

Policy Paper

Energy, Climate Change and Poverty Alleviation



Preface

Recent years have seen something of a sea change in the climate debate. The focus is no longer exclusively on reducing greenhouse gas emissions as it has become increasingly evident that not only is climate change already occurring but that future change, resulting from past emissions, is bound to take place. The need for adaptive strategies to reduce vulnerability to this change is now a pressing need.

Nowhere is this more the case than in developing countries, where so many people still depend on subsistence agriculture as their source of food and on the biomass as their source of energy, both highly vulnerable to climate change. All of the evidence now suggests that developing countries will be hit soonest, and hardest, by climate change, and that it is the poor in those countries that will be hit hardest of all.

This has important implications for all aspects of their future development and more specifically where energy is concerned. For energy policymakers and planners climate change represents a dual challenge since energy plays a pivotal role in development often at the same time with GHG emissions contributing to climate change but is also a sector that will itself feel the effects of climate change in a variety of ways.

This dual challenge is the focus of the studies presented here. The papers from three of GNESD's Member centres examine different aspects of the complex links between climate change, energy and poverty, to help clarify the debate and to demonstrate that the issues, while complex, are nonetheless perfectly manageable.

Probably the most salient finding of the studies is that energy, in spite of its pivotal role for sustainable development and for successful adaptation, is hardly mentioned in the adaptation plans prepared by developing countries under the UNFCCC's National Adaptation Programmes of Action (NAPA) process. Moreover, some countries are continuing to view energy as somehow set aside from other considerations, apparently unaware that the impacts of climate change may render the solutions they opt for invalid.

In the immediate future, developing countries are not only going to have to respond to climate change that is already occurring, they are going to have to anticipate and plan for future changes. Their plans must therefore include policies and strategies that will structure the modern energy supplies that are vital not only for low carbon economic and social development but also for successful adaptation to climate change.

Successful adaptation and sustainable development are inextricably linked, and energy is a key factor for both. Only an integrated approach that fully encompasses the dual challenge facing the issue of energy in developing countries will enable them to reduce their vulnerability to climate change and ensure that their future is sustainable. It is our hope that the information and ideas in the papers presented here, together with the policy recommendations stemming from those ideas, will make a positive contribution to the emergence of such an approach.

List of acronyms and abbreviations

CDM	Clean Development Mechanism
CELADE	Latin American Demographic Centre
CEPAL	United Nations Economic Commission for Latin America
COP	Conference of the Parties
CO₂	Carbon dioxide
ECLAC	Economic Commission for Latin America and the Caribbean
ENSO	El Niño Southern Oscillation
GCM	General Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GNESD	Global Network on Energy for Sustainable Development
GoK	Government of Kenya
GoU	Government of Uganda
GWh	Gigawatt hour
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
KCCL	Kasese Cobalt Company Limited
KenGen	Kenya Electricity Generating Company
KIHBS	Kenya Integrated Household Budget Survey
KML	Kilembe Mines Limited
KPLC	Kenya Power and Lighting Company
Ksh	Kenya Shillings
kWh	Kilowatt hour
LDCs	Least Developed Countries
LEG	Least Developed Countries Expert Group
MDGs	Millennium Development Goals
MW	Megawatt
MWh	Megawatt hour
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaption Programmes of Action
OLADE	Latin American Energy Organization
PPA	Power Purchase Agreement
RoE	Republic of Ethiopia
RoR	Republic of Rwanda
SIEE	Energy-Economic Information System
SMEs	Small and Medium Enterprises
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
Ug. Shs	Uganda Shillings
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
US\$	United States dollar

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TERI, The Energy and Resources Institute, India.

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ERI, The Energy Research Institute of the National Development and Reform Commission (NDRC), China.

GNESD

The Global Network on Energy for Sustainable Development (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 for reaching the Millennium Development Goals (MDG) by:

- Strengthening the Members 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, and
- Strengthened 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 World Summit on Sustainable Development (WSSD) in Johannesburg, September, 2002.

Policy Paper on Energy,
Climate Change and Poverty Alleviation

Climate Change and Energy Security in East Africa

Prepared for
The Global Network on Energy for Sustainable Development (GNESD)

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October, 2009

Executive summary

Historically, the East Africa region has been dependent on hydropower for its electricity and this source currently accounts for around 79 per cent of the electricity generated in the region. At present, and in spite of past experiences and warnings about changing weather patterns and foreseeable reduction in precipitation, several countries in the region are continuing to invest heavily in ambitious hydropower projects. A notable example is Uganda with its controversial Bujagali hydropower plant. Since East African countries (with the exception of Kenya which has slightly diversified its energy generation sources) lack diversified power sectors, a combination of increased drought and shortened rainy seasons frequently cripples operation of their power sectors, leading to sharp drops in their respective GDPs. Furthermore, the current ongoing unabated encroachment of agricultural and commercial activities into the region's water catchment areas appears to be making hydropower development more vulnerable to the impacts of drought and to the erratic weather patterns currently being experienced across the region.

Experience shows that there is a direct relationship between climate change and energy security, in that varying rainfall patterns have led to severe drought affecting hydropower generation, and in some cases, flooding. Excessive flooding on the other hand contributes to a rapid build up of silt in hydropower dams, affecting the amount of water available for electricity generation.

A major shortcoming of governments in East Africa is their failure to plan adequately to tackle the crises in their respective power sectors and, more specifically, drought-induced reductions in hydropower generation. As a result, the immediate response during power crises is to procure emergency thermal electricity to meet the shortfall in power supply. The problem with emergency thermal electricity is that it is expensive, in some cases double the price for planned and installed thermal generated electricity, as witnessed in Uganda at the height of the power crisis in 2006 (Baanabe, 2008). The high cost of emergency thermal power is also partly linked to fluctuating world oil prices which peaked at a record high of US\$140 per barrel in September 2008.

In light of the challenges facing the power sector in East Africa, there is a need to reduce the vulnerability of large scale hydropower generation to the impacts of drought (which is often thought to be climate change related). Since it is impossible to predict the occurrence of drought or the nature of fluctuation in world oil prices, governments and electricity utility companies within the East and Horn of Africa region need to adopt more robust, resilient and well thought out plans for dealing with drought-induced power crises, especially with respect to hydropower generation. Some of the ways in which they can achieve this are by:

(i) Diversifying energy generation source – having a wider mix of energy sources

Countries using renewable energy sources to diversify their sources of electricity generation appear to better survive the impacts of severe drought than those exclusively relying on hydro electric power generation. For example, Kenya appears to be more resilient than Tanzania and Uganda to drought-induced power generation shortfalls, largely because Kenya has a higher level of diversification of electricity generation sources, mainly through promotion and use of renewable energy sources such as geothermal, biomass-based cogeneration and, to a lesser extent, wind. As a result, Kenya's security of electricity supply is significantly greater than that of Tanzania or Uganda.

(ii) Promoting proven renewable energy technologies for electricity generation

In spite of the abundant availability of renewables in the region, East African governments are still stuck in the 'vicious cycle' of heavy investment in hydropower and meeting shortfalls in demand from thermal resources. There is an urgent need for East African governments to break out of this cycle. Investment in mature renewable energy options such as geothermal, small hydro, biomass cogeneration and wind are attractive since they not only provide the requisite power but also have multiple benefits and are ideal candidates to complement hydropower generation in the region. In addition, the resources are widely available in the region, are environmentally friendly and can provide additional development benefits such as job creation and reduction of oil import bills.

(iii) Setting renewable energy targets in the energy mix

Renewable energy targets in East African countries' energy policy must be entrenched in the national modern energy mix and in power purchase agreements (PPAs) in order to induce more private sector led renewable energy investment.

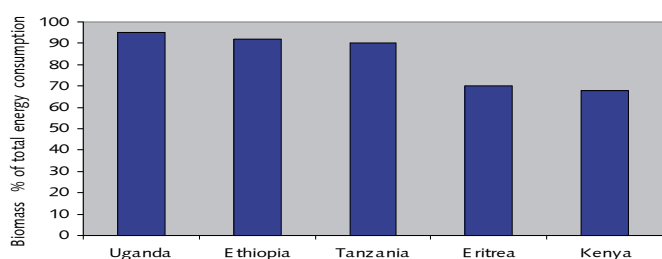
Although the national energy policy of the three countries in the region (Kenya, Tanzania and Uganda) are target-specific and are aimed at promoting the development of and investment in renewable energy technologies in East Africa, and all the countries have enacted and are offering standard PPAs, the PPAs must be very attractive, and must have a pre-determined standard-offer (or feed-in tariff) at which the national utility will purchase all energy produced by renewable energy plants in order to lead to successful scaling up of renewables-based power investments in the East African power sector.

1.0 Vulnerability of East African energy to climate change

Energy sources available in the region include biomass, petroleum, hydropower, geothermal power (used only in Kenya), natural gas (used only in Tanzania) and sources of renewable energy such as solar, wind, small-hydropower and biomass based cogeneration.

The energy sector in East Africa has a key characteristic, namely: over-reliance on traditional biomass energy resources (used mainly for the energy needs of most rural households), and heavy dependence on hydropower and imported petroleum (which meet the energy demand of the modern economy). The level of dependence on biomass in the region is very high. In Uganda, for example, biomass accounts for up to about 95 per cent of the total energy consumed (IEA, 2007), with a similar pattern repeated all over the region. Figure 1 shows the level of dependency on biomass within the East Africa and selected Horn of Africa region countries.

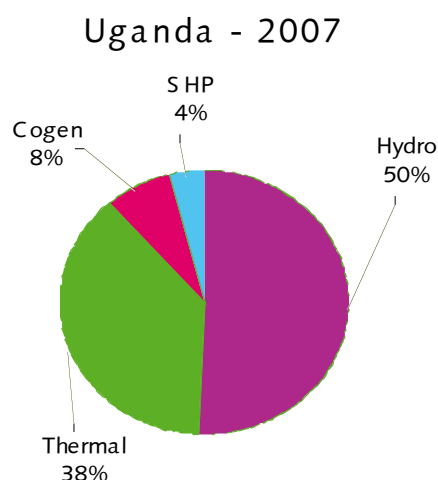
Figure 1: biomass energy as a percentage of total energy for selected Eastern African and Horn of Africa countries (2005)



Source: IEA, 2007

In the past, electricity generation in Uganda has been predominated by hydropower sources. Uganda has two large hydro power dams, Kira Hydropower Station and Nalubale Power Station, which have a combined installed capacity of 380 MW. In addition, Uganda has an installed thermal power capacity of around 150 MW. The country has recently begun to harness renewables in an aggressive fashion, with cogeneration in sugar factories now contributing about 30 MW of electricity and small hydropower stations contributing a further 16 MW (Baanabe, 2008). Figure 2 demonstrates Uganda's heavy reliance on hydropower in Uganda

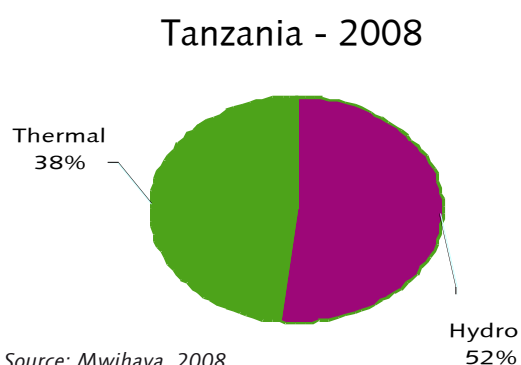
Figure 2: Uganda's reliance on hydroelectric power generation



Source: World Bank, 2007

Electricity generation in Tanzania is based on hydropower and thermal energy sources. As of July 2008, Tanzania's electricity installed power generating capacity was 1165.6 MW (including independent power producers (IPPs) and imports from neighbouring countries); installed hydropower capacity accounted for around 50 per cent of the total electricity installed capacity in 2008 (Mwihava, 2008). Figure 3 shows the sources of Tanzania's electricity and the country's reliance on hydropower.

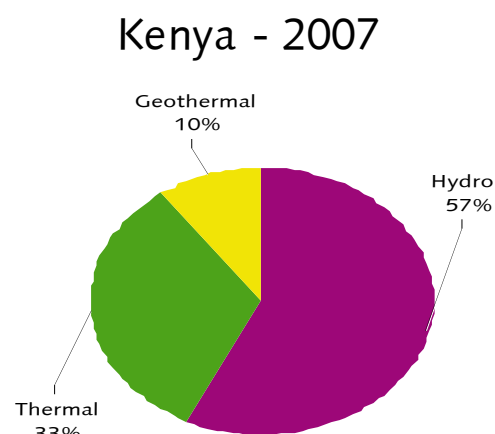
Figure 3: Tanzania's reliance on hydroelectric power generation



Source: Mwihava, 2008

Kenya's situation is no different, as illustrated by Figure 4.

Figure 4: Kenya's reliance on hydroelectric power generation



Source: KPLC, 2007

Consumption of modern energy within the East Africa region is still very low, in spite of the growth of national economies. This is evidenced by low levels of electricity consumption in Kenya, Tanzania and Uganda. For example, per capita consumption of electricity in Tanzania is alarmingly low at 65 kWh (Mwihava, 2008), only about 2.4 per cent of world consumption of 2,751 kWh/per capita (World Bank, 2007). The picture is even grimmer for Uganda. Only 10 per cent of the population has access to electricity and the per capita electricity consumption stands at 44 kWh (Baanabe, 2008). Kenya's per capita electricity consumption appears to be better than its counterparts; it is estimated to be 128 kWh (GoK, 2004). Table 1 presents the electrification levels in East Africa. These are low, particularly in rural areas.

Table 1: electrification levels in East Africa (2006)

Electricity Access Levels	Kenya	Tanzania	Uganda
National %	20	12	10
Urban %	51	39	47
Rural %	8	2	3

** 2007 data

Source: World Bank, 2007; World Bank, 2007b, AFREPREN/FWD, 2008, GoK, 2004; Baanabe, 2008; Mwihava, 2008.

The challenges facing East Africa's power sector are far-reaching and varied. However, the challenges considered to be the most immediate are the following:

Drought-induced generation capacity shortfalls

The frequency of droughts in the region has increased over the past couple of decades. The intensity of droughts is now so severe that their occurrence almost cripples the region's power sector. This often leads to unprecedented power crises that have become a common feature of the region's power sector.

Rapid urban population growth rate

The region's population growth rate is rapid, much higher than the rate for the provision of electricity services. For example, Kenya's population was estimated at 37.2 million in 2007 and is projected to increase to 42.2 million by 2012, (KIHBS, 2007). The rate of provision of electricity service has not been able to keep pace with the population increase (Kiva, 2008). This has placed a strain on the electricity supply network within the region, leading to frequent power fluctuations, intermittent supply and increased non-technical losses through illegal connections.

