Sixth Annual Meeting of the

AFRICAN SCIENCE ACADEMY DEVELOPMENT INITIATIVE (ASADI)

Turning science on: Improving access to energy in sub-Saharan Africa

7 – 10 November 2010

ASSAf
ACADEMY OF SCIENCE OF SOUTH AFRICA

Statements from Academy Presidents

	A very warm welcome to all the participants! As hosts of the ASADI VI Conference, we believe that energy access is pivotal to the attainment of the Millennium Development Goals and that lack of reliable and affordable energy is a major obstacle to sustainable development on the African continent. While acknowledging that great strides have been made by some African countries, including South Africa, a lot remains to be done in providing access to clean and affordable energy to all. We hope that science-based solutions and interventions suggested in this publication will make a contribution towards energy access strategies in sub-Saharan Africa. Robin Crewe *President, Academy of Science of South Africa*	75	**Percent access to electricity**
	Energy is a crucial factor in poverty alleviation in both urban and rural populations of Cameroon. A strategic plan for supplying Cameroonians with reliable and affordable energy is required. Research and planning in the sector are key to avoiding shortages of supply being met with 'quick fix' but expensive solutions. Samuel Domngang *President, Cameroon Academy of Sciences*	29	
	Ghana could sustainably harness ample solar energy to meet the basic electricity needs of a significant percentage of the population not served. In 2007, GAAS commissioned a study on "Generating Electricity from Sunlight", in which it recommended the establishment of a clear policy and regulatory framework including renewable portfolio standards and investment incentives to foster business support to private developers. Reginald Fraser Amonoo *President, Ghana Academy of Arts and Sciences*	54	
	Provision of adequate modern energy services is critical to the achievement of Vision 2030, Kenya's national development blueprint for making the country a newly industrialised country with a high quality of life. In pursuit of this, Kenya has made the necessary reforms to ensure increase in provision of energy, including accelerated electricity connectivity, and facilitating private sector participation in energy provision. Joseph O Malo *President, Kenya National Academy of Sciences*	15	

Statements from Academy Presidents

	Energy is the source of all livelihoods, and we have to ensure that everybody has access to it for living a decent life. Our Academy is ensuring that the people are aware of the global and local situation, that they reduce consumption, and in the face of the global warming and climate change phenomena, are ready to sacrifice certain nonessentials for reducing our carbon footprints. Soodursun Jugessur *President, Mauritius Academy of Science and Technology*	99	Percent access to electricity
	Mozambique's vast reserves of coal, gas and hydropower have recently come under intense scrutiny from global investors. Notwithstanding future prospects, the situation today is one of low electricity access for the vast majority of the poor. Our Academy is therefore called upon to contribute with innovative ideas on how to balance industrial and mining development that also serve the poor. Orlando Quilambo *President, Academy of Science of Mozambique*	12	
	Africa was known derogatively in the past as a 'Dark Continent' – dark in terms of the level of illumination, level of scientific knowledge and access to energy. Now, the scenario is changing for the better in terms of emerging, rich scientific know-how on the continent. This will change the perception of the continent to that of an 'Informed, Rich and Knowledgeable Continent'. Oye Ibidapo-Obe *President, Nigerian Academy of Science*	47	
	One of the major challenges facing sub-Saharan African countries like Senegal is the resolution of the problem of increasing the provision of energy services. It becomes urgent to make energy more accessible to the mainstream society and to reinforce its role in the economic and social promotion of populations. Modern energy services must be extended to poor people and rural populations in order to create conditions for the achievement of the Millennium Development Goals. African science academies have to mobilise themselves around this vital issue, putting their expertise at the service of populations and policy-makers. Doudou Ba *Permanent Secretary, l'Académie Nationale des Sciences et Techniques du Sénégal*	42	

Statements from Academy Presidents			
	Given its natural resource endowments, Uganda has great potential to generate and improve energy access. The Uganda National Academy of Sciences would like to highlight the importance of energy for health and well-being and national development in general. The Academy calls upon the government to accord this matter the priority it deserves to accelerate economic and social development. Paul Mugambi *President, Uganda National Academy of Sciences*	9	**Percent access to electricity**
	Energy provision and national development are interlinked. The Zimbabwean national power utility has been reviving a number of thermal power stations to supplement the ever-growing demand for energy. There is a vibrant rural electrification programme that has been underway for years in Zimbabwe. Scientists in Zimbabwe subscribe to the notion of the right to quality and consistent energy for all. Research is being carried out particularly in environmentally friendly energy forms like solar. Christopher Mutambirwa *President, Zimbabwe Academy of Sciences*	42	

Turning science on: Improving access to energy in sub-Saharan Africa presents an overview of the current status of access to electricity and modern fuels in sub-Saharan Africa. The importance of energy access to the achievement of the Millennium Development Goals (MDGs) is underlined and some key interventions that have worked in Africa are described. This publication was prepared for the Sixth Annual Meeting of the African Science Academy Development Initiative (ASADI), hosted by the Academy of Science of South Africa (ASSAf) from 7-10 November 2010 in the Western Cape.

ASADI is a project funded by the Bill & Melinda Gates Foundation through the United States National Academies of Sciences (USNAS) to strengthen the ability of African science academies to offer policy advice to their national governments. This document focuses specifically on the seven ASADI countries (Cameroon, Ghana, Kenya, Nigeria, Senegal, South Africa and Uganda), as well as three southern African countries (Mauritius, Mozambique and Zimbabwe) that were included as part of an academy development initiative of ASSAf.

Main Abbreviations

ASADI	African Science Academy Development Initiative
ASSAf	Academy of Science of South Africa
CBWP	Community-based Woodfuel Production
CDM	Clean Development Mechanism
EDI	Energy Development Index
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
HDI	Human Development Index
IPP	Independent Power Producer
LPG	Liquid Petroleum Gas
MDGs	Millennium Development Goals
NEPAD	New Partnership for Africa's Development
SSA	Sub-Saharan Africa

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Key Messages for Policy-makers

- *Increasing access to energy is pivotal to the achievement of the Millennium Development Goals. Policy-makers must push for the inclusion of an additional goal related to energy access*
- *Private sector investment, governance reform of state-owned power utilities and the unlocking of regulatory barriers are necessary to improve energy access*
- *Universal access to electricity can only be achieved by an integrated approach that relies on extensions to the national grid, as well as the installation of mini-grids and off-grid isolated systems*
- *In the short- to medium-term, whilst there is a continued reliance on traditional biomass fuels for cooking, improved cook stoves that minimise emissions harmful to human health must be promoted. Fuelwood continues to be a major energy source for households and commercial enterprises, hence its sustainable production has to be included into national energy and rural development programmes*

1. Introduction

Access to modern energy services, defined as electricity and clean cooking fuels, is central to a country's development. Poor access retards the pace of national development and poverty reduction and delays the achievement of the Millennium Development Goals (MDGs). The availability and use of energy will greatly influence how rapidly African countries are able to increase their agricultural productivity, provide safe water, achieve economic development, and use information and communications technologies to become increasingly integrated into the global economy.

