Directing climate finance to improve energy access in Sub-Saharan Africa

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Paper presented at the Conference
"IMPROVING ENERGY ACCESS
THROUGH CLIMATE FINANCE:
PICKING THE WINNERS"

26 – 28 March 2013, Twente

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Abstract

Two main challenges to create a sustainable and equitable future are formed by the need to ensure universal access to energy to the population groups that currently lack them and, second, the need for more climate-friendly energy supply and use. Over 1.3 billion people are without electricity and about 2.7 billion are without clean cooking facilities, of which 585 million and 653 million in sub-Saharan Africa respectively. To achieve universal modern energy access by 2030, capital investments of about USD 45-50 billion per year would be needed up to 2030, of which about USD 24 billion per year for sub-Saharan Africa. This is an ambitious goal, but not insurmountable.

The strategies of development agencies and governments should focus on energy access as a full global issue with appropriate funding channels. Achieving universal modern energy access will require a substantial increase in financing from all major existing sources, i.e. from governments in developing countries, including utilities, private sector and bilateral and multilateral ODA. This will include directing resources from the climate change financial mechanisms.

Considerable global funding has been channelled into renewable or low-carbon technologies through carbon markets (such as the Clean Development Mechanism) and through donor arrangements, including the Global Environment Facility. None of these mechanisms have contributed greatly up to now to energy access, as their focus has more been on markets or technologies that will deliver substantial greenhouse gas emission reduction.

Africa has a unique opportunity as nearly two-thirds of the additional capacity needed in 2030 has yet to be built. The continent could benefit from its vast untapped renewable energy resources and from recent progress and cost reduction in renewable energy generation technologies. For example, only 10-20% of the economic potential of hydropower has been tapped. Many countries have great potential for large and small hydropower.

However, renewable energy technologies alone will not meet Africa's energy challenge. To deliver access to modern energy will require a full range of energy options including grid energy, supplemented by decentralized (mini-grid and off-grid) solutions in rural areas and remote towns, both with renewable energy technologies and with options based on fossil fuels together with increased energy efficiency. Thus, energy access financing should allow for making the full range of energy options available; i.e. not subjected to screening with regards to climate change only, but considering criteria of equitable access, poverty alleviation, cost of technology and availability of local equipment and after-sales service providers.

The public sector will remain important as the main source of financing. Here, governments need to take responsibility, by having specific grid-based and off-grid policies for improving levels of energy services that are well integrated in national and rural development programmes and by eliminating the financing gaps in the energy sector. The magnitude of investment needed is such that public-private partnerships are needed, but the business environment and policy framework will have to be sufficiently robust to attract private investment and viable business models need to be developed.

With examples from small hydropower and other renewable energy sources, the paper will illustrate the above issues and highlighting the role of local communities, private sector, NGOs, government and climate funding.

Modern energy access

Energy is a basic need. Access to the right energy fuels and services provides opportunities for development and improved well-being. Access to fundamental energy services such as cooking, heating and lighting are essential for survival. Basic energy needs include the above functions and, in addition, provide basic services (health, education, communication, and others) and for basic productive uses.

In an energy poverty situation, these needs are met by inefficient devices using a diversity of solid biomass products, supplemented with candles and kerosene for lighting, but with no access to modern energy sources, such as electricity or gas. Access to modern energy sources allows providing the basic energy services. Energy access is a crucial input to a wide range of productive and income-generating activities. Few enterprises of any scale can operate without a supply of electricity, fuel or mechanical power with which to produce the energy services needed in appliances and processing equipment, from boilers to computers.

Globally over 1.3 billion people are without access to electricity and 2.7 billion people are without clean cooking facilities (IEA, 2011). The situation in Sub-Saharan Africa is of particular concern[2]. The region has the lowest rates of electrification and access to modern cooking fuels in the world at 26% and 22% respectively, implying that 585 million people have no access to electricity and 653 million people no access to modern fuels (see Exhibit 1). About 56% of total energy use in Sub-Saharan Africa comes from traditional biomass. If current trends would continue, in 2030 there would still be 655 million in Africa without access to electricity (42% of the population) and 855 million people without access to clean cooking facilities (IRENA, 2013b)

Such figures should be treated with some caution, as there is no universally agreed consensus what 'energy access' means. The United Nations report on 'Energy for the Sustainable Future' (AGECC, 2010) defines universal energy access as "access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses". The World Energy Outlook reports of the International Energy Agency (see IEA, 2010 and IEA, 2011) define modern energy access as "a household having reliable and affordable energy access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time to reach the regional average". While definitions may differ, the order of magnitude the figures imply does not.

Similarly, the threshold level of electricity consumption to escape the energy poverty trap is defined differently. The IEA report mentions 250 and 500 kilowatt-hours (kWh) per year for rural and urban households respectively to power at least a fan and a few light bulbs and some appliances, such as a TV or small refrigerator. Regarding cooking fuels, literature shows that the amount of clean cooking fuel required to displace these solid fuels is modest and is estimated to be about 35 kg of liquid petroleum gas (LPG) per person per year[3].

From the above figures, the present electricity requirement to provide this service to the 585 million without electricity in Sub-Saharan African countries amounts to 70.2 billion kWh per year. This represents only 0.4% of the total electricity consumed worldwide (16,378 billion kWh)[4], however

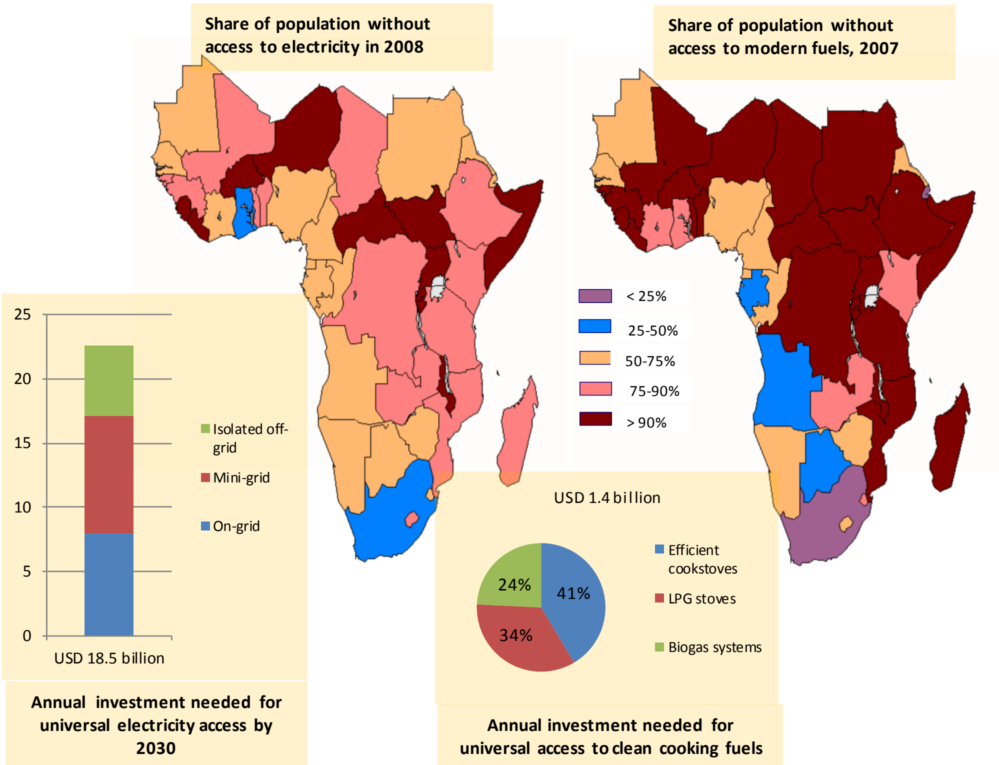
[2] Worldwide, electrification was 78.2% in 2008, in OECD countries and economies in transition, 99.8%. The average electrification rate in developing countries was 72%, but only 26% in Sub-Saharan Africa. Source: IEA (2009), UNDP (2009)

[3] www.iiiee.lu.se/publication.nsf/c05cf705a5648c8c1256b4a004a5a9f/6848cd20ca737308c1256f1f0043ac2/ $FILE/Goldemberg%20et%20al.pdf, quoted in Sanchez (2011)

[4] www.eia.doe.gov/iea/elec.html, mentioned in Sanchez (2011)

comparing this with the total consumption in Africa the requirement is significant (12.8%). Similarly, the requirements of modern fuels for cooking (assuming that 90% of the population that presently cook with solid biomass switch to LPG); will be 29.4 million tons of LPG, which is about 13% of the total consumption of LPG worldwide (In 2006 the total consumption of LPG worldwide was 223 million tons)[5].

Exhibit 1 Share of people without modern energy access in Sub-Saharan Africa and annual investment needed 2010-2030 to achieve universal energy



Source: Based on publications by IEA (2011) and UNDP (2009). Total annual investment needed in Sub-Saharan Africa is about USD 24 billion a year over 2010-2030 to achieve universal energy access (IEA website, World Energy Outlook

The UN declared 2012 the 'Year of Sustainable Energy for All' and has set the target of 'universal access to modern energy services by 2030'. Achieving universal energy access is an ambitious goal. Ensuring universal access to modern energy services will thus involve providing new electricity connections to around 400 million households by 2030, and modern fuels and technologies to 700 to 800 million households over the same period. To achieve universal modern energy access by 2030, capital investments of about USD 48 billion per year would be needed up to 2030. This amount is more than 5 times the estimated level of actual investment in energy access in 2009[6]; a staggering amount of money, but it would be equal to 3% global investment in energy infrastructure over the period to 2030 (IEA, 2011) and 10% of the global investment in energy in 2009.

Almost 60% of additional investment needed over 2010-2030 would be needed in Sub-Saharan Africa, i.e. about USD 24 billion per year, of which USD 22.6 for electricity access and USD 1.4 billion

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5 www.worldlpgas.com/page_attachments/0000/0330/Petroleum_Economist, referred to in Sanchez (2011)

6 According to IEA (2011) the capital investment incurred globally in 2009 was USD 9.1 billion, providing 20 million people with access to electricity and 7 million people with advanced cookstoves. This investment came from bilateral ODA (14%), multilateral organisations (34%), developing country governments (30%) and private sector finance (20%).

for access to cleaner cooking fuels (see Exhibit 1). The IEA has calculated these figures, using a combination of on-grid, mini-grid and isolated off-grid solutions to provide electricity access and a mix of improved biomass cookstoves, LPG stoves and biogas systems to provide access to clean cooking facilities.

The paper investigates the ability of Africa to reach universal access to modern energy carriers for all and the potential to use its vast renewable resources of energy. This would be an unprecedented achievement and will not happen by itself. It can only be made possible by a concerted effort by national and international policy makers to develop enabling frameworks to spur both public and private investment in both conventional and non-conventional energy options and in both grid electricity and decentralised options through regional cooperation and sound policies. These policies must address the current large funding gap. The paper further looks into the role of climate financing is currently playing and how can be re-directed better to help cover the funding, and better address the energy needs of the poor.

Exhibit 2 Transforming traditional biomass use Kenya

Fuel-wood and charcoal markets are well established throughout sub-Saharan Africa, mostly in the informal sector. In spite of its grey market status, the Kenyan charcoal industry produces 1.6 million tonnes of charcoal per year, equivalent (by weight) to one third of Kenya's sugarcane production. The annual income from charcoal is around USD 400 million, almost equivalent to the income generated from Kenya's tea industry. Improving the energy conversion efficiency from fuel-wood into charcoal would increase sustainability by reducing the impact that the requirements for wood feedstock have on the environment. Roughly half as many trees are needed for the same amount of charcoal if an improved half-orange or other kiln, rather than a traditional earth kiln, is used.

