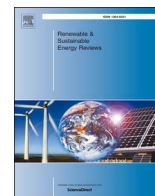




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Renewable energy to improve energy situation in African island states

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ABSTRACT

The energy situation of the African island states which include Cape Verde, São Tomé and Príncipe, Comoros, Guinea-Bissau, Madagascar, Mauritius and Seychelles are overwhelmingly dependent on fossil fuels with paradoxically high potential of renewable energy which are sparsely developed. This paper lay emphasis on the present electricity situation in these countries and highlights the potential of renewable energy resources on their territories. Among Africa islands, demographic and economic features are dissimilar and their power sector is complex by unique challenges. It is seen that there is a critical lack of electricity in Guinea-Bissau and Madagascar, which are 21% and 13% respectively, due to political instability and high spending on diesel. Moreover, the electricity consumption per capita is alarming in Guinea-Bissau, Comoros and Madagascar where it is below the average consumption for low income countries.

Sustainable energy supply can be achieved by renewable energy sources, however, not all renewable resources are technically and economically feasible for development in these countries, for example wind in Comoros and hydro in Mauritius have little potential – which this paper elaborated further. Based on these analysis, a roadmap was developed, on to how to address some of the energy issues in these countries and accelerate the uptake of renewable energy. Through energy governance reform, political decision makers can drive change within their government, especially when a reform entails opening market opportunities and stimulating private participation and exerting pressure on existing government agencies to work efficiently.

1. Introduction

Rising carbon dioxide level in the atmosphere and associated environmental problems have compelled responsible policymakers to implement policies and to look for innovative strategies to shift towards cleaner energy sources. While the annual increase in renewable energy consumption (biomass and waste, geothermal, ocean, solar, wind and hydro) is expected to be almost five times higher than for fossil fuels by 2030, the latter will still be the dominant primary energy source to satisfy global energy demand by the target year [1]. This is not unfavourable but simply means that mankind has to increase effort to speed up the integration of more renewable energy in the global energy system. In this context, it is essential to firstly analyse the existing energy system of a country before further planning is made to develop their energy sector in a more sustainable way. This paper provides a picture of the energy situation in the African island states and lays emphasis on the prospects for renewable energy development on their territories. The paper attempts to bridge the gap in literature on energy sector development in African islands which has been vaguely studied in the scientific discourse [2].

The structure of the article is as follows: after the introduction and

methodology for data collection and analysis (Section 2), Section 3 highlights their present electricity industry – their electrification status, energy profile, installed capacity and contribution of renewable energy for electricity generation. Section 4 discusses the various types of renewable energy resources – their availability and exploitable capacity in the selected countries. Lastly, Section 5 presents the conclusion of this study.

2. Data collection and analysis

The countries selected in this study are progressive island countries located in the African region; namely Cape Verde, São Tomé and Príncipe, Comoros, Guinea-Bissau, Madagascar, Mauritius and Seychelles. With the exception of Madagascar, all countries constitute of a number of small island archipelagos, spread over the Indian and Atlantic Ocean. Madagascar originates from a huge land mass detached from the supercontinent Gondwanaland million of years ago to be re-located in the Southern Indian Ocean [3]. 69% of Guinea-Bissau is composed of continental area and the remaining area forms part of the archipelagos of Bissagos [4]. All countries are tropical countries and are highly susceptible to recurrent cyclones [5]. Climate conditions are hot

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List of acronyms

CEB	Central Electricity Board
EAGB	<i>Empresa De Electricidade E Água da Guiné-Bissau</i>
EDA	<i>Electricité d'Anjouan</i>
EMAE	<i>Empresa de Água e Electricidade</i>
GDP	Gross Domestic Product
HDI	Human Development Index
IIAG	Ibrahim Index of African Governance
IPP	Independent Power Producer

JIRAME	<i>Jiro sy rano Malagasy</i>
MAMWE	<i>Gestion de l'Eau et de l'Electricité aux Comores</i>
PUC	Public Utilities Corporation

Measurement units

GWh	gigawatt hour
MT	million tonnes
MW	megawatts

and humid with little variation over the years [5].

Materials and methods in this work were derived from a desktop literature search with statistical data compiled from a wide range of sources including country-level publications, online databases, and working papers from international and intergovernmental agencies, peer-reviewed scholarly works and other think-tank reports. Reliability and accuracy of data collected has been maintained by cross-checking same information with different sources. Based on a literature search, data collected was analysed through simple analytical instruments like graphs and percentages. Simple mathematics was used to derived percentages and figures from raw data collected from the sources mentioned hitherto.

