

The Pay-As-You-Go Solar Home System as a Tool of Ending Energy Poverty in Sub-Saharan Africa

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Abstract:

Access to reliable sources of energy can have tremendous impact on the livelihoods of rural people, yeti two-thirds of people living in sub-Saharan Africa have no access to electricity. Pay-As-You-Go solar home systems have been touted in the solar industry as the panacea to affordable and clean renewable energy for remote rural areas. The paper critically reviews the corpus of work on Pay-As-You-Go solar home systems' adoption, usage, role, and impact in addressing energy poverty in rural communities of sub-Saharan Africa. The review evaluates academic and non-academic literature the success of the Pay-As-You-Go solar home system financing model in addressing the need for reliable sources of energy in rural sub-Saharan Africa. Using Google Scholar, Scopus, and Semantic Scholar to select peer-reviewed journal articles focused on Pay-As-You-Go solar home systems, the study critically analyses the existing literature on Pay-As-You-Go solar home systems over the years and unearths various views on the subject. The study concluded that the Pay-As-You-Go platform on solar home systems has been playing a pivotal role in the energy matrix of rural Su-Saharan Africa and consequently has been instrumental in increasing solar u sage and reducing energy poverty in Sub-Saharan Africa.

Keywords:

Pay-As-You-Go, Solar Home System, Energy Poverty, Sub-Saharan Africa.

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Introduction

This study presents the results of a literature review on the role of Pay-As-You-Go (PAYG) solar home systems in driving energy poverty out of the sub-Saharan African region. The review established that, despite the recorded successes of the PAYG solar home system in reducing energy poverty in Asian countries such as India and Bangladesh, the sub-Saharan African region has not recorded such successes and thus continues reeling under immense energy poverty.

Electricity plays a critical role when it comes to the economic and social development of a country (Zhao et al., 2022; Bhatia & Angelou, 2015; Adwek et al., 2020). Globally, according to the International Energy Agency (IEA, 2023), about 1.2 billion people, or about 17 percent of the people on planet Earth lack access to electricity. In Sub-Saharan Africa (SSA) region, 600 million people have no access to reliable electricity, and this is approximately 53 percent of the people globally who live without access to electricity (European Commission, 2021; Zubi et al., 2019; Mukisa et al., 2022). These statistics do not only paint a gloomy picture but also highlight the massive global demand for electricity by humanity.

The Sub-Saharan African region has been grappling with power shortages for some time now (Kizilcec et al., 2020; Mukisa et al., 2022). Businesses, hospitals, factories, educational institutions, homes, and a whole lot of electricity users from several Sub-Saharan African countries, among them Zimbabwe, South Africa and Zambia have had to endure long load shedding hours initiated by the grid-power suppliers of the respective countries (SADC & SARD, 2016). The debilitating power shortages have hurt the rural population of over 600 million in Sub-Saharan Africa the most (Mukisa et al., 2022; European Commission, 2021; Zubi et al., 2019). The rural population has been the most heavily affected considering that in most countries in Sub-Saharan Africa, new connections to the national electricity grid have been at a snail's pace if not non-existent, with the little available power being channelled to the urban areas where most industries are located (Afrobarometer, 2022). This study zeroed in on Sub-Saharan Africa because of the region's well-documented energy poverty (Mukisa, et al.2022; Adwek et al., 2020).

According to Tigabu et al. (2017), in the last two decades, solar energy has been the fastest growing source of energy globally. Afrobarometer (2022) echoes the same view that the most popular source of electricity world-wide besides the national grid has been solar energy. The attractiveness of solar energy as a source of electricity generation stems from its unparalleled abundance in Africa, (Maka & Alabid, 2022). Some authors and researchers argue that one of the most useful tools that has been key in easing energy poverty in rural Sub-Saharan Africa has been the solar home system (SHS) (Kizilcec & Parikh, 2020; Yadav et al., 2019; Mergulhao et al., 2022). Almost all consulted literature consistently hailed entry of the solar home system as key in the reduction of energy poverty and projected it as an unparalleled electricity game-changer in the SSA region.

