MALAWI

Beyond Connections

Energy Access Diagnostic Report Based on Multi-Tier Framework

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FOREWORD

The energy situation in Malawi, like in other developing countries, is broadly characterized by low access to affordable, reliable, and clean energy services. A key enabler to the inclusive wealth creation agenda of the Malawi 2063 is economic infrastructure where energy access is highlighted. Specifically, the goal of the first 10-year Implementation Plan (MIP-1) of the Malawi 2063 is to increase energy generation and access by 2030 by diversifying sources of energy, including renewable and sustainable energy. Government of Malawi seeks to achieve universal access by providing 30% of energy access through on grid connections while 70% access will be met by off-grid solutions.

For a long time, the term access to energy was binary and largely contextual. It differed widely, from one context to another, from being defined as access to clean energy for cooking, access to clean lighting, access to electricity, access to energy for productive use, depending mostly on the priorities of the countries. To achieve Malawi's vision and commitment to achieving universal access to electricity, promoting clean cooking solutions, and significantly increasing the share of renewable energy by 2030 requires a multidimensional understanding of energy access.

For the first time in Malawi, the Energy Access Diagnostic Report Based on Multi-Tier Framework provides the status of energy access using a multi-dimensional approach. The report uses the Multi-tier Framework which goes beyond the traditional binary measurement of access to capture the multidimensional nature of energy access at the end user level, and the vast range of technologies that can provide energy access, while accounting for the wide differences in user experience.

The report provides critical data for designing programs and strategies to achieve universal energy. It offers insights on how Malawi's energy access is distributed across sources, technologies, and locations. This in-depth understanding of energy access enables prioritisation of resource allocation to effectively increase energy access and explore viable technologies that are renewable and sustainable. I implore all policy makers, development partners and investors to fully utilize this report in the drive to increase energy generation and access in Malawi.

I extend my sincere gratitude to the National Statistical Office, the Ministry of Energy and the Energy Sector Management Assistance Program (ESMAP) of the World Bank for their leadership in producing the report. Special appreciation goes to the United Nations Development Program (UNDP) and the World Bank for the financial and technical support throughout the survey administration and report production processes.

Engineer Alfonso CHIKUNI
Secretary for Energy

PREFACE

The Energy Access Diagnostic Report Based on Multi-Tier Framework is the first survey of its kind to measure energy access in Malawi comprehensively. The report provides a detailed status of energy access, including the source of energy, technologies, and level of access. The survey was undertaken by the Ministry of Energy and implemented by the National Statistical Office (NSO) with technical support from the Energy Sector Management Assistance Program (ESMAP) of the World Bank and financial support from United Nations Development Program (UNDP). through Access to Renewable Energy Project (ACRE) and the World Bank, through the Malawi Electricity Access Project (MEAP).

The purpose of this report is to establish a baseline for tracking progress towards the Sustainable Development Goal (SDG) #7.1 on access to affordable, reliable, and sustainable modern energy by 2030. The report also provides information for prioritisation of effective strategies and interventions for increasing energy access. It also serves as evidence to guide resource mobilization and investments in clean and renewable energy.

The Multi-Tier Framework (MTF) considers several dimensions of energy services, assessing their adequacy, availability, reliability, quality, affordability, legality, convenience, health, and safety for all required energy applications across households, productive enterprises, and Public institutions. More specifically, the MTF evaluates energy access through the following seven attributes: Capacity, Availability, Reliability, Quality, Affordability, Formality, and Health and Safety. Each attribute, depending on the level of service a household receives from its main source of energy, is assigned one of the six tiers—Tier 0 referring to the lowest level of service and Tier 5 the highest.

This report used data collected from a nationally representative sample of 9,195 households between 26 May and 25 July 2023. The report presents the context of energy access in Malawi, the methodological design and techniques used in the Multi-Tier Framework. The report further presents access to electricity, access to modern cooking solutions and gender analysis of energy access at national; regional; and rural and urban areas. Furthermore, the report presents policy implications based on the findings and proposes recommendations for consideration when developing energy access strategies and programs.

I would like to express my appreciation to the various stakeholders who participated in the production of the report. Specifically, let me thank the staff from the National Statistical Office, Ministry of Energy and ESMAP for leading the report production process. More importantly, let me thank the respondents for providing responses that have informed the analysis and production of this report.

Finally, I wish to extend a special thanks to the United Nations Development Program (UNDP) and the World Bank for their financial and technical support on the whole cycle of implementing the survey and for the production of this report. We look forward to continued support and collaboration as we continue to track progress towards Malawi's commitment to universal electricity access, promoting clean cooking solutions, and increasing the share of renewable energy by 2030.

Shelton KANYANDA
Commissioner of Statistics

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ACKNOWLEDGEMENTS

The Multi-Tier Framework (MTF) international initiative would not have been possible without the valued technical support of the Energy Sector Management Assistance Program (ESMAP), which is administered by the World Bank.

ESMAP is a global knowledge and technical assistance program that supports low- and middle-income countries to increase their knowledge as well as their institutional capacity to achieve environmentally sustainable energy solutions for both poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Denmark, the European Commission, Finland, France, Germany, Iceland, Italy, Japan, Lithuania, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and the Rockefeller Foundation, as well as the World Bank.

The MTF survey in Malawi was undertaken by the Ministry of Energy and implemented by the National Statistical Office (NSO). The survey was conducted with financial support from United Nations Development Program (UNDP) through the Access to Renewable Energy Project (ACRE) and the World Bank through Malawi Electricity Access Project (MEAP). The financial support provided by the UNDP and World Bank is greatly appreciated.

This Energy Access Diagnostic Report details the results of the MTF survey in Malawi and provides the status of both access to electricity and access to modern energy cooking solutions in the country. This initiative has relied on the critical support of multiple entities and individuals that the MTF team would like to acknowledge.

The main contributors to the realization of the Malawi MTF survey project from the Ministry of Energy are; Lucy Chimombo (Chief Energy Officer), Saidi Banda (Deputy Director for Off-Grid Electricity), Thokozani Malunga (Deputy Director for R & D), Austin Theu (Principal Energy Officer) and Emmanuel Mjimapemba (Project Manager). The key officers who worked on the implementation of the survey from the National Statistical Office are Lizzie Chikoti (Commissioner of Statistics, retired), Shelton Kanyanda (Commissioner of Statistics), Hector Kankuwe (Deputy Director of Economic statistics), Bright Mvula (Chief Statistician), Samuel Chipokosa (Statistician). Other Key NSO officers who contributed to the survey implementation are; Imran Chiosa, Twika Mwalwanda, Philip Simkonda, Benson Chambo, Isaac Mwale, Steve Pakundikana, Moses Majiya and Rehema Msosa. From MTF-ESMAP team, we acknowledge immeasurable contributions by Bryan Bonsuk Koo (Energy Specialist) and Hussain Samad (Energy Specialist).

Most importantly, special thanks should go to the data collection team and respondents for making the survey a success.

This report was jointly prepared by the NSO team and an MTF-ESMAP team.

ABBREVIATIONS

ACRE	Access to Renewable Energy Project
EA	Enumeration Area
ESCOM	Electricity Supply Corporation of Malawi
ESMAP	Energy Sector Management Assistance Program
GOM	Government of Malawi
GTF	Global Tracking Framework
ICS	Improved Cookstove
kW	Kilowatt
kWh	Kilowatt-hour
LDC	Least Developed Country
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
MAREP	Malawi Rural Electrification Program
MEAP	Malawi Electricity Access Project
MIP-1	Malawi 2063 First 10-Year Implementation Plan
MWK	Malawi Kwacha
MTF	Multi-Tier Framework
NSO	National Statistical Office
PHC	Population and Housing Census
PPS	Probability Proportional to Size
PSUs	Primary Sampling Units
RISE	Regulatory Indicators for Sustainable Energy
SE4All	Sustainable Energy for All
SHS	Solar Home System
SDGs	Sustainable Development Goals
SLS	Solar Lighting System
SRS	Simple Random Sampling
UN	United Nations
UNDP	United Nations Development Program
W	Watt
WTP	Willingness to Pay

EXECUTIVE SUMMARY

Malawi adopted the Sustainable Energy for All (SE4All) by the United Nations (UN) which seeks to achieve universal access to electricity by 2030. Through the country's National Energy Policy, 2018, the Government of Malawi seeks to achieve 30% of energy access through on grid connections while 70% access will be met by off-grid solutions. The goal of the policy is to increase access to affordable, reliable, sustainable, efficient and modern energy for every person in the country. Electricity access has traditionally used a binary measure – whether a household is connected to the grid or not. Cognizant of emerging off-grid solutions such as mini-grids and solar products, the Government of Malawi through the Ministry of Energy adopted a more nuanced method of measuring and tracking energy access developed by the United Nations under the SE4All.

The World Bank's Energy Sector Management Assistance Program (ESMAP), in consultation with multiple Development Partners, has developed the Global Tracking Framework (GTF) to measure and monitor energy access using the attributes and tiers laid out in the Multi-Tier Framework. The MTF was developed to address the shortfall of the binary measure of energy access outlined in the Sustainable Development Goals (SDGs) of the United Nations. Beyond access, the MTF takes into account several aspects of the energy service, such as the ability to obtain energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy, and safe for all required energy applications across households, productive enterprises, and community institutions.

In order to establish a baseline for tracking progress towards the Sustainable Development Goal (SDG) #7.1 on access to affordable, reliable, and sustainable modern energy by 2030, the Ministry of Energy through the National Statistical Office (NSO) conducted the Malawi MTF survey. The survey was conducted with financial support from UNDP through the Access to Renewable Energy Project (ACRE) and the World Bank through Malawi Electricity Access Project (MEAP). The survey covered a nationally representative sample (including rural and urban areas) of 9,195 households and was carried out between 26 May and 25 July 2023.

■ Access to electricity

The MTF approach measures electricity access provided by any technology based on seven types of energy services, called attributes: Capacity, Availability, Reliability, Quality, Affordability, Formality, and Health and Safety. Depending on the level of service a household receives from its main source of electricity, each attribute is assigned one of the six tiers—Tier 0 referring to the lowest level of service and Tier 5 the highest. The aggregate or final tier for a household is determined by the lowest tier that a household attained across all attributes.

Source of electricity:

In Malawi, 25.9% of households have access to at least one source of electricity: 11.3% of households have access through the national grid, and 14.6% have access through off-grid solutions, mostly solar. The difference in access to electricity between urban and rural areas is substantial: About half of urban households (56.5%) have access to electricity through the national grid compared to only 3.8% in rural areas. More rural households rely on off-grid solution (15.9%) compared to urban households (6.5%). At regional level, the Southern region has the highest proportion of grid connected households (15.2%) followed by the Northern and Central regions at 14% and 8.1%, respectively. The Northern region has the highest proportion of households using off-grid solutions at 27.7%, followed by the Central region at 15.3%, and the Southern region at 11.9%

MTF aggregate tier for access to electricity:
22.5% of households have access to at least 4 hours of electricity supply a day (Tier 1–5 access), 9.3% have access to at least 8 hours of supply a day (Tier 3–5 access). Only 5.9% % of households are in the top supply category (Tier 5), with access to 23 hours of supply a day with adequate Reliability, Quality, Affordability, and Health and Safety. Electricity access is mostly a rural challenge: While 61.1% of urban households are in Tier 1 or above, only 16.1% of rural households are in Tier 1 or above.

Households in Tier 0:
3.4% of households in Tier 0 have grid or off-grid access, however, they do not satisfy Tier 1 requirements. This is mainly due to the limited Capacity or Availability of off-grid solutions (3.3% of households) or to the limited Availability of grid supply for 0.1% of the households.

MTF Attributes:
11.4% of households in Malawi receive high-capacity electricity (over 2,000W). However, only 3.8% of rural households receive high-capacity electricity compared to 56.7% of households in urban areas. In terms of availability, 45.4% of households with any source of electricity receive electricity 23 hours a day, 7 days a week and 88.7% receive more than 4 hours of electricity in the evening. Electricity supply is reliable for 87.7% of grid-connected households that experience less than 4 electricity disruptions a week and only 12.3% of grid-connected households face voltage issues such as low or fluctuating voltage. The electricity tariff is not affordable for 45.3% of grid-connected households. Health and Safety issues do not seem to occur widely in Malawi, as only 1.4% of grid-connected households reported accidents that caused permanent injury or death. Formality is universal as no household reported an informal connection in the survey.

Grid-connected households:
The majority of the grid-connected households (78.9%) are in Tier 3 or higher for access to electricity of which 51.9% are in Tier 5. Availability, Reliability, Quality and Affordability are the main attributes that prevent grid-connected households from reaching Tier 5 of access in Malawi.

Use:
In Malawi, average monthly household consumption is 125.6 kWh with a monthly expenditure of MWK8,924.95 . Spending on electricity accounts for 14.3% of the average monthly expenditure. About 99% of off-grid households use very low or low-load appliances (mostly for lighting and phone charging) compared to 45.1% among grid-connected households.

Willingness to pay for grid and off-grid electricity:
52.7% of rural households and 25.2% of urban non grid-connected households are willing to pay the full connection fee of grid electricity upfront. An additional 27.9% of urban non-grid connected households are willing to pay the full connection fee in installments of 3 to 12 months. The most cited reason for urban households not willing to pay for grid connection was that they were renting and could, therefore, not decide on behalf of their landlords at (71.3%). Most households are willing to pay for off-grid solar solutions over a period of 6 to 24 months.

Main reasons for not having a grid connection:
The main barriers that prevent households from gaining connectivity to the grid are the high connection fee (48.3% of households) and long distance from the grid infrastructure or grid unavailability (40.2% of households).

Access to modern energy cooking solutions

The MTF measures access to modern energy cooking solutions using tiers ranging from Tier 0 (no access) to Tier 5 (full access) through six attributes: Cooking Exposure, Cooking Efficiency, Convenience, Availability of fuel, Affordability, and Safety of the Primary Cookstove. The aggregate or final tier for a household is determined by the lowest tier that a household attained across all attributes.

Primary cook stove and fuel:
98% of households in Malawi use biomass for cooking and 69% of households use three-stone stove as their primary stove. Only 2% of households use clean fuel for cooking, of which 1.7% use electricity. Stove and fuel stacking (using multiple cookstoves or fuel) occurs in 14.5% and 29.3% of the households, respectively. While most households (87.7%) in rural areas cook using firewood, urban households predominantly use charcoal for cooking (68.5% of households).

MTF aggregate tier for access to modern energy cooking solutions:
Most of the households (90.2%) are in Tier 0 for access to modern energy cooking solutions and only 9.8% are in Tier 1 or above. A higher proportion of rural households (91.7%) is in Tier 0 compared to urban households (81.4%). More urban households (5%) are in Tier 5 compared to those in rural areas (0.1%).

MTF attributes:
Most households (90.2%) are in Tier 0 for the cooking exposure attribute due to predominant use of three-stone stoves and traditional biomass stoves which are associated with high emissions and poor ventilation structure. 40.6% of households spend more than 7 hours per week collecting and preparing fuel, or at least 15 minutes preparing a stove before each meal. Only 4.3% of households find their current cooking solution affordable as they spend less than 5% of their total household expenditure on cooking fuel. Fuel Availability is a major constraint for over one-third of the households as 42% reported that fuel is rarely or sometimes available throughout the year.

Willingness to pay for improved and clean fuel cookstoves:
In rural areas, most households (74.9%) that are using three-stone stove or traditional stove are willing to pay upfront the full price (MWK2,000 or US$1.18) for Chitetezo Mbaula with an additional 20.4% who are willing to pay in installments of 6, 12 and 24 months. In urban areas, about one-third of households (35.4%) using 3-stone stove, traditional stove or manufactured biomass stove are willing to pay for Jiko Ceramic cookstove upfront when offered the full price of MWK6,000 (US$3.53) while 27.1% are willing to pay in installments of 6, 12 and 24 months. More urban households (50.1%) are willing to pay the full price (MWK109,000 or US$64.12) of an LPG stove in installments of 6, 12 and 24 months.

Gender analysis

- At national level, 31.2% of households are female headed.
- Only 18% of female-headed households have access to any source of electricity, compared with 29.4% of male-headed households.
- The difference in access is mainly due to the lower access of female-headed households to off-grid electricity both in rural areas (9.3% of female-headed households, compared to 19% for male-headed households) and urban areas (4.5% of female-headed households versus 8.7% for male-headed households).
- Connection cost is a more common barrier to grid connection among female-headed households than male-headed households (56.3% compared to 44.6%, respectively).
- The share of Tier 0 households for electricity access among female-headed households (84.3%) is higher than among male-headed households (74.4%).
- More male-headed households (58.5%) in rural areas are willing to pay for grid electricity upfront compared to female-headed households (39.1%).
- Only 8.9% of female-headed households are willing to pay for Solar Home System upfront compared to 20.8% of male-headed households.
- Women spend the highest time in fuel collection and fuel preparation compared to girls, boys and men.
- About 43% of women using an improved cookstove and 39.5% of women using traditional stoves had a cough during a month preceding the survey.

POLICY IMPLICATIONS

Access to electricity

Economic infrastructure, where energy access is highlighted, is a key enabler to the inclusive wealth creation agenda of the Malawi 2063. More specifically, the goal of the Malawi 2063 first 10-year Implementation Plan (MIP-1) is to increase energy generation and access by 2030 by diversifying sources of energy, including renewable and sustainable energy. Through the country's National Energy Policy, 2018, the Government of Malawi seeks to achieve universal access by providing 30% of energy access through on grid connections while 70% access will be met by off-grid solutions. Malawi's greatest challenge is to provide access to at least basic electricity supply (Tier 1 or above) to 77.5% of households without any access (households in Tier 0). While the ultimate goal may be for all households to be in Tier 5, this goal is likely going to take time. Key policy implications for improving access to electricity are proposed below:

Increasing access to electricity through grid connection is more viable and cost-effective in urban areas where grid infrastructure is widely available and households tend to use high-load appliances.
There is an opportunity to connect an additional 27.5% of urban households who are willing to pay the full connection fee upfront. Further, the survey results show that there is potential to connect 31.7% more urban households who are residing in areas where grid electricity is available but not connected.

Off-grid solutions are likely to be cost-effective and more suited for electricity needs in rural areas.
Households in rural areas are mostly far from the national grid and consume very little electricity, primarily for lighting, phone charging, or sometimes for low-load appliances such as radios. Considering that 80.9 % of the rural households do not have access to electricity, the most immediate intervention is to provide electricity solutions that meet their basic energy needs at a least cost. Promoting off-grid solar solutions in rural areas will ensure households meet their basic energy needs at minimum cost. However, in an effort to move the rural households to higher tiers of electricity access in the long run, initiatives aimed at expanding the grid and providing affordable electricity connection cost need to be intensified. The biggest bottle neck of wiring cost cited by 66.7% of rural households can be addressed through flexible or subsidized payment options.

Expanding rural electrification programs in terms of coverage and services that include renewable energy such as solar can improve access to electricity in rural areas.
The Malawi Rural Electrification Program (MAREP) which is being implemented by GOM and Electricity Supply Corporation of Malawi Limited (ESCOM) using the Rural Electrification Fund, is one such initiative that has had some impact on electrification of rural and peri-urban areas in Malawi. The program has mainly targeted grid extensions to selected trading or rural growth centres in the districts. Expanding the program in terms of coverage and energy solutions will improve energy access in rural areas.

Willingness to pay for off-grid solar devices can be enhanced by spreading payments over time by using payment plans such as pay-as-you-go.
From the results, more households are willing to pay for solar products in instalments of 6, 12 and 24 months. The Ministry of Energy may consider advocating for such arrangements among distributors of solar products to increase adoption.

ESCOM needs to improve Availability, Reliability, Quality and Affordability of electricity supply to improve access to electricity among grid-connected households.
Reducing power disruptions to less than four per week, increasing daily Availability from 16–23 hours to over 23 hours and charging affordable tariffs would move households towards Tier 5 of electricity access.

Enforcement of quality standards of solar products and awareness campaigns can ensure households are getting the best services from solar products.
About 44% of households are not satisfied with their off-grid solar products. Improving access to electricity among households using off-grid solar solutions would require enforcement of quality standards to ensure households get the best value for money. In addition, awareness campaigns can increase households' understanding of the technology on how to utilize the full potential of the solar products.

Investments in other off-grid solutions such as mini-grids which have potential to move households in remote areas to higher tiers of electricity access have to be explored.
Only 0.2% of households have access to electricity through mini-grids. Financing establishment of mini-grids powered by solar, hydro or wind or thermal energy in very remote areas where grid electricity is not available would provide households with high-capacity electricity which cannot be provided by low-capacity solar products.

Access to modern energy cooking solutions

The biggest challenge Malawi is facing on access to modern energy cooking solutions is the predominant household use of highly polluting three-stone and traditional stoves with a very low percentage of households that use clean fuels. Achieving universal access to modern cooking solutions that are clean, efficient, convenient, affordable, safe, and available (Tiers 4 and 5), might require enormous resources and time. It is therefore, important to intensify initiatives that increase availability of affordable and efficient biomass stoves. Considering the low penetration of improved biomass stoves in rural areas, where majority of Malawi's population reside, rural households should be prioritized. Proposed policy interventions on improving access to modern cooking solutions are outlined below:

Promotion of improved biomass stoves could be a short-term solution to move households in Tier 0 (90.2%) to Tiers 1–3 while long term solutions are being designed or rolled out.
The MTF survey results show a high willingness to pay for Improved Cookstoves in rural areas which can be further enhanced by providing a flexible payment plan. Such cooking solutions should, therefore, be promoted more widely with requisite understanding of the supply and demand side constraints to their adoption. Increasing local skills in manufacturing of improved cook stoves and supporting manufacturers and distributors with financing would increase availability, enhance competitiveness and increase access. A drastic transition to improved cookstoves in the rural areas can benefit household members through reduced spending and time spent collecting fuels and preparing meals.

Conduct awareness campaigns to improving households' knowledge on the importance of improved ventilation, having separate cooking areas, and minimizing time spent in the cooking areas to minimize household member exposure to harmful pollutants.
Reduction in exposure to harmful pollutants will help move 90.2% of households who are in Tier 0 of the cooking exposure attribute towards higher tiers.

Promotion of clean fuel stoves and awareness campaigns on benefits of clean fuel stoves such as LPG and electric stoves would increase adoption.
Persistent use of charcoal stoves in urban areas where 56.5% of the households have access to electricity is a concern which requires aggressive interventions. Transitioning to clean fuel stoves would be more feasible among households in the top spending quintiles. However, financing plans such as pay-as-you-go arrangements would be more effective for households in the low spending quintiles to address affordability issues. High cost of electricity and gas is a bottleneck that requires addressing. Tariff structures that cushion households in low spending quintiles may lower cost of using and improve adoption of electric cookstoves. Building capacity in installation of other affordable renewable energy such as biogas would help increase adoption of clean fuel stoves in the rural areas where most households cannot afford electric or LPG cookstoves.

Further research on demand side constraints would also be critical in increasing adoption of clean fuel stoves.
The MTF survey results show that over and above affordability issues, a third of urban households not using clean fuel stoves are not willing to pay for an LPG stove because fuel is not reliable. Such perceptions require further investigation and corresponding interventions such as awareness campaigns if adoption of LPG stoves is to be increased.

■ Gender analysis

The MTF survey results show a gender gap in access to electricity and modern energy cooking solutions. Female household heads are more likely to be vulnerable financially and are less educated than male-household heads. Female-headed households have lower access to electricity than male-headed households for both grid and off-grid access with the majority of them citing high cost as the main constraint. As such, more female-headed households are in Tier 0 of electricity access compared to male-headed households. Further, female-headed households are more likely than male-headed households to use three-stone and traditional biomass stoves, while male-headed households are more likely to use charcoal and clean stoves. Women spend the highest time in fuel collection as they are the main cook. The following are some of the policy recommendations on gender analysis:

Gender sensitive initiatives are required to ensure equity in electricity access by female- and male-headed households.
Interventions that enable women access energy services are required to increase grid connections for female-headed households and ensure that they benefit equally from grid and off-grid solutions.

Further research on constraints that female-headed households face on access to electricity and modern cooking solutions is required to design effective gender-targeted programs.
Gender-targeted energy access programming could considerably improve female-headed households' access to modern cooking solutions. Such programs could include gender-targeted subsidies, interest-free credit to finance cost of electricity access or cookstoves and payment plans that allow installments over a period of time. Women would benefit most from switching to an improved biomass stove because female household members spend more time collecting, preparing cooking fuels, and in the cooking space resulting in high exposure to health impacts related to smoke.