Increasing electricity demand and diminishing reserve margin

East Africa's economy has been expanding, leading to an increased demand for electricity due, especially, to growing manufacturing and services sectors. The growth in electricity supply has, however, not kept up with the growing demand, partly due to inadequate strategic planning by policy makers and partly due to lack of financing. For example, in 2007/08, Kenya's peak electricity demand was projected to be 1,153 MW, for an effective generation capacity of 1,185 MW, leaving a reserve capacity of only 3 per cent instead of the required safety margin of 15 per cent (KPLC, 2007). This severe constraint led to load shedding of electricity supply in 2009. A similar situation is experienced in Uganda and Tanzania, and in all of the East African countries; it is made worse by drought-induced hydropower generation capacity shortfall.

2.0 Methodology

This was mainly a desk study complemented by computer-based collection of data on climate change patterns and their impacts on hydropower in East Africa. The methods used to achieve the study objectives including the following:

Data and statistics compilation: compilation of existing data and statistics on large hydro and the contribution of large hydro to the power sector of the three East African countries studied.

Literature review: a review of available statistical publications on energy, the power sector, renewables and poverty, and research reports and publications on climate change as well as the contribution of renewables to the power sector in the region.

Review of Energy Policies: analytical review of current energy policies of the respective countries in the region.

The key challenges and limitations in undertaking the study were the short completion time and availability of data. The study duration was brief and this limited the level of detailed analysis. Access to recent data and information was difficult, especially information regarding the direct impacts of climate change on the power sector in the East Africa region. In addition, available information was based on just a few empirical studies and not on a regional comprehensive assessment of the energy sector and climate change.

Government sources and other reports often provided different and conflicting definitions and figures for energy sector and for climate change, and for the effects of change on the energy sector. However, efforts were made to compile the available data and to make estimates that helped to paint a clear picture of the energy situation in East Africa.

3.0 Analysis and key findings

3.1 Impacts of climate change on the East Africa energy sector

Scientists recently confirmed that the Earth's average temperature increased by approximately 0.74°C over the past century (UNEP, 2007). This rise in temperature is said to have contributed to rising sea-levels and to increased frequency and intensity of heat waves, storms, floods and droughts experienced throughout the world in recent years. There is growing evidence of climate change in the East Africa region. In Kenya, for example, the gradual yet dramatic disappearance of glaciers on Mount Kilimanjaro and Mount Kenya has already been evidenced. Mount Kenya, in particular, acts as a 'water tower' for major rivers, supplying water to Kenya's major hydro electric power dams.

It is projected that, by the year 2020, the ice cap on Mount Kenya could disappear completely (UNDP, 2006). The glacial retreat on Mount Kilimanjaro is better documented within the region, and it is reported that the glacial area of the mountain has decreased by 80 per cent since the early 20th century (URT, 2007). There have also been widespread changes in extreme temperatures in the region. Time series data recorded between 1978 and 1999 over the East Africa region show that maximum and minimum temperatures have changed, with significant increases generally recorded at all sites (UNDP, 2006). Cold days and nights have become less frequent and hot days and hot nights more frequent.

Frequent and recurrent episodes of drought (thought to be climate change related) in East Africa have, in the past, resulted in huge losses of livelihood, migration of people, loss of crops and livestock, decline in hydroelectric power generation and displacement of wildlife across the continent (RoE, 2007; IPCC, 2001; Stern Review, 2007, RoE, 2007; RoR 2006 ; GoU 2007; URT 2007) (see Table 2). For example, in Uganda prolonged and severe droughts have led to low water levels in rivers and underground aquifers and reservoirs, affecting hydrology, biodiversity and water supply. The most severe impacts of drought were felt during the drought of 2004–05, which led to a reduction of water levels in Lake Victoria and in the Nile River, seriously impacting power generation and the whole of Uganda's economy (GoU, 2007).

Drought in East Africa resulted in reduced water in rivers which greatly affected hydropower production. Figures 5, 6 and 7 show how the region's power generation has been affected by drought over the years.

Table 2: recent rain shortages in agriculturally productive areas in East Africa

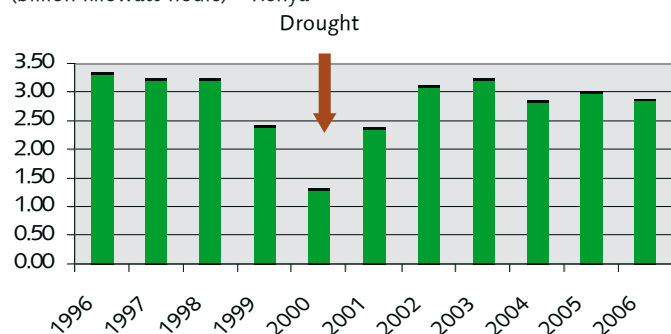
Country	2000	2001	2002	2003	2004
Kenya	D	D	D	D	D
Tanzania	D		D	D	D
Uganda	D	D	D	D	

D = Year in which there was a significant rain shortage in agriculturally productive areas

Source: World Bank, 2005

Figure 5: hydroelectric power generation

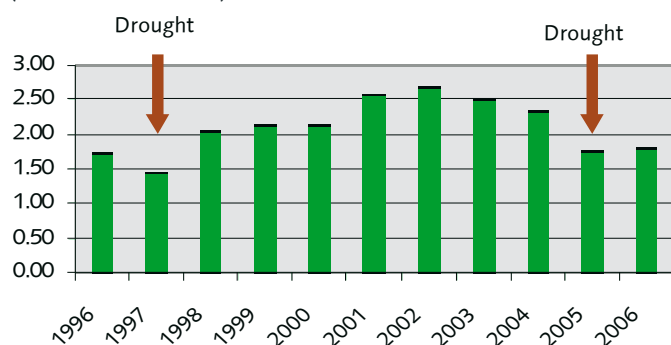
(billion kilowatt-hours) – Kenya



Source : IEA, 2008

Figure 6: hydroelectric power generation

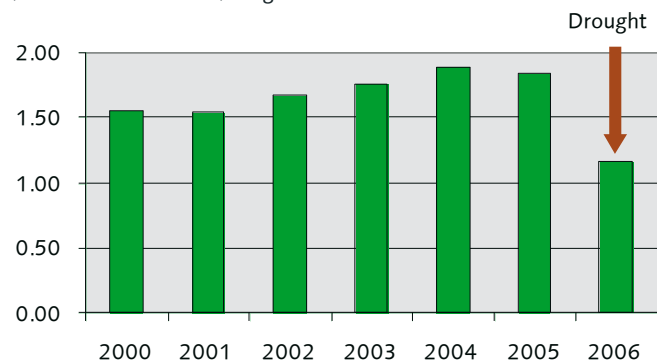
(billion kilowatt-hours) – Tanzania



Source : IEA, 2008

Figure 7: hydroelectric power generation

(billion kilowatt-hours) – Uganda



Source : IEA, 2008

As already mentioned, the drop of at least two metres in the water levels in Lake Victoria—the main water catchment for hydropower generation in Uganda—over the past three years resulted in reduced power generation at the Kira and Nalubale hydropower stations (Baanabe, 2008). The power shortage experienced in 2006 was a threat to Uganda's macroeconomic performance. This worsened the already bad situation where only 5 per cent of the population has access to electricity (Baanabe, 2008). Table 3 shows the amount of electricity purchased by UETCL (the Government owned electricity transmission utility in Uganda) from the various generators to fill the gap. The table shows how power generation from large hydro (UEGCL) decreased from 448,476 MWh in the first quarter of 2005 to its lowest level of 262,810 MWh in the fourth quarter of 2006.

It also worth noting that, for many decades, Uganda was a net supplier of electricity to Kenya but that in recent times Uganda has not only become a net importer of electricity from Kenya but its consumption of electricity from Kenya has increased nearly three fold.

Kenya's situation was not much different from that of Uganda. Impacts of drought (often thought to be climate change related) on hydroelectric power generation in Kenya stem mainly from low water levels in catchment areas as a result of poor rainfall. This implies reduced head and subsequent reduction in hydro generating capacity. This was experienced in Kenya in 2000, when the country suffered its worst drought in 37 years. In June–July 2000 electricity generation fell by 25–30 per cent (Kiva, 2008). During that period, the effective power generation capacity of the hydropower plants was reduced from a high of 665.8 MW to 501 MW (Kiva, 2008). In addition, droughts can reduce the water retained by hydroelectric power dams. For example, one of the largest hydroelectric power dams in Kenya, the Masinga Dam, has a total capacity of 1.6 billion litres but in August 2008, due to the drought at that time, it held only 599 million litres (Kiva, 2008). This adversely impacted the country's hydropower generation capacity and led to the suspension of electricity generation from the dam in mid 2009.

The impacts of drought in Tanzania mirror those of its regional neighbours. In the 1990–2008 period, Tanzania experienced three incidences of drought. The worst was in

1997 when the Mtera dam reached its lowest ever level resulting in a 17 per cent drop in hydropower generation and bringing the Tanzanian Government to announce major power load shedding across the country, a move which adversely affected the industrial and commercial sectors (Karekezi et al, 2009).

In the light of the preceding discussion, the impacts of what are often thought to be effects of climate change on the energy sector in East Africa are wide and far reaching. The following section provides an assessment of the impact of climate change on energy costs in the region.

3.2 Impact of climate change induced drought on cost of energy in the region

There are virtually no widely recognised experts or major reliable regional studies focusing on the linkages between climate change, adaptation and energy security. In addition, no major study has examined the link between climate, energy security and the poor in the East Africa region. The impacts of climate change on energy supply and demand appear to be unclear. This is because the impacts of climate change on energy supply and demand depend not only on climatic factors, but also on patterns of economic growth, land use, population growth, distribution, technological change and social and cultural trends that shape individual and institutional actions.

There is, however, a direct relation between climate change and energy security in that varying rainfall patterns have led to severe drought which affected hydroelectric power generation in the region. On the other hand, excessive flooding, which appears to occur after severe droughts, contributes to rapid build-up of silt in hydropower dams, affecting the amount of water available for electricity generation. Silt can also damage hydropower station turbines. In addition, flooding leads to spillage of excess water which cannot be stored for use during water shortages.

One major shortcoming of governments in the East Africa

region is their failure to plan adequately to tackle the crises in their respective power sectors and, more specifically, to plan for drought-induced reductions in hydropower generation, now a recurrent feature of the region's power sector. As a result, the immediate response from Governments during the recurrent power crises is to procure emergency thermal electricity to meet the shortfall in power supply (Karekezi et al, 2009). Emergency thermal electricity is expensive, in some cases twice as expensive as planned and installed thermal generated electricity. This was the case in Uganda in 2006 (Baanabe, 2008).

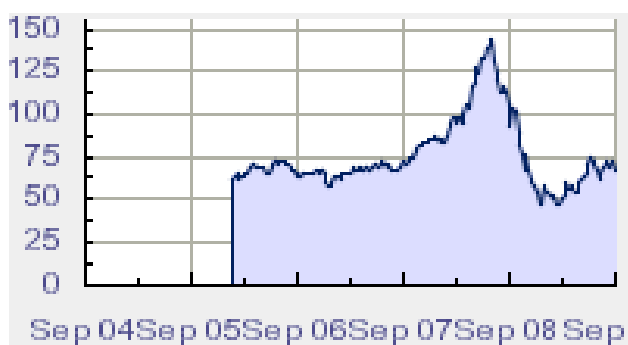
In addition, the high cost of emergency thermal power is also partly linked to the fluctuating world oil prices. Recent episodes of drought in East Africa coincided with the period of high oil prices. The volatility of world oil prices (as witnessed in 2008 when the price of oil peaked at an all time high of US\$140 per barrel) is one of the key factors that have led to the persistent quandary in which governments and power utilities find themselves whenever drought related power crises occur. When a shortage in electricity power supply (due to drought) coincides with escalating oil prices, unreliable power supply and/or shortfalls occur (as in 2007–2008) and governments, utilities and end users are faced with exorbitant electricity bills which have a serious ripple effect on the economy. Figure 8 shows the world price of oil over a four year period, with a steep rise in oil prices in September 2008 which, coincidentally, happened to be the period of drought in East Africa.

Table 3: electricity purchased by UETCL from various generators in Uganda (2005–2006)

UETCL Energy Purchases (MWh)							
	KCCL	KML	Aggreko	Kenya	Rwanda	UEGCL	
Year	(mini-hydro)	(mini-hydro)	(diesel)	(import)	(import)	(hydro)	Total
2005-1	108	3,230	0	6,579	159	448,476	458,552
2005-2	154	5,693	24,162	6,144	0	425,723	461,876
2005-3	451	3,441	54,390	5,022	397	421,180	484,881
2005-4	343	7,842	61,752	5,418	458	403,156	478,969
2006-1	401	6,588	62,743	6,031	475	321,655	397,893
2006-2	428	7,137	73,469	6,452	511	296,155	384,152
2006-3	629	6,675	91,803	16,848	799	279,836	396,590
2006-4	164	7,999	141,484	17,397	514	262,810	430,368

Source: Baanabe, 2008

Figure 8: world price of oil, September 2005 – September 2009



Source: www.oil-price.net/

Changes in international oil prices are often directly reflected in consumer end prices. For example, the fuel cost charge on electricity consumption in Kenya rapidly increased from 284 cents to 314 and then 359 cents per kWh in March, April, and May 2008. In June of the same year it rose further to 649 cents per kWh, reflecting an increase in both use of thermal generation and actual fuel prices. The fuel adjustment cost component of the electricity tariff also rose, from a low in January 2007 of Ksh1.12 per unit of electricity consumed, to Ksh1.77 in January 2008, then to Ksh7.69 in August 2008, an almost 600 per cent increase over about one and half years (Kiva, 2008).

The energy crisis in Uganda in 2005–06, caused by the prevailing drought, affected the power sector drastically, almost grounding it completely. In order to meet the electricity supply deficit and to alleviate the impacts caused by the power shortage, the Ugandan Government brought emergency thermal power into the energy mix, leading to an increase in the price of electricity of almost 100 per cent (Baanabe, 2008) in 2006, as indicated in the last tariff adjustments in 2006 to cater for increased cost in power generation: electricity generated from thermal sources (effectively petroleum) is more expensive than hydropower. During this period, businesses were forced to lay off workers to reduce operating costs. Moreover, a number of institutions and enterprises resorted to buying back-up diesel generators—which ended up being very costly and led to an increase in operating costs—to ensure continuity in production or delivery of services. Table 4 shows the trends in the change in electricity tariff adjustment in Uganda.

