Chapter 3

Energy for Sustainable Development

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3.1 Basic Facts and Issues

The concept of sustainable development refers to development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987). This has social, economic and environmental dimensions. The way energy is produced and used plays an essential role in all the three dimensions. Current primary energy sources are shown in Figure 3.1. The energy system today is heavily dependent on the use of fossil fuels (coal, oil and gas), which together account for 80% of global primary energy consumption (Johansson and Goldemerg, 2002). It is clear that countries differ significantly in the structure of their energy consumption (Figures 3.2-3.4).

Fossil fuel consumption accounts for 83% of the energy consumed in industrialized countries and 93% in the transition-economy countries, but only 70% in developing countries. In contrast biomass represents only 3.4% of primary energy used in industrialized countries, is virtually non-existent in countries in transition, and accounts for 26% of energy used in developing countries. Nuclear energy is also significant in industrialized countries (where it is the source of 11% of primary energy) and countries in transition (5%), but makes only a minor contribution in developing countries (1%). The figures also highlight the extreme inequalities in per capita use among groups of countries. Industrialized countries use 4.7 tons of oil equivalent (toe) per capita, in contrast to developing countries, which use only 0.78% toe per capita; the world average is 1.6 toe per capita.

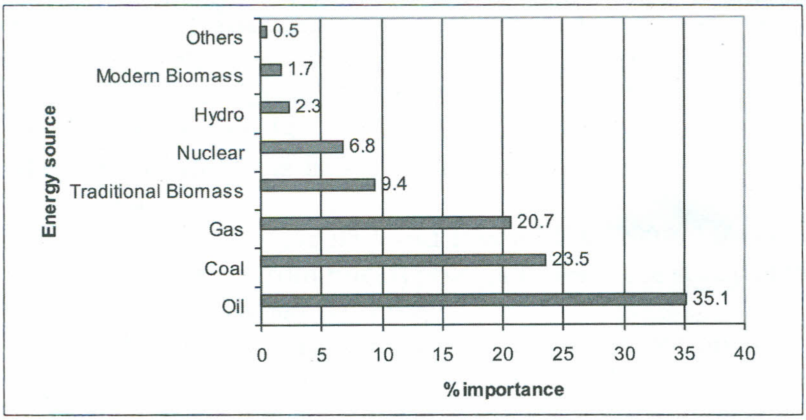

Figure. 3.1. Primary energy sources in the world (Johansson and Goldemerg, 2002)

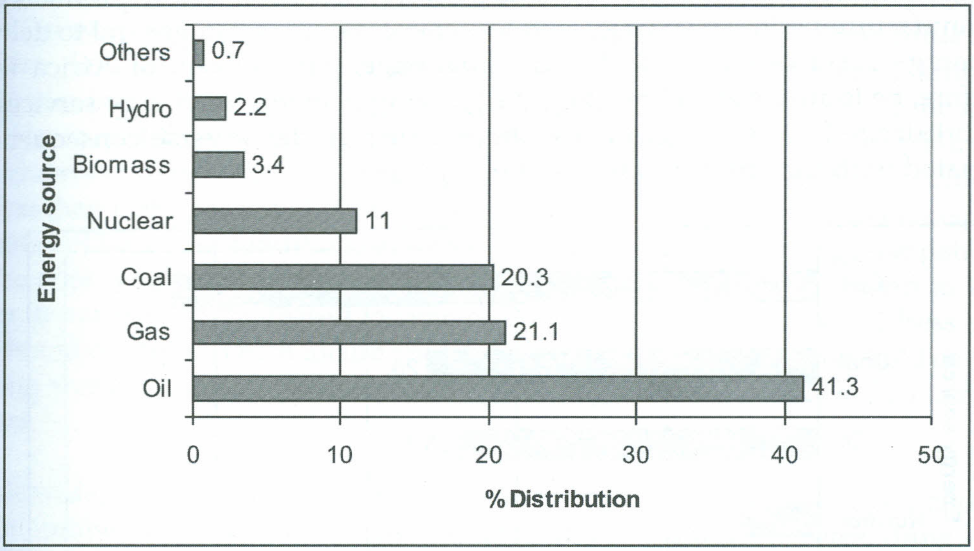

Figure 3.2. Primary energy sources in industrialized countries (Johansson and Goldemerg, 2002)

3.2 Key Issues in Energy and Sustainability

The pattern and profile of energy use prevailing today raises important questions about linkages between energy and the economy, social issues, security and above all, environmental protection.

During most of the twentieth century, primary energy supply has been cheap and abundant. However, due to limited emphasis on optimising the use of more energy efficient end-use technologies the energy system as a whole has evolved with limited regard for optimisation. The energy system is made up of the energy supply sector and energy end-use technologies; the object of the system is to provide energy services. Thus, if the end-use technologies are not efficient, the system cannot be efficient either. One of the most important economic issues related to energy has to do with the relationship between energy prices and energy use. Energy prices influence consumer choices and behaviour. High-energy prices can lead to high-energy bills, which in turn have adverse consequences for business, employment, and social welfare.

