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Evidence, Business Models and Policy Gaps from a Scoping Review of Women and Youth Led Clean Energy Enterprises in Malawi

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Abstract

Clean energy transitions in sub-Saharan Africa present significant opportunities to address energy poverty, climate change, and socio-economic inequality, yet the role of women and youth as entrepreneurs and enterprise leaders remains insufficiently documented. This study synthesizes evidence on women- and youth-led clean energy enterprises and business models in Malawi to inform more inclusive energy transitions. Applying a scoping review methodology guided by the PRISMA-ScR framework and the Arksey and O'Malley approach, the review drew on peer-reviewed literature and grey sources published between 2000 and 2025. Searches conducted in ScienceDirect, Emerald, and through hand searching yielded 44 eligible documents focusing on solar energy and clean cooking subsectors, which were thematically analyzed.

Findings reveal growing engagement of women and youth in downstream value-chain activities such as distribution, retail, small-scale manufacturing, and servicing. Inclusive business models, including pay-as-you-go financing, microfinance, and community-based distribution, have improved affordability and market access. However, participation in upstream activities such as technology design, large-scale manufacturing, and finance remains limited. Persistent barriers include restricted access to finance and assets, gendered social norms, skills and information gaps, time poverty, and weak institutional coordination. Evidence on empowerment outcomes is fragmented and largely donor-driven, with limited application of standardized gender impact measurement frameworks. The study concludes that women- and youth-led enterprises contribute meaningfully to energy access and livelihood creation, but their transformative potential remains constrained. It recommends integrating gender- and youth-responsive indicators into national energy monitoring systems, expanding gender-responsive financing mechanisms, strengthening technical and entrepreneurial skills development, promoting participation in higher-value segments of clean energy value chains, and institutionalizing standardized gender impact measurement frameworks aligned with national policies and the Sustainable Development Goals.

1.0 Background and context

Informal small and medium-sized enterprises (SMEs) are central to economic growth, employment creation, and income generation across sub-Saharan Africa (SSA). Women and youth constitute a substantial share of actors within this sector, yet they remain disproportionately vulnerable to economic shocks and climate-related stresses, particularly within informal markets (International Energy Agency, 2022; UNDP, 2022). Despite gradual declines in poverty over the past two decades, energy poverty remains a persistent development challenge. An estimated 570 million people in Africa lack access to electricity, and population growth is expected to intensify energy demand through 2040 (International Energy Agency, 2019).

At the same time, SSA possesses significant renewable energy potential across solar, wind, hydropower, biomass, and geothermal resources. Distributed renewable solutions such as mini-grids and solar home systems have expanded access in remote areas, and renewable energy is projected to account for up to 75% of new power generation in the region by 2040 (International Energy Agency et al., 2019; International Renewable Energy Agency & Climate Policy Initiative, 2023). Harnessing this potential requires not only technological deployment but also inclusive entrepreneurial ecosystems capable of sustaining innovation, employment, and service delivery.

Women and youth are increasingly recognized as critical actors in clean energy transitions, not only as end-users but also as entrepreneurs, innovators, and leaders. Empirical evidence suggests that women's participation in enterprise leadership is associated with improved firm performance and governance outcomes (ILO, 2019), while

inclusive environmental governance has been linked to improved environmental outcomes (Collins, 2019). However, participation is often unevenly distributed across energy value chains, with women and youth concentrated in lower-value, downstream activities.

In Malawi, national policy frameworks including the National Energy Policy (2018), the Malawi Growth and Development Strategy IV, and Malawi Vision 2063 explicitly recognize clean energy as a driver of sustainable development and acknowledge the importance of gender and youth inclusion (Government of Malawi, 2018). Nonetheless, women- and youth-led clean energy enterprises continue to face structural barriers such as limited access to finance, fragmented markets, skills gaps, and weak institutional support (UNDP, 2022). Existing evidence on these enterprises is dispersed across donor reports, policy documents, and a small body of academic literature, limiting cumulative learning.

Despite growing investment in clean energy transitions, there remains limited systematic evidence on how women and youth engage with clean energy entrepreneurship in Malawi, the business models that shape their participation, and the extent to which such engagement translates into meaningful empowerment outcomes. This scoping review addresses this gap by synthesizing fragmented evidence across technologies, enterprise models, and policy contexts, thereby contributing to debates on inclusive and gender-transformative energy transitions.

2.0 METHODOLOGY

2.1 Conceptual framework

The conceptual framework provides a structured analysis of Malawi's energy sector, highlighting the key challenges, policy direction, priority clean energy sectors, opportunities for innovation, and expected outputs. It guides the study by linking the context of Malawi's energy ecosystem with the interventions necessary to achieve sustainable, affordable, and reliable energy access. The framework also supports the methodological orientation under the conceptual and contextual analysis of the study.

1. Scoping Malawi's Energy Ecosystem

Malawi's energy sector is dominated by biomass and a hydropower-based electricity system, both vulnerable to climate variability, with low rural electrification. National policies including Malawi Vision 2063, the Malawi Growth and Development Strategy IV, and the National Energy Policy (2018) guide responses to these challenges. Despite constraints, Malawi possesses significant clean energy potential in solar, hydropower, wind, biomass, biogas, and geothermal resources, enabling diversification, resilience, and energy security.

This study targets clean energy subsectors with high scalable and inclusive impact, particularly solar systems and clean cooking technologies, supported by sustainable biomass alternatives. These solutions improve access for underserved populations while addressing environmental and health risks. The transition also fosters decentralized energy innovation and entrepreneurship, encompassing manufacturing, distribution, installation, and maintenance. Mini-grid and off-grid enterprises, supported by digital technologies, advance rural electrification, while regional integration via the Southern African Power Pool enhances market opportunities and scale.

2.2 Methodological framework

To generate evidence for scaling clean energy innovations and fostering energy entrepreneurship among women and youth, this study conducted a scoping review following the PRISMA extension for Scoping Reviews (PRISMA-ScR). The review was grounded in the methodological framework of Arksey and O'Malley (2005), refined by Levac et al. (2010), and operationalized by Tricco et al. (2018). Scoping reviews are well-suited for mapping broad fields, synthesizing evidence, clarifying concepts, examining methodologies, and identifying knowledge gaps (Munn et al., 2018). Alignment between research objectives and guiding questions was central to ensuring rigor.

The review focused on women- and youth-led enterprises in Malawi's clean energy sector. PRISMA-ScR enabled the integration of diverse sources, including peer-reviewed articles, book chapters, reviews, conference proceedings, and editorials (Becerra-Encinales et al., 2024). The PICO framework guided the scope: Population women and youth in Malawi; Intervention solar energy initiatives (Pico Solar Systems, Solar Home Systems, Productive Use of Energy technologies); Comparison policy variations; Outcome best practices, policy frameworks, and business and financing models. Given the study's broad objectives, meta-analysis was unsuitable. Only sources explicitly addressing women- and youth-led clean energy enterprises were included, providing nuanced insights into innovations, challenges, opportunities, and strategies for strengthening their engagement in Malawi's clean energy sector.

Step 1: Specifying the research question

According to Arksey and O'Malley (2005), the first step involves specifying and refining the research question(s). Arksey and O'Malley emphasized the value of broad and exploratory questions, while Levac and colleagues underscored the importance of conceptual clarity, precise scope definition (including population, concept, and outcomes), and methodological direction to ensure comprehensiveness and rigor. Accordingly, the overarching aim of this study is to map the structural dimensions, barriers, opportunities, and support mechanisms within Malawi's CEIE, with a specific focus on women and youth entrepreneurs.

Guiding Research questions:

1. What is the current status of women- and youth-led initiatives in clean energy enterprises in Malawi?
2. What financing models are available to women- and youth-led clean energy enterprises in Malawi, and how do these models influence their growth, sustainability, and accessibility?
3. What opportunities and challenges do women and youth entrepreneurs encounter in Malawi's clean energy sector?

Step 2: Identifying relevant studies

Arksey and O'Malley's (2005) framework emphasizes the development of a comprehensive search strategy to capture both peer-reviewed and grey literature. While breadth is a key strength of scoping reviews, practical constraints such as time, funding, and database access often necessitate a balance between comprehensiveness and feasibility. Levac et al. (2010) caution that overly expansive searches can produce unmanageable volumes of literature, complicating synthesis and analysis. They therefore recommend achieving an appropriate balance between scope and feasibility, supported by teams with methodological and subject-matter expertise, and transparently justifying any applied restrictions.

For this scoping review, explicit inclusion and exclusion criteria were established to ensure relevance and rigor. Multiple sources were systematically consulted, including electronic databases, reference lists, hand-searched key journals, organizational reports, and conference proceedings. A temporal limit was applied, restricting eligible documents to those published between 2000 and 2025. The review focused thematically on solar energy enterprises and clean cooking, with particular emphasis on women's and youths' participation.

