GNESD

GLOBAL NETWORK ON ENERGY FOR SUSTAINABLE DEVELOPMENT

Reaching the Millennium Development Goals and beyond: access to modern forms of energy as a prerequisite

2007

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ISBN 978-87-550-3600-0

GNESD

GNESD is UNEP-facilitated knowledge network of centres of excellence and network partners, renowned for their work on energy, development, and environment issues. The main objective of GNESD is to work towards reaching the MDGs (Millennium Development Goals) through the following.

- Strengthening the member centres' ability to acquire, assimilate, and apply existing knowledge and experiences.
- Working for a better understanding of the links between sustainable energy and other development and environment priorities, and technology and policy options, leading to better articulation of practical policies that can be adopted so as to promote and highlight the crucial role of energy for sustainable development.
- Working to provide research findings to the governments to be considered in formulating their policies and programmes, and the private sector to attract investments in the energy sector, so that these favour energy sector growth for sustainable development, especially for the poor in the developing countries.
- Promoting a communication infrastructure that provides a means for members to share experiences and draw on each other's strengths, expertise, and skills.
- Strengthening South–South and North–South exchange of knowledge and collaboration on energy issues of common interest.

GNESD is one of several Type II partnerships in the field of Energy that were launched at the WSSD (World Summit on Sustainable Development) in Johannesburg, September 2002.

Acknowledgements are due to the co-chairs of GNESD for their valuable input, to the member centres, and the secretariat of GNESD for their contributions towards publication of this paper. We thank TERI for doing the final editing and printing.

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Summary

Energy services have a significant role in facilitating both social and economic development. Energy underpins economic activity, enhances productivity, and provides access to markets for trading purposes. It enables fulfilment of the basic human needs of nutrition, warmth, and lighting, in addition to education and health. Therefore, ensuring energy access to all remains important in order to achieve the MDGs (Millennium Development Goals).

At present, about 1.6 billion people worldwide lack access to electricity and about 2.5 billion rely on traditional fuels as their primary source of energy. This lack trickles over to negatively impact their access to basic needs such as those enshrined in the MDGs. Therefore, unless concerted actions are taken to ensure provision of energy services, achieving the MDGs would remain a distant aspiration. The objective of this paper is to be seen against this background, linking energy with the MDGs. This publication builds on the earlier analytical work of GNESD (Global Network on Energy for Sustainable Development) network on the issue of energy access, and documents the importance of energy service provision for both achieving and sustaining the MDGs. Table 1 provides an account of relevant MDGs for each case study. It also summarizes key lessons learnt from case studies that prove energy access leads to a gamut of social and economic benefits for the beneficiaries.

The levels of energy consumption are not evenly distributed among regions and countries of the world due to many external and internal factors. Generally, it is seen that the countries with higher level of industrialization and improved health coupled with other social factors tend to use far more energy than those with relatively low industrial activity and having poor social development indicators. Further, existing disparities can also be linked to the different shares in the world's wealth as wealthier regions tend to have better access to energy sources than poorer nations because of their ability to pay. Two issues are of particular relevance when considering energy services for the poor—high dependency on inefficient traditional fuels, and limited access to electricity. Overcoming these challenges will involve reduction of extreme poverty through injection of funds through either aid and loans/grants, or trade through market access for creation of new wealth. Besides provision of modern energy input, better financing options are required to build the kind of energy infrastructure that will enable countries to reduce the number of people surviving on less than a dollar a day by 2015.

To pursue these goals, several developing countries have undertaken rural electrification programmes for enhancing access to electricity. While many have not been very successful, catering to only a fraction of the population, the Rural Electrification Programmes, for example in Bangladesh and Brazil, have clearly made an impact, improving the lives of the people. In Bangladesh, the Rural Electrification Programme was launched in 1977. Since then, about 70 rural electrification cooperatives have been established, providing energy services to more than 40 million people. Over 38 000 villages have been provided with electricity under the programme. The initiative has promoted non-farming activities, such as cottage, small, medium, and agro-based industries, in the rural areas, generating employment and improving overall economic growth. The Bangladesh Rural Electrification Programme case study, presented in this paper, is a clear pointer to the fact that provision of clean and modern energy is one

Table 1 Millennium Development Goals relevant for case studies

Case study	*Millennium Development Goals*							
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Bangladesh rural electrification	x	x	x	x	x			
Brazil rural electrification	x	x	x	x	x	x	x	x
Kenya pump for irrigation	x		x					
Senegal National Liquefied Petroleum Gas Programme	x	x	x		x		x	
South Africa National Electrification Programme	x	x	x	x	x	x		

of the most effective ways to achieve poverty alleviation. It can be considered a model to be followed by highly centralized national electricity utilities.

Another success story where electricity promotion has changed the lives of the people is the PROVEGAM project in Brazil. The project aims to use natural vegetable oils in adapted engines for electricity production and use. In an isolated community of Vila Soledade, new diesel generators, adapted with a conversion kit to operate with 'in natura' palm oil, were introduced in 2003. The advantages of replacing the old generator with the innovative set were many. It brought benefits such as the reduction of technical failures of the system and the increased energy supply, since there were few supply interruptions. Besides, locally produced biofuel could be used in the generator. Other similar interventions have also borne positive results; for instance, the pilot project involving investments by Agropalma, an oil palm producer, in production of biodiesel through partnerships with small farmers. In one such programme in the city of Moju, the Pará State Land Institute provided land to farming families for the cultivation of oil palms. Agropalma supplied the saplings, the initial infrastructure, and taught techniques for cultivation of the palm, besides agreeing to purchase the entire crop at international market prices. The initiative has raised the incomes of the families and demonstrates the importance of partnerships between government, industry, and non-governmental organizations.

The South African NEP (National Electrification Programme) gives yet another example of how access to clean energy can translate to socio-economic benefits. Launched in two phases by the utility ESKOM, beginning 1994, the programme left a remarkable impact on rural areas, where access to electricity increased from about 20% to 50%. The remarkable aspect of NEP was the absence of external funding. ESKOM funded the programme from its own resources. At several stages of the project, the provision of electricity was found to be economically unviable. However, social concerns outweighed economic concerns, pushing the case for provision of electricity to dispersed communities. Pre-payment meters were widely installed under the electrification programme, which gave households better control over electricity expenditure and avoided the accumulation of electricity debts. This also made the utility avoid problems associated with billing and non-payment.

Though NEP provided electricity to many poor households, it did not ensure that the poor households could afford to buy it. Thus, the Government of South Africa introduced a policy in 2003 on electricity subsidy to reduce the worst effects of poverty on communities. The policy provides a 'poverty tariff' targeted at the poor. Studies show that this was a very successful policy as it not only improved quality of life of households but also increased income-generating activities. The project illustrated that financial gains should not be the only parameter in deciding on public sector projects; other concerns such as social gains and long-term benefits also remain equally important.

The MDGs of improving maternal health and reducing child mortality can be attained by providing cleaner and more affordable cooking fuels, as women and children suffer the most due to inferior fuel usage. According to WHO (World Health Organization), a large proportion of children die due to exposure to polluted air from the use of traditional fuels. To reduce the consumption of domestic biomass energy by 50% in order to address problems of rural poverty in the country, the Government of Senegal initiated a LPG (liquefied petroleum gas) Programme, commonly known as the 'butanization' programme in 1974. Since then, the consumption of LPG has been increasing, replacing firewood consumption. Through various supplementary measures such as ensuring adequate and continuous supply of LPG; technology development and adaptation; adequate regulation of prices; and targeted incentives and awareness programmes, the government has successfully enhanced LPG consumption levels in the country.

Although the butanization programme has been successful, it imposes a heavy subsidy burden on the government. Another approach, therefore, could be to

develop and adopt the use of biomass and biomass-derived fuels, improved stoves, and practices that reduce exposure to harmful emissions and increase the efficiency of conversion of biomass to biomass-derived fuel. This is basically keeping in mind the sensitivity of the subsidies in Senegal, where a slight price increase due to withdrawal of subsidy on LPG can drive people down the energy ladder.

While electrification and LPG programmes involve considerable expense, cost-effective techniques to boost the use of modern energy have also borne fruit in many parts of the developing world. The case study included in this paper – the ApproTEC (Appropriate Technologies for Enterprise Creation) treadle pump in Kenya — is an example in this regard. Treadle pumps for irrigation were introduced by the organization ApproTEC in Kenya in 1991. Today, over 24 000 treadle pumps are in use, benefiting over 120 000 people. The experience in Kenya shows that low-cost energy solutions for farming have several positive impacts, notably on farming practices and socio-economic and cultural aspects. The success of these pumps has led to the replication of the programme in other parts of Africa, such as Tanzania and Uganda.

While the case studies above are examples to support the hypothesis that access to modern forms of energy is a prerequisite for reaching the MDGs, there remain several constraints for achieving the desired goals. The most important being the lack of adequate financial resources. Energy investments, mainly from multilateral sources, have recently witnessed a decline. Most private investments are channellized in infrastructure sectors, where energy is not a favoured choice. In such a context, various innovative financing options need to be explored. These include measures such as debt relief; better usage of private investments, aid and grants; micro financing schemes, and FDI (foreign direct investment). Besides these, new sources of capital through carbon funds can provide opportunities for the energy sector of developing countries.

Some other strategies that also need to be followed to ensure access to energy to all include macro-economic stability for growth, provision of targeted energy services for the poor in urban and peri-urban areas, and energizing rural areas. Further, for provision of modern energy services for rural areas, the focus should be on scaling up existing interventions, provision of low-cost but high-impact interventions, and exploring various available cost-effective technological options.

In conclusion, the paper demonstrates that though energy access is not an MDG in itself, adequate provision of energy is crucial for achieving the MDGs; and the case studies clearly bring out this linkage. Further, as the macro-economic environment improves, so does the demand for modern energy services, and consequently the improvement of the overall quality of life. Thus, assisting countries to not only achieve the MDGs, but also to increase their capacity to sustain the MDGs remains important. In this context, the role of government in enabling both public and private energy development (political commitment, mobilizing financial resources, and selection of projects) remains crucial. The paper recommends the need to put in place an appropriate energy policy to achieve and sustain the MDGs. Specific energy options should be explored and accordingly promoted for rural and urban poor. Special attention must be given to the productive use of energy to increase and improve livelihoods through income-generating activities. Innovative financial and technological interventions should be explored, along with measures to enhance awareness amongst the people for promoting energy efficiency and conservation.

Introduction

Background

Since access to modern energy lies at the heart of human development, it is evident that in order to meet the MDGs (Millennium Development Goals), substantial improvements are needed in the type of energy services that the poor have access to. Unless concerted actions, with more emphasis on providing the poor with basic modern energy services, are taken, 1.6 billion people will still remain without access to electricity and 2.5 billion people will still be relying on traditional biomass for cooking (IEA 2005a).

The importance of the access issue was first brought forth by many individual publications in the UNDP (United Nations Development Programme) book to Rio+5–*Energy after Rio – prospects and challenges*. To further frame the energy agenda, Rio+5 created CSD (Commission on Sustainable Development)-9. Subsequently, WEA (World Energy Assessment) report was prepared by the UNDP, UNDESA (United Nations Department of Economic and Social Affairs), and the World Energy Council to inform CSD-9, and had an extensive chapter on these issues. CSD-9 said, inter alia

> *To implement the goal accepted by the international community to halve the proportion of people living on less than $1 per day by 2015, access to affordable energy services is a prerequisite (CSD-9 outcome, para. 22).*

The CSD met in April and May of 2001. The official term agreed upon to juxtapose energy and human development was 'energy for sustainable development'. Next, in preparation for the WSSD (World Summit on Sustainable Development) in Johannesburg, September 2002, the Secretary-General issued the WEHAB (water, energy, health, agriculture, biodiversity) documents in June/July 2002, with the 'E' referring to energy, and the discussion drawing heavily on the WEA. The Johannesburg PoI (plan of implementation) contains the same message as CSD-9. The linkages between energy and the MDGs are thus well established and agreed upon by the international community.

Momentum on the energy–MDG agenda was built by the Millennium Project of the UN (United Nations), which in 2004 evolved a vision comprising a set of energy services that could provide a way forward towards meeting the MDGs by 2015. The overriding conclusion was that energy services must be explicitly addressed within the planning for poverty reduction and for meeting the broader MDGs. Among the project's recommendations were the ones that called for modern liquid and gaseous fuels for cooking for 100% of the world's urban population and 50% of the world's rural population, improved biomass stoves for 50% of the world's rural population, and electricity and clean cooking fuels for 100% of the world's health facilities and schools.

The UN Millennium Project also noted that a prerequisite for meeting the MDGs is to reduce the share of the global population that does not have access to basic levels of electricity, as well as the population reliant on traditional solid fuels for cooking, to no more than about 1 billion people by 2015. This *MDG Energy Vision* foresees improved access to modern energy for about 1.5 billion people.