Education campaigns targeting both men and women are also recommended to raise awareness about the benefits of clean and efficient cooking solutions.

MEASURING ENERGY ACCESS IN MALAWI

■ Multi-Tier Framework (MTF): Rationale

Access to modern energy is well recognized as a key factor in economic, social, and human development. It is one of the United Nations Sustainable Development Goals (SDGs). However, given the specifics of these goals, the traditional binary definition of energy access (that is, whether or not a household has access) is no longer considered adequate to determining effective access. To date, the SDG 7.1, defined as 'access to affordable, reliable and modern energy for all,' is measured through two binary indicators: the proportion of population with access to electricity and the proportion of population with access to clean cooking fuels and technologies, as available data do not allow for a more elaborate measure (Angelou et al. 2013; World Bank and IEA 2015; World Bank 2018).

While grid-connected households in developed countries enjoy exceptional service, many in the developing countries suffer from unreliable and poor-quality supply, stemming from short duration, frequent outages, low or fluctuating voltage, and poor capacity. These issues lower the usefulness of grid access. Calling all households "electrified" (a binary measure) misses all these details, which are critical to achieving the benefits of the electricity service. Second, demand-side issues such as affordability, legality of connection, and safety also prevent the households from reaping the full extent of electrification benefits. Third, technical advancement in recent years has made decentralized off-grid solutions (such as mini-grid and solar home systems) viable alternatives to the grid, particularly in rural and remote areas, and ignoring them is likely to underestimate the electricity access rate and its utility.

To address these issues, the Energy Sector Management Assistance Program (ESMAP), a global knowledge and technical assistance program in the World Bank, in consultation with multiple Development Partners, has developed MTF to measure and monitor energy access in a more nuanced way. This framework takes into account several aspects of the energy service, and transitions from the traditional binary definition of access to a multi-dimensional one as the ability to obtain energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy, and safe for all required energy applications across households, productive enterprises, and community institutions. MTF is thus meant to improve our understanding of electricity access as well as identify bottlenecks that hold back households and institutions from benefitting fully from electricity access. And unlike a traditional approach, MTF considers off-grid sources as valid sources of electricity. For example, a solar lantern is not considered an electricity source in traditional measures, but, it can satisfy basic electricity needs to some extent for lower-income households without access to electricity.

Country context

Malawi is a landlocked country located in Southeastern Africa with a population of 19.8 million (2023) and sharing borders with Mozambique, Zambia, and Tanzania. Malawi achieved independence from the United Kingdom in 1964. The country remains one of the poorest countries in the world although it made significant economic and structural reforms. Agriculture is the backbone of the economy with tobacco, tea, and sugar being the main export products. Agriculture employs over 80% of the population, but the sector is vulnerable to external shocks, particularly climatic change. The country has one of the youngest populations in the world, with 43.9% of people under the age of 15; thus, agricultural development and diversification are urgent priorities to protect and improve their livelihoods and their children's futures.

[2] *See Goal 7: Affordable and Clean Energy, http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html.*

[3] *The development partners include organizations such as Gesellschaft für Internationale Zusammenarbeit (GIZ), Lighting Africa, Practical Action, Clean Cooking Alliance, the UN Development Programme (UNDP), the UN Industrial Development Organization (UNIDO), and the World Health Organization (WHO)*

[4] *MTF was introduced in the Global Tracking Framework (GTF) report (World Bank 2013).*

According to United Nations Department of Economic and Social Affairs Economic Analysis (2021), the country got the Least Developed Country (LDC) status in 1971, and has a gross national income per capita of $631.

GDP growth fell to 0.8% in 2022 from 2.2% in 2021, mostly due to 2-years of Covid-19 restrictions. Growth was projected to be 1.6% in 2023, compared to 0.9% in 2022. The economy is expected to grow at 2.8% in 2024, supported by further anticipated macroeconomic reforms. However, such growth remains inadequate to mitigate the prevailing high levels of poverty. In January 2021, the government launched the Malawi 2063 Vision with a view to transforming the country into a wealthy, self-reliant, industrialized upper-middle-income country, through a focus on agriculture commercialization, industrialization, and urbanization.

Figure 1 : Malawi on the Africa map

Sector context: Electricity

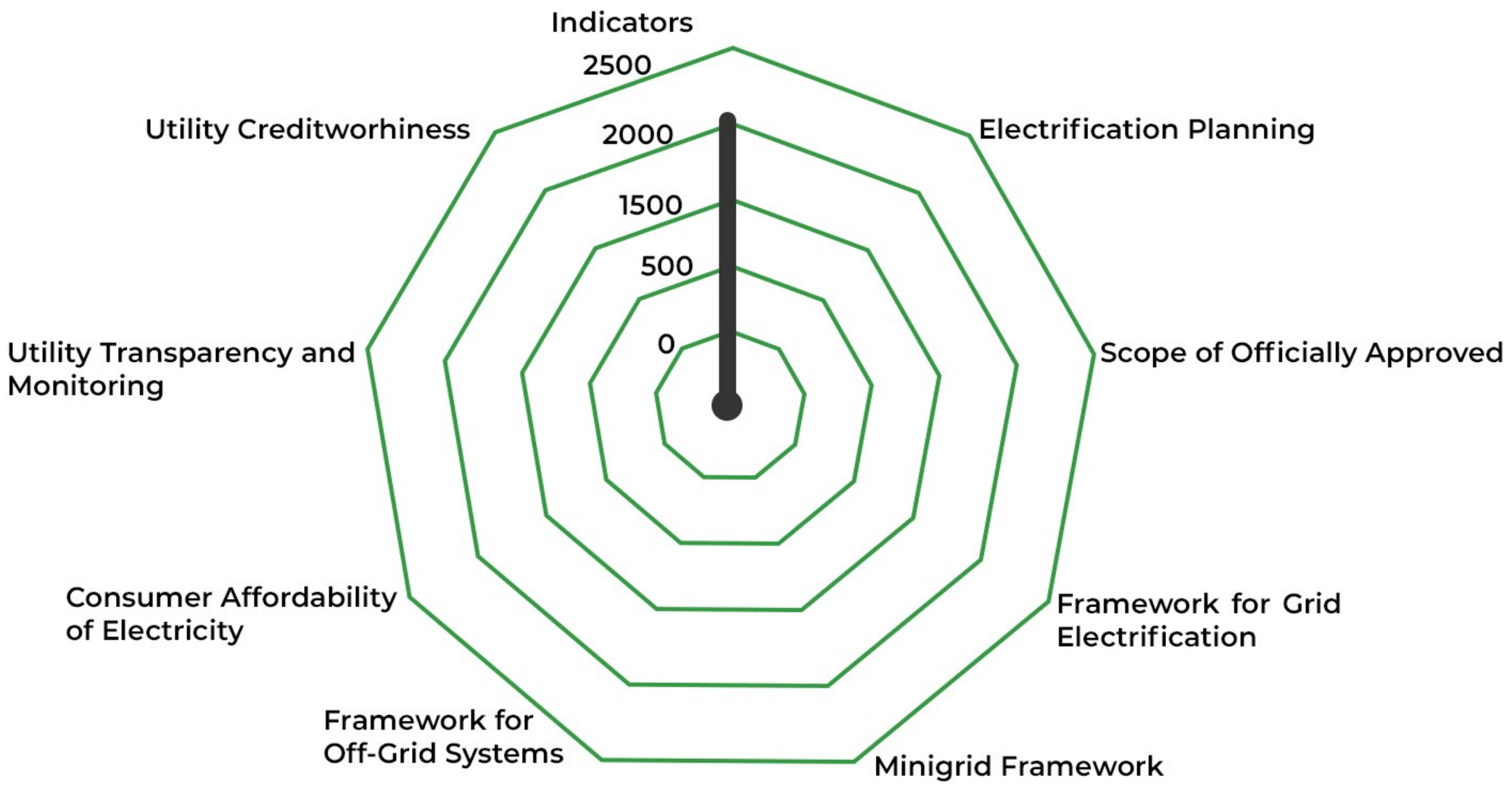
Malawi has one of the lowest proportions of access to electricity in the world, which is 15%. That means about 17 million people remain without access to electricity, and those with access experience blackouts on a regular basis. Urban-rural disparity is high with access in urban areas is 55%, compared to 10% in rural areas (World Development Indicators, 2018). However, the country has made considerable gains in energy access since 2000, when only 28.7% of urban households and 0.7% of rural households had access to electricity (World Development Indicators, 2018).

Increasing electrification rates, particularly in rural areas is an explicit goal of Government of Malawi (GOM. The 2019 National Electrification Strategy and Action Plan had a goal to provide more lighting in rural areas, relying more on expansion of solar technology and the development of mini solar and hydro grids for electricity generation (GoM, 2019). Moreover, increased investment in rural electrification has also been planned under the Malawi Rural Electrification Program (MAREP) which is expected to run through 2025.

95% of Malawi's electricity supply comes from hydroelectric power plants. Renewable sources such as solar and geothermal, also contribute to energy supply. Even for those connected to the electricity grid, high tariffs and cost of electricity appliances makes most households complement electricity with other energy sources. The National Energy Policy 2018 aims to increase the affordability and reliability of energy nationwide by reaching 80% electricity access by 2035, in part through investment in solar and other renewable energy sources.

According to Regulatory Indicators for Sustainable Energy (RISE), 8 regulatory indicators are defined for electricity access policy framework, with scores ranging from 0 to 100. The Malawi's aggregate score of electricity access is 76 in 2021 (see Figure 2).

Figure 2 : Status of regulatory indicators on electricity access in Malawi, 2022



Sector context: Cooking solutions

Considering the low access to electricity in Malawi, most households rely on solid fuels for cooking. Heavy reliance on biomass contributes to climate change with greenhouse gas emissions from burning firewood and charcoal, and due to lost forest carbon stocks.

Measuring access to electricity using MTF

Acknowledging that electricity access is a spectrum of services, the MTF measures the extent of such services, resulting in an innovative narrative about electrification status. More specifically, MTF captures information on seven types of energy services, called attributes:

Capacity ("What appliances can I power?")
The Capacity of the electricity supply (or peak capacity) is the ability of the system to provide a certain amount of electricity to operate various appliances, ranging from a few watts for light-emitting diode (LED) lights and mobile phone chargers to several thousand watts for space heaters or air conditioners. First, appliances are classified into tiers based on their power ratings (see table 1). Then, each household's appliance tier is determined by the highest tier of all its appliances; that is, if a household owns multiple appliances, the highest-capacity appliance determines the household tier. Capacity is measured in watts for grid, mini-grid, and fossil-fuel-based generators, and in watt-hours for rechargeable batteries, solar lanterns, solar lighting systems, and SHSs. It may be difficult to determine the Capacity attribute of the system by simple observation. An estimate of the available Capacity may be done based on the source of the supply (for example, grid is considered greater than 2,000 watts) or appliances used.

Availability ("Is power available when I need it?")
The Availability of supply refers to the amount of time during which electricity is available. It is measured through two indicators: the total number of hours per day (24-hour period) and the number of evening hours (the 4 hours after sunset) during which electricity is available.

Reliability ("Is my service frequently interrupted?")
The Reliability of electricity supply is a combination of the frequency and the duration of unexpected disruptions. In this report, the Reliability attribute is measured only for households connected to the grid or mini-grid.

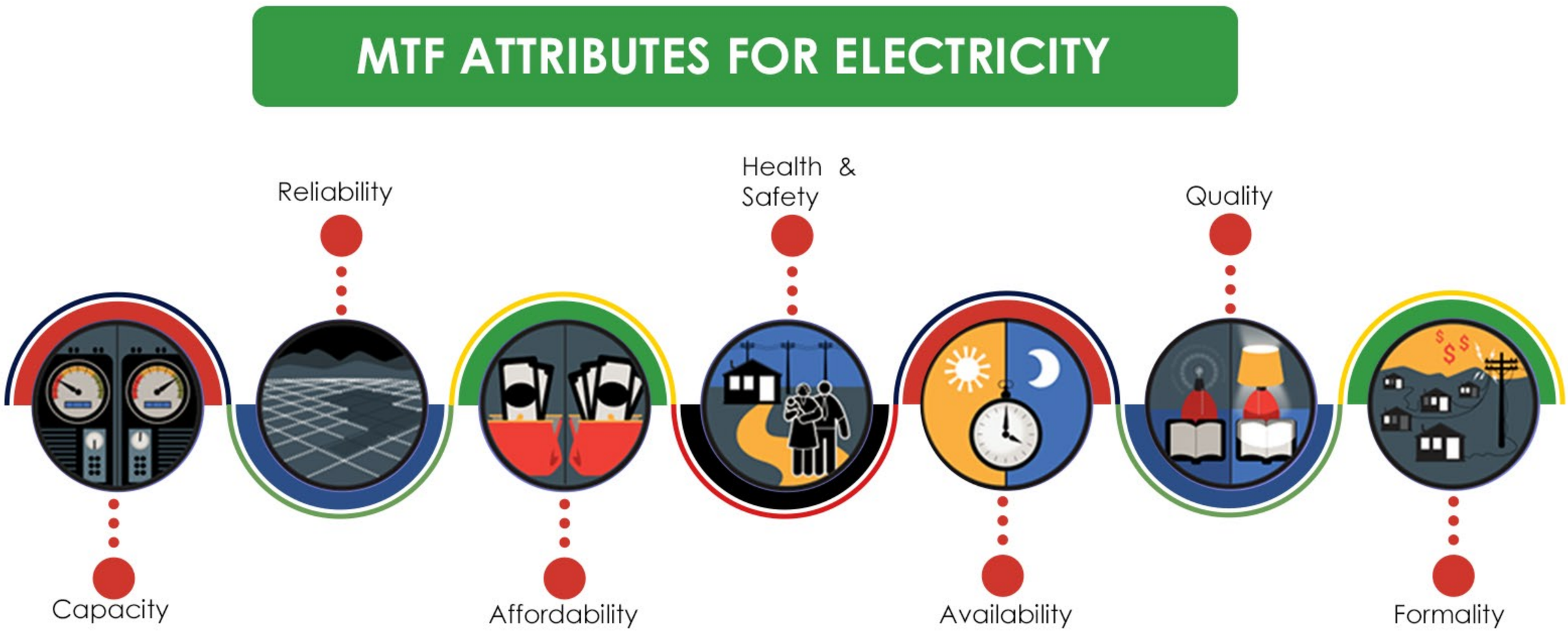
Quality ("Will voltage fluctuations damage my appliances?")
The Quality of the electricity supply refers to the absence of severe voltage fluctuations that can damage a household's appliances. Electric appliances generally require a certain level of voltage to operate properly. Low or fluctuating voltage can damage appliances, and even result in electrical fires. A low or fluctuating voltage supply tends to result from an overloaded distribution system or from long-distance low-tension cables connecting dispersed households to a singular grid. The MTF survey does not measure voltage fluctuation directly but uses incidents of appliance damage as proxy. In this report, the Quality attribute is measured for households connected to the grid or mini-grid only.

Affordability ("Can I afford to purchase the minimum amount of electricity?")
The Affordability of the electricity service is determined by comparing the price of a standard electricity service package (1 kilowatt-hour [kWh] of electricity per day or 365 kWh per year) with household expenditure. The price of the package is determined from the prevailing lifeline tariff. If the package costs more than 5% of the household expenditure, then electricity service is considered unaffordable for that household.

Formality ("Is grid electricity provided through a formal connection?")
The Formality of the grid connection is important since it ensures that the electricity authority gets paid for the services it provides, besides providing for the safety of electric lines. A grid connection is considered formal when the bill is paid to the utility, a prepaid card seller, or an authorized representative. Informal connections pose a significant safety risk and also affect the financial sustainability of the utility company. Reporting on the Formality of a connection is challenging. Households may be sensitive about disclosing such information in a survey. The MTF survey, thus, infers information on Formality from indirect questions that respondents may be more willing to answer, such as what method a household uses to pay the electricity bill. If households use the electricity service from the grid, but do not pay anyone for the consumption, their connection is assumed an informal connection.

Health and Safety ("Is it safe to use my electricity service?"):
This attribute refers to any injuries to household members from using electricity service from the grid during the preceding 12 months of the survey. "Injury" could mean limb injury or even death from burn or electrocution. Such injuries can result not just from faulty internal wiring (exposed bare wire, for example) but also from incorrect use of electrical appliances or negligence. The MTF analysis, however, does not make a distinction between the two. Electricity access is considered safe when users have not suffered from past accidents from their electricity supply resulting in permanent injuries.

Figure 3 : Multi-Tier Framework attributes for access to electricity

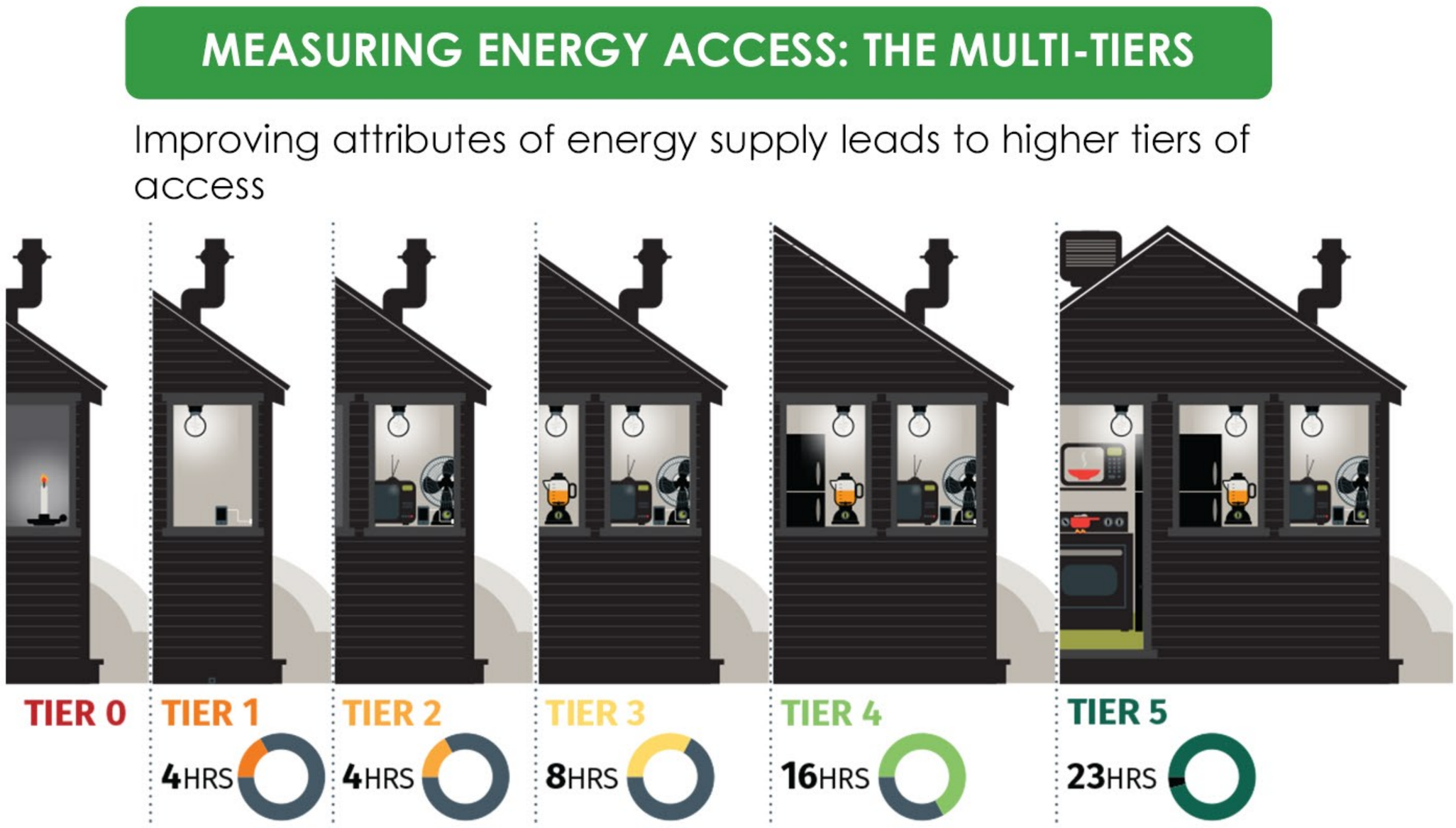


Each attribute, depending on the level of service a household receives from its main source of electricity, is assigned one of the six tiers—Tier 0 referring to the lowest level of service and Tier 5 the highest. Annex 1 gives a general definition of different tiers for each attribute. The aggregate or final tier for a household is determined by the lowest tier across all attributes. Box 1 demonstrates typical scenarios in which households may be assigned different aggregate tiers. Grid households (or mini-grid households, if available) are the most likely candidates for Tier 5, while those without access to electricity are assigned Tier 0.

In addition, households with electricity who do not get the service for required minimum hours during the day (4 hours) or the evening (1 hour) get Tier 0, so do those who have electricity but cannot even power light bulbs with capacity higher than 3w. It should be noted that certain attributes (Reliability, Quality, Affordability, Formality, and Health and Safety) do not apply to households if they do not have access to the grid or a mini-grid.

[5]*Details of tier calculation are revisited when individual attributes are discussed.*

Box 1. MTF Tiers for electricity access and minimum requirements



TIER 0

Electricity is not available or is available for less than 4 hours per day (or less than 1 hour per evening). Households cope with the situation by using candles, kerosene lamps, or dry-cell-battery-powered devices (flashlight or radio).

TIER 1

At least 4 hours of electricity per day is available (including at least 1 hour per evening), and capacity is sufficient to power task lighting and phone charging or a radio. Sources that can be used to meet these requirements include solar lighting systems, solar home system (SHS), a mini-grid (a small-scale and isolated distribution network that provides electricity to local communities or a group of households), and the national grid.

TIER 2

At least 4 hours of electricity per day is available (including at least 2 hours per evening), and capacity is sufficient to power low-load appliances—such as multiple lights, a television, or a fan—as needed during that time. Sources that can be used to meet these requirements include rechargeable batteries, an SHS, a mini-grid, and the national grid.

TIER 3

At least 8 hours of electricity per day is available (including at least 3 hours per evening), and capacity is sufficient to power medium-load appliances—such as a refrigerator, freezer, food processor, water pump, rice cooker, or air cooler—as needed during that time. In addition, the household can afford a basic consumption package of 365 kWh per year. Sources that can be used to meet these requirements may include an SHS, a generator, a mini-grid, or the national grid.

TIER 4

At least 16 hours of electricity per day is available (including more than 3 hours per evening), and capacity is sufficient to power high-load appliances—such as a washing machine, iron, hair dryer, toaster, and microwave—as needed during that time. There are no frequent or long unscheduled interruptions, and the supply is safe. The grid connection is legal, and there are no voltage issues. Sources that can be used to meet these requirements include mini-grids or the national grid.

TIER 5

At least 23 hours of electricity per day is available (including 4 hours per evening), and capacity is sufficient to power very high–load appliances—such as an air conditioner, a space heater, a vacuum cleaner, or an electric cooker—as needed during that time. The most likely source for meeting these requirements is the national grid, though in theory it could be a generator or mini-grid as well.

Source: Bhatia and Angelou 2015.

Box 2. Typology of off-grid solar devices and tier calculation for capacity

Three types of solar devices are classified by the number of light bulbs and the type of appliance or service that a household can use.

1

Solar lantern

Powers a single light bulb and allows only part of the household to be classified in Tier 1. Under the MTF methodology, the number of household members in Tier 1 is based on the light output (lumen-hours) and phone charging capability of the solar lantern.

2

Solar lighting system (SLS)

Powers two or more light bulbs and allows part or all of the household to be classified in Tier 1.

3

Solar home system (SHS)

Powers two or more light bulbs and appliances such as a television, iron, microwave, or refrigerator. For a household that uses an SHS, it is assumed that all the household members are at least in Tier 2 for Capacity. See table 1 for the load level associated with each tier.

Source: Bhatia and Angelou 2015.