Searches were conducted in the Emerald and ScienceDirect databases using predefined keywords and Boolean operators. Key search terms included:

"clean energy and women," "clean energy enterprises," "clean energy entrepreneurship," "clean energy business and women," "clean energy business and youth," "youth in clean energy entrepreneurship," "women energy entrepreneurs," "clean energy value chains," "platforms youth and energy," "energy hubs and youth," "women and energy," and "youth and energy."

These terms were combined into the following search string, which was applied consistently across both databases:

("Clean energy" AND women) OR ("Clean energy" AND youth) OR ("Clean energy enterprises") OR ("Clean energy entrepreneurship") OR ("Clean energy business" AND women) OR ("Clean energy business" AND youth) OR ("Youth in clean energy entrepreneurship") OR ("Women energy entrepreneurs") OR ("Clean energy value chains") OR ("Platforms" AND youth AND energy) OR ("Energy hubs" AND youth)

The geographical scope was limited to Malawi, with specific attention to women- and youth-led clean energy initiatives in solar and clean cooking technologies. Particular emphasis was placed on productive uses of energy, enabling policies, gender-responsive programs, and documented best practices, including innovative clean energy enterprises, business models, and financing mechanisms. Documents outside the defined temporal, thematic, or geographical scope were excluded.

Step 3: study selection

In the framework proposed by Arksey and O'Malley (2005), the study selection stage entails applying predefined inclusion and exclusion criteria to identify eligible studies, although the original guidance provides limited procedural detail. Subsequent methodological refinements highlight that this stage is inherently iterative and strengthened by a systematic approach.

Step 4: Charting the Data

Charting involved the systematic extraction and analytical organization of data from included studies using a standardized form. Studies were assessed for methodological rigor, clarity, and alignment with the review objectives, with findings cross-checked against key reports and seminal literature. Any discrepancies or unclear information were resolved through discussion among the review team. Extracted data were then synthesized into thematic categories such as women-led, youth-led, and solar energy enterprises to identify patterns and evidence gaps.

Step 5: Collating, summarizing & reporting the results

Following systematic data charting, the extracted findings from 44 (see figure 1) documents were synthesized to provide a comprehensive overview of women and youth clean energy enterprises in Malawi. Evidence was organized using tables and figures to enable cross-comparison of technology categories and to highlight patterns in study designs, populations, and outcomes. Reviewed studies were categorized by clean energy technologies, including pico-solar systems, household solar appliances, and productive-use solar equipment, with each category analyzed for core characteristics such as geographical and institutional context, target populations, study design, and methodological approach. Measurement frameworks and principal findings were documented in detail, and for scoping review studies, the number of included articles was scrutinized, with supplementary literature incorporated to ensure comprehensiveness. This structured synthesis facilitated the identification of thematic trends, gaps in the evidence base, and critical insights into the roles, dynamics, and challenges associated with women's and youth participation in clean energy enterprises in Malawi.

Table 1. Data collection and sources

Sources	Full	Malawi (2010-2025)	Screening
Science Direct	948	201	119
Emerald	246	41	9
Hand searching	248	138	82
Total	**1442**	**380**	**210**

3.0 Findings

This section presents the results of the scoping review on women- and youth-led clean energy enterprises in Malawi. The findings are organized in line with the guiding research questions and draw on evidence synthesized from peer-reviewed journal articles, policy reports, program evaluations, donor and non-governmental organizations (NGOs) publications, and other forms of grey literature. To ensure clarity and comparability, the results are summarized using descriptive tables, graphs, and figures, highlighting the characteristics of women- and youth-led enterprises, the financing models that support them, the opportunities and challenges they face, their contributions to development outcomes, and the strategies and policy options identified in the literature for strengthening gender-inclusive and youth-responsive participation in Malawi's clean energy sector.

3.1 Overview of clean cooking and solar energy subsectors in Malawi

Malawi's energy sector is characterized by low levels of electricity access and high reliance on biomass for household energy. Approximately 25.9% of the population has access to electricity, with 11.3% connected through the national grid and 14.6% utilizing off-grid solutions such as solar home systems, solar lanterns, rechargeable batteries, and generator sets (GoM, 2024). A significant urban-rural divide exists, with 56.5% of urban households connected to the national grid compared to just 3.8% of rural households (GoM, 2024).

Over 90% of Malawian households rely on traditional biomass fuels, primarily firewood and charcoal, for cooking (GoM, 2024). These practices contribute to deforestation, environmental degradation, and adverse health impacts due to indoor air pollution. To address these challenges, Malawi has promoted clean cooking initiatives including

improved cookstoves, alternative fuels, and supportive policies. The Malawi SDG7 Cleaner Cooking Energy Compact aims to provide all households and institutions with access to climate-friendly, energy-saving cooking solutions by 2030. Notable technologies include the locally produced Chitetezo Mbaula clay stove and high-efficiency biomass stoves by BURN Manufacturing, which leverage carbon financing to increase affordability and adoption (Malinski, 2008). In terms of solar, Malawi possesses substantial solar energy potential, with average annual energy output for photovoltaic systems ranging from 1,350 to over 1,700 kWh/kWp (Chisale et al., 2025). Solar energy has emerged as a key strategy to diversify energy sources, particularly in rural areas underserved by the national grid. As of 2021, 22 active community energy systems operated in Malawi, predominantly utilizing solar PV technology (Hara, 2021). Private sector engagement in off-grid solar solutions has increased, although challenges remain regarding unregulated suppliers and inconsistent product quality (Hara, 2021).

3.2 Characterizing the evidence

3.2.1The nature of the documents synthesized

The analysis of the 44 documents included in the scoping review (Fig. 2) reveals a marked imbalance in the literature on women and youth clean energy enterprises in Malawi. Reports dominated the evidence base, comprising 35 documents (79.5%), reflecting the prominence of programmatic and policy-oriented work by development partners, government agencies, and Non – Governmental Organizations.

While these sources provide practical insights, their methodological rigor and peer-reviewed validation are often variable. Journal articles accounted for only 8 documents (18.2%), highlighting a limited presence of peer-reviewed research and a gap in scholarly exploration of the topic. Working papers were scarce (2.3%), suggesting that early-stage or exploratory findings are infrequently disseminated in ways that stimulate academic debate. Overall, the evidence base is heavily skewed toward applied, non-academic sources, underscoring the need for stronger research collaborations between academia, practitioners, and policy actors to enhance theoretically grounded, generalizable insights while capturing the practical realities of women's and youth participation in Malawi's clean energy enterprises.

3.2.2 Analysis by year publication

The analysis of documents by year of publication (Fig. 3) reveals temporal trends in research on women and youth clean energy enterprises in Malawi. Early years contributed few publications, reflecting limited focus on gender and youth in the sector, consistent with global trends where these dimensions only recently gained visibility. From 2015 onwards, publications increased markedly, coinciding with donor-funded programs, renewable energy policies, and integration of the SDGs, highlighting growing recognition of women and youth as key actors. Occasional declines or plateaus in recent years may reflect shifting priorities, COVID-19 disruptions, or publication delays.

Overall, the upward trend demonstrates a strengthening evidence base, while the uneven distribution underscores the need for sustained research and continuous documentation to capture evolving sector dynamics.

3.2.3 Sources of information

The sources of information listed represent a combination of peer-reviewed academic journals, professional publications, and credible organizational or governmental reports relevant to clean energy, sustainability, and

socio-economic development in Malawi and globally. These sources were selected to ensure the review captures a comprehensive and reliable evidence base on women- and youth-led clean energy enterprises.

- Peer-reviewed journals such as Energy for Sustainable Development, Journal of Power and Energy Engineering, Open Journal of Energy Efficiency, Climatic Change, Discover Sustainability, and The Lancet provide rigorously reviewed research on renewable energy technologies, energy efficiency, environmental impacts, and socio-economic outcomes. They offer empirical studies, systematic reviews, and theoretical frameworks that support evidence-based analysis.
- Specialized sustainability journals like Journal of Sustainability Research and Energia focus on gender, energy access, and sustainable development, providing insights into the role of women and youth in energy innovation and entrepreneurship.
- Organizational and government sources such as Energy 4 Impact and the Malawi Government Press, provide practical and policy-oriented data, including program reports, policy documents, and national statistics relevant to the Malawian context. These sources help contextualize academic findings within real-world energy interventions and governance frameworks.

The diverse range of sources enables the scoping review to integrate scientific evidence, policy guidance, and programmatic experience, offering a comprehensive understanding of clean energy adoption, associated challenges and opportunities, and gender- and youth-inclusive initiatives in Malawi.