Table 4: changes in domestic tariffs in Uganda

Domestic electricity tariff for Uganda	
Period	Tariff in Ug. Shs
2006–2008	426.10
2005	216.90
2004	171.40
2003	170.10
2002	168.00
2001	189.80

Source: Baanabe, 2008

The situation described prevailed throughout the region, with Kenya and Tanzania also suffering a loss in electricity generation capacity during in 2008–2009. The most notable case was in Kenya, as the country increased its use of expensive oil-fired electricity generation to bridge the electricity supply deficit. According to the Kenya Association of Manufacturers, the overall effective cost per kilowatt-hour of electricity for the industrial sector rose on average from Ksh8.00 to Ksh15.00 between April and August 2008 (at the height of the power crisis). By way of comparison, the cost per unit of electricity in other developing countries such as China and India is the equivalent of Kshs.2.50 and 3.80 respectively (Kiva, 2008). The situation during this period was so bad that energy costs accounted for some 40 per cent of total manufacturing costs in Kenya (Kiva, 2008).

The impact of drought on the region's power sector adversely affected the respective national economies. In Uganda, for instance, hydroelectric generating capacity dropped by half following Lake Victoria's near two metre drop in water level (Wines, 2007). As a result, economic growth projections dropped from 6 or 7 per cent to 4.5 per cent (Baanabe, 2008). The country had to turn to costly thermal generators to ease the supply deficit. Electricity supply was more intermittent than usual, and the price of electricity increased.

In Kenya and Tanzania, drought-related power shortages and their impacts mirrored those in Uganda but were less severe. In Kenya, the drought that occurred between 1999 and 2002 affected hydropower generation drastically and, in 2000, hydropower generation was reduced by 25 per cent. The resultant cumulative loss was variously estimated to be about 1–1.5 per cent of total GDP (Karekezi and Kithyoma, 2005). Tanzania was not spared either: the country rolled out a major power load-shedding exercise that adversely affected industrial and commercial sectors, with a loss estimated to be slightly less than 1 per cent of total GDP earnings.

Boxes 1 and 2 present summarised case studies of the impacts of drought related hydropower crises in Kenya and Uganda.

Box 1: case study of the impact of drought related power crisis on the Kenyan economy

In Uganda, electricity generation from hydro accounts for about 50 per cent of all electricity generated. Lake Victoria dropped by at least six feet over a period of three years, resulting in reduced power generation at the Kira and Nalubale hydropower stations. This made it necessary to acquire alternative sources of energy, an exercise which increased operation costs across the board, though the impact varied across industry.

Power shortages were of particular concern to the industrial sector given industry's huge demand for electricity for its operations. The electricity supply shortage had a negative impact on GDP growth which dropped from an average of 6.5 per cent over the past 10 years to 5 per cent in 2005/2006.

Turning to emergency electricity plants in Uganda led to increased power tariff: in 2005, the domestic tariff was US\$216.90 per kWh, when emergency electricity generation was at its peak the tariff rose to US\$426.10 per kWh, a 96 per cent increase (Baanabe, 2008). This had negative impacts for low income users who were forced to either reduce their consumption of electricity or to stop using it altogether.

Source: GoU, 2008; Baanabe, 2008

Box 2: case study of the impact of drought related power crisis on the cost of electricity in Uganda

The first spell of drought that affected hydropower generation in Kenya occurred in 1992, when failure of rains led to power rationing between April and May. In 1999–2000, a severe drought decreased hydro generation (by up to 25 per cent in 2000) and led to an unprecedented power supply shortfall, resulting in a serious power rationing programme. In 2006–2008, low water levels at hydro dams (due to both drought and siltation) resulted in a decrease in power generation: Emergency Diesel Power Plants are currently supplying high cost 100 MW to the national grid (KPLC, 2007; GoK, 2007; KenGen, 2007).

Emergency power generation resulted in higher power costs as the cost of diesel used for generating electricity was passed on directly to the consumer. The estimated loss of GDP due to power sector crises was estimated at about 1.5 per cent of Kenya's GDP (the country's GDP is about US\$29.5 billion), translating into US\$442 million of lost GDP. If that sum could have been used to develop renewable energy options to complement hydropower resources, about 221 MW worth of renewable energy power could be generated (assuming an installation cost of US\$2 million per 1 MW). That is slightly more than twice the installed emergency thermal power capacity in 2006–07.

It is therefore safe to assume that, if the equivalent sum of money had been spent on diversifying sources of electricity generation through the development of an additional 221 MW of renewables (cogeneration, geothermal, wind and small hydropower), the drought related hydro power crises would have been largely avoided.

Table 5 shows the recent reliance on emergency power generation because of the drought-induced electricity generation shortfall and illustrates the negative impact on the country.

Table 5: impact of emergency power generation on GDP

Country	Date	Contract Duration	Emergency Capacity (MW)	Percentage total installed capacity (%)	Estimated annual cost as % GDP	Drought Related?
Uganda	2006	2 years	100	41.7	3.29	Yes
Tanzania	2006	2 years	180	20.4	0.96	Yes
Kenya	2006	1 year	100	8.3	1.45	Yes

Source: Eberhard et al, 2008

The impacts of climate change on hydropower generation can be summarised as follows:

- Reduced water levels in catchment areas
- Reduced hydro-electricity generation capacity
- Reduced ability to meet growing demand for power
- Increased use of thermal (oil based) power
- Increased cost of electricity

As already stated, electricity generation in the region is largely dependent on large scale hydro, meaning that the occurrence of drought severely affects the power sector and leads to the following drastic and negative effects:

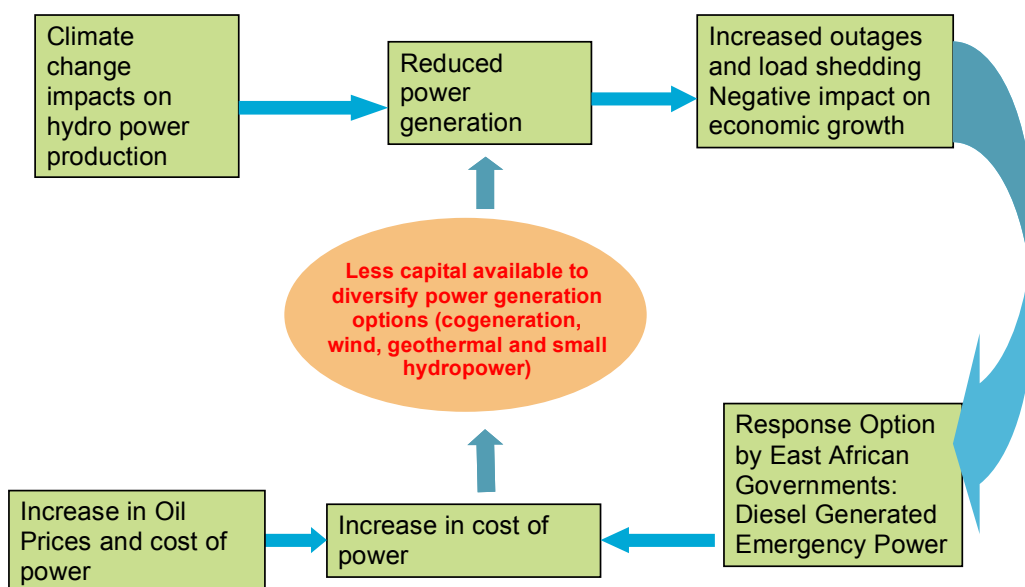
- Massive load shedding programmes which, in turn, result in,
- Massive losses in the region's economies.

3.3 Impact of climate change induced drought on energy investment in the region

The governments in the East Africa region appear to be entrapped in a vicious cycle when it comes to responding to what appears to be climate change induced drought that affects their respective power sectors. Figure 9 illustrates the vicious cycle in which all three East African countries are caught when trying to respond to the hydropower crises in the region.

spective governments in trying to minimise the adverse impacts of drought-induced power crises (often thought to be climate change related) to the extent of neglecting both further development and the expansion of the region's power sector that would make it better equipped to deal with the adverse impacts of drought. This is illustrated clearly by Table 6 which shows the level of investment by the governments of Kenya and Uganda in their respective power sectors, with a large percentage of the investments being used for the development of large hydropower and thermal power plants.

Figure 9: vicious cycle of hydropower crises in East Africa



Source: Authors' Compilation

As shown in Figure 9, much effort is expended by the re-

Table 6: budget allocations for the power sub-sector in East Africa

Uganda			
Item	Budget in US \$ Million (2008/2009)		
Support to the Energy Fund.	64.12		
Subsidy to Thermal power.	56.44		
Resettlement action plan for Kairo- Tonya transmission line.	21.47		
Rural Electrification.	6.53		
Bujagali Interconnection Project.	29.17		
Karuma Interconnection Project.	2.67		
Capacity charges and fuel for Mutundwe power plant and energy efficiency programmes.	52.49		
Total	226.21		
Kenya			
YEAR	Budget in Kshs.		
	2007/2008	2008/2009	2009/2010
Electrical Power	7,120,488,779	11,025,472,475	14,090,000,000
Energy Sector Recovery Project	4,300,113,001	131,940,000	135,600,000
Renewable Energy	162,500,000	419,000,000	217,900,000
Geothermal	2,833,768,300	6,754,640,586	8,913,628,300
Coal and Petroleum	211,100,000	489,000,000	487,600,000
Total	14,627,970,080	18,820,053,061	23,844,728,300

Source: Kiva, 2008; Baanabe, 2008.

Table 6 clearly demonstrates the low level of priority given to renewable energy sources such as cogeneration, wind, solar and bio-energy, which can not only act as a buffer against climate change induced drought, but can also strengthen the supply and distribution network as well as creating employment for a large part of the population and lead to significant development of rural areas. For example, the development of cogeneration plants in the sugar industry—mainly located in rural areas (where a majority of the population reside)—has the potential to reduce rural poverty as it not only provides direct employment for skilled workers manning the cogeneration plant (roughly 5.2 jobs per MW) but also has the potential of creating employment on farms as demand for sugarcane increases to meet the needs of the cogeneration facilities.

As already mentioned, the respective governments' immediate response to drought-induced power crises in the region is to systematically bring in thermal power to bridge the supply deficit. The return on investment for thermal power plants is very high with a very short pay back period. A result of this is that 'fly-by-night' investors, hungry to cash in on their investments in the shortest possible time, are setting up thermal power stations across the region at an alarming rate. As a consequence, East African governments often have limited resources to invest in the development of alternative sources of energy for electricity generation.

3.4 Loss of income and employment

The majority of the population in East Africa is poor and relies mainly on employment in either the informal or the manufacturing sectors. These are two sectors that are considered to be energy intensive and requiring electricity for their sustenance.

Inadequate electricity generation capacity often leads to massive load-shedding programmes, already seen in the region and load shedding often has a negative effect on the most productive sectors of the economy, namely SMEs and the manufacturing sectors. A majority of SMEs in the region are either owned by or employ poor people and low-income households.

During power crises, the cost of electricity therefore invariably rises due to the expensive thermal electricity generated to meet the supply deficit. This, in turn, often leads to an increase in production costs and subsequently to factories and SMEs having to shut down operations. Both of these outcomes have a negative impact on the overall performance of the economy, as they can lead to a reduction in economic growth within the region.

3.5 Concluding remarks

Since it is impossible to predict the occurrence of drought or the nature of fluctuations in world oil prices, governments and electricity utility companies in the East and Horn of Africa region need to adopt more robust, resilient and well thought out plans for dealing with drought-induced power crises, especially with respect to hydropower generation. The following section provides policy recommendations on how to better adapt/mitigate drought-induced power crises

4.0 Policy recommendations

The following policy recommendations are proposed as measures to minimise the adverse effects of drought-induced hydropower generation capacity shortfall in East Africa

4.1 Diversifying energy generation sources - a wider mix of energy sources

Over-reliance on one source of energy such as large-scale hydropower—as has been the case in the East Africa Region—can make a country or region highly vulnerable to the adverse effects of climate change. This can not only have serious implications for the energy sector but for the economy as whole. Conversely, countries using renewable energy sources to diversify their sources of electricity generation appear to better survive the impacts of severe drought than those relying exclusively on hydroelectric power.

For example, Kenya, which has a significant level of renewable energy investment for the region, appears to be more resilient to drought-induced power generation shortfalls than Uganda and Tanzania. This is due in large measure to the fact that Kenya has a higher level of diversification of electricity generation sources, mainly through promotion and use of renewable sources of energy such as geothermal, biomass-based cogeneration and, to a lesser extent, wind energy. As a result, Kenya's security of electricity supply is much more greater than that of its neighbouring countries (Karekezi et al, 2009).

4.2 Promotion of proven renewable energy technologies for electricity generation

In spite of abundantly available renewables in the region, the respective governments are still trapped in the 'vicious cycle' of heavy investment in hydropower and of meeting any shortfalls in demand from thermal resources. There is an urgent need for East African governments to free themselves from this 'vicious cycle' while still responding to the drought-induced power sector crises within the region. Investment in mature renewable energy options such as geothermal, small hydro, biomass cogeneration and wind are attractive as they not only provide the requisite power but also have multiple benefits and are ideal candidates to complement hydropower generation in the region. In addition, such resources are widely available in the region. Moreover, they are not only environmentally friendly but also provide additional development benefits such as job creation and reductions in oil import bills. The extensive promotion and use of such energy sources can therefore assist in reducing dependence on hydro and thermal power and thereby help to reverse the 'vicious cycle'.

Given the numerous problems facing the energy sector in East Africa, and the environmental, commercial and social

benefits of using the above-mentioned renewable energy technologies, it is time East African governments seriously implemented renewable energy technologies such as biomass based cogeneration and geothermal energy, in order to protect their power sectors from the climate change induced drought that severely affects hydro-electric power generation in the region. Benefits that could be accrued from investing in renewable energy technologies as precautionary measures with regard to the drought that affects the power sector in the region include:

- (i) Greater energy security through wider use of locally available and more secure renewable energy resources.
- (ii) Higher job creation potential of renewables: renewables have a higher job creation potential (both formal and informal, casual and permanent employment) than conventional energy sources; their implementation would, therefore, have a greater positive impact on the population.
- (iii) Poverty reduction benefits of renewables. This is particularly true of small-scale renewables that are made locally and operate on the basis of solar, thermal or animate power that can be used by local communities for income generating activities.
- (iv) Rural development benefits of renewables. As the bulk of renewable resources are found in rural areas, investment in renewables would result in increased rural development.

4.3 Renewable energy targets in energy mix

Renewable energy options are ideal candidates that can be developed to complement large scale hydropower generation to reduce the impacts of what are perceived to be drought-related power crises in the region. Renewable energy options such as geothermal, small hydropower, biomass, cogeneration and wind are attractive since the resources are widely available in the region. These renewables are not only environmentally friendly but possess additional benefits which include being suitable options for adaptation responses to the impacts of drought (which could be climate change related) on the power sector.