Some authors and researchers further argue that rural energy uptake has been further enhanced with the introduction of the Pay-As-You-Go (PAYG) version of the solar home system (Mergulhao et al., 2022; Carr-Wilson & Sandeep, 2018; Kizilcec & Parikh, 2020; Yadav et al., 2019; IRENA, 2020). The PAYG solar home system is being touted in the solar sector as the ideal solution for ensuring and enhancing accessibility to affordable and clean renewable energy (Riedke & Adelman, 2022; Yadav et al., 2019). According to International Renewable Energy Agency (IRENA, 2020), eight million people all over the world started accessing energy via the PAYG financing model between the years 2015 and 2020. For customers to continue using their PAYG solar home system kits, they must consistently make incremental payments to the energy service provider; lest the unit will automatically be locked and thus unusable (Guajardo, 2021; IRENA, 2020).

This review paper set out to critically analyse the role of the PAYG solar home systems in ending energy poverty in the SSA region. It highlights the dynamics that have characterised usage of the PAYG solar home systems in the SSA rural areas and the role these solar kits have played in subduing energy deficit, as well as the challenges and prospects of these PAYG solar home system kits ending energy poverty. Energy poverty can be defined as a lack of access to reliable sources of modern energy, such as electricity (Zubi et al., 2019).

Methods and Data

This article conducts a comprehensive review of literature pertaining to Pay-As-You-Go (PAYG) solar home systems in Sub-Saharan Africa (SSA). The study's objective is to synthesize and evaluate the existing body of knowledge of this subject.

Using three distinguished scholarly databases - Google Scholar, Scopus, and Semantic Scholar — we embarked on a meticulous search for peer-reviewed articles centred on PAYG solar home systems. Our analysis was structured to uncover insights about:

- The rate of adoption of PAYG solar home systems in SSA.
- The system's significance to the rural communities in SSA.
- Challenges hindering the widespread adoption of PAYG solar home systems in the region.
- Strategies proposed to bolster the adoption rate in SSA's rural locales and the accompanying challenges.

Furthermore, this research sheds light on the role of PAYG solar home systems within the broader energy matrix of SSA. To ensure the study's relevance and to derive insights from contemporary findings, only articles published between 2015 and 2023 were considered.

Literature Review

Out of 588 million people in sub-Saharan Africa without access to electricity, 84 percent reside in rural areas (IEA, 2018). This clearly shows that a lot of attention and resources should be channelled towards rural areas if the war against energy poverty is to be won in this region. Several governments in sub-Saharan Africa have been undertaking initiatives and programmes aimed at addressing energy poverty in the rural areas of their respective countries (Davidson & Mwakasonda, 2004). In Kenya, it is the Ministry of Energy that is responsible for all energy policy development and implementation (George et al., 2019). In Zimbabwe, one of the Zimbabwean government's initiatives after the country regained its independence in 1980 was the establishment of the Rural Electrification Authority (REA), hoping to speed up the electrification of rural areas by connecting them to the national grid. The success of these rural electrification initiatives by the sub-Saharan countries is open to debate, but what is apparent is that most rural areas of SSA remain unconnected to the national power grid (IEA, 2023).

With prospects of getting connected to the national grid not encouraging for most rural communities, it remains without doubt that solar usage remains the logical and viable option for countries in the SSA region. Besides being readily available throughout the year in sub-Saharan Africa, solar energy is not only clean but far cheaper than other forms of energy in the long run. The good news is that the generation of power from solar energy is projected to increase by 48 percent by the year 2050 (Kost et al., 2013).

The PAYG Technology

PAYG technology, according to Barry and Creti (2020), is a technology-driven way that affords customers the chance to make affordable, regular payments using mobile money platforms in their quest to acquire a stand-alone electricity generating device (Alstone et al., 2015). The success of the PAYG model for solar home systems hinges on repayment performance (Riedke & Adelman, 2022; Guajardo, 2021). Because PAYG energy consumers must make regular agreed-upon instalments to the service providers for a specific period before they take ownership of the solar home system kits, the issue of repayment performance is topical.