The underlying conviction that runs through the international community's deliberations on the MDGs and energy is that although improving access to modern forms of energy is not an explicit part of the MDG goals, access to energy is a prerequisite to reach all or any of them (Kjorven 2006; WEA 2004; CSD-9 2001;[1] WSSD 2002[2]).

The objective in this paper is to be seen against this background, and it recognizes the main issue as being the road map to achieve a successful linkage between energy and the MDGs. The contribution of GNESD (Global Network on Energy for Sustainable Development) in the Energy Access Theme has

[1] Commission for Sustainable Development annual meeting. 2001
[2] WSSD (World Summit on Sustainable Development). 2002. Johannesburg, South Africa

provided important insight on how to move ahead. In this paper, the idea is to build on this and add a broader picture with the help of five case studies from GNESD members and five other case studies that have had a documented impact on the movement towards the MDGs in terms of what made these cases happen and what were the roles of governments, NGOs (non-governmental organizations), financiers, research organizations, local communities, the ODA (official development assistance), and so on.

Energy, sustainable development, and the poverty challenge

Although several definitions have been put forward for sustainable development, none have been universally accepted but the one suggested in this paper is still considered most credible. This definition fully integrates social and environmental concerns with economic growth. An important feature of this concept, which is of direct relevance to this paper, is the improvement in the welfare of people who live in extreme poverty and are most vulnerable to shocks and stresses.[3]

Energy is intrinsically linked with sustainable development at the local, national, and regional levels. At the local level, modern energy is required to improve the overall quality of life (especially, that of the poor) by enhancing productive activities and enterprise, which will result in increased incomes. At national and regional levels, adequate modern energy leads to stable economic development, promotion of trade, and enhancement of participation in global markets, besides the added benefits of better social and economic linkages.

Looking at the centrality of energy to sustainable development from another perspective, it is known that the reduction of extreme poverty must include injection of funds either through aids, loans/grants, or trade through market access for creation of new wealth. With the current trend of dwindling aid and the debt situation of poor countries, trade and wealth creation through market access appears to be the most plausible solution. This will need significant modern energy input because trading higher value products for higher gains requires high-quality energy input. Therefore, poverty reduction requires significant input of modern energy, which falls within the interest of this paper.

While assessing energy's relevance to the poverty challenge, two priority challenges emerge. These are high dependence on, and inefficient use of, traditional fuels, and limited access to electricity.

The stranglehold of traditional fuels

Within the developing regions of the world, the share of the population that depends on traditional biomass-based fuels varies from 23% in Latin America and the Caribbean to 89% in sub-Saharan Africa (see Table 1). Apart from the low quality of life generally associated with the use of these fuels, there are serious environmental problem of indoor air pollution, especially when used in enclosed surroundings with limited ventilation (Smith 1998).

Most investments in the energy sectors of developing countries have targeted the modern energy sector, albeit relatively modest investments in the dominant traditional energy sources have been made that could potentially make a significant difference. Likewise, most interventions on better use of traditional fuels are often the scaled-down versions of conventional industrial plantation forestry, with fuelwood production the sole objective. Participatory forest management offers a fresh approach, whereby rural people are given regulated responsibility for managing existing forests and woodlands. It is better attuned to traditional practices and appears more successful in achieving sustainable management. It should be noted that this solution to concerns over deforestation and fuelwood crises has been brought about not by massive government investments, but by an attitudinal revolution, followed by the

Table 1 Percentage share of population that depends on traditional biomass

Country/region	*Percentage share of population*
China	56
Indonesia	74
Rest of East Asia	37
India	58
Rest of South Asia	41
Latin America and the Caribbean	23
North Africa and Middle East	0.05
Sub-Saharan Africa	89

Source IEA (2005a)

[3] A commonly used definition of sustainable development is the one proposed by Brundtland Commission – 'Meeting the needs of the present generation without compromising the needs of the future generations'.

creation of new markets, patterns of ownership, and institutional environments.

On the demand side of the traditional fuel equation, interventions have focused on improved cooking stoves. With nearly half the world's population cooking with traditional biomass, greater fuel efficiency is the need of the hour. However, acceptance by rural populations has not been as high as hoped; and even where improved stoves were adopted, fuel savings are less than anticipated. Too often, designs do not meet users' needs closely enough, and are not robust enough for real-life conditions. They do, however, assist in other important ways, especially in reducing indoor pollution, thereby contributing to the MDG 5—improved maternal health.

A glaring absence of pro-poor electricity programmes

Past results of electricity interventions have often been disappointing. Repeated investments in poorly operated systems, perennial shortage of cash because of below-cost tariffs, and chronic inefficiencies and system losses often failed to increase access to electricity or productivity in many developing countries. The poor typically bore the brunt of these failures, suffering from unreliable access when connected to energy sources, while many are still waiting for access to gas or electricity networks, or to improved distribution systems for kerosene, LPG (liquefied petroleum gas), and other modern fuels. It did not help that improving the welfare of the poor was rarely an explicit policy objective, with energy policies focusing on higher productivity and growth through increased access to modern energy sources by cities, towns, and businesses. The benefit was expected to have a trickle-down effect on the poor and those in rural areas.

In the context of rural access to electricity, most developing countries have developed and implemented some type of rural electrification programme. Although sometimes these promote decentralized electrification – for example through renewable energy sources – more often they focus on grid extension. Yet, despite the doubling of the number of rural households with access to electricity in the 1970–90 period, rural electrification barely kept pace with the increase in population. Moreover, experience from rural electrification programmes shows that electrification may act as a catalyst but does not guarantee economic development of the poorest. Most of their benefits tend to accrue to the wealthier groups in the electrified areas, which is not compatible with the MDG of poverty alleviation.

On the demand side, switching to more efficient, modern energy systems typically entails an initial capital cost that is beyond the means of rural households, although their running costs may be less than the energy sources already in use. To overcome this, rural micro-credit schemes have attempted to remove the initial capital hurdle, typically by utilizing the savings resulting from the lower operating cost of the new systems. They have the added advantage that the poor become clients, rather than recipients of government or donor funding. Under this relatively new approach, poor rural households represent a potentially significant commercial market.

The continuing use of traditional fuel and lack of electricity access among the poor point to the fact that developing countries, faced with other challenges and the need to serve burgeoning urban populations, have not developed strategies for supplying energy to the poorest people, most of them in rural areas, and with increasing urbanization in slums and peri-urban areas. In addition, billions of dollars worth of energy subsidies are in most cases not targeted at the poor, neither do they benefit them.

Seeking a better approach

As the scale of energy poverty is made clear, very limited progress has resulted from all the well-intended efforts made to date. A better way forward to extend affordable modern energy to the poor must be found. In the re-evaluation taking place, five imperatives have been emphasized.

1 There is a need to address energy considerations in broader development strategies, such as in agriculture, education, infrastructure, and social cohesion. In order to do so effectively, there is a need to quantify the linkages between energy and development, and move beyond the intuitive understanding of how energy and development are related. This will enable policy-makers to better understand the costs and benefits of scaling up energy services, and the importance of energy services versus growth in other input as a means of stimulating development.
2 Rural and increasingly growing peri-urban energy development must be accorded higher priority by

policy-makers. Hoping that improvement will 'trickle down' from more advanced sectors of the economy or that rural and peri-urban energy poverty can be solved by a 'technical fix' is untenable.

3 Rural energy development should have clear-cut pro-poor policies and must be decentralized to place rural people at the heart of all long-term energy planning and implementation. Bottom-up, people-led development shows the best promise of achieving sustainable development.

4 Top-down aggressive policies for the poorest, like ring fencing of investment funds, targeted tariffs, and even free basic services must be put in place and implemented efficiently and transparently.

5 Greater appreciation and awareness of the role energy can play in other development activities, especially among non-energy specialists, are also vital to integrate energy into development strategies. Clarifying misconceptions about energy (Table 2) in order to encourage the development community to take a more pragmatic approach towards issues related to energy supply, energy access, and energy use is the first step towards greater appreciation of the linkages between energy and development.

These imperatives aside, there is a need to improve access to appropriate energy services through better management and regulation of the energy sector, increasing the efficiency of energy provision and use, increasing the choice of energy services, providing access to finance, encouraging partnerships, attracting private investments under strict regulatory control, and designing subsidies that work.

Equally important is the need for more financial input to build the kind of energy infrastructure that will enable countries to reduce the number of people living on less than $1 a day by 2015, one of the important MDGs. The International Energy Agency (WEA 2004) estimates that the projected demand will entail investment in the energy sector of some $16 trillion from 2003 to 2030, or $568 billion per year. The electricity sector will absorb the majority of this investment. Developing countries, where production and demand are set to increase the most will require about $8 trillion investment over the next 25 years to meet the energy needs.

If issues on financing, policy reforms, capacity development, and good governance are not addressed, and the current pathway of development in sub-Sahara and South Asia remains unchanged, the population without electricity will increase in sub-Saharan countries and will fall only marginally in South Asia by 2030 (Figure 1) (IEA 2005b).

Table 2 Common energy 'myths' and clarifications on them

Myth	*Reality*
The poor do not consider access to energy a priority.	The poor may not use the term 'energy' but they often spend far more time and effort obtaining energy services compared to the richer section of the population. They spend a substantial proportion of their household income on energy for basic survival activities, that is cooking, keeping warm, and so on.
Access to electricity, grid or decentralized, will solve all the energy service needs of the poor.	People need to access a range of energy sources to satisfy their energy needs, that is cooking, heating, transport, and communication.
Poor people cannot pay for their energy services.	Many poor people pay more per unit of energy than the better off, partly due to inefficient conversion and lack of integrated planning.
Only rural areas suffer from lack of access to energy.	Poor people in urban and peri-urban areas also suffer from lack of access to energy services, and their numbers are likely to increase. It is predicted that almost 61% of the world's population will be living in urban and peri-urban areas and services are not expected to grow commensurately.
Commercial energy required to satisfy the needs of the poor is significant with respect to total global energy consumption.	Reaching the poor with basic modern energy services as envisioned in the *MDG Energy Vision* would increase global commercial energy consumption by about 900 TWh (terrawatt-hour) per year, which is less than 1% of the global energy demand.

MDG – Millennium Development Goal

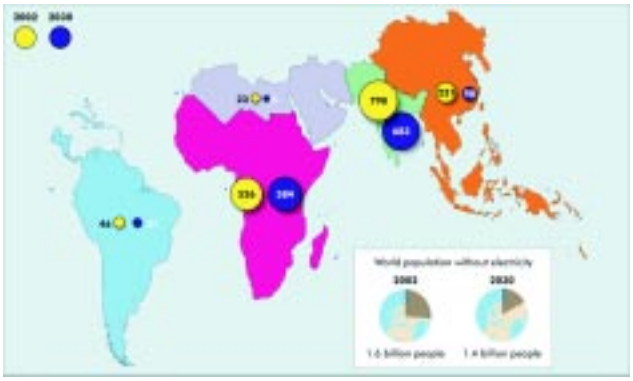


Figure 1 Population with no electricity (million)
Source IEA (2005b)

Energy interventions to meet the MDGs

While modern energy services are an essential element enabling a country to meet the MDGs, it is not possible to establish direct quantitative relationships between energy access and progress towards the MDGs. In order to estimate the resources required for improving access to energy, a definition of minimum adequate levels of 'MDG compatible' services needs to be established, with an aim to specifically close the gaps in achieving the MDGs. Identification of those services whose widespread use will facilitate the realization of the MDGs needs to be carried out, and a portfolio of possible energy interventions to improve access needs to be built.

At the country level, governments should consider grounding their intervention plans on a foundation of aggressive policy intervention to support increases in access to both electricity and clean fuels to the poorer sections of society, as well as for the agriculture and SME (small and medium enterprise) sectors. Governments also need to undertake a participatory planning process involving the local communities, investigate possible low-cost solutions, implement training and capacity-building programmes, and promote demand-side efficiency interventions (to reduce wastage) at household, commercial, and industrial levels.

As regards the cost of a robust MDG–Energy Programme, a study – Millennium Development Goals Needs Assessment, 2004 – was conducted by the UNDP in Bangladesh, Cambodia, Uganda, Ghana, and Tanzania. The study has estimated that the overall per capita MDG–Energy Programme cost, in terms of both electricity and fuel, ranges from $13 to $18 per capita per year between 2005 and 2015 (calculated by dividing the total MDG–Energy Programme cost by the total population of the countries covered in the study, and not on the portion of the population actually reached by the programme). This reflects that the investment in the energy sector to achieve the MDGs is astronomically high and comparable with other sectors like the education and the road sector investment estimates. This was estimated from four sets of costs: end-use devices, fuel consumption, electrical connections, and power plants. Table 3 shows the percentage share of investment required for the four components to cover the MDG–Energy Programme cost for each country studied.

