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The Place of Sunlight in African Culture: Traditional Wisdom in the Light of Present Knowledge and Future Requirements

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Abstract:

The amount of solar energy (insolation) falling on the earth from the sun is estimated to be about $1.73x10^{14}$ kilowatts, which is about $1.5x10^{18}$ kWh/year – about 10,000 times more than the world's annual energy consumption (Karekezi and Ranja, 1997; Ahmed, 1994; The Open University, 1994). The average insolation in Africa is estimated at between 5-6 kWh/m^2 (Karekezi, 2002b). This is high, compared to other regions. In addition, most renewable energy technologies (RETs) are derived from the sun, either directly or indirectly. The sun, therefore, presents an enormous energy resource for Africa.

Using data mainly from sub-Saharan Africa (the region with the lowest levels of modern energy consumption worldwide (World Bank, 2003; IEA, 1999), this paper reviews the status of a range of renewable energy technologies in Africa (the article addresses solar energy in a holistic as it is the source of most renewable energy technologies), and the role of traditional/indigenous knowledge in developing renewable energy in Africa. The paper ends by providing recommendations on how traditional knowledge can be instrumental in promoting renewable energy technologies in Africa.

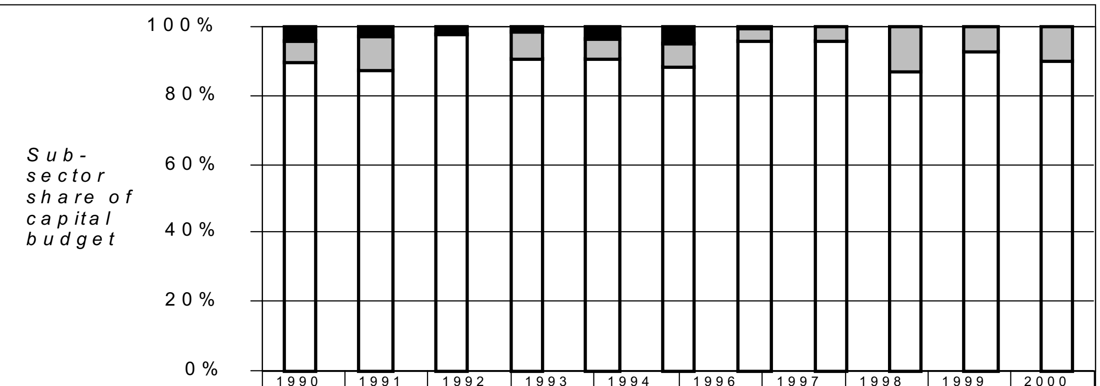
1. Introduction

Interest in renewable energy technologies (RETs) in sub-Saharan Africa is linked to several recent global events. In particular, renewables featured high on the agenda of the Johannesburg World Summit on Sustainable Development (WSSD) in 2002. In the UN-led implementation plan of action for the WSSD, dubbed WEHAB (which stands for Water, Energy, Health, Agriculture and

Biodiversity), top priority was given to the renewables and other alternative forms of energy services (WEHAB Working Group, 2002). One of the targets proposed at WSSD was for every country to commit itself to meeting 10% of its national energy demand from renewables.

A second key driver for the interest renewables is the poor performance of the conventional energy sector (mainly electricity), despite the high amounts of investment allocated to the sector. Very little expenditure is allocated to small and medium scale renewable energy technologies. For example investment trends in Ethiopia's energy sector reveal heavy investments in the electricity and petroleum sub-sectors. As shown in figure 1, investments in petroleum quadrupled from 1990-2000, while investments in electricity almost tripled in the same period. In contrast, expenditure on traditional and alternative energy (which includes RETs) has steadily decreased from about 1% of total expenditure in 1990, to 0.1% of total expenditure in the year 2000 (Wolde-Ghiorgis, 2002).

Figure 1: Energy sector capital budget shares % and total budget shares in million Birr for Ethiopia, 1990-2000



	1990	1991	1992	1993	1994	1996	1997	1998	1999	2000
Traditional and alternative	14.2	5.9	4.0	4.1	10.5	0.7	0.5	0.5	0.4	0.5
Petroleum	21.8	19.8		20.1	16.9	5.5	36.1	81.0	93.2	94.3
Electricity	314.0	182.0	187.0	240.0	267.0	145.0	861.0	539.0	1,209.	886.0

As shown in the table 1, about 72% of total forecast expenditure for the energy sector in Kenya would be allocated to electric power generation. When one considers allocations to other sectors directly linked to electric power generation, the proportion increases to 85% (Ministry of Energy 1987). In addition, the public investment plan indicates that only 1% of priority project investment for the energy sector was allocated to small scale RETs in 1999/2000 (Ministry of Finance and Planning, 1998).

