Adapted from (UN, 2005)

2.2 MDG # 1: Eradicating extreme poverty and hunger

Target 1a: Reduce by half the proportion of people living on less than a dollar a day

Target 1b: Achieve full and productive employment and decent work for all, including women and young people

Target 1c: Reduce by half the proportion of people who suffer from hunger



For low-income women in the rural and mountainous regions of Bolivia, cooking involves a great deal of drudgery and expense. Forced to either spend large portions of the day collecting firewood or to spend substantial portions of their income purchasing it, many Bolivian women are beholden to the cycle of cooking. When energy efficient cooking products are introduced, the benefits include better use of time and money, improved health for mothers and children and opportunity to generate added income.

Source: Energy Through Enterprise website, <http://www.eandco.net/Portfolio-Instance-50.html#>

The number of people living with less than \$1 a day is roughly the same as the number of those lacking access to energy: 2 billion. Those who do not have access to electricity have to rely on primitive energy sources. In this situation, poverty becomes inevitable. For this reason, the road to eradicate poverty should be by providing clean energy for sustainable development for the rural poor. Poor people see access to energy as a priority, not for energy in itself, but for the energy services it provides, such as cooking, lighting, heating, water pumping, and transport. The benefits to the poor of access to energy services are immense. There is sufficient evidence to suggest that improved access to clean energy in the rural areas fosters economic growth, enhances social progress and reduces poverty.

Considering that the priority energy needs of poor people are for cooking, heating and lighting, they spend more time and effort fulfilling those needs compared to the richer class because they lack modern energy. Relying on biomass (wood, animal dung, crop waste) creates a big burden on women and children. As many households' use of kerosene is high, a big proportion of their household income goes to purchase energy for basic survival activities such as cooking, keeping warm, and so on. Without adequate supplies of affordable energy, it is impossible to create viable living conditions or carry out economic activity.

Access to clean energy services can provide the poor with many direct benefits by

increasing their economic productivity. They need energy to improve their incomes through small-scale industries and food processing. Similarly, modern energy can offer enormous social benefits for rural women and girls who are currently spending hours gathering fuel wood, inefficiently processing food and inhaling smoke from wood-fired cooking stoves. Imagine how providing electricity for lighting, pumping water and refrigeration could eliminate the drudgery hours associated with the lack of efficient energy. People could have more time and energy to engage in income generating activities. The income could be used to purchase food in food-scarce areas. The time and energy saved from drudgery work could be used for education and schooling. Electricity also provides increased income for men through direct use of affordable and reliable energy services.

Decentralized clean, renewable energy is the most cost effective option for the areas where electrification by grid is not available. As an example, photovoltaic (PV) solar home systems can be a viable option for less populated areas where a modest amount of electricity is needed. It has socio-economical benefits by extending days after sunset and enabling productivity and education. Freeing the communities from diesel, kerosene and wood and saving thousands of liters of fossil fuel while improving the quality of life can all be achieved at the same time.

Importance of energy to achieving the Goal:

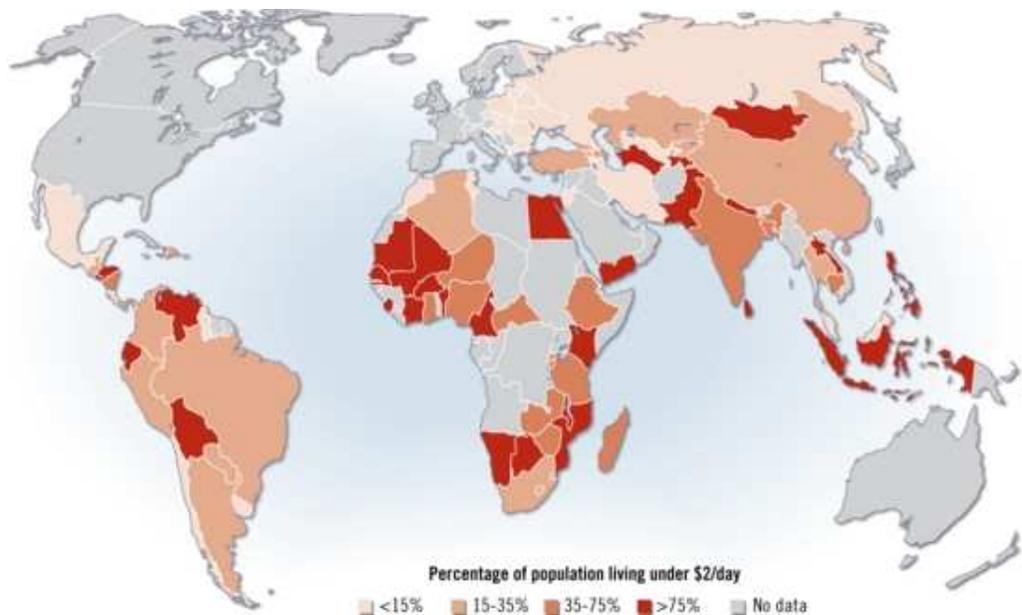
- Access to affordable energy services from gaseous and liquid fuels and electricity enables enterprise development
- Lighting permits income generation beyond daylight hours
- Machinery increases productivity
- Local energy supplies can often be provided by small-scale, locally owned businesses creating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

Source: Modi, V., S. McDade, D. Lallement, and J. Saghir. 2006. "Energy and the Millennium Development Goals," New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project and the World Bank. http://www.unmillenniumproject.org/documents/MP_Energy_Low_Res.pdf

Clean and affordable technologies such as improved cooking stoves, solar home systems, biogas and water pumps have important social and economic impacts for the people through better income and health, food security, cleaner air and more opportunity for study.

An example of a cost effective energy source is **biogas***. It is being used in countries like India and Sri Lanka and has already brought significant changes in the lives of farmers. The waste material used to produce biogas is available everywhere. With nothing more than cow dung, they have enough power for cooking, ironing the laundry and providing heat and light for their houses without using a single piece of wood. The benefit of biogas is **that women and children are freed from firewood collection. They gain two hours a day for other activities. About 80% now use this time to earn extra income that currently accounts for approximately 24% of the family's monthly income.** Another advantage of using biogas is that there is very little waste from the process, and it is environmentally friendly. Biogas plants have reduced human dependency on natural gas and firewood, saving forests and increasing soil fertility. **Poor people can save money by using biogas rather than buying natural gas or firewood for their domestic needs.**

Poverty by country, share of population living under USD 2 per day, 2004



In the world today 2.6 billion people live on less than USD 2 per day and three quarters of them live in rural areas.