The estimates carried out in each of the countries studied reveal that these per capita needs per year between 2005 and 2015 are in the same range as the education sector ($13–17 per capita per year), and even lesser than required for the road sector ($10–19 per capita per year). The study also indicates that households will be able to pay 30%–50% of the programme costs, as many modern interventions lower the recurrent fuel costs a household needs to pay. This is especially true in urban areas where biomass fuel sources

Table 3 Percentage share in investment in the MDG–Energy Programme cost

Type of cost	*Percentage share of the total cost*	*Components*
Fuel	40%–53%	All fuels used for lighting and cooking (except electricity): wood, coal, charcoal, kerosene, liquefied petroleum gas
Electrical connections	20%–33%	Central grid connections, mini grid, solar home lighting systems
End-use devices	12%–19%	Light bulbs, kerosene stoves, kerosene lamps, and gas stoves
Power plants	3%–22%	Additional generation capacity for the energy programme

Source UNDP (2004a)

Looking beyond the MDGs

Many energy projects have a long implementation time, and sound energy policies also have long gestation periods before their benefits are apparent. It is, therefore, crucial that interventions in the energy sector, particularly those directed towards providing clean energy services for the poor, should look beyond the MDGs (Millennium Development Goals). Energy development planning should be the crucial element in sustaining the achievements of the MDGs beyond 2015, and must also evolve into a major multiplier in the continued development efforts beyond the MDGs by adopting longer-term pro-poor strategies.

are often more expensive than gas and kerosene alternatives.

Need for this publication

Since the adoption of the MDGs, several attempts have been made by the UN bodies and other stakeholders to develop modalities for countries to achieve them, such as the UN Millennium Project (UN 2003). A few studies have specifically looked at the role of energy in achieving these goals, even though energy is not a specific MDG (DFID 2002; Modi 2004). Most of these studies have been geared towards looking at the energy needs of the poor and the role energy plays in achieving the MDGs. Others have focused on treating energy needs as an emergency situation in its own right. However, while achieving the MDGs is extremely important, it is perhaps even more crucial that the actions and policies used to achieve the MDGs also provide a sound basis for sustaining them in the future. This paper, therefore, looks at energy service provision to ensure both meeting and sustaining the MDGs.

On the issue of sustaining the MDGs, experience has adequately demonstrated that if necessary policies and infrastructure are not correctly designed in poor countries, these very often revert to their poor state of affairs in the MDG interventions, if subjected to economic, political, or ecological stresses. This is also true for the energy sector. Countries reverting to increased use of firewood as a result of economic stress, after having implemented successful fuel substitution programmes, is a clear example of this phenomenon (Davidson 1992).

The ensuing discussion will make a distinction between energy requirements for achieving the MDGs and for industrialization, which includes energy provision for major infrastructure building. The latter requires large quantities of fuel and electricity, while achieving MDGs in the rural and peri-urban areas is much more a matter of access than quantity of energy. Hence, meeting the needs of the poor may not necessarily involve development of major transmission lines, central station generation, and major gas developments. However, an improvement in the overall economic growth is also vital for sustaining the MDGs.

To conclude, access to modern forms of energy, and its relation to environmental sustainability and poverty reduction, is the focus of the paper. Environmental damages relating to energy activities are discussed as most of these impacts are yet to be adequately addressed by the countries that are struggling to achieve the MDGs. Further, achieving environmental sustainability is a specific MDG. This paper will not directly address energy for economic growth as well as security and trade, as these issues are outside its scope. Case studies partly from the GNESD centres, supplemented by case studies from other published sources, have been used to analyse and articulate strategies and suggestions for countries trying to achieve as well as sustain the MDGs.

Study approach

The study presented here is based on six hypotheses, summarized as follows.

1 Access to modern forms of energy is a prerequisite for achieving the MDGs and providing the platform for future growth.
2 Design and implementation of appropriate policies and measures to increase access to modern forms of energy are crucial.
3 Continuing along the current path of energy system, development is not compatible with sustainable development objectives.
4 It is crucial to find ways to accelerate progress for new and appropriate technologies along the energy innovation chain, from research and development to demonstration, deployment, and diffusion.
5 Developing robust pro-poor energy policies in many developing countries is essential.
6 The lack of community or stakeholder participation in energy sector planning must be addressed for faster results.

The overall objectives of the paper are to

- demonstrate that access to modern forms of energy will contribute to achieving and sustaining the MDGs;
- identify energy systems for sustainable development that will prevent countries from undergoing energy reversal trends, that is going down the energy ladder; and
- identify and put in place policies that will generate clean energy access and energy for sustainable development through productive use of lessons learnt from the case studies.

These objectives are addressed within a framework of some basic premises, as outlined below.

- Only proven, robust technologies and measures can be used in reaching out to the poorest of the poor.
- A diversity of technologies and service delivery mechanisms will be promoted.
- Energy end-use efficiency will always be promoted first.
- The need to energize rural areas for both household and productive uses will be treated as vital.
- The need to energize the growing poor population in the urban and the peri-urban centres will become increasingly important.
- All energy sources will be considered, with an emphasis on local and renewable energy.
- A comprehensive approach on gender issues, especially in relation to policies on use of traditional biomass for cooking, will be encouraged.

Energy and its linkages to the MDGs

A framework of 8 goals, 18 targets, and 48 indicators was adopted by an international consensus to be used as benchmarks to monitor the progress made by countries towards achieving the MDGs (Millennium Development Goals). Even though energy has not been included as one of the MDGs, it is universally accepted that energy development will be a key to achieving the targets of most or all of the MDGs.

Energy and MDG 1: Eradicate extreme poverty and hunger

Central to overcoming poverty is the need to create opportunity for the poor to generate income. The most plausible way of ensuring this is to involve them in productive activities at the household, national, and regional levels. Invariably, 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 selling firewood, especially in rural areas, generates income only to fulfil basic survival needs, as most of the gains go to the transporters or others in the middle of the distribution chain. While on the one hand, those involved in employment generated through LPG (liquefied petroleum gas) or electricity seem to raise their lifestyles by increased access to education and health (Davidson 2004; Prassad 2002). On the other hand, the recent experience of the Multi-functional Platform Project in Mali (detailed in this paper) shows clearly that the introduction of mechanical energy creates the potential of substantially changing rural livelihoods, especially for women (UNDP 2004b).

The role of energy is also crucial to the goal of eradicating hunger. It remains a paradox that most countries suffering from hunger are to a great extent also suffering from major food losses. For instance, a large number of countries in sub-Saharan Africa, which spend up to 30% of their foreign exchange earnings in importing food, suffer from serious on- and off-farm losses (FAO 2000). Reducing these losses, occurring along the entire food chain, will require substantial input of high-quality energy. Further, the method of farming in poor countries is largely dependent on biomass burning for bush clearing, rain-fed systems for irrigation, and very little fertilizer input. This has resulted in poor yields compared to the systems based on mechanized agriculture. Changing this pattern will require major energy input for bush clearing, irrigation, and soil enrichment. Similarly, harvesting in poor countries is largely a manual process that is not only inefficient for large farms but also uncompetitive. Introduction of mechanized harvesting methods to improve efficiency and to be competitive will require energy input. Access to modern energy will also bolster food storage and transportation, other sources of food losses in poor countries.

Energy and MDG 2: Achieve universal primary education

Modern education, which enables students to be competitive, needs major teaching aids to compliment their normal pedagogical skills. Operating these aids require high-quality electricity. Students who do not get exposed to these aids and skills are disadvantaged in the modern world. Further, these students will not have access to modern knowledge and techniques such as those relating to computing, which are strongly tied to the provision of electricity.

In poor homes that have no access to electricity, children spend a significant portion of their time doing household chores. Further, they do not have light to study at night. This situation affects their capacity to undertake assignments or review their lessons. A few hours of electricity to students can result in major improvements in their performance (UN 2005).

Energy and MDG 3: Promote gender equality and empower women

The collection of wood for cooking and heating is a time-consuming affair that continues to worsen as resources get scarcer. With women assigned this task, much of their

productive time is wasted travelling long distances to collect fuel. Within the house too, women spend far too long to cook due to the lack of suitable household appliances. Providing energy near households and modern cooking stoves can save time for women and reduce their drudgery. Time thus saved by using improved fuels and appliances can provide opportunities for women to be involved in other productive activities. Another aspect in which improved energy can help women is by cutting down the time taken to take children to and from schools, if modern transport is made accessible.

Energy and MDGs 4, 5, and 6: Reduce child mortality, improve maternal health, combat HIV/AIDS, malaria, and other diseases

Poor sanitation facilities and other factors are directly linked with high child mortality. Hence, improving these facilities, which require heavy energy input, will reduce child mortality significantly. Another aspect that accounts for poor health indicators is the presence of weak health delivery services. Improving health delivery systems will require good transport networks, and this requires energy for transport systems and for developing good roads.

Poor homes use large quantities of traditional fuels such as firewood, charcoal, or animal dung, and the burning of these fuels can result in significant adverse emissions (particulates, carbon monoxide, nitrogen dioxide, benzene, and so on). These emissions can lead to significant respiratory problems among children and women (Smith 1998). This problem is more acute in areas where cooking is done inside poorly ventilated kitchens. Changing the sources of energy used for cooking to those with far less adverse emissions such as LPG and kerosene can greatly assist in overcoming these problems.

Reducing or eradicating preventable diseases will require very good clinics that have refrigeration facilities for preservation of vaccines and other useful drugs. To operate such systems, reliable and adequate electricity is a must.

Energy and MDG 7: Ensure environmental sustainability

The production and use of energy is strongly linked to environmental degradation because the level and type of emissions from energy are highly dependent on the type of energy source. Therefore, ensuring environmental sustainability at the national, regional, and global levels will be directly linked with the type of energy produced and used. At the national level, using fuels with reduced emissions will provide an improved national environment, which will also result in other benefits such as good health. Some of the harmful emissions from conventional energy use can be transboundary and this can lead to regional problems. Since it is a very general statement there is no need to refer to UNEP (United Nations Environment Programmes). Globally, the emission of greenhouse gases, which is leading to climate instability, is largely caused by the energy sector. Using cleaner fuels will help in reducing the threat of climate instability (IPCC 2001).

Energy and MDG 8: Develop a global partnership for development

Many poor countries are small and fragmented. These may have some energy resources but lack adequate manpower, technical expertise, or financial resources to develop them. By using cooperative mechanisms, such resources can be developed so as to provide optimal benefits to the citizens of such countries. In addition, suitable trade mechanisms can be used to lower energy costs and improve access to it.

Table 1 provides a concise understanding of the role of energy in meeting the MDGs along with the policy interventions required to integrate energy into the MDGs.

Although access to modern energy is a prerequisite to move people out of poverty, it is not an end in itself.

It is a vital tool that has to be given a central place to accomplish the goals of sustainable development. WSSD (World Summit on Sustainable Development), held at Johannesburg, South Africa in 2002, fully recognized this linkage between energy and the pillars of sustainable development. In its declaration, the Summit called for the intensification of global efforts to increase access to modern energy by the poor (UNDP 1997).

However, the challenge is to embark on a modern energy growth path that will achieve development in a sustainable manner and will result in minimum adverse environmental impacts. New approaches must fully reflect economic, social, and environmental concerns. The search for a new energy growth paradigm, which will not only provide accessible and affordable energy services to the needy but will also significantly reduce the adverse environmental impacts, is within the scope of this paper. The case studies that follow present exactly the kind of opportunities that can make the new energy growth paradigm possible.