Access to energy in sub-Saharan Africa (SSA) is the lowest in the world, even though Africa has significant energy resources in the form of oil, gas, coal, hydro and renewable energy.

Africa, and SSA in particular, is characterised by some dramatic statistics:

- In SSA, 585 million people or approximately 70 percent of the population do not have access to electricity[1].
- In some countries, such as the Democratic Republic of Congo, Malawi and Uganda, over 90 percent of the population has no access to electricity[2].
- The entire installed power capacity in SSA is 68 GW, comparable to that of Spain and 10 percent of that of Latin America[3].
- If South Africa is excluded, installed capacity falls to only 28 GW[3].
- Up to a quarter of this capacity is unavailable due to poor maintenance[3].
- Growth in new power capacity is largely stagnant.
- Energy consumption *per capita* is barely 1 percent of that of high-income countries[3].
- An investment of over $340 billion is required to provide all households with electricity[1].
- In SSA, 80 percent of the population or 653 million people rely on biomass fuels for cooking[1].

Yet the substantial increase in coverage of mobile telephone connectivity in Africa over the last decade is evidence that it is possible to roll out infrastructure on the continent.

2. Energy access and development

The lack of energy access has a major impact on development and livelihoods[2].

- Energy is central to most aspects of human welfare, including access to water, agricultural productivity, health care, education, job creation, climate change and environmental sustainability.
- Millions of households in developing countries have no access to modern energy services that are affordable, clean, reliable, and safe, and pay high prices for poor-quality substitutes.
- Lack of energy access entrenches poverty, negatively affects health and education, inhibits local service delivery, increases vulnerability to climate change, limits expansion of opportunities and erodes environmental sustainability.

Energy access and human development, as measured by the Human Development Index (HDI) [see Box 1] are closely linked. There is a positive correlation between percent electricity access and the HDI (Figure 1a) and a similar relationship exists between education enrolment rates and percent electricity access. A negative correlation exists between child and maternal mortality rates and percent access to electricity (Figure 1b), as well as between the percent of the population living on less than $1 a day and percent electricity access.

Box 1: Human Development Index

The Human Development Index is a summary composite index that measures a country's average achievements in three basic aspects of human development: health, knowledge and standard of living. Health is measured by life expectancy at birth; knowledge is measured by a combination of the adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratio; and standard of living by Gross Domestic Product (GDP) *per capita* (US$ at purchasing power parity)[4].

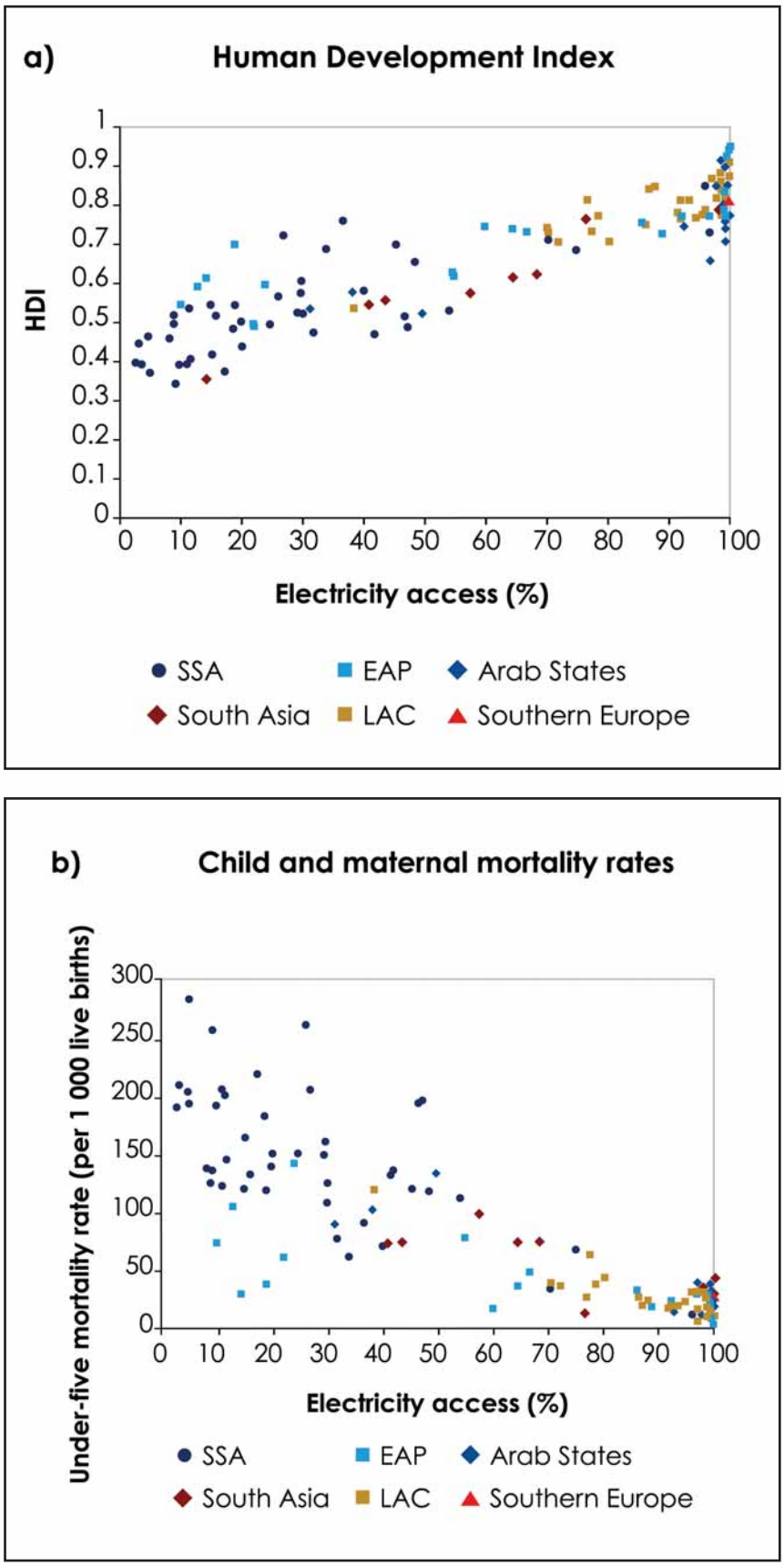


Figure 1: Relationship between energy access and human development measures[2]

Each symbol represents a country from sub-Saharan Africa (SSA); East Asia and Pacific (EAP) and Latin American countries (LAC)

The close relationship between access to energy and various indicators of human development has prompted development of an Energy Development Index (EDI) as a tool to track systematically progress in this area [see Box 2]. Most of the sub-Saharan African countries included in this publication have an EDI less than 0.21.