Source: Poverty by country, share of population living under USD 2 per day, 2004. (2008). In UNEP/GRID-Arendal Maps and Graphics Library. Retrieved 23:23, September 16, 2008 from <http://maps.grida.no/go/graphic/poverty-by-country-share-of-population-living-under-usd-2-per-day-2004>.

An evaluation of World Bank-assisted rural electrification projects in Asia indicates that in Bangladesh and India, rural electrification raises the use of irrigation, thereby significantly reducing poverty incidence. The beneficiaries feel an improvement in their lives, a

* A biogas plant consists of two components: a digester (or fermentation tank) and a gasholder. The conventional (and cheapest) biogas plant creates electricity from human or animal dung. Extracting chemical energy from organic materials in a sealed container called a digester produces biogas. That is simply used as gas to power a cooker or water heater or light, or it can be turned into electricity via a gas powered diesel generator.

Source: Natural Energy by Katie, Nov 04, 2006. <http://www.off-grid.net/2006/11/04/cooking-with-biogas>, Oct 19, 2008.

diminution in the sense of powerlessness and instability, and an increase in empowerment. Electricity improves the poor's access to productive activities, thus lessening their vulnerability to shocks.⁹

The key to eliminating poverty is creating opportunities for the poor to generate income. This can be done by involving them in productive activities at the household, national, and regional levels. The presence of electricity extends the work hours and increases the income. Nonetheless, employment generation involves the supply of modern energy; as productive activities linked with low quality or traditional energy hardly result in better standards of living. Those involved in employment generated through electricity seem to raise their lifestyles by increased access to education and health.¹⁰

Lack of electricity and heavy reliance on traditional biomass are signs of poverty in developing countries. The vicious cycle of lack of electricity causing poverty contributes to its continuity as it hinders creation of industrial activities and jobs. Access to clean electricity is one of the most effective means for the poor to bring about the significant increase in economic productivity. Taking into account the energy needs of the poor is needed to get on track of achieving the poverty reduction goal and the MDGs as a whole. The goal of halving poverty by 2015 will not be reached without increased production, job creation, education, and reducing daily drudgery for gathering conventional fuels. To get on track with achieving the poverty reduction goal and the MDGs as a whole, we need to solve the energy needs of the poor.

2.3 MDG #2: Achieve Universal Primary Education

Target 2a: Ensure that all boys and girls complete a full course of primary schooling



“We don’t need to buy kerosene and our children can study at night,” says a mother of five in Rema Village, Ethiopia about the benefits of the solar panel that protrudes from her mud and straw hut. The solar energy allows Rema’s residents to have small lights in their huts, and both children and adults are now able to study at night due to the introduction of electricity. Before this, like most of the Ethiopia’s rural residents – only 1 percent of which have access to electricity - they used diesel generators and kerosene lamps.

Source: Wilhelm, Ian. “Clinton Foundation Promotes Solar-Energy Projects in Africa,” *The Chronicle of Philanthropy*, August 01, 2008
<http://philanthropy.com/news/updates/5334/clinton-foundation-promotes-solar-energy-projects-in-africa>

Solar powered lanterns replace kerosene and enable children to study at night.

Source: Energy Through Enterprise website,
<http://www.eandco.net/Portfolio-Instance-41.html#>

⁹ Ali, Ifzal. M. Pernia, Ernesto. “Infrastructure and Poverty Reduction-What is the Connection?” Asian Development Bank http://www.adb.org/Documents/EDRC/Policy_Briefs/PB013.pdf

¹⁰ “Reaching the Millennium Development Goals and beyond: Access to Modern Forms of Energy as a Prerequisite 2007” Global Network on Energy for Sustainable Development, 2007, pg 15
http://www.gnesd.org/Downloadables/MDG_energy.pdf

The second MDG aims at ensuring that by 2015 all children, particularly girls, in difficult circumstances and those belonging to ethnic minorities, have access to and complete free and compulsory primary education of good quality. Probably the most important social benefit of providing access to clean electricity is its education related usage. In low income countries, spending countless hours on collecting traditional fuels, fetching water, processing food or other physical work are the main reasons for low school enrollment. Electricity may affect education by increasing efficiency and productivity. Eventually, poor women, who suffer from doing most of the housework, can find time to attend school and let their children have basic schooling by freeing them from being child laborers. Having free time to go to school and to study after school improves the quality of life for all people in the society.

Electricity enables schools to receive lighting, especially during hours when sunshine is limited. It can improve the quality of schools by attracting teachers to move into unconnected rural areas. Most of the teachers are hesitant to stay in places without access to electricity. Electrification helps retain them in these areas where they can maintain an improved quality of life. Moreover, teaching can be done more efficiently using equipment such as a computer, overhead projector, printer, photocopier, science equipment all of which are feasible with electricity. Thereby, access to electricity makes these remote locations more attractive to teachers. Consequently, it can create a child-friendly environment (access to clean water, sanitation, lighting, and space heating/cooling) thus improving attendance at school and reducing drop-out rates.¹¹

Increased school attendance as a result of access to electricity replaces child labor.

Reading is easier and healthier with electricity compared to kerosene or candle. The electric lighting is brighter and can ensure the house doesn't catch fire. In most of the rural areas, mothers and their young daughters are busy with the housework all day; and having electricity at home enables them to study during the night. Having access to educational media and making use of television can facilitate the learning process and can allow distance learning. With television and radio people who were previously cut off from electronic information, educational and entertainment can be reconnected. Therefore, electricity is a prerequisite for development as it facilitates education and connection to the outside world.

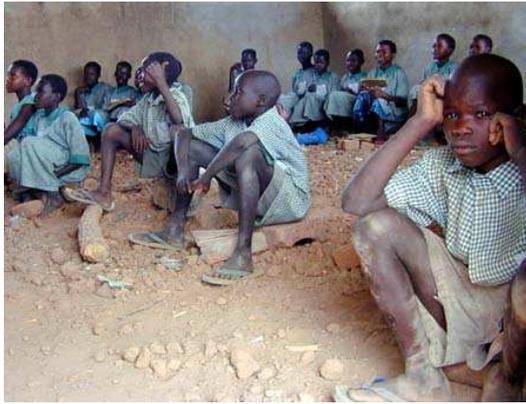
Children in electrified households have higher education levels than those without electricity. The reason for this may be that the higher education levels, with improved school quality, encourage students to stay on longer or their grades improve from better teaching.¹² **Electricity facilitates studying as the quality of the light from electric lamps is much higher than light from kerosene lamps or candles.** It also increases study time. Education benefits from higher educational attainment by the children of electrified households which results in higher future earnings. Studies suggest that girls

¹¹ Ibid.

