Volume 36 Number 1 2025

Journal of Energy in Southern Africa

A review of the adoption of renewable energy technologies by hotels in Malawi

Hope Baxter Chamdimba*[1], Emmanuel Mtanila Banda[2]

[1]*Department of Energy Resources, Ndata School of Climate and Earth Sciences, Malawi University of Science and Technology, Limbe, Malawi*

[2]*Department of Tourism, Faculty of Tourism Hospitality and Management, Mzuzu University, Mzuzu, Malawi*

Abstract

The hotel sector is a vital component of the tourism industry, as it plays a critical role in the determination of tourism destination competitiveness. However, lack of reliable, affordable, and sustainable energy supply remains a major bottleneck to the development of the hotel sector in Malawi. The adoption of clean and renewable energy sources around the globe is driven by different factors, such as the need to address environmental challenges and reduce energy costs. Usually, less affordable energy supplies increase the cost of service delivery, thus making these hotels less competitive on the global market. The article investigates the opportunities and barriers to the hotel industry's adoption of renewable energy technologies and includes a literature review. The paper shows that renewable energy technologies have multiple applications in a typical Malawian hotel, and these present numerous economic and environmental opportunities. However, the hotel sector is failing to capitalise on the energy policy and regulation improvements taking place in the country, mainly due to a lack of technological awareness by hotel managers. To reverse this, the government needs to adopt policies and regulations that target the hotel sector to increase awareness and adoption of clean and renewable energy technologies.

Keywords: tourism, environment, policy, economy, bottlenecks, interventions

Journal of Energy in Southern Africa 36(24),1–11

DOI: https://dx.doi.org/10.17159/2413-3051/2025/v36i1a16047

Published by the University of Cape Town ISSN: 2413-3051 https://journals.assaf.org.za/jesa

Sponsored by the Department of Science and Innovation

Corresponding author: Email: chamdimbahhope@gmail.com

1. Introduction

Malawi's economy is agro-based, with agriculture driving the livelihoods of two-thirds of the country's population (World Bank, 2018; ICLEI, 2021), although it accounts for only a third of GDP (GoM, 2017). Climate change continues to threaten agriculture, thus making the economy more vulnerable (UN, 2018; World Bank, 2018; GoM, 2016). To address such economic challenges, the government of Malawi (GoM) has been working on economic diversification programs, including the development of the tourism industry (GoM, 2017). Currently, the tourism industry contributes 7% to GDP, 6.2% to employment creation, 2% to foreign currency earnings, and 4.7% to total investment (GoM, 2017; GoM, 2019a). In 2024, the tourism sector in Malawi accounted for about 6.8% of the GDP, up from 5.5% in 2023 (Ndawala, 2025). Malawi, with numerous tourist attractions, has a strong potential for tourism growth, which is key to the achievement of national economic growth and diversification goals (Magombo et al., 2017; Destination Malawi, 2017; GoM, 2019a). It is estimated that by the year 2023, the tourism industry will account for about 11% of the national GDP (Gadama, 2025). The hotel sector is a vital component of the tourism industry, as it plays a crucial role in determining tourism destination competitiveness (Magombo et al., 2017; Ștefănică and Butnaru, 2019). However, Malawi's unreliable power supply continues to deter investments in different sectors of the economy, thus negatively affecting the performance of the tourism industry (MCC, 2020; GoM & UNDP, 2020).

Diversifying Malawi's economy requires an increase in the supply of clean, reliable, and affordable energy (GoM, 2018; GoM, 2017; Aisyah et al., 2021). Energy is one of the main inputs for any industry and is the backbone of economic development (Kumar, 2017). However, Malawi faces the challenge of a huge energy deficit, with a widening gap between power demand and generation capacity (UN, 2018; GoM, 2017; GoM, 2018; MCC, 2020). Currently, only 18% of the population has access to electricity, and power supply is unreliable due to frequent outages (GoM & UNDP, 2020). Electricity supply is heavily dependent on hydropower: 98% of electricity supplied is hydro, and 99% of the hydropower plants are located on just one river, the Shire (GoM, 2018; ICLEI, 2021). Hydropower continues to be affected by climate change due to floods and droughts (GoM, 2016).