Box 2: Energy Development Index[1]

The EDI comprises four indicators:

- *Per capita* commercial energy consumption
- *Per capita* electricity consumption in the residential sector
- Share of modern fuels in total residential sector energy use
- Share of population with access to electricity

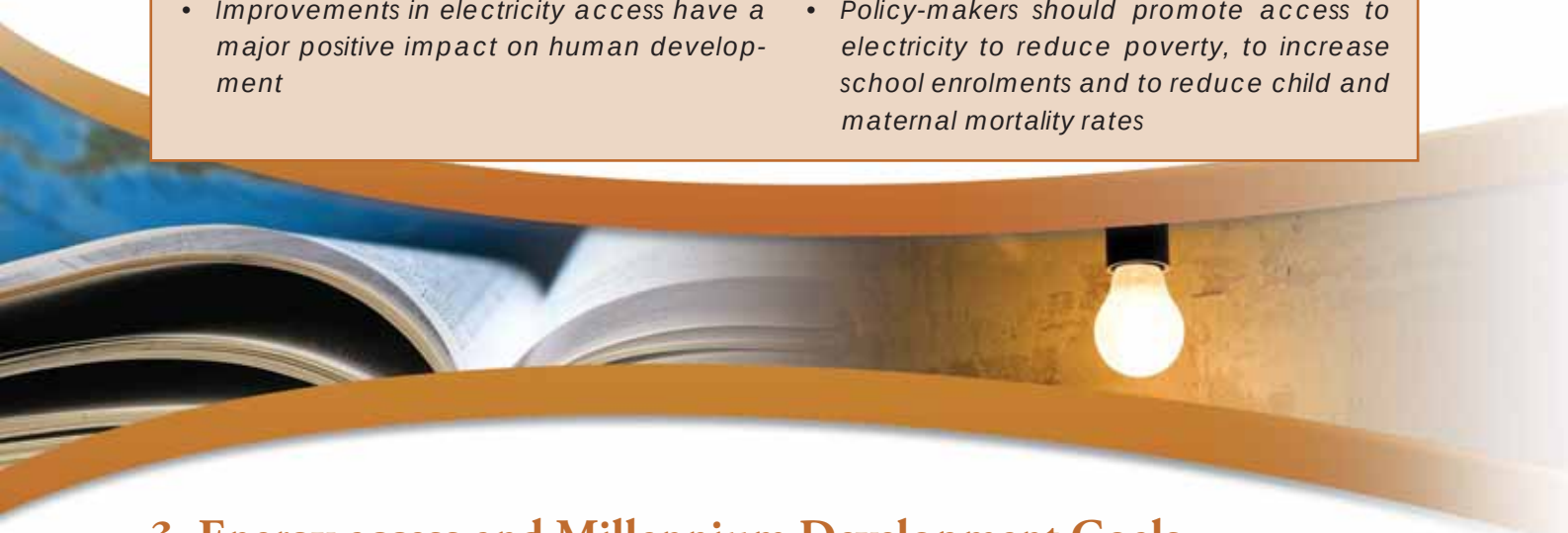
Performance on each indicator is expressed on a scale from 0 to 1 and is calculated using the following formula

$$\text{Indicator} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

The EDI for each country is calculated as the arithmetic mean of the four values for each indicator.

Key Messages

- *Improvements in electricity access have a major positive impact on human development*
- *Policy-makers should promote access to electricity to reduce poverty, to increase school enrolments and to reduce child and maternal mortality rates*



3. Energy access and Millennium Development Goals

The MDGs were endorsed by governments at the United Nations (UN) in September 2000 and aim to improve human well-being by reducing poverty, hunger, child and maternal mortality, ensuring education for all, controlling and managing diseases, tackling gender disparity, ensuring sustainable development and pursuing global partnerships. Access to energy is a critical determinant for achieving these goals [see Box 3], yet there is currently no MDG related specifically to energy. The UN Advisory Group on Energy and Climate Change has called for the inclusion of an energy goal in which universal access to modern energy services is achieved by 2030[6].

Box 3: Improved energy services are required for achieving the Millennium Development Goals [1,5] (adapted)

Millennium Development Goals	*Contribution of access to modern energy*
Goal 1: Eradicate extreme poverty and hunger	• Enables irrigation to increase food production • Provides energy for income-generating activities • Powers machines to increase productivity
Goal 2: Achieve universal primary education	• Reduces time spent on fuelwood and water collection • Provides better lighting in homes and schools to help children study • Facilitates communication, particularly information technology
Goal 3: Promote gender equality and empower women	• Reduces time spent by women in fuelwood collection, giving more time for productive activities, education and child care • Reduces risk of assault and injury to women by minimising fuelwood collection activities and providing street-lighting
Goals 4, 5, 6: Health	• Reduces exposure to indoor air pollution • Supports functioning of clinics and hospitals • Allows for medicine refrigeration and equipment sterilisation • Enables access to the latest medicines/expertise through telemedicine systems
Goal 7: Environmental sustainability	• Reduces the reliance on fuelwood and lessens pressure on forests, reduces erosion and deforestation • Promotion of renewable energy applications is consistent with goal of protecting the environment
Goal 8: Develop a global partnership for development	• Electricity promotes information and communications technology applications

Key Messages

- *By addressing access to modern energy services, policy-makers can prevent thousands of deaths in their country, alleviate poverty, improve education and contribute to the achievement of the MDGs*
- *Policy-makers must push for the inclusion of a ninth MDG goal related to energy access*

4. Access to electricity and modern fuels

4.1 Electricity

Compared to other developing regions, SSA has the lowest electrification rate, with 585 million people or 70 percent of the population having no electricity access[1]. Electrification rates (number of people with access to electricity as a percentage of the total population) in other developing regions, notably China and East Asia (88.5 percent), South Asia (51.8 percent) and Latin America (90 percent), stand in stark contrast[2]. Some countries in SSA have made great advances, for example, Mauritius has almost 100 percent access, and South Africa follows with 75 percent. However, most countries have less than 50 percent access (Figure 2).

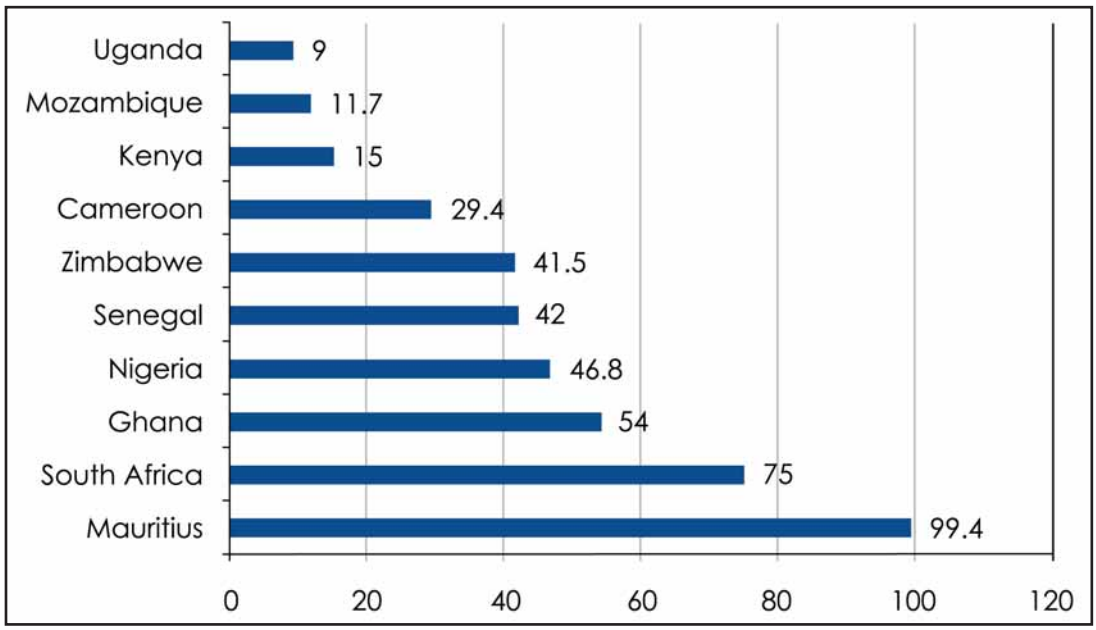


Figure 2: Percentage of population with electricity access in SSA countries[2]
(The data were collected at different times ranging from 2003 and 2007.)