The Kenya Ceramic Jiko (KCJ) is a portable charcoal stove now used in over 50% of all urban homes and 16% of rural homes in Kenya and its use is spreading to neighbouring African countries. With proper use and maintenance, the KCJ can reduce fuel consumption by 30-5%, saving the consumer money, reducing toxic gas and particulate matter and resulting in better overall heath for the user. Less charcoal use also means that less wood is burned to make charcoal and thus that fewer trees have to be cut down. The cost ranges between USD 2 and USD 10. With around three million KCJs in use in Kenya, KCJ production contributes significantly to employment in Kenya´s informal economy.

Improved charcoal production kiln
Kenyan charcoal stoves (below)
Photos and information taken from UNDP (2012).

Modern cooking facilities

For cooking the following options can be considered to improve energy access:

- **Improved cookstoves**

Improved cook stoves (ICS) offer a feasible alternative to traditional inefficient cooking facilities. These stoves double or triple the thermal efficiency of traditional fuels and reduce the harmful effects of poor ventilation. Efficient stoves are relatively inexpensive. A large number of models of efficient stoves have been tested and developed worldwide, but only a few have managed to reach commercial stage. This appears to be a consequence of poor or ill-conceived business concepts, or

Exhibit 3 LPG cooking in Sudan

High dependency on biomass fuels for household energy may cause serious health problems if cooking is indoors, especially for women and young children. Often, poor families keep using biomass and charcoal for cooking because they could not afford to purchase LPG cookers and canisters, despite the fact that there is a commercial supply of LPG. In Sudan, the government has implemented a number of policies and subsidies to encourage the increased use of LPG in the household sector. Cooking with charcoal and biomass is about three times the cost of cooking with LPG. Affordability of LPG cylinders and burners is a constraint; the cost range between USD 45-85.

www.carbonclear.com/static/Hedon_Sudan_article.pdf

In 2007 Practical Action started the implementation of a project with the objective of promoting the use of LPG among poor families in rural and peri-urban areas of Al Fasher. The project aims at facilitating 10,000 households to switch to LPG using a revolving fund and credit scheme, awareness raising among the population, ensure gas supply with LPG providers and provide training to different stakeholders on safety and standards in the use of LPG. Households should be able to repay the cost of appliances (cylinder, filled bottle and a plate to bake *kisra*, a thin sorghum pancake) in 6 months (Sanchez, 2010; Sanchez, 2012)

perhaps a misunderstanding of the requirements of the users or both[7]. There have been a few successful programmes, such as the Jiko stoves in Kenya (see Exhibit 2). Such programmes were developed with commercialization in mind from an early stage and there has been an important focus on market, replication, local mass production, low cost and efficiency.

- **Switch to liquid and gaseous fuels (fossil fuels and biofuels)**

Switching to kerosene and LPG for cooking is an important option, providing much more efficient use of energy than traditional biomass. The affordability and people's willingness to pay for modern fuels and technologies largely depends on whether and how much people currently pay for fuel. Many urban families have to buy wood or charcoal. LPG and its alternatives[8] will therefore often be viable in urban areas. In addition, the operational delivery of LPG-type solutions in urban areas is typically feasible because population densities and available infrastructure make distribution easier than in rural areas. The case from Sudan (see Exhibit 3) demonstrates that distribution challenges can be overcome, at the same time creating local jobs and livelihoods (e.g. local restaurants). In many cases modern fuels cost significantly more than people are currently paying or can afford. Often they do not have money to pay the upfront cost of the cookers (or cylinders in the case of LPG). Subsidies have been used in some cases to tackle affordability challenges (e.g., LPG programmes in Senegal). The challenge with subsidies is that they place a significant strain on government resources, and may be unaffordable in the longer run to the capital-constrained government of many least developed countries.

Electricity access options

The scale and nature of the access gap and locations involved means that electricity will need to be provided through both centralized and decentralized energy technologies and systems[9]:

[7] One reason is failure to deliver cooking devices that match social/cultural practices. Projects have often focused on 'giving away' stoves to potential users, without insufficient promotion, education, monitoring and follow-up and without addressing the development of the supply chain (manufacture, sell and maintain).

[8] Such as dimethyl ether (DME) and ethanol gel

[9] In the IEA (2011) scenarios to achieve global universal energy access by 2030, 100% of urban, but only 30% of rural population would be connected to grid electricity; the remainder are expected to be connected with decentralized systems (Practical Action, 2012)

Exhibit 4 South Africa's energy access for the poor

In 1994, electricity coverage reached only 30% of the South African population with rural areas standing at below 10%. To address this imbalance in energy access the post-Apartheid Government started the National Electrification Programme (NEP) and its implementation was mainly in the hands of the state utility ESKOM (which holds 96% of power generation, while distribution is shared between ESKOM and local utilities). By 2004, the national level of access of households had risen to around 73%, connecting about 4.7 million people, focusing on the huge (informal) urban settlements. Grid extension was 100% financed by the government though ESKOM. Cost analysis led the government to the conclusion that for remote area off-grid solutions were more cost effective to avoid excessive investment cost in grid and in future grid power generation expansion. In 1999 a process was initiated to award to private companies concessions to supply energy services to rural households outside the reach of the electricity grid using the fee-for-service (FFS) approach. The overall rate of installation was initially promising (in 1998/9) but later slowed down considerably. As of 2002 about 5,200 systems were installed against a target of 300,000 households (50,000 per concession) to be electrified over a period of 10 years. Major challenges inhibiting off-grid PV electrification include the issue of equipment ownership and the perception of photovoltaic electricity as being inferior to ESKOM's grid electricity.

National power demand increased from 22,600 MW in 1992 to 34,000 MW in 2004 (DME, 2006), almost 1,000 MW annually. Demand has raised much over the past decades, because of the continuation of strong economic growth that began in the 1990s as well as South Africa's large-scale NEP. However, capacity has not increased accordingly. The recent past has already witnessed the implication of power supply capacity shortage in the form of unprecedented load shedding, especially during times of scheduled maintenance of plants. By a mix of measures (returning to service mothballed coal plants, adding natural gas plants, power rationing and demand-side management) ESKOM tries to bring the system back in balance (Van den Akker and Mushamba, 2008).

- **Grid extension**

The extension of the existing power transmission and distribution infrastructure to connect communities is often the least-cost option in urban areas and in rural areas with high population densities. If pursued at the regional level, especially in Africa, it also offers the opportunity to tap into significant hydropower potential

- **Decentralised systems**

In a *mini-grid***,** a local community or communities are linked to a small, central generating capacity, typically located in or close to the community. The power demand points are linked together in a small, low-voltage grid that may also have multiple smaller generating sources. These can be powered by diesel generators, small-scale hydropower plant, wind generators, biomass technology (e.g., biogas or biomass burning and gasification). In *off-grid access***,** the generating capacity provides power for a single point of demand, for example for a household and/or small business, e.g. by provided by a solar home system (SHS) or pico-hydropower system.

In Africa, South Africa is a compelling example of successful large-scale grid extension. Existing over-capacity capacity and the good condition of the existing grid formed the basis for the national utility ESKOM to implement an intensive grid extension programme that achieved electrification of over 2.5 million households in less than seven years (see Exhibit 4). One environmental issue is that large-scale grid-based electrification programmes have historically utilized predominantly fossil fuel-based generating technologies. This was certainly the case in South Africa where electrification was based on the existing of coal-fired plants.

Exhibit 5 Rural electrification of Yei, Sudan

Source: NRECA; UNDP (2012)

Yei is a medium-sized South Sudanese market town near the borders of Uganda and the Democratic Republic of Congo. It was electrified with USAID funding in 2005-07, shortly after the end of the civil war, with 1.2 MW of diesel-based generation providing service to residential and 979 registered customers, of which 717 as commercial. This indicates that enterprises strongly value (and are able to pay for) the service in the town and demonstrates demonstrate the facilitative role that energy plays to support business development and enable economic and employment growth.

A survey organized by NRECA (National Rural Electric Cooperative Association, based in USA) among 150 commercial customers, showed that 63% were started during or after 2007. This reflects that Yei is local business hub, but also the facilitative role that energy plays to support business development and enable employment growth. (UNDP, 2012)

The levelised costs of decentralised power supply solutions relative to grid-based solutions depend on a number of factors, in particular on the capital cost of the generation technology and distance from the existing grid and the cost of fuel used and is linked with the level of demand (energy needs of communities to be electrified)[10]. The challenge In Africa will be that people who lack access will be more dispersed, more rural and having relatively low incomes[11]. Here, mini-grid and off-grid solutions may become be more attractive. First, they can often be deployed more rapidly than grid solutions[12]. Second, they do not rely on excess generation capacity in the main grid. Third, there is often a significant potential local business- building and job creation opportunities from these solutions (see Exhibit 5 and Exhibit 6). If available for productive use during non-peak hours in addition to the household use this will lower the unit cost per kWh.

Many mini-grid systems have failed, whether based on diesel or small-scale hydropower, not because the energy supply option was not technologically proven, but badly implemented. The key challenges related to both mini-grid and off-grid solutions include significant initial capital investments, the capabilities required to install and maintain these systems, and defining and implementing appropriate pricing systems. The long-term sustainability of mini-grid and off-grid programmes hinges on developing the capabilities of local participants and ensuring local supply chains (servicing, spare parts) are in place.

[10] According to a cost comparison by the World Bank, off-grid solutions have a levelised cost of electricity (LCOE) of USD 0.11-.60/kWh; mini-grids have a LCOE of USD 0.05-0.50/kWh and grid-connected power USD 0.04-0.15/kWh to which the cost of transmission and distribution (USD 0.05-0.10/kWh) must be added (ESMAP, 2007)

[11] In 2010, the Sub-Saharan population distribution was a s follows: megacities (14%), intermediate cities (10%), peri-urban cities (10%), rural hinterlands (50%) and remote rural areas (16%). Source: Foster and Briceño (2010), quoted in IRENA (2012). The same source mentions that urban population would rise by 20% by 2050, effectively more than doubling urban population

[12] In many cases, the grid may take one or more decades to arrive, but decentralised options can often be deployed more rapidly than grid solutions. In many cases, communities, if offered to choose between constant grid access in the future and the less-optimal solution providing more intermittent power much sooner may opt more intermittent access earlier

Exhibit 6 Power and telecomm in Africa

In 1999, only 10% of the African population had mobile phone coverage, primarily in northern and southern Africa. In 2009, 60 % of the population in Sub-Saharan Africa had mobile phone coverage, while only around a quarter had access to electricity. The mobile phone sector has been strongly linked with economic growth and local job creation. Apart from personal communications, mobile Internet services can be provided. For example, these can offer services to agricultural extension workers and farmers a quick access to up-to-date. Power reliability is a major factor in network performance; provision for redundancy or back-up to grid power supply is a requirement. These services are now increasingly provided by decentralised energy solutions, such as diesel generators inverter and battery back-up, and solar power systems. By harnessing the rapidly expanding infrastructure of mobile phone towers in Sub-Saharan Africa as an anchor demand and source of revenue, government could provide incentives for private investment and market demand for other services, such as connecting up rural communities to power that it already provided to base stations. Source: UNDP (2012) and http://www.esi-africa.com/node/15890.

Public phone booth in Zimbabwe, powered woth solar panels (left), battery banks for powering billing equipment and phones (right),

Basedon UNDP (2012)

For example, the subscriber base in Zimbabwe alone grew more than 300 percent, from just under two million in January 2009 to over six million in 2010 as business conditions improved. Zimbabwe's power generation is a long way off meeting the estimated peak demand of 2,500 MW. The country's power stations are generating under 900 MW with an additional 460 MW being imported. As a result of the power shortage there has been a proliferation of solar lanterns in the country, with over 400,000 households now owning solar lanterns from cellular and wireless telecommunications group Econet. The company also has the largest number of diesel generators operating in Zimbabwe and recently began replacing some of them with solar-powered systems.