With electrical power supply in Malawi insufficient and unreliable and a lack of clean and alternative sources of energy, commercial entities such as hotels have been forced to rely on biomass for cooking and heating activities (Kemausuor et al., 2018; GoM, 2016; ICLEI, 2021). Biomass is estimated to meet over 90% of the country's energy requirements (GoM, 2024). Unsustainable charcoal production and fuelwood consumption have led to high rates of deforestation and land degradation (GoM, 2016; ICLEI, 2021). The deforestation rate in the country is estimated to be more than 34%, which means that in the near future, biomass fuel will become scarce and expensive to both households and commercial entities (Kemausuor et al., 2018; World Bank, 2018). The use of diesel generators for power backup is common in hotels. Operating diesel generators is costly for Malawi, given that it is a net oil importer and given limited foreign currency reserves for fuel imports. Businesses in Malawi bear an estimated cost of MWK 1557 (USD 2.09) per kilowatt-hour of electricity lost due to grid disruptions (Malawi Priorities Project, 2021). Moreover, increased consumption of unclean fuels does not support national and global goals that seek to reduce greenhouse gas (GHG) emissions (GoM, 2016; Aditya et al., 2020; Rahman et al., 2019). The energy sector accounts for 36.76% of Malawi's GHGs, largely due to reliance on unclean fuels (EAD, 2021), and this contribution is expected to grow to 55% by 2040 (GoM, 2024). Energy consumption stands out as the primary contributor to carbon emissions within hotel buildings (Arenhart et al., 2024). Thus, there is a need for the nation to adopt deliberate measures that would help to decarbonise the energy sector by, among other means, transitioning to clean and renewable energy sources (MacAskill et al., 2023; Ghimire et al., 2024).

The govenment recognises that renewable and sustainable sources of energy such as solar, wind, and biofuels will play a crucial role in the achievement of socio-economic and environmental goals (GoM, 2017; GoM, 2018). The country has ample renewable energy resources, and harnessing them effectively will contribute significantly to achieving various national objectives (GoM, 2017; GoM, 2019a). Moreover, the substantial amounts of solid waste produced in urban areas offer a valuable opportunity to diversify energy sources and enhance energy security for the expanding urban population by utilising waste as an alternative energy resource (Kemausuor et al., 2018; GoM, 2018).

Hotels are heavy consumers of resources, particularly energy and water, which, if not properly checked, may contribute to higher operating costs (Singh et al., 2024; MacAskill et al., 2023; Arenhart et al., 2022). In addition, unsustainable use of these resources may contribute to environmental degradation (Karvounidi et al., 2024; Makoondlall-Chadee & Bokhoree, 2024). Understanding energy consumption of hotels, where specific energy-demanding activities are identified and analysed, will help to understand the potential of the adoption of

renewable energy technologies (RETs) by the sector. Furthermore, prospects and constraints associated with renewable energy development and usage need to be analysed, as they tend to influence energy choices made by the managers of the hotels. Therefore, this review paper seeks to evaluate the opportunities and challenges that impact the adoption of RETs by the hotel sector in Malawi. Specifically, the approach is to analyse energy-consuming activities in a typical hotel in Malawi and probe the opportunities and challenges that affect the adoption of the RETs by hotel managers.

2. Research methodology

On the prospects and limitations associated with the renewable energy technology adoption by hotels in Malawi, the study utilised a meta-analysis and content analysis of the openly available data. The sources of data were published academic work and government documents from the Ministry of Tourism, the Ministry of Energy, and the Malawi Energy Regulatory Authority. Among the reviewed government documents were the National Energy Policy (2018), Malawi Growth and Development Strategy III (MGDS-III), Malawi National Tourism Policy (2019), National Waste Management Strategy 2019-2023, and the National Climate Change Management Policy (2016). A comprehensive review of the literature helped achieve an understanding of the GoM policy direction on the tourism industry, renewable energy technology, energy efficiency, and climate change. In addition, the literature helped an understanding of energy use in hotels, the potential use of RETs in hotels, and drivers and bottlenecks that affect the adoption of RETs. With the challenge of limited data in Malawi, the study also examined findings of similar studies in other countries.