Table 1 The role of energy and scope of policy interventions for achieving and sustaining the MDGs

MDG	*Indicator*	*The role of energy*	*Energy needs and policy interventions for meeting and sustaining the MDGs*
1 Eradicate extreme poverty and hunger	▪ Proportion of population <$1/ day ▪ Poverty gap ratio ▪ Share of poorest 20% of society quintile in national consumption. Prevalence of under-weight children < 5 ▪ Share of population below minimum dietary consumption. Share of population suffering from water-borne diseases	▪ Access to energy services facilitates economic development– development of micro enterprises, livelihood activities, locally owned businesses that create employment, and so on – and assists in reducing extreme poverty ▪ To reduce hunger and improve access to safe drinking water, energy services can provide pumped water and fuel for cooking 95% of the staple food.	▪ Post-harvest processing for home consumption and for generating surplus ▪ Support improved nutrition ▪ Improve supporting infrastructure and services to properly utilized surplus ▪ Enhance income-generating activities
2 Achieve universal primary education	▪ Net enrolment in primary education ▪ Share of pupils finishing primary school ▪ Literacy rate among 15–24 years	▪ Energy services reduce time spent by school-going children (especially girls) on basic survival activities (gathering firewood, fetching water, cooking, and so on) ▪ Lighting permits home study, increases security, and enables to use educational media and communication in schools	▪ Electricity for teaching aids ▪ Improved energy efficiency in school buildings ▪ Free children from the drudgery of fuel collection
3 Promote gender equality and empower women	▪ Girl/boy ratio in school and tertiary education ▪ Literate women/men ratio for 15–24 years ▪ Share of women in wage employment ▪ Share of women in parliament	▪ The use of improved devices reduce the household burdens of girls, making them stay in school longer; they also have the time to do school work at home	▪ Provision of better cooking fuels to reduce indoor air pollution ▪ Access to mechanical energy for women

MDG	*Indicator*	*The role of energy*	*Energy needs and policy interventions for meeting and sustaining the MDGs*
4 Reduce child mortality	▪ Under-five mortality rate ▪ Infant mortality rate ▪ Share of 1-year-olds immunized against measles	▪ Energy is the key component of a functional health system, contributing, for example, in lighting operating theatres, refrigerating vaccines and other life-saving drugs, sterilizing equipment, and providing transport to health clinics	▪ Increase facilities and transportation for immunization among 1-year-olds ▪ Provision of adequate clinics with access to modern energy
5 Improve maternal health	▪ Maternal mortality ratio ▪ Share of births through health personnel	▪ Besides its centrality to the health system, modern energy can have a great impact on maternal mortality by reducing indoor air pollution	▪ Improved medical facilities for maternal care using modern systems ▪ Provision of fully equipped clinics and hospitals ▪ Adequate training and housing ▪ Reduction of excessive household work load ▪ Effective drug manufacture and distribution
6 Combat HIV/AIDS, malaria, and other diseases	▪ HIV prevalence in women above 15 ▪ Contraceptive prevalent rate ▪ Number of orphans ▪ Prevalence of malaria death rates ▪ Prevention against measles ▪ Prevalence and death rates of TB ▪ Share of TB cases detected	▪ Modern energy services for communication and power for rural clinics and hospitals enable a quantum leap for health services	▪ Increased facilities for sterilization, refrigeration, and storage facilities for vaccines ▪ Improved reuse facilities ▪ Improved blood donation systems ▪ Improved distribution systems ▪ Improved communication system using ICTs
7 Ensure environmental stability	▪ Change in land area ▪ Protected land area ▪ GDP/energy use ▪ CO_2/capita ▪ Share of people to clean water ▪ Share of people with sanitation ▪ Share of people with respiratory diseases	▪ Improved energy efficiency and use of cleaner alternatives achieve sustainable use of natural resources, as well as reduced emissions, which protects the local and global environment	▪ Integrate energy in PRSP and development plans ▪ Use low-carbon-emitting fuels and renewable energy resources ▪ Use more energy-efficient systems ▪ Improved transport planning
8 Develop a global partnership for development	▪ ODA ▪ Market access ▪ Debt sustainability	▪ Trade and international cooperation are vital to energy development and supply	▪ Promotion of fair energy trade, including renewable fuels ▪ Use of gains from debt relief in the energy sector

GDP – gross domestic product; CO_2 – carbon dioxide; ODA – official development assistance; ICT – information and communication technology; PRSP – poverty reduction strategy paper; MDG – Millennium Development Goals; TB – tuberculosis

Developed by GNESD (Global Network on Energy for Sustainable Development)

Case studies

Bangladesh: switching on progress

Socio-economic impacts of effective rural electrification

The programme

Seventy-six per cent of the population of Bangladesh resides in rural areas, which also houses more than three-quarters of the 65 million people living in absolute poverty.[1] Rapid electrification in rural areas is, therefore, accorded a priority by the government that acknowledges that access to electricity produces greater traction to a host of development goals.

The Government of Bangladesh launched REP (Rural Electrification Programme) in 1977, which has since delivered on many of Bangladesh's development priorities. Over $1.4 billion has been invested in the programme, under which 155 000 kilometres of electrical line have been installed, 6.7 million metered connections have been provided, and access to electricity to more than 40 million people in over 38 000 villages has been made possible. Seventy rural electrification cooperatives, known as Palli Biddyut Samities, have also been established, employing 16 000 people. The effectiveness of Bangladesh's REP can be gauged by the fact that system losses in the REP are about 16% compared to 30%–35% for the national utility. Additionally, the programme's billing and collection ratio of 96% is far higher than that of other utilities, and over $276 million is billed and collected annually from consumers.

One of the mandates of REP was to provide electricity for non-farming activities such as cottage and agro-based industries. Figure 1 shows the types of industries that have been set up under REP, leading to the creation of rural jobs and making a significant contribution to the economy of the country. More than two million rural people are employed in the running of electricity-based irrigation pumps, equipment handling, and businesses. It has been demonstrated that rural businesses with electricity can generate 11 times more jobs than those without electricity. The economic impact of greater rural access to electricity can be gauged by rising productivity in non-farming economic activity. In an electrified village, productivity in industries has been calculated at Taka 131 per hour in contrast to Taka 46 per hour for non-electrified villages (Barakat 2003).

Figure 2 shows a comparison of productivity between electrified and non-electrified industries. Productivity has been calculated by dividing the total

MDGs impacted

MDG 1: Eradicate extreme poverty and hunger

MDG 2: Achieve universal primary education

MDG 3: Promote gender equality and empowerment of women

MDG 4: Reduce child mortality

MDG 5: Improve maternal health

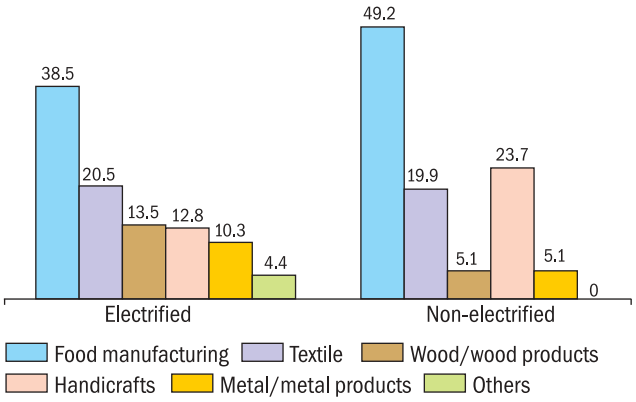


Figure 1 Types of industries (%) set up under Rural Electrification Programme
Source Barakat (2003)

[1] People in absolute poverty are those living on less than 2122 kcal/day (Government of Bangladesh 2001).

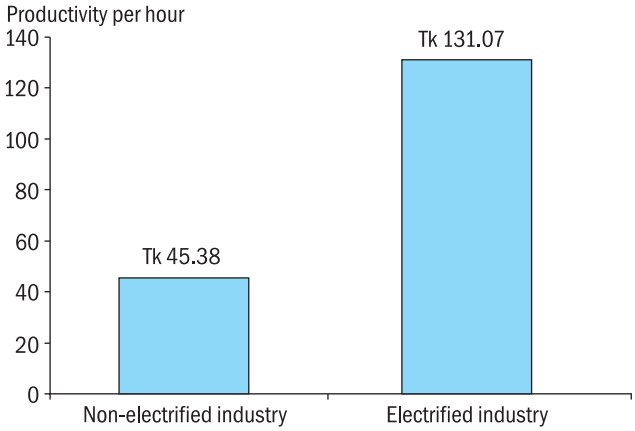


Figure 2 Comparison of productivity per hour between electrified and non-electrified industries
Source Barakat (2003)

value of production by total person hours devoted to the production of that value. The difference clearly indicates that one of the prerequisites for poverty alleviation is to make clean and modern forms of energy available to the poorer sections of the population (Barakat 2003).

REP has also had a profound impact on women's mobility, their decision-making freedom in using income and savings, utilization of credit, knowledge about gender issues, attitudes towards health care, and schooling for both boys and girls.

The HDI (human development index) value obtained for electrified household in Bangladesh is 0.642. HDI for non-electrified households in electrified villages is 0.440, while that for households in the non-electrified villages is 0.436. The significant differences in HDI values between the electrified and non-electrified households imply that access to electricity for non-electrified household will have immense impact on human development in rural Bangladesh.

Based on past experience of costs incurred in providing electricity under REP, it is estimated that $350 million per year over the next eight years would be required to complete 100% basic electricity coverage in Bangladesh. The size of the investment is not beyond the capacity of the country. But it requires political will, vision, and inspiration, all of which have been demonstrated in REP itself since its inception.

Impact of the case study on the MDGs

MDG 1: Eradicate extreme poverty and hunger

A nationally representative survey conducted in 2002 covering 23 Palli Biddyut Samities has found that electricity access in rural areas has had a profound impact on poverty alleviation by increasing the incomes of the poor. The annual income attributable to electricity in poor electrified households was 65% higher than that in non-electrified households, and the income of the poor and landless in electrified households was 50% higher than the income of those in non-electrified households. On average, 16.4% of the income of electrified households can be attributed to electricity. The corresponding figure for the non-electrified households in electrified villages was 12%, and for those in non-electrified villages, only 3.6%.

The higher incomes in rural electrified households are a result of the positive impact of electricity on employment. Electrified industries, on average, generate 3.3 times more employment than non-electrified industries. Besides, there has been an enormous spill-over effect of rural electrification on employment in various support services such as retail shops, restaurants, banks, fax–email–photocopy facilities, schools and colleges, and clinics.

A large part of the impact of electricity was realized through its cost-reducing effects on the use of irrigation machines. Average cost of electricity-operated irrigation pumps is substantially lower than that in the case of diesel-operated machines. The cost per hectare for electricity- and diesel-operated low lift pumps was found to be Taka 887 and Taka 2946, respectively. Hence, access to electricity for irrigation has had a favourable impact on the poorer farming households.

Electricity and education for children from poorer households

School enrolment among children in the age group 6–15 years is much higher among electrified households in Bangladesh. The difference in enrolment is more evident among lower income households. For households having an annual income of less than Taka 10 000, the school enrolment per electrified and non-electrified households are 75% and 11%, respectively. But for the higher income group (Taka 10 000–20 000), the enrolment ratios for electrified and non-electrified households are 38% and 29%, respectively. The enrolment ratio is almost equal between electrified and non-electrified households for higher income groups.

Source Barakat (2003)

MDG 2: Achieve universal primary education

The impact of electricity on education is much more pronounced among the poor and (particularly) among girls in rural electrified households than those in non-electrified households. The literacy rate among the poor in the electrified villages was about 41% higher than that of the poor in the non-electrified villages. Similarly, literacy among females was 31% higher in electrified households compared to the non-electrified households. Additionally, electrified households were better off in terms of adult literacy rates, enrolment ratios, expenditure on education, attendance rates, and average time spent on studies after sunset. Thus, household access to electricity should be seen as one of the major strategies to reduce knowledge poverty.

MDG 3: Promote gender equality and empowerment of women

In electrified households, reduced household chores for female members and a reduced gender gap in terms of daily average time for studying are indicative of improved gender status. Furthermore, women in electrified households are involved in more income-generation activities. Electrified industries have been providing better opportunities for female labour than the non-electrified industries. During the period between 1997 and 2002, it was found that the skilled female labour force in electrified industries in rural Bangladesh has increased from 202 to 1045, whereas the overall female labour in non-electrified industries saw a marginal rise from 80 to 125 in the same period (Barakat 2003).

MDG 4: Reduce child mortality

REP has had a measurable impact on IMR (infant mortality rates) in rural Bangladesh. Electrified villages had an IMR of 42.7/1000 live births as against 57.8/1000 live births in non-electrified villages. Estimates show that if access to electricity is 100% in rural households, and those households maintain the same IMR as the current electrified households, the annual number of infant deaths that could be prevented would be about 37 000.

MDG 5: Improve maternal health

The national survey of 2002 found that maternal health in electrified villages is better than that in non-electrified villages. A total of 79.2% of households in electrified villages routinely seek medically trained persons in child delivery, access antenatal and post-natal care check-ups, accept TT (tetanus toxoid) immunization, and seek treatment by medically competent persons in maternal morbidity, as against 57.4% of households in un-electrified villages. Likewise, households in electrified villages score over those in non-electrified villages by a margin of 52.5% to 27.3% for health indicators such as full immunization of children, reduction in infant deaths, use of family planning methods, use of hygienic latrines, and so on. In all these indicators, not only is the rich–poor divide less pronounced in electrified villages compared to non-electrified villages, but poor households in electrified villages also show much better health outcomes than their counterparts in non-electrified villages.

Lessons learnt from the case study

- Strong commitment and collaboration between the government, the people, and the implementers of a project are crucial to its success.
- Adding productive activities to such a project provides the opportunity to realize both social and economic benefits.
- Key technologies and policies that accelerate rural electrification include renewable energy, fuel switching, demand-side management, and standards.
- A much lower system loss is possible in rural systems by adopting best practices through participatory management and good governance.
- REP can be considered as a model to be followed by highly centralized national electricity utilities in Bangladesh and elsewhere, which are typically under-performing and inefficient.

- Increases in productivity in rural industrial activities is essential for supplementing agricultural income and realizing poverty reduction.

