EXPLORING THE POTENTIAL OF GREEN HOUSING FINANCE FOR SUSTAINABLE DEVELOPMENT: A SCOPING REVIEW OF CONCEPTS AND INSTRUMENTS

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Abstract
The increasing need for sustainable housing solutions for emerging and developing countries spotlights the need for environmentally sustainable financing. Therefore, green buildings and financing have evolved separately to address this need. This scoping review explored global literature to provide a synthesised definition of Green Housing Finance (GHF), including the various concepts and themes dominating this solution. Scopus, Google Scholar and Google were searched for eligible peer-reviewed articles. Thirty-eight papers published over 20 years (2003-2023) were analysed. Atlas-ti's Sankey visualisation and descriptive reporting summarised the studies to understand and describe GHF comprehensively. The study found that GHF in global literature refers to housing finance innovations that address the energy efficiency needs of households while mitigating the climate change impacts of housing provision. Also, some of the most significant GHF instruments identified in research literature include Green Loans, Subsidies, Green Credit, and Climate Finance. Concerning the geographical reach or impact of GHF, the study finds that research in developing markets is sparse and limited to South Africa.

Keywords
Green Housing, Housing Finance, Green Finance, Climate Finance, Sustainable Housing.

1. Introduction
Many housing studies, especially those focused on emerging markets, highlight the growing demand for economically and ecologically viable cities (Smets and van Lindert, 2016; Moghayedi and Awuzie, 2023). Concern over sustainability and environmental preservation in the face of increased global warming and the need to expand affordable housing is growing. This is because construction has been notoriously linked to 39% of global carbon emissions (Akomea-Frimpong et al., 2022). Therefore, for Africa's housing construction to be adequate and sustainable, growth, financial viability, affordability, and environmental factors must be balanced.

Green buildings balance nature or biosphere conservation, health, environmental protection, and resource conservation. Gomez and Yung (2018) describe green buildings as structures that preserve the natural surroundings and use resources efficiently for durable and healthy dwellings. A green building can also be described as efficiently addressing embodied carbon reduction, water conservation, waste reduction, and energy efficiency. Ahmed et al. (2013) also describe the value of green buildings as the economic and environmental advantage of using low-cost, local, and low-embodied energy building resources that support and adapt appropriately to the local biosphere and climate. It is widely acknowledged (see Boshoff and Mey, 2020; Ross, Bowen, and Lincoln, 2010; Debra et al., 2022) that green buildings can deliver environmental gains and stimulate local economies and microenterprises while creating sustainable housing, cities, and communities. Therefore, for this study, Green Housing Finance (GHF) refers to financing that facilitates the development of housing that addresses embodied carbon reduction, water conservation, waste reduction, and energy efficiency.

Studies, like Bashir et al. (2023), Debra et al. (2022) and Gomez and Yung (2018), have found that financing has proven to be a significant roadblock to achieving green affordable housing in Pakistan and Bangladesh. There are many other mitigating factors, including the competency of design teams, market readiness and adoption, reliability, and quality (Gomez and Yung, 2018). However, financing is a common and recurring theme (Ojo-Fafore et al., 2018). While these studies have a clear concept of what constitutes green building or housing, there is little to no comparative study on the nature of financing instruments targeting green housing, the opportunities they present, and the challenges to implementing them. This is also emphasised by a limited literature review defining what constitutes GHF. Telma (2023) estimates that a $16 trillion financing gap for affordable housing cannot be met by governments alone. If green buildings are to be financed with significant private sector participation, the government must persuade the private sector that green affordable housing is both possible and profitable. It is therefore imperative to discover what constitutes GHF and whether these instruments can serve the dual role of achieving affordability and environmental sustainability in emerging markets. This study seeks to conduct a scoping review to define GHF and identify the various GHF concepts and themes dominating this

solution. Further to this objective, the study will also identify the geographical reach of GHF implementation. This review synthesised existing knowledge around GHF, identified gaps in the literature, and informed future research and policy development. This study's specific research questions include: 1) What constitutes GHF in global literature? 2) Which financing instruments dominate the GHF space? 3) What is the geographical reach of these GHF instruments in the literature? The study's findings provide evidence of predominant instruments that the private sector can access.