3. Results and discussions

3.1 Current government policy direction on tourism, energy, and the environment

Understanding the country's direction regarding tourism and energy industries by analysing the existing national policies and regulatory frameworks that impact the hotel sector is crucial, because they influence the adoption of RETs. The goal of the 2019 National Tourism Policy is to create an enabling environment for the development of the tourism sector. This policy highlights inadequate supporting infrastructure as a major bottleneck to that development. Energy infrastructure remains underdeveloped meaning that the country lacks adequate power to support the tourism industry. The policy also recognises that energy is a major resource for tourism development; as such, government and stakeholders must promote the development of energy infrastructure for improved energy supply (GoM, 2019a). The main goal of the National Energy Policy is to increase access to affordable, reliable, sustainable, efficient, and modern energy for socio-economic development. To achieve this goal, the policy highlights energy diversification, which includes the development of RETs and alternative energy sources. Therefore, different sectors of the economy, such as hotels, are supposed to localise the National Energy Policy by adopting its provisions. For instance, reducing dependence on biomass from the current 89% to 33.5% in 2035 is one of the GoM's long-term goals; as such, hotel managers should consider setting their own targets for biomass consumption reduction in line with national goals. In addition, increasing the uptake of renewable energy in hotels is in line with the National Energy Policy objective of expanding the role of renewable energy in the national energy mix from 10.7% in 2020 to 28% in 2035. Hotels must pursue green growth, where issues such as those regarding climate change and environmental degradation must be properly addressed (Makoondlall-Chadee & Bokhoree, 2024). The National Climate Change Policy, the National Forest Policy, and the National Environmental Policy call for sustainable development, in which the environment must be protected from any harmful activities. Localisation of such national policies by hotels will help to improve their corporate image because of their efforts to promote environmental sustainability.

3.2 Energy use in a hotel

Hotels are major consumers of resources (Omidiani and Hashemihezaveh, 2016; Ghimire et al., 2024). Many studies conducted around the globe have revealed that the energy use intensity of hotel buildings is the highest amongst all the building categories (Ştefănică and Butnaru, 2019). In a typical office building, electricity is the main source of energy that is used for lighting and powering equipment (Arenhart et al., 2024). However, hotels usually utilise more than one type of energy source due to the variation of activities undertaken on a daily basis. Hotels use electricity as their primary energy source for lighting, heating water, and powering equipment, such as vertical transport and washing machines. Liquefied petroleum gas and other sources of energy are also used for cooking and heating. Table 1 outlines the energy-consuming activities in hotels.

Space conditioning, which involves heating/cooling, ventilation, and air-conditioning, generally accounts for the largest share (more than 35%) of a hotel's total energy usage (Singh et al., 2024; MacAskill et al., 2023). Outside weather conditions and indoor temperature are the major factors that influence the consumption of energy for air conditioning (Arenhart et al., 2024; Karvounidi

Table 1: Energy consumption activities in a hotel

Activity	*Description*
Lighting	Power for interior and exterior lighting
Space conditioning	Power used for heating and cooling of hotel rooms
Water heating	Hot water for bathing and other uses in a hotel
Food preparation	Energy for food preparation
Transportation	Fuel for transportation activities

et al., 2024). During the winter, hotel room occupants will require proper heating, while during the summer, energy is required for space cooling (Ran et al., 2022). Green building, which involves developing highly energy-efficient structures, can help reduce energy consumption for space conditioning in hotel buildings (Singh et al., 2024). Energy-saving opportunities must be exploited, starting from hotel structure design and development. In most cases, water heating is the second-largest energy-consuming activity in hotels, accounting for up to 15% of total energy demand (Karvounidi et al., 2024).