Brazil: remote but recharged

An isolated community is electrified with locally available energy sources

The programme

The Amazon region of Brazil has the lowest electrification rate in the country due to its geographic conditions, which are not compatible with the electricity supply model used in the country. The difficulty of supplying remote area communities with electricity limits the organization of economic activities in the communities. However, several of these remote areas have favourable conditions for the implementation of alternative energy projects, especially biomass-based energy systems. Brazil possesses vast tracts of arable land in the North-East and Middle-West, where cultivation of oleaginous species such as babaçu, buriti, and Brazil nuts could be promoted. The oils originating from these species, if used for electricity generation, have the potential to create significant local employment and meet remote area energy needs. The PROVEGAM project, aiming to develop specific solutions for electricity generation in remote areas, decided to test the workability of vegetable oils from oleaginous plant species as a strategy for electricity production and use.

The PROVEGAM project was financed by FINEP, Projects and Financial Studies, and developed jointly by the Brazilian Reference Centre on Biomass (CENBIO); Biomass Users Network of Brazil (BUN); Brazilian Agricultural Research Corporation (EMBRAPA); the Agropalma Group; Moju Municipality; and the Federal University of Rio de Janeiro (COPPE/UFRJ). Its main objective was to install and field-test a conventional diesel engine adapted using natura palm oil to produce power for the community of Vila Soledade, municipality of Moju, Pará state, Brazil.

MDGs impacted

MDG 1: Eradicate extreme poverty and hunger

MDG 2: Achieve universal primary education

MDG 3: Promote gender equality and empowerment of women

MDG 4: Reduce child mortality

MDG 5: Improve maternal health

MDG 6: Combat HIV/AIDS, malaria, and other diseases

MDG 7: Ensure environmental sustainability

MDG 8: Develop a global partnership for development

Vila Soledade is an isolated community that has approximately 700 inhabitants. Before the execution of PROVEGAM project, the community was served by an old and inefficient diesel generator that was unable to supply sufficient electricity. In 2003, the project installed a 200-kW (kilowatt) new diesel generator, equipped with a conversion kit to operate with 'in natura' palm oil, working six hours a day, and generating 3.3 MWh (megawatt-hour) every month. The new diesel generator brought benefits such as reduction of technical failures in the system and the increase in energy supply, since there were hardly any supply interruptions. However, the most important benefit was the use of a biofuel that is locally produced.

Vila Soledade also has an agricultural project that involves the cultivation of palm trees and production of palm oil with 100 families. The first output from the plantation was in December 2004, giving the necessary fruits to extract oil needed to supply the engines in the PROVEGAM project. In the agricultural project, each family is responsible for 10 hectares; hence, for 100 families, 1000 hectares are under cultivation. By the end of the project, the community was producing most of the palm oil needed for electricity generation, and was also creating more local jobs.

In February 2004, CENBIO undertook a socio-economic survey of the community with the main objective of identifying the changes in people's life due to the project. Results showed that majority of inhabitants were pleased with the results of the project, and registered significant life improvements

The positive results of this project led to the replication of this model to other communities in the Amazon region by several institutions. One such programme has been implemented by Agropalma, the biggest palm oil producer in Latin America. The company has launched a pilot project in the city of Moju where about 150 families work on the cultivation of oil palms. The project has the support of the government of the state of Pará, the Brazilian Agricultural Research Cor-

poration (Embrapa), and the Bank of the Amazon (BASA). Each family in Moju receives 12 hectares of land from Pará State Land Institute (Iterpa). Agropalma supplies the palm saplings, initial infrastructure, and teaches cultivation techniques. The company has also agreed to purchase the entire crop of small farmers at prices based on foreign market prices. As the palm tree takes 36 months to produce fruit, BASA is extending loans to farmers so that they may live on the farm and purchase the necessary input for the crop. The total value of the loan is to be paid back with a 4% interest per annum, with a grace period of seven years. With respect to income generation from the partnership between Agropalma and Para's government, it has been reported that each participating family has an annual gross income of $15 300. In case family is involved only in the handling of the crop, the annual net income can reach about $5800.00.

Another programme engaging local agricultural capacities for alternative energy production is being implemented in the state of Piauí. An area of about 18 000 hectares of government-owned land has been given to the company Brasil Ecodiesel under the guarantee that the land would be shared with small farmers who would produce castor seeds for the production of bio-diesel. The families sign a contract in which they guarantee to cultivate castor plants for a period of 10 years on the nine-hectare plot of land that each family receives. Up to now, about 5000 hectares are being cultivated on the farm. Annual revenues for each farmer vary between $1100 and $1330. The farmers also receive a brick house to live in, with electricity and plumbing. In 10 years, if they comply with the contract they have with the company, the residents will receive the title deeds for the piece of land.

Effective partnerships

To execute partnerships with small farmers, companies Brasil Ecodiesel and Agropalma sought the support of the federal government programme that created fiscal incentive policies for industries that process castor and palm oil in the poorest regions of the country – the North and North-East – and support family farming. Another point of federal support is the contribution of institutions like the Brazilian Agricultural Research Corporation (Embrapa), which researches varieties and methods to increase productivity. Individual state governments have also contributed, offering areas for the setting up of the industries and land for the growing of the crops.

Source Brazilian Reference Centre on Biomass (CENBIO)

Impact of the case study on the MDGs

MDG 1: Eradicate extreme poverty and hunger

Electricity produced from the PROVEGAM project has given a boost to the quality of life in Vila Soledade. Energy availability allows the processing of local products like palm oil, manioc, açaí, and cupuaçu (Amazonian fruits), adding value to these raw materials and leading to rising incomes, reduced migration, and better standards of living. The socio-economic survey by CENBIO showed a marked improvement among households, with more than 80% of them now using electric appliances and electromechanical equipment.

MDG 2: Achieve universal primary education

One of the main social benefits achieved by the project was the initiation of night study classes, which are attended by the whole community, including adults, reducing illiteracy levels of the community.

MDG 3: Promote gender equality and empowerment of women

According to CENBIO's socio-economic survey, women are active workers in the palm oil production units and are also using electricity to operate appliances such as sewing machines, registering a marked increase in their income potential.

MDG 4: Reduce child mortality

The availability of potable drinking water from electricity-powered pumps has significantly reduced the chances of children being affected by water-borne diseases such as cholera, leptospirosis, typhoid fever, giardiasis, hepatitis, amoebiasis, and salmonellosis. Availability of electricity also allows for the refrigeration and storage of vaccines and food items.

MDG 5: Improve maternal health

Besides the reduction in child mortality, potable drinking water and adequate food/medicine conservation improve maternal health.

MDG 6: Combat HIV/AIDS, malaria, and other diseases

Local population can now receive information on HIV/AIDS, malaria, and dengue prevention through television and radio, among others, because of increased access to electricity.

MDG 7: Ensure environmental sustainability

The partial shift from a fossil fuel to biofuel is a significant step forward for environmental sustainability.

MDG 8: Develop a global partnership for development

An effective partnership among governments, private sectors, NGOs (non-governmental organizations), academics, and, above all, the local community lay at the heart of the success of the project.

Lessons learnt from the case study

- Strong partnerships among governments, institutions, and NGOs are vital to the success of development programmes.
- Access to electricity has the effect of developing or enhancing productive activities, which can, in turn, assist in recovering some of the costs of the project.
- The project demonstrates the viability of mini-grid systems in remote areas.

Kenya: brighter harvest

A low-cost, non-electric pump for irrigation, which has increased agricultural output and incomes

The programme

Energy for irrigation is vital to increase food production and broaden access to nutrition. Increased nutrition and improvement in health, in turn, open up opportunities for employment and income generation. However, the lack of adequate, affordable, and efficient energy in the farming sector stymies agricultural output in most developing countries. This can be eradicated to a large extent through the use of low-cost and easy to operate non-electrical energy technologies, as seen by the treadle pump (illustrated in Figure 3) experience in Kenya.

MDGs impacted

MDG 1: Eradicate extreme poverty and hunger

MDG 3: Promote gender equality and women's empowerment

Treadle pumps for irrigation have been widely used in Kenya since 1991, when the first version was introduced in both urban and rural areas by the ApproTEC (Appropriate Technologies for Enterprise Creation). The popularity of the treadle pump in Kenya spread through technology demonstration shows and word of mouth, and over 24 000 treadle pumps are now in use in Kenya, benefiting over 120 000 people. Currently, there are 150 dealer outlets in Kenya for the pumps, and most of the dealers are agricultural and veterinary product stores, which are known and easily accessible to farmers. ApproTEC acts as a link between manufacturers and dealers, since many dealers do not have the capital or access to credit to work directly with the manufacturers.

A 1999 survey by the ApproTEC showed that most of the pumps had been in use for over eight months (the pumps were first introduced in 1998), drawing water mainly from streams and wells of an average depth of about 4 metres. A majority of the pumps are used on an average of three hours per day, although farms in the western and central parts of Kenya use the pumps for up to four hours. The introductory price in 1998 was about $70 for the ApproTEC metal pump body and about $50 for the concrete pump body, popularly known as Swiss Concrete.

Surveys also confirmed that treadle pumps are typically purchased through savings made by the users.

Figure 3 Treadle pump
Source *Operational Manual on Treadle Pumps,* Appro TEC, Kenya

Other important sources of capital include sale of crops and livestock and retirement benefits. Women manage nearly three-quarters of these pumps, which are primarily used for irrigation, although they also supply energy in some instances for household and livestock needs.

Treadle pumps have yielded several benefits for users, both in their farming practices and their socio-economic and cultural lives. Irrigation through treadle pumps has also led to an increase in the number of growing cycles, and farmers are reporting higher incomes as a consequence. The practice of bucket irrigation, which was the preferred mode of irrigation prior to the popularization of treadle pumps, was a strenuous and time-consuming affair. With the introduction of treadle pumps, farming families, especially women, have had their workloads reduced and now have time for cultural and educational activities. The success of these pumps has led to their being replicated in other countries in the region, and they are sold through dealerships in Tanzania and Uganda.

Impact of the case study on the MDGs

MDG 1: Eradicate extreme poverty and hunger

Treadle pumps have increased incomes for poor families and created over 16 000 new jobs. Each pump sold allows for crop cycle sales income of KES 46 031 ($606). Subtracting KES 5943 ($79) spent on production costs, the treadle pump delivers profits of KES 40 088 ($528) per crop cycle.

Reinvigorating the small-scale farmer

Mrs Janet Ondiek, a small-scale farmer in rural Kenya, is a widow who manages her farm following the death of her husband in 1997. Mrs Ondiek's farm is next to a perennial stream, and using bucket irrigation, she used to make a profit of KES 7000 ($93) per season. In early 1999, Mrs Ondiek saw the treadle pump being demonstrated at a local market and liked it so much that she bought one instantly. She has since used it to transform her horticultural business, as well as her family's life. She now irrigates 2.5 acres, growing high-value crops like bulb onions, tomatoes, and sweet peppers as well as kale (borecole) and spinach. Her profits top KES 240000 ($3158), and she now employs five workers. After the death of her husband, Janet's six children had almost dropped out of school due to the lack of money for school fees, but thanks to the treadle pump, she can now send them to college.

Source ApproTEC (1999)

MDG 3: Promote gender equality and women's empowerment

While men own 84% of treadle pumps in Kenya, women are the managers of nearly three-quarters of these pumps.

MDG 7: Ensure environmental sustainability

Increased agricultural productivity due to the treadle pump has reduced the need to bring more land under cultivation, reducing the pressure on ecosystems.

Lessons learnt from the case study

- The success of this project is largely based on its demand-driven nature.
- There is a need for the necessary technical back-up on such projects to maintain their sustainability.
- While the project was linked to economic objectives, it provided major social benefits as well.

Senegal: cleaner kitchens

A long-term LPG (liquefied petroleum gas) Programme for environmental sustainability and health

The programme

After a period of severe drought in the 1970s, the Government of Senegal recognized the importance of replacing traditional sources of cooking energy for achieving the development goals. In 1974, it launched the LPG Programme, commonly referred to as the 'butanization programme'. The objective of the programme was to reduce the consumption of domestic biomass energy by 50%, and increase the consumption of LPG, in order to address the problems of desertification and rural poverty.

Since the start of the programme, LPG consumption in Senegal grew from 3000 tonnes in 1974 to above 13 000 tonnes in 1985, and then soared to 56 000 tonnes in 1995. In 2005, it had risen to 120 000 tonnes, an average annual increase of 10%–12% (see Figure 4). The boom in LPG use resulted in the diversification of household cooking equipment. Presently, nearly 85% of households in the capital Dakar and 66% of households in other urban areas own LPG stoves. This remarkable increase in LPG use was due initially to

MDGs impacted

MDG 1: Eradicate extreme poverty and hunger

MDG 2: Achieve universal primary education

MDG 3: Promote gender equality and empowerment of women

MDG 5: Improve maternal health

MDG 7: Ensure environmental sustainability

tax breaks (exemption from customs duties on LPG-related equipment) and later on account of subsidies for LPG starting 1987. The LPG price structure was further affected by gradual elimination of subsidies between 1998 and 2002. Free imports were also granted to various operators involved in LPG distribution and other petroleum products.

