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Wind energy in sub-Saharan Africa: Financial and political causes for the sector's under-development

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ABSTRACT

In this article, the first comprehensive overview of the region's wind energy sector, we describe how sub-Saharan Africa's wind energy markets have evolved over the years, and the structural characteristics affecting the development of wind energy projects on the continent. We identify in the literature a number of social, political, economic and environmental issues affecting wind energy. Our analysis of the 94 wind projects in Africa, focusing on 38 projects located in sub-Saharan Africa, suggests that wind energy markets in Africa remain small, concentrated and nascent. We estimate that only 43 megawatts (MW) have been installed in sub-Saharan Africa at a cost of $122 million and projects worth $612 million are under construction to add 230 MW to the existing capacity. Seven of the eight completed wind energy projects in the region are pilot projects with the only project operating at a commercial scale being the Cabeolica wind farm in Cape Verde. We notice a shift from the use of concessional funding toward non-concessional funding and an increasing participation of the private sector to finance the projects. We also find that the public sector remains a key player in developing the wind energy sector in sub-Saharan Africa.

1. Introduction

Over half a billion people in Africa lack access to electricity, most of them in sub-Saharan Africa (SSA), the subject of this Special Issue.[4] The continent's significant endowment with renewable energy sources constitutes plausible solutions to address this existing power gap. Indeed, Africa's reserves of renewable energy resources are the highest in the world and are enough to meet the continent's projected future energy needs [1]. 18 of the 35 developing countries ranked highest in renewable energy reserves, normalized by annual domestic energy consumption, are located in Africa [2]. Similarly, eight African countries are among the developing world's most endowed with wind energy potential. Hence, for many African countries, an opportunity exists to generate electricity in a clean and sustainable manner, including the use of wind. Table 1 shows the number of countries, in their respective regions, with highest potential in renewable energy.

Despite these positive trends, and Africa's potential supply of wind energy, installed capacity of wind-based electricity in Africa, estimated at 1.1 gigawatts (GW) in 2011, does not exceed 0.5% of global capacity. Only 43 megawatts (MW) have been installed in SSA, accounting for a mere 4% of the total installation. Given the difference between renewable energy levels in northern Africa vs. sub-Saharan Africa, it is important to separate the two sub-regions to get a fuller understanding of the challenges and opportunities facing SSA.

The underdevelopment of wind markets in Africa also contrasts with the high growth rate of this industry worldwide. With an

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[4] In this article, we focus on sub-Saharan Africa but also have some analysis that includes northern Africa. Thus, when we refer to Africa, we mean the entire continent.

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Table 1
Number of countries per developing region with the highest potential for solar, wind, hydro and geothermal energy.

Region	Total renewable energy	Solar	Wind	Hydro	Geothermal
Africa	18	24	8	11	9
East Asia/Pacific	4	5	3	6	4
Europe/Central Asia	3	0	6	5	14
Latin America/Caribbean	7	5	8	9	3
Middle East	1	0	1	0	0
South Asia	0	0	1	1	0
All world bank regions	33	34	27	32	30

Source: Adopted from Buys et al. [2].

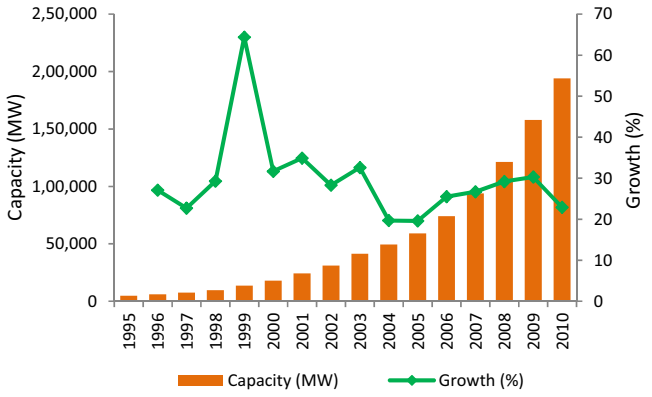

Fig. 1. Growth in global wind generation capacity.
Source: Wind Power [32].

average annual rate of about 30% between 1996 and 2008, wind is one of the world's fastest-growing energy resources in terms of both coverage and technological innovations (Fig. 1). In the first place, this growth reflects advances in technology and energy security concerns in a decade that saw the highest oil prices recorded in history. Climate change considerations have played a role as well.