Mechanical power and modern fuels

In many cases electricity is not the most urgent need, but some sort of power for a specific application or to drive an engine. Fossil fuels (e.g. gasoline, fuel oil or diesel) and renewable fuels (biodiesel and bio-ethanol) can be used to drive motors and engines for mobile and stationary shaft power directly. Mechanical power has been used for centuries for agro/food processing, water pumping and other productive uses, providing some of the most fundamental services required for poverty reduction and human development. Indeed, over the past century, technological advances have helped reduce the drudgery and increase the productivity of human labour through the widespread use of mechanical power. Nonetheless, mechanical power is often viewed however as being inferior to other forms of energy, such as electric motors. Mechanical power is critical to enhancing the productive use of labour in many ways, directly supporting core day-to-day activities such as transporting and lifting water, irrigating fields, processing crops into edible forms and many more. Often, small diesel (or gasoline) engines are used, as is the case in the multifunctional platforms in Mali (see Exhibit 7).

The contribution of biofuels in the global energy mix is small, about 0.3% of global final energy consumption (1.8% of transport fuels). Biofuels trigger polarised views among policy-makers and the public. Some see them as central in the fight against climate change; on marginal and degraded lands that cannot support agriculture in any case, they see great potential for biofuel crops, which require less water and nutrients. Africa's vast land resources could also make the continent a competitive exporter of biofuels, which could bring in money for the basic infrastructure needed to transport and

Exhibit 7 Multifunctional platforms

The concept of the multifunctional platform for rural energy access has been introduced in Mali in the first time by UNIDO in 1993 and UNDP from 1996 to 1998. The MFP typically has a 6-9 kW diesel engine, mounted on a chassis, to which can be added as many as 12 modular components in an integrated system that can supply a variety of services. A basic MFP costs about USD 4,000- 10,000, depending on the amount of modules attached. These include mechanical power for time-and labour-intensive work such as agricultural processing and carpentry, as well as electricity for battery charging, lighting (approximately 200–250 small bulbs), welding and other applications. About 1,300 platforms were installed by 2011 (UNDP, 2012)

The programme in Mali initially focussed on women´s associations. An estimated 10,000 women use the MFPs currently installed in Mali every day on a fee-for-service basis, while management and maintenance of the platforms there employ over 6,000. Mali. The concept has faced some drawbacks. Many village women groups experienced difficulties in management, leading to significant numbers (20-35%) that leave operations after some time. The MFP programme is now broadening into expanding into private ownership with a subsidy given by the government and/or loans by micro-finance institutions The initiative has caught attention. Burkina Faso initiated a similar programme in 2004 and is now aiming at having 400 MFPs installed and Senegal aims at 400 by 2010 and 1,000 by 2015. The initiative has expanded to other countries, such as Ghana and Tanzania, Source: UNDP (2012), WB-UNDP (2005) and Nygaard (2009)

MFP equipped with small electric generator and cereal grinding machine (left) and; Pharmacist using electricity to keep vaccines and medicine cold (right). Photos and info taken from UNDP (2012), draft version 2010.

process food. Others criticise them as a contributing to deforestation, a threat to food security and with small net climate benefits.

Energy efficiency

As part of the 'Sustainable Energy for All by 2030' initiative, the United Nations calls 'reduction of energy intensity' by 40% (AGECC, 2010). Energy efficiency is the key to driving the required incremental reduction in energy intensity[13]. Energy efficiency forms one of the few "no-regret" policies[14] that can offer a solution across challenges as diverse as climate change, energy security, industrial competitiveness, human welfare and economic development[15]. The UN calls for 'doubling the rate of improvement of energy efficiency' (UN, 2012). Capturing all cost-effective energy efficiency measures could reduce the growth in global energy consumption to 2030 from the 2,700-3,700 million tonnes of oil equivalent (Mtoe) forecast to 700-1700 Mtoe. The energy efficiency savings potential is split almost evenly between high-income countries and the rest of the world, mostly due to the retrofitting opportunities on the large existing stock of infrastructure in the developed world and the potential to reduce energy demand in middle-income developing countries (AGECC, 2011). Low-income countries, of which many located in Africa, represent a relatively small part of the absolute global energy efficiency potential, and may receive little attention. Nonetheless, there is huge untapped potential for improvements available in most countries across both *supply* and *demand*. A significant opportunity exists in the power sector in the developing world to improve

[13] Energy intensity is energy consumption over Gross Domestic Product (GDP)

[14] Meaning that net lifecycle cost (investment + annual benefits – annual costs) are negative, as shown in Exhibit 16

[15] Apart from energy efficiency, energy intensity of a country can be reduced by shifts in the economic structure of individual from high energy intensive activities such as manufacturing to low energy intensive activities (services) while maintaining total GDP

generation efficiency and reduce transmission and distribution losses, and thereby reduce the amount of primary energy (e.g., coal, gas, oil) consumed for the same output. Improving power sector efficiency is also directly linked to improving energy access, discussed above (see also Exhibit 4). This is especially important in many African countries, where there are already power supply shortages in many countries and that have significant capital constraints (reducing the total need for investment in new capacity and keeping energy costs lower). Energy efficiency allows lower energy consumption for the same end-use energy services (an overview of energy efficiency options is given in Exhibit 8), which lowers energy costs for consumers – industrial, commercial and residential. This leads to higher affordability, which is particularly important for low-income groups.

Exhibit 8 Options for demand energy efficiency in Africa

There is a huge cost-effective EE (energy efficiency) potential and great opportunities to save a bulk of energy and money in many areas (lighting, ventilation, cooling, buildings heating, pump systems, appliances and equipment, transportation, electric motors, power plants boilers, etc.). Although high EE products already exist in or are entering the market, they are not yet deployed and disseminated at the scale they should be:

- **Lighting** is a substantial energy use in Africa, and also the most common experiment realized by the African countries, in terms of energy savings. This may be justified because measures on lighting are an easy cost-effective tool for achieving energy savings and lighting can represent up to 20 - 30% or more of the total electricity consumption in African countries. For example, promotion and diffusion of compact fluorescent lamps (CFLs) to replace existing incandescent lamps have been implemented in various countries (Ghana:6 million CFLs since 2007; South Africa: more than 18 million CFLs since 2004; Uganda: 800,000) or are being implemented (countries such as Nigeria, Kenya, Rwanda Uganda have plans for 0.5-1.5 million). Source: ESMAP (2009); UNEP (2012);
- For African households with electricity access, electric appliances, such as refrigerators and TV can represent more than 60% of their electricity consumption. Important are **EE standards and labelling** (S&L). For example, Ghana has mandatory S&L for CFLs, room air conditioners and refrigerators (since 2008/9), while Nigeria and South Africa have S&L programmes under development (www.clasponline.org);
- Promotion of **solar water heaters**. For example, South Africa: solar water heaters are initially promoted by ESKOM, but Government is now considering the establishment of a national strategic framework to all interested stakeholders in order to develop a large national programme of SWH with national targets (see also Exhibit 4);
- Regarding **buildings**, the location, surroundings, architectural design, materials and efficient management can bring substantial energy savings. For Africa, although EE may be difficult to handle in the building sector in general, due to a prominent stock of ancient buildings with poor quality of construction and low standards, there is yet substantial potential of savings mainly in the new buildings and dwellings, by introducing measures such as buildings codes and energy audits of large buildings;
- Few policy measures and regulations have been implemented so far in the **industry and** SMEs sectors of a few countries, although the potential of savings is immense throughout Africa. The most common successful measures are energy audit and savings programmes, development of energy management & operation capabilities and improving industrial processes;
- EE improvements in the African **transport** sector include labelling for new vehicles, restricting import of old inefficient vehicles (e.g. Senegal), establishing cars manufacturing facilities and providing financial schemes to taxi & public bus drivers to buy new cars (e.g. Senegal); improving quality of transport infrastructure, introducing urban planning, modernising public transport and promoting rail & waterway transport modes, improving the traffic management system (e.g. South Africa).

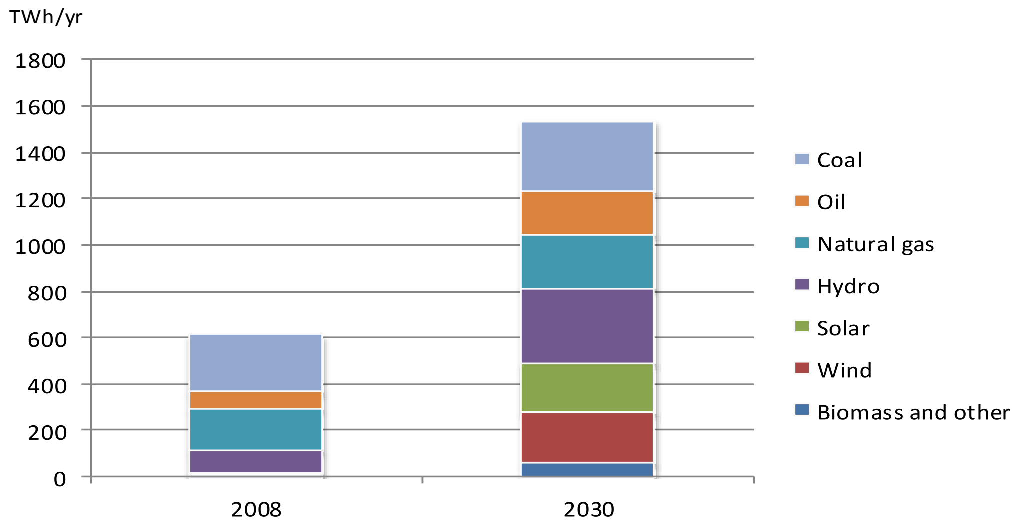
The implementation of the following measures offers suitable ways for **power utilities** to cut their energy costs and become more efficient (Fall, 2010):

- Improving efficiency of thermal power plants new high-efficient power generation technologies (e.g., natural gas combined cycle; clean coal technology, combined heat and power), and reduction of technical & non-technical electricity losses (e.g., Kenya reduced losses in transmission and distribution from 21.5% in 2000 to 16.5% in 2007);
- Promoting Demand Side Management (DSM) measures, such as load shifting through tariffs, load factor management, load re-distribution, network planning (e.g. South Africa)

Future electricity access and renewable energy potential

Africa currently has 147 GW of installed electric power capacity. Average per capita electricity consumption in sub-Saharan Africa (excluding South Africa) is 153 kW per year; this is one-fourth of the consumption in India and just 6% of the global average (IRENA, 2012a). According to IEA (2011), the cost for universal electricity access in Africa would be at least around USD 22-23 billion a year, or around USD 475 over 2010-2030 (see Exhibit 1). Other studies have different estimates. UNECA (2011) mentions amounts as high as USD 50 billion per year. A study by IRENA on the power sector gives average annual investment between over the period 2010-2030 as varying between USD 30 and 55 billion per year (IRENA, 2012a). The latter figure is the annual cost of investment to achieve universal access under a scenario of ambitious energy efficiency and renewable energy policies. Adding fuel cost and cost of transmission and distribution, annual electricity system cost would be about USD 134 billion a year. The IRENA report further mentions that such a 'renewables' based scenario would be more expensive than a fossil-fuel based scenario. In general, the costs of non-hydro, renewable energy-based sources are typically somewhat higher than fossil fuel-based technologies. However, this larger initial capital investment would be offset in the period after 2030 by the lower fuel cost for generation.