Rolffs et al. (2015), in their case study that focused on the PAYG solar home system model in Kenya, highlight reasons why past approaches of loans, microfinance, and hire purchase agreements were not as effective as expected. In their discussion, the authors offer insights on reasons why the PAYG finance approach is likely to ensure rural people access energy better than past finance models. Opiyo (2019) also regards the PAYG model as a game changer, arguing that the PAYG model has enabled energy firms to combine their energy products with loan services to come up with a single item. A mobile money platform is necessary to support this system as it enables customers in faraway rural areas to pay for

their energy instalments through mobile money (Opiyo, 2019; Pelizan et al., 2019). Thus, PAYG solar home system models need a vibrant telecommunication network and reliable mobile money facilities for them to operate effectively and efficiently.

Accessing Electricity in Rural Sub-Saharan Africa via PAYG Solar Home Systems

Accessing electrical energy is critical for the well-being of humanity and the economic development of any country (Adwek et al. 2020). The view that the PAYG solar home system is one of the most effective strategies for connecting the “last mile” that has no access to electricity is shared by several authors and researchers (Yadav et al., 2019). Zubi et al. (2019), are in agreement with this view and offer solar home systems as solutions to ending energy poverty. Zubi et al. (2019) view energy poverty as a major global concern and the rural areas as being the most affected, especially those in South Asia, South-East Asia, and Sub-Saharan Africa. This view supports the essence of offering rural areas huge and undiluted attention in regard to energy needs.

Zubi et al. (2019) believe that what makes home systems unique and ideal are the technological advancements and the reduction in the cost prices of lithium-ion batteries. In their paper the authors' focus is on the exploitation of innovations in the provision of solutions to the domestic energy poverty faced by developing countries. And one of these innovations is the introduction of the PAYG model utilised by solar home systems in production of electrical power. Chowdhury and Mourshed (2016), in their research in which they focus on assessing the performance of solar home systems, attribute the increase in SHS installations in emerging countries to declining photovoltaic costs and success in microfinancing activities. They view the SHS as an alternative option for off-grid electrification in rural areas in developing countries.

Carr-Wilson and Sandeep (2018) give particular attention to the way the PAYG model has played a bigger part in lighting millions of rural Kenyan homes through solar energy, in the process assisting in the energy poverty fight in Kenya. In their endorsement of the role played by the PAYG solar kits, the authors attribute this massive and rapid growth to the introduction of the PAYG home system model in the year 2011, that enabled Kenyans, especially in rural communities to afford solar energy. According to Carr-Wilson and Sandeep (2018), poverty was no longer an excuse or a hinderance to accessing electricity for rural people, thanks to the PAYG model's introduction in Kenya.

Pelizan et al. (2019), in an assessment, sees great potential in addressing energy poverty in the rural areas of Ghana through the utilisation of the PAYG home systems solar lamps. According to Pelizan et al. (2019), there was now hope for the Ghanaian rural populace, who had endured long years of going without electricity in their communities. Their paper argues that this hope emanated from the PAYG model, which offers unprecedented flexibility in terms of payments.

In a study that focused on Rwanda, Mergulhao et al. (2022) provide confirmation that the PAYG model is currently the main way through which solar home systems are being distributed in the Sub-Saharan Africa region. Their work investigates solar home system PAYG user payment patterns. Mergulhao et al. (2022) reflected on the performance and acceptance of the PAYG model, which hinged on elimination of the need for cash payments by providing flexible payment in the form of instalments. The authors argue that while the adoption rate of non-PAYG solar home systems was not very bad in Sub-Saharan Africa, the PAYG model tremendously increased the adoption rate of SHSs by tackling the issue of affordability. The authors also noted the importance of studying user behaviour in the determination of PAYG solar home system adoption in Rwanda.

Kizilcec et al. (2021), in their case study of Rwanda, believe that it is vital to understand the PAYG solar home system customer journey in full if energy access is to be increased. Kizilcec et al. (2021) posits that solar home system models are fulfilling energy needs globally with massive success, especially when they also have the PAYG facility which allows households to pay energy providing firms in small, affordable instalments. It is this convenience of paying small, affordable amounts of money that has undoubtedly made PAYG solar home systems popular in the SSA region. The understanding of the customer journey is pertinent because it highlights to the energy service providers how future payments can be structured for their own good and to the benefit of customers as well.