3.3 The environment issue

In Malawi, challenges in electricity supply have led to a growing reliance on diesel generators as a source of backup power. These are costly to operate in a country that is landlocked and a net oil importer. Disruptions of fuel supply, due to various reasons including lack of foreign currency, also make the use of diesel generators unsustainable. LPG is the preferred source of energy for cooking but is less affordable. So hotels are also forced to use biomass in the form of fuelwood and charcoal as an alternative cooking energy. Increased use of fossil fuels and unsustainable biomass by energy-intensive sectors such as hotels will negatively impact the environment. Therefore, stakeholders must accelerate the adoption of environmentally sound practices and products in the hotel sector (Ştefănică and Butnaru, 2019). In countries in the region, such as South Africa, it is estimated that carbon emissions per room per night are 50 $KgCO_2e$ (Circular Ecology, 2023). Malawi's poor electricity supply obliges hotels to rely more on fossil fuels and unsustainable biomass, which are blamed for increased emissions of CO_2. Achieving lower carbon emissions per hotel room can help improve the public image of the company and improve customer and investor relationships (Schulz et al., 2021; Schulze et al., 2016). However, Malawian companies, including hotels, usually do not keep records of their emissions. In addition, hotels, as major consumers of resources, produce large quantities of both liquid and solid waste (Omidiani and Hashemihezaveh, 2016). Large volumes of biodegradable waste, mostly in the form of cooked and uncooked food waste, if allowed to undergo uncontrollable biodegradation, release a lot of methane, a GHG that is more dangerous than CO_2 (Zohoori and Ghani, 2017; Ndala and Ndala, 2022).

3.4 Opportunities to reduce hotels' energy costs

The volatility of energy prices on the international market usually sends a strong signal to countries and industries that they have to pay more attention to opportunities presented by proper energy management (Rahman et al., 2019; Sarangi, 2018; Schulze et al., 2016). Energy management can simply be described using the energy management pyramid, where the least costly energy interventions are considered before adopting the expensive options. In this case, energy conservation must be the first energy management intervention for hotels, and energy efficiency the second (Times Tech, 2020). Energy conservation implies prevention of energy wastage, whereas efficiency means using less energy for the same, or even increased, output. The other option that a hotel can adopt to meet energy demand is developing new energy infrastructure. However, this is expensive, so priority must be given to the least costly options. Energy efficiency and conservation can help hotels save up to 20% in energy costs (Cingoski & Petrevska, 2018). However, energy savings depend on the specific energy-consuming activity. Therefore, hotels should target specific activities within the hotel to achieve higher energy savings.

A combination of energy conservation and energy efficiency can help hotels reduce the energy demand and escape the need for costly new energy infrastructure. When expansion of energy infrastructure cannot be avoided, then hotels should look at the best option in terms of energy source. In this case, according to the energy management pyramid, renewable energy must be considered for sustainable energy supply (Times Tech, 2020). Renewable energy sources such as solar and wind are available in abundance and for free. The prices of RETs are getting lower, making investment in renewable energy development economically more attractive for the hotel sector as a major consumer of energy (IRENA, 2021b; World Economic Forum, 2021). Onsite energy generation will help these hotels wean themselves from utility energy bills, which account for the largest share of the hotel operational costs.

3.5 Potential applications of renewable energy in hotels

Renewable or regenerative energies, such as bioenergy, geothermal, hydropower, solar, and wind, are inexhaustible energy sources, whereas fossil energy sources are finite (Schulz et al., 2021; Aditya et al., 2020). Renewable energy technologies have many applications in hotels, and some of them are discussed below.

3.5.1. Natural lighting

Using natural light costs nothing, unlike artificial lighting (Mbadinga and Alibaba, 2019; Singh, 2018). Natural lighting has always been used, where crude openings were created in caves and houses to let light in during the day. The use of these openings has developed over the centuries depending on the architectural preferences, but its purpose of letting in daylight has remained its principal role (Singh, 2018; Allery et al., 2018). This natural lighting can be described as the direct use of solar energy for lighting purposes (Hou, 2018; Kaheneko, 2021). The natural lighting design concerns the energy consumption and its associated costs in buildings. Natural lighting has higher-level relationships and interdependencies with the architectural design, considering that the building shape, dimensions, and other architectural features influence the use of natural light while also defining the image of the building (Mbadinga and Alibaba, 2019). It should be understood that the scientific and rational design of natural lighting is key to the design of energy saving for a physical environment (Yang, 2017; Singh, 2018). The natural lighting for a building should be designed in such a way that adequacy of illuminance in relation to the activities undertaken in a particular space is achieved.