Exhibit 9 Possible power capacity development in Africa



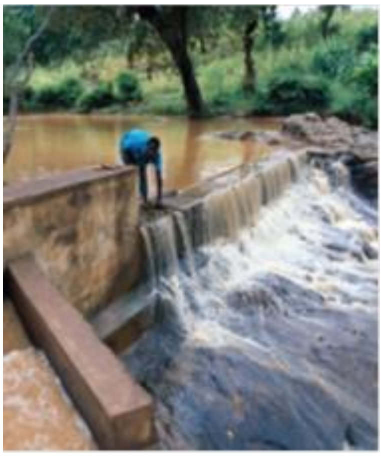
Data are taken from the Renewable Energy scenario in IRENA (2012a). In this scenario, ambitious energy efficiency improvements (20 to 30% over baseline projections) are assumed to be implemented with significant renewable energy electricity (share increase from 16% to 50% in 2030), providing universal energy access in 2030. Energy production figures are 620 terawatt-hours per year (TWh/yr) in 2008 (including North Africa, 237 TWh) and 3,146 TWh in 2030 (of which 1,158 TWh in North Africa). To this generation, about 950 TWh should be added, of which 40% grid-connected, 42% mini-grid and 18% isolated off-grid (IEA, 2010)

According to recent analysis (UNEP, Bloomberg, 2011), global investments in renewable energy in 2010 reached a record of USD 211 billion (not including large hydropower), of which roughly half in developing countries. Only USD 3.6 billion was invested in Africa[16]; a small share globally, but a substantial increase in comparison with investment in 2009 (USD 750 million). For comparison, African countries imported USD 18 billion worth of oil. In addition, fossil fuel subsidies cost an estimated USD 50 billion a year (IRENA, 2013b; IEA, 2011)

16 Figures exclude small-scale projects

The renewable energy potential of Africa is massive and remains largely unutilised:

- **Hydropower** has dominated renewable power investment across the continent, but only generates 5% of its total technical potential of 1,800 TWh[17]. Existing installed capacity is about 23,500 MW. Hydropower can be divided into large hydropower (>10 MW) and small hydropower (<10 MW)
  - *Large hydro.* The Grand Inga (on the Congo River) and Ethiopian hydropower projects stand out as large resources. The projects would add some 5.3 to 6.8 GW (Inga Dams, Congo; Millennium Hydropower project, Nile) with even larger projects being mooted, such as the Grand Inga Dam (32 GW). Also countries in West and Central Africa also have great potential for large and small hydropower[18]. Investment costs are USD 1,000-2,000 per kW; electricity price at USD 0.045-0.09 per kWh (IRENA 2012a; see also Exhibit 10);
  - *Small hydro.* Africa has 588 small hydropower plants with an average size of 2.5 MW (a total of around 1.5 GW). Significant hydropower potential remains in Africa, with around 4.7 GW of potential in 13 West African countries (IRENA, 2012a). *Micro hydropower* generally refers to plant below 1 MW and is ideally suited to the development of mini-grids[19]. The cost of small hydropower in Africa is relatively high, because of the high materials and transportation costs for equipment, although varying widely, somewhere between USD 0.09 and 0.18 per kWh at USD 2,000-4,000 per kW investment cost (IRENA, 2012a), which could drop to USD 2,300-2,800 per kW by 2030.



Source: Practical Action

- Total installed **wind capacity** in Africa amounted to 0.9 to 1 GW in 2010 (0.5% of global capacity); most of it in North Africa (Egypt, Morocco, Tunisia; together about 950 MW). South Africa could become the leader in wind energy in southern Africa as a result of the introduction of a new bidding system (bids have been presented for about 630 MW). Wind resources in Africa are very large, potentially about 3,800 TWh, but they are not evenly distributed geographically (mostly located in coastal areas). Cost of a 2MW turbine is about USD 1,750 per kW (electricity price at USD 0.10-0.16 per kWh), which could drop to USD USD 1,400-1,700 per kW by 2030 (IRENA, 2012a)

- **Solar energy**. Total installed solar photovoltaic capacity in Africa is not known with any certainty, but could to be in the order of 160 MW (EPIA/Greenpeace, 2011)[20]. The prospects for growth are good given that PV panels are a very good solution for the off-grid market (and replace diesel generators and provide back-up power supply where the grid supply is unreliable; see Exhibit XXX). The technical potential for solar PV could be as high as 6,567 TWh for off-grid and utility scale applications. Development of concentrated solar power (CSP) is just starting and has been limited to the desert nations of North Africa. The potential could be 4,719 TWh (IRENA 2012a).

17 Unexploited economically feasible potential is 58%, generated by 100-150 GW. See http://hydro4africa.net and IRENA (2012a)

18 Africa's renewable energy potential is not evenly distributed and not always located close to demand centres. Very large investments will therefore be needed in electricity transmission lines. This includes special Interconnectors between countries and regional power pools.

19 Systems smaller than 0.1 MW are sometimes referred to as pico hydropower and cost can be double that of small hydropower (0.1 to 10 MW).

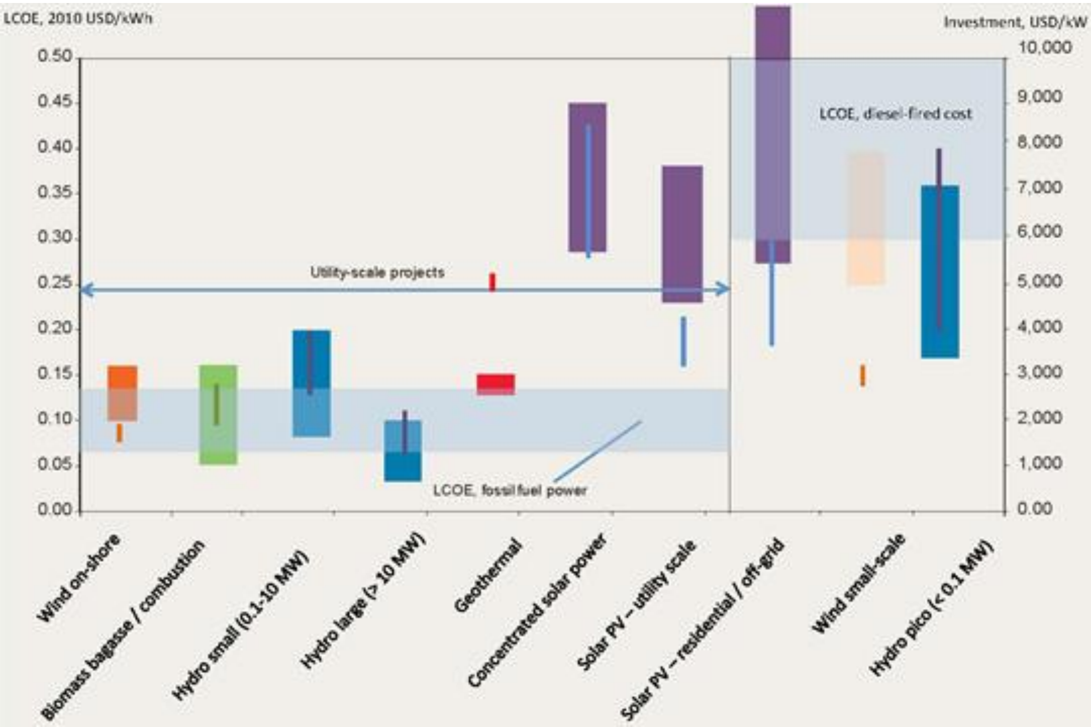
20 Africa has one utility-scale PV plant at Cape Verde (7.5 MW). Source: IRENA (2012a)

Costs are currently about USD 5,500-8,500 per kW (electricity price of USD 0.31-0.43) that could fall to USD 4,200-5,100 by 2030 (IRENA, 2012a)

- The contribution of **geothermal energy** to Africa's electricity generation is currently modest, with around 210 MW of installed capacity. However, excellent geothermal resources exist in the East African Rift system and the potential is large, particularly in Kenya and Ethiopia, estimated to be between 7 and 15 GW (AUGRP, 2010). Only Kenya has started to exploit its potential, currently producing 205 MW in the Olkaria geothermal field, and aiming at installing 5 GW by 2030 (IRENA, 2012a). Costs are about USD 5,000 per kW (electricity price USD 0.14 per kWh) that could drop to about USD 3,000-3,250 per kW by 2030 (IRENA, 2012a).

- *Bagasse* is the most important source of **bioenergy** power in Africa, accounting for 94% of the 860 MW of installed bioenergy power generation capacity in 2011. The technical potential for the use of bioenergy for power generation is estimated to be 2,631 TWh, with 60% of this potential in Central Africa (IRENA 2012a). Costs of a bagasse-fired boiler is about USD 2,500 per kW (assuming fuel cost of USD 0.5-3 per gigajoule, GJ, this implies an electricity price of USD 0.12-0.15 per kWh). Costs of biomass combustion (cogeneration) are about USD 1,250 (assuming biomass fuel cost of USD 1-5 per GJ, electricity price is USD 0.05-0.09 per kWh). Cost of gasification of biomass is about USD 2,000 per kW (IRENA, 2012a). *Biogas and landfill gas* are widely used for power generation in many parts of the world, but not in Africa. The availability of sufficient quantities of organic feedstock to make biogas production attractive is an issue. In countries, such as Kenya and Tanzania, biogas has been tried for half a century for cooking or power generation, but without much success. Major obstacle for households or villages is the high initial cost and unfamiliarity with the technology. Often small farmers do not have enough number of cattle or other animal required to feed the digester. To overcome this barrier, some countries have

Exhibit 10 Renewable energy costs estimates in African conditions



The graph is based on info in IRENA (2012a) and IRENA (2013); levelised cost of energy (LCOE) assume 10% cost of capital. Bars give LCOE (USD/kWh) and lines give the range in cost of investment (USD/kW). Average electricity tariffs in Sub-Saharan Africa are about USD 0.13/kWh (http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/)

introduced national biogas programmes that provide technical assistance and capacity building with technology subvention.

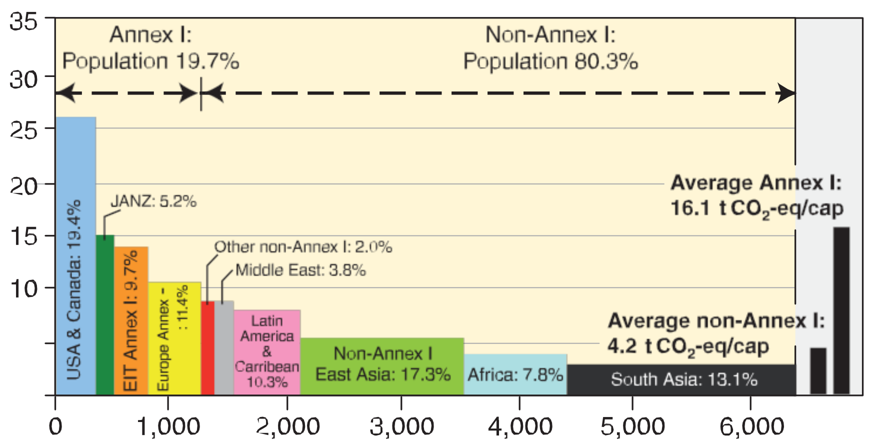
Climate change

Changes in the atmospheric concentrations of greenhouse gases[21] s and aerosols, land cover and solar radiation alter the energy balance of the climate system and are drivers of climate change. The threat of climate change to humankind and to the planet as a whole has gradually become more evident and there is a clear link between greenhouse emissions from human activities (including emission from fossil fuels in the energy sector) and climate change.

According to latest IPCC reports (IPCC, 2007), 66.3% of anthropogenic carbon emissions come from energy-related activities[22] and the rest derives from activities that include agriculture and residue burning (13.5%), forestry, deforestation, savannah burning and forest burning (17.4%) and waste and wastewater (2.8%).