Furthermore, the national energy policy of the three countries in the region (Kenya, Uganda and Tanzania) are target specific and are aimed at promoting the development of and investment in renewable energy technologies in East Africa. All the countries have enacted and are offering a standard power purchase agreement (PPAs) for renewables. A standard PPA can limit market uncertainty, which stands in the way of substantial investment in renewable energy in the region. Power purchase agreements (PPAs), must be very attractive and have a pre-determined standard-offer (or feed-in tariff) from the national utility to purchase all energy produced by renewable energy plants in order to lead to successful scaling up of renewables-based power investments in the East African power sector (UNEP/GEF, 2006).

Renewable energy targets in the energy policies of the East African countries must therefore be integrated into the national modern energy mix and PPAs, to encourage increased private sector-led renewable energy investment.

The implementation of the policy options proposed in this report would go a long way towards ensuring that East Africa's economy enjoys energy security even in the face of climate change induced drought causing shortfalls in hydroelectric power generation.

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Policy Paper on Energy, Climate
Change and Poverty Alleviation

Energy in the National Adaptation Programmes of Action (NAPAs) in Africa

Prepared for
The Global Network on Energy for Sustainable Development (GNESD)

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Summary

While the climate change debate within the international community focuses primarily on how to reduce greenhouse gas emission—particularly through energy efficiency and reduced energy consumption in developed countries—the concerns of least developed countries (LDC) are more oriented towards adaptation policies and measures that will help them to reduce their vulnerability to the impacts of climate change.

Vulnerability in LDCs is characterized by over-dependence on natural resources (water, forests, soils, etc.) and on the primary economic sector (crop and livestock farming) that, in turn, depend heavily on climatic conditions. Climate change therefore adds environmental vulnerability to the already present social and economic vulnerability of the poorest.

At its seventh Conference of Parties (COP), held in Marrakech, the United Nations Framework Convention on Climate Change (UNFCCC) introduced National Adaptation Programmes of Action (NAPA) to help LDCs address their urgent and immediate needs for adaptation, addressing all forms of vulnerability and the low capacities of countries to cope with climate variability and change.

At completion of identification, under the NAPA process, of adaptation actions to be carried out, some 455 adaptation projects were identified by 41 LDCs. The projects are highly diverse and varied, and are concentrated mainly in sectors such as agriculture, water resources and forestry.

However, energy—in spite of its importance and of its cross-cutting nature for all development activities—barely figures in NAPA projects. Out of a total of 455 projects, only 3.7 per cent are energy sector related, even though the implementation of all of the projects identified in LDCs will require energy services.

This can be partly explained by the fact that planners have little control over the integration of energy services into the adaptation options selected, and that the energy sector is still not a mainstream element of analysis of the different forms of vulnerability. Yet sectors such as agriculture, central to reducing people's vulnerability, cannot help to improve conditions and livelihoods without extensive input from energy services. Currently, however, even though, for instance, water management may be an issue that is covered by planning, the adaptation option concerning it will make no reference to energy security.

There is a sharp contrast between the pattern outlined

above, in which energy is seen to be central in addressing development needs, and the actual situation of LDCs facing energy insecurity in terms of both access to petroleum products (as a result of rising crude oil prices on the international market) and of use of biomass (deforestation).

Energy is clearly of paramount importance for the implementation of climate change adaptation strategies.

This research paper focuses on analysis of the NAPA options and assesses the extent to which the energy dimension is included in the proposed options.

Two main facts emerge from the analysis of NAPA documents from 41 countries:

- the absence of an energy component in adaptation options; and
- the need to introduce this component to improve the effectiveness of the adaptation options proposed.

The main findings highlight the failure to include energy in vulnerability analysis and a resulting inadequate definition and development of the role of energy in adaptation options.

The study also provides a matrix of sustainable energy services that are necessary if adaptation options are to be effective and for successful attainment of their expected outcomes, particularly where priority options are concerned.

The study also recommends key policy options for energy and adaptation, mainly based on:

- integration of adaptation into the planning process;
- the role of renewable energies and energy efficiency in the sustainability of adaptation options, particularly in oil-importing countries;
- evaluation of the impacts of climate change on the energy systems themselves.

Introduction

In its Article 4.9, the United Nations Framework Convention on Climate Change (UNFCCC) acknowledges the particular vulnerability of LDCs with regard to the adverse effects of climate change and, via Decision 28/CP.7, calls upon LDCs to develop National Adaptation Programmes of Action to address their urgent and immediate adaptation needs. The particular vulnerability of LDCs' also arises because of their lack of access to energy services.

In accordance with the guidelines developed by the LDC Expert Group, LDCs are invited to engage in a participatory process to identify adaptation options that could be implemented at national level to meet the objectives set by the NAPA process. These options are then to be classified in order of national priority, whilst also ensuring that they meet the criteria of sustainability, gender balance and complementarity with other initiatives under the framework of other Rio¹ Conventions.

Given the essential nature of energy for any development actions, LDCs' responses to their own vulnerability will require availability of sustainable energy services not only for implementation of adaptation options but also for achievement of the NAPA objectives. However, all over the world, but mainly in LDCs, climate change will, in most cases, also adversely affect the energy sector.

A rapid review of NAPA documents indicates that energy is still not sufficiently mainstreamed and that implementation of the adaptation options assumes that the required energy services and infrastructures already exist. It goes without saying that the role of energy in meeting urgent and immediate adaptation needs in LDCs is critical.

On the basis of the analysis of 41 LDCs' NAPA documents, this study demonstrates the quasi absence of the energy sector from NAPA priority options, in spite of the paramount role of energy in meeting LDCs' urgent and immediate adaptation needs. The study also explores ways and means of filling this gap and proposes alternatives, in the form of policy recommendations, for revision and successful implementation of NAPAs.

1. Methodology

As indicated above, this study is based on the analysis of 41 NAPA documents submitted by LDCs to the UNFCCC Secretariat in May 2009. 48 countries are currently classified as LDCs² in terms of their level of socio-economic development; 33 of the 48 are in Africa.

The methodology adopted in this study is described below:

- The analysis of the NAPA documents proposed here includes listing of projects developed in each country under the NAPA process. For the 41 LDCs studied, 455 projects from various socio-economic sectors are proposed and classified in order of national priority. The classification of the NAPA projects by sector used in this study is that proposed by the UNFCCC³ Secretariat.
- Three priority projects were selected for each country from the set of projects, and classified according to the sectors to which they are relevant. This helps to evaluate the position and importance of the energy sector in the vulnerability/adaptation analyses, according to the various NAPA processes in LDCs.
- Analysis was conducted in terms of the energy required for implementation of the priority projects identified for each LDC.
- Potential gaps resulting from insufficient mainstreaming of the energy dimension in the NAPA vulnerability/adaptation were highlighted.
- Based on the analysis described above, alternatives were proposed and policy options recommended.

¹ Convention to Combat Desertification, Convention on Biological Diversity.

² According to the UN Economic and Social Committee, countries with a GDP under USD 1035 are considered as LDCs.

³ http://unfccc.int/files/national_reports/napa/application/pdf/napa_index_sector_march_09.pdf

2- NAPA projects in LDCs

The projects resulting from this process are diverse and relate to different socio-economic sectors of the countries concerned: there are cross-sectoral projects (i.e. ones that involve different sectors) and sector-based projects that relate to food security, coastal areas, early warning and disaster management, capacity building, energy, health, infrastructure, insurance, terrestrial ecosystems, tourism and water resources.

Table 1 shows the list of countries covered by this study and the number of projects developed in each of them under the NAPA framework.

Table 1: Number of NAPA projects per LDC

Country	Number of projects	Country	Number of projects	Country	Number of projects
BANGLADESH	15	GUINEA	25	RWANDA	7
BENIN	5	GUINEA-BISSAU	14	SAMOA	9
BHUTAN	9	HAITI	14	SAO TOME ET PRINCIPE	22
BURKINA FASO	12	KIRIBATI	9	SENEGAL	12
BURUNDI	12	LAOS	12	SIERRA LEONE	24
CAMBODIA	20	LESOTHO	11	SOLOMON ISLANDS	7
CAPE VERT	3	LIBERIA	3	SUDAN	5
CAR	10	MADAGASCAR	15	TANZANIA	6
COMOROS	13	MALAWI	5	TUVALU	7
DRC	3	MALDIVES	11	UGANDA	9
DJIBOUTI	8	MALI	19	VANUATU	5
ERITREA	5	MAURITANIA	28	YEMEN	12
ETHIOPIA	11	MOZAMBIQUE	4	ZAMBIA	10
GAMBIA	10	NIGER	14	TOTAL	455

(source:http://unfccc.int/cooperation_support/least_developed_countries_portal/napa_project_database/items/4583.php)

3- NAPA project classification by sector

3.1 Project sectors

According to the Least Developed Countries Expert Group (LEG) guidelines⁴, each LDC should identify its urgent and immediate needs and concerns which will then be translated into climate change adaptation project profiles. Identified project profiles will then be classified in order of national priority. The number of projects identified varies from one country to another, from 3 to 28, depending on the choices and number of adaptation options arising from the NAPA⁵ processes.

⁴ Annotated guidelines for the preparation of National Adaptation Programs of Action Least Developed Countries Expert Group - July 2002.

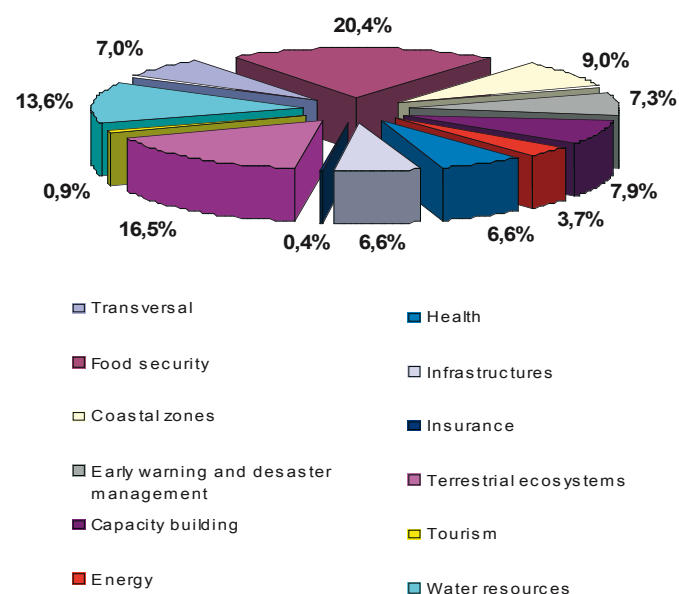
⁵ The complete list of projects per country and per sector is available on http://unfccc.int/cooperation_support/least_developed_countries_portal/napa_project_database/items/4583.php

Table 2: Energy sector NAPA projects

Country	Order of National Priority	Title
Burkina Faso	12	Promotion of the use of energy saving equipment (improved stoves, M'Bora stew pan) and renewable energy-based technologies (pressure-cooker, water heater and solar dryers, etc.)
Burundi	12	Increase in micro-hydropower stations
CAR	6	Promotion of carbonisation of wood by-products from forestry firms
DRC	1	Energy related projects
Gambia	6	Briquetting and carbonisation of groundnut shells
Guinea	5	Promotion of adaptation-oriented technologies (2). Promotion for sea salt production using solar energy
Guinea	9	Promotion of adaptation-oriented technologies (6). Promotion of solar energy for fish drying, to reduce pressure on mangroves
Lesotho	10	Promotion of wind, solar and biogas energy use to supplement hydropower
Mali	9	Energy recovery from <i>Typha australis</i>
Mali	10	Contribution to removing barriers for promotion of solar energy in Mali
Mali	18	Promotion of jatropha oil
Rwanda	7	Preparation and implementation of national fuelwood substitution strategy, to combat deforestation and erosion
Sao Tomé	11	Introduction of new technology for firewood use and charcoal making
Sao Tomé	19	Introduction of renewable energy
Sao Tomé	20	Construction of two hydro power stations, at Claudino Faro and Bernardo Faro
Sierra Leone	8	Promotion of renewable energy (solar) in Sierra Leone and improvements in energy efficiency and conservation of energy resources.
Tanzania	5	Community based mini-hydro plant for economic diversification as a result of climate change in Same District
TOTAL		17 energy sector projects

Figure 1 indicates that the three main sectors are food security (20.4%), terrestrial ecosystems (16.5%) and water resources (13.6%).

Figure 1: Energy sector NAPA projects in 41 LDCs⁶ (source: UNFCCC, compiled by Moussa Na Abou M.)



⁶ The classification of the NAPA projects by sector adopted here is the one proposed by the UNFCCC secretariat.

3.2 NAPA projects in the energy sector

Table 2 shows that out of the 455 NAPA projects identified, only 17 projects (proposed by 12 countries out of 41 in this study) are in the energy sector. It is also worth highlighting that these projects focus on the introduction of alternative renewable energy technologies to diversify sources of supply.

These 17 projects represent only 3.5 per cent of the total of projects in the 41 LDCs, illustrating the degree to which the role of energy is absent from the mainstream of development of adaptation options. This is a reflection of a basic lack of an energy vision in all areas of vulnerability analysis (including energy) even though the economies of these countries are stagnating under the burden of their bills for petroleum products, and successful implementation of the NAPA projects could be jeopardised by the absence of sustainable energy services.

The absence of the energy sector is not therefore an indication that it lacks importance. In fact the sector is vital and its absence can be explained, at least partially, by the fact that that energy access is not among the criteria the NAPA projects are supposed to meet. Moreover, governments in LDCs are more immediately concerned with issues such as food security (as demonstrated by the NAPA project sec-

tors) in countries where agriculture occupies more than 70 per cent of the labour force.

The essential role of energy for NAPA projects could actually be assessed once the projects have been implemented, as adaptation is a process and not a one-off event. Nonetheless, by the 14th UNFCCC COP, held in Pozna'n in December 2008, only one LDC (Bhutan) had implemented a priority project developed from the National Adaptation Programmes with funding support from the Climate Change Convention.

4. Classification of priority projects by sector and position of the energy sector

4.1 Sectors of the three NAPA priority projects

The approach suggested in the framework of the NAPA process seems to be guided by the impacts of climate change in terms of strong variability in rainfall patterns and to focus, as a priority, on the primary sector. Quite a lot of LDCs (21 out of the 41 in this study) therefore consider food security (agriculture, irrigation, water control, animal production, etc.) as part of the first three priority adaptation options in their respective NAPAs, as illustrated in Table 3 and Figure 2, below.

