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Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Status of renewable energy consumption and developmental challenges in Sub-Sahara Africa

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ARTICLE INFO

Article history:

Received 9 August 2012

Received in revised form

27 May 2013

Accepted 28 June 2013

Available online 1 August 2013

Keywords:

Renewable energy

Sub-Sahara Africa

Challenges

Development

ABSTRACT

Energy use is a prerequisite for physical and socio-economic development in both rural and urban communities. There is a need to promote and guarantee energy security, availability and reliability to preserve any existing level of development and further new developmental strides for human comfort. Access to modern energy is considered one of the foremost factors contributing to the disparity between developed and developing nations. Undisputedly, Sub-Saharan Africa (SSA) is the most physically and economically backward developing and poverty-stricken region in the world. The slower rate of development can be attributed to the low access to modern energy use in the region as a result of a high level of constraints ensuing from underprivileged energy policies, inadequate funding, ineffective energy infrastructures and the low pace of technological diffusion. These overlapping deficiencies are responsible for the looming scenario of energy crisis in the region, which has heightened the degree of dependency on combustible renewable energy sources for primary energy consumption. The application of modern renewable energy is a negligible component in the regional power sector compared with its naturally endowed potential. This review presents the current state of affairs of renewable energy application in SSA. From a focal point of view, wind energy, solar energy, hydropower, bioenergy and geothermal energy are fundamentally discussed within the framework of socioeconomic and technological developmental challenges in this review article. It was stressed that combustible bioenergy is excessively consumed in the region especially in the rural segment of society. It also pinpoints some prevailing challenges negatively influencing the development of renewable energy using modern technologies. Conclusively, this research highlights the need for effective international and cross-sector collaboration on inputs from financial, resource and technological development mechanisms for renewable energy exploitation.

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Contents

1. Introduction	454
2. The role of energy in the development of a society	455
2.1. Energy in a progressive society	455
2.2. Rural electrification factors for diffusion of innovation in developing countries	455
3. Current uses of renewable energy in SSA	456
3.1. Bioenergy sources	456
3.1.1. Biogas	456
3.1.2. Agricultural crop biomass residues	457
3.1.3. Forest bioenergy resource	457
3.2. Solar energy sources	458
3.3. Wind energy source	459
3.4. Hydropower sources	459
3.5. Geothermal energy	460

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4. Challenges facing renewable energy development in SSA.	460
4.1. Cultural constraints.	460
4.2. Educational background	461
4.3. Unstable economies and low levels of foreign investment	461
4.4. Poor financial support and high interest on credit facilities	461
4.5. Unsustainable renewable energy policy	461
4.6. Impracticable demonstrations, absence of core technologies and poor capacity building.	461
5. Regional bodies and renewable energy for rural development in SSA	461
6. Renewable energy policy issues	462
7. Conclusion	462
References	462

1. Introduction

The Sub-Saharan Africa (SSA) region is at the moment engrossed in the mesh of an energy crisis and undisputable socio-economic deficits. The region accommodates 13% of the human population in the world [1]. Access to modern energy in SSA has been time after time ranked underprivileged and the region was said to have occupied the last position in terms of growth in gross domestic product (GDP) and contemporary developmental strides. SSA is the least developing sub-region of the world with a very high number of dispersed rural settlements. The scattered nature of the rural settlements is responsible for the sub-region being technically and economically weak in achieving substantial grid connection development in the power sectors of many countries in the region despite the continuous increase in electrical energy demand. Between 1980 and 2007, world energy consumption grew by 5.4% while that of SSA grew by 1.54% with the regional countries' consumption accounting for only 2% of the world total [2]. Approximately 30% of the population in the region has access to electricity [3,4]. It is apparent that the nominal potential of renewable energy in SSA is great but the sustainable political will and enthusiasm to enact the regulatory framework for exploitation through modern techniques is low. This disparity is explained in more detail in Table 1 [5], which expresses the annual production potential of renewable energy (RE) relative to the present annual domestic energy consumption in the majority of countries in SSA.

Furthermore, in urban areas where the government has focused more attention on the delivery of electricity services to consumers, many households are subjected to underserved conditions, a problem resulting from supply system constraints and insufficient generation. Most urban areas in SSA have a very low percentage of electricity connection access due to the high price of fossil fuel electricity, unregulated tariff mechanisms and poor

subsidy packages. In the last few years, some countries in the region, though limited in number, have made remarkable steps forward in providing access to electricity. In 2008, household access to electricity in Mauritius, South Africa, and Ghana stood at 100%, 70%, and 56%, respectively [6].

The majority of people in SSA exceedingly depend on biomass especially combustibles for primary energy generation for domestic cooking and heating purposes. Combustible renewable energy resources especially charcoal, wood fuel, dried crop and animal residues have some environmental effects due to incomplete combustion. Charcoal and firewood produce emissions but they are lower in charcoal compared to firewood stoves [7–9]. These combustible bioenergy sources are used in traditional stoves with no provision for direct or indirect indoor air pollution control. Low combustion efficiency is another characteristic of the stoves although presently technical efforts are being harnessed for improvement. The degree of success has reportedly varied with the ability of designers to alter some design parameters and the introduction of new design concepts.

Recent increases in the atmospheric concentration of greenhouse gases (GHGs) have renewed concerted interest in renewable energy to safeguard the environment. Exploitation of renewable energy (RE) sources is one of the most prevalent and suggested strategies to mitigate the impacts of climate change [10–12]. In many countries worldwide, national administrators in cooperation with international communities have been making rigorous efforts to moderate the discharge of greenhouse gases (carbon dioxide, methane, carbon monoxide and others) into the atmosphere. A report by the International Energy Agency (IEA) [13] stated that in 2005, 68% of total anthropogenic GHG emissions were obtained from energy related-activities. Improving electricity access in SSA has become a serious aspiration for regional stakeholders, which is in concert with global efforts towards rapid transformation to renewable energy supply. Currently, there is the potential for

Table 1
Annual production potential of RE to current domestic energy consumption.

Country	Total	Country	Total	Country	Total
Namibia	100.5	Burkina Faso	15.9	Kenya	6.5
Central African Republic	90.9	Madagascar	14.6	Malawi	6.4
Mauritania	86.2	Guinea-Bissau	14.2	Ghana	5.7
Chad	77.3	Tanzania	14.1	Uganda	3.1
Mali	58.4	Cameroun	12.7	Gambia	2.7
Niger	50.4	Senegal	12.5	Burundi	2.2
Congo	43.6	Benin	12.5	Nigeria	2.0
Angola	27.9	Sierra Leone	10.1	Swaziland	1.6
Sudan	27.6	Cote d'Ivoire	9.6	Lesotho	1.4
Zambia	25.2	Eritrea	9.5	South Africa	1.3
Congo Dem. Republic	24.7	Guinea	9.0	Equatorial Guinea	0.9
Mozambique	23.4	Togo	8.9	Cape Verde	0.9
Botswana	22.4	Ethiopia	8.5	Rwanda	0.7
Gabon	20.3	Zimbabwe	8.0	Comoros	0.2

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