¹² "The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits," IEG Impact Evaluation, pp. 46.

¹³ "Education for All," UNESCO report

with literate mothers are more likely to go to school than girls without.¹³



A classroom in Sudan without electricity or chairs¹⁴



Young girls in Chitral can study at night thanks to electric light¹⁵

All of these links are critical in supporting the achievement of a healthy educational environment, universal primary education as well as the equal participation of boys and girls in education at large.

2.4 MDG #3: PROMOTE GENDER EQUALITY AND EMPOWER WOMEN

Target 3a: Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015

The income sources for a family living in Semoi village Indonesia are pepper cultivation and the small general store attached to their house, where one of the female members of the family sells various goods. She cooks and packs boiled beans during her spare time to sell at the store. As a result of an electrification project, she has been able to spend more time doing such piecework and to operate the store even at night. The increased opportunity to sell her produce contributes to the family income.



Source: Rural Electrification Project
http://www.jica.go.jp/english/operations/evaluation/jbic_archive/post/2002/pdf/033_full.pdf

<http://www.un.org/cyberschoolbus/briefing/education/education.pdf>, Nov 2, 2008.

¹⁴ USAID,

http://africaphotos.usaid.gov/search_results.cfm?Keyword_ID=239&Country_ID=25&Sector_ID=10&StartRow=31. Nov 24 2008.

¹⁵ Energia website http://www.energia.org/resources/newsletter/pdf/en-122006_ummar.pdf

Lack of access to electricity affects the whole society as people without modern energy services must spend more of their time and energy on survival. Consequently, they have fewer opportunities for education and income generating activities. However, it affects men and women differently. Women comprise the most vulnerable section of the society, especially the poor ones who already suffer from socio-economic inequalities and have no possibility of gaining a higher status due to hard domestic work. In the rural areas of the developing world, it is the woman who is responsible for unpaid domestic activities, and lack of electricity at home makes her work tougher and longer. Young girls don't go to school, because they need to help their mothers gather wood and carry water. In such an environment, gender equality - men and women sharing power equally within a society - can not exist. One solution to solving this gender biased problem lies in enabling them to generate income for the household and freeing them from inefficient time use.



Women in Niger bear water and children back to their village, near Tillaberi.

Source:

http://www.transitionsabroad.com/publications/magazine/0611/traveling_responsibly_in_west_africa.shtml

Photo by Jason Motlagh

Worldwide, two billion people rely on traditional fuels such as wood, dung, and agricultural residue for cooking and heating. In Bangladesh, for example, women and girls take 2-5 hours daily to collect water.¹⁶ The same is true for many rural regions of Africa and other less economically developed settings.

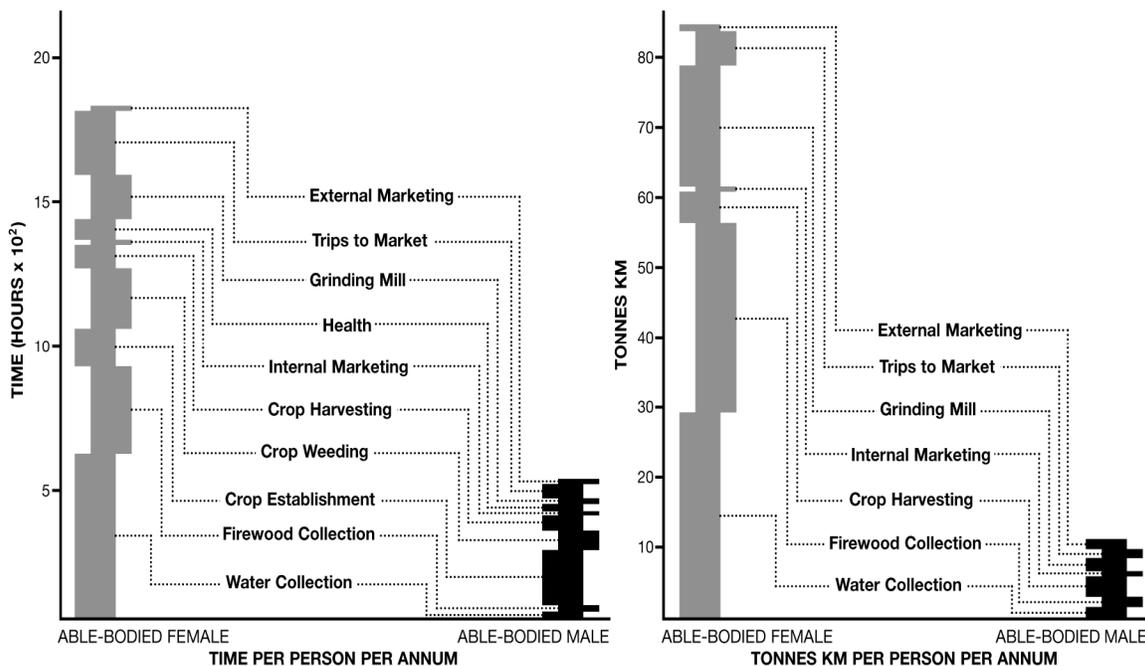
Cooking is the activity that takes women the most important energy inputs - time and effort. Biomass continues to be the main source of cooking energy in developing countries. Inefficient biomass use accounts for nearly 60% of total human exposure to particulate air pollution world-wide. Indoor air pollution creates serious human health problems, especially for women and children.¹⁷ They are exposed to large amounts of smoke and particles from indoor fires and suffer from a number of respiratory diseases. Other than

¹⁶ Hunter, Lori M. "Population, Health and Environment through a 'Gendered' Lens," World Watch Volume 2, number 5, Sept-Oct 2008, pp. 16.

¹⁷ Gender and Energy: How is Gender Relevant to Sustainable Energy Policies?
<http://www.undp.org/energy/publications/2000/SEStrategy/chapter2.doc> pp. 15.

having negative impacts on women's health and time, cooking and heating with biomass and fossil fuels contributes to carbon dioxide emissions, deforestation and soil erosion.