The importance of the financing component of the PAYG model is also highlighted by Adwek et al. (2020), who in their paper justify the need for SHS in rural areas of Kenya and give an analysis of the financing model of the PAYG solar home systems, as well as how this has been key in the war against energy poverty in rural Kenya. Rolf et al., (2014) shares this same view by highlighting the way new financing models attempt to by-pass shortcomings of past financing models. In their paper, Roff et al., (2014), present an analysis of past, current as well as emerging financing models that are useful for financing solar home systems in Kenya through an analysis of their strengths and limitations.

Nature of PAYG Solar Home Systems

There is a difference between the PAYG solar home systems and the ordinary solar home systems that are non-PAYG. A typical standard PAYG solar home system kit is usually made up of a solar panel that converts sunlight into electrical energy, a battery that has the responsibility of storing the energy for later use, and a control unit with the ability to power items such as lights, radios, and mobile phones (Chowdhury & Mourshed, 2016). Bigger PAYG systems can power much bigger items such as televisions, fans, and even fridges. According to Chowdhury and Mourshed (2016), a stand-alone solar home system (SHS) that comes with a battery for storing energy is regarded as a standard one that is ideal for off-grid electrification in faraway, remote areas.

PAYG solar home system kits afford customers opportunities to cater for their energy needs through payments in smaller instalments over an agreed period, usually through mobile money services, to the energy providing firms. Customers start by paying a deposit, and then the balance is paid in instalments over an agreed period (Guajardo, 2021) that could range from six months to even two or three years. The PAYG model has the capability of being remotely locked if no payment is received on scheduled dates and this reduces investment risk (Tongsopit et al., 2016). If a customer misses the scheduled date for settling an instalment, the PAYG solar home system kit is automatically locked (Guajardo, 2021; IRENA, 2020). When the customer eventually pays the instalment, the unit is unlocked for the agreed period. When a customer pays all the instalments in full as agreed, ownership of the PAYG product transfers to the customer, and the kit is now continuously enabled (unlocked for good) and no more payments are required (Guajardo, 2021).

Pay-As-You-Go Solar Home System Adoption in Rural Sub-Saharan Africa

Van der Vleuten et al. (2007) posit that solar home systems have become a household name in Africa, and their paper focuses on lessons that can be learnt from the experiences of the adoption of solar home systems in ending energy poverty in Africa. Van der Vleuten et al. (2007), in the article, take a holistic view on the adoption of solar home systems but seem to take divergent views from some authors on certain points. Van der Vleuten et al. (2007) for example, focus their argument on the contentious classification of solar home systems, where some people regard them as a luxury item while others see it as a necessity. They also appear to be sceptical as to whether the solar home systems are capable of triggering or facilitating total rural electrification. Van der Vleuten et al. (2007) also argue that a new energy policy is needed if solar home systems are to play a useful role in the development and rural electrification of African communities.

Andrews (2019) is confident that the PAYG solar home system can condemn the use of kerosene to the dustbin of history and regards kerosene as an expensive, dirty, and dangerous means of lighting homes that work with questionable effectiveness. Andrews (2019) argues that even though many developing countries, including those in SSA regard electricity as a luxury product, the advent of the PAYG model is bound to end this.

Around 100 million people all over the world are currently benefiting from the PAYG technological model (Andrews, 2019). The growth of solar home systems has been rapid, and they have proved to be a viable source of energy for households since they can be used in remote areas that have no access to grid power (Kizilcec & Parikh, 2020). In the second half of 2022, according to GOGLA (2022), solar home systems recorded a 68 percent global growth in sales, and this was the highest of all solar product categories. This clearly shows the favourable growth which the solar home systems are enjoying the world over.

Ojong (2021) authored an article that is based on scholarly papers on the topic of solar home system adoption in Zimbabwe, their usage, and the energy consumption in Zimbabwe's rural areas. In the article, Ojong (2021) argues that solar home systems are being increasingly used to provide electrical energy in Zimbabwe. Zimbabwe is one country that has been going through rough economic times, and its energy sector has not been spared. The debilitating economic situation in the country could have been key in pushing up usage of solar home systems in terms of numbers. Both rural and urban people had to resort to PAYG systems to access electricity.

Benefits of the PAYG Solar Home Systems

Solar energy is a renewable source that plays a critical role in the achievement of sustainable development energy goals (Maka & Alabid, 2022). Solar energy is very important when it comes to the existence and growth of human communities and it is a clean energy source that is plentiful, cheaper, requires less maintenance, and is environmentally friendly (Maka & Alabid, 2022).