3.3 Key findings and discussion

This section presents the findings, interpretation and discussion, organized around the key research questions: the overview of Women- and Youth-Led Initiatives, the characteristics of women- and youth-led clean energy enterprises, financing models, and the opportunities and challenges women and youth entrepreneurs face in Malawi.

Women- and Youth-Led Initiatives

Engagement of women and youth in Malawi's clean energy enterprises remains limited due to significant structural, socioeconomic, and capacity-related barriers. Women's participation in energy generation, distribution, and governance is minimal, constrained by gaps in knowledge, technical skills, and investment capacity, despite their central role as beneficiaries of energy services (Hivos, 2019). Integrating gender considerations into renewable energy projects is essential to promote equitable benefits, given the proven global link between clean energy access and women's economic empowerment, health, education, and social status. Initiatives such as SolarAid's Shining Mothers program have sought to enhance women's inclusion, yet broader recognition of their economic contributions remains critical for sustainable growth (SolarAid, 2020). Youth engagement is similarly constrained by limited access to employment, finance, and technology, compounded by social and developmental vulnerabilities during the transitional period of 10–35 years, which can increase exposure to risky behaviors (NYP, 2023; Kalowekamo, 2022).

Status of Women- and youth-led clean energy enterprises

Table 2 illustrates the diversity and depth of women's and youth participation across Malawi's clean energy enterprise landscape, highlighting their roles not only as end-users but as entrepreneurs, innovators, and workforce participants across multiple segments of the energy value chain. The enterprises span both electricity

and clean cooking subsectors, with a strong emphasis on decentralized energy solutions that are particularly relevant for rural and peri-urban contexts

Table 2
Existing Clean Energy Enterprises with Women and Youth Participation

Name	Youth / Women Involvement / Ownership / Leadership	What They Do	Technology
EcoGen	Youth-led	Designs and installs waste-to-energy solutions	Biogas / Waste-to-Energy
Sollys Energy	Youth-led sales force	distributing solar systems	Solar PV / Solar Appliances
Green Impact Technologies	Youth-led, co-founded by Joyce Sikwese and Admore Chiumia.	Provides renewable energy & sustainable agriculture tools.	Solar PV, Clean Cooking, Agriculture Technologies
Mpasta Engineering	Led by a youth entrepreneur	Works on water supply, irrigation and energy.	Solar PV
Solar Ku Midzi	Strongly women-led/owned component	Imports, assembles, distributes & services solar products	Solar PV, Clean Cooking, Batteries
Village Solar	Co-founded by women	Provides training and tools for clean energy entrepreneurs	Solar PV / Clean Energy Products
TENERGY	Youth employed as sales agents & staff	Distributes solar home systems, clean energy solutions	Solar PV / Clean Energy Solutions
Mudzi Cooking Project	Youth-led	Produces biomass briquettes from waste.	Biomass Briquettes / Improved Cookstoves
BURN Manufacturing	About 50% of employees are women in manufacturing workforce.	Large-scale production of clean biomass cookstoves	Clean Cookstoves
PRHE Women's Briquette Enterprise	Women in rural Lilongwe District lead enterprise.	Make briquettes from agricultural waste; promote smokeless stoves; tree planting for sustainable fuel.	Biomass Briquettes / Clean Cooking
Malawi Living Lab (Going Green / MIG Bio Cooker)	Female-led social enterprise (Going Green) with farmer groups.	Produces bio-briquettes from sunflower stalks and sawdust; assembles/distributes clean bio-cookers; builds supply chain.	Briquettes / Bio-Cookers
The Moses Stove Producers (Machinga)	Women producers group.	Manufacture Chitetezo Mbaula improved cookstoves; sell thousands per year in local markets.	Improved Cookstoves

A clear pattern emerging from the table is the prominent leadership role of youth-led enterprises, especially in technology-oriented and service-based models. Enterprises such as EcoGen, Sollys Energy, Mpasta Engineering, and Mudzi Cooking Project demonstrate youth engagement in design, installation, distribution, and production of clean energy technologies. These initiatives suggest that young entrepreneurs are well-positioned to drive

innovation in off-grid solar systems, waste-to-energy solutions, and alternative cooking fuels, particularly where digital tools, flexible business models, and community-based delivery mechanisms are required.

Women's participation is especially pronounced in the clean cooking value chain, where enterprises such as Solar Ku Midzi, PRHE Women's Briquette Enterprise, Malawi Living Lab (Going Green), and the Moses Stove Producers reflect strong female ownership and leadership. These enterprises combine energy access objectives with livelihood creation, environmental conservation, and health benefits. Women-led models are frequently embedded within local production systems such as briquette manufacturing and improved cookstove assembly enhancing affordability, local acceptance, and supply-chain resilience. The case of BURN Manufacturing further illustrates women's participation at scale, particularly in manufacturing roles, indicating the potential for gender-inclusive employment within larger, formalized clean energy firms.

The table also highlights the breadth of technologies and business models through which women and youth engage, ranging from solar photovoltaic systems and mini-grid–compatible solutions to biomass briquettes, bio-cookers, and improved cookstoves. Several enterprises, notably Green Impact Technologies and Solar Ku Midzi, operate across multiple sectors, integrating energy access with agriculture, sustainable land use, and battery storage. This cross-sectoral approach underscores the role of clean energy enterprises as part of a broader rural development and green economy ecosystem. The enterprises documented in Table 3 demonstrate that women and youth are already central actors in Malawi's clean energy transition. However, their activities remain largely concentrated in small- and medium-scale, decentralized enterprises, often operating under resource constraints. This pattern underscores the importance of targeted policy, financing, and capacity-building interventions to enable these enterprises to scale, formalize, and integrate more fully into national energy strategies. Strengthening support for women- and youth-led clean energy enterprises has the potential to simultaneously advance energy access, employment creation, and inclusive economic development.

Business models/how clients are reached

The clean energy enterprise sector in Malawi features a variety of business models, primarily focusing on retail, PAYG, and social enterprise approaches, with several companies actively incorporating women- and youth-led initiatives.

Table 3
Clean Energy Enterprises in Malawi

Business Model	Brand / Product Focus	Operations & Notable Initiatives
Retail (cash & credit)	Pico-solar, SHS, larger systems, solar thermal systems, water pumps, Zuwa SHS, SHS pumps	Kumudzi Kuwale operates two retail outlets and > 20 rural charging stations for rental, purchase, and charging. Implements the "No One Should Be Left in the Dark" project (€342,000 / USD 414,000, EEP 2019–2021). Women-led micro-enterprises participate in distribution and local sales. Powered by Nature focuses on cash and credit retail of SHS, Sun King systems, larger solar systems, and solar thermal solutions. Yellow Solar operates through rural agent networks and recruits agents in 20 districts, engaging women and youth. Zuwa Energy sells through own shops, partnering with Malawi Posts Corporation and mobile money platforms. Kuwala Energy distributes SHS and solar pumps via own outlets and agent networks, mainly in Nkhata Bay, planning northern expansion by 2025. Women-led micro-enterprises support sales and engagement.
Retail & PAYG	SHS kits, component-based systems, appliances, Sun King, Biolite, X-Solar, Indigo, Azuri, Pico-solar (initially)	Solar Works! Sells through agricultural shops and agents, opened new shop in Mchinji, and set up a call centre. Partners with TNM and Airtel Money for PAYG, supporting women entrepreneurs. Green Impact Technologies sells Sun King and Biolite via agents with mobile money PAYG, recognized by UNDP, SEED initiative, and Applied Research Innovation Window grant. M-PAYG sells Sun King and X-Solar, partnered with Total Land Care on €1.3 million (USD 1.6 million) SHS project (Nordic Climate Facility); youth-led enterprises contribute technical and installation services. Team Planet Solar Solutions initially distributed pico-solar, now larger systems through shops and agents; youth-led technical participation. RECAPO sells Indigo and Azuri, implementing rural electrification reaching 3,000 households (AECF-funded) with women-led agent networks.
Retail, wholesale & PAYG / Social enterprise	Sun King pico-solar, OV multi-light systems	Sunny Money sells through individual and shop agents, installed plug-and-play SHS in COVID-19 hotspot hospitals. Women- and youth-led micro-enterprises participate in distribution and community engagement.
Retail via commercial partnerships	Sun King pico-solar, d.light, Sundaya T-lite 2	Total Malawi sells through Total filling stations; promotes Total Solar brand via dedicated Solar Project Coordinator. Women-led micro-enterprises act as local agents distributing products to rural households.