Table 1: Gross Expenditure Forecast for the Energy Sector, Kenya (1987-2000)

Sub-sectors	TOTAL (Thousand Kenyan pounds)
Administration Services	11,515
Planning Services	6,677
Solar And Wind Energy	4,423
Woodfuel Resources	74,321
Other Biomass Resources	2,057
Petroleum Exploration	32,118

Electric Power Generation	1,985,210
Transmission Lines/Substations	141,158
Distribution	178,550
Geothermal Exploration	80,200
Rural Electrification	224,081
Total Gross Expenditures	***2,740,311***

Source: Ministry of Energy, 1987

The Public Investments Plan for Uganda, which highlights priority projects for funding by Government, indicates heavy emphasis on electricity projects in the energy sector portfolio. Out of 12 priority projects in 1994/95 – 1996/97, 10 were conventional electricity generation, distribution or transmission projects. The projects were estimated to account for 99.7% of the total budget for that period (Ministry of Finance and Economic Planning, 1994).

Although the expenditure on renewable energy has been increasing over the years in Botswana, the bulk of expenditure is allocated to rural power supplies, which mainly involves the extension of the grid to rural areas. Table 3 provides time series data on expenditure in the energy sector in Botswana.

Table 2: Energy Sector Development Expenditure in Botswana (1997-1998)

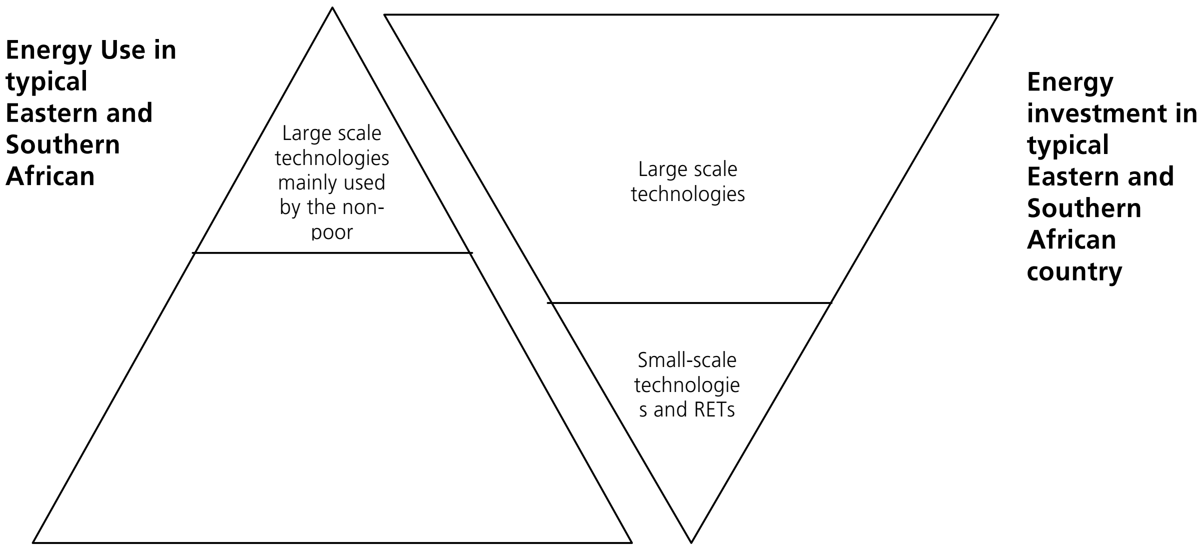
	(Pula million, constant 1997/98 prices)						
Project Name	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**Total**
Coal Development	2,00	2,00	2,00	2,00	2,00	5,00	15,00
Renewable Energies	0,65	0,97	0,25	0,25	0,25	1,34	3,70
Rural Power Supplies	24,00	25,00	25,00	25,00	25,00	11,00	135,00
TOTAL	26,65	27,97	27,25	27,25	27,25	17,34	153,70

Source: Ministry of Finance and Development Planning, 1997

The planned disbursement for the energy sector in Zambia indicates a heavy emphasis on electrification (mainly grid extension). Only about 2.5% of planned investments in the public investment plan are allocated to RETs, namely micro hydropower (1.5%), woodfuel efficiency (0.2%), and solar PV (0.8%) (Ministry of Finance and National Planning, 2002).