Regardless of the region of the world, benefits of electrifying rural areas are too numerous to mention. For the sub-Saharan African region, these benefits are much more pronounced and immense considering that most people with no access to electricity on the globe are domiciled there (Mukisa et al., 2022; George et al., 2019). Thanks to solar energy, remotest parts of a country can have citizens enjoying mobile network coverage, and thus being in touch with world events, rural to urban migration being stemmed, children being able studying at night (Barman et al., 2017; Kennedy et al., 2019) and some rural tasks being undertaken in the evenings (Adwek, et al. 2020).

Maka and Alabid (2022) highlight the critical role that solar energy plays in achieving sustainable development in their study. Candles are very expensive, and kerosene-based lamps are not very efficient (Mills, 2016; Barman et al., 2017). It does make a lot of sense therefore, to replace these with SHS, which, besides being very efficient, also reduce the health issues associated with them (Mahapatra et al., 2009; Yoon, 2015). Barman et al. (2017) notes the benefits that accrue to the adoption of SHSs in rural areas of India, including a reduction in kerosene usage, an increase in the studying hours of children, and the extended working hours of small businesses. Barman et al. (2017) observes that user perceptions of the SHS in India are positive, but in the study point out that cost considerations appear to be the main obstacle hindering the adoption of the SHS. This is exactly what motivated the introduction of the PAYG SHSs, the issue of affordability. We can no doubt draw parallels between this Indian observation and the SSA region experience.

Affordability is one of the biggest benefits of the PAYG solar system (Mergulhao et al., 2022). Because the need for a large one-off payment is eliminated, poor rural people do not have to strain their pockets and budgets to access clean and sustainable energy (Guajardo, 2021). PAYG solar systems are scalable. This means people can initially start with a small system and scale it up or expand it as their

energy needs grow. This flexibility in terms of scalability is beneficial for those people who cannot afford one-off payments.

The Future of PAYG Solar Home Systems in Rural Sub-Saharan Africa

PAYG solar home systems, according to Riedke and Adelman (2022), are regarded by some as tools that foster financial inclusion. Their ability to provide access to electricity to underprivileged members of society clearly articulates this issue of financial inclusivity. Those who cannot afford one-off payments are accorded the opportunity to pay in instalments until ownership transfers to them. This has made PAYG home system models very popular and looks set to remain so into the future. Guajardo (2021) looks at the issue of repayments that is central to all PAYG solar home systems. Guajardo (2021) argues that firms that run the PAYG model are bound to contribute greatly to the sustainable development war and clean energy goals if they utilise the PAYG financing model in serving the poor members of their communities. Guajardo (2021) also posits that there is a lot that the PAYG model borrows from the microfinance institutions, and one of these things is the flexibility in terms of payments that characterises the PAYG systems. Guajardo (2021) provides a description and analysis of repayment performance for PAYG solar lamps based on pilot studies conducted in six countries in SSA and Asia during 2014 and 2015.

In their analysis of PAYG contracts, which were subscribed by 10 120 consumers who were living in Benin, Barry and Creti (2020) noted that consumers who were residing in very remote and less electrified areas were more likely to honour their payment obligations because they had no other clear energy option in place they could jump to. What this implies is that if consumers have no other option in terms of accessing electricity, they are less likely to default on their PAYG payments. It is very evident from this study that the PAYG solar home system model through utilisation of mobile banking has made accessibility of electricity to be much easier.

Alstone et al. (2015) regard the success of the PAYG model in Kenya as having hinged on certain pre-conditions, two of which are the high cost of being connected to the electricity grid and the wider acceptance of mobile money payments through the M-Pesa mobile money platform. Thus, (Alstone et al., 2015; Opiyo, 2019; Pelizan et al., 2019) argue that the PAYG model needs reliable and robust mobile money systems if it is to be successful. In other words, telecommunications companies such as Safaricom in Kenya that run the M-Pesa platform are prerequisites for the success of the PAYG solar home system model.

Maka & Alabid (2022) argue that the future of energy generation lies in solar energy since fossil-fuels seem to have reached their peak in terms of usage. This, thus, places PAYG solar home systems in good steady to consolidate their usage in the rural areas of sub-Saharan Africa.