Natural lighting for indoor lighting has an irreplaceable advantage when compared with artificial lighting. Apart from providing the much-needed lighting for rooms, it also brings in radiant heat, which can help reduce the consumption of heating energy during winter (Yang, 2017; Hou, 2018; Kaheneko, 2021). The reduction in energy consumption can translate into reduced energy costs and carbon footprint for hotels (Senthilkumar and Taj, 2020; Mbadinga and Alibaba, 2019; Zhu et al., 2017). Therefore, optimum use of natural light must be considered in new hotel buildings. Space conditioning is a major energy-consuming activity in a hotel, so any reduction in the demand for it can help the hotel reduce its overall energy consumption significantly.

Natural lighting's application is limited by time and the location of the building (Hou, 2018). Solar radiation varies in its intensity and inclination, so proper use of daylight requires appropriate structural design to ensure comfort and energy savings (Singh, 2018; Mbadinga and Alibaba, 2019; Kaheneko, 2021). Malawi's seasons are characterised by high availability of natural light, meaning that it can contribute to interior lighting throughout the year (Mohan & Ngwira, 2019).

3.5.2. Waste-to-energy for cooking and heating energy supply

Proper management of waste is intended to reduce its adverse effects on health and the environment (Zohoori and Ghani, 2017; Abam, 2017; Allan, 2024). Waste management includes its collection, transportation, treatment, and disposal (Abam, 2017; Zohoori and Ghani, 2017). Waste management is not cheap and accounts for the largest share of a city's budget in many developing countries, including Malawi (Mensah, 2020). Local authorities lack adequate resources to manage municipal solid waste, making it difficult to collect and properly dispose of it (Zohoori and Ghani, 2017; Allan, 2024). Inadequate and poor infrastructure, low awareness, and limited human and financial resources are the main factors that affect solid waste management in the urban areas (GoM, 2019b; ICLEI, 2021). Generally, the waste collection rate is very low in Malawi's major cities. For instance, waste collection rates in the cities of Zomba, Blantyre, Lilongwe, and Mzuzu are at less than 30% (UN Habitat, 2024; Allan, 2024). It is common for waste to be dumped in open spaces, which presents health and environmental challenges (Abam, 2017; Zohoori & Ghani, 2017; GoM, 2019b; ICLEI, 2021; Ndala and Ndala, 2022).

As the hotel industry is the largest sub-sector of the tourism industry, it has the largest impact on the environment (Mensah, 2020). Hotels are among the larger consumers of resources (Singh et al., 2024; MacAskill et al., 2023) and so generate large quantities of solid waste. It has been estimated that a typical guest produces in excess of one kilogram of waste per day, which accumulates to tons of waste every year (Mensah, 2020). Managing such waste is expensive and can cause significant environmental damage if not effectively managed (Allan, 2024). The accommodation subsector alone accounts for 20% of the tourism industry's GHG emissions (Ghimire et al., 2024). Therefore, there is a need to adopt sustainable waste management practices in hotels. Based on the waste management hierarchy model, the goal of waste management is to reduce the amount of waste disposed of at landfill sites. However, the volume of waste generated can only be minimised if hotels undertake prudent waste management practices (Mensah, 2020). Waste prevention and reduction must be prioritised in hotels' waste management practices. If waste cannot be avoided, then it should be reused, recycled, or used for resource recovery before a

waste disposal option is considered (Allan, 2024; Ghimire et al., 2024).

Solid waste is a valuable resource that can help hotels meet their growing energy demand and achieve sustainability (Makoondlall-Chadee & Bokhoree, 2024). Converting waste management challenges into opportunities should be prioritised. Waste-to-energy is one of the circular economy solutions that can play a critical role in the achievement of socio-economic and environmental goals in urban settings (ADB, 2020). Usually, food waste accounts for the largest share of the total solid waste generated by hotels. It is biodegradable, so it can be used to generate methane through anaerobic digestion. This is a mature technology, used around the world for many years, so any investment by the hotel in it will not present major technical and financial risks.