Rural Transport Activities by Males and Females in Tanzania



A woman's daily work in the rural areas consists of spending hours for planting, harvesting, grinding, milling, crop processing by hand, collecting fuel wood and water, household maintenance and inefficient cooking. In return they are deprived of time for education, engaging in income generating activities or caring for their health.

Source: UNDP, 1997

The time spent collecting fuel wood for cooking reduces the proportion of daylight hours otherwise available.

According to the World Bank, in rural sub-Saharan Africa, many women carry 20 kilograms of fuel wood an average of five kilometers every day. The effort uses up a large share of the calories from their daily meal, which is cooked over an open fire with the collected wood.

These hours may be critical to other income-generating activities such as commercial foods vending, which is facilitated by improved heating and lighting; agricultural processing using mechanical power; beer brewing, and many trading activities. The costs of energy inputs into these businesses are high and the lack of more-affordable alternatives limits the income-generating opportunities faced by women. Case studies show that access to modern energy services can greatly improve the profitability of these businesses as well as

the quality and quantity of the traded product.¹⁸ Thus, an important way to improve energy services and contribute to gender equality is by enabling productive work that is primarily undertaken by women.



Rural electrification in Bhutan allows women to earn an income with improved lighting.¹⁹

Having access to electricity enables the improvement in women's educational attainment as they have more free time to dedicate for education. Women in households with electricity can have easy access to information about gender issues from radio and television compared to women in households without electricity. Educated women spend less time on unpaid labor, and they are more likely to have access to reproductive health information and services. Awareness and choice lead to reductions in birth rates. Thereby, empowerment through education leads to later marriages and having fewer children, which in turn slows population growth.

Access to high quality energy and energy efficient devices can save them time from searching for biomass fuel for cooking and heating. Electricity can free women from the burden of carrying large loads of fuel wood and from exposure to harmful indoor smoke coming out of traditional cooking stoves. It can ease access to education, health, literacy and income generating activities. Moreover, electricity for lighting and motive power enable women to develop productive activities which increase their incomes. Better health, higher income and improved literacy all help to empower women.

Women without the modern energy services are obliged to spend more of their time and

¹⁸ Modi, V., S. McDade, D. Lallement,, Energy and the Millennium...pp. 27.

¹⁹ ETC Energy. www.etc.org

energy for survival and are left with fewer opportunities to engage in economic endeavours and education. Access to more efficient and environmentally sustainable energy services is mandatory in order to improve women's status, provide them with more opportunities for income-generating work, and also improve their general health and living conditions and those of their families. While energy is not solely responsible for the inequality between genders, it can make an enormous difference.

2.5 MDG # 4: Reduce child mortality

Target 4a: Reduce by two thirds the mortality rate among children under five



Micro-hydro power generator powers a home

The micro-hydro power generators used in a small village in Southwest China are for cooking, heating and to power the occasional radio or television. They provide night time lighting for homework, housework and business. The generators reduce fuel wood consumption which improves indoor air quality and lowers infant mortality from respiratory illness.

Source: Energy Through Enterprise Website,
<http://www.eandco.net/Portfolio-Instance-41.html>

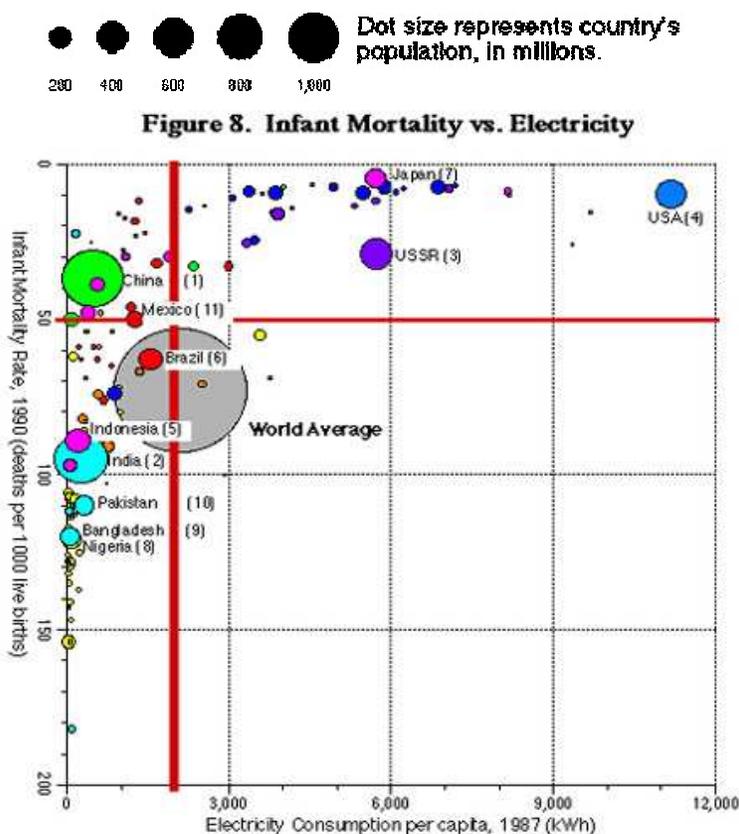
The main causes of infant mortality are respiratory diseases, diarrhea, asphyxia, low birth weight, short spacing between births and the young age of mothers. An important factor affecting both child and infant mortality is limited access to health services, which is also of low quality, especially in rural areas. Poor living conditions, limited access to electricity and low levels of mother's education worsen the situation.

Poor people in the developing world are constantly exposed to indoor particle and carbon monoxide concentrations many times higher than World Health Organization standards. Traditional stoves, which use dung and charcoal, emit large amounts of carbon monoxide and other harmful gases. Women and children suffer most, because they are exposed to burning fuels for long periods of time. Acute respiratory illnesses affect as much as 6% of the world population. The WHO estimates that 2.5 million women and young children in developing countries die prematurely each year from breathing the fumes from indoor biomass stoves. Acute respiratory infection kills more children under five than malaria or TB.²⁰ In addition, prolonged exposure to smoke dramatically increases the likelihood of very young children developing chronic lung disease.²¹

Achieving low rates of infant and under-five mortality is of central importance for social well-being and human development. Reducing child malnutrition is a key millennium development goal, as child malnutrition produces a wide and diverse range of adverse

economic and social consequences. Malnutrition substantially raises the risk of infant and child deaths, and increases vulnerability to a variety of diseases in later life. In addition, malnutrition impairs cognitive ability and decreases school performance and lowers labor productivity and lifetime earnings. Access to clean electricity can reduce the malnutrition related deaths by sustaining food production and powering equipment for water pumping and purification. Provision of cooked food and boiled water improves the health conditions. Furthermore, it enables refrigeration of vaccines, sterilization of medical equipment and lighting so that hospitals and clinics can operate 24 hours a day.²⁰ **With one percent increase in electricity coverage in a province, the child malnutrition rate declines by 1.2%**²¹

Access to sanitation facilities significantly reduces infant mortality. Child mortality is lower when a separate room is used for cooking and when the house has electricity and some type of toilet facility. Mortality rates are significantly lower within families with some type of toilet facility.