For instance, industries in Kenya have cited high electricity tariffs as principal reasons for closure and relocation (Karekezi and Kimani, 2002). On the other hand, high energy prices can also stimulate exploration and development of additional resources, create incentives for innovation and efficiency improvements, and attract new investments. The oil crisis of the 1970s highlighted the importance of energy efficiency and ultimately contributed to a significant decoupling of energy consumption and gross domestic product. As a result, more products can be manufactured with less energy, and less energy is needed in general to deliver the energy services required. A major challenge, particularly for Africa will, therefore, be to find ways of meeting the growing demand for energy services to support desired economic growth without incurring the adverse consequences associated with the current patterns of energy use.

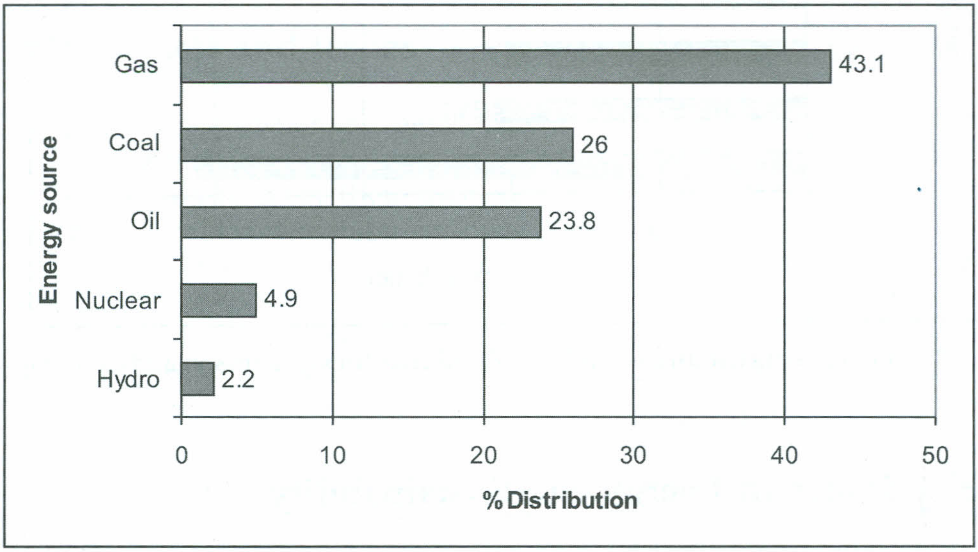

Figure 3.3. Primary energy sources in transition-economy countries (Johansson and Goldemerg, 2002).

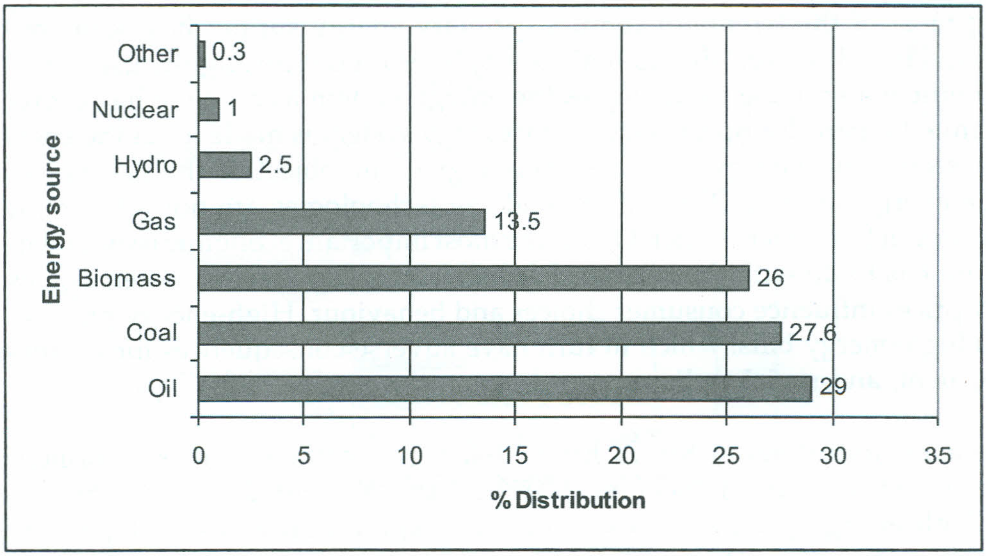

Figure.3.4. Primary energy sources in developing countries (Johansson and Goldemerg, 2002)

Energy use is closely linked to a wide range of social issues, including poverty alleviation, population growth, urbanisation, and creating opportunities for women. In addition, poverty is the overriding social consideration in Africa in particular and other developing countries in general, and poses one of the main threats to political stability in many countries. According to the Human Development Report 2003 by some 1.3 billion people in the developing world live on less than US$1 per day (UNDP, 2003). Income alone, however, is an inadequate measure of the social conditions in which poor people live. The energy use patterns of the poor - especially their reliance on traditional biomass fuels - tend to keep them impoverished. Increased income by itself would not therefore address their needs and concerns which include reducing physical labour for household chores, having access to safe and potable water, reducing the need to collect fuel, among others.

Worldwide, an estimated 2 billion people are without access to electricity and the same number use traditional fuels - fuel wood, agricultural residues, dung - for cooking and heating (UNDP and WEC, 2000). Over 100 million women spend hours every day gathering and carrying fuel wood and water and then spend additional hours cooking in poorly vented spaces. The traditional and inefficient stoves and open-fire cooking devices used often lead to significant health impacts through the generation of pollutants that expose women and children to air pollution corresponding to smoking two packs of cigarettes a day (Johansson and Goldemerg, 2002). The hours, women and children spend gathering fuel significantly reduce their opportunities for education and/or engaging in more productive income-generating activities. Bellamy (1995) has observed that the more time and effort a woman spend dealing with ramifications of environmental degradation such as gathering fuel-wood, the less time and effort she spends on other productive activities such as farming.