The United Nations therefore considers that access to modern energy services must be reliable and affordable, sustainable and “*where feasible, from low-greenhouse gas (GHG) -emitting energy sources*”. The ‘Global Action Agenda on Sustainable Energy for All’ mentions the objective of ‘doubling[23] the share of renewable energy’ and ‘doubling the rate of improving energy efficiency’ (UN, 2012).

Exhibit 11 Regional distribution of greenhouse gas emissions



Source: IPCC (2007)

The share of Africa in greenhouse gas emissions is small, around 8%, as indicated in Exhibit 11 and that of Sub-Saharan Africa even smaller (around 3-4%). While Africa’s contribution to global greenhouse emissions may be limited, the continent will feel the impacts of a changing climate. The area covered by arid and semi-arid land would increase, which would lead to increased water stress and decreasing agricultural production areas that become drier with would adversely impact food security and exacerbate malnutrition (see Exhibit 12). Climate finance needs for adaptation might total USD 40 billion a year, according to one estimate (AfDB, 2012; CPI, 2011), but annual finance over 2004-2011 was only USD 132 million.

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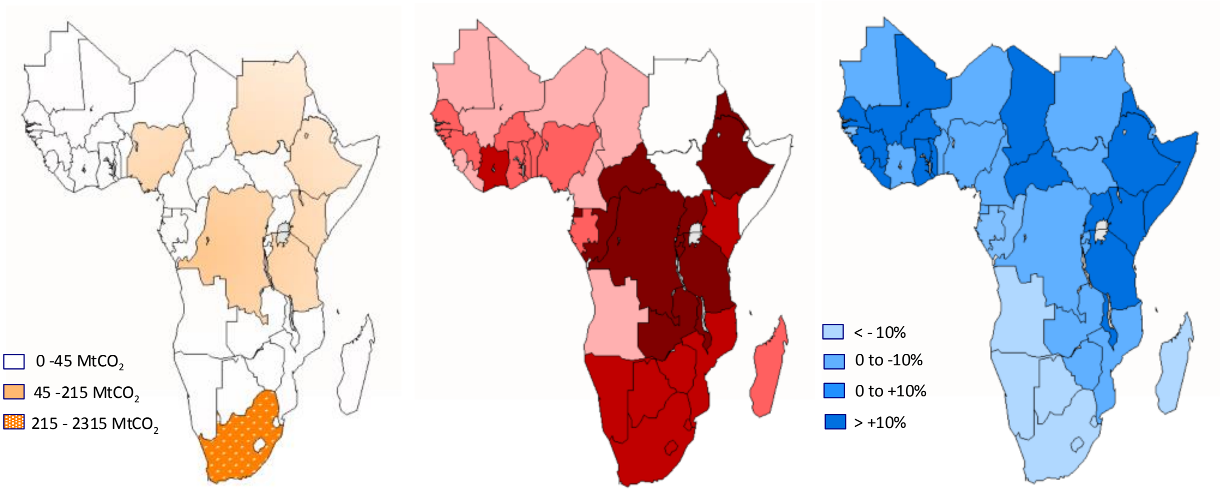
21 Human activities result in emissions of four long-lived GHGs: CO_2, methane (CH_4), nitrous oxide (N_2O) and halocarbons (a group of gases containing fluorine, chlorine or bromine).

22 Energy supply (25.9%), transport (13.1%), residential, buildings and traditional biomass use (7.9%) and industry (19.4%), the latter including refineries and non-energy industrial emissions (e.g. cement)

23 There is still a long way to go. The share of renewables in global final energy consumption was 16.7% in 2010 (traditional biomass 8.5% and modern renewables 8.2%. Source: REN21 (2012)

Exhibit 12 Climate change emissions and impacts in Africa



Based on data given in AfDB (2012), WRI (2005) and UNDP (2007)
Left: Annual CO_2 emissions per country. Sub-Saharan Africa emitted only 663 million tonnes of carbon dioxide ($MtCO_2$) in 2004; developing countries 12,303 $MtCO_2$ and the world as a whole 28,983 $MtCO_2$
Middle: Health impacts expected due to climate change. Dark: deaths resulting from climate change are highest (especially in Central and Southern Africa); lighter shading: where deaths are lowest.
Right: changes in water availability (expected to decrease in South Western Africa. Currently, already lack access to clean water and 68% do not have access to sanitation facilities

There are two types of measures to respond to the threat of adverse impacts of climate change:

- ***Mitigation*** action to decrease men-made greenhouse gas emissions in order to reduce the effects of global warming, such as:
  - Investments in renewable source of energy and energy efficiency;
  - Promoting greener transport;
  - Enhance sustainable land use and forestry management; reducing emissions from deforestation and forest degradation (REDD)

- ***Adaptation*** actions reduce the vulnerability of biological systems and society to climate change effects, such as:
  - Building adaptive capacity through water resources management and storage infrastructure;
  - Improve community resilience and adaptive capacity to climate-related disasters (e.g. droughts, floods, storms)
  - Addressing food supply and health risks;
  - Improved forestry management, halting deforestation and reducing land degradation;
  - Economic diversification and infrastructure development.

Source: AfDB (2012**)**

Actions needed to achieve energy access for all

A number of building blocks for universal energy access can be identified as requirements, at both national and international levels. These will all rely on the mobilization of resources and support at appropriate levels from a range of actors in different countries.

- **Policy support**

Governments need to prioritize energy access, set national targets for universal energy access in their country, and put in place plans and the enabling environment to deliver them. Successful large-scale electrification programmes are underpinned by government targets, accompanied by the necessary policies, programmatic capabilities, tariff structures and incentives to support these targets and participation from the private sector also need to be put in place. Energy access strategies should address the full range of energy needs and various types of energy, including electricity and fuels and set targets for community power and decentralised generation by fossils fuels and renewable sources of energy.

Energy access targets should be more integrated within national development strategies by adopting a goal-oriented approach to address the combined energy needs of households, social institutions and productive activities for cost-effective energy service delivery (electricity, fuels and mechanical power). This will require both flexibility in prioritizing programs and coordination across ministries of finance, economic management, energy, labour, industry, health, education, agriculture (or rural development), water and sanitation, and transport[24].

Regarding energy and electricity policies, this requires:
- National plans to accelerate the deployment and provision of modern energy services in all sectors of the economy;
- Re-orienting regulatory policy frameworks, including tariff structures and market regimes, to stimulate business innovation and private sector participation;
- Further investment in the capabilities of public utilities and electrification agencies;
- Improvement in the design and careful targeting of energy subsidies.

A critical issue is to avoid policies supporting rural electrification that are biased towards grid extension and to promote policies that support the implementation of mini-grid (or stand-alone) systems when these are more cost-effective. The idea behind an integral energy supply and electrification planning is to include the entire spectrum of primary energy sources, distribution and end-use technologies from which proven, robust, and cost-effective technologies can be chosen for implementation at larger scales with appropriate standards. This requires an appropriate rural electrification planning framework is needed that evaluates the cost-effectiveness of potential renewable energy mini-grid options in comparison to grid-extension.

The mandate for expansion of electricity services into rural areas often rests with a national or regional rural utility company. However, most utility companies are structured exclusively around electricity supply networks, and they often exhibit a strong institutional resistance to the mini-grid solutions. Under such circumstances, a regulatory framework for rural electrification should give the right to non-utility service providers, such as community cooperatives and the private sector, to serve in off-grid areas. Both large-scale vertically integrated utilities and smaller decentralized businesses can deliver the required solutions, using public, private and cooperative approaches,

[24] Land use planning, water resource management, food production and agricultural productivity enhancements should be integrated with energy planning, especially in the case of large hydropower and bioenergy projects

depending on the administrative and financial strength of the existing utilities and local businesses. In all cases, however, a degree of central programme-level coordination and planning is necessary.

On the national level, successful rural electrification programs demonstrated that setting up such a planning agency dedicated to rural electrification is one of its most basic requirements. The exact institutional structure, however, does not appear to be critical, as a variety of approaches have been successful. Successful institutions generally have a high degree of operating autonomy to pursue rural electrification as their primary objective, to create standards and to evaluate proposals for investment. Such institutions should be responsible for defining the roles of grid extension vs. off-grid, and developing separate regulatory frameworks including tariff structures and subsidy schemes for grid extension and off-grid options.

- **Energy sector and energy company performance**

Many (state-owned) utilities suffer from the problem of ´circular debt´; being forced to subsidize, the inadequate tariffs are unable to collect enough revenue from customers (including the so-called non-technical losses of theft and non-payment) leading to poor quality infrastructure (and technical losses in power transmission) and lack of investment in generating capacity or simply being unable to by fuel for the power plants. This often leads to frequent power shedding and blackouts. Thus, cost recovery is essential for the on-going sustainability of the energy sector as a whole. Creditworthy national utilities are a key element to create an enabling environment for public-private partnerships and attract private sector investments. In many countries grid access could be improved for independent power producers.

To be able to provide energy access for all, the national power system needs to be functioning well enough to support the additional capacity and demand and enable recovery of costs. In many developing countries this is not the case and would require a refurbishment of the existing infrastructure (generation and grids), improvement of the performance of the utilities through local capability building, implementing best practices for operational improvements (e.g., loss reduction programmes) and resolving fuel supply issues by ensuring the appropriate fuel supply chains and logistics infrastructure are established.

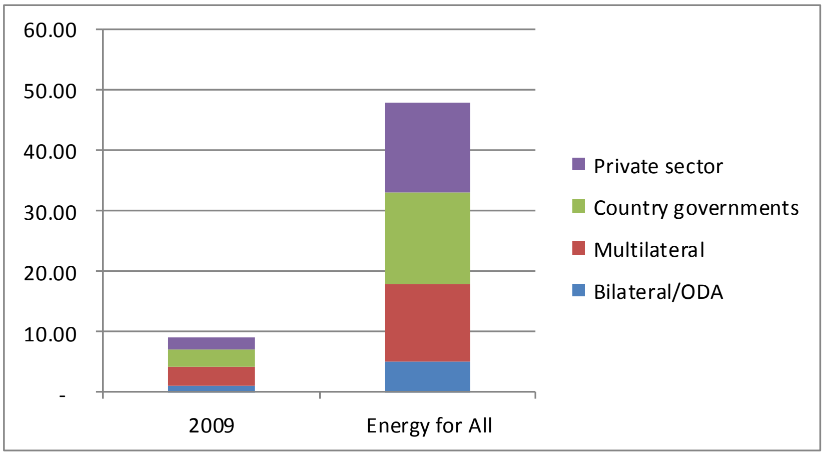
Security and reliability of grid power supply can be greatly improved by regional cooperation. Building interconnections is the first step towards integration in regional power pools. This requires strengthening of regional planning, harmonization of standards, practices, grid codes and regulatory arrangements, coordinated energy system planning and operation at power pool level. Expanding regional power trade will be critical to unlock the continent’s large renewable potential, in particular hydropower.

Exhibit 13 Subsidising the rich in Zambia

In Zambia at least 56% non-urban residents are poor. Only 48% of the urban population has access to electricity. Urban residents in Zambia depend on four main fuels, electricity, charcoal, firewood and kerosene. Of the four, electricity is subsidised. However, the bulk of subvention is captured by the non-poor, about USD 4.2 million (in 1998), which represented 83% of the total subsidy on electricity. This implies that richer people have benefitted from subsidies. *Source:* Sanchez (2010), Kalumiana (2004)

Subsidies often end up providing limited benefit to the people who need them most. In many countries energy costs are subsidized, such as electricity for low-consuming households and prices of kerosene and LPG to help the poor. Unfortunately, in many cases only the better-off have reliable access and profit more due to their higher consumption per capita than the poor. Subsidies are best used only where necessary and have a phase-out schedule built in, preferably targeting investment in infrastructure (e.g., extension of transmission lines or generating equipment) rather than consumption (fuel usage or operation and maintenance of systems).