Table 1. Power rating of electric appliances and corresponding tiers

Power rating	Indicative electric appliances	Corresponding tier
Very low load (3–49w)	Task lighting, phone charging, radio	1
Low load (50–199w)	Multi-point general lighting, television, DVD player, computer, printer, fan, electric sewing machine	2
Medium load (200–799w)	Air cooler, refrigerator, freezer, food processor, water pump, rice cooker	3
High load (800–1,999w)	Washing machine, iron, hair dryer, toaster, microwave, electric kettle	4
Very high load (2000w or higher)	(2000w or higher) Air conditioner, space heater, vacuum cleaner, water heater, electric cookstove	5

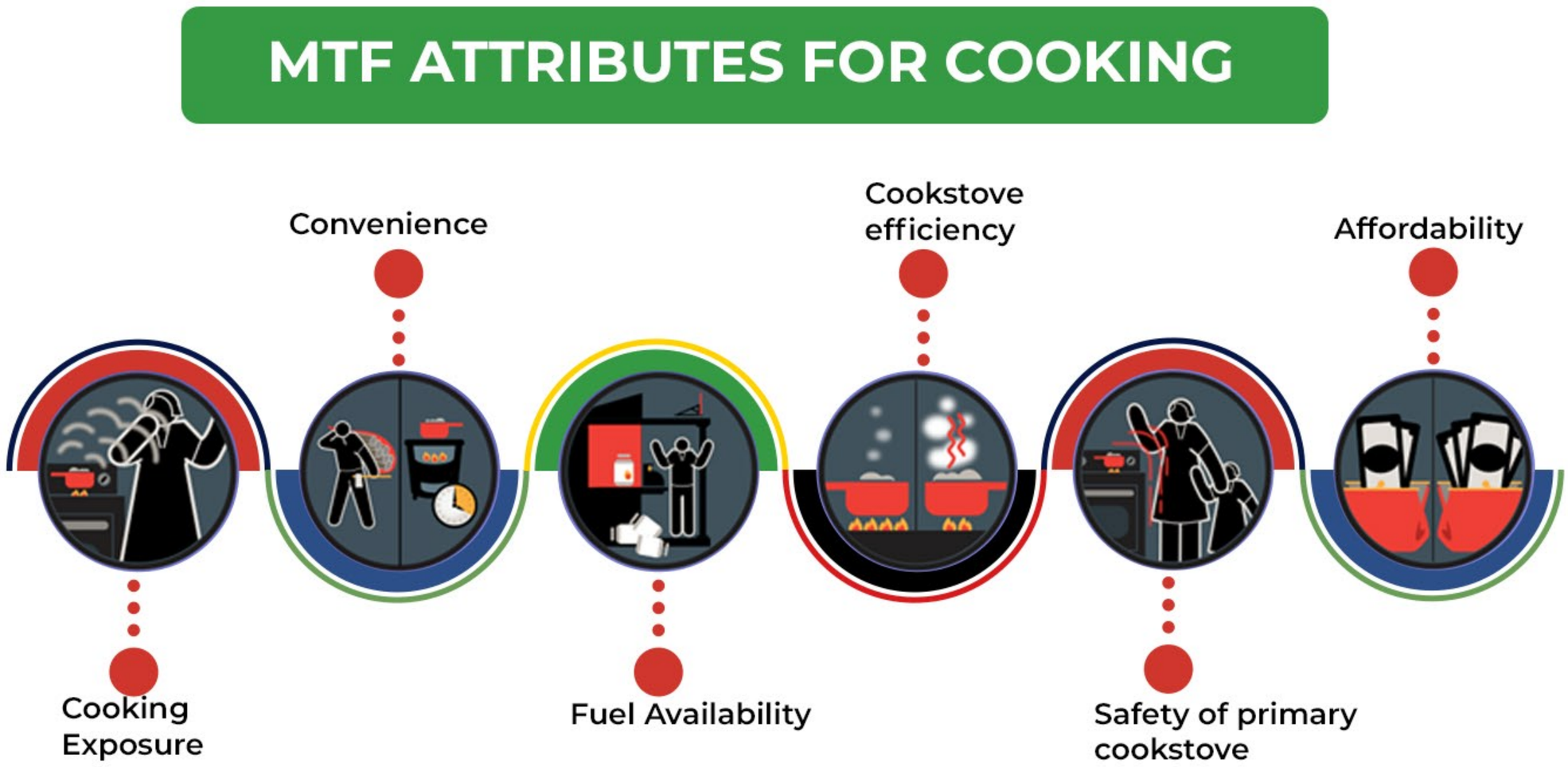
Source: Bhatia and Angelou 2015.

Note: The list is by no means comprehensive but shows appliances that are most common. Tier calculation should consider all appliances that households use in the country in question, which may not be covered by this list.

■ Measuring access to modern energy cooking solutions using MTF

Despite the well-documented benefits of access to clean cookstoves, around 3 billion of the world's population still use polluting and inefficient cooking solutions. The inefficient use of solid fuels has significant impacts on health, socioeconomic development, gender equality, education, and climate (Ekouevi and Tuntivate 2012; UNDP and WHO 2009; World Bank 2011). The consequences of inefficient energy use for cooking extend beyond direct health impacts. Such use also affects socioeconomic development; for example, fuel collection and cooking tasks are often carried out by women and girls. Collection time depends on the local availability of fuel and may reach up to several hours a day (ESMAP 2004; Gwavuya et al. 2012; Parikh 2011; Wang et al. 2013). The time spent on fuel collection and preparation often translates into lost opportunities for gaining education and increasing income (Blackden and Wodon 2006; Clancy, Skutch, and Batchelor 2003). In addition, the associated drudgery increases the risk of injury, and traveling far away may pose the risk of physical attacks (Rehfuess, Mehta, and Pruss-Üstun 2006).

Figure 4: Multi-Tier Framework attributes for access to modern energy cooking solutions



The MTF measures access to modern energy cooking solutions based on six attributes: Cooking Exposure, Cookstove Efficiency, Convenience, Affordability, Health and Safety of primary cookstove, and Fuel Availability (see annex 1).

Cooking Exposure ("How is the user's respiratory health affected?")
This assesses the personal exposure to pollutants from cooking activities, which depends on stove emissions, ventilation structure, including cooking location and kitchen volume (see annex 2). This attribute is a composite measurement of the emissions from the cooking activity, that is, the combination of the stove type and fuel, and mitigated by the ventilation in the cooking area. If a household uses multiple stoves, the Cooking Exposure attribute is measured as a weighted average of the time each stove is used.

Cookstove Efficiency ("How much fuel will a person need to use?")
Cookstove Efficiency is a combination of combustion efficiency and heat-transfer efficiency. Laboratory testing of the efficiency of various types of cookstoves informs the breakdown of efficiency levels by cookstove and fuel combinations, which can be observed in the field with relative ease.

Convenience ("How long does it take to gather and prepare the fuel and stove before a person can cook?"):
Convenience is measured by the amount of time a household spends collecting or purchasing fuel and preparing the fuel and the stove for cooking.

Affordability ("Can a person afford to pay for both the stove and the fuel?")
Affordability assesses a household's ability to pay for both the cookstove and fuel. For this report, affordability is measured using the levelized cost of the fuel. A cooking solution is considered affordable if a household spends less than 5% of total household expenditure on cooking fuel.

Health and Safety ("Is it safe to use the stove?")
The degree of safety risk can vary by type of cookstove and fuel used. Risks may include exposure to hot surfaces, fire, or the potential for fuel splatter. Reported incidences of past injury or fire are used to measure safety.

Fuel Availability ("Is the fuel available when a person needs it?")
The availability of a given fuel can affect the regularity of fuel use, while shortages in the fuel can cause households to resort to inferior secondary fuel types. This attribute assesses the availability of fuel as needed for a household's cooking purposes.

A methodology similar to the electricity framework is applied to obtain the aggregate tier for modern cooking solutions. The lowest tier among the attributes is taken as the final tier for the household (for more information on the threshold and tier calculation, see annex 1.) Box 3 shows the typical cookstoves observed in Malawi.

Box 3. Typology of cookstoves in Malawi

During the survey, the enumerators observed six types of cookstoves in Malawi.

1. Three-stone stove
The three-stone stove consists of three stones of approximately the same height on which a pot may rest over a fire built amid the stones. It is characterized by open fire. Fuel rests on the ground.

2. Traditional stove
It is made of mud. Fire is enclosed in the combustion chamber that is not fully insulated. Fuel rests on the ground.

3. Improved cookstove (ICS)
Combustion chamber is well insulated and fuel rests on a shelf. It comes in different forms—some have a metal lining, some are equipped with a chimney, some are portable, and some are fixed to a location. It can be single- or double-mouthed. Charcoal Jiko is an example of Improved Charcoal stoves.

4. LPG stove
It is considered a clean stove and is more common in urban areas.

5. Electric stove
Most people use an induction type stove (almost exclusively in urban areas), and some use a rice cooker. It is considered the cleanest of all stove types.

Source: MTF household survey 2023.

3 stone stove open fire.

Traditional biomass stove. - Enclosed combustion chamber

Chitetezo Mbaula biomass stove (ICS). Combustion chamber is insulated.

Jiko ceramic charcoal cookstove

Envirofit Jikokoa improved charcoal stove

LPG Cookstove

Electric cookstove

Using the MTF to drive policy and investment

The MTF benefits Governments and Development Partners. It provides comprehensive and consistent household demand and supply data. It provides crucial information or data on cooking expenditure and fuel consumption and gender related data. The framework provides better information and tools to set country-appropriate access targets. Using the tiers, the government can focus on providing full energy service to smaller population (Tier 4-5) or a lower tier access (Tier 1-2) to everyone. Lastly, governments can use the approach to make informed decisions on access interventions since data can be disaggregated for each attribute and technology. Specifically, the MTF benefits to policy makers and private sector can be described as the following:

a. Inform project design.

More accurate measurement of energy access and an improved understanding of the underlying shortfalls are crucial for the success and sustainability of energy projects. MTF data can inform project design during preparation and provide better ex-ante estimation of the likely impact of projects on access.

In addition, MTF data on energy consumption, willingness to pay (WTP), and several socio-economic variables for households and firms complement and enhance upstream planning activities such as geospatial electrification planning, market assessments for off-grid technologies, assessment for the potential for productive usage development, and demand forecasting for least-cost planning. The MTF data can establish a baseline and provide nuanced information on an intended project, as well as potential for scale-up. The data can also be useful in understanding consumer WTP, whereby information can be used in developing a financial plan (subsidies and installments) that would be affordable for the communities.

b. Prioritize investment and interventions.
By shedding light on the constraints that prevent energy end-users from achieving higher tiers of access, MTF data can be used to prioritize investments and interventions aiming to move users into higher tiers. MTF data helps identify specific gaps and assess deficiencies in the performance of the energy supply as well as identify opportunities in improving energy access of specific target groups.

c. Setting country-specific energy access targets.
The multi-tier measurement of energy access enables governments to set their own SDG 7.1 targets, by selecting any energy access tier above Tier 0. Such targets can be based on the country's current context, its development status, the needs of its population, and the budget available; thus, making the MTF adaptable to any country context. Where funding is limited, governments can adopt a phased approach, for example starting off with moving people to Tier 1 or 2. Then to higher tiers in another phase when additional funding is available.

d. Support policy formulation.
The MTF captures detailed information on the quantity and quality of energy access. MTF data show the distribution of energy access technologies across the country, including grid and off-grid solutions, as well as the range of cooking solutions (cookstoves and fuels) used, and report on the attributes of the energy supply and other related energy aspects. Thus, detailed baseline data can help support policy formulation.

e. Assessing the contribution of broader energy interventions in improving energy access. Defining and measuring energy access by considering attributes of energy supply yields a better understanding of how various interventions improve access (Angelou and Bhatia 2014). Energy access projects are typically thought of as those that either provide additional grid connections or disseminate off-grid systems, such as solar lanterns or solar home system (SHS). However, other types of projects also contribute to improving energy supply and may have a positive effect on access. For example, a generation project may allow for longer hours of supply and address voltage issues; an energy efficiency intervention may increase the duration of energy supply or improve affordability.

f. Tracking progress toward SDG 7.1 and beyond.
Regular and sustained data collection can be used to evaluate the progress made by a given country towards achieving the SDG 7.1, as well as reflect the contributions of various projects towards improving energy access. In addition, MTF data may lead to a better assessment of the linkages between energy access and economic growth, poverty reduction, human development, and gender equality.

MTF survey in Malawi

The MTF survey in Malawi, undertaken by the Ministry of Energy and implemented by National Statistical Office (NSO), was based on a nationally representative sample (including rural and urban areas) of 9,195 households and was carried out during 26 May–25 July 2023. Geographically, the survey covered all 28 districts which were split between urban and rural, making a total of 32 districts or strata. The sample of households was proportionally distributed with respect to number of households in the district. Probability proportional to size (PPS) was used to determine sample sizes for the district and for both rural and urban areas.

Urban areas were the designated four cities namely Blantyre City, Lilongwe City, Mzuzu City, and Zomba City. All other areas were considered rural. The primary sampling units (PSUs) are the Enumeration Areas (EAs). From each district or urban area, the number of EAs were selected as proportional to the population. EAs were randomly selected based on:

(a) The sample size of each district or urban area;
(b) A total of 20 households were sampled in each EA so the sample size of the district or urban area was divided by 20 to get the total number of EAs to be sampled.

EAs that fell in protected areas such as game parks, defense or security areas and industrial areas were removed before randomly picking the EAs. This approach assisted the team to avoid picking EAs in which the study could not be conducted.

Although the sample was drawn from the 2018 Population and Housing Census (PHC), households might have moved in and out of the enumeration areas. As such, to have a more recent number of households in the enumeration areas, a listing of households was conducted in all the selected EAs prior to selecting and conducting interviews. To minimize the mobility of teams, the teams conducted a household listing exercise first and then proceeded to conduct interviews immediately thereafter. A more detailed description of the sampling procedure is outlined in Annex 2.

Table 2 shows the distribution of sampled households and figure 5 shows the location of the sampled households across the country.

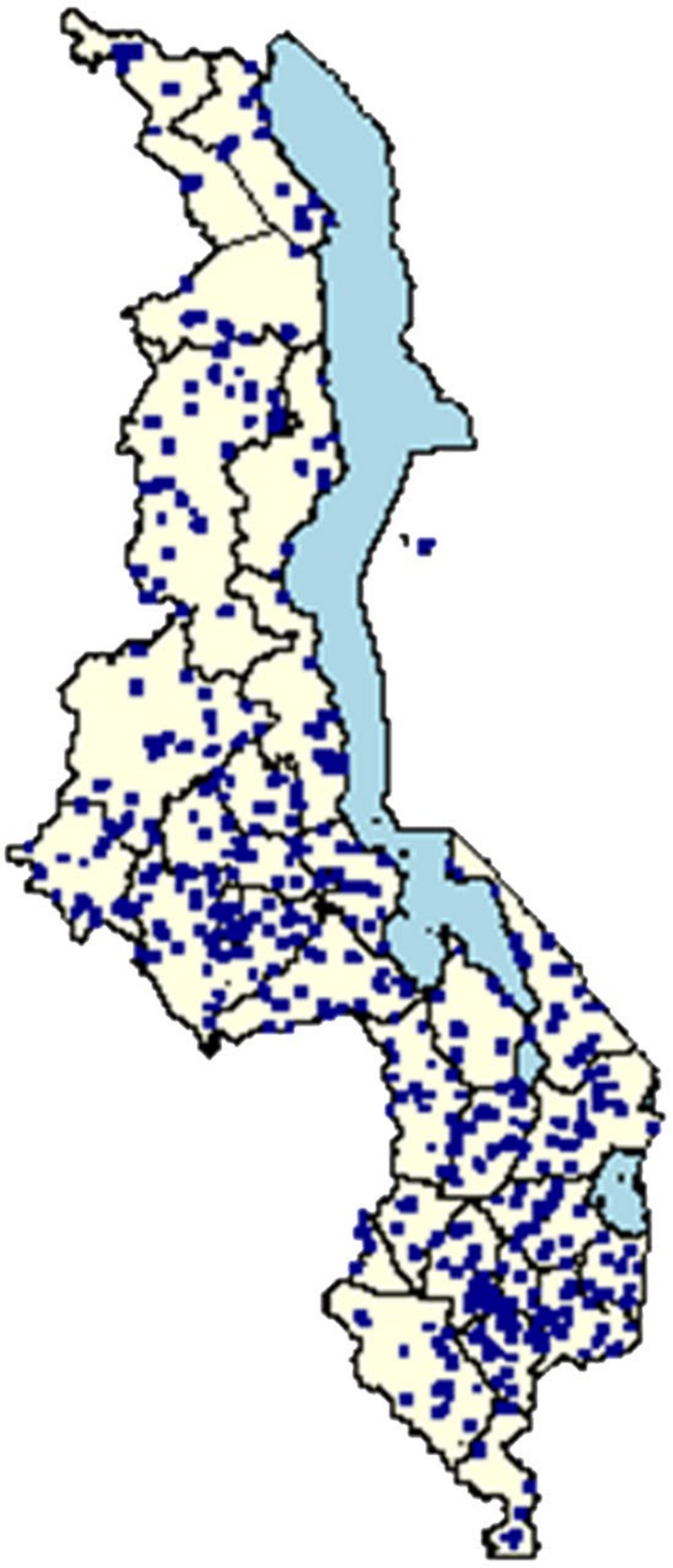
Table 2. Distribution of sampled households by grid access in the MTF survey, Malawi

Region	District	Number of EAs	Rural area HHs	Urban area HHs	Total
Northern	Chitipa	7	140	-	140
	Karonga	11	220	-	220
	Nkhatabay	8	160	-	160
	Rumphi	7	140	-	140
	Mzimba	21	420	-	420
	Likoma	4	80	-	80
	Mzuzu City	8	0	160	160

Region	District	Number of EAs	Rural area HHs	Urban area HHs	Total
Central	Kasungu	21	420	-	420
	Nkhotakota	10	200	-	200
	Ntchisi	8	157	-	157
	Dowa	20	400	-	400
	Salima	14	280	-	280
	Lilongwe Rural	40	798	-	798
	Mchinji	15	299	-	299
	Dedza	22	440	-	440
	Ntcheu	18	360	-	360
	Lilongwe City	23	0	461	461
Southern	Mangochi	27	540	-	540
	Machinga	20	400	-	400
	Zomba Rural	16	320	-	320
	Chiradzulu	9	180	-	180
	Blantyre Rural	12	240	-	240
	Mwanza	4	80	-	80
	Thyolo	19	380	-	380
	Mulanje	17	340	-	340
	Phalombe	11	220	-	220
	Chikhwawa	15	300	-	300
	Nsanje	8	160	-	160
	Balaka	12	240	-	240
	Neno	4	80	-	80
	Zomba City	8	0	160	160
	Blantyre City	21	0	420	420
Total		460	7,994	1,201	9,195

Source: MTF household survey 2023.

Figure 5 : Location of sampled households of the Malawi MTF survey



Source: MTF household survey 2023.

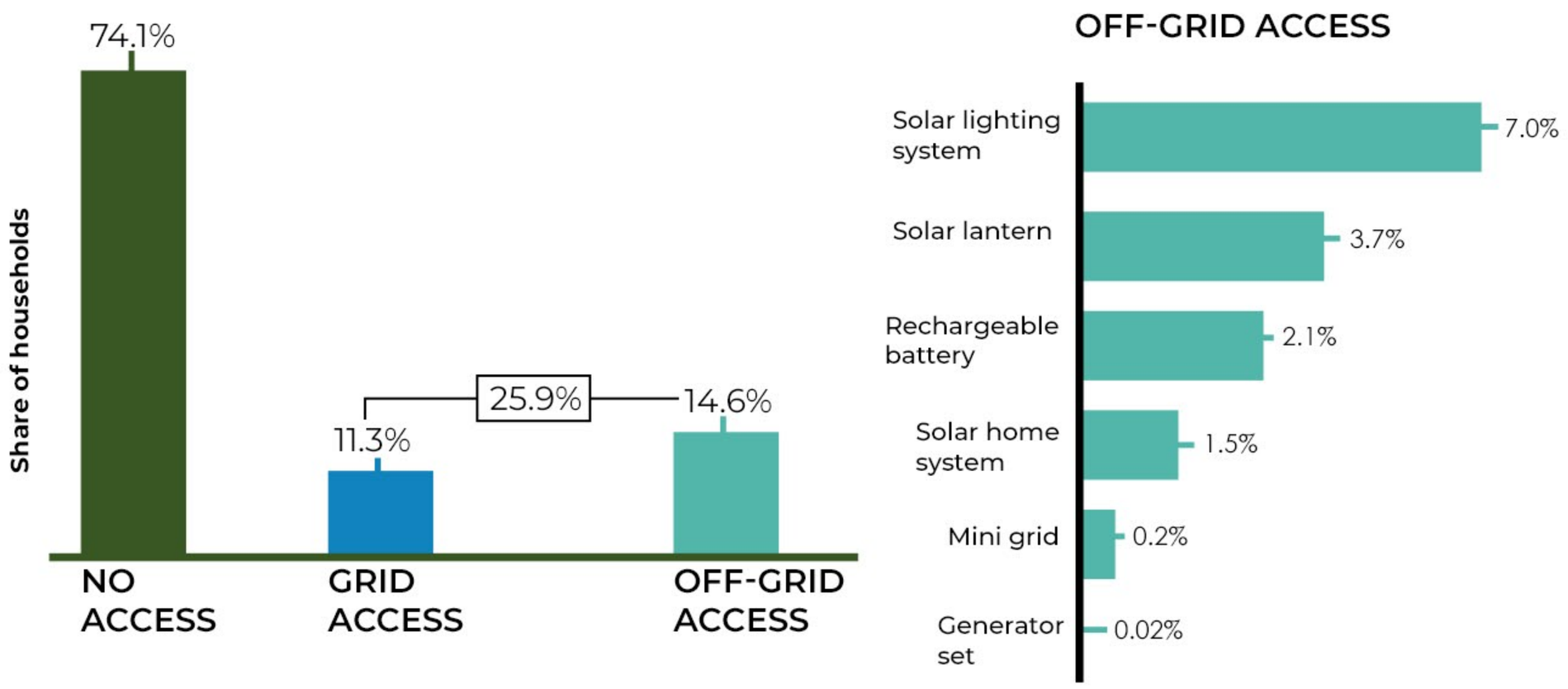
ACCESS TO ELECTRICITY

■ Assessing access to electricity technologies

Technologies

In Malawi, 25.9% of households have access to at least one source of electricity: 11.3% of households have access through the national grid, and 14.6% have access through off-grid solutions, mostly solar. Of the 14.3% of households using an off-grid solar solution, 7% use a Solar Lighting System (SLS), 3.7% use a solar lantern, and 1.5% use a Solar Home System (SHS). The other off-grid solutions, which are rechargeable batteries, mini-grids and generator sets are used by 2.1%, 0.2% and 0.02% of households, respectively (Figure 6).

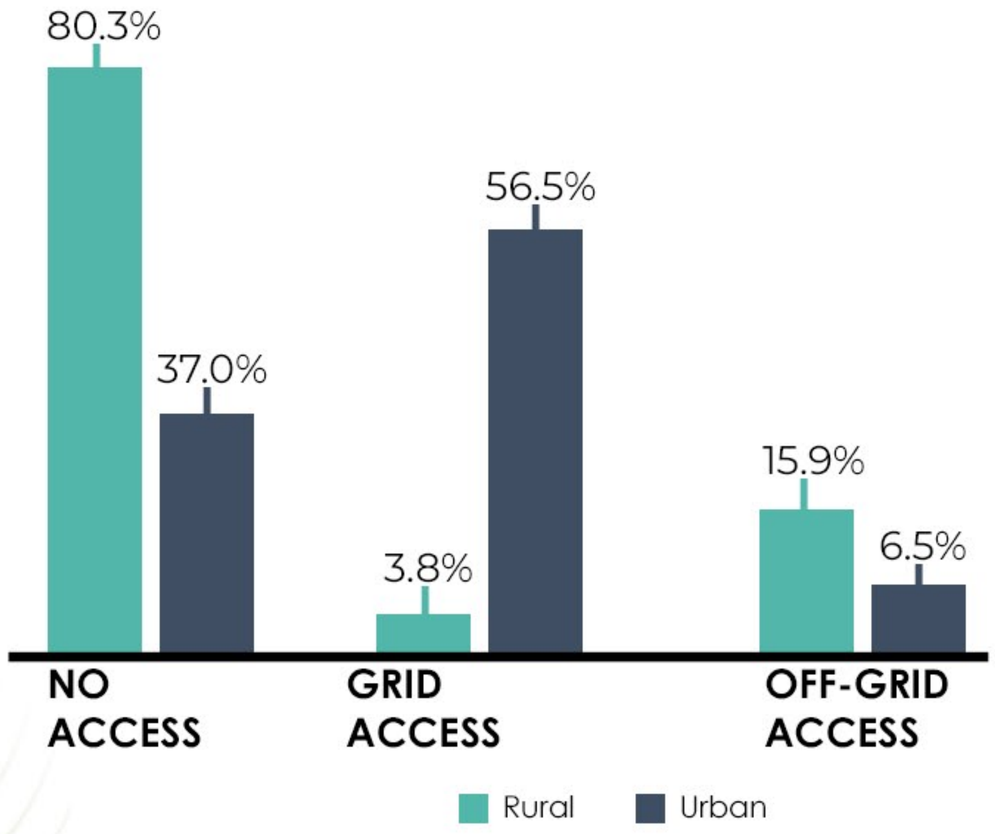
Figure 6 : Share of households with access to electricity by source at national level



Source: Malawi MTF household survey 2023.