Although it is generally accepted that population growth tends to increase energy demand, it is however, less widely understood that the availability of adequate energy services can lower birth rates. Adequate, affordable and quality energy services can shift the relative benefits and costs of fertility towards a lower number of desired births in a family. An acceleration of the demographic transition to low mortality and low fertility (as has occurred in industrialised countries) depends on crucial developmental tasks, including improving the local environment, educating women, and ameliorating the extreme poverty that make child labour a necessity. All these tasks will require low-cost and quality energy services. Providing energy services than can address the many social needs in Africa and other developing countries will require major changes in the energy systems.

Environmental degradation associated with the production and consumption of energy today, threatens human health, quality of life, and affects ecological balance and biodiversity. Human Disruption Index is a measure of the extent to which human-generated activities alter the environment (UNDP & WEC, 2000). It is also defined as the ratio of human-generated flow of a given pollutant to the natural or baseline flow. In the case of sulphur, for example, human-generated emissions are 2.7 times the natural baseline flow. And 85% of this disruption is a result of fossil fuel burning (UNDP 2000) and the use of traditional forms of energy, such as biomass. Current patterns of energy generation and use threaten human and eco-system health at every level. At the household level, solid fuel use for cooking and heating has significant health impacts. About 2 billion premature deaths occur every year from exposure to indoor air pollution caused by burning solid fuels in poorly ventilated spaces (Reddy, et al., 1997). The environmental impacts of a host of energy-linked emissions - including suspended fine particles and precursors of acid deposition - contribute to air pollution and ecosystem degradation. Further, emissions of anthropogenic greenhouse gases, mostly from the production and use of energy are altering the atmosphere in ways that very likely influence the global climate.

Thus preventing further environmental damage, or even reversing it, must be an important goal of energy policy. Finding ways to meet the inevitably growing demand for energy services without causing local, regional or global environmental damage is a major challenge. Similarly, attention to energy security (the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices) is critical because of the uneven distribution both of the fossil fuel resources on which most countries currently rely and of capacity to develop other resources. The energy supply could become more vulnerable over the near term due to growing global reliance on imported oil. The potential for disruption of energy security due to increased conflicts, sabotage, disruption of trade, and reduction in strategic reserves are additional important considerations. Present energy systems also provide targets for acts of terrorism. These potential threats point to the necessity of strengthening global as wells as regional and national energy security.

The challenge of sustainability

Although there seems to be no near-term physical limits to the world's energy supply, today's energy system is unsustainable because of equity issues as well as environmental, economic, and geopolitical concerns that have implications far into the future. Firstly, modern energy and electricity are not universally accessible, an inequity that has moral, political and practical dimensions in a world that is becoming increasingly interconnected. Secondly, the current energy system is not sufficiently reliable and affordable to support the desired widespread economic growth. The productivity of one third of world's population, majority of them in sub-Saharan Africa, lack access to commercial energy, and perhaps another third suffers economic hardship and insecurity due to unreliable energy supplies (UNDP and WEC, 2000). Thirdly, negative local, regional, and global environmental impacts of energy production and use threaten the health and well being of current and future generations. Addressing these issues is the major challenge facing Africa in particular and the world community in general while sustainable development remains the goal in both cases.

3.3 National incomes and Consumption of modern Energy

National income levels in sub-Saharan Africa are significantly lower than in North Africa and South Africa. When North African countries are excluded from the GNP per capita estimates, the region's per capita drops from US$677 to US$492 in 1999. If South Africa is excluded, the per capita drops to US$306 (Karekezi, 2002); which is less than 14% of the incomes in industrialized countries. Sub-Saharan Africa's total GNP was less than Korea (population of 47 million) in 1999 and also less than that of Netherlands (16 million). In 1998, the total merchandized exports of sub-Saharan African countries (mostly in the form of unprocessed commodities) was about half that of Korea.

The high levels of poverty prevalent in sub-Saharan Africa are more dramatically reflected in the consumption of modern energy. Between 1990 and 1997, per capita consumption of modern energy in sub-Saharan Africa has remained small and stagnant - falling slightly from an average of 248 kg of oil equivalent (kgoe) to 238 kgoe - about 50% of the world average. The low levels of modern energy consumption in sub-Saharan Africa are even more striking when one considers electricity consumption. Excluding South Africa, per capita consumption of electricity drops from 447 to 126 kWh. There appears to be a correlation between GNP per capita and modern energy use per capita (Karekezi, 2002). The low incomes that are found in most sub-Saharan African countries could, in conjunction with other factors, account for the very low level of modern energy consumption. One may therefore conclude that increasing incomes is one way of increasing consumption of modern energy in sub-Saharan Africa.

According to the International Energy Agency (IEA, 2002), approximately 50% of the population in developing countries relies on biomass energy, with some regions recording higher proportions (73% in Africa). Biomass is the energy source for the poor. This is especially true for traditional biomass energy, which is often collected as a 'free' fuel (Karekezi and Kithyoma, 2002). There appears to be a correlation between poverty levels and traditional biomass use in many developing countries. As a rule, the poorer the country, the greater the reliance on traditional biomass resources.