Exhibit 14 Annual investment in modern energy access



Energy for All: annual average investment over 2010-2030. The graph is based on data given in IEA (2011) and AGECC (2010). The capital needed could be obtained from:

- About 55-70% would come from the end-users through tariffs (including cross-subsidies) or upfront payments and could therefore be funded through loan finance. This equates to concessional finance of $20-25 billion per year to provide loan capital to banks and microfinance institutions to fund capital requirements.
- In addition, $15-18 billion is likely to be required by government, utilities and private developers, of which some USD 3-5 billion from national budgets (10-15%) and USD 10-15 billion from International grants (20-30%)

- **Access to financing**

Worldwide, all rural electrification programmes have involved some form of subsidy. Rural electrification or piped gas infrastructure in Europe or USA started with incentives, cross-subsidization and government investment, whether implemented by public agencies, private companies or cooperatives. In fact, all around the globe, rural electrification is loss-making. In the developing world this segment of the population is also often the poorest, with the lowest ability to pay. Subsidies are therefore often required to cover capital (and, in some cases, operating costs). In principle, subsidies should be easy to administer (i.e., be efficient), have an impact on the desired population (i.e., be effective) and reach the poorest of society (i.e., be equitable).

Based on IEA estimates (IEA, 2011), the AGECC (2010) report concludes that it will be that it is in principle possible to provide access for the energy poor in the next 20 years but at an average capital investment of around USD 48 billion per year (an extra USD 35 million, in addition to the expected business-as-usual investment of around USD 9-13 billion a year). Around USD 15 billion of grants would need to be made available, mainly to cover the capital investment and capacity building required in least developed countries. In addition, some USD 20-25 billion of loan capital will be required for governments and the private sector above business-as-usual.

The energy access investment needed would come from:

- *Bilateral official development assistance* (ODA) for energy; to be increased from USD 1.1 billion in 2009 to about USD 5 billion. For comparison, bilateral ODA in 2009 was USD 101.0 billion[25] of which 6% was destined for energy; so slightly more than 1% (USD 11 billion) was for extending energy access;
- *Multilateral organisations* would have to increase their funding from the USD 3 billion in 2009 to about USD 13 million annually over the period 2010-2030. For comparison, multilateral ODA in

[25] Statistics compiled from www.oecd.org/development/stats, IEA (2011) and AGECC (2010)

2009 was USD 38.8 billion of which about 14% was destined for energy; of which USD 3.1 billion was for energy access.

- Estimated investment in energy access from *governments in developing countries* (governments and state-owned utilities) was about USD 3 billion in 2009. In the IEA projections this would need to be increased to almost USD 15 billion to achieve universal access in 2030;
- *Private sector* is estimated to have accounted for 24% of energy access investments (USD 2.2 billion), which would need to be increased to around USD 15 billion annually.

Exhibit 15 Issues and options for decentralized and renewable energy systems

The initial cost of decentralized energy technologies can be relatively high. One mistake i in setting up decentralized systems in the past has been assuming that poor people cannot pay or do not think it is a priority to pay. Tariffs were thus set too low and consequently there were no sufficient funds for operation and maintenance; systems were often abandoned or not functioning after a couple of years, due to maintenance and operation problems and inability to pay for fuel. Often, systems were installed with government of donor money, without giving sufficient attention to training of local people to do O&M and revenue collection in a technically and financially sustainable way.

Photo: J. van den Akker

The level of energy access required is dependent on the needs of each community as well as contextual constraints, such as climatic conditions. This is also linked to the ability and willingness to pay. Acceptance within the local community before implementation is also essential. The local population (the beneficiaries of the energy technology) needs to be engaged in the whole energy technology development process, from assessment and preparation to construction and O&M&M (operation, maintenance and management). With proper local awareness creation, confidence building and capacity strengthening a community can successfully organize and manage local infrastructure.

Local involvement is essential regardless of the management model, i.e. whether the community has formal ownership (cooperative, or via an enterprise) or a service company or utility owns it. It is vital to educate energy users and potential energy users – about costs, and life span of energy schemes, for example, so that they understand why they need to pay, and to care for the systems (energy literacy).

The long-term sustainability of mini-grid and off-grid programmes hinges on developing the capabilities of local participants and ensuring local supply chains are in place that provide technology and after-sales services. This includes the capacity to plan, design, deliver, install, service and repair renewable energy systems and can be strengthened via government projects and international cooperation; however, such capacity should be consolidated within private sector, industry associations and academic institutions within the Sub-Saharan Africa region. Another critical factor is ensuring that quality standards for equipment and installation are met. Appropriate technical standards for system design and customer connections can also lead to significant reductions in construction and operating costs. Specifically for mini-grids, ensuring that the technology is forward-compatible with later grid connections is important.

Energy initiatives should incorporate end-use finance and business development support. Micro-loans for appliances and business mentoring, for example, can connect energy access and productive uses of energy. Cost of appliances is often forgotten as on the 'other side of the energy'. Strictly speaking not part of energy supply, any electric appliances cost money to its user.

- **Capacity development**

Finance alone will not be sufficient to improve energy access without complementary efforts to develop the capabilities and capacities of local institutions for the provision of delivery, quality monitoring, finance, and operations and maintenance services. Such capacity development is needed in both the public and private sectors, and at all levels – national, sub-national and communities.

The cost of equipment is a key hurdle for most renewables. Currently Africa must import most of this equipment. The import of mass-produced equipment (from China) has brought costs down. But, the cost can be reduced further through import tax exemptions, and by developing and strengthening the national equipment supply chains. This requires strengthening the existing capacity to design, manufacture and install energy systems and support the development and transfer of appropriate energy technology.

In the initial stages of the market uptake of a (new) energy technology, the capacity building initiatives are often conducted on project by project basis. This takes time and is one of the reasons for an often slower than anticipated uptake of the industry. With the market growing, the industry should start to bundle capacity building efforts, including technical training for hundreds of installers of systems through industry associations; formal training with integration of curriculum in regular program. These kinds of initiatives could train quickly thousands of employees.

The private sector could play an important role in providing initial off-grid electricity supply. For example, mobile phone companies currently use diesel generators to provide power for their antennae in rural areas in Sub-Saharan Africa. By installing solar PV systems, mobile phone operators could be able to generate sufficient power for their requirements and excess capacity (see Exhibit 6).

- **International community**

These financing requirements could be partly met by funds from the international climate finance and official development assistance and finance (ODA). However, for ODA to be effective, this will require governance structures that stress accountability and reflect the needs of beneficiaries in the recipient countries. The donor community itself needs some re-thinking. The experience of the last three decades shows that neither global strategy (poverty reduction, productive uses, climate change mitigation) nor many of the individual country strategies have been clear to tackle energy access in the least-developed countries, of which most are located in Sub-Saharan Africa. Often strategies and concepts have led to changes in goals several times and have demonstrated slow progress. The government of the least-developed countries, with budgets in large part depending on donor support, often follow the lead of the multilateral agencies.

In developing countries, donor aid needs to take the lead in the seed-finance area. Traditionally, donor agencies have provided grant funding for demonstration projects that provide electricity access either at the community (e.g., for health clinics, education facilities, and central recharging facilities) or household level (domestic lighting. However, for rural electrification (and mini-grid renewable energy systems), funding the up-front costs of developing a new clean energy business may be more successful in the long term:

- Setting up funds dedicated to rural energy supply;
- Provision of credit to energy service providers (by commercial or development banks, performance-based co-financing grants/subsidies offered by the government; and/or partial risk guarantee arrangements);
- Consumer credit for stand-alone systems (dealer-extended credit or credit through a micro-finance organization or a local development bank).

Climate finance

According to CPI (2011) already USD 97 billion per annum of climate finance is currently being provided (not including the official development assistance, ODA):

- For mitigation (USD 93 million) and adaptation (USD 4 million);
- Out of the estimated USD 97 billion in global climate funding, on average USD 55 billion is provided by the private sector, while some USD 21 billion is provided by public budgets. Private funding is in the form of direct equity and debt investments; investments, to which bilateral and multilateral agencies and banks also contribute another USD 19 billion by leveraging the public funding they receive;
- A relatively small share, about USD 2 billion, is provided by carbon off-set markets (compliance and voluntary carbon offset markets)[26].

The role of the private sector in the figures is a reminder of the fact that capital investment is crucial for any mitigation and adaptation activities. In fact, the relatively small role of the public sector compared to the private sector is remarkable, in light of the debate in the global climate change negotiations where many have emphasized the need for developed countries to fund mitigation and adaptation in developing nations. Under the recent Copenhagen Accord[27] it was agreed to increase (public) funding to USD 100 billion a year by 2020 (for both mitigation and adaptation). Bilateral and multilateral carbon finance amounted to USD 39 billion in 2010. Of this amount, only 9% (USD 3.5 billion) reached Sub-Saharan Africa). On private sector flows, the CPI (2011) report mentions a concentration of climate-related investments in a small number of large emerging economies. For example, 68% of the renewable energy investments in the developing world (USD 72.2 billion in 2010) were located in China, 10% in Brazil and 5% in India (CPI, 2011; UNEP, Bloomberg, 2011)

Current climate change mechanisms have ignored Sub-Saharan Africa in terms of supporting energy access; if not intended so, at least in practice. This can be illustrated by analysing the Clean Development Mechanism (CDM) and the Global Environment Facility (GEF), which are two main multilateral funding mechanisms in the area of climate change and environment:

- *Carbon markets*. A UNDP study (UNDP, 2006) showed that CDM funding has been skewed towards a few countries and leaving certain sectors out:
  - By that date (2006), four countries (China, India, Brazil, and South Korea) accounted for 70% of CDM projects and 80% of the Certified Emission Reductions (CERs) through 2012[28]. In contrast, Sub-Saharan Africa (SSA) accounted for only 2% of registered projects and 5% of CERs (through 2012). [29] The UNEP RISOE website mentions that the e fraction hosted by India, China, Brazil and Mexico rose from 50% in the start to 85% in mid-2006, and since more and more countries are active it has now fallen to around 70%;

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[26] The outlook of the off-set market is uncertain, depending on the form the successor of CDM will take and the use of off-set in new markets (other than Europe). CERs issued by 2012 amounted to 1,266 million. The total issuance in the period 2013-2020 is expected to be about 6,500 million CERs. In August 2008 prices for CERs were USD 20 a tonne. By September 2012, prices for CERs had collapsed to below USD 5, reflecting the Eurozone crisis and uncertainty on the post-Kyoto phase (Wikipedia and UNEP RISOE websites)

[27] Promulgated at the UNFCCC Conference of the Parties (CoP) in December 2009. The acknowledgement in the Copenhagen Accord of the importance of reducing emissions from deforestation and degradation (REDD) may create a link between carbon finance and energy access initiatives that have reduction of deforestation as a benefit

[28] China. India, Rep. of Korea and Brazil accounted for 84% in 2012 (source: en.wikipedia.org)

[29] Of the CDM project pipeline (consisting of registered and projects under validation and fin al check) and about 266 were in Sub-Saharan Africa (with an emission reduction of 67 million CER), which is 3% of the total of 9,016 projects (with a total of 1,248 million CER). In the voluntary market, these percentages are higher. A higher proportion of projects are in Sub-Saharan Africa 18.5%. Also there is higher proportion of energy efficiency projects (domestic sector, 40%; public sector 29%). Source: UNEP RISOE website; www.cdmgoldstandard.org/our-projects/project-registry; Hui and Sánchez (2012) and IGES website (www.iges.or.jp)