2. Literature Review

2.1 An overview of the green housing concept

It is important to determine what green housing entails according to existing literature whether it is a house built solely as a climate- or energy-efficient structure. Alternatively, if green housing is more encompassing of other efforts to introduce efficiency to existing structures in the form of energy retrofit, waste, and water conservation measures, another perspective on defining what green housing entails could be the kind of financing adopted. In this case, green housing would be financed specifically for its design, which is intended to promote energy efficiency, water and material conservation, and waste reduction.

While there is ample literature exploring innovative approaches to financing green housing projects across the globe, the nature and affordability of these instruments have not been thoroughly investigated to provide a comprehensive understanding of what constitutes green and affordable housing finance.

2.2 Green housing finance instruments

A few comparative studies have investigated the features of Green Housing Finance instruments relative to other non-green financing. For example, Giraudet, Petronevich, and Faucheux (2021) compared green home retrofit loans with green car loans. They found that greener, less risky automobile projects have lower financing rates, while greener house retrofits do not. Meanwhile, typical autos, on the other hand, have lower interest rates than typical house retrofits, despite potentially equivalent risk. Other studies that have attempted to explore the features of green finance instruments (Gomez and Yung, 2018; Zhang et al., 2020; Agbajor and Mewomo, 2022; Mills, 2023) have also been limited by the focus on a few local instruments and their lack of details on providing any comprehensive global comparison of these instruments.

2.3 The reach of green housing delivery

Mistry and Spocter (2022) discovered that sustainable housing solutions tend to be exclusionary due to the affordability gap. Thus, there is a need to create incentives for green housing by making it affordable (Ntombela and Okoro, 2024). This incentive would include financial incentives and providing access to environmentally friendly housing, communities, and cities (Gan et al., 2022). Such opportunities and the associated challenges of developing specific green finance instruments have been discussed in some literature. Gan et al. (2022) explored the knowledge gap in adopting GBTs in China's rural housing construction and examined cause-and-effect interrelationships. While this is a valuable study, it does not particularly showcase the scale of reach for the financing that was adopted for this intervention. Likewise, Ntombela and Okoro's (2024) study highlighted the policies that could support incentivising green housing developments through expense reductions, rebates, and savings. in Africa. Therefore, the current study delineates the application of existing green finance instruments for green housing finance.

2.4 Sustainable finance theory

This study contributes a unique perspective to discussions on Sustainable Development Goals and Finance theories by demonstrating how financial innovation is a critical mechanism for aligning housing development with sustainable goals. The United Nations member states adopted the SDGs as a baseline for addressing critical issues across economic, social, and political dimensions with unified objectives. Finance plays a significant role in achieving most, if not all, of these objectives (Mills, 2023; Debra et al., 2022; Li et al., 2022). The SDGs guide government leaders, policymakers, and housing stakeholders to make decisions aligned with environmental sustainability goals. In the context of housing and the built environment, sustainable development goals require an alignment between the strategies for addressing housing needs and environmentally sustainable outcomes. In adopting the SDGs, housing finance stakeholders address 1, 7, 11, and 13 to contribute to eradicating housing poverty, promoting renewable energy, developing sustainable cities and driving climate action. Sustainable Finance Theory proponents like Ryszawska (2024) and Ozili (2023) have described sustainable finance as financial instruments or resources that prioritise, or address projects aligned with sustainable development goals in three ways: economic, environmental, and social. This theory holds that finance adapts itself to new trends of the green economy. This entails a shift (evolution) away from the current economic paradigm and toward one predicated on more social and environmental responsibility, according to Ryszawska (2024). They propose that Sustainable Finance Theory explains the emergence of new concepts like green finance, sustainable finance, climate finance, and carbon finance. By this, green housing becomes more than a physical construct but also a financial and policy-driven process aiming to achieve inclusive and sustainable housing outcomes.