For SSA, the underdevelopment of wind markets reflects mainly affordability issues as well as sociopolitical and technical considerations. Indeed, it has been widely argued that renewable energy is not a priority for SSA given more basic issues that these countries are dealing with, such as high poverty rates, stagnant economic growth, and health crises, and that until renewable sources are cost-effective, African countries should not pay a high price due to past pollution from advanced economies [3]. Conversely, opponents to this view have claimed that costs related to renewables and wind technology in particular, have come down in the past years [4], and have provided solutions to SSA countries looking to decrease their oil bills, as well as for resource-constrained countries [5].

Africa's installed capacity is expected to grow to 1.5 GW by 2015 and 3.9 GW by 2020 compared to global wind capacity of 396 GW by 2015 and 610 GW by 2020 (Table 2) [6]. This paper examines how wind energy markets have developed in Africa with a focus on SSA. There are two key objectives: to provide a mapping of wind energy potential and projects developed on the continent so far; and to identify impediments hindering further development of wind energy markets on the continent.

2. Literature review

2.1. Social, political, economic and environmental considerations

Before discussing the actual implementation of wind energy projects in SSA and barriers to this market development, we review

Table 2
Installed wind capacity in MW for selected regions.

Region	Year		
	2015	2020	2030
Africa	1589	3896	10,774
European Union	140,623	182,206	253,847
Latin America	9771	15,211	24,945
Middle East	163	1031	10,982
Non OECD Asia	1309	5855	23,005
North America	77,497	118,108	181,398
OECD Asia Pacific	9299	18,953	43,148
Global total	396,311	610,979	964,465

Source: GWEC [6].

the social, political, economic and environmental literature to better understand the theoretical justifications for the development of such projects. The first justification for the need to develop wind energy projects in SSA is that energy is a necessary condition for economic growth. Literature is replete with papers that study the link between energy and economic growth. Interestingly, there seems to be no consensus on the type of relationship linking these concepts. A strand of the literature finds a bidirectional positive relationship between energy and economic growth in Asia [7,8,10] and Africa [9], for instance, suggesting that energy provision fosters economic growth while demand for energy increases with income level. Some suggest that this relationship holds both for energy importers and energy exporters [7].

However, another literature stream points either to a unidirectional relationship running from economic growth to energy demand [11], a unidirectional relationship from energy to growth [12] or a lack of relationship altogether [13]. What's more, Wolde-Rufael [12] documents the absence of a relationship between economic growth and energy provision for the Democratic Republic of Congo, South Africa, Kenya, Congo and Sudan. The fact that SSA is not exempted from this debate is embodied in Wolde-Rufael [12] who studies such relationships between 17 countries on the continent. Findings suggest that there is a positive unidirectional relationship in six countries running from GDP growth to electricity consumption, an opposite causality for three countries and a bi-directional relationship for three of them.

While these conflicting conclusions could constitute at face value an argument against the development of wind energy projects, they should be interpreted with caution. The absence of an empirical relationship could reflect, among others, a type II error[5] in the measures used for access to energy or other binding constraints to growth that cancel the economic benefits generated by enhanced access to electricity.

In terms of social effects, there is much less ambiguity as to the fact that electricity consumption is closely linked to improvements in health and education of the poorest strata of the population [14]. While the positive effects of energy as a whole are well documented, it should be borne in mind that the modalities of energy provision matter when it comes to social welfare. Acknowledging that access to electricity is a pre-requisite for the achievement of health, Markandya and Wilkinson [15] highlight how electricity generation from fossil fuel is also a cause of adverse health outcomes. Against this background, they argue renewable energy solutions can decrease the health-related opportunity cost of traditional energy supply. Beyond the benefits of renewables linked to pollution and health, social perks can also come about considering the spatial structures of SSA. While urbanization is on the rise,

[5] In statistical testing, a type II error means there is an effect the analysis failed to detect.