This approach seems to assume that the energy services required to meet these priorities are available and accessible, as even the energy related options are insignificant in the priority NAPA projects.

Figure 2: Sectors of the priority NAPA projects

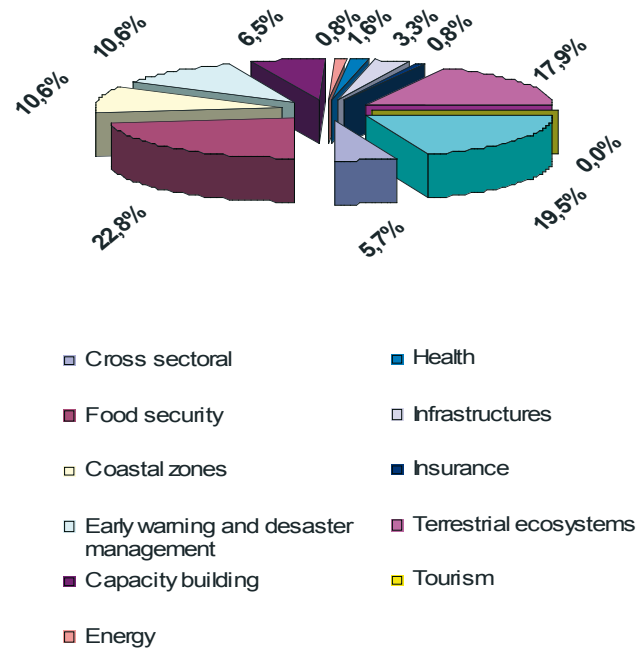


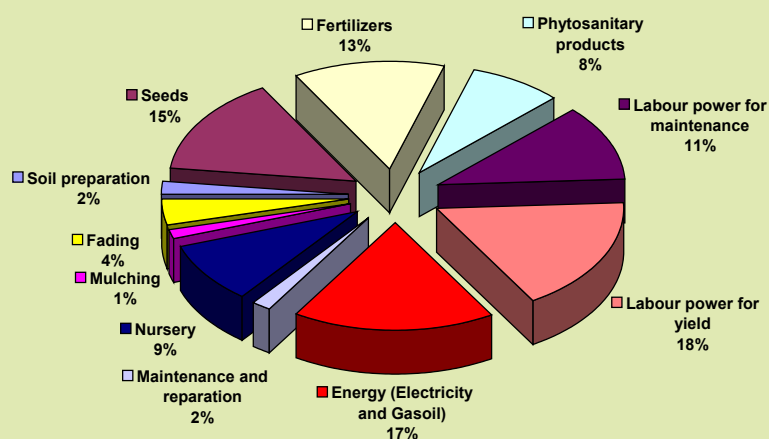
Table 3: Top 3 NAPA projects in the LDCs and their sectors (source: UNFCCC)

	Project sector and priority ranking		
	1 st	2 nd	3 rd
BANGLADESH	Coastal zones	Water resources	Capacity building
BENIN	Cross-sectoral	Capacity building	Water resources
BHUTAN	Early warning and management of disasters	Terrestrial ecosystems	Early warning and management of disasters
BURKINA FASO	Early warning and management of disasters	Food security	Terrestrial ecosystems
BURUNDI	Early warning and management of disasters	Terrestrial ecosystems	Terrestrial ecosystems
CAMBODIA	Infrastructures	Infrastructures	Water resources
CAPE VERT	Water resources	Food security	Coastal zones
CAR	Capacity building	Terrestrial ecosystems	Terrestrial ecosystems
COMOROS	Food security	Water resources	Water resources
DRC	Energy	Food security	Coastal zones
DJIBOUTI	Coastal zones	Terrestrial ecosystems	Water resources
ERITREA	Food security	Food security	Terrestrial ecosystems
ETHIOPIA	Insurance	Early warning and management of disasters	Water resources
GAMBIA	Early warning and management of disasters	Water resources	Food security
GUINEA	Terrestrial ecosystems	Terrestrial ecosystems	Coastal zones
GUINEA-BISSAU	Food security	Water resources	Capacity building
HAITI	Terrestrial ecosystems	Terrestrial ecosystems	Terrestrial ecosystems
KIRIBATI	Water resources	Water resources	Coastal zones
LAOS	Capacity building	Food security	Food security
LESOTHO	Food security	Food security	Cross-sectoral
LIBERIA	Food security	Early warning and management of disasters	Coastal zones
MADAGASCAR	Infrastructures	Water resources	Food security
MALAWI	Food security	Terrestrial ecosystems	Food security
MALDIVES	Coastal zones	Coastal zones	Water resources
MALI	Food security	Food security	Food security
MAURITANIA	Water resources	Water resources	Water resources
MOZAMBIQUE	Early warning and management of disasters	Capacity building	Coastal zones
NIGER	Food security	Food security	Food security
RWANDA	Terrestrial ecosystems	Cross-sectoral	Water resources
SAMOA	Water resources	Terrestrial ecosystems	Health
SAO TOME ET PRINCIPE	Food security	Early warning and management of disasters	Health
SENEGAL	Terrestrial ecosystems	Terrestrial ecosystems	Terrestrial ecosystems
SIERRA LEONE	Early warning and management of disasters	Infrastructures	Capacity building
SOLOMON ISLANDS	Cross-sectoral	Early warning and management of disasters	Cross-sectoral
SUDAN	Cross-sectoral	Cross-sectoral	Food Security
TANZANIA	Food security	Water resources	Water resources
TUVALU	Coastal zones	Food security	Water resources
UGANDA	Terrestrial ecosystems	Terrestrial ecosystems	Early warning and disaster management
VANUATU	Food security	Water resources	Terrestrial ecosystems
YEMEN	Coastal zones	Water resources	Capacity building
ZAMBIA	Early warning and disaster management	Food security	Coastal zones

Box 1: Role of energy in the implementation of agricultural production systems in Sébikotane – Niayes – Senegal

After labour (accounting for 18%) energy represents the most important expenditure item (17%) in the agricultural production systems of Sebikhotane, as illustrated by the pie chart below.

Main items of expenditure for irrigation



Source: *The SME profile in agriculture and food agro business in Africa – SYSPRO/ENDA TM, December 2004.*

In these irrigated systems, the cost of water results mainly from the cost of the energy used to operate the pumps. Expenditure is, essentially, for purchase of fuel for the pumps that supply the water to the crops. For an oil importing country in a context of international oil price volatility, particular consideration should be given to adaptation policies and to their sensitivity to energy. For the Sebikhotane production systems, the possibility of conversion of windbreak biomass conversion and use of crop residues is being considered. The table below indicates the amounts of energy required for the development of one ha of irrigated land depending on the crop.

Type of crop	Energy expenditure/ha/year (in FCFA)	Energy quantities in gasoil (litres/ha/year)
Green beans	450,000	900
Sweet corn	200,000	400
Melon	100,000	200
Seedless watermelon	100,000	200
Cherry tomato	800,000	1,600
Asparagus	750,000	1,500
Sweet pepper	500,000	1,000
Hot pepper	500,000	1,000
Strawberry	500,000	1,000
Okra	500,000	1,000
Jakhatou	500,000	1,000
Potato	500,000	1,000
Average	450,000	900

Table 4: NAPA priority options and potentially required energy services²

Dominant priority options	Potentially required energy services
Food security	<ul style="list-style-type: none"> o Pumping services (irrigation) o Transportation o Drying, smoking and freezing for conservation of produce o Motive power for processing of agricultural products o Etc.
Early warning and disaster management	<ul style="list-style-type: none"> o Operation of decentralised warning systems o Communication systems o Electrification of disaster-hit areas o Logistics in case of disaster o Etc.
Terrestrial ecosystems	<ul style="list-style-type: none"> o Logistics (in case of afforestation, reforestation, etc.) o Rehabilitation of degraded ecosystems (water courses, lakes, soils, etc.) o Etc.

4.2 The position of the energy sector in priority options

Apart from the cross-sectoral projects (in Benin, Lesotho, Rwanda, Salomon Islands and Sudan), only one LDC (the Democratic Republic of Congo) developed an energy access project following the NAPA process and classified it amongst the three priority projects for urgent and immediate adaptation needs. This clearly illustrates the insignificant position of energy (0.8 per cent of priority projects in 41 LDCs, as indicated in Figure 2) and the fact that it is totally absent from the vulnerability assessments used to identify NAPA projects in the LDCs.

The following section of this paper illustrates and analyses the cross-sectoral nature and essential role of energy not only for implementation of most of the adaptation options identified in the NAPAs, but also for achievement of the objectives set by those options. (An example is also provided in Box 1)⁷.

4.3 Analysis of potential energy needs for implementation of priority projects

Energy, because of its cross-sectoral nature, is an essential component of socio-economic, human and technological development. The adaptation options identified in the main sectors (food production, and water resources) all, in some way, require, appropriate energy services for their implementation as well as for the achievement and sustainability

of their objectives. The same is true for the other sectors, but to a lesser extent.

Food security emerges as the priority sector (22.8%) for the LDCs, based on identification of the sectors of the priority projects developed from the NAPA process in the LDCs. Analysis of the priority projects indices indicates that implementation of the adaptation projects identified will require a significant energy input since ensuring food security requires energy that is available and accessible in sufficient quantity and quality, and that is sustainable.

In a context of climate variation/change, guaranteeing food security requires control of water resources. In LDCs, this involves building of basic hydraulic infrastructure such as wells, bore-holes and water treatment and/or desalting plants for irrigation purposes.

Here energy is required to provide mechanical power to draw, transport and distribute water for irrigation or for consumption. In the irrigation systems used in most LDCs as an alternative to rain-fed crops, energy—used for farm machinery and irrigation pumps or for processing of agricultural produce, transport, etc.—is the most important item of expenditure for agriculture production⁸.

Table 4 indicates the priority options of the NAPA projects as well as the potential role of energy and energy services for implementation of the projects.

A more detailed illustration of the links between energy needs for adaptation is provided by Box 1, below, which presents an example of adaptation to climate variation/

⁷ *The SME profile in agriculture and food agrobusiness in Africa – SYSPRO/ENDA TM, December 2004.*

⁸ *The SME profile in agriculture and food agrobusiness in Africa – SYSPRO/ENDA TM, December 2004.*

change in the agriculture sector and the role of energy services in project implementation and in the achievement of expected outcomes. It is a practical farming example from a Sahelian environment.

Of the 41 LDCs in this study, 37 (i.e. around 90%) identified agriculture as a vulnerable sector with regard to climate change, and accordingly proposed adaptation projects in the framework of the NAPAs. Of these 37 countries, 11 (i.e. around 27%) exclusively chose irrigated farming production as an alternative to rain fed farming, subject to variations in rainfall. As indicated in Box 1, irrigation has important energy needs without which farming output would be limited. Failure to identify alternatives for access to energy would therefore adversely affect the implementation of irrigation based NAPA projects.

5- Key findings and policy recommendations

Absence of energy from vulnerability analysis and the failure to mainstream energy in the development of adaptation options

The above analysis highlights a lack of mainstreaming and even an absence of energy services in vulnerability analysis and in development of NAPAs. Given the cross-cutting role of energy for all forms of socio-economic development, and especially for implementation and the attainment of the goals set by LDCs' in their NAPAs there is a clear need to review the NAPAs to correct this oversight.

Energy choices could integrate clean energy so as to allow inclusion of NAPAs in clean development mechanism (CDM) strategies and thus link these documents to Nationally Appropriate Mitigation Actions. With the inclusion of the NAMA process in the climate negotiations, a new approach opens up and provides potential niches for mobilisation of renewable energies.

By December 2008, (COP 14 in Pozna'n), only one LDC country (Bhutan) had begun implementation of its NAPA. While such a low rate of implementation is of course regrettable, it nonetheless opens up an opportunity for review of all NAPAs and for the assessment of energy needs and associated costs before the NAPA projects re implemented.

Integrating adaptation into the planning process

NAPAs should also be in line with national development planning and prospects. Of course, they are intended to meet 'urgent and immediate adaptation needs', but their effective mainstreaming in national sectoral policies would, without doubt, help to integrate the identified adaptation options with other current development activities at the national level. To that end, rather than starting with an ex-nihilo vulnerability study, the NAPA processes should have been carried out with a view to integration. With this approach, The NAPA documents obtained, rather than being based solely on 'new studies' and vulnerability analysis, would be developed on the basis of evaluation of additional actions and costs, so as to underpin the resilience of the development of sectoral projects and programmes. The energy needs and services required would be highlighted and would be less costly to obtain as they would be integrated into already planned or on-going activities.

Role of renewable energies and energy efficiency in the sustainability of adaptation options in non oil-producing countries

Given that many LDCs are net importers of petroleum products to meet their energy needs, the promotion of renewable energies and energy efficiency in LDCs would also help to meet the energy challenges arising from implementation of NAPAs. For most developing countries, renewables are indeed not only cleaner and more sustainable energy sources, they also represent an essential component of increasing access to low-cost energy. The promotion of small renewable energy-based systems could contribute to alleviating the energy poverty that is already affecting many communities in the least developed countries excluded from centralised energy services. In many LDCs this would help to reduce oil bills, thereby reducing energy vulnerability.

The challenge facing LDCs is a major one: they must implement NAPAs as a matter of urgency in order to adapt to ongoing climate change that is adversely affecting the energy sources that are required not only for implementation of the NAPAs but also for development. Meeting such a challenge will involve moving from traditional energy sources to modern, renewable and diversified ones.

Thinking beyond just immediate adaptation, LDCs are also addressing future adaptation and considering how to meet the energy demand that results from increasing industrialization and growing populations, so as to ensure low-carbon development. Countries could, for example, develop/enhance energy efficiency best practices, tap into the so far unexploited renewable energy potential, and reduce dependence on fossil fuels.

With the decentralisation effective in many LDCs, countries should invest in decentralised and sustainable renewable sources, since it is at local level that the impacts of climate change will be felt first and foremost.

It is equally important to remove all structural and financial barriers that hinder the development of renewable energies and energy efficiency in LDCs. These include issues of governance, difficulty of access to funding, capacity shortage or simply an absence of policy in the sector.

Evaluation of the impacts of climate change on energy systems

Climate change will adversely affect the resources and livelihoods of communities, especially the energy resources required for implementation of the NAPAs. There is a proven need to conduct studies of the impacts of changes in climate on renewable energy sources (such as solar, wind, hydro-electric and biological sources, etc.) in LDCs.