Grid access is the main source of electricity in urban areas where 56.5% of households use the national grid for their electricity compared to only 3.8% in the rural areas. In contrast, the proportion of households using off-grid solutions as their primary source of electricity is higher in rural areas at 15.9% compared to urban areas at 6.5% (Figure 7).

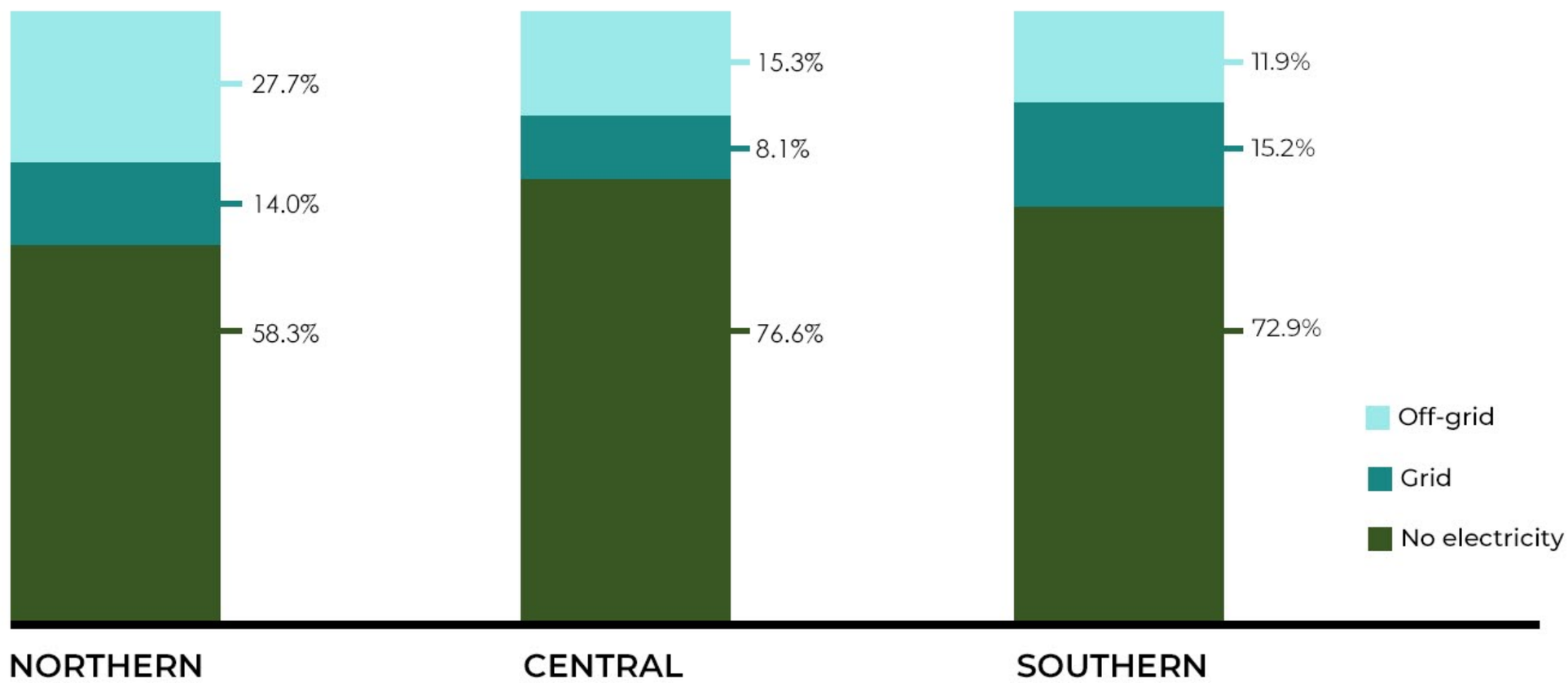
Figure 7 : Share of households with access to electricity by source and place of residence



Source: Malawi MTF household survey 2023.

At regional level, the Southern region has 15.2% of households with grid electricity followed by the Northern and Central regions at 14% and 8.1%, respectively. The Northern region has the highest proportion of households using off-grid solutions at 27.7%, followed by the Central region at 15.3%, and the Southern region at 11.9%. The Central region has the highest proportion of households with no electricity at 76.6% followed by the Southern region at 72.9% while the Northern region has the lowest at 58.3% (Figure 8).

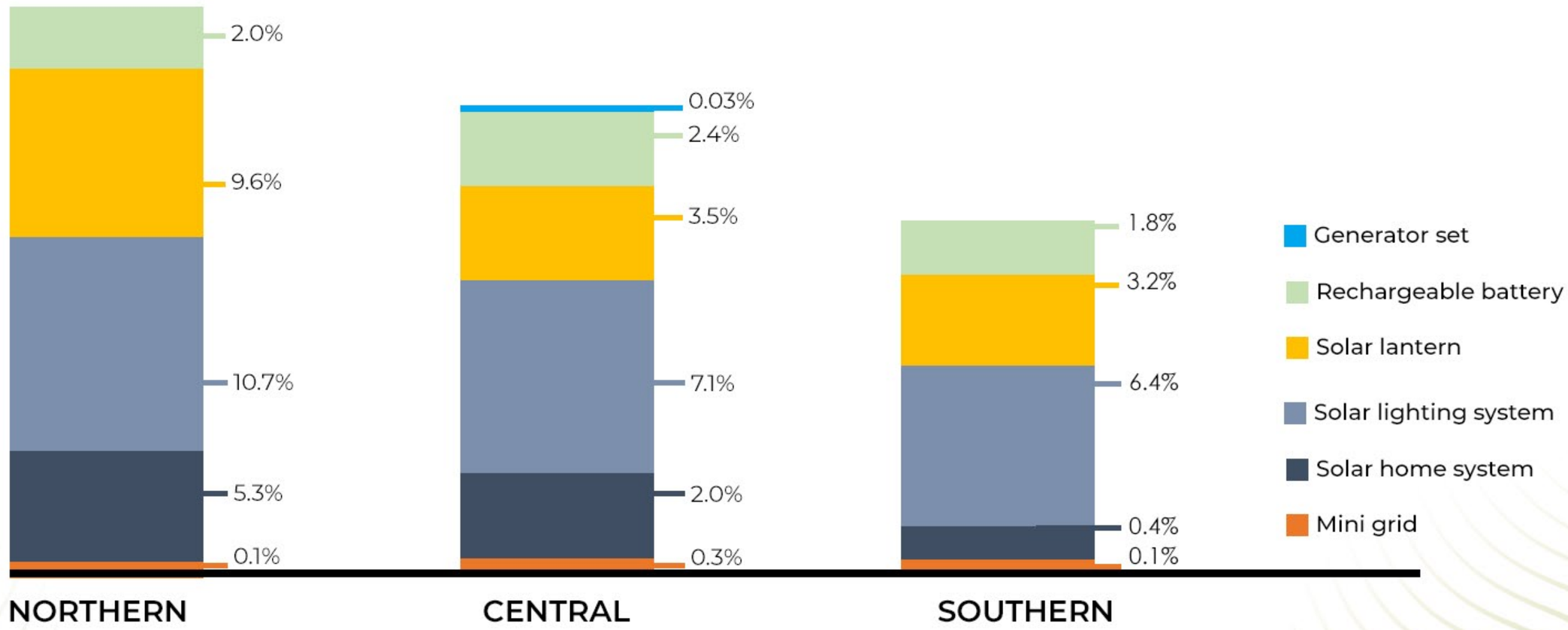
Figure 8 : Share of households with access to electricity by region



Source: Malawi MTF household survey 2023.

Across regions, households that are not connected to the national grid are mostly using solar compared to any other off-grid solution with the Northern region having the highest proportion of households at 25.6% (Figure 9).

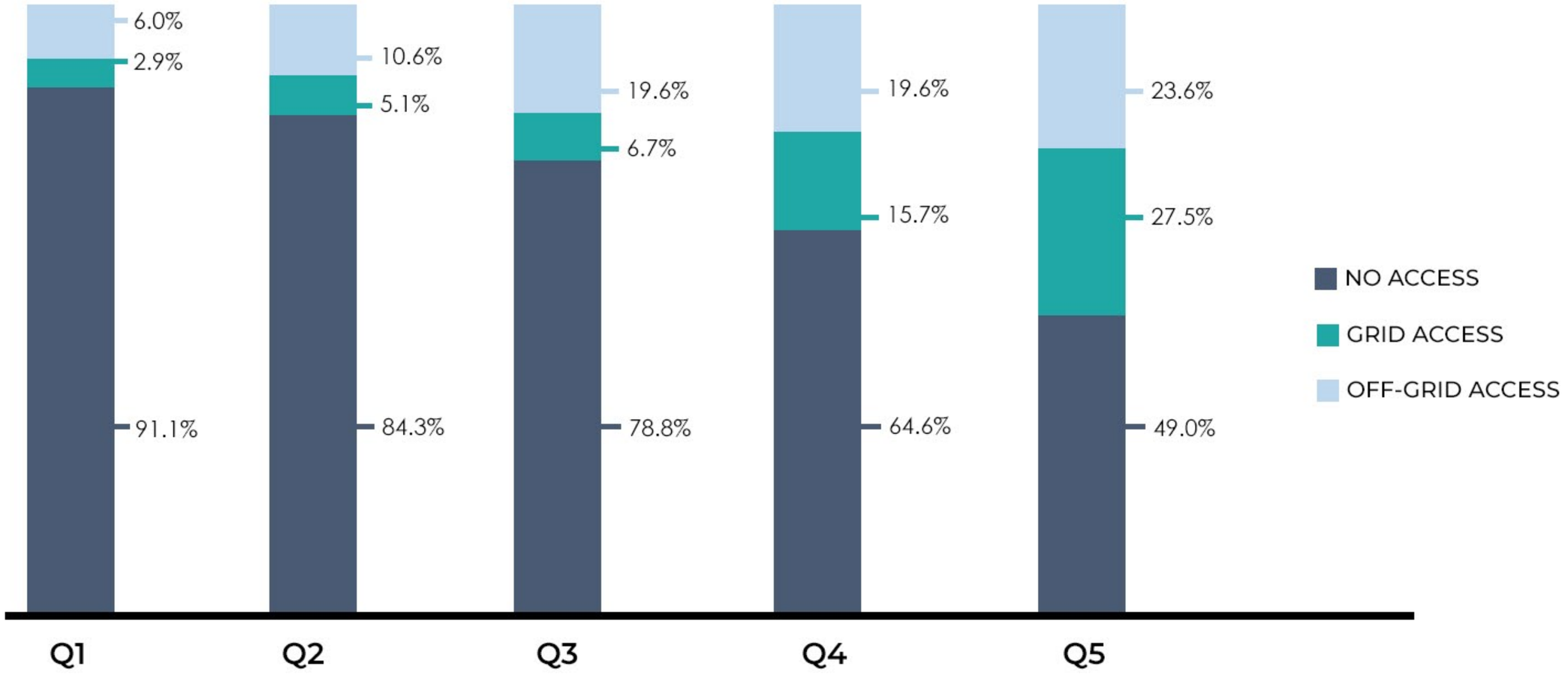
Figure 9 : Share of households with access to off-grid electricity solutions by region



Source: Malawi MTF household survey 2023.

The grid is the leading technology for wealthier households: 49% of households in the top spending quintile are connected to the national grid. Similarly, off-grid penetration is higher among wealthier households with 23.6% of households in the 5th quintile using off-grid solutions (Figure 10).

Figure 10: Share of households with access to electricity by expenditure quintile

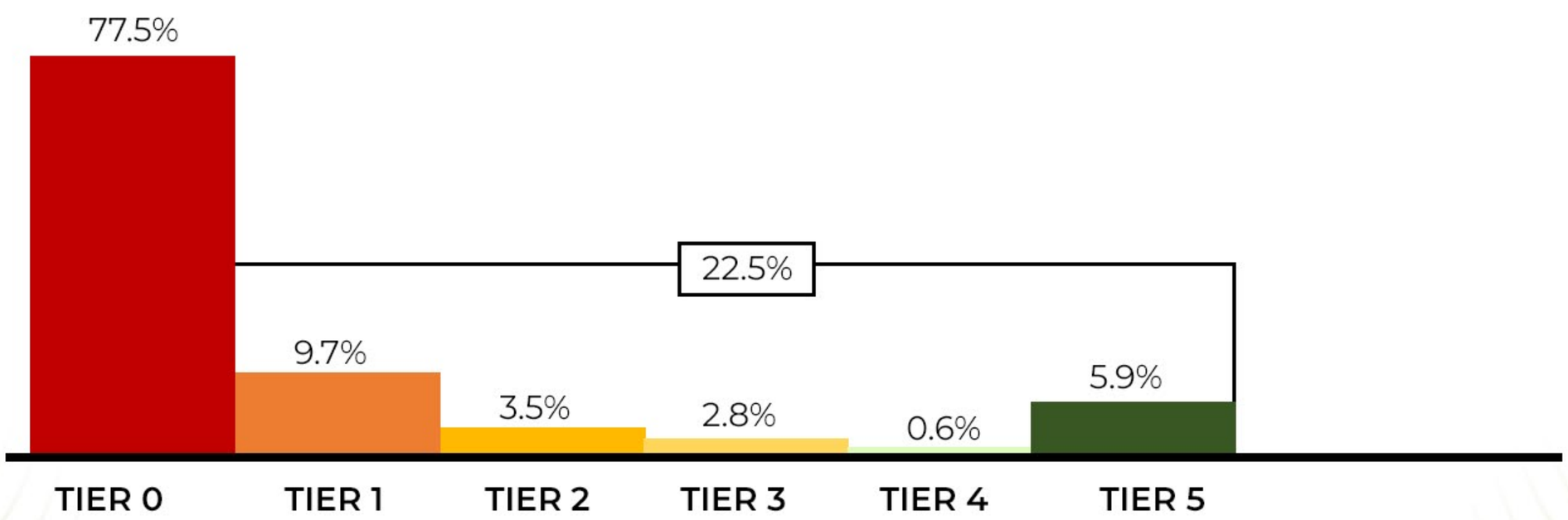


Source: Malawi MTF household survey 2023.

MTF tiers

In Malawi, 22.5% of households are in Tier 1 or above for access to electricity with the highest proportion of electrified households (those in Tier 1 or above) being in Tier 1. Although 25.9% of households are electrified through a connection to the grid or through off-grid solutions, only 22.5% of households are in Tier 1 or above (Figure 11). Households with access to electricity are concentrated in lower tiers: more than half of the 22.5% of households in tier one and above are in Tier 1 and 2 (13.2%). This implies that most electrified households have at least 4 hours of electricity available per day (including at least 2 hours per evening), and capacity is sufficient to power low-load appliances—such as multiple lights, a television, or a fan as needed during that time (see Table 1 for the load levels associated with various appliances).

Figure 11: Share of households with access to electricity by Tier at national level

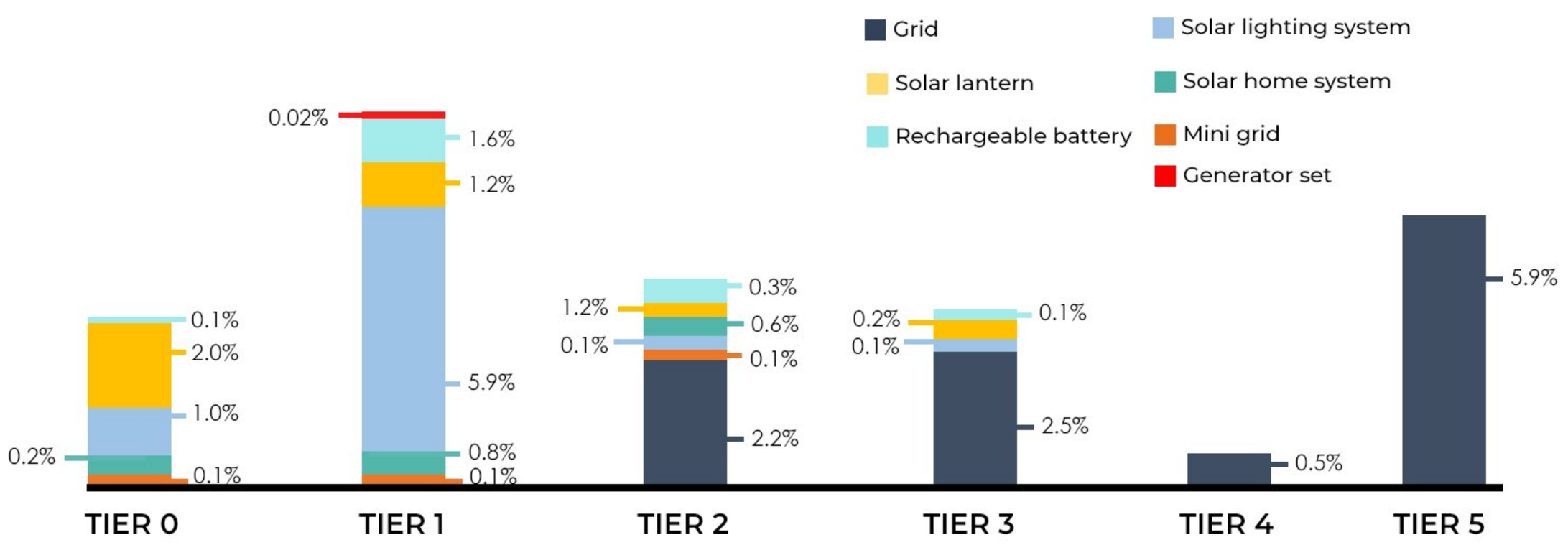


Source: Malawi MTF household survey 2023.

[6]The average tier is calculated by aggregating the proportion of households in each tier with the tier value. The average tier obtained takes into account the extent of access (how many households have access) and the intensity of access (level of access that households have)

Overall, most of the households in Tier 2 or above for access to electricity are connected to the grid. Off-grid solar solutions are used by a majority of households in Tier 1 with 60.5% using Solar Lighting System and 12.7% of the households using Solar Lanterns (Figure 12). The average tier for all households is 0.6, compared to 2.5 for households with access to electricity (households in Tiers 1–5) . The average tier explains the extent and intensity of access, thus the number of households with access to electricity and their level of access.

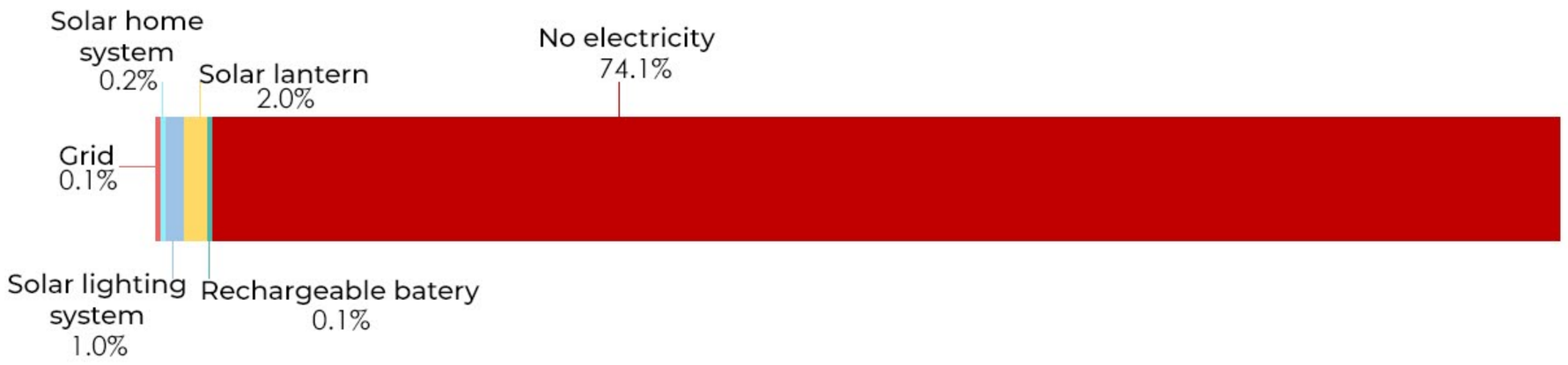
Figure 12 : Share of households with access to electricity by Tier and electricity source at national level



Source: Malawi MTF household survey 2023.

Analysis of access to electricity among households in Tier 0 shows that most of the households (74.1%) have no access to electricity. Despite 3.4% of households in Tier 0 having grid or off-grid access, they do not satisfy Tier 1 requirements. This is due mainly to the limited Capacity or Availability of off-grid solutions (3.3% of households) or to the limited Availability of grid supply for 0.1% of households (Figure 13).

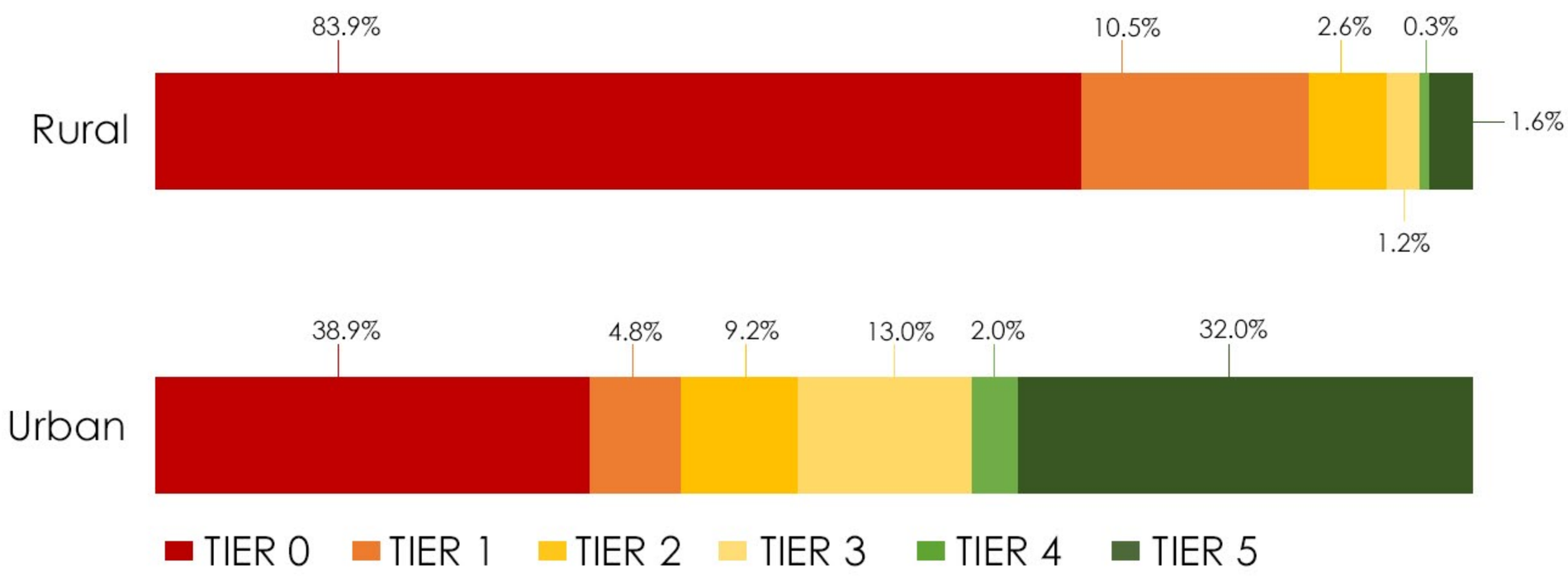
Figure 13 : Share of households with access to electricity in Tier 0 by electricity source at national level



Source: Malawi MTF household survey 2023.

Electricity access is mostly a rural challenge: Of the 3.8% of households connected to the national grid in the rural area, 83.9% are in Tier 0 compared to 38.9% in the urban areas. While 61.1% of urban households are in Tier 1 or above, only 16.1% of rural households are in Tier 1 or above (Figure 14). The average tier for urban households is 2.3 compared to 0.3 for rural households.