Analysis of countries' electricity industry was conducted by dividing data gathered into two sub-sections which are (1) the electricity access situation and (2) electricity production and supply outlook. One limitation of this article is that it focuses mostly on supply side electricity production, rather than demand side energy consumption, for the reason that government energy entities do not always record data pertaining to the energy sector [6] and data on energy consumption patterns are lacking in many of the selected islands. For comparison and contextualisation, demographic and economic indicators of these countries were provided to represent their market conditions.

3. Energy profile of African island states

3.1. Macroeconomic indicators

Table 1 provides demographic and economic features of selected countries which are highly distinct. Seychelles is the smallest among the selected countries with the highest per capita Gross Domestic Product (GDP) followed by Mauritius. Even though Mauritius is over two hundred times smaller than Madagascar with incomparable population size, the GDP per capita of Madagascar is much lower due to its larger population. In terms of economic competitiveness, the Global Competitiveness Report 2015–2016 ranked Mauritius first in sub-Saharan Africa and 46th globally while Seychelles was ranked 8th (97th globally), Cape Verde 12th (112th globally) and Madagascar 25th (130th worldwide) in the African region [7]. In 2015, Mauritius was also designated first among 54 African countries in political stability and good governance through the Ibrahim Index of African Governance (IIAG) [8]. In the same IIAG ranking, Cape Verde was ranked 3rd, Seychelles

4th, São Tomé and Príncipe 11th, Comoros 26th, Madagascar 33rd and Guinea-Bissau 43rd [8]. These indicators revealed that Mauritius and Seychelles have greater political stability, sustainable economic opportunities and higher Human Development Indices (HDI) than their counterparts (Table 1) which is 0.777 and 0.772 respectively. Little economic and political stability lead to low HDI as evident by Guinea-Bissau and Madagascar. However, political stability seems dwindling as evident by drop in IIAG score by 7.6 points for the period 2006–2015. Economic activities in most of these countries are agriculture-based, with the exception of Mauritius which has transitioned from an agriculture-led economy to a diversified economy comprising of financial services, tourism, textiles and sugar. Efforts are currently ongoing to transform the tourism industry (services sector) in Seychelles where reliable energy provision is a must.

3.2. Electricity access

There is a wide range of literature on the causes, existing challenges and possible solutions to expand electricity access in African countries and islands [11–21]. The focus here is, however laid on electrification trend in these regions. Besides Mauritius, Seychelles and Cape Verde which became almost fully electrified countries by 2012, electricity access stands as one of the most alarming energy issue in Madagascar and Guinea-Bissau where electrification levels are critically low with little progress to expand electricity access made over the last years (see Table 2). No great improvement is observed for São Tomé and Príncipe for the period 2012–2014, because of under-investment in the energy sector which left generating assets in a poor condition and because of their high reliance on imported energy [22]. Comoros showed commendable improvement with an increase of 24% in electrification rate for the period 2012–2014. For the same period, Guinea-Bissau achieved only 1% increase in electricity access, while Madagascar showed a gradual decrease in electrification rate since 2010. Reason for poor energy performance in these two countries can be attributed to a dysfunctional political system as evident by the relatively low IIAG ranking attributed to these countries (Table 1). Since independence in 1974, it was reported that Guinea-Bissau has been plunged into high level corruption, unstable politics, numerous coups d'état which have eroded the country's infrastructural base and provoked social instability to a large extent [23]. Similarly, in March 2009, Madagascar was faced to a coup d'état which installed significant tension within the civil society

Table 1

Macroeconomic indicators of selected African states (Compiled from [8–10]).

	Population (thousand)	GDP per capita (US \$/cap)	Area (km ²)	HDI, rank	IIAG scores
Cape Verde	514	3450	4000	0.646, 122th	73.0 (+1.9)
São T & P	186	1670	960	0.555, 143th	69.5 (+2.9)
Comoros	770	790	1900	0.503, 159th	50.3 (+3.7)
Guinea-Bissau	1800	550	36,000	0.420, 178th	41.3, (+4.0)
Madagascar	23,600	440	587,000	0.510, 154th	48.5, (–7.6)
Mauritius	1300	9630	2040	0.777, 63th	79.9 (+2.3)
Seychelles	91	14,120	455	0.772, 64th	72.6 (+4.0)

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