Methane produced in large quantities can effectively replace the use of expensive LPG and electricity for cooking and water heating. The by-product of the anaerobic digestion process is bioslurry (organic manure), which can be used in hotel gardens or sold to landscaping companies and urban farmers. Malawi University of Science and Technology and Green Impact Technologies have demonstrated the production of methane from market food waste for cooking and heating by restaurants and households in the Ntcheu District of Malawi. Effective utilisation of the hotel's organic waste for methane generation will not only help to reduce the cooking and heating energy costs for the hotels but also reduce the cost of waste management and improve the image of the hotels (ADB, 2020). However, in order to effectively use waste as an energy resource, hotels need to promote onsite solid waste segregation so that organic waste can easily be accessed and utilised for biogas production (GoM, 2019b; Ndala and Ndala, 2022). Moreover, the choice of waste-to-energy technology is dependent on the specific type of waste available (ADB, 2020). For instance, as described above, segregated biodegradable waste is suitable for anaerobic digestion.

3.5.3. Solar water heating

At present, hot water demands in hotels are met mainly by the use of electric heaters (Arenhart et al., 2024). To deal better with high costs and supply problems, hotels need to adopt and invest in solar water heating systems, which have become cost-effective as a result of research and development (IRENA, 2021b). Adoption of solar water heating systems remains low in Malawi, however, and awareness and policy support are needed in order to popularise them (IRENA, 2021a). Solar water heating is a system that makes use of the sun's radiation to heat water for domestic or industrial applications. The technology is not new – in the 19th century, for example, water tanks were painted black in order to absorb the sun's energy (Kassri, 2019) – but it greatly improved during the past century. Nowadays, this technology is being used to respond to the growing energy crisis. In some countries, such as Israel, solar water heaters are required to be installed with any new residential construction project (IRENA, 2021a).

Some solar water heaters do not require electricity to operate, so a hot water supply is secure from power outages if there is sufficient sunlight to operate the system. Installing the systems on the rooftops of the hotel structure also helps to reduce the demand for more land. In hotels, solar water heating systems, apart from supplying hot water for bathing and catering activities, can be used directly to heat swimming pools. Investment in solar water heating systems can help the hotels to significantly reduce electricity utility bills, with solar radiation itself a free source of energy. The efficiency of these systems, apart from the technology used, will depend on the available solar energy resource of a given site, as radiation varies geographically. Solar water heater design and installation must be correctly done by qualified and certified technicians in order for the system to supply the required hot water throughout the year.

3.5.4. On-site solar power generation and street lighting

On-site renewable energy generation is proven to be a cost-effective alternative to purchasing energy (Schulz et al., 2021) and would enable hotels to become energy independent. Investing in renewable energy technology can help hotels achieve substantial energy, environmental, and economic benefits. The combination of economic and environmental benefits that these technologies offer makes their adoption irresistible. Solar photovoltaic technology is becoming more competitive as the technology improves and costs lower (IRENA, 2021b), and installing new renewable energy technology is costing less than the cheapest fossil fuels (IRENA, 2020). Solar panels can be placed on rooftops or integrated into buildings.

In the face of the energy problems for hotels already outlined in this paper, on-site power generation can help to improve power quality and supply reliability. This can translate into improved service delivery for the hotels (IRENA, 2020). Solar modules have a long lifespan, usually more than 25 years, offering energy savings over a long period. The hotels will also improve service delivery, considering that the problems of power outages will be reduced. Using clean and renewable energy also improves the image of the company, proving its commitment to GHG emission reduction (IRENA, 2020). Moreover, such an undertaking by the company

helps to improve its relationship with key stakeholders, such as investors, financial institutions, and customers.