Figure 14 : Share of households with access to electricity by Tier and place of residence

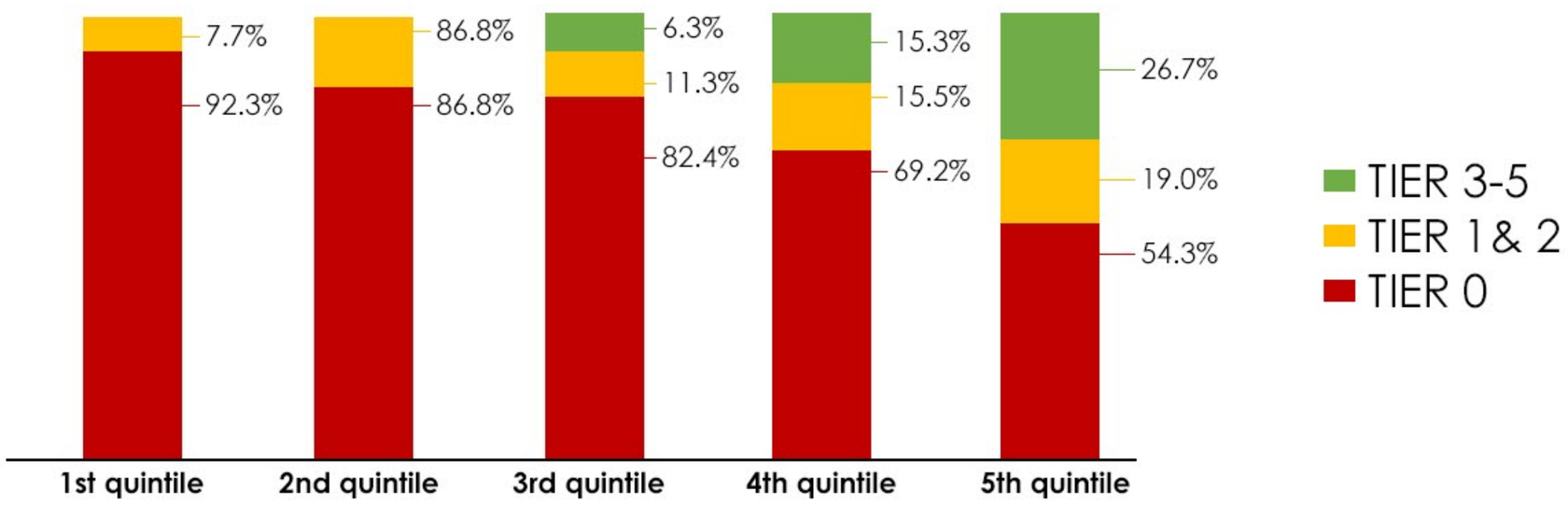


Source: Malawi MTF household survey 2023.

Access to electricity is higher among higher income households

45.7% of households in the top spending quintile are in Tiers 1 and above compared with 7.7% of households in the bottom spending quintile (Figure 15). In contrast, 54.3% of households in the top spending quintile are in Tier 0, compared with 92.3% of households in the bottom spending quintile.

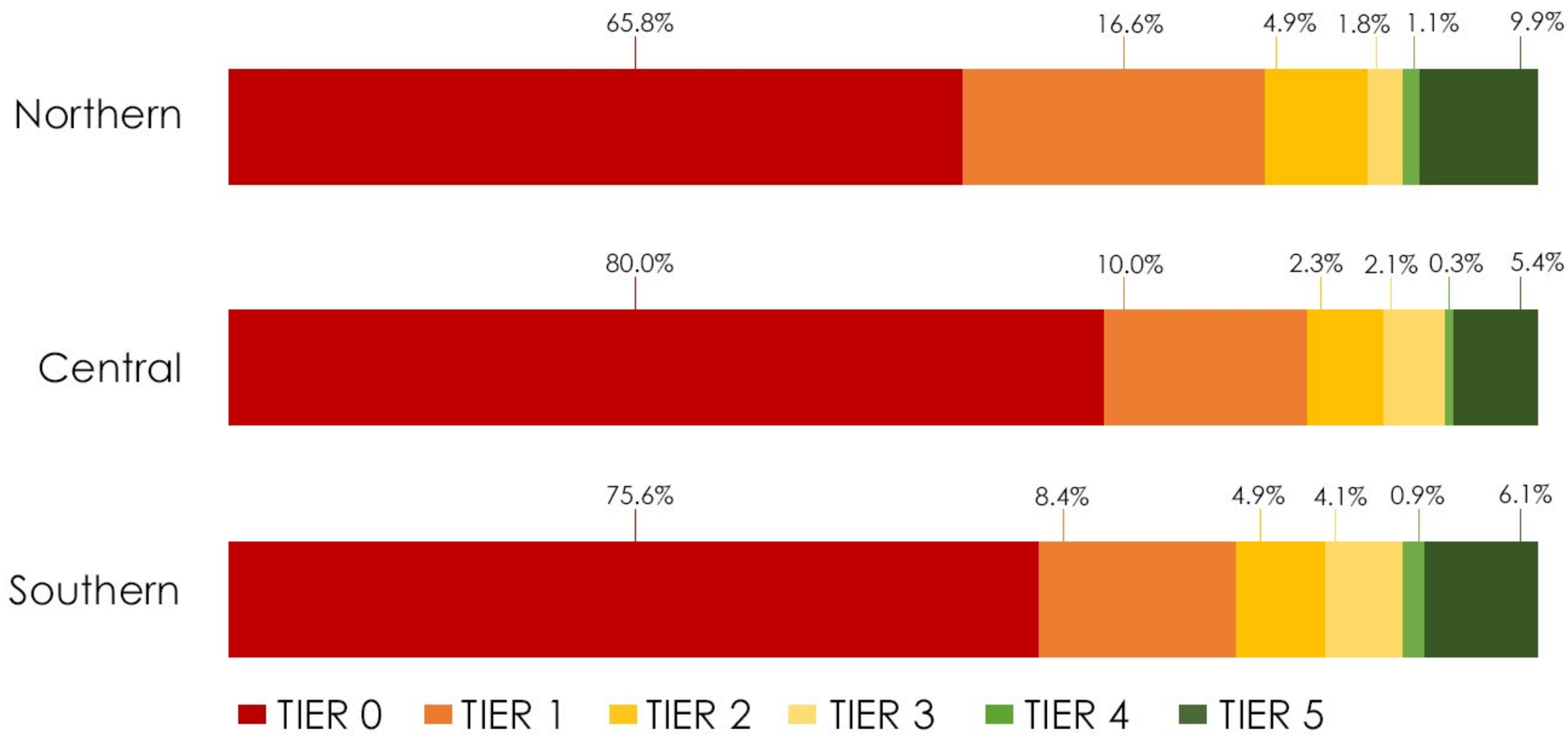
Figure 15 : Share of households with access to electricity by expenditure quintile



Source: Malawi MTF household survey 2023.

At regional level, the Northern region has the highest proportion of households with access to electricity in Tier 1 or above at 34.2% followed by the Southern region at 24.4 percent and the Central region at 20% (Figure 16).

Figure 16 : Share of households with access to electricity by Tier and region



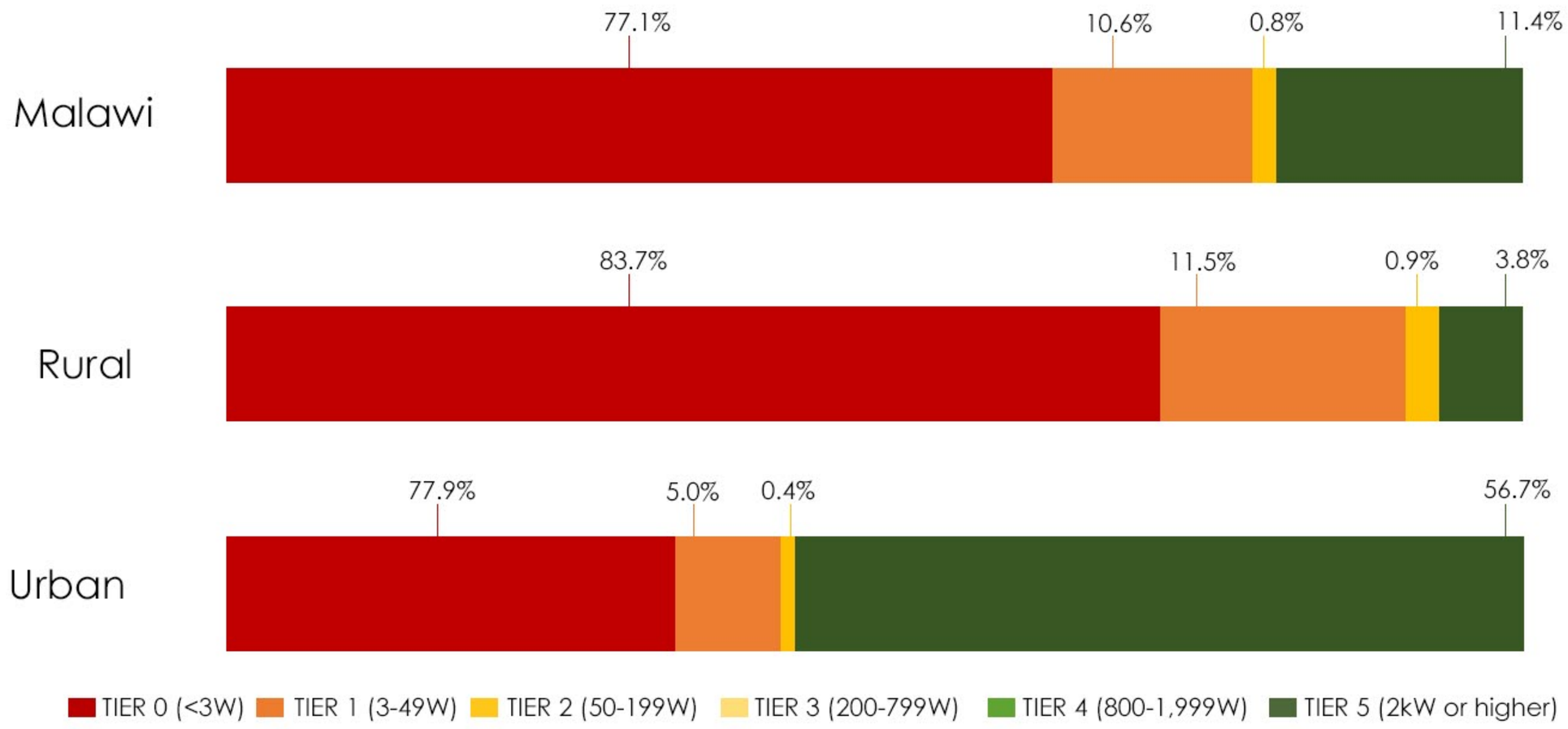
Source: Malawi MTF household survey 2023.

MTF attributes

Capacity

The MTF survey defines capacity as the load capacity of the service that households receive from electricity connection. The survey attempts to estimate capacity of the service from household appliance usage instead of direct measurement. Grid-connected households are automatically assigned Tier 5 for Capacity. For other electricity sources, tier is based on highest capacity appliance. In Malawi, the proportion of households receiving high-capacity electricity (over 2,000W) is at 11.4% which is almost the same proportion of households that are connected to the grid (11.3%). In urban areas, 56.7% of households receive high-capacity electricity compared to 3.8% of rural households. The disparity can be explained by the higher adoption of off-grid solutions in rural areas which provide limited capacity (Figure 17).

Figure 17 : Share of households with access to high-capacity electricity by place of residence



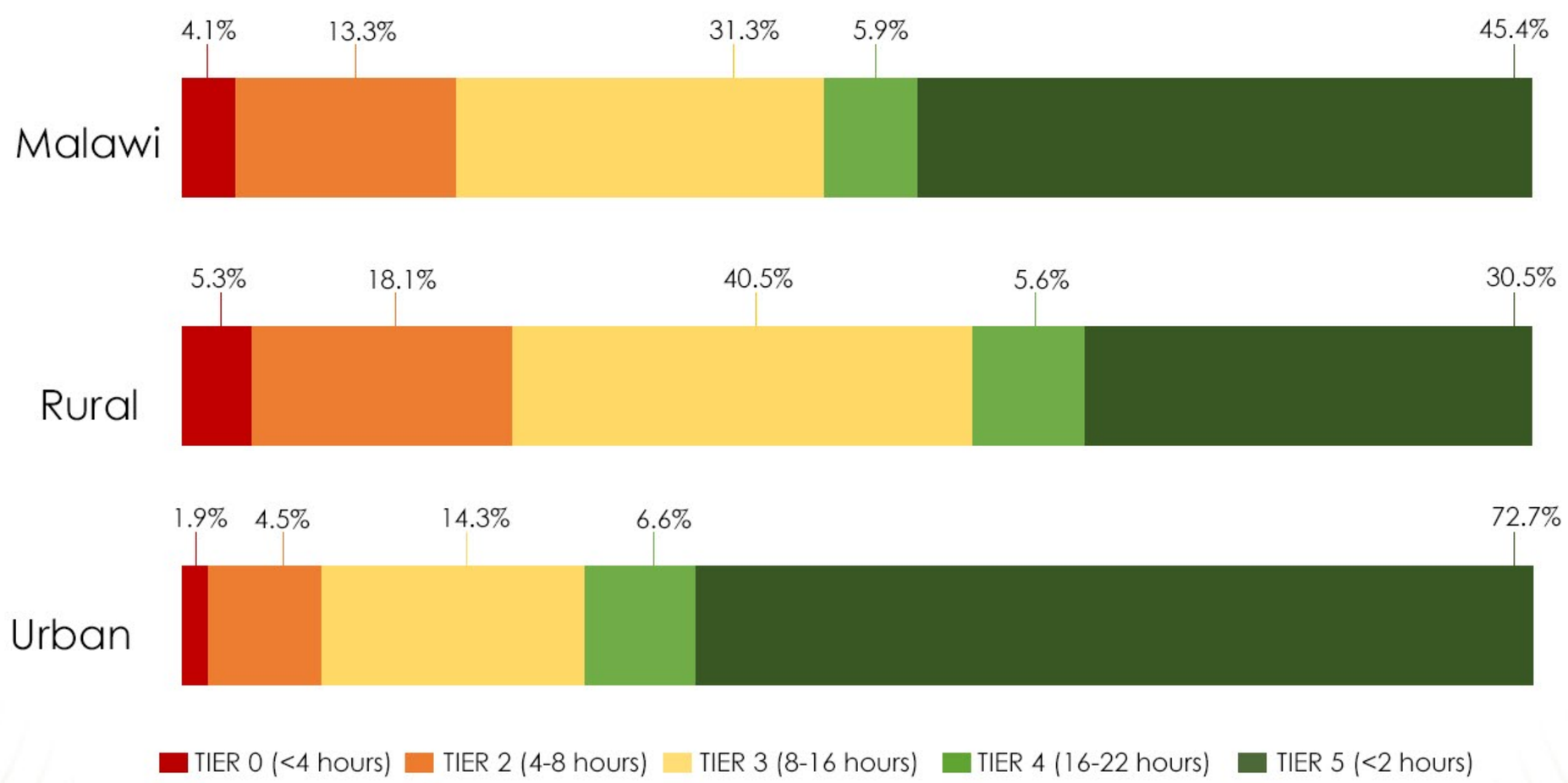
Source: Malawi MTF household survey 2023.

Availability

The Availability attribute relates to availability of electricity service during the day (24 hours) and in the evening (from 6pm to 10pm). At national level, the daily availability of electricity supply is limited for 54.6% of households. Although 45.4% of households with any source of electricity receive electricity at least 23 hours a day, 7 days a week, 48.7% receive 16 hours or less a day. In rural areas, Availability is even lower: 64.9% of households receive 16 hours or less a day compared to 20.8% in urban areas (Figure 18).

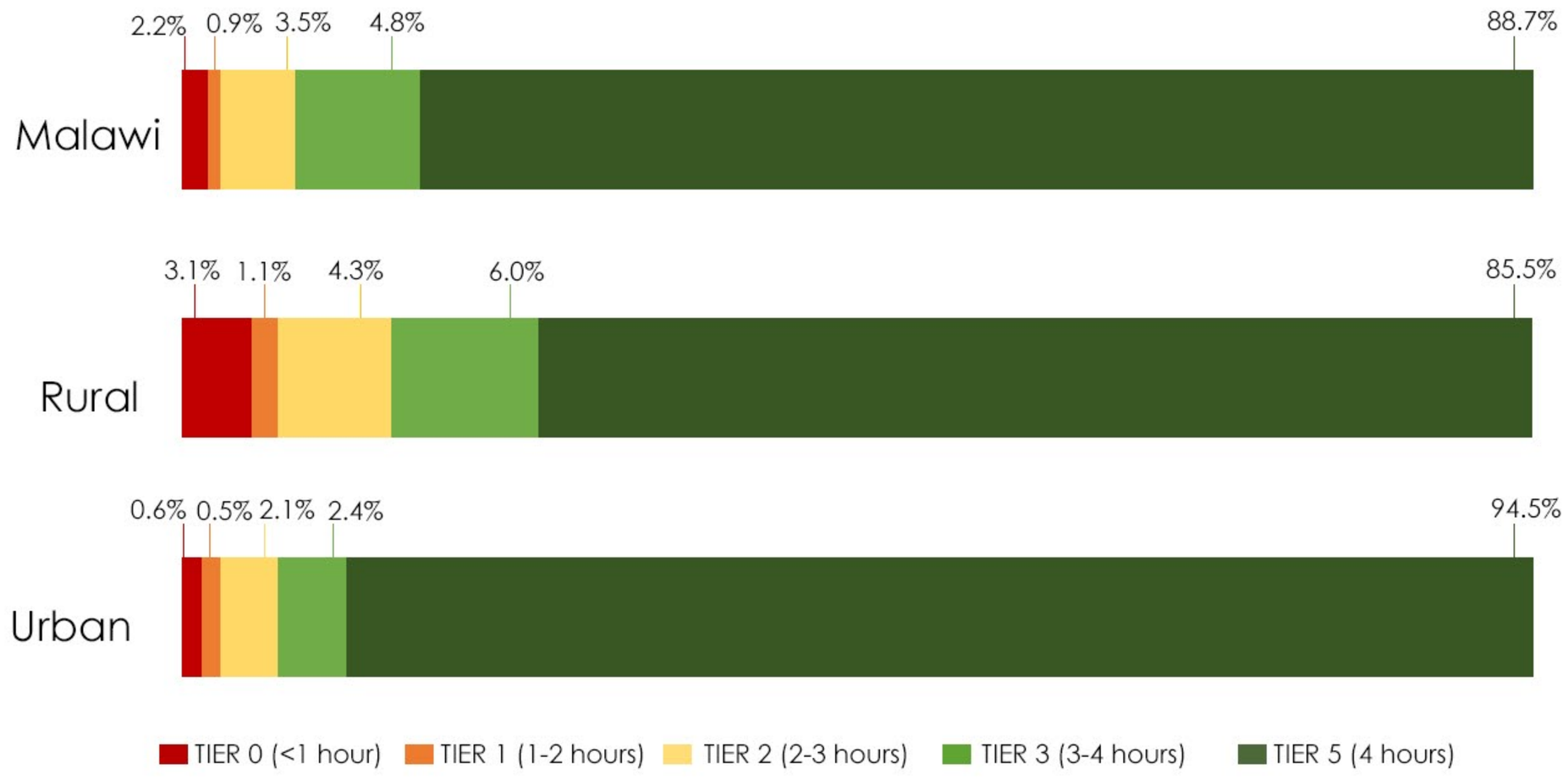
Evening Availability is adequate for 88.7% of households, with a higher proportion of households (94.5%) in the urban areas having 4 hours of electricity in the evening compared to 85.5% in the rural areas (Figure 19).

Figure 18 : Share of households with daily access to electricity by place of residence



Source: Malawi MTF household survey 2023.

Figure 19 : Share of households with access to electricity in the evening by place of residence

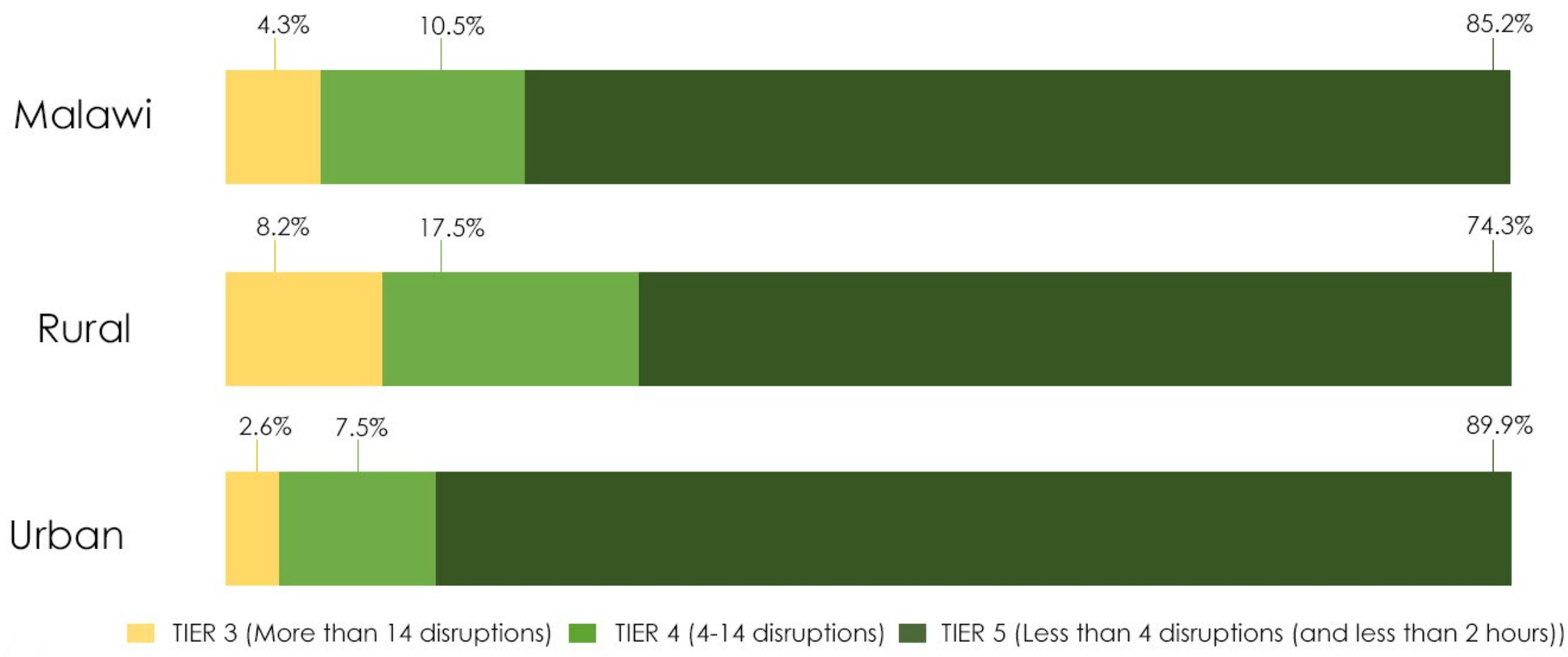


Source: Malawi MTF household survey 2023.

Reliability

The Reliability attribute relates to the frequency and duration of unscheduled outages experienced by grid-connected (national grid or mini-grid) households. The majority of grid-connected households experience less than 4 electricity disruptions a week (and less than 2 hours). At national level, 85.2% of grid-connected households experience less than 4 electricity disruptions a week. Reliability is slightly more of an issue in rural areas than in urban areas with 74.3% and 89.9% of households experiencing less than 4 electricity disruptions, respectively (Figure 20).