Increased use of electricity reduces infant mortality

Source: <http://www.geni.org/globalenergy/library/newsletters/1995/interconnections-sustainable-development-big-projects.shtml>

²⁰ “Energizing the Millennium Development Goals : A Guide to Energy,” UNDP, August 2005, pp.12.

²¹ “Attaining the Millennium Development Goals in Sri Lanka: How Likely and What Will It Take To Reduce Poverty, Child Mortality and Malnutrition, and to Increase School Enrollment and Completion?” The World Bank, February 2005, <http://siteresources.worldbank.org/INTSRILANKA/Resources/Sri-Lanka-MDG-Final.pdf>, pp. 34-58.

Electrification can contribute to reduction in the birth rate as it increases the effectiveness of family planning and other health programs. Having access to media, watching programs on public health and disease prevention, the availability of refrigeration for vaccines and medicines has contributed to a noticeable reduction in childhood diseases, diarrhea and poisoning.²²

Another example that demonstrates that availability of electricity in a household has a strong link to infant and under-five mortality is in Sri Lanka. In households there that have no access to electricity, infant mortality is more than three times as high (25.7 versus 7 deaths per 1,000 live births) and under-five mortality is more than two times as high (23.8 versus 11.6 deaths per 1,000 live births) as in households having access to electricity. Access to water and sanitation is associated with reduced rates of child malnutrition; and better sanitation is associated with lower levels of infant mortality. Expanding electricity coverage from 57% to 72% would in itself reduce the child malnutrition rate by 5 percentage points.²³



**New wells and latrines have reduced infant mortality
in the village of Maigiginya, Nigeria**

Source: www.cafod.org.uk

Diseases caused by poor quality water, and respiratory illness caused by the effects of indoor air pollution from traditional fuels and stoves, directly contribute to infant and child mortality. Improvement of sanitation facilities, reducing indoor air pollution and increasing the educational level of women (linked with MDG #2 and #3) have big impact on reducing child mortality.

²² Ghandour, Abdel-Rahman. "Sustained progress in maternal health care, but deficient access, inequities in poorest countries pull down averages," UNICEF's Progress for Children Report, Vol. 7- Middle East and North Africa, <http://www.zawya.com/Story.cfm/sidZAWYA20080921082356/Sustained%20progress%20in%20maternal%20health%20care,%20but%20deficient%20access,%20inequities%20in%20poorest%20countries%20pull%20down%20averages>, Nov 12 2008.

²³ Ibid.

2.6 MDG #5: Improve maternal health

Target 5a: Reduce by three quarters the maternal mortality ratio



This hospital in Tanzania receives its electricity from solar panels

Almost all cases of maternal mortality are preventable. An estimated 74% of maternal deaths could be averted if all women had access to prevention and treatment during pregnancy and birth complications, especially emergency obstetric care. Clinics with reliable, clean electricity can provide that.

Source: http://www.unfpa.org/upload/lib_pub_file/750_filename_reducing_mm.pdf

The indicators for measuring the overall situation of maternal health include good nutrition, adequate and qualified health care provision, the knowledge of the family planning, quality of healthcare services, educated healthcare staff, and refrigeration of vaccines and medicines. Accessibility to health care facilities is also important and is determined by geographic location. The socio-economic status of a pregnant woman and the knowledge of the risks that are waiting for her are the other determinants which can also affect the morbidity rate. All of these require a well organized health care plan and electricity which can be provided cleanly and efficiently.

Africa as a continent has the highest mortality rates in the world. Conditions in most of the African countries show the urgent need to take action to improve maternal health. Nigeria is a case in point, and its condition is caused by extreme poverty. The miserable conditions facing women in Nigeria lead to high maternal mortality and morbidity rates. Approximately 50,000 maternal deaths are recorded yearly due to complications of pregnancy and childbirth. That means that 137 women die every day or six women die every hour of the day in Nigeria due to complications related to pregnancy and childbirth. According to the 1999 figures of the Federal Office of Statistics (FOI), 77 % of residents of North Eastern Nigeria and 70 % of those in the North West are classified as living below the poverty line. Less than 31 % of people resident in the North East have access to electricity, while three of every four houses rely on traditional pit latrines and only five percent of households have flush toilets. The research findings agreed on the common causes of maternal mortality and morbidity, which are **poverty, ignorance, illiteracy, cultural factors, lack of access to health services and facilities** as well as **poor road networks**.²⁴ So, infrastructure too is a key to better maternal health. Accessible roads to get to clinics, illuminated streets and clean water at the hospitals are extremely important

²⁴ “Nigeria: Maternal Mortality . . . Why More Women Die” This Day (Lagos) ANALYSIS, 8 September 2008, <http://allafrica.com/stories/200809090180.html>, Nov 10 2008.

for the whole functioning of better health services. Transporting women to the hospital as soon as possible can decrease the mortality rate enormously.



A delivery room in Sudan with no electricity or running water²⁵

As previously discussed, electricity can free women from the daily drudgeries. Women of all developing countries spend anywhere between 2 to 9 hours each day collecting fuel and fodder for cooking. Inefficient and heavy manual labor such as carrying fuel wood and fetching water negatively affect the general health and well being of a pregnant woman. A study in Uttarachal, India found miscarriages to be five times the national average at 30 percent and linked it to heavy load-bearing during pregnancy. In Nepal, women suffer a high incidence of uterine prolapse that is in all likelihood linked to carrying heavy loads of wood soon after childbirth. Since biomass fuels are used mostly by lower-income groups, and women do most of the cooking, health is a significant issue in energy, poverty reduction and gender. Increase in the percentage of the hospitals and health clinics which have access to electricity can have a direct affect on maternal health. Energy services are needed to provide access to better medical facilities for maternal care, including medicine refrigeration, equipment sterilization, and operating theatres.²⁶

Moreover, electricity affects nutrition directly by allowing refrigerated food storage and indirectly through knowledge. Electrification enables access to piped water and having safe drinking water in a household which is extremely important for the general health of the whole family.