3.4 Energy Services for Sustainable Rural Development in Africa

Indeed, lack of access to clean and affordable energy is one of the defining characteristics of poverty in sub-Saharan Africa. It is well known that poor people tend to use biomass as their energy carrier and that in many areas there are increasing supply shortages, which add to the burden of the women who have the primary responsibility of collecting it. However, despite the fact that roughly 2 billion people use biomass fuels (World Bank, 2000), there have been limited systematic and comprehensive attempts to analyse the energy-poverty nexus. This can partly be explained by the fact that mainly women and children collect biomass in rural areas at zero monetary cost and so it falls outside national energy accounts. For instance, it is estimated that the informal charcoal industry in Kenya generates Ksh23 billion in gross annual revenues, which is about 72% of the 1998 total oil import bill (Eco-Forum, 2002). Yet the Ksh23 billion is not reflected in the national energy accounts, and is therefore unregulated, untaxed and not supported. As a consequence, decision makers are not fully aware of the significance of the use of biomass as an energy source and policies and strategies fail to fully address the critical issues relating to its demand and supply patterns.

In Africa, lack of access to clean and affordable energy services is a core dimension of poverty. It is common knowledge that poor people tend to use biomass (wood, charcoal, animal dung, and crop residues) as their energy carrier and that in many areas there are increasing supply shortages, which add to the burden of women and children who have the primary responsibility of collecting it. In Kenya, for instance, the supply of accessible biomass from all the sources was estimated at 15 million tons in 2000 - against a demand of 35 million tons, representing a deficit of 20 million tons. The deficit is projected to rise to almost 34 million tonnes by 2020 (Ministry of Energy, 2002).

The use of biomass by poor people has a number of serious repercussions. The fuel quality is low, burning with levels of smoke and particulates that are recognised as having negative effects on health. The World Health Organisation (WHO) acknowledges that use of biomass fuels leads to level of indoor air pollution many times higher than the acceptable international ambient air quality standards, exposing poor women and children on daily basis to major public health hazard (Schirnding, et al., 2001). This exposure increases the risk of important diseases including pneumonia, chronic respiratory problems and is estimated to account for substantial proportion of the global burden of diseases in developing countries. Evidence is also emerging that exposure may increase the risk of number of other important conditions including TB, low birth weight and cataract. Moreover, the poor households use less energy per household than wealthier ones. One possible consequence is that less water is boiled for drinking and other hygiene purposes.

This increases the likelihood of water borne diseases, which, in turn, reduces the ability of poor people to improve their livelihoods, not only preventing adults from working effectively but also negatively affecting children's learning. Another study has observed in extreme situations of wood fuel scarcity, some poor households begin conserving energy by altering their diets to include foods that needed less cooking and avoiding indigenous and nutritious foods such as cassava, arrow roots, maize and beans that require much more energy to cook (Kirubi, 1998). Although nearly every household in rural areas will use some form of biomass, another concern is that poor households tend to spend more time and effort searching than the households in higher income groups do.

Wealthier people are able to exercise wider choice in their energy carrier and many opt for the cleaner and more efficient energy carriers of electricity and gas (LPG or biogas). A recent study on fuel substitution carried out in urban households of Nairobi (Kenya), Kampala (Uganda) and Addis Ababa (Ethiopia) showed that, in general, higher-income households tend to use a wider range of cooking devices and associated fuels, whilst the poorer households are limited to the use of one or two types of fuel, predominantly wood fuel or kerosene. Therefore the wealthier are less exposed to the negative health and time effects and vulnerabilities linked to biomass. Wealthier people are able to afford the appliances that make use these modern energy carriers and in places where they are reliant on biomass fuels, they are able to purchase more efficient stoves.

The poorest groups already pay much more for relatively higher quality services when they are available - buying car batteries, paraffin and LPG and more efficient biomass stoves. Recent research suggests that poor families in the rural areas of Kenya, though heavily reliant on wood fuel, can spend up to one third of their disposal income on such energy services roughly US$8-12 per month while 15% of rural households in Zimbabwe use car batteries for radios and televisions and, to a lesser extent lighting (Shell Foundation, 2001). Another study estimates that a quarter of a typical family's income is spent on wood fuel and alternative energy sources like LPG are often beyond the means of most Kenyans (Kituyi, 2002). Where they are available to the poor, the prices of these quality energy services remain very high. The price of paraffin, for instance, in rural India and South Africa can be from 2-10 times its price in cities (Shell Foundation, 2001).

Thus not only are the poor paying disproportionately high costs for the lowest quality energy services, but they also adopt higher discount rates when deciding on energy services, opting for lower first cost options rather than those based on life-cycle costs. Energy services, which have lower costs per unit of energy received on a life cycle costs basis may have higher upfront investment costs. The consequence for the poor is that more of their precious cash resources are used on lower quality fuels, at lower efficiency and hence their ability to accumulate the financial resources they need to invest in strategies for improving their livelihoods and poverty reduction are significantly reduced. Therefore, understanding the decision making process within households when choosing energy services which would appear to work against sustainable livelihoods and poverty reduction is important for designing effective interventions.

Another striking example to demonstrate that the poor are paying more for much less is to be found within the solar Photo-voltaic (PV) system for rural households where grid connection is not an economic option. The cost of a typical low-end PV household system is several times higher than the GNP per capita of most sub-Saharan African countries (Table 3.1).