Figure 20 : Share of households with access to reliable electricity by place of residence

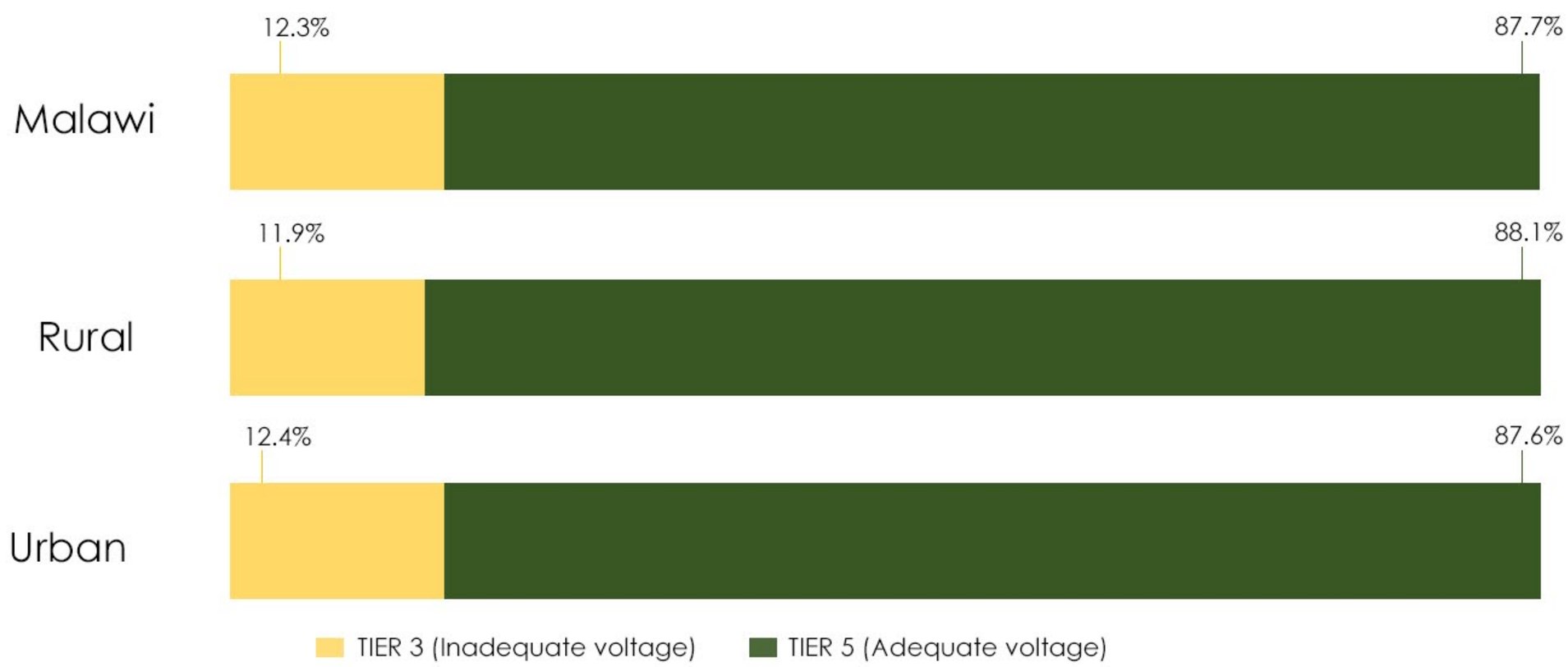


Source: Malawi MTF household survey 2023.

Quality

The Quality attribute captures voltage issues such as low or fluctuating voltage experienced by households on either the national grid or mini-grids. Low or fluctuating voltage affects performance of electric appliances and may result in damage in extreme cases. At national level, 12.3% of grid-connected households face voltage issues such as low or fluctuating voltage with little difference between urban and rural households (Figure 21).

Figure 21 : Share of households by quality of electricity access and place of residence



Source: Malawi MTF household survey 2023.

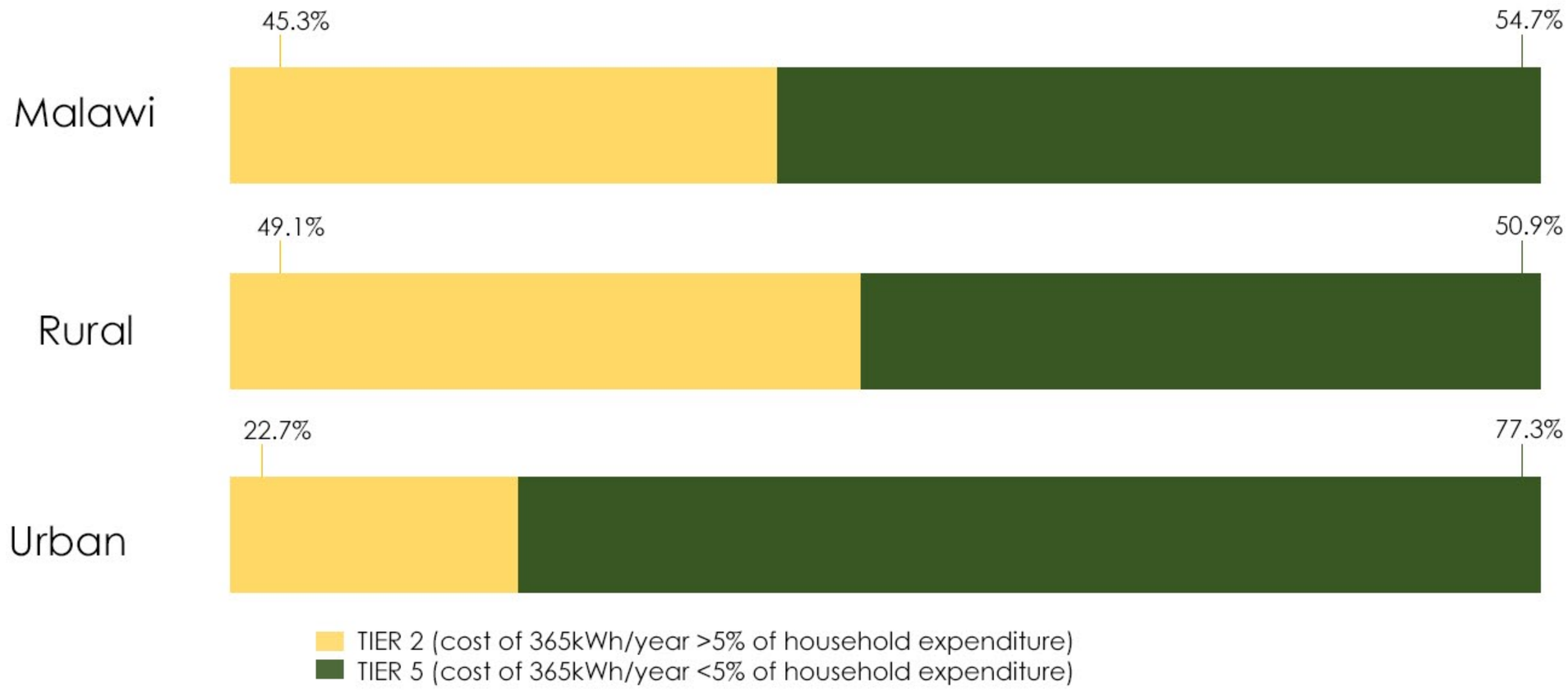
Formality

For a grid connection to be classified as formal, the household's grid connection must be provided and or sanctioned by the authority. Electricity supply is unlikely to be regulated if the grid connection is informal and may pose a safety risk and the connected household may risk being disconnected. Results show that no households reported an informal connection in the survey. Notably, reporting on Formality is challenging because households may be sensitive about disclosing such information in a survey. The Multi-Tier Framework (MTF) survey uses indirect questions that respondents may be more willing to answer to collect information on Formality. For instance, respondents are asked what method their household uses to pay the electricity bill. Therefore, the actual percentage of households with an informal connection may differ from the data reported here. Based on this definition, 100% of the grid households have formal connection.

Affordability

In defining affordability, electricity is considered affordable if a household spends less than 5% of their total expenditure on electricity corresponding to 365 kWh per year or 1kWh a day. In Malawi, 45.3% of households are in Tier 2 because they cannot afford to pay for basic electricity services, corresponding to 365 kWh per year. Affordability of basic electricity consumption is more of an issue in the rural areas than in the urban areas. Almost half of grid-connected households (49.1%) in rural areas cannot afford 365 kWh per year compared to 22.7% in urban areas (Figure 22).

Figure 22 : Share of households by affordability of electricity access and place of residence



Source: Malawi MTF household survey 2023.

Health and Safety

Health and Safety attribute covers any injuries or death of household members from using grid electricity service during 12 months preceding the survey. Electricity access is considered safe when users have not suffered any accidents from their electricity supply that resulted in permanent injuries. The Health and Safety attribute is applicable for Tiers 3 and 5. Households in Tier 3 if Health and Safety attribute have electricity access that is not safe. In Malawi, Health and Safety issues do not seem to occur widely as only 1.4% of grid-connected households reported accidents causing permanent injury or death with little difference between urban and rural areas (Figure 23).

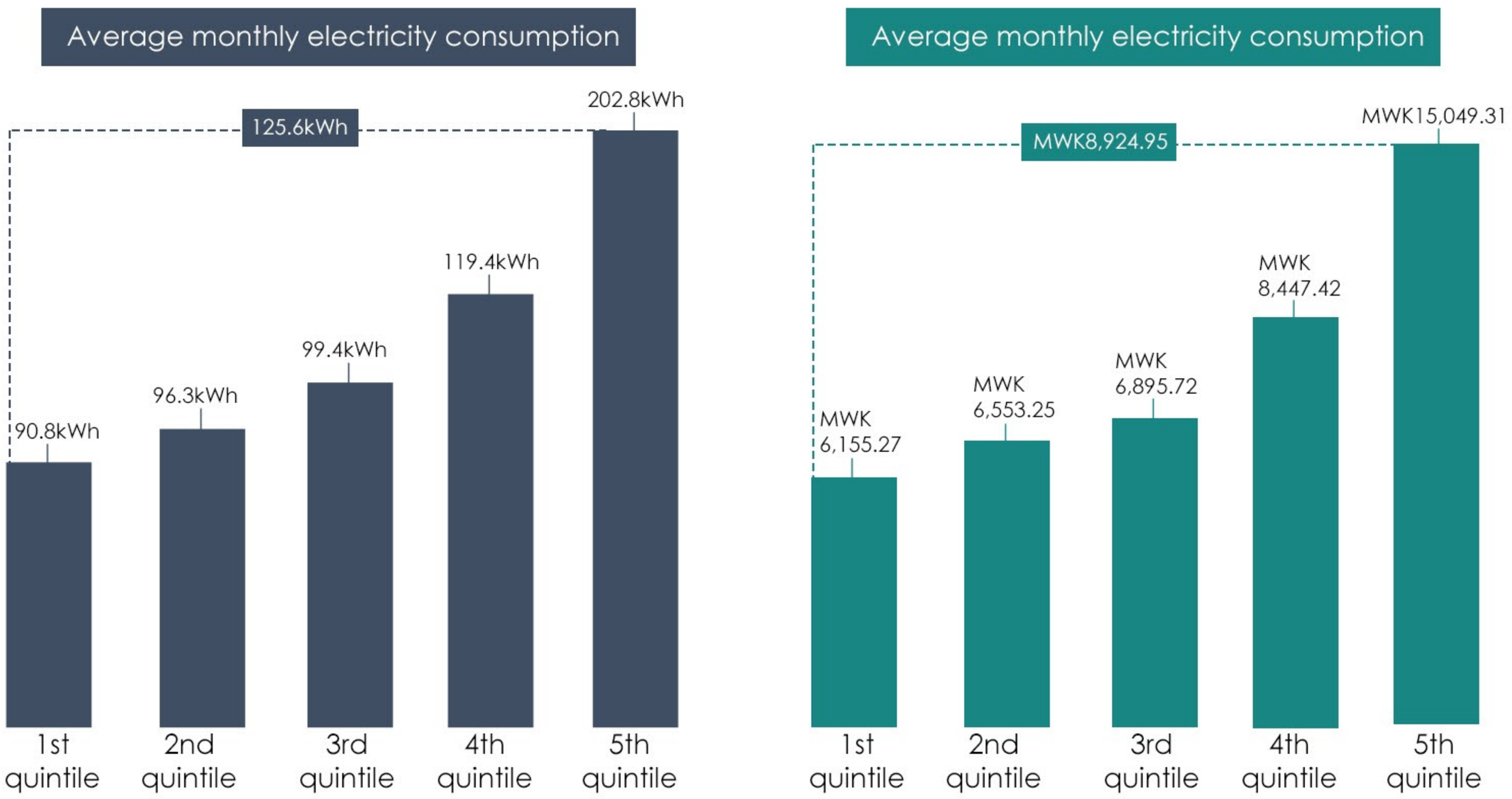
Figure 23: Share of households by Health and Safety of electricity access and place of residence

Source: Malawi MTF household survey 2023.

Use

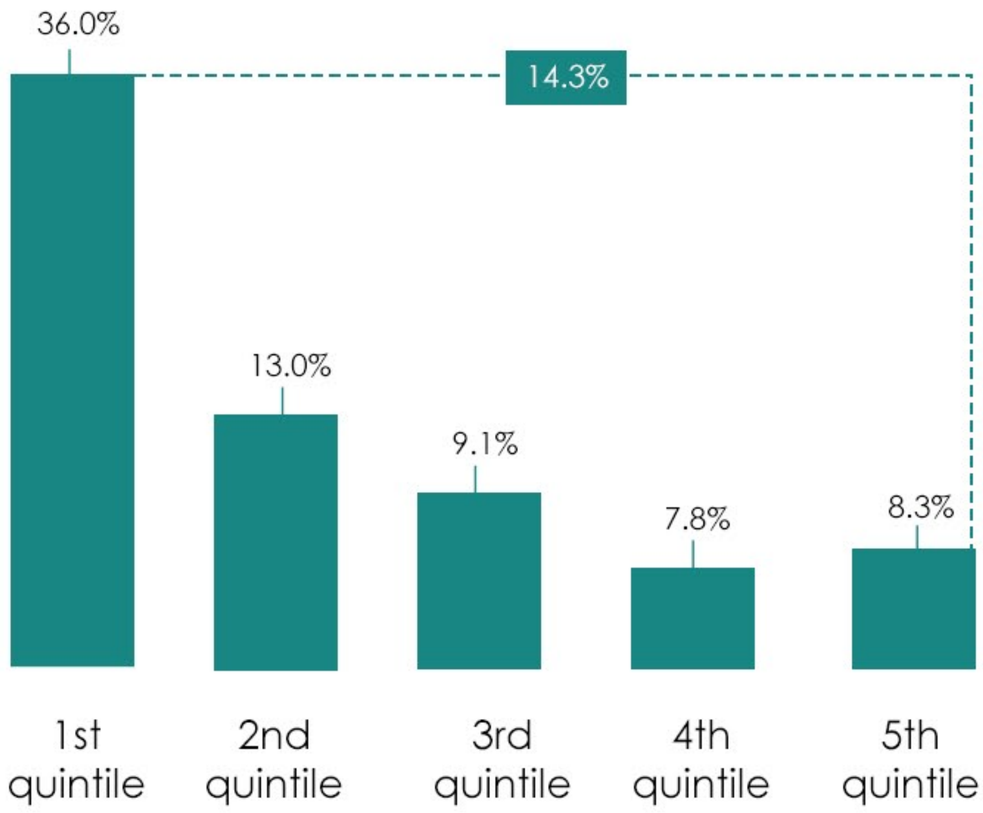
In Malawi, average monthly household consumption is 125.6 kWh with a monthly average expenditure of MWK8,924.95. Electricity consumption and expenditure is higher among households in higher spending quintiles (Figure 24). Spending on electricity accounts for 14.3% of average monthly household spending. While households in high spending quintiles spend more on electricity, the share of the electricity expenditure in their total expenditure is much less than that of households in low spending quintiles (Figure 25).

Figure 24: Share of households by average monthly electricity consumption, monthly expenditure and wealth quintiles at national level



Source: Malawi MTF household survey 2023.

Figure 25: Share of households by budget share of grid electricity expenditure and spending quintiles at national level



Source: Malawi MTF household survey 2023.

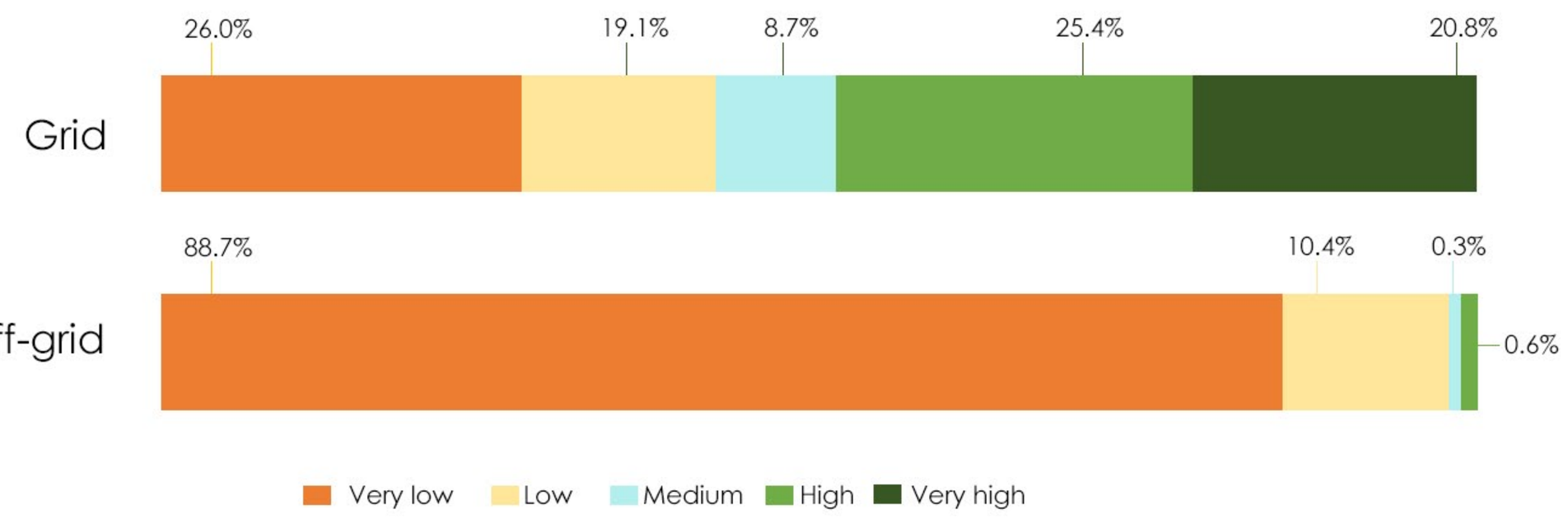
In terms of duration of grid use, households have been electrified for 3 years on average. This implies that receiving electricity is a new phenomenon for many households (Figure 26).

Figure 26: Share of households by duration of grid use and place of residence

Source: Malawi MTF household survey 2023.

Most grid-connected households own low-load appliances that can be satisfied with Tier 1 or 2 Capacity despite reaching high tiers for access to electricity. In Malawi, only about half of grid-connected households use high capacity (25.4%) and very high capacity appliances (20.8%). The low-load appliances are more common in households using off-grid solutions where 88.7% own very low capacity appliances (Figure 27).

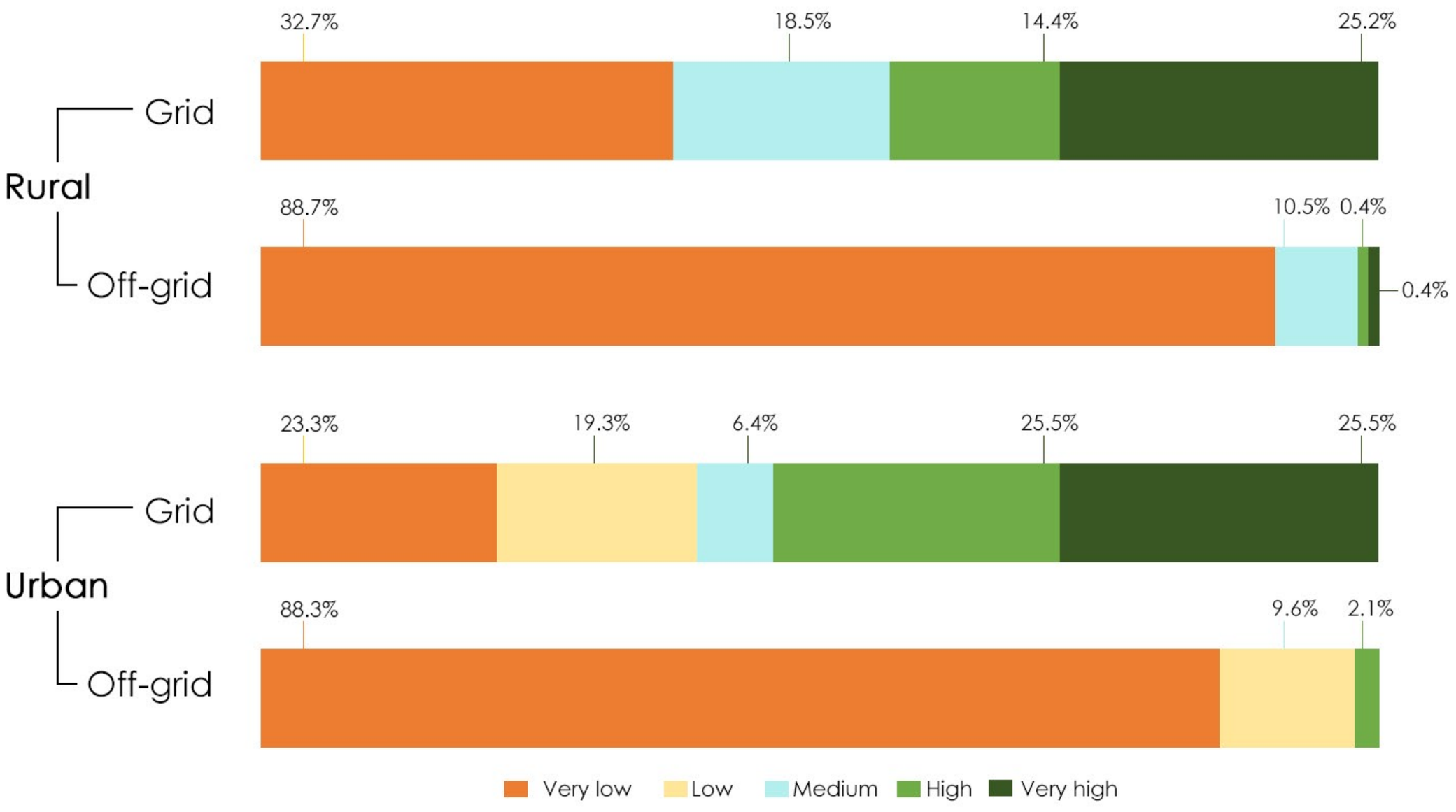
Figure 27: Share of households by electricity source and Level of Appliance Power used at national level



Source: Malawi MTF household survey 2023.

In both rural and urban areas, households using off-grid solutions as their primary source of electricity predominantly use very low load appliances. However, use of very low load appliances among grid connected households is more common in rural areas (32.7% of households) compared to urban areas (23.3% of households). There are no major differences in use of very high load appliances among grid-connected households in rural and urban areas (Figure 28).