Malawi's clean energy enterprises operate through diverse retail, credit, PAYG, and partnership-based models that embed women and youth participation across the value chain. Retail cash-and-credit enterprises including Kumudzi Kuwale, Powered by Nature, Yellow Solar, Zuwa Energy, and Kuwala Energy use shops, rural charging stations, and agent networks to distribute solar products. Kumudzi Kuwale combines retail outlets with over 20 rural charging stations and implements the EEP-funded "No One Should Be Left in the Dark" project, while women-led micro-enterprises support local sales. Powered by Nature and Yellow Solar rely on cash-and-credit retail and rural agents, actively engaging women and youth. Zuwa Energy and Kuwala Energy distribute through own shops, agent networks, and mobile money platforms, with planned geographic expansion.

Several firms apply a combined retail and PAYG model, including Solar Works!, Green Impact Technologies, M-PAYG, Team Planet Solar Solutions, and RECAPO. These enterprises sell solar home systems through shops and agents, integrate mobile money PAYG payments, and collaborate with telecom providers and development partners. Women and youth play key roles as sales agents, technicians, and installers, while donor-funded projects support rural electrification and system adoption. Hybrid retail, wholesale, and social enterprise models are

exemplified by Sunny Money, which distributes pico-solar and SHS products through agent networks and has installed systems in health facilities, with women- and youth-led enterprises supporting outreach. Commercial partnership models are represented by Total Malawi, which sells solar products through fuel stations, supported by women-led local agents.

3.4 Financing models for women and youth-led clean energy entrepreneurs in Malawi

Financing mechanisms play a crucial role in expanding access to clean energy and supporting the sustainability of SHS and pico-solar enterprises. Various financial models have evolved to address the capital-intensive nature of renewable energy investments, reduce financing risks, and promote inclusion of women and youth entrepreneurs in the sector. The key models include donor and grant-based financing, microfinance and community savings models, leasing and PAYG systems, and green bank and blended financing approaches.

Donor and Grant-Based Financing

Donor and grant mechanisms remain central to the development of solar enterprises, especially in emerging economies where private capital remains limited. These mechanisms provide non-repayable financial and technical support to enterprises for start-up capital, capacity building, and market linkage facilitation. According to Jagger (2018), approximately 60% of SHS and pico-solar enterprises receive some form of donor assistance, including grants, training, or business development services. Such external support enables small firms—often led by women and youth to overcome initial market entry barriers, experiment with innovative technologies, and expand service delivery to off-grid communities.

Microfinance and Community Savings Models

Microfinance institutions (MFIs) and community-based savings groups have become vital in providing working capital to solar entrepreneurs who lack access to traditional bank loans. In Malawi, for example, access to credit through formal banks remains limited, with only about 23% of women entrepreneurs able to secure traditional loans (Mpanga et al., 2023). High interest rates and stringent collateral requirements further constrain financing options (Nyasulu, 2024). To address this, informal community-based structures such as Village Savings and Loan Associations (VSLAs) provide small, flexible loans and savings platforms for entrepreneurs. Organizations like Mayi Walani a women-led initiative collaborate with VSLAs to provide interest-free micro-loans and mentorship to female solar entrepreneurs, enabling them to scale their enterprises sustainably (SolarAid, 2025). The FinScope MSME Survey (2023) also found that certified solar businesses in Malawi have a 68% success rate in accessing microfinance loans, highlighting the growing role of these alternative credit systems.

Green Bank and Blended Financing Mechanisms

Blended finance mechanisms combine public, private, and philanthropic capital to de-risk investments in renewable energy. A prominent example is the Connecticut Green Bank in the United States, which offers the Commercial Property Assessed Clean Energy (C-PACE) program. This initiative provides affordable, long-term financing for commercial SHS leasing and energy efficiency projects (Welden, 2019). While this model originates in developed markets, it demonstrates how public–private collaboration can catalyze clean energy growth an approach increasingly encouraged in developing contexts. Blended finance structures are particularly relevant in

Africa, where governments and donors can co-finance projects to attract private investment while addressing affordability and risk barriers faced by smaller enterprises.

National and Global Investment Commitments

On a macroeconomic scale, clean energy investment is expanding globally as part of climate action and sustainable development commitments. According to the International Renewable Energy Agency (IRENA, 2018), renewable energy markets in Africa have grown rapidly, outpacing other economic sectors and serving as engines of national development. Global projections suggest that meeting renewable energy and efficiency targets will require approximately US$550 billion annually for renewable energy development (Belden, 2015) and an additional US$381 billion per year for energy efficiency improvements (IRENA, 2019).

3.5 Opportunities and barriers for Women and Youth Entrepreneurs in clean energy sector in Malawi

Opportunities

Women and youth in Malawi's clean energy sector benefit from multiple opportunities that support entrepreneurship and participation:

1. Expanding Off-Grid Electrification in Malawi

Malawi is advancing off-grid electrification through the deployment of solar home systems, mini-grids, and clean cooking technologies, creating significant opportunities for women's participation in the energy sector (Climat Investment Funds (CIF), 2025). Decentralized solutions such as solar lanterns, improved cookstoves, and biogas digesters are particularly well-suited for micro-entrepreneurship and community-based distribution models. Rural women, integrated within local social networks, can engage as sales agents, technical service providers, or micro-franchisees. Experiences from other African contexts demonstrate that women entrepreneurs are highly effective in marketing solar products, achieving considerable reach in off-grid communities a trend that is beginning to emerge in Malawi. For instance, the SolarAid "Shining Mothers" initiative, launched in 2021, aims to train and empower 1,500 rural Malawian women as solar entrepreneurs, leveraging their community connections to expand energy access. Such initiatives underscore the critical role of women as catalysts for growth in the renewable energy sector, highlighting the potential for scalable impact across rural Malawi.

2. Global partnerships and gender inclusion

International donors, NGOs, and development partners have shown strong commitment to promoting gender equality within Malawi's energy sector. Programs led by organizations such as the UNDP, European Union, Millennium Challenge Corporation (MCC), and SolarAid are advancing innovative models that encourage women's participation through technical training, entrepreneurship support, and access to financing for women-owned businesses. For example, UNDP's Access to Clean and Renewable Energy initiative features the "Powering Gender Equality" program, which equips rural women with business management and energy-related skills, helping to reduce financial and knowledge barriers that limit their involvement in the renewable energy industry (CIF, 2025).

3. Policy Commitments and Political Will

Malawi's policy framework emphasizes gender inclusion and reflects growing political acknowledgment of the relationship between women's empowerment and access to sustainable energy. This environment provides a strong foundation for implementing tangible initiatives supported by high-level commitment. The creation of the Gender and Social Inclusion Unit within ESCOM, the national electricity utility, serves as a strategic platform to promote actions such as increasing the recruitment of female engineers, expanding internship opportunities, and ensuring fair access to new energy connections and tariff options. Similarly, the Rural Electrification Agency can reinforce these efforts by developing women-centered outreach and training programs alongside grid expansion such as workshops focused on the productive use of electricity in agriculture and rural enterprises (CIF, 2025).

4. Untapped Talent and Entrepreneurial Potential

Women in Malawi exhibit notable entrepreneurial strength, particularly within micro and small enterprises operating in agriculture, local markets, and home-based industries. Improved access to reliable energy could enable these women-owned ventures to scale up operations and boost profitability. The use of renewable technologies such as solar-powered dryers for crop preservation or electric grain mills can significantly enhance productivity and income generation. Moreover, as educational disparities between men and women continue to narrow, an increasing number of young women are pursuing studies at secondary and tertiary levels, creating a promising pipeline of skilled talent for the renewable energy sector. Internship and scholarship programs, such as those provided by ESCOM for female engineering students, can further nurture this potential and strengthen women's participation in technical and leadership roles within the industry (CIF), 2025).

Barriers

Cultural and Social Norms

Prevailing gender norms confine women to domestic roles, restricting their participation in economic activities. Technical and business roles are often perceived as male domains, discouraging women from these career paths. In rural regions, mobility constraints (such as requiring spousal permission for travel) further impede access to training and networking within the energy sector (Climat Investment Funds (CIF), 2025).

Access to Finance and Assets

Women in Malawi typically lack collateral and face financial exclusion, owning less property that could secure loans. Coupled with smaller incomes and limited credit histories, this leads to decreased access to financing for women-led enterprises in the energy domain. Institutional biases in lending create additional hurdles, and female-headed households often struggle to afford upfront costs for renewable energy technologies, thereby limiting their ability to participate in the sector (Climat Investment Funds (CIF), 2025)..

Educational and Skills Gap

Women face significant barriers to accessing technical education and training, resulting in a shortage of female professionals in energy sectors such as engineering and vocational trades. Their limited exposure to STEM subjects due to societal biases contributes to underrepresentation in roles like electricians and solar installers, creating a skills deficit that hinders competition for jobs and entrepreneurial opportunities in renewable energy sector (Climat Investment Funds (CIF), 2025).