Declining electricity access

In the early 1980s, electrification rates in SSA were equivalent to those in other developing regions, but electricity generation capacity then grew at less than 3 percent while the economy grew at about 5 percent[7]. Projecting present electrification growth rates to 2030 (Table 1), it is evident that more people in SSA will be without access to electricity in 2030 than there were in 2006 because of relatively greater population growth rates.

Table 1: Number of people and percent of population without access to electricity in 2006 and estimated numbers for 2030 in selected sub-Saharan African countries

	2006		2030	
	Million	%	Million	%
Angola	14.6	88	18	59
Cameroon	14.2	78	17	64
Chad	10.1	97	18	92
Congo	2.9	78	4	68
Ivory Coast	11.6	61	14	50
Gabon	0.9	70	1.2	66
Mozambique	18.6	89	22	72
Nigeria	76.6	53	66	29
Sudan	26.9	71	30	51

Low electricity consumption rates

Due to low levels of electricity generation and access, the *per capita* consumption averages about 124 kWh per year when South Africa is not included[7]. This compares to 1 155 kWh in the developing world and 10 198 kWh in high-income countries.

Power outages

In addition to low levels of coverage, in many parts of SSA, the power supply is unreliable. Manufacturing enterprises register power outages of 56 days on average per year, whereas, in the United States, the standard for power outages is one day in ten years[9].

Emergency power

To address the serious power shortages, many African countries enter into very expensive short-term leases for dominantly diesel-based emergency power costing up to 3-4 percent of GDP in some countries. The widespread use of emergency power can be viewed as a significant planning and procurement failure on a large scale[7].

High electricity costs

The average cost of electricity in SSA is more than US$0.20 per kilowatt-hour partly because of reliance on back-up generation and high oil prices. Revenue levels are low because of low demand and there are also many hidden costs due to theft, technical losses and collection inefficiencies[7].

Unequal electricity access

Access to electricity is unevenly distributed between urban and rural areas, and between income groups. In Africa generally, 71 percent of urban residents and only 13 percent of rural dwellers have access (Figure 3). Only 4 percent of the poorest as compared to 74 percent of the highest income group have access to electricity (Figure 4). Unequal access to modern energy reinforces inequality and is a barrier to development.

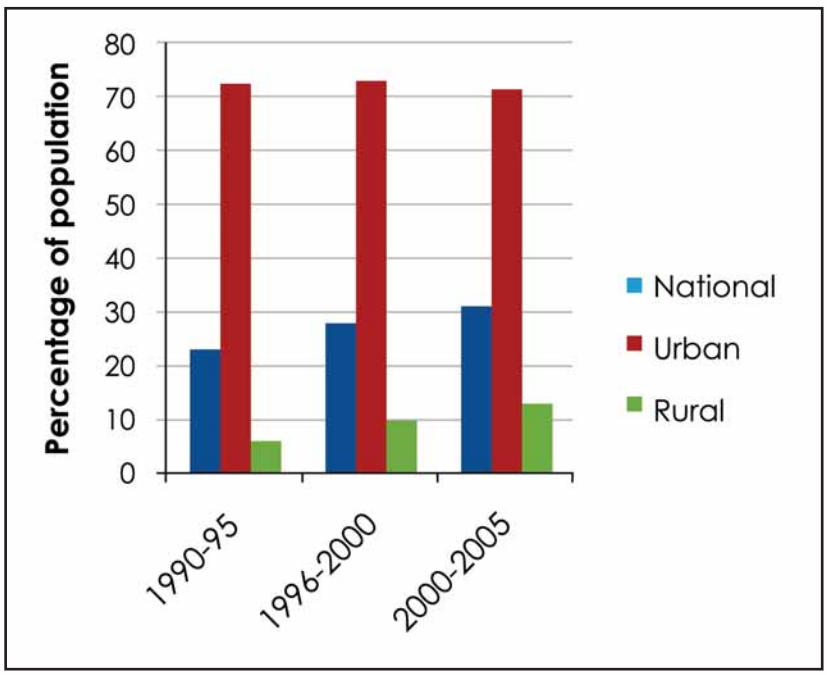


Figure 3: National, urban and rural access to electricity in Africa 1990-2005 (percentage of population)[10] (adapted)

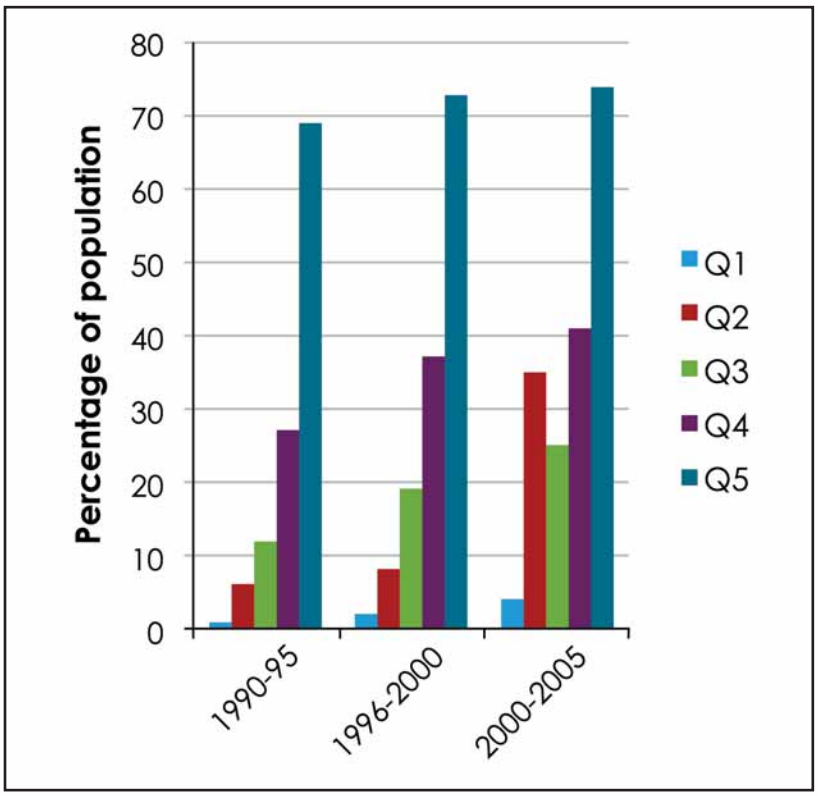


Figure 4: Trends in access to electricity 1990-2005 by income group (Q1 is the lowest income group and Q5 is the highest income group)[10] (adapted)

Addressing electricity access

All ASADI countries are working towards electrification targets (Table 2). Only Ghana and South Africa are aiming at universal electrification. In South Africa, only 36 percent of the population had access to electricity in 1995. The new democratic government implemented a successful electrification programme [see Box 4] and by 2008 the figure had risen to 75 percent. Mauritius has already achieved universal electricity access at over 99 percent.