In 1997, the development of the LPG market stimulated the creation of SITRA (filial of DIPROM, a national oil company), which produces LPG cylinders in Senegal. So far, SITRA has produced 350 000 cylinders, and has included gas packing to its activities since 1999. Several oil companies too handle the storage, packaging, and distribution of LPG, including Vitogaz/Shell, Total Gas, and Bousso. Around 100 wholesalers – private enterprises located countrywide – procure LPG from the packaging and distribution companies and distribute cylinders to retailers, typically small food stores.

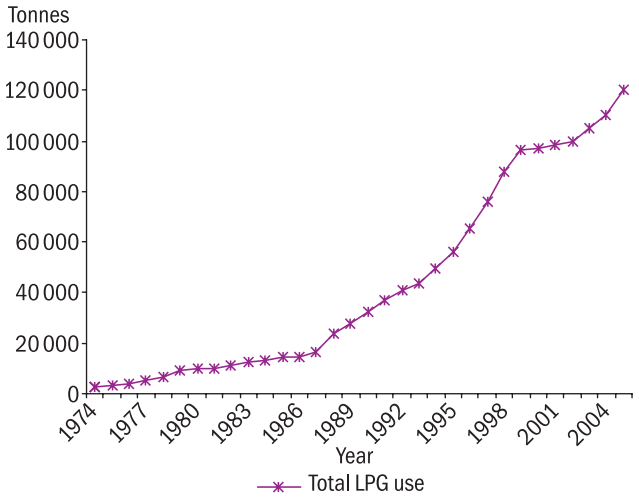


Figure 4 Liquefied petroleum gas use in Senegal (1974–2005)
Source Compiled by ENDA based on data from CRETAS (1974–99) and CNH (2000–05).

Higher income groups in Dakar were the biggest users of LPG in the initial stages of the programme. LPG use has since gradually extended to other income groups and regions. On an average, more than 50% of urban households now use LPG in the major towns – Dakar, Thiès, and Mbour – where the price of LPG is relatively low due to low transport costs.

Yet, despite the relatively successful diffusion of LPG in urban areas, fuelwood consumption is still very high in rural areas. Because it can be purchased in small quantities, and has no up-front installation costs, charcoal still trumps LPG in rural areas. The additional transportation cost in remote regions also makes traditional cooking fuels more competitive in these regions. The majority of rural households in Senegal, therefore, continue to use biomass for cooking, thus undermining the MDGs of halving poverty and achieving primary education for children (especially young girls, who spend precious time every day gathering fuel). Additionally, adverse effects on maternal health due to indoor air pollution remains unabated.

Although the increasing use of LPG has not succeeded in fully replacing other cooking fuels, it has promoted the diversification of cooking energy in Senegal, and has reduced pressure on forestry resources. For example in 2002, the consumption of 100 000 tonnes of LPG led to a reduction of firewood equivalent to 40 500 hectares of land, or the avoidance of the production of 337 500 tonnes of charcoal.

The Brazilian LPG experience

The result of the LPG (liquefied petroleum gas) Programme in Brazil was dramatic, allowing penetration to rise from 18% in 1960 to 98% in 2004. The penetration in the rural areas at 93% is particularly impressive, given the difficulties of reaching remote and thinly populated regions. Key to the success of the programme, apart from the subsidies provided, were a strong dissemination programme by the government and participation by the private sector.

In 2001, LPG prices were liberalized and collective or universal subsidy was withdrawn. This was accompanied by a voucher programme subsidizing those families with a monthly per capita income that was not more than half of the minimum wages in Brazil. This targeted subsidy has been an effective replacement for universal subsidies.

Source Janunuzi and Sanga (2004)

Additionally, thousands of jobs (Pape-Alassane DEME/ PROGEDE 2002) have been created since the implementation of the LPG programme. The job creation covers several branches of LPG activities ranging from the reception of the imported LPG to packaging and wholesale and retail distribution. While there was some concern that the LPG Programme would lead to redundancies in the charcoal industry, such fears have been largely unfounded. Urban retailers simply relocated to rural regions where charcoal consumption remains quite important.

It must also be noted that Dakar and the main cities, and not the remote regions of the country, are the chief beneficiaries of the LPG Programme as shown in Table 1. In fact, the additional transportation cost to the remote regions makes the traditional cooking fuels more competitive in these regions. To allow a better penetration of LPG to the poorer section of the population, it is necessary to redirect the subsidy through voucher schemes or any other suitable mechanism that can ensure an avoidance of leakage.

Impacts of the case study on the MDGs

MDG 1: Eradicate extreme poverty and hunger

The programme has promoted income-generation activities and direct employment opportunities, from the establishment of upstream enterprises for LPG import and cylinder production to downstream opportunities of distribution and sales.

MDG 2: Achieve universal primary education

Collection of firewood in rural areas for cooking is a time-consuming chore predominantly tasked to women and young girls. In rural households that use LPG, significant amount of time is changed, enabling young girls to concentrate on studies.

MDG 3: Promote gender equality and empowerment of women

Gender inequality related to energy manifests itself mainly in the collection of firewood and water, and in grinding of grain in rural areas, roles actively endorsed by society. The availability of cooking gas liberates women from such laborious activities and allows them to dedicate time for income-generation activities. It also provides women time to fulfil their social and educational interests, as cooking on LPG stoves is quicker.

MDG 5: Improve maternal health

The use of LPG has brought much needed relief to mothers working in family kitchens, which prior to the use of LPG were polluted with extremely hazardous fumes.

MDG 7: Ensure environmental sustainability

The LPG Programme has led to greater protection of forestry resources due to the reduction in the use of firewood for cooking, contributing to global environmental sustainability. Further, the programme has helped reduce greenhouse gas emissions, as the combustion of LPG leads to less formation of greenhouse gases, especially unburnt hydrocarbons (WEA 2000).

Table 1 Household energy consumption for cooking

Domestic Fuel	*Urban Dakar*		*Other towns*		*Urban areas*		*Rural areas*		*Total*	
	Household	%	*Household*	%	*Household*	%	*Household*	%	*Household*	%
Gas	241 405	87.2	95 394	45.9	336 800	69.5	45 092	7.7	381 891	35.8
Electricity	0	0	387	0.2	387	0.1	0	0	387	0
Fuelwood	7 011	2.5	65 619	31.6	72 630	15.0	477 409	81.9	550 039	51.5
Charcoal	23 056	8.3	44 306	21.3	67 362	13.9	48 920	8.4	116 282	10.9
Other	4 467	1.6	1 398	0.6	5 864	1.2	10 390	1.8	16 256	1.6
NA	927	0.3	814	0.4	1 741	0.4	995	0.2	2 736	0.3
Total	276 866	100	207 919	100	484 785	100	582 806	100	1 067 591	100

Source ESAMII (2004)

Lessons learnt from the case study

- Based on the national circumstances, fuel substitution can take time and, therefore, requires patience. Meaningful results only start emerging 20 years after implementation.
- Government commitment is important, as is flexibility in policy. The latter was a result of close monitoring of the programme by the government.
- Implementing policies requires supplementary measures such as ensuring adequate and continuous supply of LPG, technology development and adaptation, adequate regulation of prices, targeted incentives, and adequate awareness programmes.
- A well-structured pricing system is important to the success of such programmes.
- It is evident that to make a greater impact on poverty alleviation, sustainable biomass production is a better option due to the cost barriers of LPG and other clean fuels. Sustainable biomass production can be encouraged by exploiting its linkages with agriculture, agro forestry, animal husbandry, waste treatment, forestry, carbon credits, and income generation.
- It is difficult to bear the subsidy burden for such a programme in the long term.
- The Senegalese government implicitly manipulated charcoal prices to popularize LPG, but such distortions are unsustainable and can affect livelihoods.
- There remains the fundamental question of whether LPG interventions such as the one in Senegal can address poverty alleviation to the extent that charcoal interventions could otherwise do.

South Africa: power surge

Furthering development through the National Electrification Programme

The programme

Adequate energy is a basic survival need in itself, and suitable energy provision is a must to meet other basic human needs. Acknowledging this, the South African government instituted NEP (National Electrification Programme) in 1994, to be implemented by the national utility ESKOM from its own resources. Phase I of NEP (1994–99) provided 2.5 million electricity connections at a total cost of about R 7 billion ($1= R 6.5). Previously disadvantaged rural areas as well as schools and clinics without electricity were connected to the national grid. Phase II started in 2000 and has since provided 300 000 additional households with electricity every year.

MDGs impacted

MDG 1: Eradicate extreme poverty and hunger

MDG 2: Achieve universal primary education

MDG 3: Promote gender equality and empowerment of women

MDG 4: Reduce child mortality

MDG 5: Improve maternal health

MDG 6: Combat HIV/AIDS, malaria, and other diseases

While electricity connections were provided to several rural areas, it was found that these were financially unviable in many cases, as revenues did not cover ESKOM's operating costs. A consumption of 350 kWh (kilowatt-hour) per month was initially anticipated in rural areas, but in some areas, the average household consumption for 2000 was only 132 kWh/month (Borchers, Qase, Gaunt, *et al*. 2001). NEP overlooked this cost disadvantage by stressing social development as the primary motivation behind the programme. Figure 5 indicates the actual and projected electricity use in South Africa from 1960 to 2025.

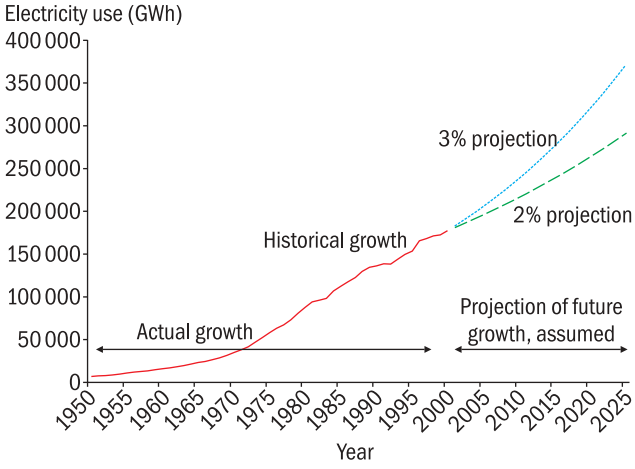


Figure 5 Actual and projected electricity use in South Africa, 1960–2025
Source UCT (2002)

The most remarkable impact of NEP was on the rural areas of the country. As Figure 6 shows, access to electricity in rural areas increased from about 20% to 50% between 1995 and 2001. The programme has demonstrated that appropriately designed rural systems need not be much more expensive than urban systems (Gaunt 2005). Between 1996 and 2001, the national average cost per electric connection decreased by 40% in current terms and 70% after taking into account inflation, eventually becoming the same as an urban connection cost. The savings were achieved by adopting designs that bring the network technology and capacity closer to customer requirements, broad application of prepaid metering, and revised industry standards and implementation procedures.

Up until 2000, NEP was almost exclusively funded by ESKOM, the national utility, either through direct investment in its own electrification projects or through transfers to an electrification fund that NERSA (National Electricity Regulator of South Africa) allocated to municipalities. In 2001, the government took over funding of electrification through a separate NEF (National Electrification Fund) housed in the DME (Department of Minerals and Energy) and funded by the National Treasury.

The DME is also responsible for the off-grid electrification component of NEP. Five private companies have been granted concessions to provide off-grid electricity services in specific remote and rural areas of the country on a fee-for-service basis. Off-grid service providers are also encouraged to improve access to a range of fuels, such as gas or kerosene, among poor rural households.

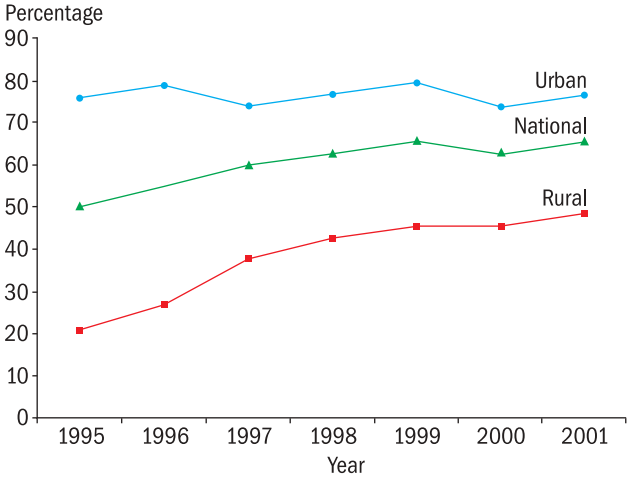


Figure 6 Access to electricity in urban and rural areas of South Africa
Source Davidson and Mwakasonda (2004)

Policy backing for pro-poor tariffs

As NEP (National Electrification Programme) progressed, it was observed that there were many poor households that could not afford the electricity provided, and a subsidy was needed to achieve greater social benefits from the investment in NEP. In 2003, the government introduced a policy on electricity subsidy, to reduce the worst effects of poverty on communities. The policy provides a 'poverty tariff' targeted at the poor. As per the tariff, 50 kWh (kilowatt-hour) of free basic electricity is provided to all poor households connected to the grid. Studies have since shown that this was a very successful policy, as it not only improved the quality of life of households, but also created income-generating opportunities.