3. Methods

A qualitative research design was adopted using secondary research (Largan and Morris, 2019). A scoping review was adopted to identify relevant materials (published literature). The purpose was to map existing literature, identify research gaps, scope a body of literature, and clarify concepts (Munn et al., 2018). Studies like Agbajor and Mewomo (2022), Akomea-Frimpong et al. (2022) and Debra et al. (2022) adopted this review technique. The current study has similarly adopted the use of the scoping review to synthesise literature about green affordable housing finance and adopted the five-stage approach by Arksey and O'Malley (2005). The research methodology includes identifying the research question, relevant studies, study selection, charting the data, collating, and reporting the results. Three electronic databases, Scopus, Google Scholar, and Google were used to identify literature. They were assessed for eligible peer-reviewed journal articles.

The search was done with the following keywords: Green, Housing, Finance, and Instruments. The exclusion criteria were based on the study by Akomea-Frimpong et al. (2022). To meet the study's goals, the selected articles focused on green finance, green buildings, housing, opportunities, and obstacles. Articles were removed from the 63 that did not satisfy the selection requirements or were not indexed in Web of Science or Scopus. Grey literatures were manually assessed for the reputation of the source. Additionally, sources that did not discuss the principles of green housing were not included—the final analysis comprised thirty-eight publications. The information included the Titles, Authors, Publication years, Keywords, Publication source, countries/regions, green finance concepts and instruments. This was based on the scoping review guideline detailed by Debra et al. (2022). The data was analysed with the aid of Atlas-ti. Sankey diagrams were used to visualise the data elements to highlight the dominant factors and show the connections between the factors. Sankey diagrams present data flows and connections across various disciplines; they visually show complex processes, supporting multiple viewing levels and the relative magnitudes or areas of the most significant contribution (Atlas-ti User Manual, n.d.). The width is proportional to the quantity represented.

4. Results

4.1 Trend and geographical reach of green housing finance literature

Table 1 shows the studies included in the review. The publication outlets and geographical regions are shown. Eleven GHF studies were from Sub-Saharan Africa (SSA), eight from South Africa, seven from Asian countries, and 11 from Europe. The studies also include three from the United States and eight unspecified. Twelve of these studies were quantitative studies against a majority (21) that were qualitative. There were also mixed-method studies (five) in this research field.

Table 1: Trend of the literature in global GHF research

	Authors	Source	Country/Region
1	Mistry and Spocter (2022)	Local Environment	South Africa
2	Mungai et al. (2022)	Resources, Environment and Sustainability	Sub-Saharan Africa
3	Fachrudin and Fachrudin (2017)	IOP Conference Series: Materials Science and Engineering	Indonesia
4	Ismael et al. (2019)	International Engineering Conference	Iraq
5	Gan, et al. (2022)	Technology in Society	China
6	Aggarwal et al. (2019)	International Journal of Energy Sector Management	India
7	Giraudet et al. (2021)	Energy Policy	France
8	Lentner and Zsamoczai (2022)	IEEE 26th International Conference on Intelligent Engineering Systems	Hungary
9	Cohen and Rosenman (2020)	Antipode	United States
10	Barreca et al. (2021)	Sustainability	Italy
11	Mangold and Mjörnell (2023)	Journal of Housing and the Built Environment	Sweden
12	Forrester and Reames (2020)	Applied Energy	United States
13	Ibañez Iralde et al. (2021)	Energy and Buildings	Spain
14	Paez, Gonzalez, Erten and Cristoforetti (2020)	IOP Conference Series: Earth and Environmental Science	EU