Energy investment patterns and energy use in the region are shown in figure 1. The large-scale conventional energy sector serves a smaller proportion of the population, but receives the bulk of energy investments in most sub-Saharan African countries.

Figure 2: Energy Use Vs. Energy Expenditure in Typical sub-Saharan African country

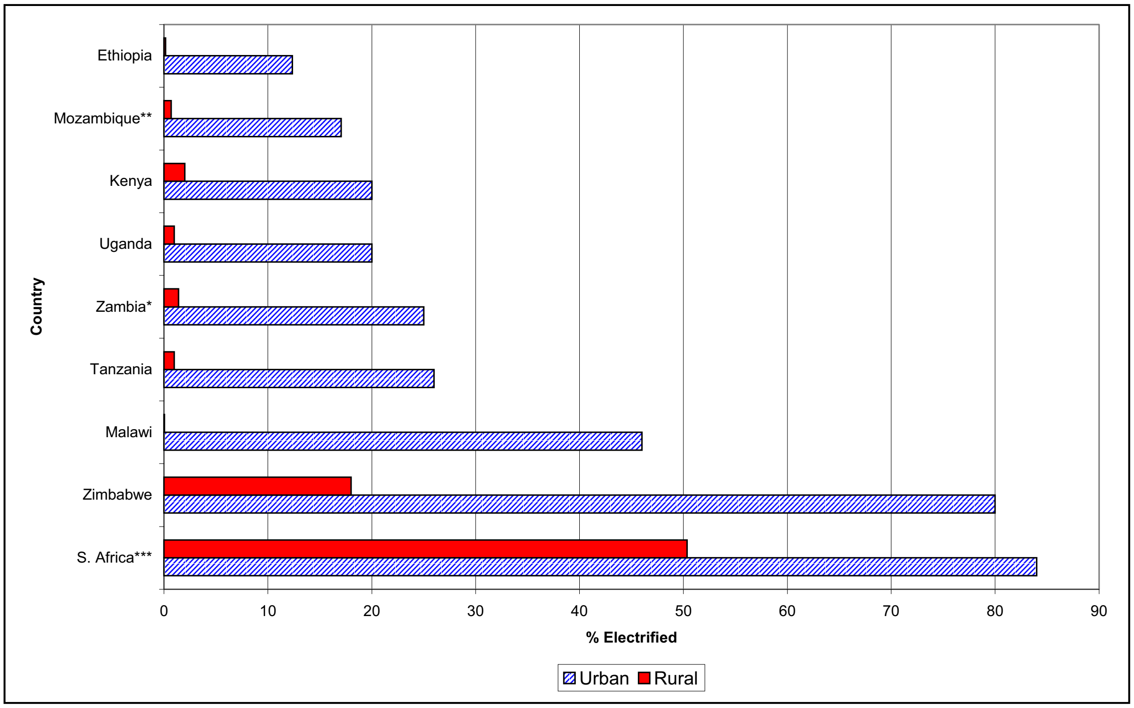


The conventional energy sector, and in particular the electricity sector has not lived up to expectations. The sector is mainly characterised by unreliability of power supply; low access levels; low capacity utilisation and availability factor; deficient maintenance; poor procurement of spare parts; and, high transmission and distribution losses among other problems (Karekezi and Kimani, 2002).

The power utilities in Africa have failed to provide adequate levels of electricity services to the majority of the region's population, especially to rural communities and the urban poor. Provision of electricity is largely confined to the privileged urban middle and upper income groups as well as the formal commercial and industrial sub-sector. The financial performance of utilities in most African countries is equally unsatisfactory.

Household electrification is low especially in the rural areas of sub-Saharan Africa. Statistics also show that even in urban areas, with the exception of Zimbabwe and South Africa, the percentage of households served with electricity is still small (Karekezi and Kimani, 2002).