Table 2: Electricity targets of countries in sub-Saharan Africa[2]

	Electricity access 2008	*Electricity targets*	*Year*
Cameroon	29	70	2015
Ghana	54	100	2020
Kenya	15	40	2020
Mauritius	99	-	-
Mozambique	12	20	2020
Nigeria	47	60	2020
Senegal	42	66	2015
South Africa	75	100	2012
Uganda	9	23	2010

Improving performance of the inefficient power sector

There are four policy areas where performance needs to be improved to improve access to electricity in SSA:

- *Reforming state-owned enterprises*

  State-owned power utilities are still dominant in SSA. There is an urgent need for them to undergo governance reform as they are not performing well.

- *Revitalising private sector participation*

  Increasing private sector investment in the power sector is vital. There are more than 40 Independent Power Producers (IPPs) across Africa that produce a total of 8 000 MW of power.[3] Further small IPPs must be encouraged to connect to the grid.

- *Targeting electrification*

  The most effective way to increase electrification is to connect densely populated urban areas first and then rural growth centres where demand is expected to increase. In these areas national grid electrification tends to be more effective and less expensive than off-grid or mini-grid systems that often use other technologies. Mini-grids are more cost effective in remote rural areas which are far away from the nearest grid points.

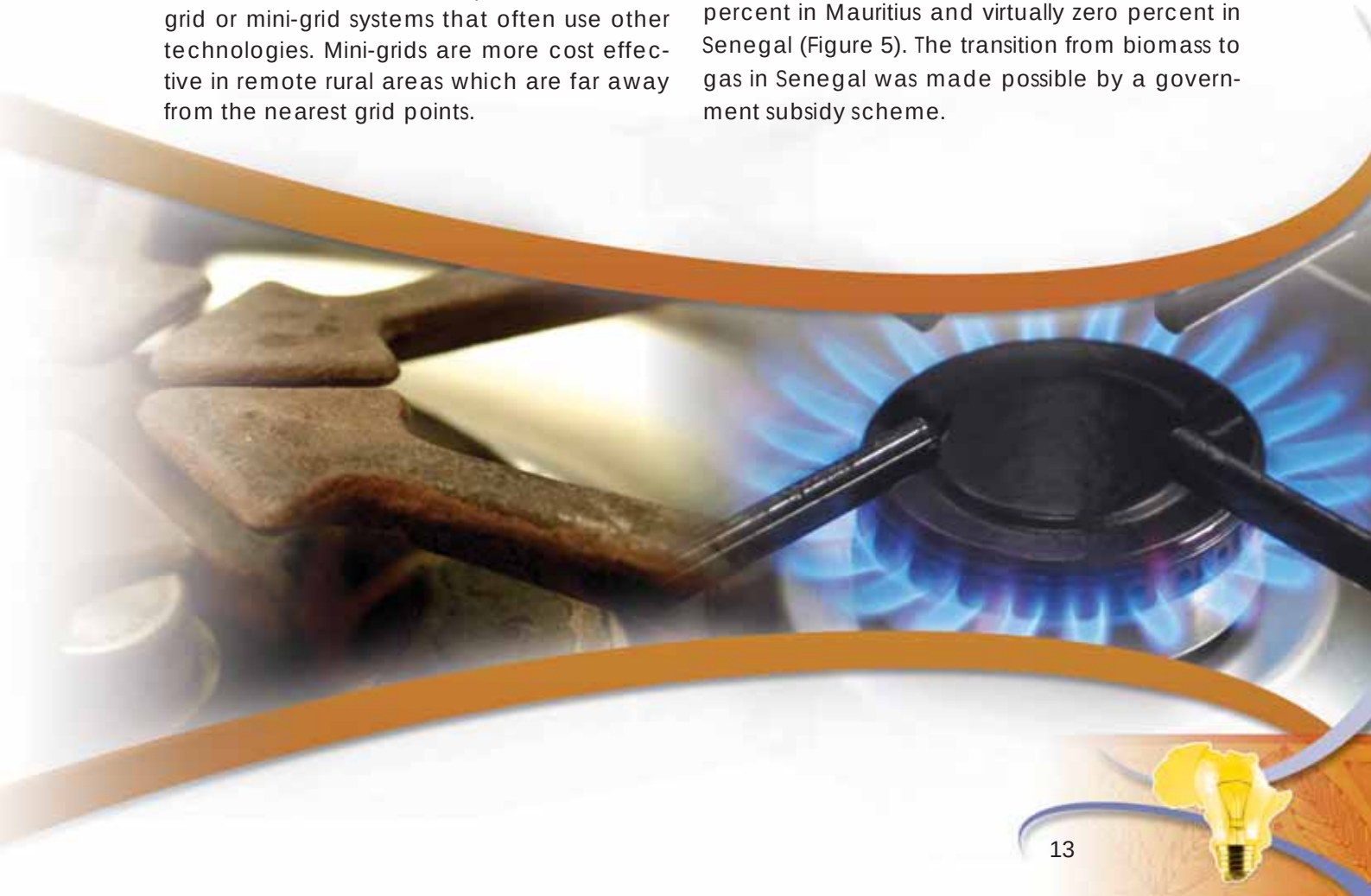
- *Potential for increased power trade*

  Expanded regional electricity trade, in which electricity is generated in countries with relatively low costs of production from large hydro, gas and geothermal schemes, and transmitted to countries where power is more expensive, would expand access to electricity.

4.2 Liquid petroleum gas (LPG), natural gas and kerosene

Both liquid petroleum gas (LPG) and natural gas are major cooking fuels in Africa. Kerosene is a relatively minor fuel and often regarded as a transition fuel (Figure 5).

Countries promote different modern cooking fuels depending on the availability of local resources. In South Africa, 66 percent of the population cooks with electricity, although this may change due to the recent increases in electricity tariffs. The situation in Zimbabwe is similar and almost all people who have access to electricity cook with it. In Senegal and Mauritius, 41 percent and 91 percent respectively of the people use gas for cooking because it is cheaper than electricity. Corresponding figures for the use of electricity for cooking are 2 percent in Mauritius and virtually zero percent in Senegal (Figure 5). The transition from biomass to gas in Senegal was made possible by a government subsidy scheme.