Information and network gaps

Women often lack effective access to information about renewable energy technologies, programs, and business opportunities due to inadequate outreach by extension services and energy firms (Climat Investment Funds (CIF), 2025). This results in lower awareness among rural women regarding solar products, financing options, and training workshops. The male dominance in the sector limits professional networking opportunities for women, as informal networks often exclude them. This absence of information and mentorship complicates their entry into the renewable energy market (Climat Investment Funds (CIF), 2025).

Networking and accelerator initiatives, such as AWIEF, aim to connect women with investors and expand their market linkages. Additionally, barriers to access in information and communication technologies persist, although mobile proliferation is improving the situation. Addressing the challenge of isolation through women's networks and cooperatives is critical for bridging gaps into mainstream energy markets (Climat Investment Funds (CIF), 2025).

Time constraints and competing household duties

Despite the existence of opportunities, many women are unable to fully participate because of the heavy burden of unpaid domestic work. In rural Malawi, women spend a large portion of their day on household activities, leaving limited time for education, vocational training, or entrepreneurship. Programs that overlook these time demands for instance, by scheduling sessions during cooking or harvesting periods often experience low female participation. Additionally, during crises such as health outbreaks or natural disasters, women's caregiving roles expand, heightening their economic vulnerability and driving some into temporary or prolonged poverty. These pressures make it difficult for women to engage in emerging sectors like renewable energy unless deliberate support systems are in place (Climat Investment Funds (CIF), 2025).

4.0 CONCLUSION, GAPS AND POLICY IMPLICATIONS

4.1 Conclusion

The scoping review reveals that women and youth are emerging as vital actors in Malawi's clean energy transition, contributing to entrepreneurship, distribution, and innovation across the solar and clean cooking value chains. Enterprises such as EcoGen, Green Impact Technologies, Solar Ku Midzi, and the Mayi Walas initiative demonstrate the potential of inclusive business models to advance both energy access and socio-economic empowerment. However, despite the increasing visibility of women- and youth-led enterprises, gender impact measurement remains weak, fragmented, and largely donor-driven, limiting the evidence base needed to inform equitable policy and practice.

Existing assessments predominantly focus on quantitative participation indicators such as the number of women trained or employedwithout addressing deeper dimensions of empowerment such as agency, leadership, decision-making power, or control over resources. The absence of a standardized Gender Impact Measurement Framework within Malawi's clean energy sector constrains efforts to systematically evaluate gendered outcomes. Furthermore, monitoring and evaluation systems within projects rarely apply recognized frameworks such as the Women's Empowerment in Agriculture Index (WEAI), the Sustainable Livelihoods Approach, or gendered innovation system frameworks, and when they do, the adaptation is inconsistent and lacks contextual relevance.

At the policy level, Malawi's National Energy Policy (2018), Gender Policy (2016), and National Youth Policy (2023) demonstrate strong political commitment to gender inclusion. Nonetheless, these policies are not operationally aligned with measurable indicators within the renewable energy sector. This disconnect results in gender mainstreaming efforts being implemented inconsistently and often influenced by external donor requirements rather than national evaluation systems.

A deeper structural analysis reveals that the progress of women and youth entrepreneurs is further constrained by systemic barriers that reinforce gender inequality and limit participation in higher-value segments of the energy value chain. These include:

Limited Access to Finance and Assets: Women and youth entrepreneurs continue to face stringent collateral requirements, low financial literacy, and exclusion from mainstream financial systems. Although community-based mechanisms such as Village Savings and Loan Associations (VSLAs) have emerged as critical enablers, their scale and capital capacity remain limited.

Educational and Skills Deficits: Persistent gender disparities in STEM education have limited women's and girls' participation in technical and managerial roles. This perpetuates dependency on male technicians and foreign expertise in system installation and maintenance.

Cultural and Social Norms: Patriarchal norms and gendered role expectations confine women to domestic or informal economic spaces, restricting mobility and access to markets and training. Such norms also undermine women's visibility in leadership and decision-making positions within energy enterprises.

Information and Networking Gaps: Women and rural youth often lack access to information about renewable energy technologies, financing options, and mentorship opportunities. The absence of gender-responsive extension services and professional networks deepens their marginalization.

- Time Poverty and Unpaid Care Work: The disproportionate burden of unpaid household responsibilities limits women's ability to engage in entrepreneurship and training programs. Many interventions overlook these structural constraints in their program design.
- Policy-Practice Disconnect: Although multiple policies recognize gender equality as a national priority, their operationalization within clean energy projects remains weak. There are limited institutional mechanisms for monitoring gender outcomes or linking energy policy objectives to measurable indicators of empowerment.

From a theoretical standpoint, the review underscores the need to move beyond the "participation paradigm" toward a transformative gender framework that captures how women's and youth's engagement in clean energy entrepreneurship reshapes social relations, market access, and power dynamics. Integrating frameworks such as Feminist Political Ecology, Gender and Energy Nexus Theory, and the Capability Approach can offer multidimensional insights into empowerment outcomes that go beyond income or employment statistics.

A contextualized Gender Impact Measurement Framework for Malawi should therefore integrate both quantitative indicators (e.g., access to credit, asset ownership, and enterprise growth) and qualitative dimensions (e.g., agency, self-efficacy, leadership, and changes in household decision-making). Such a framework should align with national policies and global commitments under SDG 5 (Gender Equality), SDG 7 (Affordable and Clean Energy), and SDG 13 (Climate Action), ensuring that clean energy entrepreneurship contributes directly to inclusive and sustainable development. In sum, Malawi's clean energy ecosystem presents significant potential for gender-transformative

entrepreneurship; yet this potential remains underutilized due to systemic, institutional, and cultural barriers. The absence of coherent gender measurement frameworks further obscures understanding of what truly constitutes empowerment within this context. Developing and institutionalizing a Gender Impact Measurement Framework for Clean Energy Enterprises grounded in Malawi's socio-economic realities and supported by robust data systems would enable evidence-based policymaking, equitable resource allocation, and sustained empowerment of women and youth in the country's renewable energy transition.

4.2 Identified Gaps in the Literature

The literature synthesis identifies several persistent gaps that constrain the development of gender-responsive research and policy in Malawi's clean energy sector. A key limitation is the absence of a standardized national framework for measuring gender impacts, with most assessments relying on project- or donor-specific indicators, thereby limiting comparability and accountability. The evidence base is also heavily skewed toward programmatic and consultancy reports, with relatively few peer-reviewed empirical studies to advance theoretical and methodological understanding of gender, entrepreneurship, and technology adoption.

In addition, limited availability of sex- and age-disaggregated data restricts analysis of differential impacts and weakens the design of targeted interventions. Existing evaluations tend to be short-term and output-oriented, offering limited insight into long-term empowerment trajectories and socio-economic transformation. Intersectional dimensions including age, geography, education, and socio-economic status remain insufficiently explored, obscuring subgroup-specific barriers. Moreover, despite widespread recognition of financial constraints facing women and youth entrepreneurs, the relationship between financing mechanisms and empowerment outcomes remains underexamined.

4.3 Policy Implications:

The scoping review highlights key implications for energy, gender, and entrepreneurship policy in Malawi, emphasizing the need to embed gender and youth considerations as measurable, actionable elements of the national clean energy agenda rather than peripheral project objectives.

1. Integration of Gender and Youth Indicators: Existing policies, including the National Energy Policy (2018) and Gender Policy (2016), lack operational gender metrics. Future revisions should incorporate measurable indicators on ownership, leadership, finance, and training to track progress effectively.
2. Gender-Responsive Financing and Fiscal Policies: Financial barriers limit women and youth from scaling enterprises. Promoting gender-responsive loans, credit guarantees, dedicated funds, and targeted fiscal incentives can enhance participation.
3. Technical and Entrepreneurial Skills Development: Gaps in STEM and technical training restrict engagement in high-value clean energy sectors. Vocational and higher education curricula should integrate clean energy modules, scholarships, and apprenticeships to develop a skilled and inclusive workforce.
4. Localization of Gender Policies: To ensure sustainability, gender initiatives should be embedded locally via district focal points, integration into development plans, and sustained funding for monitoring.

Declarations

Ethics approval:

Ethical approval for the underlying survey was obtained from the Mzuzu University Research Ethics Committee (MZUNIREC), Malawi (Approval No. MZUNIREC/DOR/26/02).

Consent to publish:

Not applicable. The manuscript does not contain any individual person's data or information that could identify a participant.

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Author Contribution

J.E drafted the manuscript with contributions and support from A.K and D.M Joyce Gathaci and Dickson Bota reviewed the manuscript and provided comments and revisions. Joyce Gathaci also contributed to the final editing and refinement of the manuscript. All authors reviewed and approved the final version of the manuscript.