Table 3.1. GNP per capita and cost of 40-50Wp Solar PV system

Country	GNP per capita (1999)	Estimated cost of solar PV system (40-50Wp) US$	% of est.cost of solar PV system per GNP per capita
Zambia	330	1200	363.63
Uganda	310	1037	334.52
Eritrea	200	600	300.00
Kenya	350	620	177.14
Lesotho	570	1000	175.44
Zimbabwe	610	800	131.15

Source: Karekezi & Kithyoma, 2002

Even after adjusting for the differences in the standards of living, rural inhabitants are poorer than their urban counterparts and their income flows are often less regular. As such the most successful renewable energy technologies in rural Africa are likely to be the ones that can generate income and facilitate the start-up of small micro-enterprises. The stress and emphasis on equity means that rural energy services must first and foremost promote poverty alleviation and improved living conditions for the poor, as measured by the Human Development Index (HDI). The HDI measures a country's achievements in three aspects: longevity, knowledge and decent standard of living (UNDP, 2003). Improving these aspects of human development, and therefore the HDI, has three crucial dimensions: (i) equity based on a marked increase in access of poor to energy services, (ii) employment, including income generation based on strengthened endogenous self-reliance, and (iii) environmental soundness based on sustainable use of resources.

As such the following features are essential for energy services meant to benefit the rural poor:

- Increase their access to affordable, reliable, safe and high-quality energy
- Strengthen their self-reliance and empower them
- Improve the quality of their environment, starting with the household environment.

3.5 Strategies for Delivering Rural Energy Services

Johansson and Goldemerg, (2002) have suggested the following strategies for the delivery of rural energy services:

- The *reduction of arduous human labour* (especially the labour for women and children) for domestic activities and agriculture
- The *modernisation of biomass* as a modern energy source in efficient devices
- The *transformation of cooking* into a safe, healthy, and less unpleasant end-use activity
- The *provision of safe water* for domestic requirements
- The *electrification of all homes* (not merely villages)
- The *provision of energy for income-generating activities* in households, farms and village industries

While the above strategies are comprehensive and progressive, recent thinking emphasizes that *choice* in energy options is critical to meeting the needs of poor people and that a variety of strategies and tradeoffs will be necessary, including fossil fuels (Cecelski, 2003). The Shell Foundation, under the Sustainable Energy Program, has aptly described this as the 'full-menu' approach to imply the wide range of energy technologies and devices required to deliver sustainable energy services for the poor (Shell Foundation, 2002). Despite many efforts, rural energy poverty is still widespread. To make a difference, new approaches and strategies must emphasize an explicit poverty focus, decentralization and participation, and the integration of energy efforts with other development sectors.

The above strategies pertain to *what* rural energy should achieve and deliver. But there should also be strategies that pertain to *how* these energy services should be achieved and delivered. Johansson and Goldemerg (2002) have suggested three process strategies for delivery of rural energy services, thus government facilitation and enabling support, individual initiative as far as possible through the market, and village community monitoring and control

With a few exceptions, the standard approach to the establishment of new infrastructures has been for governments to take the initiative. This approach often ends up with emergence of new government agencies and accompanying bureaucracies that may be plagued by red tape, delays, or even corruption. World Bank (2000) notes that corruption in the energy sector takes many forms, from petty corruption of meter reading and billing to grand corruption in the allocation of lucrative monopolies. These practices lead to weak operational and financial performance, and for the poor in particular, declining service quality or reduced chances of ever accessing network services.

Similarly, although the market may indeed do an excellent job in allocating labour, materials and resources; it does not, however, have a successful record at safeguarding equity, the environment, research and development (R&D) and dissemination of new technologies. A number of studies have acknowledged that while electricity liberalisation has led in some cases to improved technical and financial performance in generation and transmission, these beneficial results have been outweighed by negative environmental, social, economic impacts (Wamukonya, 2003). There is, however, a third option, namely encouraging individual initiative subject to local community control. It has been shown that it is possible to realise 'Blessing of the Commons' situations (converse to the well-known 'Tragedy of the Commons') in which the costs that an individual/household experiences for not preserving the commons far outweighs whatever benefits there might be in ignoring the collective interest (Johansson and Goldemerg, 2002). The authors add that *there can be a confluence of self-interest* and *collective interest* so that the interest of the commons is automatically advanced when individuals pursue their private interests.

Arguably, a pragmatic example of the third option is the upcoming innovative credit schemes facilitating the adoption of off-grid household solar PV, pico/micro-hydro power, and energy-saving woodstoves for schools in Kenya and in other many developing countries, with inspiring results. In this arrangement, an individual makes an upfront down payment, usually 25%, either as cash and/or in kind, towards meeting the total cost of the energy system. The balance is provided, either as soft loan or a mix of loan and grant by development partners, through NGOs, community-based organisations, savings and credit organisations (SACCOs) and/or banks. Successful examples in Kenya include the Community Solar Energy Project in Bahati Nakuru (by SCODE), the Micro-hydropower project in Chuka, Meru (by ITDG-EA), the Energy Saving Institutional Stoves and Woodlots in Mt. Kenya Region (by RETAP) and the Michimikuru Solar Home System in Meru (by SOLARNET) (Mwangi, 2002).