Source Prasad and Ranninger (2003)

The off-grid electrification programme is subsidized by the government. Over a five-year period, service providers have access to a subsidy of R 3500 per system installed. Depending on the individual cost structures of concessionaires, this amount should pay for about 80% of the cost of the system. Customers pay a monthly service fee of R 58 and the government pays a monthly service subsidy of R 48 directly to the service provider as part of the free basic electricity support tariff or poverty tariff for off-grid customers.

Impact of the case study on the MDGs

MDG 1: Eradicate extreme poverty and hunger

Access to modern energy services improves morale and enhances peoples' enterprise. NEP has made a significant impact on the lives of the rural poor in South Africa, opening up new avenues of employment and small-scale business, improving the standard of life, and reducing the incidence of extreme poverty and hunger.

MDG 2: Achieve universal primary education

Electricity has provided a quantum boost to education in rural South Africa. As Table 2 shows, the number of schools with access to electricity has been steadily rising since the inception of NEP. Lighting, heating, using teaching aids such as computers, photocopiers, and access to media and communication have improved

student welfare and learning opportunities. Additionally, light at night has enabled adult education.

MDG 3: Promote gender equality and empowerment of women

The benefits from cooking and heating with electricity were lower than expected because most of the poor people can only afford to pay for electricity for lighting, access to media, and very limited cooking. However, women's tasks were eased to some extent. Good-quality lighting permitted reading and access to media, informing women about issues pertaining to development, health, and education.

MDG 4: Reduce child mortality

Where electricity has replaced coal or fuelwood as cooking energy, there is less indoor air pollution, and children and women are less exposed to fumes that contribute to respiratory infections. Incidences of accidental kerosene poisoning of children, and fires and burns caused by candles and kerosene have also been reduced. Information from television and radio has improved child-care knowledge among both urban and rural communities.

MDG 5: Improve maternal health

NEP has ensured that clinics in rural South Africa can now operate electrical medical equipment in well-lit premises, encouraging women to go to clinics during an emergency at night.

MDG 6: Combat HIV/AIDS, malaria, and other diseases

Clinics receiving electricity are now able to refrigerate medicines, sterilize equipment, and provide better emergency services at night. In addition, information campaigns on diseases such as HIV/AIDS and malaria can reach wider audiences through television and radio.

Lessons learnt from the case study

- Commitment, will power, and determination by the government, as exemplified in NEP, are integral to the success of any developmental activity.
- Dramatic reductions in the capital cost per customer of rural electrification suggest that rural systems, if appropriately planned, are not more expensive than urban systems.
- Financial ends should not be the only parameter in deciding public sector projects. Other concerns such as social gains and common long-term economic benefits are also important.
- Such projects often lead to spin-offs such as pro-poor policies, as demonstrated by poverty tariffs.
- The institutional and regulatory issues that apply to centralized urban systems also apply to centralized systems in rural areas.
- A wealth of knowledge is accumulating from NEP on the best practices in structuring the roles of the governments, investors and donors, service provider institutions, and NGOs (non-government organizations). These best practices can act as a model for other developing countries.
- The benefits from cooking and heating with electricity have been negligible. In order to address the MDGs relating to maternal health, child mortality, and empowerment of women, an approach to promote sustainable biomass production and efficient cooking and heating appliances should be undertaken.

Overall lessons from the case studies

- Movements vary considerably between countries and regions. However, several examples show that much improved levels of access to modern forms of energy is possible. More importantly, it is vital that mod-

Table 2 Schools supplied with electricity (from 1994 to 2002)

	1994	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*Total*
Urban	77	188	260	38	95	0	28	19	45	750
Rural	485	802	768	511	856	486	383	313	936	5540
Total	562	990	1028	549	951	486	411	332	981	6290

Source NER (2003)

ern energy access is widened to meet the MDG targets. This is a finding of major importance.

- The role of governments is significant in all the success stories, underlining the fact that development programmes perform best when they receive institutional support. The government can manifest itself through strong political will, provision of finance, and exploitation of opportunities.
- Responsibility for ensuring energy access cannot be left to the energy supply sector alone. Access strategies need to be integrated with PRSPs (poverty reduction strategy papers), rural development, land-use policies, and the agriculture, health care, and SME (small and medium enterprise) sectors.
- The impact of energy programmes on the MDGs depends also on having access to small tools for productive end uses, as the energy platforms in Mali demonstrate.
- Women play a central role in ensuring the maintenance of modern energy systems in rural communities.
- Discussion on conventional costs (on a kWh basis) is inadequate at governmental levels, as all these services need to be recognized and reflected in market conditions.
- A clear distinction must be made between energy for MDGs and energy for industrialization or export. In the latter, huge investments in a system such as the Mali platform would require a total investment of less than 2 billion over a 10–20-year period, which is not a high figure compared to energy infrastructure or ODA.
- Partnership between various actors, local as well as external, and a cross-sectional institutional collaboration can assist energy development programmes.
- High-impact low-cost scaling-up is possible for various technologies.
- Higher value addition in productive activities is created with access to modern energy.
- Flexibility in policy formulation and implementation is needed for project success. Targeted policies aimed at satisfying the needs of the poor are extremely important, but it must be ensured that they really benefit the poor.
- Mobilization of community participation is very important for the success of the modern energy projects.
- Mobilization and organization of local capital for energy projects are vital to their success.
- Countries should use local funds to undertake projects at the lower end of the cost curve and search for external funding for more expensive projects.

The energy vision for the MDGs

Energy targets for the MDGs

Generally, it is well documented that the two most important energy indicators to track the progress of the MDGs (Millennium Development Goals) are access to electricity and reliance on traditional energy systems for cooking. Hence, most energy targets drawn by institutions are based on these indicators.

International Energy Agency targets

As per the latest IEA (International Energy Agency) estimates, 1.6 billion people globally did not have access to electricity, and 2.5 billion depend on traditional biomass for cooking. Using this as the benchmark, IEA has set the following targets (IEA 2005b).

- Reduce people without access to electricity to no more than 1 billion by 2015.
- Reduce the number of people reliant on traditional biomass to 1.85 billion by 2015.

McKinsey and Company targets

McKinsey and Company suggested the following targets to achieve the MDGs (SEI 2005).

- Reduce by half, between 2005 and 2015, the proportion of urban and rural households without access to adequate lighting.
- Reduce by half, between 2005 and 2015, the proportion of urban and rural households reliant on cooking methods that are not MDG-compatible.
- Provide adequate, clean, and efficient energy services by 2015 to all educational and health facilities.

Stockholm Environment Institute targets

The MDG project of the SEI (Stockholm Environment Institute) elaborated on the McKinsey and Company targets and defined the following targets to be achieved by 2015 (SEI 2005).

- Enable use of modern fuels for 50% of those who at present use traditional biomass for cooking.
- Enable access to reliable modern energy services for all urban and peri-urban poor.
- Provide electricity for all schools, clinics, hospitals, and community centres.
- Enable access to mechanized power for all communities.

Modi study targets

A recent paper on energy and MDGs suggested the following targets (Modi 2005).

- Enable 50% of those using traditional fuels for cooking to shift to modern energy, including improved stoves.
- Enable access to reliable modern energy services for all urban and peri-urban poor.
- Provide electricity for services such as lighting, refrigeration, ICT (information and communication technology), water pumping, and purification for all schools, clinics, hospital, and community centres.
- Provide access to mechanical power for all.
- Make reliable all-weather roads accessible to all communities.

GTZ MDG study

A study undertaken by GTZ suggested the following targets as benchmarks for achieving the MDGs.

- Achieve a 5% annual growth in gross domestic product up to 2010 and 7% by 2015.
- Double consumption of modern energy services, especially for productive uses.
- Provide access to modern cooking energy services for 50% of the African people living in rural areas and using traditional biomass for cooking.
- Enable access to reliable and affordable modern energy services for basic energy needs for 75% of the urban and peri-urban poor.
- Provide access to 75% environment-friendly electricity for schools, health facilities, and community centres.

- Promote motive power for productive uses within all major rural communities.

FEMA study

A study by FEMA (Forum for Energy Ministers of Africa) suggested the following targets for African countries to achieve the MDGs (Davidson and Conteh 2005).

- Double the consumption of modern fuels, especially for productive uses.
- Explore the use of modern biomass for industrial purposes.
- Provide access to modern energy for cooking to 50% of the rural population.
- Provide access to modern energy services for basic needs for 75% of the poor in urban and peri-urban areas.
- Extend electricity services to 75% of schools, clinics, and community centres.
- Promote motive power for productive uses in all rural areas.
- Explore the use of biofuels to offset price hikes of hydrocarbon energy.

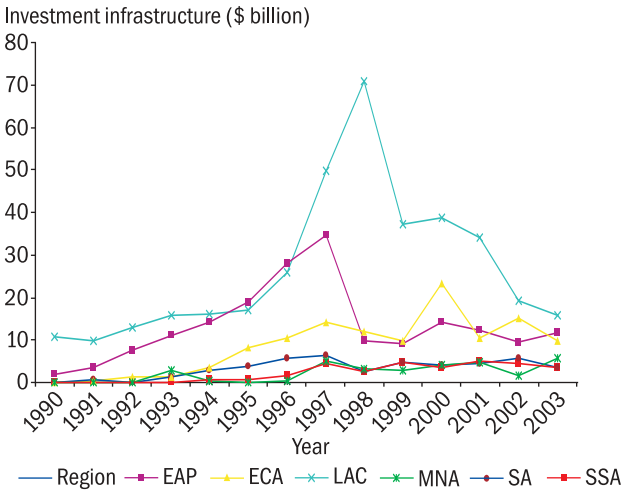
All these targets drawn by the various institutions have significant implications for energy investments. As an example, the IEA estimated that $200 billion in energy investments will be needed to achieve the increase in electricity access. The cumulative electricity investment available in developing countries will most likely fall far short of the IEA estimates. The countries that will face the biggest challenge in raising finance are those whose energy needs are higher relative to the size of their economies. Investment risks are also higher in these countries. The global financial system has the capacity to fund the required investments, but it is unlikely to do so unless conditions are right.

Energy investments in developing countries

The main bilateral agencies – Germany, Japan, and France – invest largely in water, sanitation, and telecommunications, rather than in energy development. Hence, about two-thirds of ODA (official development assistance) for infrastructure comes from multi-lateral sources, primarily the European Commission, the regional development banks, and the World Bank. Close collaboration between banks and other institutions through co-financing are being established in individual country programmes in infrastructure. However, there has been a decline in ODA energy investments recently, which could be attributed to the policies advocated by some donor agencies that favour private participation in infrastructure. Countries are thus being prompted to rethink policies that inhibit private–public participation.

In recent times, external private participation in infrastructure development has been very low in comparison to total requirements, and has been declining. Where private capital has made some contribution in developing countries, it is concentrated in certain countries and niches. For example, in the case of Africa, almost 50% of private investments in infrastructure went to South Africa.[1] Figure 1 illustrates the variation among regions in private participation in infrastructure.

Also, private investments in infrastructure show that energy has not been a particularly favoured preference (Figure 2). Telecommunications has been the most attractive sector because it has by far the highest rate of return. Investments in the other areas are negligible. Apart from returns, investments in infrastructure are also affected by the creditworthy status of the region or country.



EAP – East Asia and the Pacific; ECA – East and Central Africa; LAC – Latin American countries; MNA – Middle East and North Africa; SA – South Asia; SSA – Sub-Saharan Africa

Figure 1 Annual investment in infrastructure projects with private participation by region, 1990–2003
Source Estache (2005)

[1] *African Business*. August/September. 2005. No 312; *African Business*. July 2005. No. 311

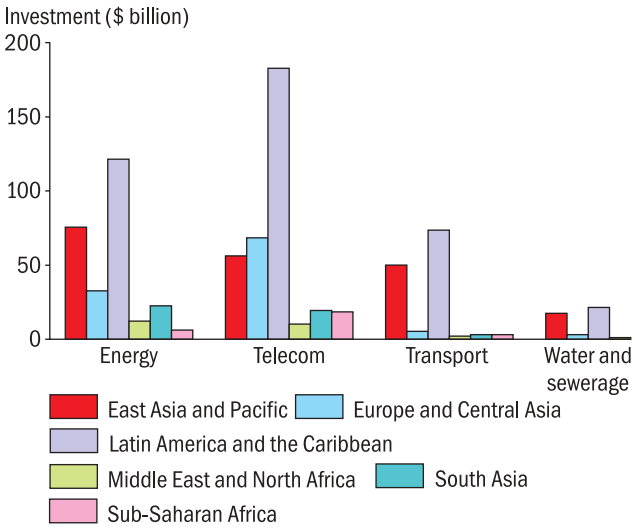


Figure 2 Total private investments in infrastructure, 1990–2002 ($ billion)
Source Estache (2005)

Within the energy sector, private participation in power has been growing as a result of the poor performance of national power utilities. Institutionally, private participation has been either as IPPs (independent power producers) or PPPs (public–private partnerships). The results of private operations have been mixed. Some experiences have resulted in higher electricity prices, job losses, and poor returns on public assets. In such a context, the most promising approach in the power sector appears to be the corporatization of utilities. This allows the electricity operator to be separated from the government administration and to function as a separate legal entity with its own commercial and financial obligations.