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References

1. Africa Clean Energy Technical Assistance Facility and Open Capital Advisors. (2021). *Impact of Tax Incentives on Access to Stand-Alone Solar: Policy recommendations from analysis in Malawi, Rwanda, and Sierra Leone* (Issue March). https://opencapital.com/wp-content/uploads/2021/05/Impact-of-Tax-Incentives-on-Access-to-Stand-Alone-Solar-Policy-recommendations-from-analysis-in-Malawi-Rwanda-and-Sierra-Leone.pdf
2. Agency IE, Outlook WE. & Dr. Fatih Birol. (2019). World Energy Outlook 2019. *The World in Figures*, 32–32. https://www.iea.org/reports/world-energy-outlook-2019%0Ahttps://www.iea.org/reports/world-energy-outlook-2019%0Ahttps://webstore.iea.org/download/summary/2467?fileName=Japanese-Summary-WEO2019.pdf
3. Amanda Soler J, Jæger DL, ARE). (. (2020). *Women Entrepreneurs as Key Drivers in the Decentralised Renewable Energy Sector: Best Practices and Innovative Business Models*.

4. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. Int J Social Res Methodology: Theory Pract. 2005;8(1):19–32. https://doi.org/10.1080/1364557032000119616.
5. Associates EC. Energy Africa – malawi. Technical assistance to model and analyse the economic effects of VAT and tariffs on picoPV products, solar home systems and improved cookstoves. Issue August; 2017. https://www.gov.uk/dfid-research-outputs/energy-africa-mozambique-technical-assistance-to-model-and-analyse-the-economic-effects-of-vat-and-tariffs.
6. Becerra-Encinales JF, Bernal-Hernandez P, Beltrán-Giraldo JA, Cooman AP, Reyes LH, Cruz JC. Agricultural Extension for Adopting Technological Practices in Developing Countries: A Scoping Review of Barriers and Dimensions. Sustain (Switzerland). 2024;16(9). https://doi.org/10.3390/su16093555.
7. Bovenkerk O, Darr D, Gomes Vale EM. (2023). A discrete choice experiment to measure the Malawian potential market for Baobab fruit shell briquettes: Evidence from consumer preferences in Mzuzu City. *Energy for Sustainable Development*, *73*(July 2022), 144–151. https://doi.org/10.1016/j.esd.2023.01.011
8. Chidzumeni B. (2025). *Malawi Digital Transformation Progress; Status as of 2024 (PART TWO): MALAWI DIGITAL TRANSFORMATION PROGRESS* (Vol. 2024, Issue May).
9. Chipula G, Sanjika T, Nyanda R. & … (2020). Solar powered technologies for the smallholder dairy industry in Malawi. In … *Policy Brief, No. 6* https://idl-bnc-idrc.dspacedirect.org/handle/10625/59571
10. Chisale SW, Lee HS, Soto Calvo MA, Jeong JS, Aljber M, Williams Z, Cabrera JS. (2025). Advanced solar energy potential assessment in Malawi: Utilizing high-resolution WRF model and GIS to identify optimal sites for solar PV generation. *Renewable Energy*, *239*(December 2024), 122084. https://doi.org/10.1016/j.renene.2024.122084
11. Chomanika K, Vunain E, Mlatho S, Minofu M. Ethanol briquettes as clean cooking alternative in Malawi. Energy Sustain Dev. 2022;68(June):50–64. https://doi.org/10.1016/j.esd.2022.03.002.
12. Coley W, Unyolo B, Eales A, Frame D. Mapping Opportunities for Microfinance and Renewable Energy Services in Malawi. Issue April); 2019.
13. Corporation IF. Off-Grid Solar Market Trends Report 20018 - Executive Summary. Issue January; 2017. .
14. Conrema. (2024). *Youth-led firm accelerating climate-smart agriculture.* Retrieved from https://conrema.org.
15. Danielle Levac HCK. K. O. Scoping studies: advancing the methodology. Representing Intervening. 2010;1–18. https://doi.org/10.1017/cbo9780511814563.003.
16. Eales A, Alsop A, Frame D, Strachan S, Galloway S. Assessing the Market for Solar Photovoltaic (PV) Microgrids in Malawi. J Sustain Res. 2020;2(1):1–44. https://doi.org/10.20900/jsr20200008.
17. Ecogen. (2010). *Introduction to Baxi The domestic heating experts HP*.
18. EEP Africa. (2019). *Profiles of change: Youth opportunities in the clean energy sector*. https://eepafrica.org/wp-content/uploads/2019/12/Youth-opportunities-brief_Digital.pdf
19. Ehimen EA, Sandula PY, Robin T, Gamula GT. Improving Energy Access in Low-Income Sub-Saharan African Countries: A Case Study of Malawi. Energies. 2023;16(7):1–26. https://doi.org/10.3390/en16073106.
20. Endev. (2020). Productive Use of Energy: Moving to scalable business cases. In *Learning & Innovation*. https://endev.info/wp-content/uploads/2021/03/EnDev_Learning_Innovation_PUE.pdf
21. ENERGIA. (2019). Gender in the transition to sustainable energy for all: From evidence to inclusive policies. In *Energia*. https://www.energia.org/cm2/wp-content/uploads/2019/04/Gender-in-the-transition-to-sustainable-energy-for-all_-From-evidence-to-inclusive-policies_FINAL.pdf

22. ESARO, & UNDP-UNEP PEI. (2015). Empowering Women for Sustainable Energy Solutions To Address Climate Change. *Unpei.Org*. https://unpei.org/files/sites/default/files/publications/working paper-feb26-web.pdf
23. ESMAP. (2022). *GENDER EQUALITY IN THE OFF-GRID SOLAR SECTOR Operational Handbook for Gender Equality in the Off-Grid Solar Sector*. http://hdl.handle.net/10986/38194
24. Energypedia. (2024). *WE4F Innovator Compendium.* Retrieved from https://energypedia.inf.
25. Foundation maryR. (2013). *Access to Sustainable Energy – The Gender Dimensions Policy Brief* (Issue May 2012).
26. Funds CI. (2025). *Gender and Renewable Country Diagnostics* (Vol. 17).
27. Gad D, Leone P. Productive use of energy of women-owned micro-, small-, and medium-sized enterprises: Insights from food and textile businesses in selected African countries. Heliyon. 2024;10(11):e32313. https://doi.org/10.1016/j.heliyon.2024.e32313.
28. GoM. (2024). *Malawi eCooking Roadmap*. *March*.
29. https://
30. Government of Malawi. (2018). *Government of Malawi National Energy Policy* (Issue August). https://library.cepa.org.mw/wp-content/uploads/tainacan-items/201/6444/FINAL-NATIONAL-WILDLIFE-POLICY-APPROVED-AUGUST-2018.pdf
31. Government TM. MALAWI NATIONAL ROADMAP FOR THE GLOBAL ACCELERATOR ON JOBS AND SOCIAL PROTECTION FOR JUST TRANSITIONS. Issue December; 2024.
32. Gogla. (2023). *Green Impact Technologies member profile.* Retrieved from https://gogla.org
33. GCA. (2024). *Accelerating climate-smart agriculture: How Green Impact Technologies is empowering Malawi's smallholder farmers.* Retrieved from https://gca.org
34. Habtezion S. (2025). Gender and energy. In *Programme, United Nations Development*. https://doi.org/10.4337/9781035310371.00071
35. Hara CM. (2021). An Overview of Community Energy Systems in Malawi. In *Community energy and the sustainable energy transition*. http://creativecommons.org/licenses/by-
36. IDRC, & CRDI. Clean Energy for Development Research for Policy and Practice Powering Change: The critical role of women and youth in sustainable energy transformation. Issue March; 2025. www.ce4dev.org.
37. International Energy Agency. (2019). Africa Energy Outlook 2019 - Overview Ethiopia. *World Energy Outlook Special Report*, 288. https://www.iea.org/reports/africa-energy-outlook-2019#energy-access%0Ahttps://www.iea.org/reports/africa-energy-outlook-2019%23africa-case
38. International Energy Agency. (2022). International Energy Agency (IEA) World Energy Outlook 2022. Int Inform Adm, 524. https://www.iea.org/reports/world-energy-outlook-2022
39. International Finance Corporation. (2022). *Women's Participation in The Renewable Energy Workforce in sub-Saharan Africa: Identifying Barriers and Opportunities for Women as Leaders & Employees*. https://www.ifc.org/wps/wcm/connect/region__ext_content/ifc_external_corporate_site/sub-saharan+africa/resources/womens_participation_in_the_renewable_energy_workforce_in_sub_saharan_africa
40. Agency IRE, I., Climate P, Initiative C. (2023). Global landscape of renewable energy finance 2023. *IRENA*.
41. Kachione L, Roberts G, Gilbert C, Majoni J, Kanyerere R, Van Buskirk R. (2023). *Empowering Efficiency: Distributing off-grid solar electric cooking systems using women-lead organizing in rural Malawi* (Issue March). https://www.mdpi.com/1996-1073/14/14/4293/htm