Exhibit 16 Climate finance

Climate finance refers to financing sourced from public, private and public-private sectors and channelled by national, regional and international entities for climate mitigation and adaptation activities, such bilateral and multilateral financing institutions (BFIs, MFIs), development cooperation agencies, the UNFCCC), non-governmental organisations and the private sector. The 2010 the World Development Report preliminary estimates of financing needs for mitigation and adaptation activities in developing countries range from USD 140-175 billion per year for mitigation over the next 20 years with associated financing needs of USD 265-565 billion and USD30 – 100 billion a year over the period 2010 - 2050 for adaptation (WB, 2010)

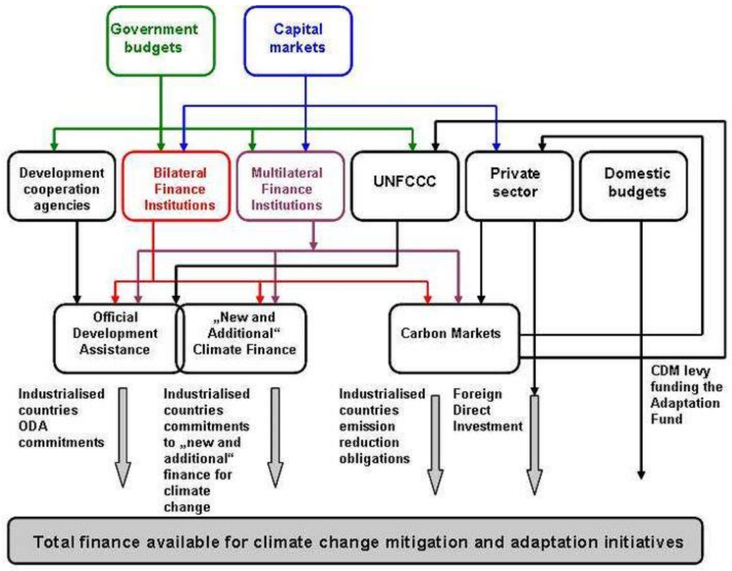


Figure 2. Financial flows for climate change mitigation and adaptation in developing countries. Note: The UNFCCC mechanism include the various funds under the Global Environment Fund as well as the Adaptation Fund.

Source: en.wikipedia.org

The UN Framework Convention on Climate Change (UNFCCC) sets the overall framework for the intergovernmental efforts to tackle climate change. The Convention came into force in 1994. There are basically two groups of countries, the so-called Annex I Parties (mainly industrialised countries and economies in transition) and non-Annex I Parties (in the developing world).

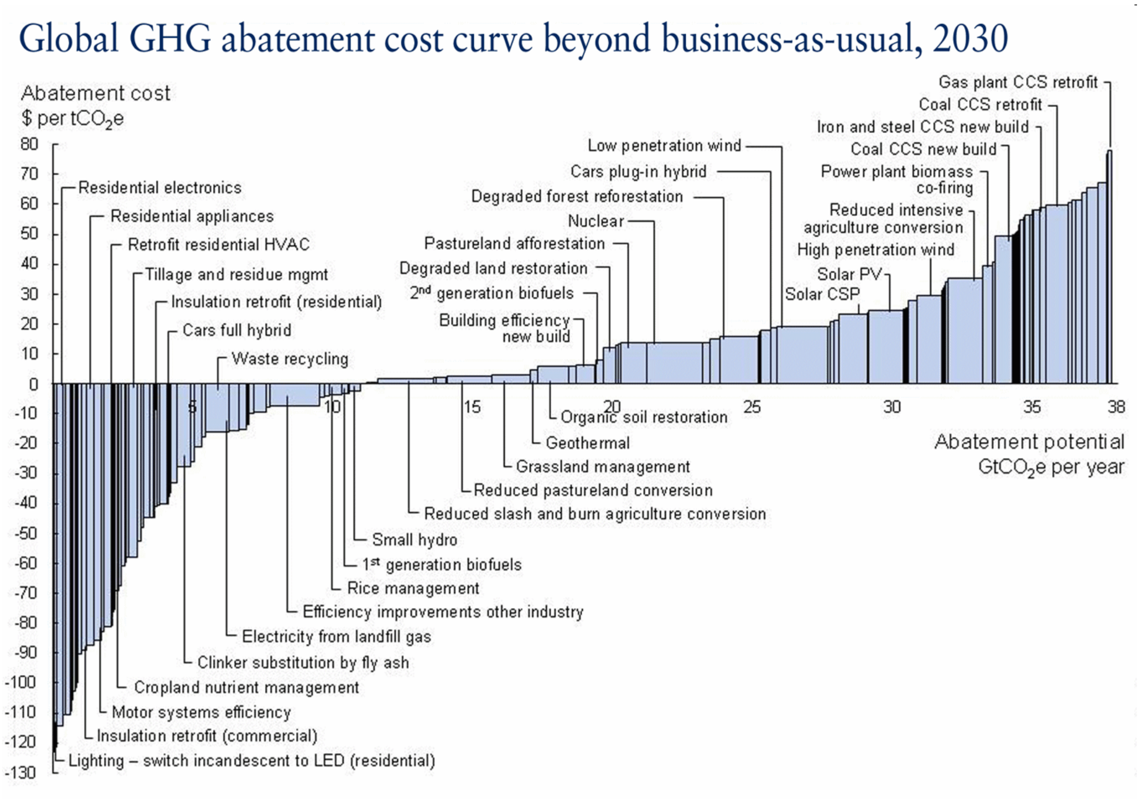
The Kyoto Protocol came into force in 2005 and binds Annex I Parties to individually binding targets to limit their man-made greenhouse gas emissions. In December 2012, agreement was reached to extend the Protocol to 2020 and to set a date of 2015 for the development of a successor document, to be implemented from 2020.

Under the Kyoto Protocol, the CDM allows the Annex I countries that are signed to the Kyoto Protocol to meet their emissions reduction targets by generating credits from emissions reduction projects in non-Annex I countries (developing countries). The projects generate emissions credits called Certified Emissions Reductions (CERs), which can then be bought and traded. One CER is equal to one tonne of carbon dioxide equivalent (tCO_2). In order to be recognised in the CDM, projects have to demonstrate savings against the business as usual (BAU) scenario of implementation, a concept known as ‘additionality‘. Additionality has to be proven and certificated. Stringent criteria and methodologies have to be followed by every project to be correctly certified, but this has also led to relatively high transaction costs. An excellent overview on CDM procedures and modalities is provided in ‘CDM in Charts’, which can be found at www.iges.or.jp/en/cdm/index.html. In the voluntary market, any organization can participate in the carbon offsetting. Carbon credits in the voluntary markets are not tradable under the Kyoto Protocols flexible mechanisms (such as CDM) and are referred to as Verified Emission Reductions (VERs).

Other financing is destined for ‘soft assistance’ for capacity building and institutional strengthening, policy and strategy formulation, analysis and reporting and research and development. UNFCCC has appointed the Global Environment Facility (GEF) as its ‘financial mechanism’. The funding for GEF in its Fourth Cycle (2006-2010) was more than US$3 billion, of which USD 1 billion was dedicated to climate change. The current GEF funding cycle (Fifth Replenishment, 2010-2014, also known as GEF-5) has an overall pledged amount of USD.54 billion. Of this amount, the Climate Change Focal Area has a pledged USD 1.14 billion. Apart from its general funds, GEF administers two special funds, Special Climate Change Fund (SCCF) and the Least-Developed Countries Fund (LDCF). The Adaptation Fund falls under de Kyoto Protocol and the new Green Climate Fund (GCF) falls under the UNFCCC directly.

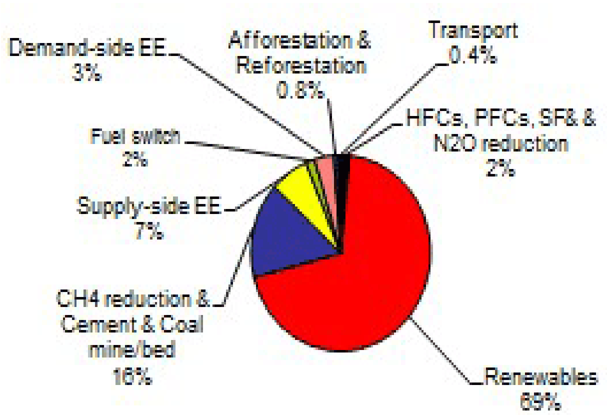
In addition, bilateral, regional and other multilateral organisations and banks have their own climate funds for mitigation and adaptation. A list is, for example, given in publications, such as CPI (2011), UNEP RISOE (2012), UNDP (2011) or the UNFCCCC website (unfccc.int/cooperation_and_support/financial_mechanism/bilateral_and_multilateral_funding/items/2822.php.

Exhibit 17 McKinsey cost curve for greenhouse gas reduction



Source: McKinsey Quarterly

- Second, the CDM has favoured larger scale projects over smaller ones, due to high transaction cost (see also Exhibit 17). Large-scale projects form about 60% of the current CDM project pipeline;
- Third, CDM has favoured technologies where project beneficiaries are one or more companies (such as the owners of a grid-connected wind farm or a bio-methanation plant) over sectors where there are large amount of end-users (e.g. millions of households may be a compact fluorescent lamps)[30]. In energy this has favoured supply-side (renewable energy projects) over demand-side (energy end-use efficiency projects; see graph; source: UNEP RISOE website), despite the fact that energy efficient technologies often have negative lifecycle cost in comparison with the more costly renewable energy technologies (see Exhibit 16).



- *Capacity building and institutional strengthening*. GEF has supported a number of rural energy access projects, including small hydro, biomass and PV projects in various parts of the world. Unfortunately, since 2007, has only been supporting a few rural energy projects. With the UN

30 One key issue relates to the fact that many of the prescribed methodologies cannot directly measure the emissions reductions but must be made upon estimates based on a small sample size

Exhibit 18 Water treatment with solar energy in Rwanda (CDM Project)

In Rwanda, nearly 59% of households do not have access to clean, potable water. The usual method for providing water to rural areas in Rwanda is through the use of surface water pipelines where surface water is collected and distributed through local water networks to community taps for public consumption. A new project will use the existing water supply infrastructure and will install photovoltaic powered ultraviolet (UV) disinfection systems on pipelines at four sites in the communities of Mugonero, Esepan, Rwesero, and Nyagasambu. The project activity targets communities that depend on surface pipelines for their source of water and has a special focus on installing the solar-powered water treatment systems on pipelines near secondary schools. These systems will offer free-of-charge, clean water.


Source: Manna Energy Ltd.

This small-scale project activity will be implemented and managed by Manna Energy Ltd. in partnership with Rwanda Environment Management Authority (REMA) and the Rwanda Ministry of Education (MINEDUC) and its development supported by UNDP's MDG Carbon Facility. The project was registered with UNFCCC in May 2011. The project methodology uses a 'suppressed demand' baseline. The solar systems will avoid the burning of non-renewable firewood (or the alternative use of fossil fuels and thus qualifies qualify to issue carbon credits. Manna will utilize the carbon credits to finance the cost of installation and maintenance of the treatment plants.

The Swedish Energy Agency will buy the projects carbon credits, including post 2012 carbon credits. Additionally, the project will reduce the amount of financial resources households and schools must spend on purchasing firewood freeing up these resources for other economic uses. The project activity also furthers the goals of sustainable development by transferring the UV disinfection system and photovoltaic power system technology to Rwanda and builds the capacity of the local Rwandan workforce by teaching them how to install, operate, and maintain these systems. Source: www.mdgcarbon.org; Van den Akker, p.c.

Energy for All initiatives, there seems to be a tendency to finance rural energy projects again, in particular grid or mini-grid projects and bioenergy[31].