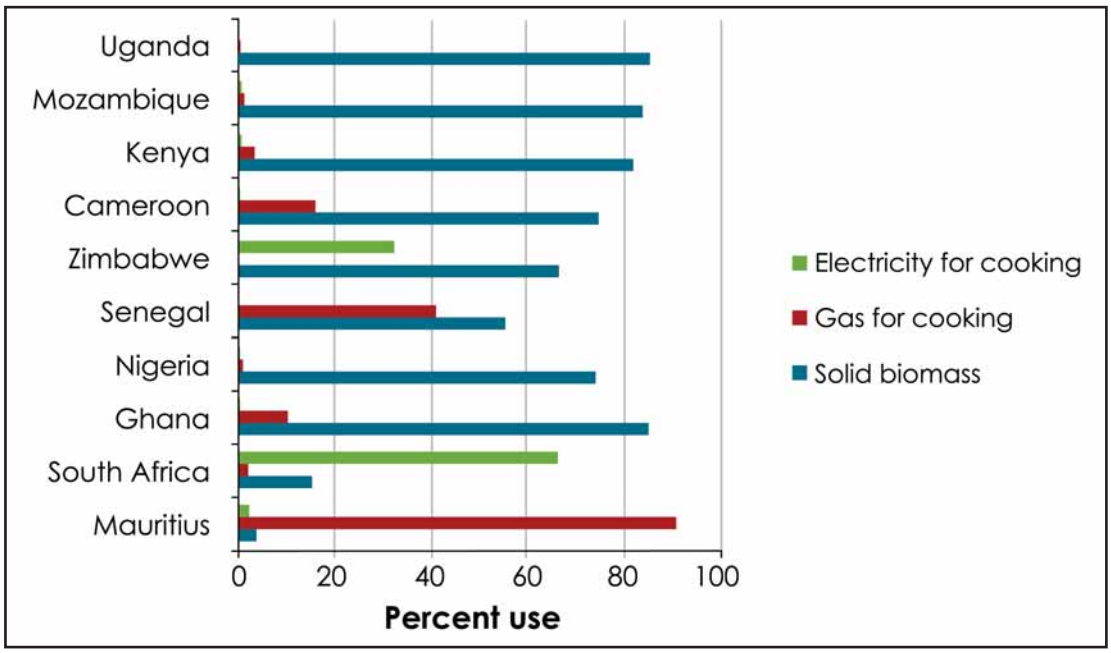


Figure 5: Electricity, gas and biomass use for cooking[2]
(The data were collected at different times ranging from 2003 and 2007.)

Key Messages

- *State-owned power utilities must undergo governance reform*
- *Private sector investment in the power sector must be encouraged*
- *National grid electrification is the most cost-effective way of increasing access to electricity in densely populated areas*
- *Cross-border trade in electricity must be promoted*
- *Government subsidies will be required to accelerate the transition to clean cooking fuels*

5. Traditional biomass

In SSA, over 80 percent of people still use traditional biomass for cooking. Even in urban areas, nearly 60 percent of the population relies on biomass fuels[1]. Most biomass used is wood but also includes dung and agricultural residues. Biomass is also widely used in the industrial and commercial sector, for example for brick-making, tea-curing and fish-drying.

In the short- to medium-term, many parts of SSA will still have to rely on fuelwood for cooking. Biomass fuels are the preferred fuel of the poor as they can be gathered free of charge, usually from nearby sources. In many SSA countries, an informal fuelwood industry and market has evolved employing thousands of rural poor as woodcutters, charcoal makers, transporters and sellers along the fuelwood value chain.

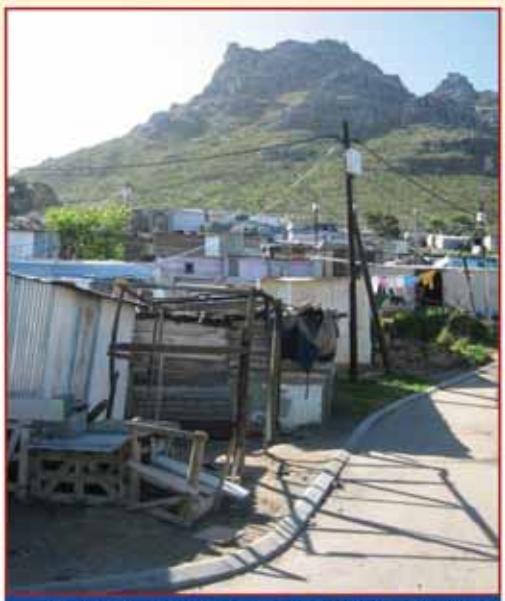
The transition from using only biomass to almost exclusive use of modern cleaner energy sources is a gradual process. However, there are many reasons for accelerating this transition process. Gathering wood is time-consuming and is predominantly the responsibility of women and girls, reducing their time spent in productive activities and school attendance respectively. The health impacts of solid biomass burning are well known and are widely reported (Table 3). The share of the national burden of disease attributable to using fuelwood ranges from 5.5 percent in Cameroon to 3.8 percent in Nigeria and 2.4 percent in Mozambique[8]. By improving fuelwood stoves, harmful emissions can be minimised.

Box 4: The South African National Electrification Programme and Free Basic Electricity

South African National Electrification Programme (NEP) and Free Basic Electricity (FBE)

Through the government's National Electrification Programme (NEP), electricity connections in South Africa grew from 36 percent of households in 1995 to over 70 percent in 2008. Electricity to low-income households is subsidised, making access more affordable for the poor. This blanket roll-out, in which whole areas are provided with electricity supply so all potential customers are served, not only customers applying and paying, significantly reduces cost. Technological innovations such as prepayment meters further reduce costs.

While the NEP facilitated access to electricity, this did not mean that the poor could fully benefit from being connected. Often they could not afford to use the electricity and consumption rates among the newly connected households remained very low. In 2003, the government introduced the Free Basic Electricity tariff (FBE) so that the poor can benefit from the huge investments in national electrification.



Imizamo Yethu, a peri-urban township of Cape Town with municipal electricity connections

How does the subsidised connection work?

An example from Cape Town, July 2010

The municipality of Cape Town charges ZAR 225 (approximately US$29) for a subsidised connection of 40 ampere to recognised areas of informal housing. If the new customers cannot pay the connection fee upfront, the amount is charged to their prepayment account and deducted gradually each time an electricity purchase is made at a rate of 20 percent of the purchase. No interest is charged on the advanced connection fee. If customers use less than 450kWh per month they are eligible for a lifeline tariff divided into three blocks. The first block up to 50kWh per month is free, the second block from 50 to 150 kWh is charged at ZAR 58.11 cents per kWh, and the third block from 150 to 450 kWh is charged at ZAR 70.47 cents per kWh. This compares to the domestic consumption tariff without subsidy of ZAR 93.32 cents per kWh.

Houses on land not zoned for settlement

Why are some excluded from subsidised access?

Informal houses built on land not approved for electrification (flood plains, road reserves, power-line servitudes, private land, etc.) cannot get a metered electricity connection and have to rely on extension cords to neighbouring houses that are metered. This generally costs twice as much as electricity from metered access.