42. Kachione L, Roberts G, Gilbert C, Majoni J. R. K. and R. V. B. (2020). Customizing Malawi-made solar electric cooking technology and business models to provide access to very low income villagers. In *MECS-TRIID report* (Issue March).
43. Maggie G, Munthali B, Nankwenya Z, Nyirenda L, Chilora L, Chiwaula BC. & W. T. (2023). *Unlocking youth opportunities in the forest sector: The role of green obs in youth employment generation in malawi*. 0–2.
44. MAIIC. (2022). *ANNUAL REPORT 2022*.
45. Malawi G. of. (2015). Malawi National Gender Policy. In *Malawi Government Press* (Issue January). http://portal.unesco.org/education/en/files/55617/11999788585MALAWI.pdf/MALAWI.pdf
46. Malawi G. of. (2024). *NATIONAL ENERGY COMPACT FOR MALAWI*.
47. Malawi Government. (2020). *Access to Clean and Renewable Energy (ACRE) Project 2020–2023* (Issue February 2020).
48. Malinski B. (2008). *Impact Assessment of Chitetezo Mbaula Improved Household Firewood Stove in Rural Malawi*. *July*.
49. McCauley D, Grant R, Mwathunga E. Achieving energy justice in Malawi: from key challenges to policy recommendations. Clim Change. 2022;170(3–4):1–22. https://doi.org/10.1007/s10584-022-03314-1.
50. MECS. (2022). Modern Energy Cooking: Review of the Funding Landscape. In *REPORT 5 OF THE FINANCING CLEAN COOKING SERIES: MECS Energy 4 Impact* (Issue February).
51. MECS. (2024). *Empowering Efficiency, Phase II: Refining an affordable Solar Home System with eCooking for rural Malawi Version 1.1: 30 November 2024*. https://mecs.org.uk/
52. MECS and Energy4Impact. Clean Cooking: Results-Based Financing As a Potential Scale-Up Tool for the Sector. Issue October); 2021.
53. Ministry of Natural Resources, E. and M. (2017). *National Charcoal Strategy 2017–2027*.
54. MoFEA. (2022). *ANNUAL ECONOMIC REPORT 2022* (Issue 2).
55. Mortimer K, Ndamala CB, Naunje AW, Malava J, Katundu C, Weston W, Havens D, Pope D, Bruce NG, Nyirenda M, Wang D, Crampin A, Grigg J, Balmes J, Gordon SB. A cleaner burning biomass-fuelled cookstove intervention to prevent pneumonia in children under 5 years old in rural Malawi (the Cooking and Pneumonia Study): a cluster randomised controlled trial. Lancet. 2017;389(10065):167–75. https://doi.org/10.1016/S0140-6736(16)32507-7.
56. Munn Z, Peters M, Stern C, Tufanaru C, A. M. and E. A. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. TBMC Med Res Methodol. 2018;147–60. https://doi.org/10.4324/9781315159416.
57. Mwalule G, Mzuza MK. Factors Influencing the Use of Solar Energy Technology in a Local Township of Blantyre City, Malawi. Open J Energy Effi. 2022;11(01):1–9. https://doi.org/10.4236/ojee.2022.111001.
58. Mwnation. (2022). *Joyce Sikwese: 2022 African YouthAdapt Challenge winner.* Retrieved from https://mwnation.com
59. Nieuwenhout FDJ, Dijk a, Van, Dijk VaP, Van, Hirsch D, Lasschuit PE, Van Roekel G. (2000). Monitoring and Evaluation of Solar Home Systems: Experiences with applications of solar PV for households in developing countries. September, 157. https://energypedia.info/images/c/c5/Nieuwenhout_monitoring_and_evaluation_of_shs.pdf
60. OECD Development Centre. Youth Well-Being Policy Review of Malawi. Youth Well-Being Policy Rev Malawi. 2018. https://doi.org/10.1787/fa0f2e45-en.

61. Office UWE. and S. A. R. (2017). *Gender, Energy and Policy Brief a Review of Energy Policies in East and Southern Africa*.
62. Remerscheid C, Kotecha S. Empowering Women in Clean Energy: Advancing and Retaining an Equitable Workforce. Issue March); 2024.
63. Robinson BL, Pemba W, Ninsiima V, Muhindo G, Chiumia A, Clifford MJ, Hewitt J, Muvule M. Is Bigger Better? Exploring Sustainable Delivery Models for Multi-Scale East African Smart Biogas Systems. Energies. 2025;18(5):0–22. https://doi.org/10.3390/en18051045.
64. Self-help Africa. (2023). *Malawi strategy 2023–2027*.
65. SMinistry of Energy Malawi. (2022). *Malawi Integrated Energy Plan - Clean Cooking Report*. https://www.epa.gov/sites/default/files/2015-07/documents/emission-factors_2014.pdf.
66. Stoves CC, Limited A. INSTALLATION OF HIGH EFFICIENCY WOOD BURNING COOKSTOVES IN Document Pr. Issue October); 2021.
67. Tagliapietra MH, · S, de Strasser L. (2018). Africa: Challenges and opportunities. In *Mediterranean Quarterly* (Vol. 19, Issue 1). https://doi.org/10.1215/10474552-2007-034
68. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MDJ, Horsley T, Weeks L, Hempel S, Akl EA, Chang C, McGowan J, Stewart L, Hartling L, Aldcroft A, Wilson MG, Garritty C, Straus SE. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Ann Intern Med. 2018;169(7):467–73. https://doi.org/10.7326/M18-0850.
69. UNDP. (2013). Sustainable Energy Management Support to Malawi UNDAF. In *Sustainable Energy Management* (Issue April). https://doi.org/10.1016/C2011-0-05403-0
70. UNDP. (2022). *HUMAN DEVELOPMENT REPORT 2021/2022: Uncertain times, unsettled lives Shaping our future in a transforming world*. https://hdr.undp.org/system/files/documents/..report../hdr2021-22pdf_1.pdf
71. Venkata Ramana P, Michael T, Sumi M, Kammila S. (2015). The State of the Global Clean and Improved Cooking Sector. In *ESMAP and GACC*. https://openknowledge.worldbank.org/bitstream/handle/10986/21878/96499.pdf
72. Walwyn DR, Hanlin R. Broadening energy access for poor households in rural malawi: How pico solar, mobile money, and cloud-based services are being combined to address energy exclusion. Front Energy Res. 2022;10(September):1–13. https://doi.org/10.3389/fenrg.2022.877307.
73. Waziri SA, Singh K, Maina UA, Jime A, Mustapha M, Goel G, Dubale M, Tripathi JP. Investigating the feasibility of agro-waste briquettes as a sustainable energy source in Borno state Nigeria as pathways for post-conflict and instability recovery. Discover Sustain. 2024;5(1). https://doi.org/10.1007/s43621-024-00488-9.
74. We Are Tech Africa. (2022, February 1). *Martin Masiya, 21, expands use of solar energy in Malawi's rural parts*. https://www.wearetech.africa/en/fils-uk/tech-stars/martin-masiya-21-expands-use-of-solar-energy-in-malawi-s-rural-parts
75. Yustas YM, Tarimo WM, Mbacho SA, Kiobia DO, Makange NR, Kashaija AT, Mukama EB, Mzigo CK, Silungwe FR. Toward Adaptation of Briquettes Making Technology for Green Energy and Youth Employment in Tanzania: A Review. J Power Energy Eng. 2022;10(04):74–93. https://doi.org/10.4236/jpee.2022.104006.