Summary and Discussion

Findings from this study point towards the PAYG model as an innovative solar home system that has been technologically instrumental in fighting energy poverty in the sub-Saharan Africa region (Kizilcec et. al., 2020). The substitution of one-off payments with small, affordable, regular instalments has meant communities have been massively empowered to finance their own energy needs. The unprecedented move of allowing the poor rural villagers to pay for their energy needs in small instalments had been the missing link in the fight against energy poverty. Through the provision of clean energy that is affordable, the PAYG solar home systems have been improving the quality of life in rural areas of SSA in terms of health, education, and the economic prospects of the small businesses and families in the rural communities. The profile of these kits has been enhanced due to their capability of reaching even the remotest users in the rural communities.

The literature revealed that there is agreement among researchers that the PAYG solar home system has played a leading role in overcoming energy poverty in sub-Saharan Africa. The review showed that the PAYG model is a promising tool that has been successfully addressing and is destined to continue addressing the energy access gap in the rural areas of SSA (Riedke & Adelman, 2022; Adwek, et al., 2020). The review also revealed that PAYG solar home system presence in SSA countries such as Ghana, Tanzania, Kenya, Nigeria, Rwanda, and Benin afforded customers opportunity of paying for their energy needs in small regular instalments.

The literature review also laid bare challenges which solar firms face in their operations in rural areas in SSA. These challenges include high costs and credit risk which are major issues for solar firms and financial institutions, as these challenges can make payment through PAYG channel a daunting task. In the same vein, the high interest rates, and devaluation of local currencies in the individual SSA countries, can impede the progress of rural people and the solar energy firms.

Though the findings showed that the PAYG solar home systems are regarded as a tool for financial inclusion, it was also revealed that despite the high adoption rate and massive success of the PAYG solar home system model in SSA, there are still a lot of rural communities which are still unconnected to modern energy sources and kerosene is still being heavily used in off-grid rural areas of some SSA countries. This could be because one of the findings that came out from the literature review was that the main barrier for PAYG solar home systems adoption remains affordability. There are a lot of poor households in rural areas who sadly still cannot afford paying for their energy needs via the PAYG solar home system technology despite the convenience emanating from the technology.

From the literature reviewed it emerged that PAYG solar home systems adoption, and how the kits have impacted on SSA rural communities, that these systems are destined to continue the provision of long-

term rural electrification and development solution in future energy needs of the SSA region. It also came out that abundance of solar energy on the African continent makes it very attractive as a future source of energy generation taking over from fossil-fuels, thus buttressing the claim of the solar home systems being the source of energy of the future.

The paper takes a holistic approach to the use and role of PAYG solar home systems in ending energy poverty in SSA rural areas and proposes that further studies be conducted on the PAYG solar home system model across different regions of Africa and the world. The article's primary aim was to appraise existing literature on PAYG solar home systems and identify the role these kits have been playing in the energy matrix of Sub-Saharan Africa, focusing on their key role in reducing energy poverty in the rural areas of the region. The several articles consulted have demonstrated that the PAYG solar home system model remains a critical aspect for ending the energy poverty of the Sub-Saharan region and other regions of the world.

The role played by solar energy in improving accessibility of electricity in Sub-Saharan Africa over the past decades is well documented. It is also very clear that PAYG solar home systems have been key and will continue to be key when it comes to increasing and improving solar uptake in rural areas of sub-Saharan Africa. Thanks to the Pay-As-You-Go initiative, whereby users of the home system can pay for their kits in instalments over an agreed period with the service provider, solar uptake in the rural areas of SSA is expected to continue increasing, and the PAYG solar home systems continue to be key in bringing sustainable and reliable electricity to the millions of residents not only in the SSA region but to the entire African continent.

The significance of this paper was to highlight the role played by the PAYG solar home system in the war against energy poverty in the sub-Saharan Africa region. Even though access to electricity in rural Sub-Saharan Africa has been a challenge, PAYG solar home systems have undoubtedly played a pivotal role in subduing energy poverty in this region. The provision of clean and affordable solar energy through PAYG solar home systems to small businesses and households has transformed the lives of millions of people in the SSA's rural areas.