Table 3: Annual numbers of deaths for various diseases attributable to biomass and coal[2]

Country	*Pneumonia*	*Chronic obstructive pulmonary disease*	*All deaths*
	Children < 5years	*Adults > 30 years*	
Cameroon	9 900	1 500	11 400
Ghana	7 800	1 800	9 600
Kenya	12 500	1 700	14 200
Mauritius	-	-	-
Mozambique	9 700	1 400	11 100
Nigeria	85 600	9 600	95 200
Senegal	5 400	900	6 300
South Africa	1 200	1 900	3 200
Uganda	17 900	1 800	19 800
Zimbabwe	2 900	1 000	3 900

Community-based woodfuel production (CBWP) has proved to be a successful strategy in many SSA countries (for example, Madagascar, Mali, Niger, Senegal). CBWP is based on the concept of decentralising forest management from exclusive government control to the local level and empowering communities to manage their nearby forest resources sustainably. Since the woodfuel prices are generally too low to recover investments in forest management, all products of the natural forest value chain (for example, fruits, nuts, forage, resins, honey and medicinal plants) are developed to increase revenue.

CBWP provides evidence that sustainable production can be achieved. In Niger, 830 000 ha and in Senegal, 315 000 ha are presently under community forest management and these areas have registered a considerable annual increase in forest stock after local communities took over the management of their forest resources[11].

One of the major weaknesses of the CBWP is that, thus far, it depends entirely on external assistance, but it is an option worth exploring to better manage natural resources.

Key Messages

- *Policy-makers can prevent thousands of deaths by making modern fuels accessible and disseminating improved cook stoves*

6. Renewable energy potential

Africa has huge renewable energy potential in the form of hydro, solar, wind, geothermal and biomass, most of which has not been exploited. It is estimated that Africa has over 1 GW of hydropower and that less than 10 percent has been harnessed[12]. Many countries in eastern and southern Africa depend heavily on large hydropower schemes, however, in view of difficulties with large-scale hydro schemes, such as siting, siltation and financing, many countries are favouring small (<10 MW) hydropower schemes. The technology is well developed and small-scale hydro is ideally suited to applications in rural areas.

There is approximately 9 000 MW of geothermal energy in Africa, of which only small amounts have been harnessed in East Africa[12]. Utilisation of geothermal energy, together with exploitation of Africa's abundant solar energy and biofuel energy are priority areas of the New Partnership for Africa's Development (NEPAD) Energy Programme.

Renewable energy is suited to generating electricity to feed into the national grid in order to reduce a nation's dependency on polluting fossil fuel sources, as well as mini-grids or small stand-alone systems that can meet the electricity demands of remote rural communities more cost effectively than grid extension.

Key Messages

- *Policy-makers should develop policies and guidelines to facilitate the integration of renewable energy into the national energy mix and into rural electrification plans*
- *Policy-makers should set targets for renewable energy and promote the implementation of specific renewable energy projects*
- *Policy-makers must commit funds and other resources to advance national renewable energy goals and objectives*

7. Energy interventions that have worked in Africa

There are many success stories in Africa that offer simple solutions to overcoming barriers, and improving access to energy and quality of life.

7.1 Local financing

Kenya presents a good example of how finance for improving energy access can be raised locally. Kenya's electricity company successfully raised substantial investments through a public offer on the Nairobi Stock Exchange [see Box 5], demonstrating that the African public is prepared to invest in the utilities it trusts.

Box 5: Case study of local financing: Kenya Electricity Generating Company[13]

Kenya Electricity Generating Company (KenGen) is a public limited liability company wholly owned by the government of Kenya. Its principal activity is to generate and sell electricity to the country's power utility, Kenya Power & Lighting Company.

In 2006, KenGen raised substantial investment finance through the issue of an Initial Public Offer (IPO) on the Nairobi Stock Exchange (NSE). The government of Kenya offered 659.5 million of its shares in KenGen to the public. The shares were priced at Kshs. 11.90 (US$ 0.17), with the minimum number of shares set at 500 shares (additional shares could be applied for in multiples of 100 shares).

The offer shares were divided into two categories:

Pool	*% Offer*	*No of shares offered*
Pool A – KenGen employees	5	32 975 422
Pool B – Other citizens	95	626 533 015
Total		659 508 437

The IPO attracted wide interest and was an unexpected success. The electricity company exceeded the targeted amount (over US$ 112 million), and the share offer was oversubscribed by nearly double this amount.

Some of the factors that made the KenGen IPO successful include the following:

1. ***Attractive & affordable pricing:*** At the price of Kshs 11.90 (US$0.17), KenGen was one of the cheapest and most affordable stocks on offer in the market to retail investors.

2. ***Dominant market position:*** KenGen is by far the largest power producer in the country, commanding an 80% market share of the Kenya electricity generating market. Many retail investors considered ownership of KenGen a sound addition to their investment portfolio.

3. ***High trading & market liquidity:*** KenGen's free float of 659.5 million shares was the largest at the NSE, providing an opportunity for a large number of retail investors to take up the stocks.

Key Messages

- Local funding is an untapped funding source in many African countries
- Policy-makers must ensure that the energy sector has the leadership and capacity to plan and attract investment-worthy projects

7.2 Improved cook stoves

In poor households, most energy is used for cooking. The most common cooking fuel in SSA is fuelwood. Although it is desirable to transition to more efficient cooking fuels, such as gas and electricity, where this is not yet possible for reasons of affordability or access, improved cook stoves which use less fuelwood, reduce indoor air pollution and improve combustion efficiency, are an important intervention. Improved cook stoves have been manufactured and distributed in many countries in eastern and southern Africa. The most successful stove programme is the ceramic jiko in Kenya [see Box 6].

Box 6: Case study of the Kenya Ceramic Jiko improved cook stove[13]

The Kenya Ceramic Jiko (KCJ) is one of the most successful improved cook-stove projects in Africa. The development of the KCJ was a combination of local input and international agency involvement. The KCJ is made of a metal cladding with a wide base and a ceramic liner and is suitable for cooking and space heating. The KCJ helps

- to direct 25-40 percent of the heat from the fire to the cooking pot as compared to 15-20 percent of the traditional metal stove and 10 percent in an open fire[14];
- to reduce fuel use by 30 – 50%;
- to save money. In sample households this amounted to a cash savings of over US$ 60/year.

Under proper use and maintenance, the KCJ reduces emissions of products of incomplete combustion which contribute to the development of acute respiratory infections.

The Kenyan government supported the stove production by de-regulation at the micro-level, allowing the informal sector to develop and market the stove. It reduced taxes and made licensing easier. Over time, continued research, feedback from users and competition from an increasing number of manufacturers improved the quality of the stove. The wholesale and retail network for stoves has extended to many other African countries and in Kenya the price has decreased from an initial US$15 per stove to about US$2 depending on stove size, design and quality. At this price, the stove is accessible to the majority of the urban population. The use of the stove in Kenya's two main towns (Nairobi and Mombasa) is very high, at over 80 percent.

The manufacture of the KCJ is now a relatively mature cottage industry in Kenya and in other countries in the region. As expected, the level of specialisation in the manufacture of the stove has increased, as has the level of mechanisation. There are now more than 200 businesses, artisans and micro-enterprises involved in the KCJ industry in Kenya alone. The KCJ industry has been particularly successful in providing employment for women.