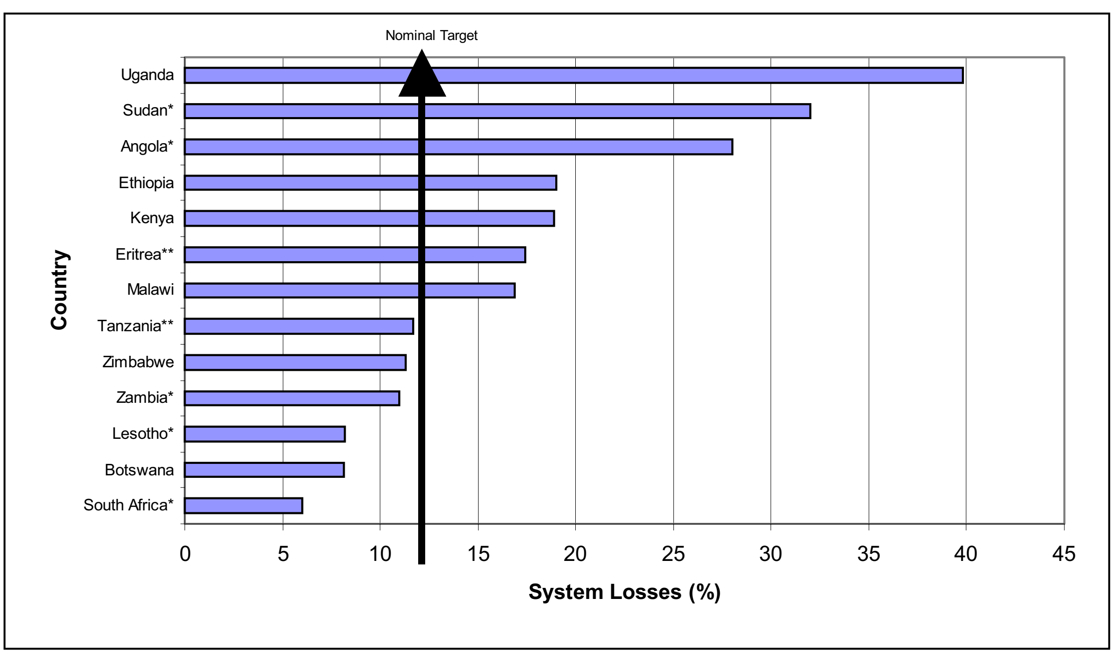
Figure 3: Urban and Rural Electrification Levels In Selected sub-Saharan African countries



Sources: Karekezi and Kimani, 2002, AFREPREN/FWD, 2001b; Teferra, 2000; Mapako, 2000; Kayo, 2001; Mbewe, 2000; Chiwaya, 2001; Dube, 2001; World Bank, 1996; NER, 2001

In addition, the electricity supply industry in Africa is characterised by high system losses when compared with the international target of about 10%-12% (figure 4). Some of the power utilities in Africa, record figures of up to 30%. The financial performance of electricity utilities in most African countries is equally unsatisfactory.

Figure 4: System Losses in Selected African Countries (1999)



Source: Karekezi and Kimani, 2002, AFREPREN/FWD, 2001b; Chiwaya, 2001; Kayo, 2001; Okech & Nyoike, 2000; Teferra, 2001; Kyokutamba, 2001

The poor performance of the conventional large-scale energy sector is partly linked to its limited links to traditional knowledge systems. Conventional large-scale energy systems are often turnkey projects using imported technology. There is very limited local involvement in the design and commissioning of these projects. Consequently, maintenance becomes a problem with the bulk of the plant components having been imported. Even in cases where local manufacture might be possible, the insurance requirements of the investment often prohibit the use of local components. The absence of local involvement also results in limited ownership leading to very high levels of waste. Nigeria provides the most shocking example, where at one stage close to a two thirds of the country's installed power generation capacity was not in use due to maintenance problems (Indigo Publications, 2000a; Indigo publications, 2000b; Indigo Publications, 2000c; Mbendi, 2001; Oduniyi and Njoku, 2003). The breakdown in its refinery industry which has resulted in recurrent shortages of refined products is also an illustration of limited ownership and involvement (Indigo Publications, 2003).

Another common problem that plagues the large-scale conventional energy sector is allegations of corruption primarily due to the scale of financial investments involved. For example, the investment cost of the 250MW Bujagali Hydropower Project in Uganda is estimated at close to half a billion US dollars. The project was halted due to allegations of corruption. A former Ugandan Energy Minister accused of accepting bribes to advocate for the project resigned from a senior World Bank appointment in 1999 (Bayliss and Hall, 2000). These allegations have been brought to the attention of the World Bank's Department of Institutional Integrity (World Bank, 2003). In addition, the Government of Uganda awarded the contract to AES Corporation through negotiations and not international competitive bidding (Bosshard, 2002, Bayliss and Hall, 2000).

The Lesotho Highlands Water Project involved the diversion of water from Lesotho to South Africa, and the construction of a hydro-power plant (72MW) to supply Lesotho with electricity (Redeby et al, 2001). A total of 19 corporate entities and individuals were accused of bribing a top official in the multi-billion pound Lesotho Highlands Water Project in order to gain project contracts. They were charged with paying a 1.2 million pounds bribe into the Swiss bank account for the former chef executive for the Lesotho Highland Water Project, Masupha Ephraim Sole (Hildyard, 2000; Probe International, 2003 and Eldis, 2003). Sole was convicted of 11 counts of bribery and two of fraud and was sentenced to 18 years in prison (Porter, 2002). The Lesotho High Court convicted Acres International, a Canadian engineering consulting firm, of paying bribes to win contracts for the project (IRN, 2002).