3.5.5. Solar water pumping for alternative water supply

Hotels consume more resources, including water, than many buildings (Rajini and Samarakoon, 2017; Omidiani and Hashemihezaveh, 2016; Ruiz-rosa and Mendoza-jimenez, 2022). Water is demanded for many different operations in a hotel daily (Rajini & Samarakoon, 2017). In Malawi, access to potable water remains low, especially in low-income communities, regardless of major improvements made over the past years (Adams and Smiley, 2018; Magombo and Kosamu, 2016; Dupas et al., 2021). High water consumption by the hotels may have a severe impact on the local population, especially in water-stressed regions, due to supply constraints (Ruiz-rosa & Mendoza-jimenez, 2022). Therefore, using potable water for watering gardens and washing cars can conflict with the efforts to achieve Sustainable Development Goal Number Six, which seeks to improve access to clean water (Adams and Smiley, 2018). However, water demand for some hotel activities, such as car washing, watering gardens, laundry, and toilet flushing, can be met by harvesting rainwater or extracting water from the ground using solar water pumping systems. These systems are easy to design, environmentally friendly, and affordable investments, and their cost of operation is low (AAH, 2020). Solar pumps are gaining popularity all over the world wherever electricity is either unavailable or unreliable. In such places, solar pumps are even viable economically in comparison to running the pump on diesel (Nadu, 2002). Solar water pumping is a suitable solution that enables sustainable water supply while also protecting the environment (AAH, 2020).

3.6 Renewable energy adoption bottlenecks, and possible interventions

3.6.1. Lack of awareness and misconceptions about RETs

The lack of technological knowledge about renewable energy sources is one of the major bottlenecks to the adoption of the RETs (Szakály et al., 2021). The National Energy Policy (2018) identified limited dissemination of information or awareness by the population as a major contributor to low adoption of RETs in Malawi (GoM, 2018). Lack of knowledge usually leads to misconceptions that become a major barrier to their adoption. For instance, RETs are still widely considered too expensive regardless of the prices being greatly reduced due to technological improvements. Public awareness is critical if the government and stakeholders are to be successful in the implementation of renewable energy programs (Zakaria et al., 2019). Educational institutions must play a crucial role in educating the population at all levels, including primary schools (Aisyah et al., 2021). The level of awareness and knowledge of RETs may differ from country to country depending on the efforts made by the stakeholders in educating the public (Szakály et al., 2021). In hotels, the major problem arises when managers are only concerned about profit-making, without environmental considerations. It is understood that those managers who are environmentally conscious tend to be more aware of the existing RETs that can bring both economic and environmental benefits. Therefore, stakeholders involved in promoting RETs should work together with environmentalists where specific sectors of the economy are targeted (Szakály et al., 2021).

In Malawi, it can be observed that renewable energy awareness campaigns focus on off-grid communities to curb deforestation and improve the socio-economic status of people. However, major energy consumers, such as hotels, are usually left out. Therefore, it should be expected that off-grid communities are more aware of RETs than hotel managers. To address this challenge, there is a need for stakeholders to come up with programs aimed at increasing RET awareness, where large energy consumers, such as the hotels, are targeted. With increased understanding of the technologies, hotel managers should be able to make proper decisions regarding their utilisation. Aditya et al. (2020) also showed that RETs' awareness may vary depending on age, so this must be considered by stakeholders.

3.6.2 Renewable energy high capital cost and financing challenges

Prices of RETs are falling, and they are therefore becoming more attractive (IRENA, 2021b). For instance, solar energy generation cost halved between 2010 and 2014 (Donastorg et al., 2017). However, RETs are still characterised by high initial capital investments (Rahman et al., 2019; Hussain, 2013; Steffen, 2020). RETs having zero fuel cost is beneficial for any consumer (Sarangi, 2018), but it is not enough to encourage its adoption as long as the initial capital cost is very high. Additionally, funding from public and concessional sources is scarce, so engaging the private sector to bring the much-needed investment in RETs is required (Hussain, 2013; Donastorg et al., 2017). Already the renewable energy sector is driven by private investment, and there is reliance on banking institutions to mobilise the required finance (Sarangi, 2018). However, the lack of awareness regarding RETs remains a major challenge that prevents banks from financing RET projects. There has been a reluctant attitude among the banking communities to finance

renewable energy projects, primarily due to associated risks and uncertainties (Sarangi, 2018). Usually, different RETs have different degrees of exposure to the various identified barriers and risks (International Energy Agency, 2023). A host of risks, such as policy and regulatory risks, perceived risks, technology-related risks, off-taker risks, and foreign-exchange risks, are associated with renewable energy sector financing (Sarangi, 2018).