Conclusion

For LDCs, meeting local development challenges, especially within a framework of adaptation to climate change, means developing national strategies that mainstream fundamental factors such as energy. Energy services can play a major role, first as an option in their own right, but they can also underpin economic, social and environmental changes that result from other adaptation options. The International Monetary Fund (IMF) and the World Bank have stated that most developing countries will not achieve the eight Millennium Development Goals (MDGs) by 2015⁹. Climate change and the high costs of oil (with their effects on food prices) cloud the prospects, according to the World Bank and IMF. Water control for intensification of agriculture, access to fresh water, reforestation, communications and health, etc. are all NAPA priority sectors that require energy services. In spite of this, the energy sector represents only 3.7 per cent of the projects identified in the NAPA processes of the 41 LDCs studied, even though energy is essential for implementation of the NAPAs.

Moreover, LDCs are facing energy poverty that adversely affects all of their development strategies. Their energy consumption is very low because of energy insecurity, exacerbated by lack of infrastructure, and because of production and consumption of non sustainable forms of energy such as biomass. This will increase people's economic, environmental and social vulnerability in a context of changing climate. It is therefore necessary to refocus the issue of energy access with regard to development, especially regarding the linkages with other strategic sectors in the fight against people's vulnerability included in NAPA projects.

Analysis of the priority adaptation options in the 41 NAPA documents indicates a worrying lack of linkage with energy services, even though most of the countries in question are not oil producers.

The principle of common but differentiated accountability recommended by the Convention on Climate should help LDCs to access energy services that would allow them to both adapt to present and future climate changes as well as achieving their development priorities.

⁹ *Global Monitoring Report – 2008*,

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Energy, poverty and climate change in
Latin America and The Caribbean:

Current situation and perspectives

Prepared for
The Global Network on Energy for Sustainable Development (GNESD)

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A-Background

A growing consensus has been developing in recent years within the scientific community regarding key issues surrounding climate change. Some of these can be highlighted, especially issues such as those listed below that encompass the linkages between climate change, energy and poverty:

- *Increased responsibility of human activities in climate change trends, mainly in the past century, resulting from emissions of greenhouse gases (GHG) and the build up of their concentrations in the atmosphere.*¹
- *The expected impacts of climate change, which will be diverse and may affect the poorest people more than other social groups.*²
- *Immediate and future implementation of mitigating measures to curb the causes of climate change or moderate the impacts that are already being observed will not be enough to avoid the necessity of introducing immediate adaptation measures.*³
- *The United Nations Framework Convention on Climate Change (UNFCCC) recognises that developing country Parties have the right to pursue their development. This process may result in increased GHG emissions in developing countries in the context of the Global Climate Change Regime Negotiations.*^{4&5}

There are specific aspects to each of these issues. The first, for example, relates to two main concerns: vulnerability to climate change and reductions in GHG emissions. Where vulnerability is concerned, it is not only the general vulnerability of poor people to climate that must be considered but also the vulnerability of energy systems themselves, with a focus on the aspects most closely related to poverty.

B-Energy, poverty and climate change: links, synergies and conflicts

1-Poverty and climate change: expected impacts and vulnerabilities facing the poor⁶

Despite international efforts, poverty has become more widespread in many countries in recent decades, making poverty reduction the core challenge for development in the current century.⁷ In this context, climate change is a serious risk to poverty reduction and threatens to undo decades of development efforts.⁸

Two of the main messages that emerge from studies are: first, climate change is already happening and will increasingly affect the poor and, second, adaptation is necessary and should be in the form of integrated responses to climate change as well as adaptation measures that include strategies for poverty reduction. These two issues must be considered when considering sustainable development strategies.⁹

The impacts of climate change and vulnerability of poor communities to it vary greatly, but vulnerability to climate change is generally superimposed on other existing vulnerabilities. The degree of vulnerability of different communities to the potential effects of climate change is closely related to their capacity to absorb, mitigate, attenuate or adapt to the effects of those changes. This is, in turn, influenced by the possibility of acceding to technologies, infrastructure and other appropriate means. The poorest populations will, probably, be the most vulnerable.¹⁰ In addition, increases in the divide between North and South could be expected as well as in inequalities between different social groups within developing countries.¹¹

The best way to address climate change impacts on the poor is to integrate adaptation measures into sustainable development and poverty reduction strategies. Only a comprehensive approach will provide options for poor people to reduce their vulnerability to current and future risks, not only climate change related risks but also many others. In this sense, a process of strengthening adaptation efforts will require progress on aspects such as improving vulnerability assessment, combining approaches, empowering communities to participate in assessments, guaranteeing access to good quality information on the impacts of climate change, integrating the impacts into macroeconomic projections and increasing the resilience of livelihoods and infrastructure within an effective poverty reduction strategy.¹²

1 IPCC (2007).

2 IPCC(1998); UNFCCC (2006); UNFCCC (2007); UNDP (2007a); WORLD BANK (2008); GIRARDIN (2000); GIRARDIN (2008).

3 GIRARDIN (2007).

4 WORLD BANK (2008).

5 GOBIERNO DE LA REPUBLICA ARGENTINA (2007); GIRARDIN (2008)

6 This point is based on UNDP et al (2003) and GIRARDIN (2007).

7 UNDP et al. (2003).

8 UNDP et al. (2003).

9 UNDP et al. (2003).

10 GIRARDIN (2008).

11 GIRARDIN (2007)

12 UNDP et al. (2003).

Where vulnerability to climate change and adaptive capacities in Latin America are concerned, some social indicators improved in the 1990s (in comparison with the 1980s); these include life expectancy and access to clean drinking water. However, other factors such as high infant mortality, low secondary school enrolment and great income inequality still contribute to limit adaptive capacity.¹³ Areas of particular concern are agriculture (mainly subsistence agriculture in indigenous communities), fisheries, water resource management, natural ecosystems, infrastructure, coastal zones, forests and health, amongst others. Some of these are illustrated in Box 1.¹⁴

Adaptation to climate change appears as a priority if poverty is to be effectively eradicated. It should, however, be noted that the resources dedicated to certain policies and measures will not be available for allocation for alternative uses. For developing countries the decision between allocating resources for adaptation to climate change or for its mitigation is one of the most relevant from the economic point of view. The main paradox is that—while most funding is available for mitigation, an issue that is primarily one for developed countries—adaptation is the most important issue for most developing countries, and lack of funding is a major barrier for these countries in adapting to climate change.

2-Expected impacts and vulnerability to climate change in Latin America & the Caribbean

The information available on expected impacts and vulnerability to climate change in Latin America and The Caribbean Region is reviewed below. Most of the information mentioned is contained in the National Communications on Climate Change prepared by the countries of the region. Particular attention is paid to the vulnerabilities and Impacts that are relevant to the poor sectors of society in each country.

Some efforts had been made to 'regionalise' the expected impacts of climate change addressed in the IPCC's Assessment Reports, to present them in a more detailed manner.¹⁵ The two main documents of relevance are: the IPCC's Special Report on Climate Change Regional Impacts (1998)¹⁶ and the UNFCCC's Special Report on Impacts, Vulnerability and Adaptation in Developing Countries (2007).¹⁷

In the first study mentioned above (IPCC; 1998), Latin America included all the continental states of America from Mexico to Argentina and Chile, as well as their adjacent seas.

It is recognised that the Latin America region is diverse in terms of its climate, ecosystems, human settlements, population distribution and cultural traditions. Different countries in the region¹⁸ have been significantly affected by the adverse socioeconomic consequences of seasonal and inter-annual climate variations, especially by the El Niño Southern Oscillation (ENSO) phenomenon. The largest part of the region's production is based on the extensive use of the natural ecosystems, making it even more vulnerable to climate change given the degree of climate dependency this situation implies in most cases. The impacts of climate variability on natural resources, both currently and in the recent past, suggest that the potential effects of the projected changes in the climate could be significant enough to warrant being addressed in planning and prospective initiatives at both national and regional levels. Change in soil use is the main element that explains current changes in ecosystems, interacting with climate in diverse and complex ways. This makes the task of identifying common climate change vulnerability patterns very difficult.¹⁹

Socioeconomic and health problems could be aggravated, migration from rural, coastal and poor areas encouraged and national and international conflicts deepened by increasing environmental deterioration arising from climate variability (reflected in the changes in water availability, losses in agricultural lands, coastal, river and low plains floods amongst other things), and from climate change, prevailing productive and technological practices, and changes in soil use. In this context, it is increasingly important to take coordinated action at the regional level and to prevent conflicts arising from the abusive use of shared natural resources, notably in new endeavours that can be appropriately designed from the very start of a project. It is always more costly to repair what has already been damaged or to change technologies that are already installed than to apply the best technologies available at the time of design and authorisation of projects.²⁰

¹³ UNDP et al. (2003), page 4.

¹⁴ UNDP et al. (2003); UNFCCC (2007) and GIRARDIN (2008)

¹⁵ See GIRARDIN (2007).

¹⁶ IPCC (1998).

¹⁷ UNFCCC (2007).

¹⁸ Particularly Central American Countries, Ecuador, Peru, Chile, Brazil and Argentina.

¹⁹ IPCC (1998)

²⁰ IPCC (1998)

Box 1

Potential impacts of climate change on selected sectors in Latin America

Impacts and Sectors Identified		
<p>Natural Ecosystems</p> <p>It is expected that large forests and pasture areas will be affected by the anticipated changes in the climate, with extremely vulnerable areas such as mountain ecosystems in the transition areas between different types of vulnerable vegetation. Climate change may add additional stress to the adverse effects of ongoing Amazon deforestation. This impact may lead to biodiversity losses, reduced rainfalls and run-off within and around the Amazon basin (reducing rainfall deriving from recycling evapotranspiration) and affecting the global carbon cycle.</p>	<p>Hydrology and Water</p> <p>Climate change may significantly affect the hydrological cycle, altering the temporal and spatial intensity and distribution of rainfall, surface run-off and recharging of underground aquifers, with impacts on natural ecosystems and human activities. Arid and semi-arid areas are particularly vulnerable to changes in water availability. Hydroelectric generation, production of grain and cattle farming are particularly vulnerable to the water supply in Central America and in the Pedemountain Andes, as well as in the Andean zones of Chile and Argentina between the 25° and 37° parallels. The impact on hydro resources may lead to conflicts between users, regions and countries.</p>	<p>Food and Textile Production</p> <p>Decreases are expected in agricultural production in Mexico, Central America, Chile, Brazil, Uruguay and even Argentina. (even taking into consideration the positive effects of a higher amount of CO₂ available for plant photosynthesis, with subsequent effect on the increase in performance and moderate levels of adjustment of farmers)</p> <p>In addition, production in the livestock sector will fall if warm pastures face significant decreases in water availability. Extreme events such as droughts, floods, ice storms and storms may potentially adversely affect pasture areas and agriculture production (for example, banana trees in Central America or coffee in other producer regions). The traditional lifestyle of the populations of many Andean communities may be threatened if there is a reduction in the productivity of traditional pasture and agricultural areas.</p>
<p>Coastal Systems</p> <p>Low-lying coasts and estuaries may experience losses of beaches, coastland and biodiversity (for example, mangrove swamps, coral reefs, estuaries wetlands, marine mammals and seabirds), damage to infrastructure and saline intrusion as a result of sea level rise in countries such as Mexico, the Central American isthmus, Argentina, Venezuela and Uruguay. A rise in average sea levels blocking running of water from plains rivers into the ocean may increase problems of flooding in river basins, for example in areas such as the Buenos Aires Pampa.</p>	<p>Human Settlements</p> <p>Climate change is expected to have direct and indirect impacts on welfare, health and safety of Latin America's inhabitants. Direct impacts may result from the rise in sea level or be in the form of adverse climatic conditions (floods, wind storms, landslides, as well as cold and heat waves or peaks). Indirect effects, via impacts on sectors such as water and food supply, transport, energy distribution and health services could be exacerbated by the expected impacts of climate change. Particularly vulnerable groups include those living in slums around large cities, especially when located in floodable areas or on unstable hillsides.</p>	<p>Human Health</p> <p>Expected changes in climate may increase the already serious impacts of the chronic diseases or situations of malnutrition of the vulnerable populations of Latin America. The geographical distribution of disease transmission agents (malaria, dengue fever, the Chagas disease) and of infectious diseases (e.g. cholera) could extend further south and to higher altitudes if rainfall and temperatures increase. Increased contamination and high concentrations of (low-level) tropospheric ozone, exacerbated by increases in land surface temperatures may have negative effects on human health and welfare, especially in urban areas.</p>

Source: GIRARDIN (2007), based on IPCC (1998)

The second report published recently by the UNFCCC highlights the impacts and vulnerabilities expected from changes in climate in the different developing countries in the different regions of the planet. The basic information used in drafting the report came from the material and presentations produced for the workshops and meetings organised by the UNFCCC Secretariat²¹, completed with information from the IPCC's Fourth Evaluation Report (IPCC-4AR, 2007).

