1. Introduction

Sub-Saharan Africa will triple its renewable energy capacity by 2030 to account for most of the new global additions, if all nationally determined contributions are met [1]. The forecasts come at a time when the continent is endeavouring to achieve universal access to reliable, affordable, and modern energy by 2030 and increase renewable energy consumption in end-use sectors. Electricity access in Sub-Saharan Africa is still low, with about 54% of the population unserved [2], while 85% has no access to clean cooking technologies [3]. According to IEA [4], Africa has great potential to be the first continent to base a significant portion of its economic and industrial development on clean and renewable energy sources. The development will rely on business models that serve underserved markets, drive socio-economic development, and meet environmental targets.

Business models for renewable energy in Africa are rapidly emerging to reach new markets, implement niche technologies, and respond to policy requirements. To this end, there is a broad range of highly adapted business models that are creating, delivering, and capturing social, economic, and environmental value. At the same time, these business models keep evolving for various reasons. First, they evolve to offer new value propositions (i.e. the reasons for consumers to choose a company's products and services), for example, consumer financing to incentivise the uptake of renewable energy [5], or promote energy security [6]. Second, business models evolve to capitalise on emerging business opportunities that increase renewable energy use and, hence, the companies' revenue [7]. Third, business models evolve to respond to stringent environmental regulations aimed at decarbonising power generation e.g. [8].

Past research efforts demonstrate the diffusion [9], trends [10], viability [11], and drivers [12] of these business models for different markets on the continent. However, only a few studies e.g. [13,14] have performed literature reviews of renewable energy business models in Africa so far. These reviews have focused mainly on business models for solar energy, primarily solar home systems and providing energy access. The main themes of these reviews can be summarised as socio-economic development, technology innovation, policy, and viability.

This study builds on the existing work to take stock of the incumbent business models for diverse renewable energy sources covered in literature to critique whether their products and services create the intended value. Hence, the first objective of this study is to offer an in-depth analysis of the status quo of renewable energy business models in Africa to understand why they are adopted and the factors affecting their viability.

Once value propositions are created, they are monetised and delivered to customers for social and economic gains. At the same time, the value creation and delivery process translate to significant environmental impacts. The impacts are positive during the use stage when renewable energy displaces fossil fuels [15] or negative occurring throughout the life cycle of renewable energy technologies e.g. ecotoxicity, pollution, resource depletion, climate change, and exposure to carcinogens and non-carcinogens [16]. For example, a jatropha bioenergy system that converts fallow land has a climate change potential (CCP) of 172.0 g CO_2 eq./kWh which is higher than the CCP of converting cropland i.e. 66.7 g CO_2 eq./kWh [17]. In a different study [18], the CCP of a Libyan wind farm was found to be 10.5 g CO_2 eq./kWh. The insights into the environmental impacts of business models for renewable energy are scarce because this type of research is not yet fully developed. This study seeks to identify whether incumbent business models for

renewable energy in Africa address these concerns. Therefore, the second objective of this study is to evaluate whether the value propositions deliver social, economic, and environmental value. In this context, this study performs a systematic literature review to answer the following research questions:

- RQ1. What types of business models for renewable energy are adopted in Africa and what factors affect their viability?

- RQ2. Do these business models deliver social, economic, and environmental benefits?

This paper is the first review article that investigates business models for diverse renewable energy sources in Africa as covered in existing research. It contributes to the wider literature on the topic by providing synthesised empirical evidence that can be used to evaluate the needs of the sector beyond Africa. This study also provides an understanding of the extent to which different business models for renewable energy in Africa integrate the three dimensions of sustainability. This paper can steer decision-making to improve the performance of the incumbent and future business models.

This paper is organised as follows. Section 2 provides a detailed description of the method used to perform the systematic literature review. It covers the search strategy, the inclusion criteria, and the framework used in the analysis of the results. Section 3 analyses the types and archetypes of business models of renewable energy, and their social, economic, and environmental sustainability. Section 4 discusses the implications of the findings to a broader understanding of Africa's renewable energy sector followed by the conclusion and recommendations for future research in Section 5.