Figures

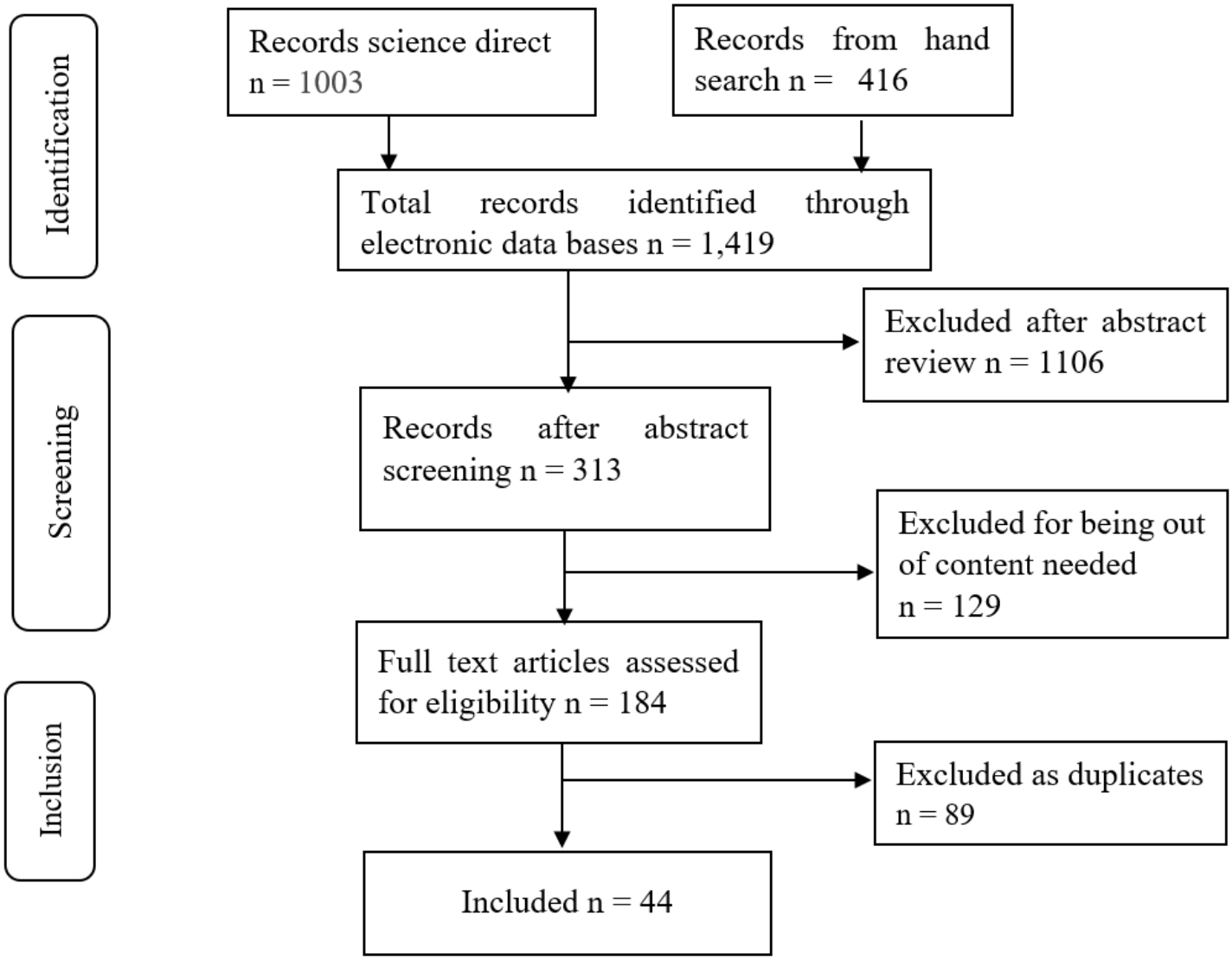


Figure 1

PRISMA flow chart

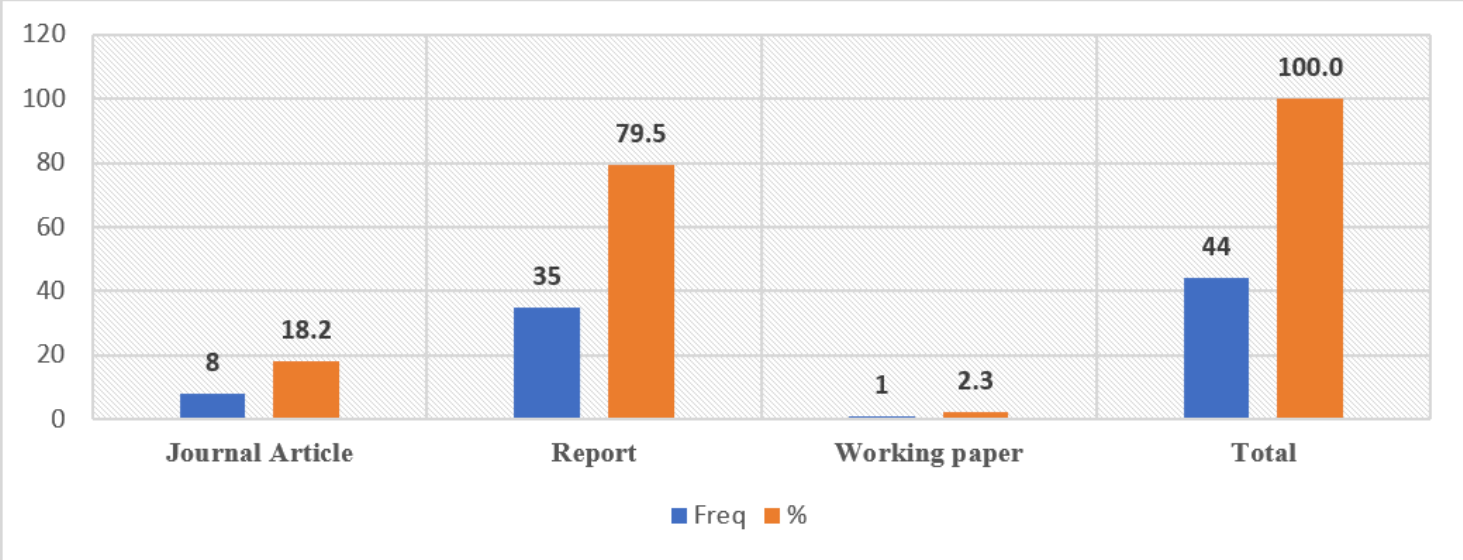


Figure 2

Nature of the documents synthesized

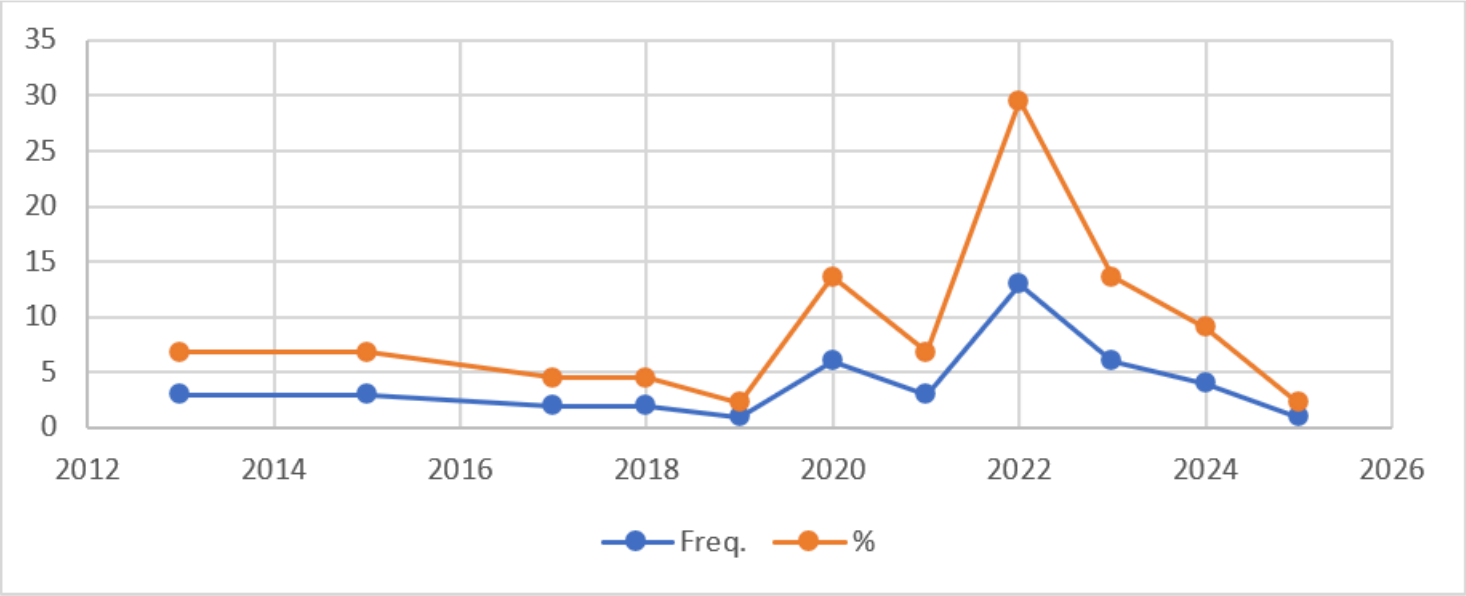


Figure 3

Analysis by year of publication

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AppendixA.docx