Maternal mortality is preventable if women have access to information and to health services. Low levels of female education and access to information among women reduce rural women's use of maternal and child health services. This is closely related with poverty. The services, qualified health personnel, availability of medicines as well as their refrigeration, drinking water...how can these be achieved without electricity for power and

²⁵ Picasa web albums,

<http://picasaweb.google.com/alison.smith01/SudanPictures2007#5121995985623600658>

²⁶ Ibid.

light? Electrification improves facilities in clinics, enables storage of vaccines and medication; modern energy sources prevents the diseases caused by indoor use of wood fuels for cooking; lighting provided on the roads enables transport services so that women can have better access to health care services. To sum up, electricity is the key to deliver health services and to create an adequate infrastructure for reducing maternal mortality.

2.7 MDG #7: Ensure environmental sustainability

Target 7a: Integrate the principles of sustainable development into country policies and programs; reverse loss of environmental resources

Target 7b: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss

Target 7c: Reduce by half the proportion of people without sustainable access to safe drinking water

Target 7d: Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020

In most of the MDG countries, the vast majority of electricity is generated from non-renewable resources such as coal, oil and natural gas. Their use contributes to respiratory diseases, acid rain, global warming, and other environmental and health problems. In fact, fossil fuel based electricity generation causes more pollution than any other single human activity.

Green electricity refers to electricity produced in ways that are considered to have less environmental impacts than burning fossil fuels or nuclear energy. It uses environmentally friendly resources which are non-depleting (sun, wind, hydro) and producing low amounts of pollution. Electricity generation through harvesting the energy of sun, wind, hydropower, bioenergy, geothermal, ocean waves, tidal currents, and agricultural waste is the efficient way to reduce the CO₂ emissions. They have fewer harmful environmental impacts than burning fossil fuels. The renewable means of producing electricity is a perfect alternative to conventional petroleum-based transportation fuels.

While nuclear plants emit no carbon dioxide, sulphur dioxide or nitrogen oxides, they can be dangerous considering radioactive waste, the potential for severe radioactive contamination by accident or sabotage and the possibility of nuclear proliferation.²⁷

The use of more renewable energy resources is essential for creating a better environment as it can reduce emission of carbon dioxide and other gases and thus the green house effect.

²⁷ Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/wiki/Nuclear_power, Oct 13 2008.

* More information can be found about the article by Sten Bohlin, Kjell Eriksson, Gunnar Flisberg "Electrical Transmission" on GENI website: <http://www.geni.org/globalenergy/library/technical-articles/transmission/abb-power-systems-a-b/electrical-transmission/index.shtml>

The active use of renewable energy sources replacing polluting energy sources to generate electricity could eliminate in 10 to 15 years about the following amounts:

- 1500 million tons/year of CO₂
- 5 million tons/year of NO_X
- 15 million tons/year of SO₂*

As most of the poor households in rural areas have no access to electricity or modern renewable fuels, they use wood, dung and crop waste for heating and cooking. Biomass accounts for 10-11% of all primary energy, but in the developing world this is mostly for cooking fires, with their negative impacts on health due to indoor air pollution.²⁸ It is the main source of fuel for the urban and rural poor and contributes to the rapid rate of deforestation in many parts of Africa.

Burning fossil fuels, especially coal, is the main cause of the greenhouse effect because of the carbon dioxide it releases into the atmosphere. Carbon dioxide contributes at least 60% of the human-induced increase in the greenhouse effect. Electricity generation is one of the major sources of this carbon dioxide, giving rise to about 9.5 billion tons per year. Apart from its contribution to greenhouse gas emissions (GHG) emissions, traditional fuel use leads to erosion, reduced soil fertility, and desertification.

Studies show that societies that derive a greater portion of their energy from electricity have higher economic output and lower emissions of pollutants and carbon dioxide per unit of energy consumed. The benefits when direct fuel combustion is displaced by conversion of fossil fuels to electricity are observed in developing countries such as in China where electric cooking stoves are replacing the inefficient coal-burning stoves that cause respiratory problems.

MDG #7 aims also to increase the proportion of the population using improved drinking water sources and sanitation facilities, both essential for human health. According to a report by WHO and UNICEF Joint Monitoring Program for Water Supply and Sanitation in 2000, 2.4 billion people lacked access to basic sanitation, and 1.1 billion people did not have access to safe water supply. Access to sanitation in rural areas is much worse than in urban areas. In 2000, only 15% of India's rural population of 730 million had sanitation coverage while in the same year, the remaining 600 million people living in rural China had no access to basic sanitation. Urban areas, on the other hand, are faced with the challenge of extending sanitation coverage to slum settlements. Currently, 930 million people live in slums worldwide, and this figure is growing at an accelerated rate. UN Habitat recently reported that 83% of the population in 43 African cities lives without connection to a sewerage system.²⁹ Across South Africa, there are about 7.5 million children whose families have to rely on unsafe or distant sources of drinking water. These

²⁸ "The Reality of Renewables" Sustain magazine, 29 December 2007, pp. 13.

²⁹ Marshall, Sarah Jane. "Flagging global sanitation target threatens other Millennium Development Goals," World Health Organization, <http://www.who.int/bulletin/volumes/82/3/MDG034/en/print.html>, November 17 2008.

children are responsible for fetching and carrying drinking water to their homes. If they had clean electricity to purify water or pump clean ground water, they could reduce daily drudgery and wouldn't be exposed to health risks.

The conclusion of the Rio and Kyoto conferences led to the commitment of the majority of the world's nations to the reduction of CO2 emission. In this aspect, using renewably generated electricity will reduce GHG emission. Clean electricity increases the efficiency of energy consumption and reduces the emission of pollutants. Clean energy services can encourage better management of natural resources, including better water quality. They improve environmental quality, reduce GHGs, enhance socio-economic development, reduce fuel imports and extend energy services to households in rural areas. Decreasing levels of indoor smoke, saving from fuel and reducing GHGs can make an important contribution to achieving the MDG 7 as well as the Kyoto commitment.