3.6 The Human Development Index (HDI) - Energy Nexus

For rural energy systems or technologies to advance sustainable rural development, the emphasis must be on *energy services* and not merely on energy consumption (or supply) or on energy technology (however efficient) as an end in itself. The focus has to be on energy services that improve the HDI (Table 3.2). The role that energy can play in improving the HDI is not merely a matter of hope or conjecture. There is empirical basis to the relationship between HDI and energy. Strictly speaking, the relationship must be between energy services and HDI. However, if end-use efficiency is virtually constant, energy consumption can serve as a proxy for energy services as illustrated in Figure 8 by (Johansson & Goldemerg, 2002). The relationship between HDI and energy has several important implications.

Large improvements in HDI can be achieved with small inputs of energy (i.e., small improvements of energy services), making the HDI-energy (benefit-cost) ratio very high. Similarly, even large inputs of energy (large improvements of energy services) result only in marginal improvements in HDI, i.e., the HDI-energy (benefit-cost) ratio is very low.

Table 3.2. Welfare improvements (HDI) for households using improved woodstoves in Kenya and Ethiopia

Welfare improvements (HDI)	Kenya	Ethiopia
Increases speed of cooking	62%	69%
Reduces indoor air pollution & smoke	70%	55%
Increases safety when handling the stove	82%	83%
Increases convenience for cooking	77%	81%
Improves the taste of food	81%	60%
Is easier to clean & maintain	80%	56%
Is more durable	40%	66%

Source: Energy for Sustainable Development (2000)

The Micro-Hydropower Project in Chuka and Meru, in Kenya is another example linking small investment to significant improvement in HDI. The project is funded by UNDP/GEF/SGP (Kenya) and implemented by the Intermediate Technology Development Group-East Africa (ITDG-EA) in conjunction with the Ministry of Energy and local community (Mwangi, 2002). The project is nearly complete and targets to generate 14kWe to provide power to 300 households within the community where the prospects for grid connection are remote. As at May 2003, a number of small to medium enterprises such as a barber shop, hair salon, welding, battery charging and video entertainment were functional, employing more than 20 people and generating direct income for their households. In Phase Two, it is anticipated that, at night, when power demand by households and enterprises is off, the system will be used for water pumping, resulting in further welfare improvement and poverty alleviation for the rural community. The success of this project has convinced the Government, which was hitherto ambivalent to community ownership and distribution of non-grid power, to accept and support mini-grid systems and 1000kW has been set as a ceiling that can be owned by a community (Mwangi, 2002). This is major policy step forward in addressing rural energy services taking into account that ITDG-EA estimates that Kenya has over 100 locations with potential for such small scale power plants (100-1000kW) and many more pico power plants (10kW).

3.7 The Energy-Gender-Poverty Nexus

The poor use energy and other scarce resources to eke out livelihood strategies. Poverty influences and determines which source of energy is chosen and used in a household. It is also one element that can enhance or detract from survival strategies of the poor. Furthermore, rural energy poverty has a gender bias. Cecelski (2003) highlights some "gendered" findings of past research on energy demand of the rural poor are as follows:

- Energy is needed for household uses, such as cooking, lighting, space heating, and other appliances; for agricultural uses, such as tilling, irrigation, and post-harvest processing; and for rural industry uses, such as milling and mechanical energy and process heat. Energy is also an input to water supply, communications, commerce, health, education, and transportation in rural areas. Much of this energy use and production is by women.

- Higher-income people generally use more efficient and more convenient sources of energy, such as gas and electricity, whereas poor people use less efficient and less convenient sources, such as fuel wood and human energy. In actuality, multiple fuel use is common at all income levels and the "fuel ladder" is perhaps more accurately replaced by a "fuel pyramid" of multiple fuels for different purposes and at different times. What is important to note is that poor people have fewer energy options than do the rich, and they often pay more for them both absolutely (paying higher unit prices) and relatively (as a percentage of their income) than do the rich. Poor women nonetheless highly value and need multiple energy options to help manage their daily work and time. In Java, Indonesia, families using electricity have lower lighting expenditures and receive on average six times as much light as households using kerosene (World Bank, 2000). For cooking, the urban poor often pay more for wood and charcoal than they would for LPG, once the end-use efficiencies of the fuels are taken into account.

- The main use of inanimate energy in rural areas is for cooking and heating. Biomass is the primary fuel used and will continue to be so for the foreseeable future. The major source of energy in rural areas is human labour, used for both survival activities and production. This dependence on biomass and human energy is an important factor in rural poverty, and it is not measured either in national accounts or in energy balances. Women's (and children's) role in this energy use system is well known. Negative effects of energy scarcity on poor women have been well documented. Health is a primary concern here.

- The presence of a large number of female-headed households in many developing countries, as well as women's primary responsibility for energy procurement and management (and the invisibility of these tasks in national energy accounts), gives this energy poverty a particular gender bias. The risk of poverty is greater for women, with about one-third of rural households in developing countries being female-headed.

- Neither public nor private energy infrastructure provision is gender-neutral. Women use energy and electricity differently than men because of their different household and productive activities. For example, decisions on how and where electricity and electricity services (such as information and communication technology packages) are provided to households and communities influence women's ability to take advantage of these services.