15	Marchand, Koh and Morris (2015)	Energy Policy	England
16	Rosca, Arnold and Bendul (2017)	Journal of Cleaner Production	Not Specified
17	Li et al. (2022)	Journal of Environmental Management	Mexico, Indonesia, Turkey, and Nigeria (MINT)
18	Hannon et al. (2023)	Energy Research and Social Science	United Kingdom
19	Godin et al. (2021)	Cleaner and Responsible Consumption	Canada
20	Akomea-Frimpong et al. (2022)	Journal of Cleaner Production	Not Specified
21	Mills (2023)	Energy Policy	Not Specified
22	Moghayedi and Awuzie (2023)	Sustainable Cities and Society	South Africa
23	Bashir et al. (2023)	Sustainability	South Asia
24	Agbajor and Mewomo (2022)	Energy and Built Environment	South Africa
25	Bredenoord (2015)	Journal of Architectural Engineering Technology	Not Specified
26	Wilkinson and Sayce (2020)	Journal of European Real Estate Research	Europe
27	Gupta and Gregg (2014)	30th International PLEA Conference	United Kingdom
28	Abidin et al. (2013)	Construction Innovation	Malaysia
29	Zhang et al. (2020)	Energy Strategy Reviews	China
30	Debra et al. (2022)	Building and Environment	Not Specified
31	Ross et al. (2010)	Construction Management and Economics	South Africa
32	Nakhooda et al. (2014)	Overseas Development Institute	Not Specified
33	Smets and Van Lindert (2016)	International Journal of Urban Sustainable Development	Not Specified
34	Jones and Stead (2020)	Environment and Urbanization	Africa and Asia
34	Marais and Cloete (2017)	Habitat International	South Africa
36	Ganiyu, Fapohunda and Haldenwang (2017)	International Journal of Housing Markets and Analysis	South Africa
37	Boshoff and Mey (2020)	Acta Structilia	South Africa
38	Ahmed et al. (2013)	ICLEI – Local Governments for Sustainability	Not Specified

Further, regarding the publication year, there were periods in which no research was published relevant to GHF, like 2006-2009, 2012 and 2018, as shown in Fig. 1. The publication trend fluctuated over the years but gained the most attention in 2022. While Energy Policy (journal) had the most publications (three), the diverse outlets indicated a broad interest in GHF.

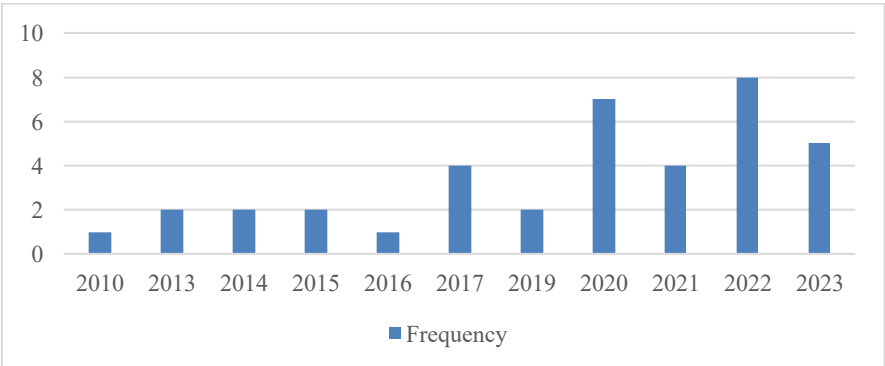

Fig. 1: GHF publication trend over 20 years

4.2 Green housing finance concepts

There was an overlap of research themes that comprise green buildings and finance literature. Fig. 2 shows some of these themes: Development, Sustainability, Cost, Climate Change, Energy Efficiency, Water, Environmental Finance, Housing, Subsidies and Policies. Concepts demonstrating the largest co-occurrence include Development, Sustainability, Cost, and Climate Change. Therefore, green housing finance encompasses financial policies integrating climate change, energy efficiency, and water conservation, while considering cost and sustainability.