In Kenya, the Turkwell Gorge Hydro Power Project was riddled with numerous controversies. The awarding of the contract to French contractors was not done through competitive bidding. The project cost increased from the initial cost of Kshs. 1 billion to Kshs. 5 billion, a move that raised questions both locally and internationally. There were allegations of under-the-table payments involving prominent politicians (The Standard Limited, 2003; The United Kingdom Parliament, 2001). The project operated on less than half its installed capacity for up to 2 years after its completion. Due to the corruption scandal revolving around this project, international donor assistance to Kenya's energy sector was cancelled for a decade (The United Kingdom Parliament, 2001).

There were allegations of corruption in the awarding of the contract to YTL, a Malaysian firm interested in the coal-fired Hwange power project in Zimbabwe. The project, which involved the renovation of the existing 6 generation units and the construction of 2 additional units of 300MW each, was initially supposed to be awarded through a tender process (Indigo Publications, 1997a). However, the Malaysian YTL was declared the preferred bidder after the first round of shortlisting of bids, effectively short-circuiting the bidding process. The Board for the state-owned utility, Zimbabwe Electricity Supply Authority (ZESA), resisted the decision to award the tender to YTL. As a result, the Board was dissolved, and a new board constituted to begin negotiations with YTL. There are indications that the project will result in high construction costs and significant tariff increases (Sader 1999, Indigo Publications, 1997b).

With the right approach, the renewable energy industry in Africa can be designed to avoid the pitfalls associated with conventional large energy systems. Future renewable energy initiatives in the region can be designed to tap local indigenous knowledge thus ensuring local ownership, facilitating maintenance and availability of components and eventually leading to greater sustainability.

Renewable energy technologies can play a major role in national development in terms of job creation and income generation as well as providing an environmentally sound energy service. Compared to the conventional large-scale energy systems that require massive investments, most renewable energy technologies are available at modest capital costs. In addition, renewables are modular and are well suited for meeting decentralised rural energy demand. The modular nature (i.e. can be developed in an incremental fashion) of most renewable energy technologies and the low investment levels makes them particularly suitable for capital-constrained African countries.

Renewable energy technologies refer to energy sources that cannot be depleted. The ultimate source of renewables is the sun's radiation, through direct heating or electricity generation or indirectly, through energy from the wind, waves, running water, plants and animals. This paper deals with solar energy holistically, and discusses solar energy, wind energy, micro-hydro power and biomass energy. The following section of the paper discusses the past and present contribution of traditional and indigenous knowledge on the above RETs.

2. Traditional Wisdom and RETs Development

2.1 Direct Solar Energy

Direct solar energy can broadly be categorised into solar photovoltaic (PV) technologies, which convert the suns energy into electrical energy; and solar thermal technologies, which use the suns energy directly for heating, cooking and drying (Karekezi and Ranja, 1997).

Solar energy is perhaps the most well-known renewable energy technology in sub-Saharan Africa. Solar energy has for a long time been used for drying animal skins and clothes, preserving meat, drying crops and evaporating seawater to extract salt. A lot of research has been done over the years on exploiting the huge solar energy resource. Today, solar energy is utilised at various levels. On a small scale, it is used at the household level for lighting, cooking, water heaters and solar architecture houses; medium scale uses include water heating in hotels and irrigation. At the community level, solar energy is used for vaccine refrigeration, water pumping, purification and rural electrification. On the industrial scale, solar energy is used for power generation, detoxification, municipal water heating, telecommunications, and, more recently, transportation (solar cars) (Karekezi and Ranja, 1997; Ecosystems, 2002).

Solar photovoltaics have been promoted widely in the region, with almost every sub-Saharan African country having had a major PV project. Table 2 shows the dissemination of solar PV in selected countries.

Table 3: PV dissemination in selected sub-Saharan African countries

Country	Estimated Number of systems	Estimated kWp
Uganda	538	152
Botswana	5724	286
Zambia	5000	400
Zimbabwe	84,468	1689
Kenya	120,000	3600
South Africa	150,000	11,000

Sources: Nieuwenhout, 1991; Bachou and Otiti, 1994; Diphaha and Burton; 1993; Karekezi and Ranja, 1997, AFREPREN, 2001, Hankins, 2001; DBSA, 1999.