It is an impossible dream to aim at zero impact on the environment. However, making use of untapped renewable energy sources instead of importing depletable fossil fuels will reduce pollution, increase energy efficiency and improve living conditions. What matters is enabling the socio-economic development parallel with the protection of the environment.

3. Best Examples

3.1 Best Example #1: Rural Electrification in Tunisia



Tunisian Energy Grid
Source: <http://www.geni.org>

Tunisia has been chosen as one of the best examples because of its achievement in increasing the number of electrified rural households from 6% to 88% and 95% of all households in 23 years. The Government of Tunisia has made rural electrification a top priority in its social and economic development plans and invested more than 450 million Tunisian Dinars (319.5 million US Dollars) between 1977 and 2000. When Tunisia's rural electrification program was launched in the mid-1970s, only 30,000 (6 percent) of the country's rural households were electrified, even though half of the population lived in rural areas. At that time, rural electrification became the third pillar in an integrated rural development drive that also emphasized basic education and improved health services.³⁰

Tunisia's electrification plan included both grid and photovoltaic programs which are complementary. The national PV program underscores the country's commitment to provide at least a minimal level of electrification service to even its most remote rural households, which otherwise would remain unconnected. Currently, 7,750 households (about 1 percent of total electrified rural households), 200 schools, and a few clinics and forest / border posts have PV installations.

The growth in rural electrification had a positive impact on national socio-economic indicators. The benefits mainly affected the status of health, gender equality and income. The increase in the rate of rural electrification from 6 percent in 1976 to 88 percent in 2000 has been paralleled by a reduced rate of poverty (MDG#1) from 40 percent in 1956 (from France) to 7 percent in 1995. It enabled nearly total primary school enrollment; increased life expectancy from 50 to 74 years and improved status of women (MDG #3) who form one-third of the Tunisian labor force. Between 1975 and 1999, real GNP per capita increased from US\$770 to \$2,060, while regional disparities have been reduced and income distribution has improved.³¹

Thanks to public lighting, schools were better electrified and the students improved their skills (MDG #2). The rate of graduation has increased by 60-70%.³² Refrigeration for foods and preservation of vaccines is extremely important as hot weather can quickly spoil them. Electrification permitted higher penetration of the media, especially television, which changed the role of Tunisian women in the household. They were informed on contraceptive methods and disease prevention which eventually helped to create better family planning. All the above mentioned social returns had a big impact on meeting the MDGs.

Electrification as the Third Pillar of Rural Development:

The national goal of raising the living standard of rural citizens included a considerable investment in rural electrification. Rural development was initiated under Tunisia's 4th

³⁰ Cecelski, Elizabeth. Ounalli, Ahmed. Aissa, Moncef. Dunkerley, Joy. "Rural Electrification in Tunisia: National Commitment," Efficient Implementation and Sound Finances Report, Energy Sector Management Assistance Programme (ESMAP) August 2005, <http://www.esmap.org/filez/pubs/30705Finaltowebsite.pdf>, pp. 1.

³¹ Ibid.

³² Cecelski, Elizabeth. "Enabling Equitable Access to Rural Electrification: Current Thinking on Energy, Poverty and Gender," Briefing Paper Asia Alternative Energy Policy and Project Development Support January 2000, Revised July 2002. pp. 45.

Five-year Plan (1972–76). It was based on three pillars:

- Basic education (including education of both girls and boys),
- Improved health services (including family planning), and
- Rural electrification to support the above two elements and rural development.³³

Rural electrification, the third pillar of Tunisia’s rural development, supported both education and health. The political will to invest in rural electrification has proven remarkably steady in weathering political and economic changes. From 1977 to 2000, total investment in rural electrification amounted to nearly 319.5 million US Dollars; over this period, the Government’s contribution increased from 45 percent to more than 80 percent of total investment

Tunisia’s achievement of 100 percent urban and 88 percent rural electrification is all the more remarkable, because the country strictly defines *rural electrification* as connections outside incorporated areas and *rural population* as only the population outside incorporated villages and towns. Today, Tunisia’s rural population represents 35% of the country’s total population and is highly dispersed and isolated, with long distances between small groups of scattered houses. Moreover, in Tunisia, every household in an electrified village or hamlet receives a connection and wiring, sometimes with the assistance of other households in the village. This is contrary to other countries, where only a few households in an “electrified” village may be connected. The highly scattered positioning of rural households and the national goal of all households in an area receiving electricity have strongly influenced the country’s rural electrification program in terms of its costs, choice of institutional set up, distribution system, and technology.³⁴

The Tunisia example shows that enabling poor to have access to electricity through low cost technologies makes a big impact on their daily lives and the quality of life. Usage of energy creates job opportunities and generates incomes for the rural people. Consequently, they can afford to pay for the electricity without the need for a subsidy. Creating a centralized grid system and a PV program as a complementary alternative to it, form a national coverage at a fast and efficient pace are the proofs of success. Through a sustained political commitment, decentralized planning, public funding that combined domestic resources and borrowings from the Development Banks as well as other sources, access to electricity was supplied as a minimum standard of public service.

According to World Bank Energy Sector Management Assistance Program since 1975, more than 600,000 rural connections have been made, 7,700 with 50-100 watt, solar photovoltaic (PV) systems. By the end of 2000, 88% of rural households and nearly 95% of all households had been electrified. The current goal is to achieve 100% electrification, 97% household grid connection and 3% PV service, by the year 2010.

³³ Cecelski, Elizabeth. Ounalli, Ahmed. Aissa, Moncef. Dunkerley, Joy, Rural Electrification..., pp. 9.

³⁴ Ibid., pp. 20.

3.2 Best Example # 2: Rural Electrification of China

According to 2007 estimates, the population of the People's Republic of China is 1.321 billion. Being the largest country in East Asia and the most populous in the world, its rapidly growing economy created a significant increase in energy consumption as well as a rise in harmful emissions and power shortages over a very short period of 60 years.