3.6.3 Poor organisational structure of hotels

Energy prices keep on rising, a situation that demands that companies take energy input seriously. Moreover, it is of vital importance to remain cost-effective in order to remain competitive, especially for the more energy-intensive companies (Sannö et al., 2019). Prioritising energy management in a hotel may provide an opportunity to reduce energy costs, minimise outage costs, and increase turnover (Schulz et al., 2021; Schulze et al., 2016). To achieve energy efficiency, hotels must adopt and implement an in-house energy management programme, where the position of energy manager in an organisation is key (Sannö et al., 2019; Schulze et al., 2016). The hotel organisation structure can explain whether the company considers energy management as a priority, considering that decision-making support is required if the company is to invest in renewable energy options (Schulz et al., 2021). However, several hotels do not have anyone responsible for energy management issues. If an energy officer is available in a particular hotel, then he or she is usually at the bottom of the organisation structure, with little influence on major energy decisions.

3.6.4. Lack of policies and regulations that promote RETs

Policies and regulations can be the most important tools for promoting the use of RETs by reducing administrative barriers and enacting RETs obligations for new buildings or those undergoing major renovation (Painuly & Wohlgemuth, 2022). For instance, Israel was the first country to mandate the installation of solar water heaters in new buildings and currently has among the highest penetration rates of solar water heaters in the world (IRENA, 2021a). However, policies and regulations in Malawi do not mandate the developers to incorporate RETs in their new buildings. This creates a weak case for stakeholders to consider RETs in their development plans. Malawi needs policies and regulations that deliberately promote the adoption of RETs. Increased awareness and the introduction of the regulatory frameworks that make adoption of RETs mandatory can help both the government and companies achieve their energy and environmental goals.

4. Policy implications

- Increased awareness is needed to promote the uptake of RETs by large energy-consuming sectors. Awareness campaigns must target hotel managers, who are responsible for key decisions regarding the operations of the company. Such campaigns should also target financing institutions so that misconceptions about RETs are eliminated.
- Improvement in hotel organisational structure is required, with energy personnel as part of the top hotel management team. The motivated energy manager will help bring value to the team by proposing energy solutions that help the company achieve energy objectives for competitive advantage.
- Government must adopt deliberate policies and regulations that promote the adoption of RETs in the hotel sector. Regulations that demand that new hotel buildings must incorporate RETs, such as solar water heating systems, solar street lighting systems, and rooftop solar power generation, as well as structural designs that enable utilisation of natural lighting and heating.

5. Conclusions

In Malawi, energy deficiency remains a major bottleneck to the growth of the tourism industry, a situation that hinders government efforts to diversify the economy. In the absence of a reliable utility power supply, hotels are forced to switch to expensive options such as diesel generators. However, apart from diesel generators being expensive to operate, these hotels are unable to access a sustainable fuel supply, which is blamed on a lack of foreign currency. Therefore, exploring alternative energy options that are sustainable and affordable is critical to the development of the tourism industry in the country. RETs, having zero fuel cost, can help to reduce a company's energy bills and improve service delivery, which can translate into competitive advantage. RETs in a typical Malawian hotel can be applied in different ways —through natural lighting, waste-to-energy, rooftop solar power generation, solar water heating, and street lighting. However, there is a problem of low uptake of these RETs regardless of renewable energy having great potential for addressing energy challenges faced by the hotel sector. The root causes of this low adoption rate include a lack of technological awareness and RET reliability misconceptions; high capital cost for RETs; organisational structures of the hotels that do not accommodate energy personnel in the top management team; and a lack of deliberate policies and regulations that promote the adoption of RETs by the hotels. To reverse these trends, there is a need for increased technological awareness,

targeting key stakeholders such as hotel managers and financing institutions, and adopting policies and regulations that will support the uptake of RETs by the hotel sector.

Author contributions

Hope Chamdimba conceptualised the study. Hope Chamdimba and Emmanuel Banda collected the required secondary data through the review of the existing literature. Hope Chamdimba wrote the paper, which was edited by Emmanuel Banda.

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