One of the major causes inhibiting private investments in the energy sector is the scale of investments required to develop energy infrastructure. However, governments can reduce investment needs significantly by introducing energy efficiency policies and measures. The use of modern power practices can provide up to 10% or more power for use by consumers. Likewise, reducing transmission and distribution losses can in turn reduce investment needs significantly.

Investments in rural energy need specific attention in the context of their importance to meeting the MDGs. The use of well-designed and targeted subsidies that focus on bringing down upfront fixed costs of appliances (cooking stoves, LPG (liquefied petroleum gas) cylinders, electricity connection, and so on) rather than the recurrent costs will substantially increase affordability.

Suggested financing options

Financing energy development to reach the MDGs is a challenging prospect. Exploring new and innovative financing options to meet these needs is very important. Suggested options include intensification of regional and sub-regional power projects, regional procurement of crude oil and petroleum products, greater use of regional expertise, cross-learning among regional utilities, and more rational development plans. In addition, there are some existing financial instruments, listed below, that countries can exploit to satisfy their infrastructural development needs.

- Debt relief
- Better use of private investments
- Aid and grants
- Recent climate change initiatives
- Micro financing and other innovative financing schemes
- Foreign direct investment

As the recent debt relief announced by the G8 countries shows, countries now have the opportunity to use such an instrument to source developmental funds. However, using funds from HIPC (highly indebted poor countries) for energy projects will not be easy due to other compelling demands. Health, education, and agriculture are the usual priorities. The energy ministries in developing countries would need to show a compelling case to the finance and development ministries for the use of such funds in the energy sector.

As discussed earlier, private involvement in energy infrastructure has been less than satisfactory. What further inhibits private investments is the complex and time-consuming process it typically involves. Generally, governments require a significant amount of knowledge to cope with private investment overtures. At a macro level, the following guidelines are presented to assist governments in encouraging private participation in the energy sector.

- Initiate private sector intervention in energy, rather than waiting for the private sector to make the first move.
- Explore the option of co-financing of energy projects with local investors.

- Develop manuals for private sector investments in energy infrastructure.
- Use local or regional experts to undertake needs-based assessments, feasibility studies, and risk assessments.
- Use international experts, with local or regional involvement, for financial and technical studies.

Moving on to the next financing option, aid is normally misconstrued as the transfer of wealth from developed countries to developing countries without expectation of repayment. But nearly all aid is tied to certain conditions, though these vary from country to country. For instance, one such condition is that funds should be spent on specific goods from certain companies and specified consultants, preferably from the donor country.

As regards grants, an opportunity for grant funding has emerged in the form of EUEI (EU Energy Initiative), launched at the Johannesburg Summit as a long-term commitment from the EU to increase energy access to meet the MDGs. This initiative is demand-led and aims at creating partnerships between the EU and the African countries, in addition to the private sector and other organizations (EU 2003).

Another source of grants for the energy sector investments has emerged from the UNFCCC (United Nations Framework Convention on Climate Change) and the GEF (Global Environment Facility). Grants prompted by the climate change debate include the CDM (clean development mechanism), a collaborative mechanism between developed countries and developing countries for the development of greenhouse gas reducing projects, besides other carbon-financing funds.

In general, accessing these funds will pose problems due to high transaction costs relative to the expected price of carbon credits. Access to these grants also remains a problem partly due to the rules and regulations of these grants, and partly due to some inherent weaknesses in the infrastructure of the developing countries.

Strategies and options

Introduction

Most of the countries that are yet to achieve the MDGs (Millennium Development Goals) need to transform themselves from the economic survival stage that they find themselves in to a stage of sustained development. This will involve substantial improvement in their overall net productivity, as this will lead to the creation of 'new wealth', a major ingredient to tackle extreme poverty. Hence, the suggested strategies to meet the energy challenges in these countries will cover aspects of both macro- and micro-economic and social aspects. What follows is a discussion of these strategies.

Ensuring macro-economic stability: a strategy for growth

This section will deal with energy for economic development more than energy and the MDGs, and options suggested will relate to energy for major economic growth, rather than for poverty alleviation. This perspective is included because if countries are to sustain the MDGs, their macro-economic superstructures must be sufficiently resilient to cope with minor economic shocks.

Extant energy literature clearly demonstrates the positive correlation between growth in modern energy services and macro-economic improvement. It is absolutely necessary that countries in which a large share of the population lives in extreme poverty increase their consumption of modern energy services at the national and local scale. One way these countries can achieve this is by creating and enhancing their enabling environment for the promotion of local and external investments. The basic approach to achieve this is to develop their infrastructure, in particular energy infrastructure, as a relatively developed energy infrastructure is crucial for attracting investments in other areas.

Developing energy infrastructure promotes rapid economic growth, as the case of Mauritius shows. The country achieved 100% electricity in about 30 years, leading to substantial economic improvement (UNECA 2004). Likewise, as shown in the case study presented in this paper, the well-developed energy infrastructure in South Africa has assisted the national electrification programme significantly, doubling the country's electrification rate in five years, a feature that clearly manifested itself in their economic performance.

Another strategy countries should focus on is to encourage local investments in the energy sector by forming consumer associations. Such associations can invest in both development and operations of the national utility, as has been done in many countries to meet social investments. The task now is to replicate such efforts in the energy sector.

Targeted energy policies: a strategy to enable access for urban and peri-urban poor

Urban-based policies and measures aimed at addressing poverty tend to ignore the large number of marginalized people migrating from rural areas with very little skills and opportunities. Studies have shown that this group of people does not have access to reliable supplies of electricity or other forms of modern energy. Even in cases when they do have access, they pay very high tariffs relative to their incomes. There is thus an urgent need to develop specific targeted policies and measures that address the needs of the urban poor and those living in the peripheries of urban areas.

The case of Brazil in providing subsidies for the poor in urban and peri-urban areas to access liquefied petroleum gas is a good example of how to approach this requirement. Another example comes from South Africa's poverty tariff, launched in 2003 as a response to the identified needs of the poor, which ensures access to electricity for basic household activities.

Energizing rural areas: a strategy to accelerate towards the MDGs

Past energy interventions in rural areas have largely focused on households, and very little attention has been paid to energy for income generation and public services. An analysis of current literature shows that

the impacts of most energy interventions have been limited because they are either too small or are concentrated on satisfying emergency household needs. As a result, even among those that appear successful, the success is not always sustainable. To redress this, a strategy in the provision of modern energy services for rural areas should focus on scaling up existing interventions, launching new low-cost but high-impact interventions, and diversifying technological options.

Energy interventions in rural areas must have a productive element included. As the case of the Rural Electrification Programme in Bangladesh shows, doing so increases the incomes of beneficiaries. This increase in incomes leads to improved health and educational services. The benefits from extending energy for productive uses in rural areas are amplified if the fuel is produced locally, as the case of Vila Soledade in Brazil showed.

Another aspect in rural areas is the provision of modern energy services for education and health. The provision of electricity for schools in Bangladesh, South Africa, and the Amazon region in Brazil changed the lives of people as they can now access a higher quality of education, and are able to compete for after-school education in the countries. The biogas project in Nepal shows that the use of biogas to solve the public health problem in a rural area produces significant multiple gains–social, economic, and institutional. Similarly, the case studies presented here show that the provision of adequate electricity in clinics for refrigeration of vaccines assists in preventing mortality and maternal health problems.

Threats to suggested strategies

While the strategies outlined above are workable mechanisms towards meeting and sustaining the MDGs, there are a few major threats that could act as barriers to the effective implementation of these strategies. These threats can arise from the following sources.

Internal threats

- Political interference
- Inability of governments to cope with obligations
- Poor technology choice or limitation in technology options
- Poor enforcement of regulations
- Poor risk mitigation
- Non-participation of local communities in energy development planning
- Poor implementation of externally funded projects

External threats

- Reduction in research and development expenditure in OECD (Organization for Economic Cooperation and Development) countries—the main source for energy innovations
- Decline in public and private investments in energy
- Impact of continued high oil prices
- Poor credit ratings

Conclusions and recommendations

Conclusions

This paper demonstrates that though access to modern energy is not an MDG (Millennium Development Goal), it is a major force multiplier in attempts to reach the MDGs, as it facilitates the overall economic development of a country. Further, existing literature has amply demonstrated that with the improvement in macro-economic environment, the demand for energy services, and consequently the overall quality of life, also improves. Adequate access to modern forms of energy also enables countries to not only achieve the MDGs, but also increase their capacity to sustain the MDGs.

This paper also shows the important role of the government in both the public and the private energy development to achieve and sustain the MDGs. This role could include astute policy-making, political and financial commitment, and selection of projects with a focus on energy for sustainable development. Also, an important parameter that requires attention is the pricing of energy. The transition from a price reflecting social and political concerns to that reflecting full market value is a major challenge.

Private participation, as the case studies presented in the paper have shown, can be a tonic for energy development, provided governments are prepared to undertake needs-based analysis and feasibility studies; conduct risk transfer/management analysis; and promote technology transfer, employment opportunities, and cost minimization.

It has also been seen from the case studies that the use of public funds to support energy interventions having high social returns can have positive results towards reaching the MDGs. However, subsidies should benefit the poorest and care should be taken so that the comparatively better-off do not get more benefits, as has been the case in badly designed universal subsidies.

The paper also illustrates that greater facilitation is needed to launch dedicated projects for the poor. This includes provision of financial assistance, subsidy, or free service; a fully engaged community at every stage of a project; and encouraging rural entrepreneurs with support systems (roads, market, standards, and so on) to promote productive activity. On the issue of cost-effective strategies to deliver clean energy services to the rural and urban poor, it is clear from the case studies that multiple technologies are required, depending on resource availability and cost-effectiveness of the available delivery systems.

Finally, in order to address energy considerations in broader development strategies, there is a need to quantify the linkages between energy and development, and move beyond the intuitive understanding of how energy and development are related. This will enable policy-makers to better understand the costs and benefits of scaling up energy services and the importance of energy services versus growth in other inputs as a means of stimulating development. It is important to understand that failure to include energy considerations in national development strategies will undermine the ability to achieve all the MDGs.

Recommendations

The main recommendations from this study include the following.

- Providing access to affordable modern forms of energy is a prerequisite for achieving and sustaining the MDGs. Action to achieve this access should become part of the PRSPs (poverty reduction strategy papers).
- A dedicated energy policy is required to achieve and sustain the MDGs, and such a policy should consider not just households, but productive sectors of the economy too.
- National utilities should explore the provision of free basic electricity for households in both urban and rural areas (~50 kWh (kilowatt-hour)/hh (household)/

month), and measures such as cross-subsidies should be used to help defray the cost.

- While designing subsidies, care must be taken to ensure that capital cost subsidies are not too high when the service rates are likely to be low.
- Specific cooking energy options should be promoted for the poor. Options like using liquefied petroleum gas or electricity that can be produced at lower costs should be explored, given the fact that recent hikes in the international oil prices are not likely to reverse to $30 a barrel in the near future. In this context, it is crucial that sustainable and modern forms of biomass, especially charcoal, and improved cooking stoves be accorded higher priority.
- High priority should also be given to the promotion of biogas, which has shown promising results in different parts of the world. Efforts should be concentrated on removing social stigma that is still a barrier towards full utilization of its potential. Financial and institutional reforms should be carried out to promote biogas use through innovative financing, building a strong operation and maintenance base, and putting in place standards for the manufacture of biogas plants.
- Productive use of energy to increase and improve livelihoods through income-generating activities should be given special attention.
- Community participation should be fully exploited in energy projects targeted at the poor. There is also an additional need to strengthen capacities at the district and municipal levels for planning, implementation, and monitoring of energy programmes efficiently.
- Tools and methods to facilitate access to energy in the context of PRSP planning need to be developed.
- A systematic knowledge management system must be put in place targeting professionals and decision-makers regarding approaches to achieve symmetry between energy development and MDG priorities.
- The use of renewable energy should be promoted, keeping in mind the following considerations.
  - Systems based on a needs-based assessment
  - Selection of technology based on technology assessment
  - Provision of adequate and suitable technical back-up systems
  - Provision of subsidized financial systems
  - Support for existing energy cooperatives and promotion of new ones
  - Promotion of private–public partnerships
  - Development of innovative financing schemes
  - Creation of a robust participatory planning process and reduction in decision-making time
  - Encouragement of good governance and transparency in implementation of projects

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ISBN 978-87-550-3600-0