There is growing evidence that solar PV projects in the region have mainly benefited high-income segments of the population, due to the high cost of solar PV. Solar PV is unaffordable to majority of the population in sub-Saharan Africa, given the high levels of poverty (Karekezi and Kithyoma, 2002).

Other solar energy technologies have not been widely promoted in sub-Saharan Africa, yet these could have an important role in meeting the energy needs of the region. The diffusion of solar water heaters, solar cookers, solar stills and solar dryers has been slower than anticipated but there are some encouraging examples of solar water heater use in South Africa, Mauritius and Botswana (Table 4).

Table 4: Domestic Solar Water Heater Installed Capacity

Country	Installed capacity ($1000m^2$)
Botswana	50
Malawi	4.8
Mauritius	40
Namibia	24
Seychelles	2.4
South Africa	500
Zimbabwe	10

Source: DBSA, 1999, Mogotsi, 2000, Mandhlazi, 2000, Mapako, 2000, AFREPREN, 2002
Traditional knowledge has an important role to play in the successful development of solar energy:

- Due to their knowledge of the environment and climate around them, local people have an intimate knowledge of solar micro insolation patterns. They have information on which locations receive the most sunlight, and would therefore be ideal for the installation of solar technologies. This information, which is not available in meteorological departments in the region, could significantly improve the performance of solar energy technologies.

- As mentioned above, other solar energy technologies, especially solar thermal technologies, have not been widely disseminated in the region compared with solar PV. Indigenous knowledge could be instrumental in developing these technologies, and ensuring more widespread dissemination. For example, solar drying has been practised traditionally for many years. Locals can easily adopt improvements to traditional drying methods, since they are familiar with the technology. Local people could, therefore, play an important role in technological development. The advantage of promoting technologies that build on existing practices such as solar dryers is the ease with which these technologies can be maintained in contrast to imported technologies such as solar PVs.

2.2 Wind Energy

Much of Africa straddles the tropical equatorial zones of the globe and only in the southern and northern regions overlap with the wind regime of temperate westerlies (Grubb and Meyer, 1993). Therefore, low wind speeds prevail in many sub-Saharan African countries particularly in land-locked nations (Table 3).

Table 4: Wind Energy Potentials and Number of Wind Pumps for Selected Countries

Country	Potential (m/s)	Number of Wind Pumps
Botswana	2-3	200
Burundi	>6	1
Djibouti	4	7
Eritrea	3-8	<10
Kenya	3	272
Morocco	>10	-
Mozambique	0.7-2.6	50
Namibia	-	30,000
Rwanda	-	-
Seychelles	3.62-6.34	-
South Africa	7.29-9.7	300,000
Sudan	3	12
Tanzania	3	58
Uganda	4	7
Zambia	2.5	100
Zimbabwe	3-4	650

Sources: Diab, 1988; Stassen, 1986; Linden, 1993; Fraenkel et al ,1993; Kenya Engineering, 1994; IT Power, 198; Mosimanyane et al, 1995; Sampa, 1994; Sawe, 1990; Mwandosya and Luhanga, 1983; Turyahikayo, 1992; Razanajatovo et al, 1994., Karekezi and Ranja, 1997; Karekezi and Kithyoma, 2002

Largely as a result of low wind speeds, the bulk of wind machines found in eastern and southern Africa are used for water pumping (Smalera and Kammen, 1995), rather than electricity generation. Wind pumping supplies water form household use, irrigation and for livestock (Table 4).

Wind energy development in the region continues to be hampered by the absence of adequate wind energy resource assessment especially at the micro-level – a barrier that could be overcome by skilful use of indigenous knowledge.

Contribution of Traditional Wisdom:

- As mentioned above, wind energy development in Africa is hampered by the absence of data on wind regimes at the micro-level. This presents an entry point for traditional knowledge. Local communities know the areas with higher wind speeds, and can therefore be instrumental in building a database on micro wind speeds.

- A second important contribution of traditional wisdom to wind energy development is in the manufacture of wind pumps. Over 90% of a wind pump's components can be manufactured locally by small and medium scale informal sector enterprises (mainly metal works and fabrication). Botswana, Kenya, South Africa, Zambia and Zimbabwe have several well-established manufacturers of wind pumps (Karekezi and Ranja, 1997). There are opportunities to further develop the manufacture of windpumps locally in sub-Saharan African countries, by building on local know-how.