- Women's micro-enterprises (an important factor in household income, as well as in women's welfare and empowerment) are heat-intensive (food processing), labour-intensive, and/or light-intensive (home industries with work in evenings). Lack of adequate energy supplies—and other coordinated support—for these activities affect women's ability to operate these micro-enterprises profitably and safely. Conversely, the provision of affordable energy can be a key factor in enabling rural enterprises.

Addressing the challenges women face in the energy sector has been a concern in Africa for the last two decades or so. First, women were viewed as the destroyers of natural resources through their harvesting of biomass for energy, then they were seen as victims of a biomass energy crisis, and more recently some view women as the saviours of natural resource management through their superior traditional knowledge. All the while, the impact of interventions in energy development have had limited positive impact on the lives of women in general.

Time and effort spent by women in their subsistence and economic chores are an indicator of quantity and quality of energy available to them. Energy poverty is associated with time burdens, drudgery and heavy workloads, poor sanitation and indoor air pollution, all leading to overall poor welfare for women and children. For example over 50% of the women and youth in rural areas in Kenya spend their time in subsistence farming, grazing cattle, fetching fuel wood and water. The time and human capital spend on these activities to meet basic necessities are the opportunity costs foregone on managing the environment (Karani, 2002).

Research indicates that reducing time burdens of women could significantly increase household cash incomes, and productivity of labour and capital. Women play a vital role in agricultural activities in rural areas of many countries in Africa.

They are heavily involved in cultivation, planting, harvesting and marketing of agricultural produce. Their work is highly fragmented and a high value is placed on time saving, especially during peak agricultural periods. Modern energy would therefore go a long way in enhancing the productivity of women in agricultural activities (Table 3.3).

With respect to poverty reduction, Johansson and Goldemerg (2002) argues that the improvement of HDI via income generation depends on what the income is used for. Is it used for HDI improvement? For liquor?, Gambling? Conspicuous consumption? This often depends on which gender gets the income. Women tend towards expenditures that improve the HDI of their families, particularly their children.

Table 3.3. Renewable energy technologies (RETs) applications in agriculture

RET	Selected agricultural process
Photovoltaic technologies	Pumping, lighting, cooling, crop processing
Solar water heaters	Dairy processing & heat energy for poultry
Wind pumps	Irrigation, crop processing
Biogas plants	Production
Bio-fuel cookstoves	Milk pasteurisation, heat energy for poultry, crop drying, crop processing
Animal-driven vehicles	Transport

Source: Karekezi & Kithyoma, 2002

The importance of bringing a gender perspective to energy policy analysis and design is still not adequately addressed, nor have the lessons for development been fully integrated by donors or national policy makers. Although many are sympathetic, gender is still commonly viewed predominantly as a peripheral rather than a central economic agenda, thus not fully integrated and accounted for in the national development plans and priorities.

3.8 Policy Measures towards Promotion of Rural Energy Services

Level playing field for all the available and potential energy technologies

A fundamentally important issue concerns the choice of technology. In a command-and-control set-up, characterized by monopolies and national utilities, technologies are chosen in a top-down manner by government and its bureaucrats. In most cases, such choices are notoriously defective, supply-driven rather than demand-driven, and prone to political interference and corruption. The other option is to allow the market to make the choice through a process of competition. Though the market option is attractive, it is only effective when there is a level playing field for the various contending technologies. This means that deliberate policies are needed to ensure that there is a level playing field for centralised supply and decentralised village-level supply, including end-use efficiency improvement. The problem is that yet-to-mature emerging rural energy technologies must not be compared on the basis of their current costs with mature conventional technologies. The place and potential of emerging technologies must be determined on the basis of their costs resulting from technological advances and organisational learning.

Sustainable development criteria

Notwithstanding the importance of the cost criterion for the choice of technology, there are other crucial sustainable development criteria as well. In particular, a technology has to be accepted by society for it to be socially sustainable. This means that there has to be social participation in the choice of technology. Special policies are required to ensure that the process of technology choice is transparent and democratic. In this process, whatever criteria can be quantified must be quantified. For the criteria that cannot be quantified today, Johansson and Goldemerg (2002) recommend that it should, as an interim measure, be represented with traffic-light colours – green for 'acceptable', red for 'not acceptable' and amber for 'uncertain' – while setting in motion a process to develop an acceptable and objective method for quantifying the criteria.

HDI improvement

As has been amply demonstrated, small investments in energy services could lead to dramatic Human Development Index improvements particularly for the low-income groups, including women. Policies are needed to promote the development and dissemination of technologies that improve HDI directly (e.g., cooking, safe water, home electrification for lighting, space conditioning for comfort, etc.) as well as technologies that improve HDI indirectly via income generation (e.g., stationary and mobile motive power, process heating, etc.).

Implementation package of hardware plus 'software'

For each rural energy system, for example, micro-hydro-based electricity generation, it is vital to have an entire implementation package of hardware plus 'software'. Where 'software' refers to instructions, procedures, knowledge, do and don'ts, etc., necessary to utilize the hardware. The software will also enhance end-use efficiency, durability, value-for-money and cost-recovery particularly when the hardware is installed on credit. Such packages must consist of the technology, economics, financing, management, training, institutions, etc., necessary for the dissemination of that system. Too often, crucial elements (e.g., institutional requirements) are missing in the dissemination programmes, leading to failures. Hence policies to encourage the preparation of implementation packages are imperative.