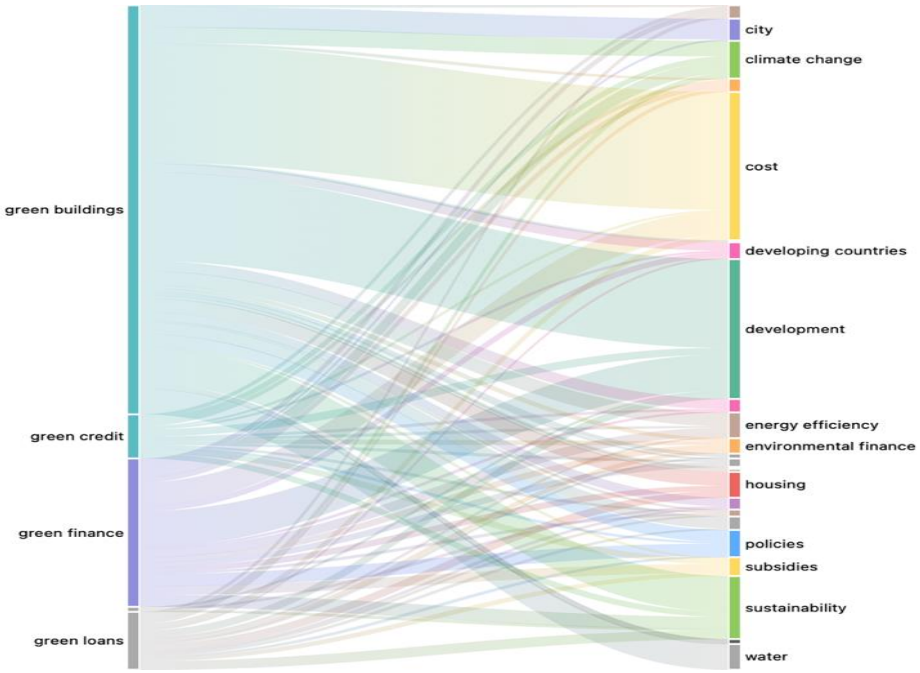

Fig. 2.: The Green Building and Finance Sankey Diagram for Co-occurrence.

4.3 Green housing finance instruments

In Fig. 3, the Sankey Diagram illustrates the financing instrument keywords that co-occur with Green Financing and Investments across the literature. These are mostly linked to Green Loans, Subsidies, Green Credit, and Climate Finance. These four instruments are the most popular in the literature and widely adopted globally in the green housing finance sectors.