2.2 Biomass Energy

Biomass energy constitutes the bulk of energy used in most sub-Saharan African countries, and constitutes for 70-90% of primary energy supply in some countries (IEA, 2001). Biomass energy, which refers to a wide range of natural organic fuels such as wood, charcoal, agricultural residues and animal waste, is often used in its traditional and unprocessed form.

Traditional biomass energy use has serious environmental drawbacks. The indoor air pollution from unvented biofuel cooking stoves is a major contributor to respiratory illnesses in highland areas of sub-Saharan Africa (Kammen, et al, 1999). Reliance on biomass (especially in the form of charcoal) also encourages land degradation. In some areas, for example around major cities like Lusaka, Zambia, Dar-es-Salaam, Tanzania and Nairobi, Kenya, charcoal demand appears to contribute to degradation of the surrounding woodlands and forests (Karekezi, 2002a, Kantai, 2002)

Over the years, efforts have been made to improve and modernise small-scale biomass energy systems to ensure environmentally sound use of biomass energy. Improved urban stoves have been developed and registered significant levels of dissemination in sub-Saharan Africa (Table 5). Improved stoves have, however, registered slower dissemination rates in rural areas of the region.

Table 5: Estimated Number of Improved Bio-Fuelled Stoves Disseminated in Selected Sub-Saharan African Countries

Country	Number distributed
Kenya	1,450,000
Burkina Faso	200,000
Niger	200,000
Tanzania	54,000
Ethiopia	45,000
Sudan	28,000
Uganda	52,000
Zimbabwe	20,880

Source: Katihabwa, 1993; Kammen et al,1994; Alemayehu, 1993; Gett, 1990; Kammen and Kammen, 1993; GTZ, 1994; Gay et al, 1993; World Bank, 1991; Karekezi, 1988; Ali and Hook, 1992; Kismuel al, 1990; Otiti, 1991; Otiti, 1993.Karekezi and Turyareeba, 1994; Karekezi and Ranja, 1997; AFREPREN Data Base, 2000

Contribution of Traditional Wisdom:

- As major uses of biomass, local communities can have an important role to play in the sustainable use of biomass fuels. Knowledge on fast maturing tree species, which is available locally, can be instrumental in initiating successful reforestation projects (Coe, 1992). In addition, local communities can practice agroforesty (combine crop farming with tree planting), and ensure sustainable biomass fuel use (Kerkhof, 1990). Local communities are well versed on which crops can be combined best with tree planting.

  For example farmers in semi-arid parts of eastern Kenya have developed and practiced an agro forestry system, using their highly developed knowledge of tree husbandry in marginal areas. The particular tree species is planted on cropland and does not interfere with crops due to its deep roots. Trees in the cropland are pruned to avoid competition with crops, especially for light. Therefore, crop yields are largely unaffected by the trees. The pruned leaves and fruits are used as animal fodder, while the branches provide firewood. The trees are also used for timber, to provide additional incomes for smallholder rural farmers. In addition, the trees have strong smelling flowers, which attract bees, and have encouraged the practice of bee-keeping (Blomley, 1994). This indigenous agro forestry has yielded significant benefits to the community, while ensuring sustainable use of firewood.

  In Tanzania, Black Pepper is traditionally planted at the base of mature trees, which provide support for the crop. The crop, however, grows unattended to heights of over 10m, which makes it difficult to harvest. Over the years, farmers have developed an agro forestry system that involves growing black pepper on living stakes of the Mexican stinkwood tree. This particular tree has several advantages, including the fact that it grows well with crops, fodder grass and other tree species, and that it establishes easily and grows rapidly. Farmers have developed methods of ensuring successful establishment of the black pepper vine, which after maturing remains productive for 15years. Once the vines are no longer productive, the trees are harvested for use as building or fencing poles and fuelwood supply (Wardell, 1991).

- On the technology end, traditional know-how has already registered significant results. For example, the Kenya Ceramic Jiko (KCJ), an improved charcoal cookstove, is widely manufactured in Kenya by the informal sector, and has been disseminated widely in urban areas. (Karekezi and Ranja, 1997). One of the success factors of the KCJ is that local communities and enterprises were involved in the manufacture of the ceramic lining for the stove, effectively building on the already established local clay industry (Muriithi, 1995), and the fabrication of the metal cladding (Karekezi and Ranja, 1997). By building on this case example, local communities, especially in rural areas, can contribute to the manufacture of improved biofuel stoves, and their dissemination in rural areas.