For the past several decades, China has given high priority to electrification to modernize and meet its high energy demand. Since 1949, rural electrification in China has expanded rapidly, contributing to the sustained and steady development of the agricultural sector, rural economy and quality of life for rural households. The most rapid growth occurred in the 1970s and 1980s. Electricity consumption in rural areas has risen from almost zero to 198 billion KW in 1997. The percentage of villages with access to electricity was 97 percent in 1996, and more than 95 percent of households had an electricity connection that year.³⁵ China has introduced electricity access to over 900 million rural residents over 50 years and achieved an electrification rate as high as 98%.³⁶

Although 98% of Chinese households have access to electricity, still fully 30 million people who mainly live in isolated rural parts still live without it. China's focus is on provision of photovoltaic (PV) and wind power based grid extension to these areas. For this reason, the most remarkable step taken to bring clean electricity to the immense rural population was implementing **The Brightness Program**. This program was introduced during the 1996 World Solar Peak Conference in Zimbabwe, and since then, China has played an active role in it. Being one of the world's largest renewable energy rural electrification programs, it is funded by the central government that develops financing options, solar applications and wind generation to provide electricity in remote areas. The target for the first stage of it is to provide electricity access for eight million people who do not currently have electricity, including about 2000 non-electrified villages, 100 non-electrified sentries and 100 non-electrified wireless message stations.³⁷

This Program, initiated in 2000 by the Chinese government, includes **The Township and Village Electrification Programs** with the same objective of bringing electricity to the rural areas and helping alleviate poverty. The final goal is providing electricity for 23 million people in remote areas by 2010 using renewable energy technologies. They promote micro-hydropower, small-scale wind power, small PV, and hybrids of these technologies to the population who still had no access to electricity.

³⁵ Ibid., pp. 24.

³⁶ Fan, Shenggen. Zhang, Linxiu. Zhang, Xiaobo, "Growth and Poverty in Rural China: The Role of Public Investments," EPTD Discussion Paper, No. 66, International Food Policy Research Institute, June 2000 <http://www.ifpri.org/divs/eptd/dp/papers/eptdp66.pdf>, September 20, 2008, pp. 16-17.

³⁷ Information taken directly from National Renewable Energy Laboratory Website. <http://www.nrel.gov/docs/fy04osti/35790.pdf>, September 3, 2008.

Percentage of population with no electricity



Source: ENF based on 2003 report from IEE Chinese Academy of Science

The Township Electrification Program is one of the largest renewable energy based rural electrification programs in the world. It aimed at electrifying 1066 remaining un-electrified townships in 7 western provinces and to contribute to poverty alleviation. It provided renewable electricity to 1.3 million people (around 200,000 households) in 1,000 townships in the Chinese provinces of Gansu, Hunan, Inner Mongolia, Shaanxi, Sichuan, Yunnan, Xinjiang, Qinghai and Tibet.

The program is being succeeded by China **Village Electrification Program** (targeted for 2005-2010) which will bring renewable electricity to 3.5 million households in 10,000 villages by 2010 to be followed by full rural electrification by 2015. China is committed to generating 10% of its electricity from renewables by 2010.³⁸

China has considerable potential for development of renewable energy resources, especially wind, hydro, solar and biomass. Renewable energy has been the subject of considerable development activity in China since the 1980s, especially in the western provinces including Inner Mongolia, Tibet, Qunghai, Gansu, and Xinjiang, which are China's poorest areas and also rich with renewable resources. The Chinese Government has made a strong commitment to efficiency in health, water, sanitation, education and poverty alleviation. Based on this, its investment in renewable energy has increased 90 fold since 1953.

³⁸ Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/wiki/China_Township_Electrification_Program, Nov 13, 2008.



Solar Home System in husbandry area of Qinghai

China realized that making better use of renewable resources is a solution to reduce poverty and to achieve the MDGs. As the rural electrification programs take effect, the Chinese government continues to take steps towards clean electricity. Through its Renewable Energy Law on 2006, the power grid operators have to purchase resources from registered renewable energy producers. The law also offers financial incentives, such as a national fund to foster renewable energy development and discounted lending and tax preferences for renewable energy projects. Thus, the State officially encourages the construction of renewable energy power facilities. China's electricity grid is obligated to purchase all the electricity generated by approved renewable energy facilities located in its service area.³⁹

Experience in China proves that income is not the only determinant of electricity access. More than half of its population is “poor” by the international definition, but it has achieved supplying electricity to the vast majority. China is eager to change its energy policies by promoting renewable energy to achieve energy efficiency and sustainable development. In 2003, the Chinese government set a new target of making all of society ‘well-off’ by 2020. Making better use of these renewable resources is seen as a way to reduce poverty to help to achieve this goal. Currently its rapid economic growth relies heavily on coal generated energy which depletes the natural resources and damages environmental quality. The ongoing, large-scale, renewable energy projects are essential steps to overcome this situation and to increase the quality of life in the rural areas.

³⁹ Li, Ling. “China Urges Electricity Suppliers to Buy 'Green' Power,” <http://www.renewableenergyworld.com/rea/news/story?id=49879>, September 10 2007.

Conclusion

Clean electricity is a major input to achieving all the MDGs. It plays a critical role in poverty eradication. Likewise, the potential of clean electricity to raise living standards by creating opportunities and improving the quality of life of rural people in impoverished communities can not be overstated. When a minimal amount of electricity is used for pumping water, providing light and refrigerating food and medicines, a community can significantly improve its living conditions. These services are essential for socio-economic development, since they yield social benefits and support income and employment generation.

The evidence that providing energy services helps achieve social objectives and generates economic growth is strong. Where electricity has been made available, the living standards have improved, and women and children were less needed as a labor force for daily survival. The poor, especially the 1.3 billion people who live on less than \$1 per day, can elevate themselves out of poverty by gaining access to electricity and mechanical power. This access is particularly important for gender equality since the majority of the poor are women. Once these societies meet their basic needs, environmental protection can take its place on their agenda.

In the absence of electricity, the world's poor have no choice but to use wood, crop residues, dung and charcoal risking their health and spending dearly. The efficient solution to reducing energy costs for those living in the remote rural areas that have low energy consumption and will not be served by a transmission line in the near future is off-grid technology. By off-grid applications, renewable energy technologies can meet their domestic, educational, nutritional and health care needs while reducing environmental impacts.

Clean electricity is the prime mover not only for modern society but also as prime leverage to lift populations out of poverty and too contribute to human well-being. In the 21st century, the world will have a huge demand for clean electricity as population explosion, urbanization and enhanced commerce are taking place. Today, one quarter of the world still live without any electricity at all. Fulfilling the Millennium Development Goals while protecting the environment can take place only with international cooperation, increased investment in electricity and R&D on sustainable energy technologies. Therefore, expansion of renewable energy usage in the Northern and Southern hemispheres and ensuring access to renewable and sustainable sources of energy for the world's poorest people should be an international goal.