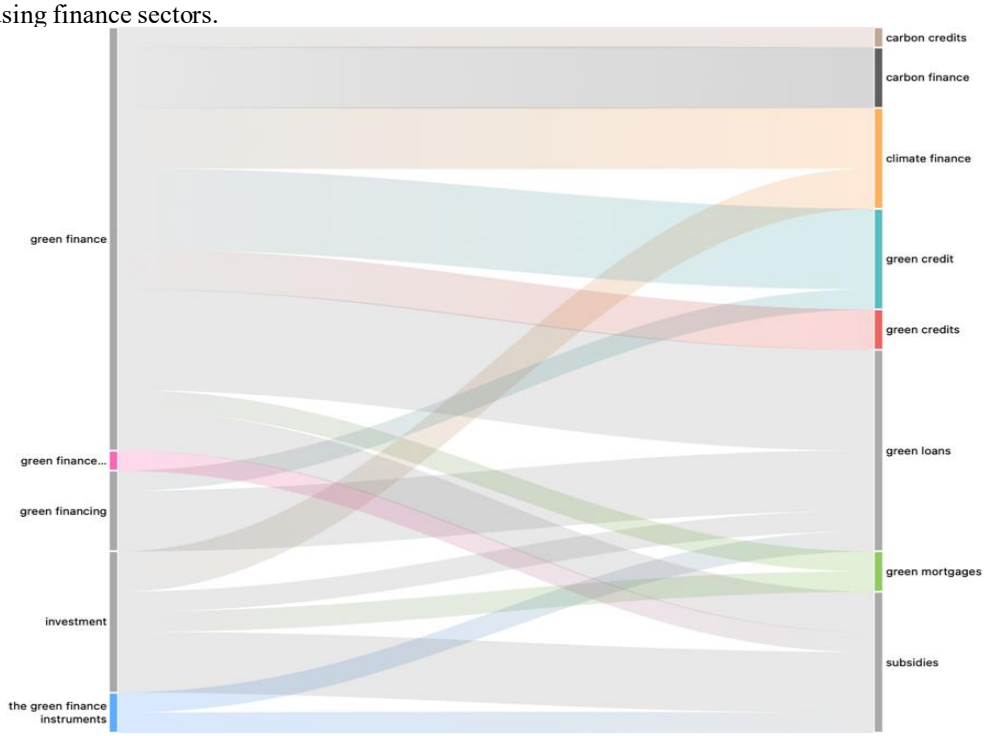

Fig. 3: The Green Housing Finance Instruments Sankey Diagram for Co-occurrence

4.4 The geographical reach of green housing finance instruments

The literature on GHF instruments is highly concentrated on European countries like the United Kingdom, France, Hungary, Sweden, and Spain. Some literature also explores GHF in Asian countries like Malaysia, China, Indonesia, and India. The only country on the African continent explored in the selected literature is South Africa. The studies also identified financing that falls within the scope of GHF. These include green bonds, Green Mortgages, Subsidies, Energy-Efficient subsidies, Government Green Deals, and Climate finance. The findings demonstrate that a wide array of financial instruments are deployed across the globe to address the challenges of climate change within the housing sector. While credit, mortgages, and loans are popular, there are several social interventions in the form of donations and subsidies in countries like South Africa (and other sub-Saharan African countries), Malaysia, Spain, Iraq, and the U.S. The U.S. and Spain are the only countries considered to be developed economies represented by using subsidies as a GHF instrument. Meanwhile, all developing economies have evidence of the use of subsidies and donations. This implies that affordability remains a massive consideration in designing financial products for green housing to reach other developing markets.

5. Discussion

The study aimed to synthesise existing knowledge around GHF with the specific objectives of answering the questions on: what constitutes GHF in global literature, which financing instruments dominate the GHF space, and the geographical reach of these GHF instruments in the literature. The core concepts that define GHF or provide a significant indication of what could be considered GHF include development, sustainability, cost, water, energy efficiency, materials, green buildings, and climate change. This positions GHF as an important tool for addressing SDG 1, 7, 11, and 13. The findings agree with previous studies (Mills, 2023; Debrah, Chan, and Darko, 2022; and Li et al., 2022) that financing is critical to achieving the SDGs. It indicates a commitment to addressing sustainability within the housing space on the economic, environmental, and social levels. Agreeing with Wilkinson and Sayce (2020), GHF addresses energy efficiency needs among other housing innovations that seek to reduce the contribution of housing to climate change.

Additionally, multiple financing instruments have emerged to support green housing innovation. There are more significant references to four instruments: green loans, subsidies, green credit, and climate finance. However, several other financing instruments are implemented by public and private entities. This also aligns with sustainable finance theories (Ryszawska, 2024). GHF offers housing stakeholders the opportunity to transition from the current economic paradigm to one predicated on more social and environmental responsibility.
Furthermore, it is important to note that the reach of GHF is still mainly limited to Europe, North America, and Asia. There is limited evidence of its adoption in emerging markets, especially in Africa. This agrees with Debrah, Chan, and Darko (2022) that most research on green finance has left a massive gap regarding adopting green financing in developing economies.

6. Conclusion

This study carried out a scoping review to define GHF and identify the various GHF concepts and themes dominating this solution. It adopts the scoping review methodology with the aid of Atlas-ti to map the literature on GHF and identify the knowledge trends, core concepts, and themes that make up GHF. About geographical reach or impact, the study finds that GHF has had limited reach in developing markets. Much of the historical research on GHF has concentrated on Europe, Asia, and North America. The study synthesised literature over 20 years, identified under-researched regions and instruments and revealed an opportunity for private-sector innovation in developing countries.
This study is limited by its use of a literature review, which does not provide for stakeholders' opinions in the GHF space. However, this presents an opportunity for further research into how GHF is understood among practitioners across the globe. There are also further research opportunities in discovering housing finance innovations that could facilitate the adoption of GHF in emerging markets.

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