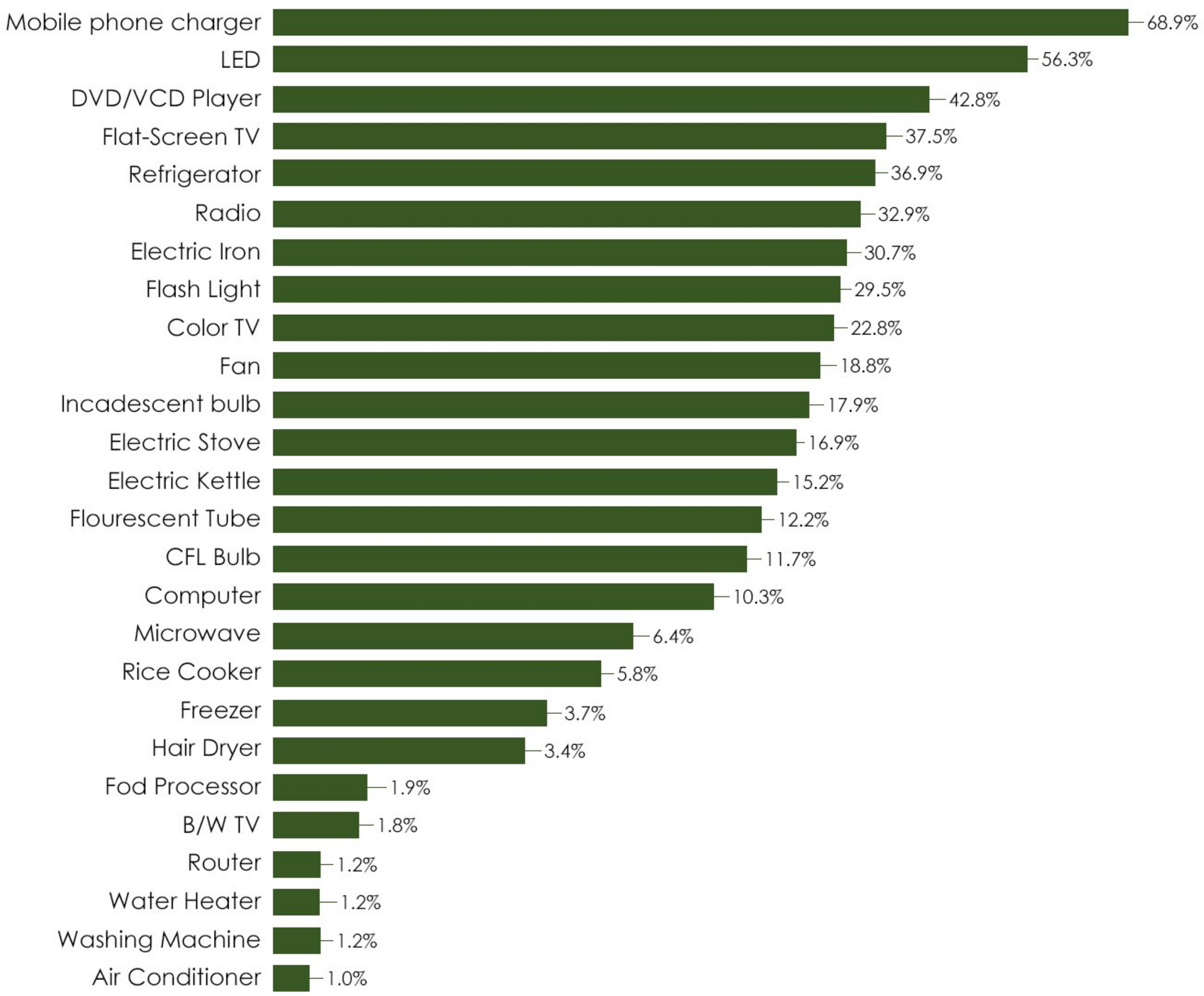
Figure 28: Share of households by electricity source and Level of Appliance Power used at national level



Source: Malawi MTF household survey 2023.

Most common appliances among grid-connected household are Low or very low load appliances, such as mobile phone charger (68.9%), light bulbs (56.3%) and DVD or VCD players (42.8%). Fewer households own medium and high load appliances such as Flat screen TV (37.5%), refrigerator (36.9%) and electric iron (30.7%). Very high load appliances are not very common in Malawi as only 1.2% of grid-connected households own a water heater, washing machine, and only 1% own an air conditioner (Figure 29).

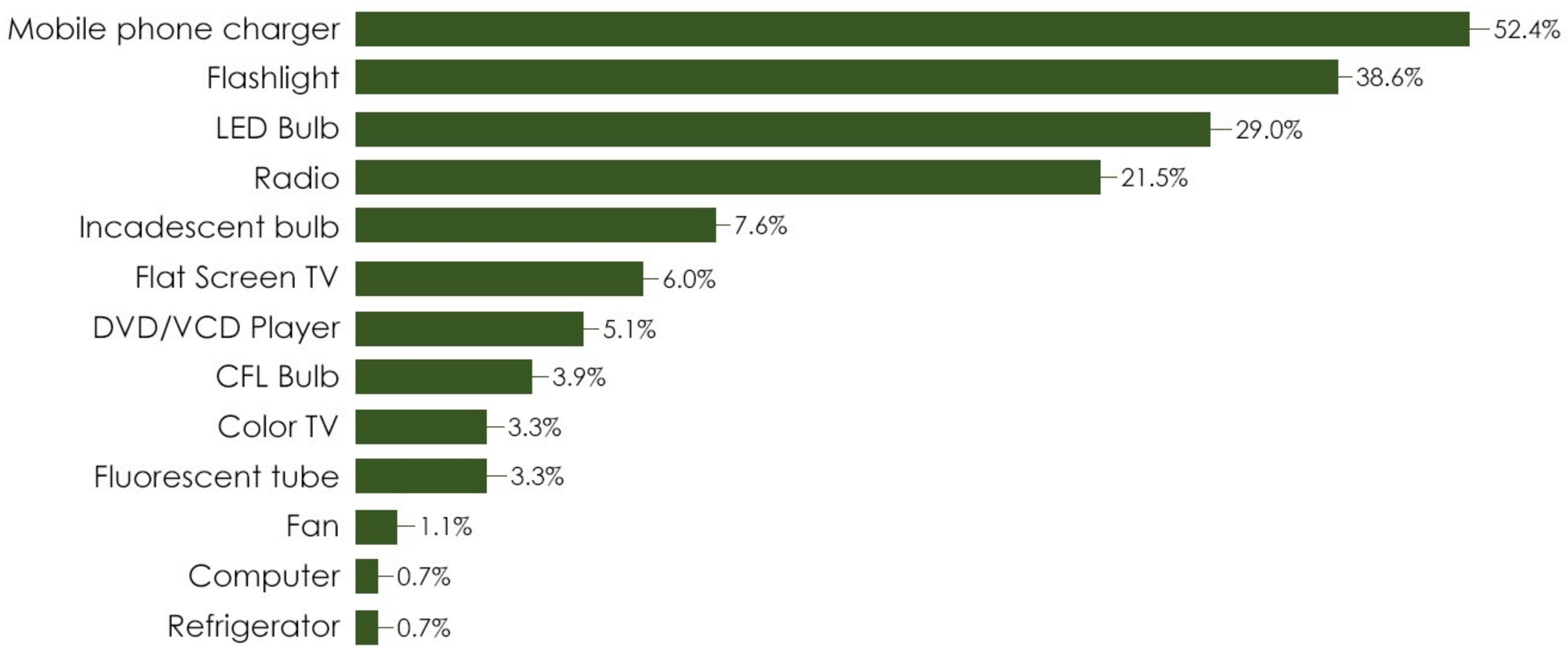
Figure 29: Ownership of appliances by grid-connected households at national level



Source: Malawi MTF household survey 2023.

The three most common appliances among households using off-grid solutions are mobile phone chargers (52.4%), Flash light (38.6%), and LED bulb (29%). Notably, very high–load appliances, such as refrigerators, are extremely rare among households using off-grid solutions (Figure 30).

Figure 30: Ownership of appliances by off-grid households at national level



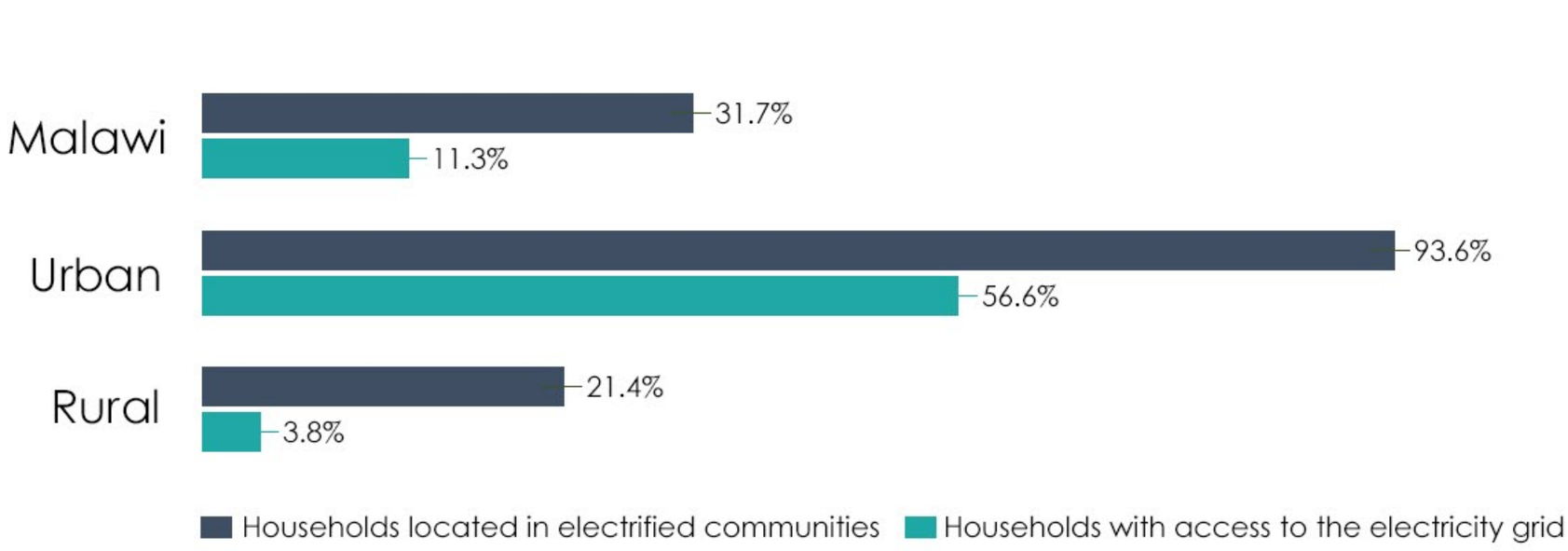
Source: Malawi MTF household survey 2023.

Improving access to electricity

Providing electricity access to households without an electricity source

The Malawi MTF survey defined households living in electrified communities as households living in an Enumeration Area (EA) where at least one household has a grid connection. At the national level, only one-third of households in grid-connected communities are connected to the grid. Specifically, while 11.3% of households in Malawi are connected to the grid, 31.7% of households are located in EAs where the grid is available. In urban areas, 93.6% of households are located in EAs where the grid is available compared to 56.6% that are connected. Similarly, only 3.8% of households in the rural areas are connected to the grid compared to 21.4% that are in EAs where grid electricity is available. Thus, 20.4% of households nationwide have potential to get access to the existing grid (Figure 31).

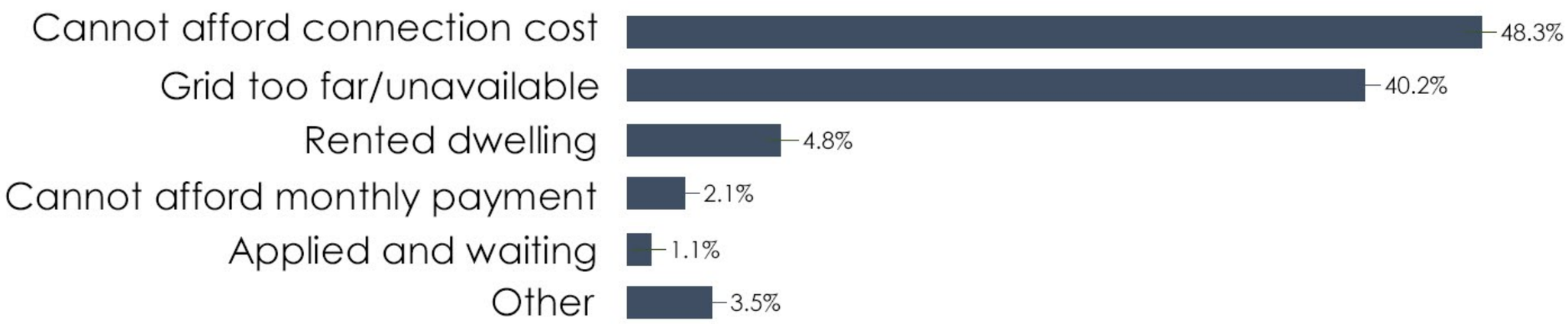
Figure 31: Electrification rates between communities (EAs) and households by place of residence



Source: Malawi MTF household survey 2023.

Nationwide, the most common barrier preventing households from gaining access to the grid is the high connection fee (48.3%) followed by long distance to the grid or grid unavailability cited by 40.2% of households without grid electricity (Figure 32).

Figure 32: Barriers to gaining access to grid electricity among households not connected to the grid

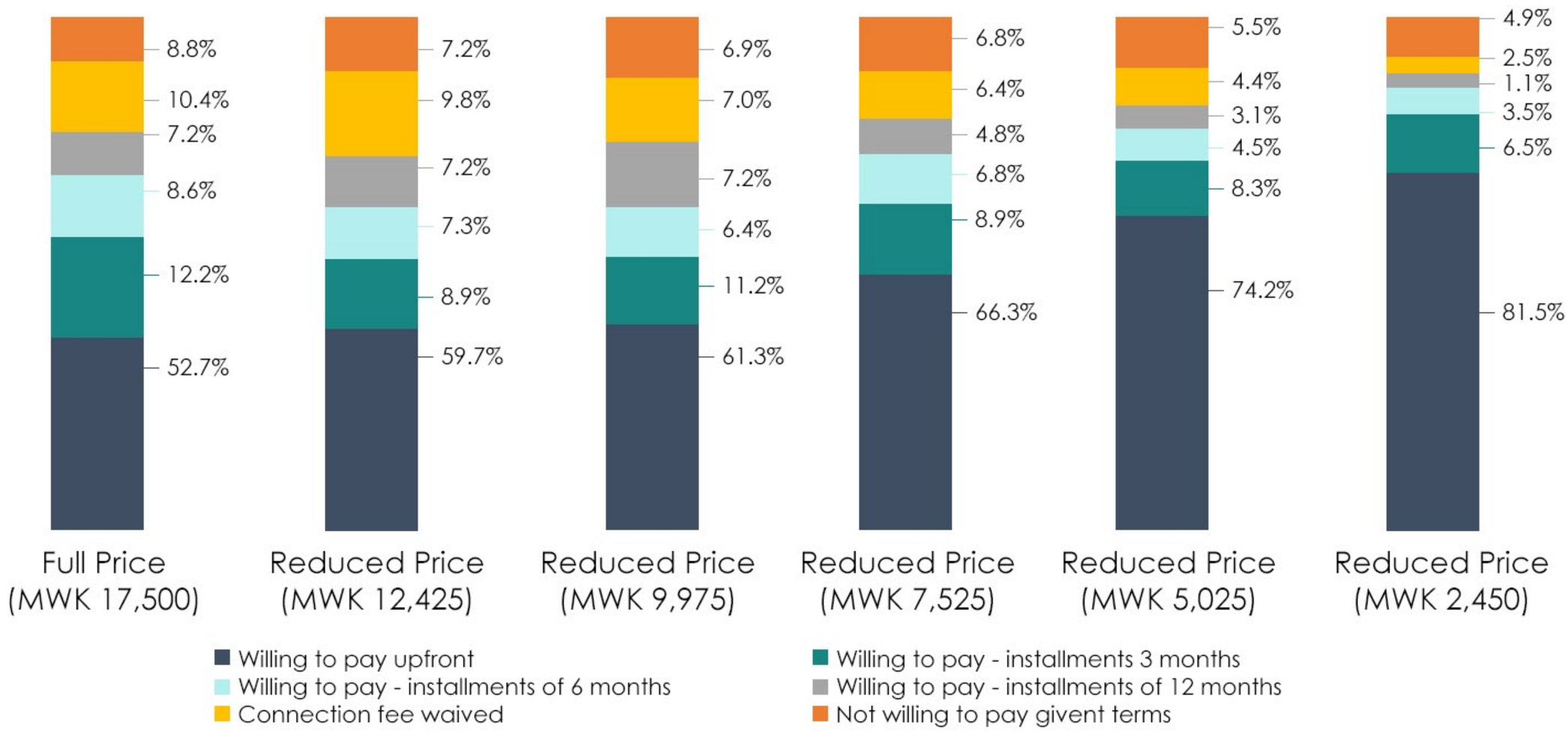


Source: Malawi MTF household survey 2023.

The modules on MTF willingness to pay try to assess whether price reduction and flexible payment periods can increase the adoption rate of the national grid. Households not connected to the grid were offered different prices and payment options such as installments paid over 3, 6 and 12 months and waiving the connection fee. The prices offered were different for the urban and rural areas based on the official connection fees charged by the Malawi power utility company, Electricity Supply Corporation of Malawi (ESCOM). Options included household's willingness to get grid connection if the fee was waived. Connection fee waived is an offer of getting connected to the grid without paying the connection fee. Not willing to pay at given terms is a scenario where a household is not willing to pay the connection fee at the offered price and under any of the payment options provided.

More rural households are willing to pay for a grid connection under any payment plan or price suggested. About half of rural households (52.7%) are willing to pay the full connection fee of MWK17,500 upfront. More rural households are willing to pay the grid connection fee if the payment plan is flexible. Specifically, if households are allowed to pay the full connection fee over a period of 3, 6, and 12 months, about 28.1 percentage points more of rural households are willing to pay. Thus, payment flexibility could be instrumental in increasing the uptake of grid electricity in rural areas. Similarly, more households are willing to pay the connection fee upfront as the price decreases, from 52.6% when offered full price (MWK17.500) to 81.6% when offered MWK2,450 (Figure 33).

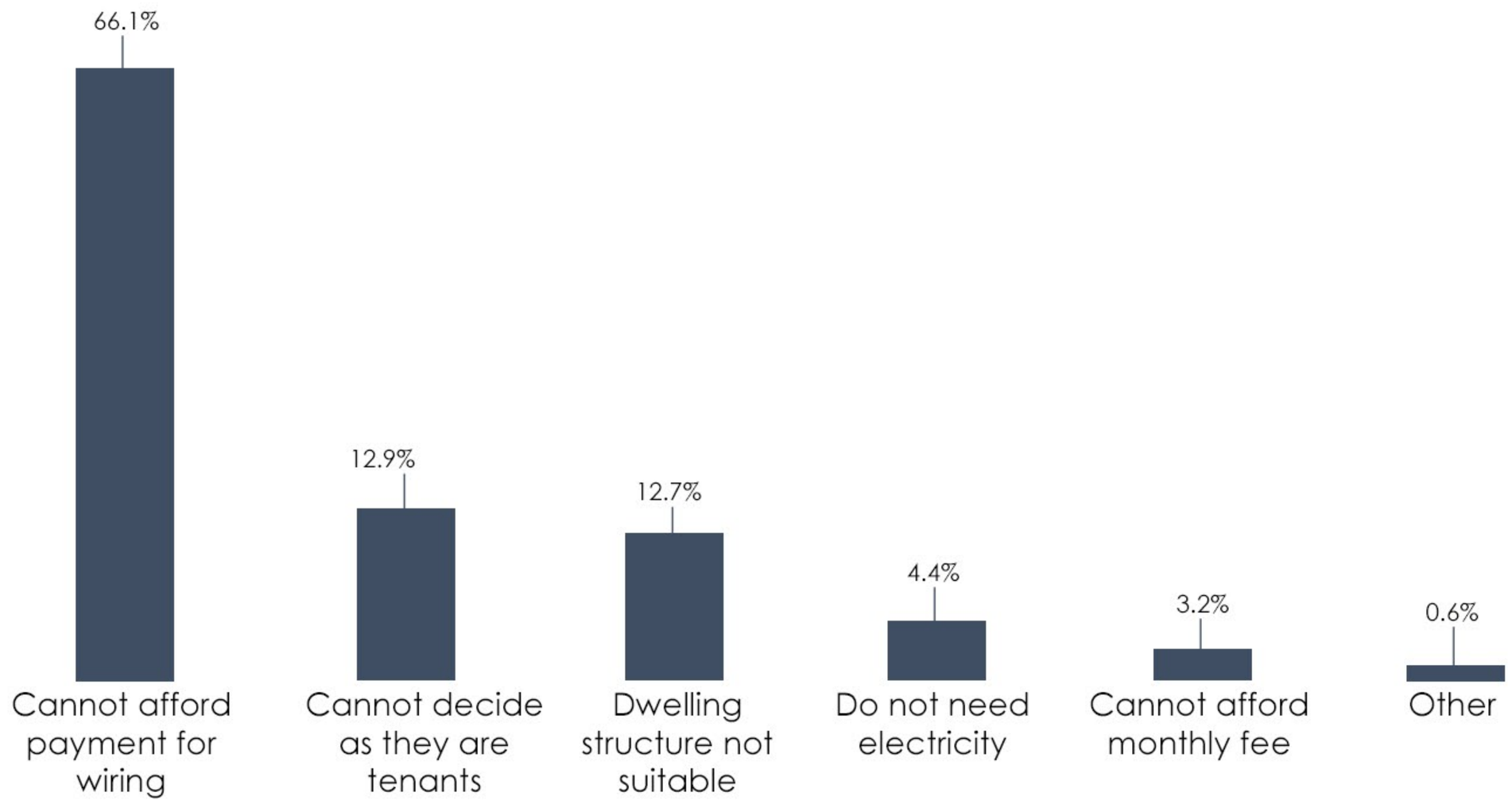
Figure 33: Willingness to pay for the grid connection fee for non-grid-connected households, rural



Source: Malawi MTF household survey 2023.

About 5% of households stated that they would not accept any offer to connect to the grid even if the vconnection cost was waived. The main reasons cited are because they cannot afford the internal wiring cost (66.1%), they cannot decide because they are renting (12.9%) and 12.8% reported that their dwelling structure was not suitable (Figure 34).

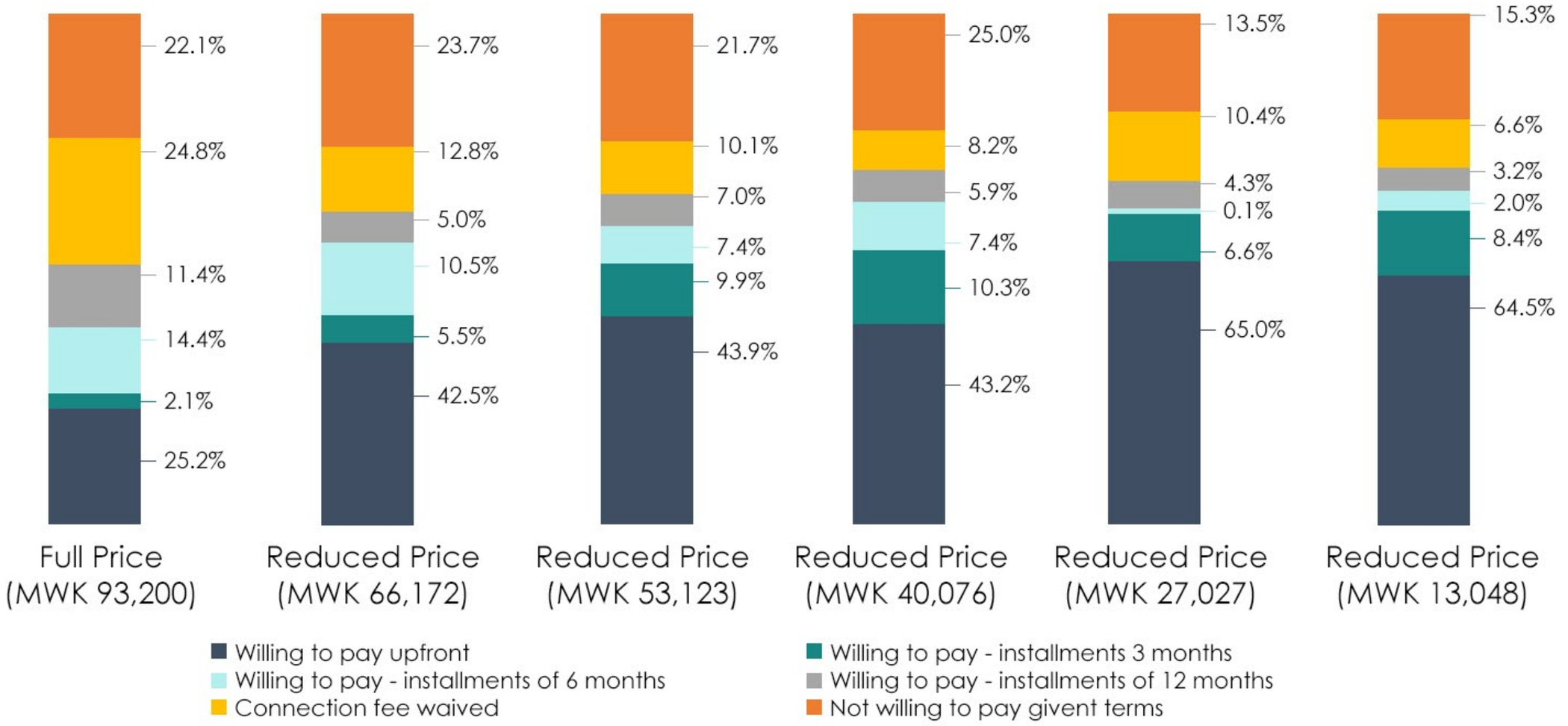
Figure 34: Reason for not willing to pay for grid connection in rural areas



Source: Malawi MTF household survey 2023.