Despite the role of PAYG solar home systems in subduing energy poverty in the SSA region, there exist challenges that need attention. For example, the issue of affordability for the very poorest households is a challenge that persists. It is a fact that there are sadly still very poor members of society who cannot afford the PAYG solar home systems. Other challenges as revealed by the literature include maintenance issues as well as after-sales support for the PAYG solar home systems once they are installed. From the literature review, it was also revealed that government support and partnerships between Non-Governmental Organisations (NGOs), private companies, and other organizations, as well as innovations, have seen some of these challengers being taken care of. An increase in investment in

the future could see the PAYG solar home system model having the potential to reach more communities on the African continent, in the process contributing to the sustainability development of the entire continent of Africa.

Conclusion and Further Research Directions

Literature that was reviewed was key in reaching the conclusions in this section. Based on the findings we can conclude that the SSA region is one of the fastest adopters of PAYG solar home systems and one of the leading and fastest growing PAYG solar home system markets in the world, thanks to the debilitating energy poverty that has been plaguing the region for a long time. We can also conclude that PAYG solar home systems have been very instrumental in changing the lives of a lot of rural people in Sub-Saharan Africa by enabling them to access electricity facilitated by PAYG solar home systems.

Based on the findings from the review paper, we can also conclude no country in SSA has so far, adequately supplied its rural areas with reliable electricity. Thus, with the majority of SSA countries battling with power deficits, we can safely conclude that the PAYG solar home model remains key in the electrification of rural areas of the SSA region. There are deficits in terms of electricity supply to the rural areas of almost all countries in Sub-Saharan Africa, emphasising the fact that there is still a lot of work that needs to be done in supplying the rural SSA region with adequate power supplies. The information gathered from the literature review has led to the conclusion that the PAYG solar home systems have brought economic development, increased educational opportunities, and positively affected the quality of life in the SSA region. The PAYG model has eliminated the necessity of a large investment for a non-PAYG solar home system by bringing affordability and flexibility options for energy needs. Because solar energy is renewable, there is a reduction in reliance on fossil fuels; thus, PAYG solar home systems promote not only a cleaner but a greener environment as well.

The paper has offered insights for solar energy policymakers and practitioners to consider the PAYG model and take it seriously in the future energy matrix of rural areas of not only the SSA region but other regions on the African continent and other parts of the world. This is because the emergence of the PAYG solar home system is being regarded as a transformative and ideal solution to energy poverty prevailing in sub-Saharan Africa. The study concluded that in terms of energy supply in Sub-Saharan Africa, the PAYG solar home system model has ensured that poor families from rural areas can afford to pay small monthly instalments for their energy requirements. The small, affordable, regular instalments can be paid for an agreed period, say from six months up to even twenty-four months. Payment of the final instalment would signal the transfer of ownership of the solar kit to the customer (Guajardo, 2021).

It can also be concluded that this article has no doubt added to the body of existing literature on PAYG solar home system usage and uptake in the rural areas of the SSA region and other developing countries in the world. The paper can hopefully motivate further research to improve our understanding of the strengths and limitations of the PAYG solar home system model for the diffusion of clean technology into the developing world. The study laid bare that the PAYG solar home system model does offer the best option when it comes to the provision of energy in the SSA rural areas (Adwel et al., 2020). In conclusion, the PAYG solar home system model has been playing a critical role in the energy equation of SSA and the findings which are documented above clearly validate this observation.

Following the findings and discussion above, main recommendations below are suggested as a way forward to the research and upon which further research can be premised upon:

- It is imperative that SSA governments step up their tempo by playing a more decisive and prominent role as the major drivers in the electrification of their rural areas through supporting solar usage and removal of customs duty on imported solar products. The governments should not leave all the tasks of rural electrification to non-governmental organisations and private solar firms but play the leading role.
- Considering the findings from the review, it is recommended the SSA governments, solar energy firms, policy makers and all stakeholders in the renewable sector explore other alternative sources of energy such as wind and extensively support and encourage more research on solar technology to improve not only usage and adoption but efficiency and effectiveness of solar energy.
- Lower costs models which are affordable cost models are required if users in rural communities are to afford PAYG solar models. It is recommended that the governments and policy makers provide a stable environment and capacitate microfinance institutions and banks in provision of affordable loans to the rural energy users.

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