Attempts are being made within the compliance market (CDM) to reduce these issues of bias towards large projects in certain sectors in a few countries only:

- *Programmatic CDM*. Under this modality, adopted in 2009, a Programme of Activities (PoA) acts as an umbrella under which an unlimited number of individual projects (of a specific methodology) can be registered. The advantages for small-scale household projects are that the costs of registration are significantly lower than for standalone projects;
- *Standardized baselines*, which are methodologies based upon uniform methods and procedures that are applicable to multiple projects of the same type;
- *Supressed demand.* A suppressed demand baseline is appropriate when basic energy services are below the minimum satisfied service level at the time of implementation of the CDM project activity. The minimum service level is a baseline of emissions where the minimum human needs for basic energy services (including lighting and cooking) are met.

[31] The argumentation given in (GEF, 2007) is that GEF "since its inception, supported projects in this area, but evaluations of these projects have indicated that these projects have resulted in neither a significant take-off of these markets nor a meaningful reduction in GHG emissions. Therefore, the market for rural renewable energy is more appropriately addressed as part of the energy access agenda of official development assistance, not as part of the climate change mitigation agenda".

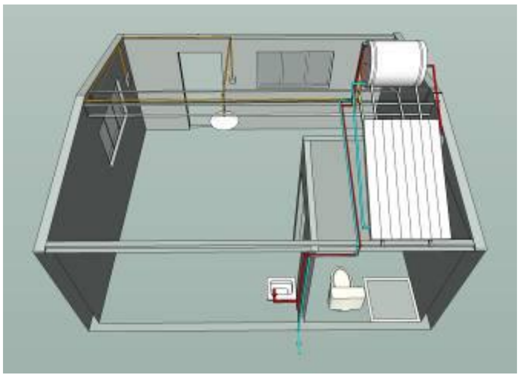
Exhibit 19 Kuyasa, Low-cost Energy Upgrade project (CDM project)

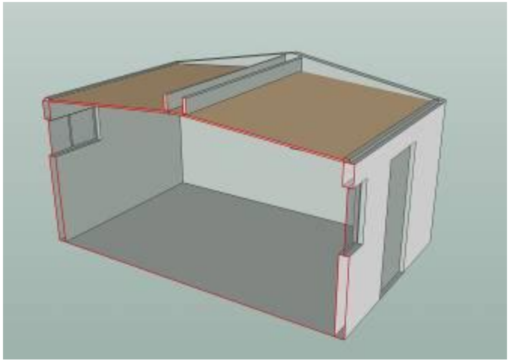
The project is a retrofit activity which entails the installation of solar water heaters, ceilings and ceiling insulation and compact fluorescent light bulbs (CFLs) in existing RDP (Reconstruction and Development Programme) houses in Kuyasa in the Khayelitsha township near Cape Town. The proponent is the City of Cape Town Metropolitan Local Authority, and the project proposal was developed with support of the NGO SouthSouthNorth as a CDM activity and was registered in 2005. The activity is implemented by the South African Export Development Fund (SAEDF), responsible for day-to-day management and the contracting of suppliers and labour, while ownership will be transferred to the Kuyasa Community Trust. The low-cost house built in the first phases of RDP was electrified, but in an energy inefficient way; i.e. these do not have ceilings or water heaters and with lighting provided by incandescent bulbs.

A first phase, with 2,309 houses retrofitted with solar water heating (SWH), insulated ceilings and compact fluorescent lamps (CFLs) is being implemented. Carbon savings are about 2.9 ton of CO_2 a year. Apart from the carbon benefits, the project has a high rating in terms of local sustainable development:

- Social (savings in the cost of energy for the homeowners; improved thermal performance and the installation of ceilings will provide health benefits to homeowners; local participation and decision-making)
- Economic (employment for and increase the capacity of local artisans; use of locally manufactured solar water heaters; Peak power demand reduced (deferring new installed capacity).

There is the potential for this project to be expanded as a Programme of Activity (PoA) under the CDM. Currently, there are over 1.5 million RDP houses in South Africa which could benefit from this project design and the Government intends to build some 200,000 units per annum for the next years. Source: Wesselink (2009); Van den Akker (2008)





Source. C. Wesselink (2009)

Under the new PoA modality, it is expected that there will be a greater uptake of the compulsory market for small-scale and/or household-size energy projects in the near future as the PoA seeks to minimise the transaction costs for such projects. The new PoA modality combined with the new guidelines on supressed demand, in theory provide a good potential to increase the amount of carbon credits generated from household energy projects as well as facilitate energy access in Sub-Saharan Africa[32]. This is illustrated by two cases, presented in the Exhibits 18 and 19.

Other mechanisms have been suggested to be included in a post-2012/2015 regime[33]:

- *Reducing emissions from deforestation and forest degradation (REDD*); this can offer more synergy between adaptation and mitigation finance, especially regarding biomass use in Africa;

[32] By March 2013, 100 PoAs were registered, of which 25% in Africa. The share of (demand-side) energy efficiency has been higher, around 38%, in comparison with about 3-4% in normal CDM projects. Source: cdm.unfccc.int and IGES (2010)

[33] Suggestions have also been made to 'de-bureaucratise' CDM by loosening the 'additionality' test. This might favour energy end-use and smaller projects, but others have warned against another wave of CERs from big developing countries. Other suggestions are to use top-down methodologies (e.g. technology standards or sectoral benchmarks) in certain sectors instead of the usual bottom-up framework.

- *Sectoral targets*[34]. These (non-binding) 'no-lose' emission targets (SNLTs) would be negotiated between the recipient country and the agency under UNFCCC responsible for sectoral targets. Being sectoral, such targets offer big scope to scale up investments;
- *Policy-based instruments* that not only have an emission reduction target, but a sustainable development target as another or primary objective. Again climate finance would be provided if emissions are reduced beyond a business-as-usual target, for example, as mentioned in a NAMA[35]
- *Transnational sectoral agreements,* based on the adoption of quantitative and/or qualitative goals for a given industry or sector. Regional power pools or sector such as transportation could benefit from such agreements;
- *Allocate a share of offset market (CDM)* projects to Africa, analogous to proceeds that go into the Adaptation Fund.

Conclusions

Energy poverty in Sub-Saharan Africa is a big concern; whilst in other parts of the world the number of inhabitants without access to modern energy services is decreasing, in Sub-Saharan Africa it is increasing. Urgent action is needed to reverse the situation and overcome the various barriers that exist at national and local level.

An effective strategy to provide energy access for Sub-Saharan Africa should consider the whole energy mix, but with a different emphasis according to location and opportunities. For urban inhabitants, grid extension for electricity supply and liquid and gas fuels for cooking are often the most appropriate solutions, although in many cases, biomass for cooking in smaller towns may still be required. For rural inhabitants, the most appropriate option may be a combination of grid for those living close to the transmission lines, with decentralized renewable energy options (including solar PV, micro-hydro and small wind) for off-grid electricity supply; for cooking biomass is likely to remain the main fuel option for the majority, though more efficient and cleaner cooking devices may be used.

Africa faces a unique opportunity as nearly two-thirds of the additional capacity needed in 2030 has yet to be built. The continent can benefit from the recent global progress in renewable energy production technologies and their cost reductions to leapfrog the development path taken by industrialised countries and move directly to a renewable-based system. Renewable energy technologies should be welcomed but their choice should be based on social and economic grounds rather than solely on environmental considerations. It should be avoided to end up forcing the use of uncompetitive renewable energy options for particular realities, for example pumping underground water either for drinking or farming in some cases may be cheaper using small diesel engines rather than renewable energy systems.

An important emerging issue is the reluctance, or low level of support, from many policy makers, international aid agencies and environmentalists, to consider the full range of energy options to meet the energy needs of the poor on the grounds of the need for reducing greenhouse gas emissions into the atmosphere. If the world's poor would gain access to modern fuels, entirely fossil-

[34] See for example, www.sectoral.org. Being negotiated in a multilateral agreement, this would avoid to an extent the high transaction cost of CDM projects to demonstrate their 'additionality'. If a country would implement a sectoral target, the sector would no longer be eligible for individual CDM projects, as this would potentially lead to double counting. Excess mission reductions are eligible credits, but no penalties would occur if the baseline target could not be met (hence the name 'no lose'. For all sectoral or policy approaches, baseline determination would be plagued with difficulties, as there is no easy way to determine real 'additonality'.

[35] NAMA: Nationally Appropriate Mitigation Actions, are part of a country's low-carbon development strategy within the framework of the national development planning

based, this would not constitute more than 2-3% of current world emissions (IEA, 2011; based on consumption of around 100 kWh per person per year).Developing countries should therefore be allowed an allowance to provide energy access with fossil fuels.

Worldwide, all rural electrification programmes have involved some form of public funding. Such support remains essential, especially in the difficult areas that do not initially offer an adequate commercial return. These financing requirements can be partially met by ODA as well as climate-related (carbon) finance, although the use of such funding to stimulate additional private sector investment in expanding access (e.g., through results-based financing or loan guarantees) will also be essential in closing the funding gap.

Carbon financing should, in theory, provide a “win-win” opportunity for sub-Saharan Africa and its potential investors by way of developing energy projects to attend the increasing energy demands of the continent and combat climate change whilst reaping the financial rewards. Africa is in a favourable position to benefit from carbon financing as it possesses abundant renewable energy resources. However, Sub-Saharan Africa has not yet benefited strongly from carbon finance, lagging well behind other regions, most notably Asia. However, some installations have received carbon finance and, with more and more funds integrating development targets, including energy access with low-carbon objectives, decentralized (renewable) energy options are likely to benefit from increased support.

Alongside expanded bilateral and multilateral grant funding, innovative use of carbon markets could expand the effectiveness of the Clean Development Mechanism and with other market-based or new post-Kyoto mechanisms could be vehicles for the mobilization of incremental funds. Such support should aim at scaling up financial instruments for energy access and energy efficiency, including risk guarantees to leverage increased private sector participation over time.

Unfortunately, the ODA and international financing have not fully addressed the energy access agenda, in the same way as they have embraced the climate change agenda. Maybe the establishment of dedicated ´Universal Energy Access Funds´ and a corresponding international institutional framework would be needed to support the aims of the UN’s ‘Energy for All’ initiative, alongside the existing institutional framework for climate change mitigation, adaptation and climate funding.

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	Global	Sub-Saharan Africa	Unit	Source:
Human Development Index	0.694	0.475		2012; UNDP (2013)
Population	7052	853	million	2012; UNDP (2013)
CO2 emissions	29,837	670	MtCO2	2008; UNDP (2013)
CO2 emissions per capita	4.5	0.9	tCO2	2008; UNDP (2013)
Climate mitigation finance	97		USD billion	
Primary energy demand	12271	655	Mtoe	2008, incl. North Africa (IEA, 2010)
Per capita energy demand	1.74	0.77	toe	
Oil imports	-	18	USD billion	
Fossil fuel subsidy	400	50	USD billion	IEA, IISD, IRENA (incl. N.Africa)
Investment in RE capacity	201	48	USD billion	2010; UNEP, Bloomberg 2011
Investment in RE (excl. large hydro)	143	4	USD billion	2010; UNEP, Bloomberg 2011
Annual energy investments	450	-		www.worldbank.org
GDP	69016	1691	PPP USD billion	2011; UNDP (2013)
GDP/capita	9787	1984	USD	
FDI	1524	35.0	USD billion	2011; UNCTAD website
Net ODA	136	47.9	USD billion	www.oecd.org/dac/stats/
Expenditures				
- health	2070	50.7	USD billion	2010; UNDP (2013)
- education	3244	88.0	USD billion	2005-2010; UNDP (2013)
- military	1725	25.4	USD billion	2010; UNDP (2013)
New energy access				
- current annual investment	9.1	4	USD billion	2009; IEA (2011)
- needed annually 2010-2030	48	24	USD billion	IEA (2011)