Latin America is not only home to much of the planet's biological diversity, it also has a wide variety of ecosystems, climate regions, topographies and soil use patterns, and is particularly sensitive to climate changes in a variety of areas such as: water availability, human, animal and plant health, agricultural activities, Andean glaciers, the Amazon Region and many other regions vulnerable to extreme climate events.²²

Some changes—such as a higher frequency and intensity of extreme events, particularly those related to the El Niño phenomenon—have already been experienced. In the past years torrential rains and resulting floods, including those related to tropical cyclones, have resulted in tens of thousands of victims, at the same time as significant economic losses and social catastrophes in the region. In the meantime, in other areas such as north-east Brazil, drought-related phenomena and the subsequent impacts are particularly significant from a socioeconomic standpoint.²³

If the Andean glaciers of the tropical zone disappear during this century, it is very likely that serious consequences will result for the populations and ecosystems of the Andean regions of Bolivia, Chile, Ecuador and Peru, which depend on thawing of the glaciers for water supply, both for consumption and for hydroelectric generation. Heavy water flows from thawing will produce erosion, floods and mud slides in low-lying areas. However, once the glaciers have disappeared (as expected in the next 15 years in Chacaltaya, Bolivia),²⁴ flows will decrease drastically leading to serious water shortages, reducing hydroelectric generation, increasing the risks of drought and floods, and causing serious environmental degradation.²⁵

There is uncertainty regarding the effects of climate change on rainfall patterns in Latin America. However, it is estimated that the arid and semi-arid areas will receive less rain than currently, which would lead to degradation of agricultural land, thereby impacting food security. A decrease in agricultural output is expected throughout the region by the end of the century, with the exception of the mid lati-

tudes where the fertilising effects of CO₂ may compensate for the negative effects of climate change.²⁶

Together with extreme events, the main risks for life and health associated with climate change are those of thermal stress, mostly due to the effect of urban heat islands found in large cities, and transmissible diseases such as malaria, dengue fever and cholera. Incidences of some diseases such as leptospirosis and the hantavirus that originate in rodents may also increase with floods and droughts. The expected increases in forest fires resulting from higher temperatures, drier climate and greater deforestation and forest fragmentation will probably increase the population's vulnerability to the health impacts of smoke generated by biomass burning, an effect that has already been observed in Brazil.²⁷

The Amazon region contains around 40 per cent of the world's remaining tropical rainforests and one of the planet's richest biodiversity reservoirs: thousands of species of plants, 1,000 species of birds and more than 300 species of mammals. Reduction in tropical areas (especially tropical rainforests) will probably bring about the loss of many of these species. The threats of climate change, which may substantially affect the Amazon, will alter the overall climate and increase the risk of biodiversity loss. Given an estimated increase of the surface temperature of around 2° C, severe losses of species are expected towards 2050 in the centre of Brazil and Mexico, and in the arid areas of Argentina, Bolivia and Chile. Furthermore, an irreversible process of 'savannisation' is expected in the central eastern area of the Amazon region.²⁸

Low-lying coasts of many countries (Argentina, Belize, Colombia, Costa Rica, Ecuador, Guyana, México, Panama, El Salvador, Uruguay, Venezuela) and large cities (Buenos Aires, Rio de Janeiro, Recife, etc.) are among the areas most vulnerable to extreme climate changes ranging from torrential rains and wind storms to hurricanes in the tropical areas of the South Atlantic, with huge waves and rises in sea level.²⁹

The National Communications report that the rise in sea level will probably have negative impacts on buildings and tourism (Mexico, Uruguay), coast morphology (Peru), mangrove swamps (Brazil, Colombia, Ecuador, Venezuela) and drinking water availability on the Pacific Coast of Costa Rica, and in Ecuador and the Plate River Estuary. The coral reefs of Middle America (México, Belize, Panama) and the location of fishing grounds of the Pacific Southeast (Chile, Peru) will probably be affected as well.³⁰

21 See <http://unfccc.int/3582.php> quoted in UNFCCC (2007).

22 UNFCCC (2007)

23 UNFCCC (2007)

24 This information is more updated than that informed in the National Communication of Bolivia.

25 UNFCCC (2007).

26 UNFCCC (2007)

27 UNFCCC (2007)

28 UNFCCC (2007)

29 UNFCCC (2007)

30 UNFCCC (2007)

Box 2

<i>Regional impacts and vulnerabilities to climate change in Latin America</i>		
Impacts	Sector vulnerabilities	Adaptation skills
<p>Temperature</p> <ul style="list-style-type: none"> - Above average warming over a large part of the region. - In the south of South America, warming similar to the world average. 	<p>Water</p> <ul style="list-style-type: none"> - Increase in the number of people that will suffer from water stress: probably approximately 7 to 77 million people by 2020. - Water run-off and supply compromised in many areas, due to recession and loss of glaciers. - Low water quality in some areas, due to the increase of floods and droughts. 	<ul style="list-style-type: none"> - Lack of modern equipment for climate control and monitoring prevents access to quality forecasts, reducing reliability of climate records and meteorological services. This has a negative impact on the quality of information providing services and early warning alerts. - Some social indicators have improved in recent years, including life expectancy, literacy level and access to drinking water. However, adjustment capacity is limited by high child mortality rate, low high-school education levels and high levels of inequality regarding both availability and access to drinking water and health services, and gender inequalities.
<p>Precipitation, Ice and Snow</p> <ul style="list-style-type: none"> - Decrease in annual rainfalls in Central America and South of the Andes, though with higher local variability in mountain areas. - Higher winter rainfalls in Tierra del Fuego. - Higher summer rainfalls in the south-east of South America. - Uncertain rainfall in the northern parts of South America, including the Amazon. - Greater recession and disappearance of the Andean Glaciers, especially at low latitudes. 	<p>Agriculture and Food Security</p> <ul style="list-style-type: none"> - Decrease in crop outputs in some areas; there may be increases in output in others. - Towards 2050, 50 per cent of agricultural lands will probably be exposed to desertification and salinisation in some regions. - Food security could become a problem in arid areas in which the agricultural land is exposed to salinisation and erosion, reducing the crop output and cattle farm productivity. 	
<p>Extreme Events</p> <ul style="list-style-type: none"> - Increase in frequency and intensity of extreme events, namely those related to the El Niño phenomenon (ENSO). - Intense rain events, with landslides and severe floods as a result. - Heat waves with greater effects especially in larger cities, due to the 'heat island' effect. - Increase in intensity of tropical cyclones in the Caribbean. - Dry seasons and droughts, as is the case in north-east Brazil. 	<p>Human Health</p> <ul style="list-style-type: none"> - Risk to life due to increase in tropical cyclones. - Health risks from heat stress and changes in the behaviour patterns of disease transmission vectors. <p>Terrestrial Ecosystems</p> <ul style="list-style-type: none"> - Significant loss of habitat and species extinctions in many tropical areas of Latin America, including tropical rainforests and forests, due to higher temperatures and loss of surface water, with effects on native communities. <p>Coastal Zones</p> <ul style="list-style-type: none"> - Impacts on low-lying areas such as the Rio de la Plata Estuary, cities and coast morphologies, coral reefs and mangrove swamps, on the location of fishing grounds, drinking water availability and tourism-related activities, as a result of sea level rise and more frequent extreme events. 	

Source: GIRARDIN (2007), based on UNFCCC (2007) and Fourth Assessment Report of IPCC Working Group II (2007).

Mangrove swamps in low-lying coastal areas will be particularly vulnerable to higher sea level, increased average temperatures and frequency and intensity of hurricanes, especially in the continental regions of Mexico, Central America and the Caribbean. Some such areas may even disappear if management is not improved. Species of fish may also be threatened by higher sea temperatures, with negative consequences for the region's fishing.³¹

Salinisation of drinking water may become a serious problem in coastal areas as a result of a rise in sea levels. In some areas, higher sea levels may lead to reduced salinity in the hyper-saline lagoons, with negative effects on biodiversity.³²

Box 2 gives a brief summary of expected impacts for the Latin America Region.

3-Expected impacts and vulnerability of the energy sector to climate change in Latin America & the Caribbean

Some National Communications on Climate Change and other relevant studies provide information related to vulnerabilities and expected impacts that may affect the energy sectors of Latin American countries. There are many different situations, depending on the energy mix and other national circumstances that justify a detailed analysis of this aspect. Special attention will be paid to those countries with a larger share of biomass fuels and/or hydroelectricity in their energy mix because there will be a variety of situations depending on expected precipitation patterns, temperatures and flow rates of main rivers, as predicted by the General Circulation Models (GCM).

The energy sector not only appears as the main source of GHG emissions all over the world but also as a sector that could itself suffer significant impact from climate change. Vulnerability of the sector varies from region to region and from country to country, and depends on the energy sources used. In this sense, there is a certain lack of information about the vulnerability of energy sectors to climate change, both at the Latin American regional level and at global level.

³¹ Ibidem.
³² Ibidem.

Box 3

Share of hydropower in total power generation, in Latin America and Caribbean Region (2007)

COUNTRIES	Hydroenergy	Electricity	% Generation
	GWh	GWh	Hydroelectric
ARGENTINA	-39,423.14	103,859.64	38.0%
BARBADOS	-	905.99	
BOLIVIA	-2,556.7	4,973.08	51.4%
BRAZIL	-360,326.4	400,888.82	89.9%
CHILE	-22,828	54,724.38	41.7%
COLOMBIA	-52,323	53,569.92	97.7%
COSTA RICA	-5,897.1	7,356.74	80.2%
CUBA	-151.75	17,037.9	0.9%
ECUADOR	-9,465.86	14,259.82	66.4%
EL SALVADOR	-2,452.06	5,040.9	48.6%
GRENADA	-	171.46	
GUATEMALA	-3,740	8,258.72	45.3%
GUYANA	-	516.83	
HAITI	-594.53	570.26	104.3%
HONDURAS	-3,374.18	6,259.1	53.9%
JAMAICA	-207.88	3,961.5	5.2%
MEXICO	-74,494.99	159,946	46.6%
NICARAGUA	-381.99	2,827.5	13.5%
PANAMA	-3,665.93	6,449.5	56.8%
PARAGUAY	-62,873.39	53,722.34	117.0%
PERU	-23,883.99	28,200.49	84.7%
DOMINICAN REP.	-1,751.,27	11,516.58	15.2%
SURINAM	-	146.64	
TRINIDAD & TOBAGO	-	7,647.79	
URUGUAY	-9,006.98	9,281.4	97.0%
VENEZUELA	-81,458.91	110,085.91	74.0%

Source: Based on Energy and Economic Information System (SIEE) from Latin American Energy Organization (OLADE). January 2009.

The following are some key findings regarding the relationship between climate change and the energy sector in the Latin America region:³³

- Most countries of the region have arid and semi-arid areas that may suffer a significant impact from hydro stress and which may cause them to become more arid. This situation would have implications for the supply of biomass for the lower-resource populations living in these areas in Brazil, Bolivia,

³³ See GIRARDIN (2007) and GIRARDIN (2008).SUAREZ

- Chile, Paraguay and certain regions of Argentina.
- All climate models used to predict future weather conditions show temperature increases, with consequent rises in evaporation and decreases in mean river flows if the temperature increases outweigh the higher precipitation expected in some hydrographic basins. The combination of the two processes may cause problems for hydroelectric generation in some areas. The most vulnerable areas are the basins that depend on the thawing of the Andes glaciers of Argentina, Chile, Bolivia, Peru and Ecuador, but problems could also occur in the Plata Basin (shared by Argentina, Bolivia, Paraguay and Uruguay) in case of significant temperature rises.
- Trends towards a higher frequency and intensity of external events may be observed, with potential consequences for energy infrastructure (mainly electric power transmission grids, but also for air generators and other sector-related equipment).
- Expected increases in mean minimum temperature values may reduce the need for heating in higher latitudes but they could also generate significant increases in air-conditioning and refrigeration demands in the more populated medium and lower latitudes.
- In certain areas (the Argentine regions of Wet Pam-pa and the Wet Chaco Region), the higher farming productivity expected in the short and medium term may imply a significant increase in the demand for diesel oil for transportation of produce to the milling and consumption markets and to ports for export. The rail cuts of the 1990s resulted in greater dependency on road transport, and it does not seem that this trend will be reversed in the short term.
- The possibility of an increase in growing of crops specifically for biofuels may, have strong adverse effects on poverty relief for some countries, as it may endanger food supply security in countries that have no self-sufficiency capacity (even though biofuels may constitute a possible alternative from the energy point of view).

As can be seen, the relationship between the energy sector and climate change involves multiple issues that should be addressed in order to improve poverty alleviation as well as sustainable development for developing countries, mainly for their poorest people.

4 -Energy and poverty – energy access for poor people: mitigation and adaptation Issues

The importance of poor people's vulnerability to climate change is evident, but it is also clear that the technological options chosen for power generation to, for example, guarantee access to modern energy also have consequences for GHG emissions. Efficient use of energy and clean energy supply options are two key issues in the field of mitigation—the challenge is to facilitate access to modern energy without increasing global emissions. The systematic inclusion of the linkages between energy and poverty in studies and documents is increasing.³⁴ However, there are still many questions that have not been answered. One of these is: what specific orientation should be given to adaptation and mitigation policies to specifically support the poor? The role of international cooperation also has implications for this point.

There are approximately 200 million people currently living below the poverty line in Latin America. Of those, 133 million live in urban areas and 67 million in rural areas. The extreme poverty figures are not lower. The estimated population living under such conditions would be approximately 72 million, of which 50 per cent live in urban areas and 50 per cent in rural areas.

The total number of poor in Latin America has increased by least 64 million people between 1980 and today, but it increased by 69 million during the same period in urban areas³⁵ (joint initiative CEPAL-UNDP-Club of Madrid, 2009). This means that while the internal migration processes continue, the capacity of urban systems to absorb these migrants is too low to include these sectors of society fully and in accordance with the trend towards modernity. There is also weakness in the production systems in rural areas which are incapable of halting emigration. There has been a displacement of rural poverty towards urban poverty and marginality, posing new challenges. On the other hand, it should be noted that with annual GDP growth rates below 4 per cent there has been no decrease in absolute poverty values in any country, indicating one of the dimensions of vulnerability of the poor and their exposure to macroeconomic conditions in general. The impact that climate change may have on economic growth would also—in the absence of other policies—affect the possibilities for poverty reduction.

As regards access to energy services by the poor, both in rural and urban areas, there are a number of issues that

³⁴ SUAREZ et al. (2001); PNUD (2007b); KOZULJ (2008); BRAVO et al. (2008), PNUD (2008).

³⁵ 5 million rural poor migrated to urban areas during the same period in addition to the increase of 64 million, explaining why although the total increase in poverty was 64 million, the urban poor increased by 69 millions.

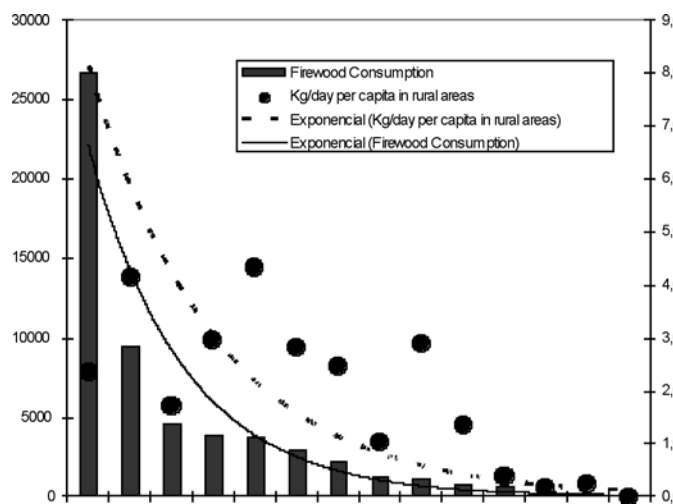
relate directly or indirectly to climate change, in turn creating a complex framework for which it is necessary to create appropriate policies that are integrated with one another if the purpose is to obtain positive results for access to energy and for reductions in poverty and GHG emissions.

4.1-The problem of rural areas: access to electricity and wood consumption

Approximately 29 million people do not have access to electricity. Of these, 21 million are poor and, by definition, most of them are found in rural areas. 95 to 96 per cent of cases are concentrated in only seven countries: Peru (25%); Brazil (24%); Bolivia (14%); Guatemala (12%); Honduras (11%); Nicaragua (6%); El Salvador (4%). Paraguay, Colombia, Chile, Argentina, Ecuador, Costa Rica and Venezuela account for the remaining 4 or 5 per cent. Except for Brazil, where the magnitude reflects the size of the population and its weight in the region, in the rest of the countries the numbers of poor people without access to electricity services also reflect the general level of poverty and low human development indices of these countries.