Key Messages

- *Reliance on traditional biomass cooking fuels will continue in the short term in many countries in SSA and hence improved cook stoves should be promoted*
- *Policy-makers must adopt policies and strategies that support market mechanisms to develop and disseminate improved cook stoves*

7.3 Integrated energy provision

In many SSA countries, space heating is needed in cold winters. Most poor people cook indoors during that time to warm the house at the same time. This practice spreads pollution from the cooking fire through the entire house and affects the health of all family members.

In the urban Kuyasa project in Cape Town [see Box 7], the thermal insulation of low-income houses was improved by fitting ceilings. This led to the decreased use of kerosene for heating and improved indoor air quality. In addition, solar water heaters were installed and incandescent light bulbs were replaced by energy-efficient compact fluorescent light bulbs.

Box 7: Kuyasa Project in Cape Town, South Africa[15,16]

The Kuyasa Clean Development Mechanism (CDM) Project provides solar water heaters, insulating ceiling boards, upgrading of internal electrical wiring and the exchange of conventional light bulbs for energy-efficient compact fluorescent light bulbs (CFLs) in 2 309 low-income houses in Khayelitsha, in Cape Town.

One person from each household has been given the opportunity to participate in a four-day training programme on life skills, gardening, banking and renewable energy. In addition, over 80 local residents of the community have been trained and employed as carpenters, electricians and plumbers. Employment was focused on including women, people with special needs and young people under the age of 25.

There is a 56 percent decrease in the number of households spending more than R100 (approximately US$14) per month on electricity and the number of households spending more than this amount on space heating has halved. Indoor air quality has improved and the use of kerosene for heating has decreased.

The project is the first African project registered under the CDM and was awarded the Gold Standard for projects with exceptionally high social benefits.

The project is funded by the national Department of Water and Environmental Affairs, the Western Cape Provincial Department of Housing and is part of the national government's Expanded Public Works Programme. The additional potential income generated through selling certified emission reductions (CERs) on the carbon market is intended for monitoring and maintenance of the installations. Part of the business model is a monthly contribution from the households; currently, ways of collecting this fee are being worked out.

Source: Gisela Prasad

Key Messages

- *The Clean Development Mechanism offers many opportunities for energy applications in SSA and should be more widely used*
- *Integrated energy solutions offer cost-effective approaches*

7.4 Mechanical power applications

The use of mechanical power has not received the attention it deserves in SSA, where much of the work in agriculture and other areas is still done by human labour. Mechanical power is a key determinant of development and has shaped the rate of advance in developed countries since the industrial revolution. Basic mechanical power could improve many agricultural activities such as ploughing, seeding, harvesting, irrigation, water-pumping, food and agricultural processing and many activities in the household, including milling and grinding.

There have been many successful applications of mechanical power in Africa, for example wind and solar pumps to lift water to the surface, and the multifunctional platform that has raised productivity in rural Mali and neighbouring countries. The multifunctional platform consists of a diesel engine with attachments for grinding mills, battery chargers, electric water pumps, vegetable or nut oil presses, welding machines and carpentry tools[17]. However, such initiatives are often limited to projects funded by development assistance. They are rarely taken up by national policies and funded and implemented by national and local government bodies.

Key Messages

- *The role of mechanical power in enhancing agricultural productivity and development must be recognised*
- *Policy-makers must develop strategies to disseminate mechanical power to farmers to boost agricultural productivity*

8. Increasing energy access and climate change

The need for universal access to clean energy was one of the key messages to emerge from the climate change talks held in Copenhagen in December 2009. Climate change policies will only work if clean energy technology transfer is extended rapidly to developing countries and particularly to poor communities.

As more people gain access to electricity, greenhouse gas (GHG) emissions, the drivers of climate change, will increase if fossil fuels continue to form the dominant source of transport energy and increased electricity generation capacity. The challenge for Africa is to increase energy access, whilst simultaneously ensuring that increased electricity generation capacity does not dramatically increase GHG emissions. Renewable energy technologies implemented in developing countries offer the opportunity to leapfrog the conventional polluting industrial development path based on fossil fuels. At present, electricity production from renewable sources is still under-utilised in SSA.

Africa is 'one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity'[18]. Major resources will be required to adapt to the impacts of climate change, some of which are longer dry periods, erratic rainfall, decreased growing seasons, sea level rise and coastal flooding[18]. The mitigation instrument, the Clean Development Mechanism (CDM), introduced to support developed countries in fulfilling their emission reduction targets and to assist the developing countries in achieving their sustainable development goals, presents an under-utilised opportunity for African countries. To date, Africa as a whole, has only 141 registered projects. South Africa has 36 projects and Morocco 14 projects[19].

The Kuyasa Project [see Box 7] in which solar water heaters, insulated ceilings and compact fluorescent lights is one of the well-known CDM examples from South Africa[16]. The low number of projects in African countries is a result of barriers related to the unattractive general investment climate, the low level of industrialisation of many countries, and the lack of CDM capacity in institutions[20].

In addition, multilateral and bilateral agencies fund many adaptation programmes and provide mitigation interventions and substitute or avoid fossil fuel-based energy sources. For example, a wind power development project in the water-stressed Temaruru and Dumbamwe regions in Zimbabwe is contributing to climate change adaptation through providing farmers with energy for water-pumping. In Hunguana, in southern Mozambique, a clean water and energy project is using a photovoltaic solar water-pumping system to improve the water supply coverage for rural communities. A Senagalese photovoltaic solar energy project brought electricity to three villages which has decreased emigration and, through the use of solar-powered pumps, kept cattle at one location, making dung collection for fertilisers possible[21].

Key Messages

- *Policy-makers should push more strongly in the climate change negotiations for international financing and support enabling them to develop low-carbon economies*
- *Policy-makers need to engage with the Clean Development Mechanism to finance clean energy development*

9. Turning science on!

Many of the major challenges facing policy-makers in their quest to improve energy access are science challenges or at least they are amenable to scientific expertise. Science academies can assist their national governments to address energy access issues in at least seven ways.

- *They can convene groups of experts to brainstorm on key scientific and policy challenges and implementation barriers and evaluate policy choices*
- *They can inform policy-makers of the role (and constraints) of science*
- *They can help highlight best-practice examples and promote information exchange*
- *They can identify research gaps, encourage high-quality research and encourage investment in research and research capacity*
- *They can translate scientific research into policy recommendations*
- *They can monitor investments by governments and track resources in order to influence policy changes*
- *They can review the state of public and private research infrastructure and advise national governments on whether they need to invest more in basic science and training in order to build additional research capacity*

10. Conclusions

Energy access is central to human development and poverty reduction. Access to modern energy services in SSA is lagging behind other developing regions. The region has one of the world's lowest electrification rates and the highest share of fuelwood users.

Political will and enabling policies and regulations are important in implementing universal access to modern energy services. Some countries have reached high rates of access supported by enabling policies. Scientific solutions to many of these problems already exist. However, policy-makers must create an attractive business climate, support market mechanisms and facilitate access to credit so that the private sector invests in the energy sector. Policy-makers can learn from energy success stories in Africa and in other regions to improve access to modern energy services.

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