2.3 Small-Hydro Power

Small hydropower is often categorized into mini and micro hydro, and refers to the harnessing of power from water at a small scale (capacity of less than 10MW). Small hydro has the advantage of multiple uses: energy generation, irrigation and water supply. In addition, small hydropower is a very reliable technology that has a solid track record. It is best suited for rural areas where the grid cannot reach. Small hydro is considered more environmentally friendly, since it avoids the significant environmental impacts associated with large-scale hydro, including loss of habitat, change in water quality and siltation (Inversin, 1986).

Much of the unexploited potential for small hydro is in remote areas of Africa (Hydronet 3, 1994). Eastern and southern Africa is endowed with a large number of permanent streams, rivers and tributaries that provide excellent hydropower development potential. Small hydro utilization in the region is still very low (Table 5). There is limited information on small-hydro sites in the region.

Table 6: Small Hydro Power Utilisation in the region

Country	**Harnessed (Small) (MW)**
Uganda*	0.50
Mauritius	6.70
Kenya	6.28
Burundi	5.17
Somalia	4.60
Zambia	4.50
Tanzania	4.00
Lesotho	3.54
Malawi	1.52
Botswana	1.00
Rwanda	1.00
South Africa	0.40
Swaziland	0.30
Mozambique	0.10

* Other stations of total capacity 6.81MW are not operational
Source: Karekezi and Turyareeba, 1995; Karekezi and Ranja, 1997

Contribution of Traditional Wisdom:

- The development of small hydropower in the region is hampered by the lack of documented resource assessment on small hydro sites. Traditional knowledge on the location of streams, rivers and tributaries could be useful in bridging this gap. Local communities also have information on patterns of river flow and flooding, which is useful for predicting the potential of small hydro power plants. Involvement of local communities in the collection of information on small hydropower potential is therefore important.

3. The Way Forward

Traditional wisdom and indigenous knowledge are key to the success of renewable energy projects in sub-Saharan Africa. Project reports that document the failure of projects in sub-Saharan Africa have often singled out the failure to involve local people in the development of the project as the major reason for the failure of projects (IK Notes No. 1, 1998). It is, therefore, important that future renewable energy projects integrate traditional wisdom and know-how in the design and implementation.

The choice of renewable energy technologies for dissemination and development in sub-Saharan Africa should take into account the existing knowledge and local industries. Technologies that improve existing methods and build on already established industries are likely to be successfully disseminated. In addition, these technologies can become self-sustainable in the long-term.

Electrical renewable energy technologies (e.g. solar PV) are unlikely to be widely disseminated in the region, due to the lack of technical know-how locally on their operation. As mentioned earlier, a significant proportion of conventional energy investments have gone to waste mainly due to the heavy emphasis on electricity and on imported technology. In addition, a significant portion of the components in electrical technologies is imported. This raises the costs and reduces out the opportunities for local technological development.

Mechanical and thermal/heat technologies (e.g. windpumps, small hydro, improved cookstoves), which reduce the drudgery of daily tasks that local people must perform build on local knowledge and skills. Consequently, maintenance is a less of problem, which would result in greater and more sustainable dissemination. In addition, these technologies are modular (can be increased gradually over time), and can be locally manufactured. This translates to opportunities for employment and enterprise creation locally. With increased financial support at national and international levels for such technologies, it may be possible for an African country to become a significant player in the global renewable energy industry. Candidate technologies that could complement traditional and indigenous knowledge and improve the livelihood of local people include:

- Low cost efficient hand tools and animal drawn implements, which would increase the agricultural productivity of rural Africa

- Low cost but more efficient biomass-based combustion technologies (e.g. improved cookstoves, efficient charcoal kilns, brick making kilns, fish smokers, tea dryers and wood dryers).
- Pico and micro hydro for shaft power that can be used to process agricultural produce and increase its value
- Ram pumps for irrigation, which increase agricultural outputs thus generating income to the rural farmer
- Solar dryers that can lower post-harvest losses and enable the rural farmer to market his produce when prices are higher
- Solar water pasteurizers that provide clean potable water and reduce water borne diseases, which translates to increased availability of labour and thus increases agricultural output and income.

There is a need to undertake further analysis on the benefits of RETs and the contribution of traditional knowledge and wisdom in the development of RETs. Data on the contribution of traditional wisdom is not easily available, and could be instrumental in convincing policy makers. A proposed study on renewable energy technologies in eastern Africa, being supported by the Heinrich Boll Foundation Regional Office for East and Horn of Africa, and co-ordinated by the African Energy Policy Research Network/Foundation for Woodstove Dissemination (AFREPREN/FWD), is a timely input to addressing this issue. Additional initiatives are, however, required for the rest of the region.

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