It may generally be assumed that wood consumption per inhabitant is higher in these areas, typifying the energy situation of the poor in rural areas.

Figure 1-Consumption of firewood in rural areas: absolute and per capita values.

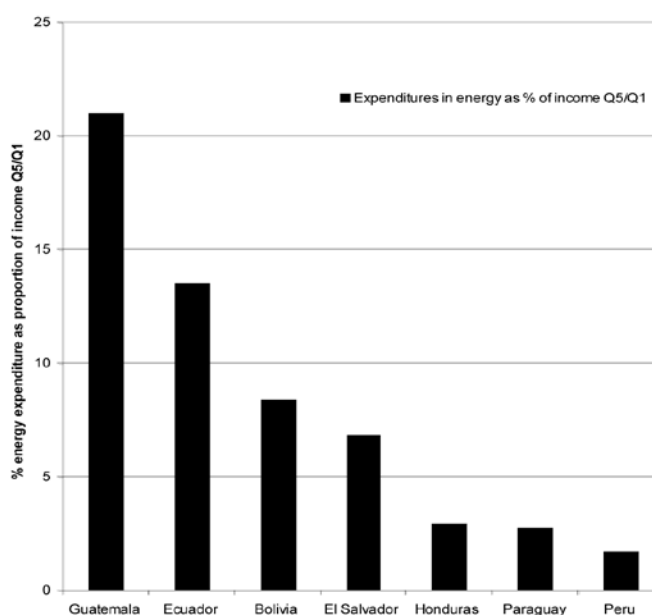


Source: Based on data of OLADE, SIIE, 2009 and CEPAL-CELADE.

4.2-The problem of urban areas: access to energy services

The problems confronting poor people living in large cities and other populated centres are different from those confronting the rural poor. These include non-regulated access to relatively affordable services (e.g. natural gas) and, in general, they spend a larger proportion of their income on energy services than other social groups.

Figure 2- Inequality in urban areas.



Source: Based on data from ECLAC, 2007.

4.3-What links can be established between access to energy services, accessibility for poor sectors and climate change?

The answer to this question involves issues and consequences that differ markedly from one region of the world to another and even between countries in the same region. Figure 3 provides a schematic illustration of some of the most evident links that may be established. If it is assumed that GHG emissions can have an impact on economic growth and human welfare (and that in turn the reduction in the numbers of poor may depend on the attainment of high growth rates), a generally valid relation may be established and one that becomes more important when growth rates are affected negatively at the global, regional or national levels as a direct or indirect result of climate change.

To clarify, a first set of impacts arises because of the ways in which different societies produce and consume energy. That is the impact produced by those who already have access to energy. The inclusion of new users—in this case the poor who formerly did not have access to certain energy services (e.g. electrical power) and who, in turn, were left with forms of consumption and energy production that

are considered undesirable (e.g. unsustainable use and consumption of biomass)—constitutes the core of what may be generally identified as the problem. The question of the possible impacts on supply security and on the environment that would result from the incorporation of approximately two thousand million people who currently consume energy in pre-modern forms or from incorporation of the one thousand million people who have no access to electricity could be worrying. However, this issue should not be at the centre of discussions at the global level, and even less so for Latin America. Access to energy by the poor could never be a cause of a generalised increase in emissions nor could it endanger energy security, simply because its impact would be marginal. This does not mean that clean and renewable sources are not an appropriate solution to prevent even these marginal impacts. However, as illustrated by Figure 3, consideration of the links between energy, poverty and the environment as a whole should move from too sharply focused a vision to a more integrated approach.

In the past, the environmental restrictions imposed on hydropower stemmed (and still stem) from the view that the technology employed to generate electricity was unsatisfactory in terms of its impacts on the environment, the region and the poor, as well as the higher prices of oil, natural gas and related products. The paralysing effect on hydroelectric power and the concurrent increase in the use of thermal power plants have been accompanied by significant increases in per capita emissions. Although it may be possible that not all of this increase can be attributed to the electricity generating sector, the guidelines derived from restrictions and regulations certainly helped in producing these negative results.

Penetration of renewable energies from sources such as wind and solar energy in the region has been slow. International cooperation programmes destined to foster the alleviation of energy-poverty via renewable energies have been characterised by fragmentation, lack of coordination within a global framework, insufficient funding of projects and very complex access to financing. Furthermore, countries' regulations, with very few exceptions, have not given the issue the significance it deserved.

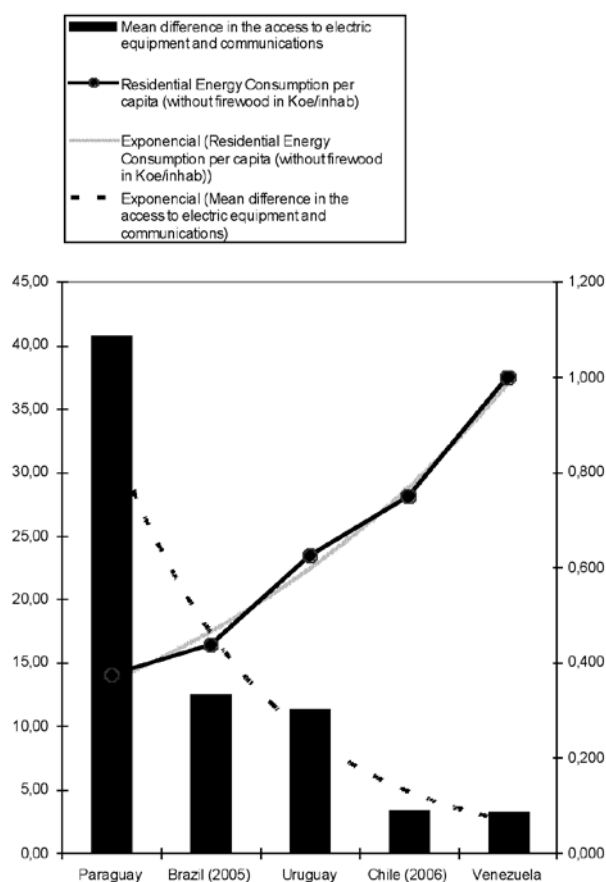
The current regional trend—arising in large part from European regulations aimed at establishing electricity production targets through renewable energies—could accelerate penetration by these sources, partially transforming the energy mix in the long term. However, such mandatory instruments imply the creation of mechanisms to assign costs to different users and support for penetration of clean energies by social tariffs to guarantee access and accessibility.

The general trend to observe and assess projects from the macroeconomic point of view that prevails in the region must be replaced or complemented in order to achieve greater diversification of the generating base for each coun-

try of the region. Given the higher relative cost of the renewables assessed in this way, regulation must be accompanied by significant social and environmental goals and, in turn, faster CDM application for desirable projects. This goal could be attained through changes in criteria required for international cooperation.

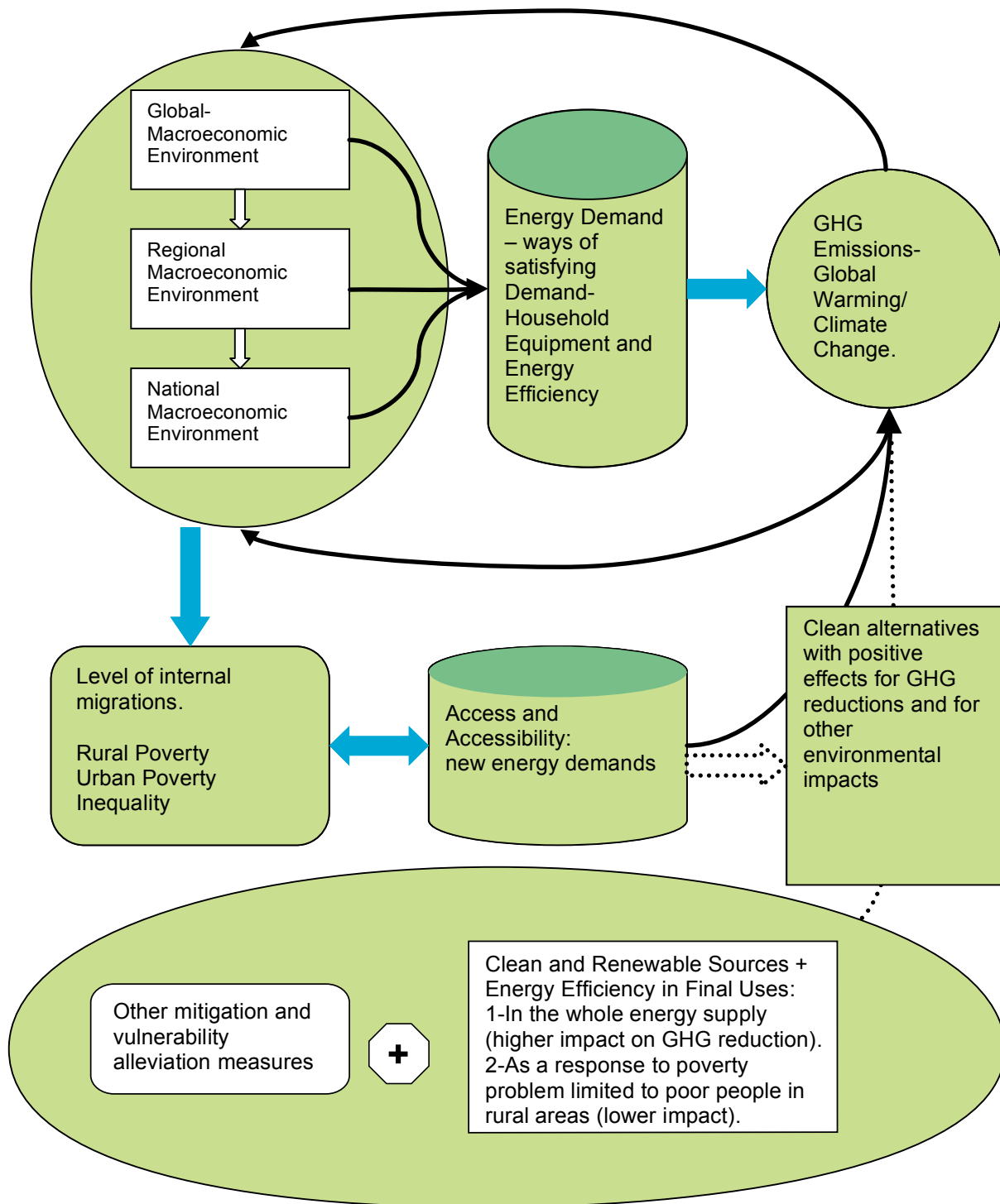
Another important issue, related to the above concerns, is the introduction of effective policies on appliances and equipment, especially in the Latin American context where the problems of poverty and urban marginality are tending to grow. It is widely known that the most efficient household appliances (as well as equipment for the transport sector) tend to be more expensive. The poor have obsolete, cheaper, second hand or used appliances that are inefficient. The relationship between access to appliances and increased energy consumption is a proven fact. For example, countries in the region with greatest social differences in terms of access to appliances are also, almost systematically, those that have lower mean energy consumption (from modern sources and in the residential sector) per inhabitant. (Figure 4).

Figure 4- Mean difference in access to equipment between 20 per cent richest and 20 per cent poorest and per capita energy consumption for residential uses



Source: Base don the study: "Contribución de los Servicios Energéticos a los Objetivos de Desarrollo del Milenio y a la Mitigación de la Pobreza", 2009, joint initiative CEPAL-PNUD Club de Madrid.

Figure 3- Simplified diagram of energy-poverty and climate change links: the necessity of an integrated scenarios approach.



It is not difficult to infer that—in the absence of integrated and explicit policies on access, accessibility, equipment for generation of electricity and household appliances—there will tend to be an increase in GHG emissions, with consequences for climate change and strong impacts on the poor, due both to their vulnerability in terms of exposure to physical events and to impacts deriving from global, regional and national macroeconomic conditions, as well as from the rules for operation of the domestic energy market operation in the absence of strong corrective measures. In contexts where people are pushing for greater deregulation, for regulations favourable to their interests and less government intervention, it will be even more complicated.

Our basic intention here is to show—over and above the fact that traditional efforts focused on renewables and on providing the poor with better access to energy introduce a favourable factor in aiming to provide modern energy services to the poor while trying carefully to avoid generating negative impacts on the environment in general and for climate change in particular—that the true relationship between energy-poverty and climate change is more complex but not at all unmanageable. On the contrary, developments in the area and the progressive identification of new links will allow for the design of a complete agenda of tasks based on a comprehensive view where adaptation factors will be multiplied as more vulnerabilities are identified. However, if such a goal is to be achieved a different international cooperation approach will be needed, especially when the main operators are global agents and national planning frameworks are weak and inadequate in the face of the challenges.

D -Conclusions and recommendations: towards a better definition of strategic paths, measures and actions

Adaptation is gaining growing importance amongst climate change issues. The Bali Action Plan³⁶ and the Nairobi Work Programme³⁷ addressed this point, as well as the close relationship between climate change, energy and poverty. The need to develop climate change strategies, policies, measures and actions based on an integrated approach to avoid overlaps, overlays, contradictions and duplication of efforts is evident, not only for mitigation, but mainly for adaptation to climate change. It is important to identify potential conflicts that could appear, for instance, between energy supply security (in some cases due to the need for adaptation to climate change) and mitigation.

A regional approach is recognized as the best one to analyse the potential cross-cutting issues among countries, given that the expected impacts of climate change do not recognise human political frontiers. The most urgent needs from the point of view of Latin American and the Caribbean region relate to:

- ✓ Identification of criteria or options that while embracing poverty alleviation and vulnerability reduction, could also contribute to mitigation.
- ✓ Identification of potential actions to reduce energy sector vulnerability, especially for the poor, related to direct or indirect impacts of climate change.
- ✓ Review criteria to satisfy multiple objectives such as GHG mitigation, adaptation, energy security, access to energy, equity, competitiveness, etc.

Every concrete strategy, policy and/or measure adopted in order to pursue GHG emission reductions will have impacts on the activities involved and consequently, require some sacrifice in terms of the economy of the society implementing the strategies, policies and/or measures. One of the most controversial aspects of the international climate change negotiations agenda is the issue of distribution of climate change mitigation costs amongst different countries. A look at some of the alternatives proposed for regulating the operation of an international climate regime reveals that the economic effects of its implementation will not be neutral for the countries, activities and social groups affected.

³⁶ Adopted at COP-13. www.unfccc.int

³⁷ Decision 2/CP.11. www.unfccc.int

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