Subsidies

Energy services companies, both private and public, may have weak incentives to provide access to quality energy services to the poor, mainly because of low population densities, which make it costly to serve remote locations. Another constraint is the low incomes of the poor, who often use little energy compared with wealthier households. Thus the main barriers to service may be access costs, the ability to pay for access, and related government policies such as import restrictions and taxation. A subsidy can be used to assist poor households in obtaining higher-quality services - either some of form of direct subsidy to the poor or, whether service networks are non-existent, incentives to business to develop such networks. However, energy subsidies should be directed at encouraging access to services rather than helping to cover the operating costs of providing the services. Historical precedent from industrialized countries provides another justification for subsidy. Just as poor areas in today's industrialized countries benefited in the past from non-market energy policies, such options should still be available and justified for the African poor.

However, the success of subsidies should be assessed by the criteria of *efficacy*, *sector efficiency* and *cost-effectiveness*. Efficacy means that the subsidy reaches those for whom it is intended, the poor (minimizing the errors of inclusion and exclusion). Sector efficiency means that the subsidy is structured in such a way that it encourages provision of service at least cost. Cost effectiveness means that the subsidy achieves social goals at the lowest program cost while providing incentives to businesses to serve poor and rural populations. To achieve these three goals, decision must be made on the subsidy's target group, on its form and its level, on the eligibility criteria for the subsidy and how to finance it.

The lessons and experience from Brazil with respect to using subsidies in promoting LPG for cooking in households are crucial for African countries. By 1999, Brazil had managed to achieve 99.4% adoption and use of LPG stoves by households, thanks to carefully designed and targeted subsidies, which catalysed and bolstered the demand and the market for LPG (Johansson and Goldemerg 2002). This almost completely eliminated the use of fuel wood for cooking and created 300,000 jobs. It is estimated that this shift in fuels has avoided the deforestation of one million hectares of forest per year. Among developing countries, Brazil ranks seventh in per capita consumption of LPG at approximately 40 kg/capita/year. In Africa, with exception of Tunisia and Algeria, average consumption is less than 1kg/ capita/year. LPG has significant potential to substitute and replace biomass fuels like charcoal and firewood used for cooking and heating. As a cooking fuel, LPG is 10 times more energy efficient than wood fuel and several thousand times less polluting (UNDP and WEC, 2000).

In Kenya, over 700,000 cylinders were in use throughout the country by March 2002 (Bess, 2002). Yet LPG remains inaccessible to most of the population due to high upfront costs as well as high tariffs and duties (18% VAT, and import duty on LPG). If the latter were removed, one industry group estimates sales of cylinders would increase by 20% and sales of gas by 18% (PIEA and EAA, 2003). Nonetheless, subsidies must not be a permanent crutch inhibiting the advancement of the technology and enterprise.

Local capacity building

The establishment and operation of rural energy services should lead to local capacity building in the matter of hard ware (technology) and 'software' (particularly management). Policies must be put in place to promote such local capacity building at the rural level, and special attention must be given to operation and maintenance know-how as distinct from construction and design know-how.

Financing

Policies are crucial to arrange and enable financing, through innovative and flexible mechanisms (e.g., through leasing, loans, revolving funds, etc.,) for households and communities so that unacceptably high initial capital costs are converted into manageable operating costs. In Ghana, a national energy fund has been successfully utilized to finance renewable energy projects and energy efficiency activities on a sustainable basis (Karekezi, 2002). The India Renewable Energy Development Agency (IREDA) is another example of an institution deliberately set up to support and finance new and renewable energy technologies and energy efficiency in India (Rao, 2001).

Other notable examples of financing schemes include the RETAP Revolving Credit Scheme for Schools in Kenya (Mwangi, 2002) and Photovoltaic programme in Bangladesh supported by the Grameen Bank of Bangladesh (UNDP & WEC, 2000). African governments should use their Poverty Reduction Strategy Papers (PRSPs) and other national development frameworks as instruments and platforms for harnessing and leveraging financing from the numerous global conventions and multilateral environmental agreements such as the Kyoto Protocol (UNFCCC), the Carbon Fund (World Bank), the Millennium Development Goals (UNDP), the Global Environmental Facility (UNDP, UNEP & World Bank), and NEPAD, among others.

Quality standards and codes of practice

Those marketing, selling and installing energy systems and equipment should be able to ensure and guarantee that their systems are both safe and long-lasting so that unsuspecting consumers can receive full value for their investments. Institutions are needed to establish and enforce minimum standards for all entrepreneurs, including installers and equipment designers (Hankins, 1995).

Synergistic government support

In view of the noted shortcomings of the government implementation, there is need to harness and combine the strengths of entrepreneurship, the dynamics of markets as well as the advantages of local community involvement, for operations independent of the government. Nevertheless, government involvement in rural energy services is essential to provide the enabling policy environment. Above all, parallel operations by government, for instance, the grid-based rural electrification programmes, must not compete with, but rather complement, other non-government rural energy initiatives. Thus policies to ensure synergistic government support for individual and/or community initiatives for rural energy services are vital.

3.9 Sample Question

i Heavy dependence on biomass energy is the main cause of environmental degradation and pollution in Kenya. Discuss using relevant examples.

ii Suggest a sustainable energy policy for Kenya in line with the out puts of both Rio 1992 and the World Summit for Sustainable Development, Jo'burg 2002.

iii Critically examine the challenges of developing and using clean energy in Kenya.

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