In urban areas, 25.2% of the households are willing to pay for full price upfront while an additional 27.9% are willing to pay the full price in installments of 3 to 12 months. Further, 24.8% are willing to get grid connection if the full connection fee was waived and 22.1% are not willing to get connected under any of the payment options offered. Just as in rural areas, payment flexibility could be an effective way to increase the uptake of grid electricity in urban areas. The proportion of households willing to pay upfront increases as the connection fee is reduced, from 25.2% when the full price is offered to 64.5% when offered 14% of the full price which is MWK13,048 (Figure 35).

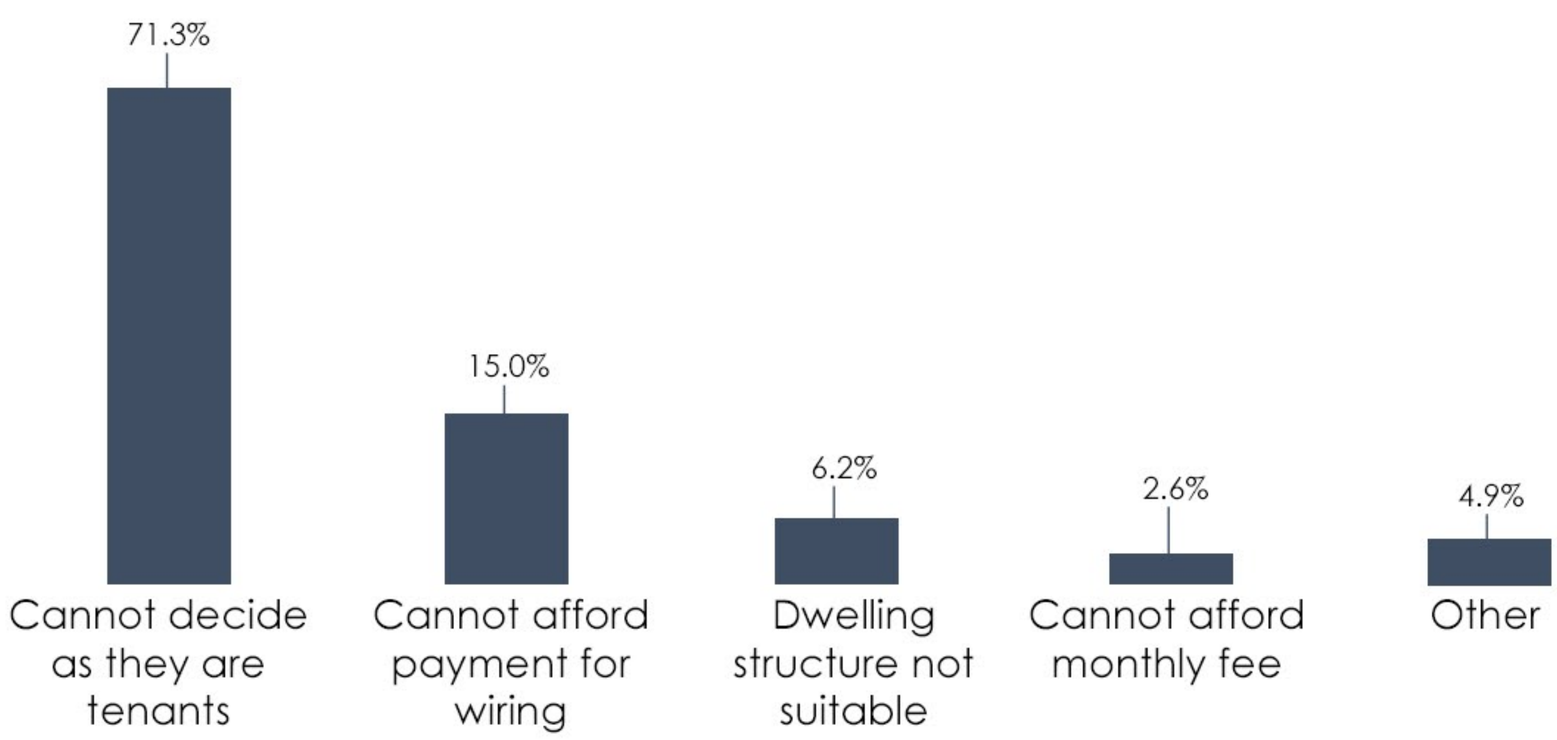
Figure 35: Willingness to pay for the grid connection fee for non-grid-connected households, urban



Source: Malawi MTF household survey 2023.

The most cited reason for urban households not willing to pay for grid connection was that they were renting and could, therefore, not decide on behalf of their landlords at 71.3% (Figure 36).

Figure 36: Reason for not willing to pay for grid connection in urban areas



Source: Malawi MTF household survey 2023.

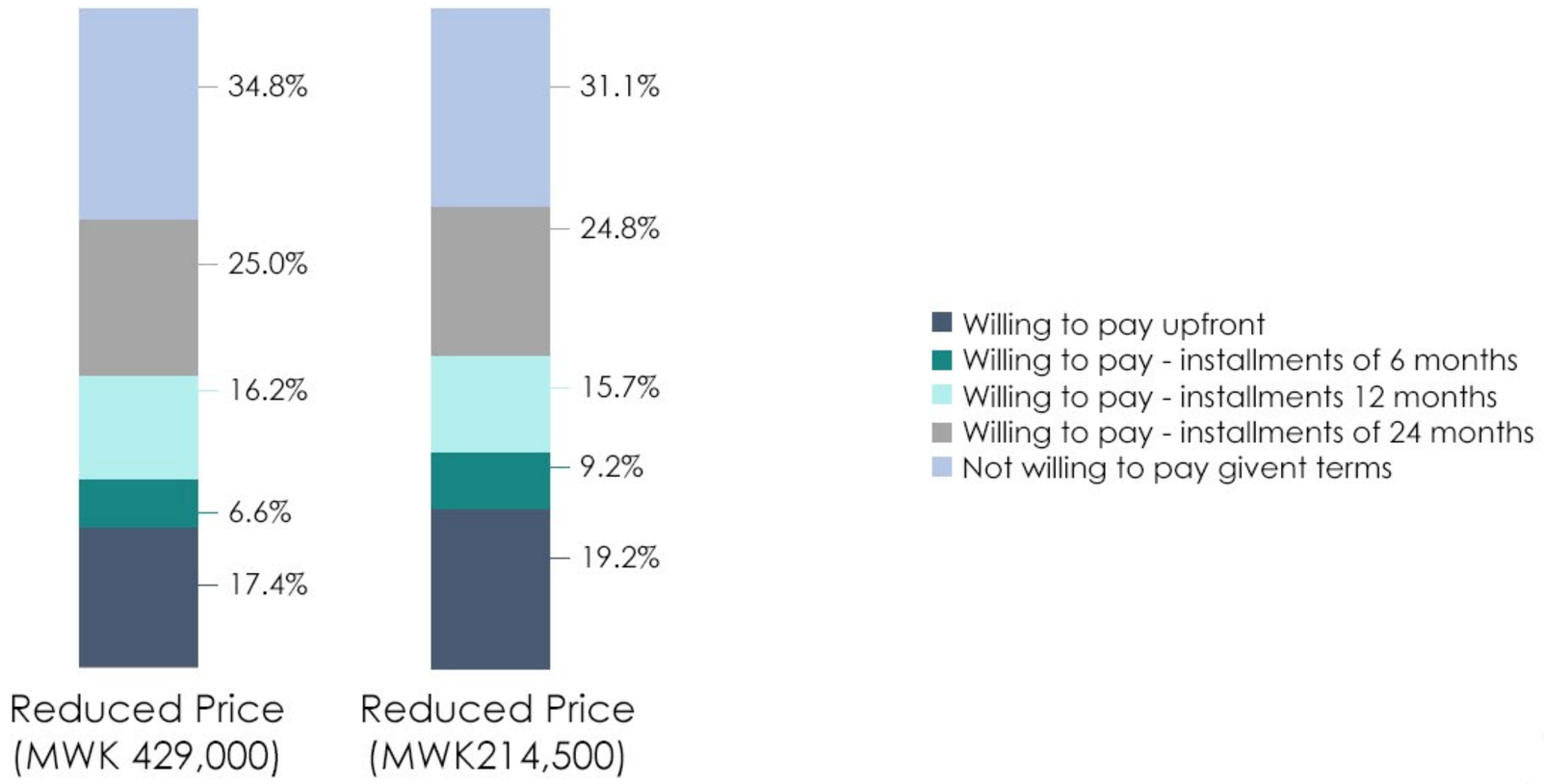
Willingness to pay for solar was assessed among households that had no access to grid and off-grid solutions. Households with a Solar Lantern were offered a solar home system while those without were offered a Solar Lighting System under different prices and payment options such as installments paid over 6, 12 and 24 months. The full price for a solar lighting system offered was MWK130,000 (US$76.47) and MWK650,000 (US$382.35) for the solar home system. Respondents were offered 33% and 66% of the full price. Only 22.4% of households are willing to pay for solar lighting system upfront. Most households (52.1%) are willing to pay for the solar lighting system over a period of 6, 12, and 24 months. Households' Willingness to pay increases as the price is reduced. Using flexible payment plans can increase the adoption of Solar Lighting system (Figure 37).

Figure 37: Willingness to pay for a Solar Lighting System

Source: Malawi MTF household survey 2023.

Willingness to pay for a solar home system (SHS) is much lower than willingness to pay for a solar lighting system (SLS), although it increases as the price drops. More households are willing to pay for the SHS in installments of 6, 12 and 24 months compared to those willing to pay upfront. Nearly half of the households (47.8%) are willing to pay for the SHS at 66% of the price (MWK429,000) over a period of 6, 12, and 24 months while 34.8% were not willing. About a third of the households (33.1%) offered 33% of the full price were not willing to pay under any of the payment options offered to them (Figure 38).

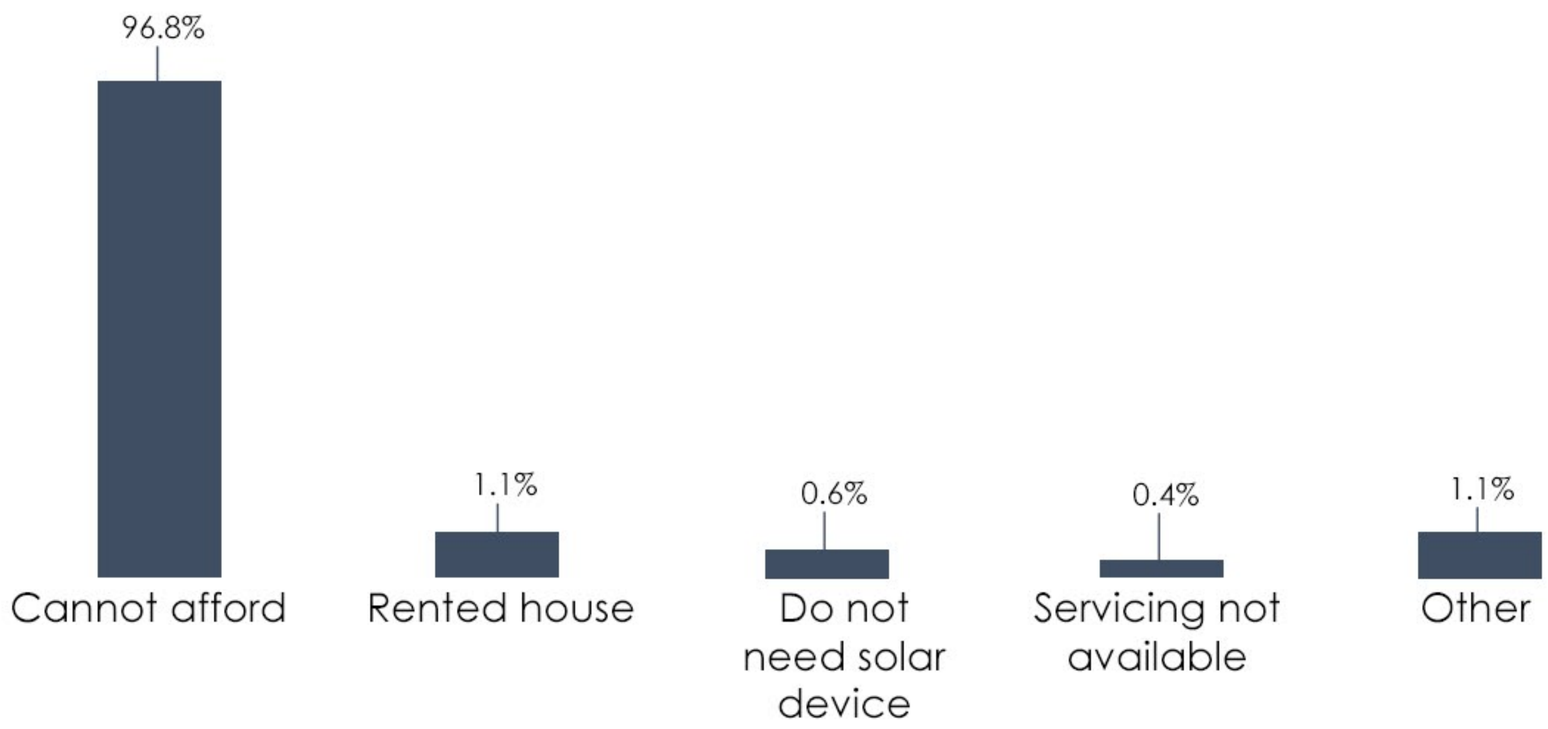
Figure 38: Willingness to pay for a Solar Home System



Source: Malawi MTF household survey 2023.

Households that were not willing to pay for the solar products offered to them were asked to provide reasons for their decision. The most common reason is that they cannot afford to pay for the solar products at 96.8% (Figure 39).

Figure 39: Reason for not willing to pay for Solar Lighting System and Solar Home System



Source: Malawi MTF household survey 2023.

Improving electricity access tier for grid-connected households

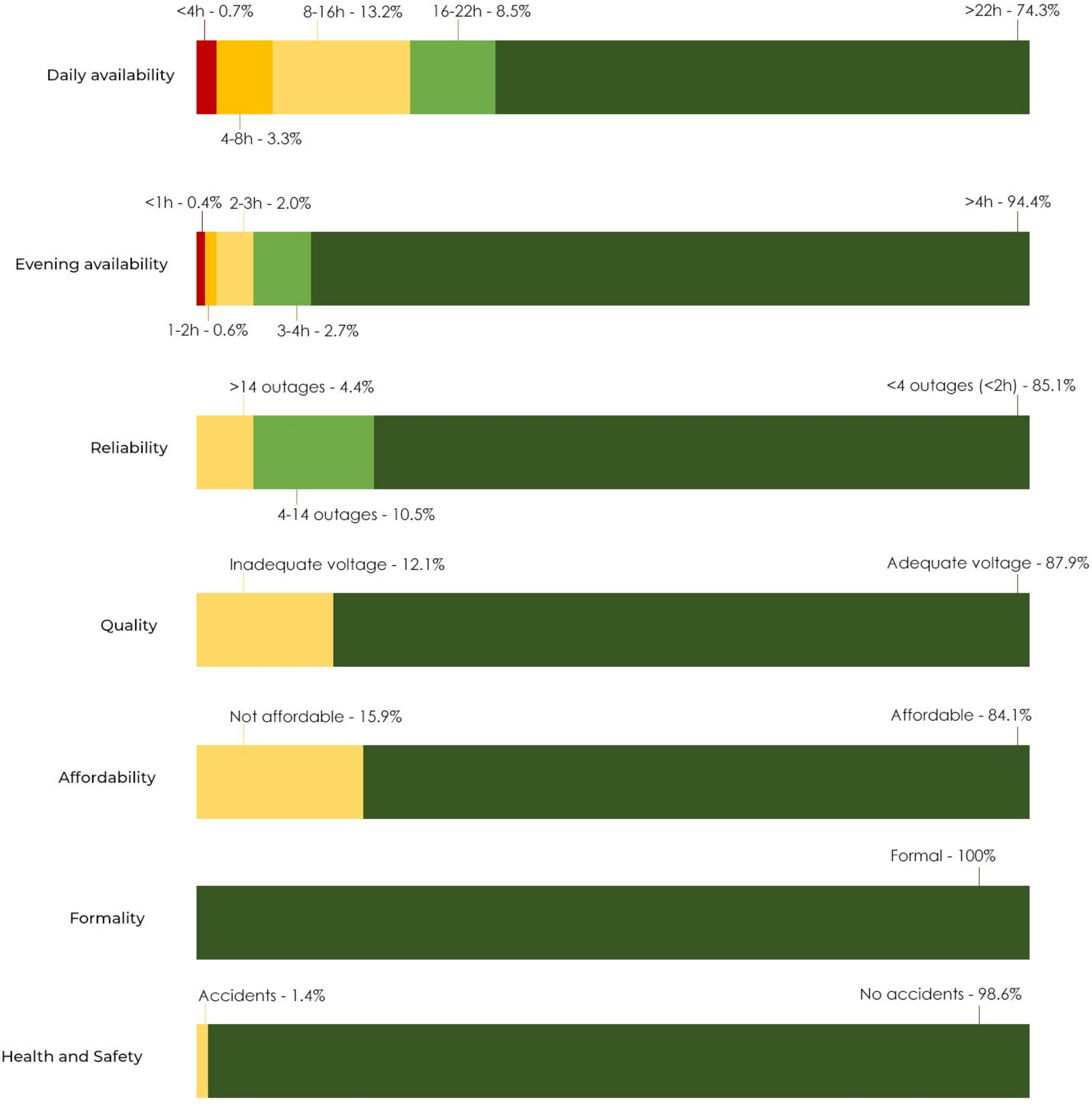
In Malawi, 11.3 percent of households are connected to the national grid. The majority of the grid-connected households (78.9%) are in Tier 3 or higher for access to electricity of which 51.9% are in Tier 5. The rest of the households are in tier 2 (19.7%) and 1.4% are in Tier 1 or Tier 0 (Figure 40). Households in lower tiers are not utilizing the full potential of grid connection necessitating the need for more improvement in the electricity supply to move them to Tier 5.

Figure 40: MTF tier distribution of grid-connected households at national level

Source: Malawi MTF household survey 2023.

Availability, Reliability, Quality and Affordability are the main attributes that prevent grid-connected households from reaching Tier 5 of electricity access in Malawi. About 26% of grid-connected households have limited daily availability of electricity supply of less than 22 hours. Further, 14.9% of grid-connected households experience between 4 and 14 outages or more per week, lasting more than 2 hours in total. Voltage issues affect 12.1% of the households while 15.9% perceive electricity cost as not affordable (Figure 41).

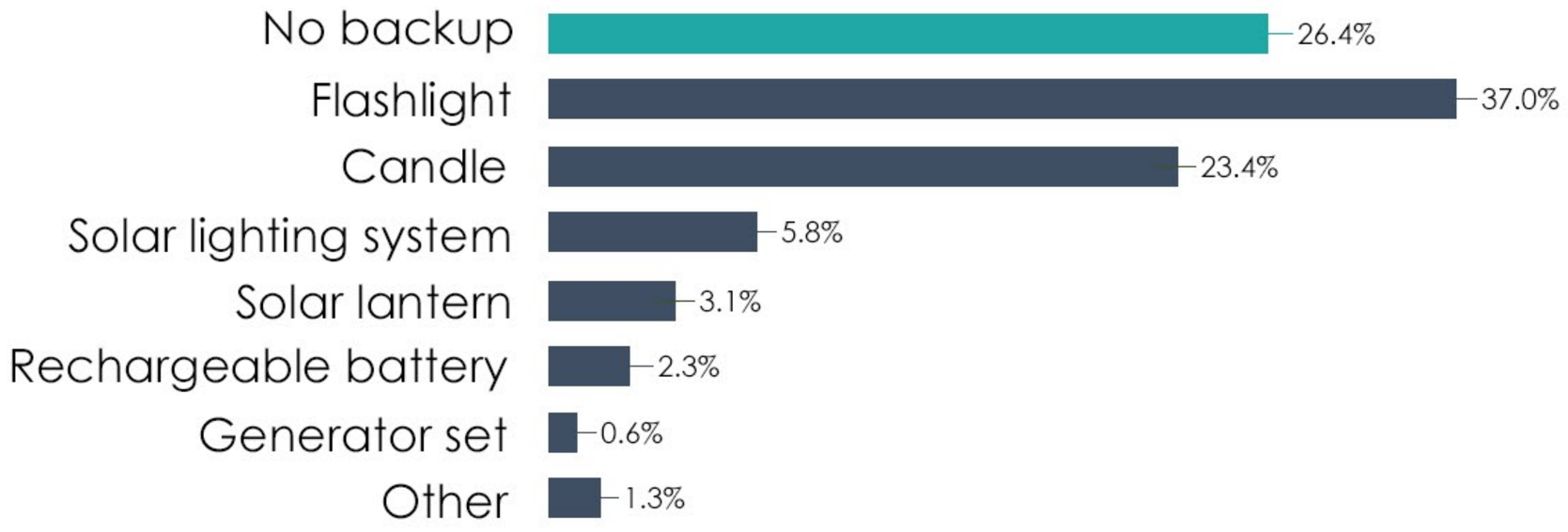
Figure 41: Distribution of grid-connected households by Multi-Tier Framework attributes



Source: Malawi MTF household survey 2023.

Grid-connected households in Malawi use various sources of lighting as backup solution to cope with power outages. Nearly 1 in 3 households (37%) use dry-cell powered flashlights while 23.4% of households use candles as back up sources of lighting. Notably, 26.4% of grid-connected households have no backup source for lighting (Figure 42).

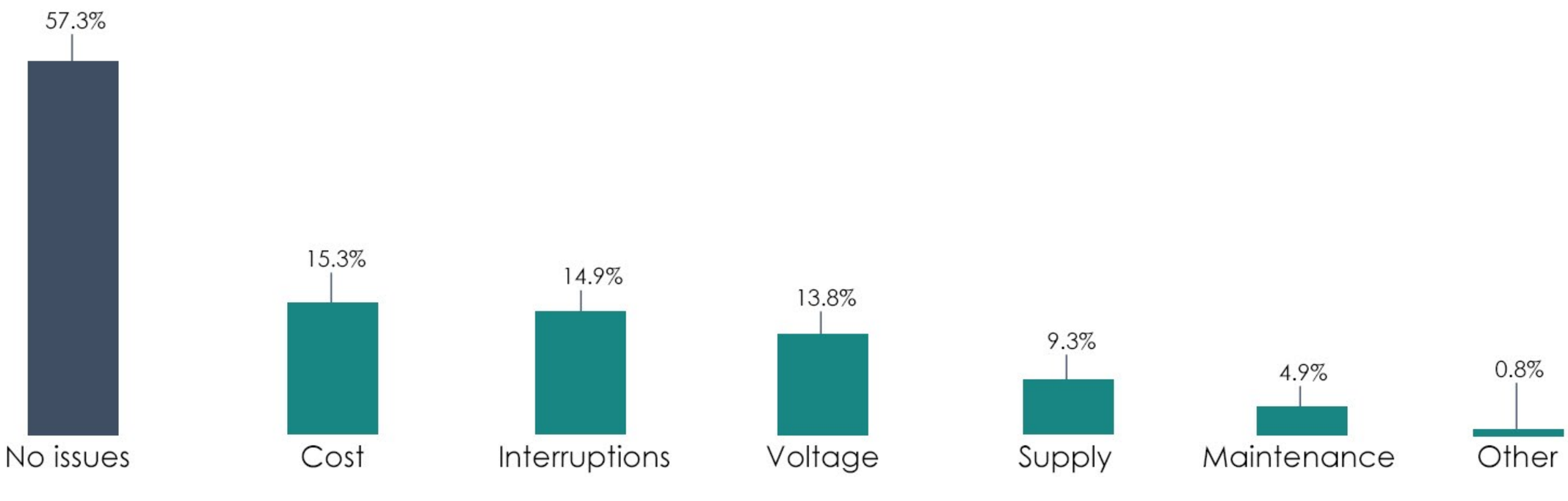
Figure 42: Distribution of grid-connected households by backup source for lighting at national level



Source: Malawi MTF household survey 2023.

While 57.3% of grid-connected households did not cite any issues with the grid, some households mentioned high cost of electricity (15.3%), power interruptions (14.9%) and voltage fluctuations (13.8%) as some of the issues they face with grid electricity (Figure 43).

Figure 43: Main issues related to grid electricity supply at national level

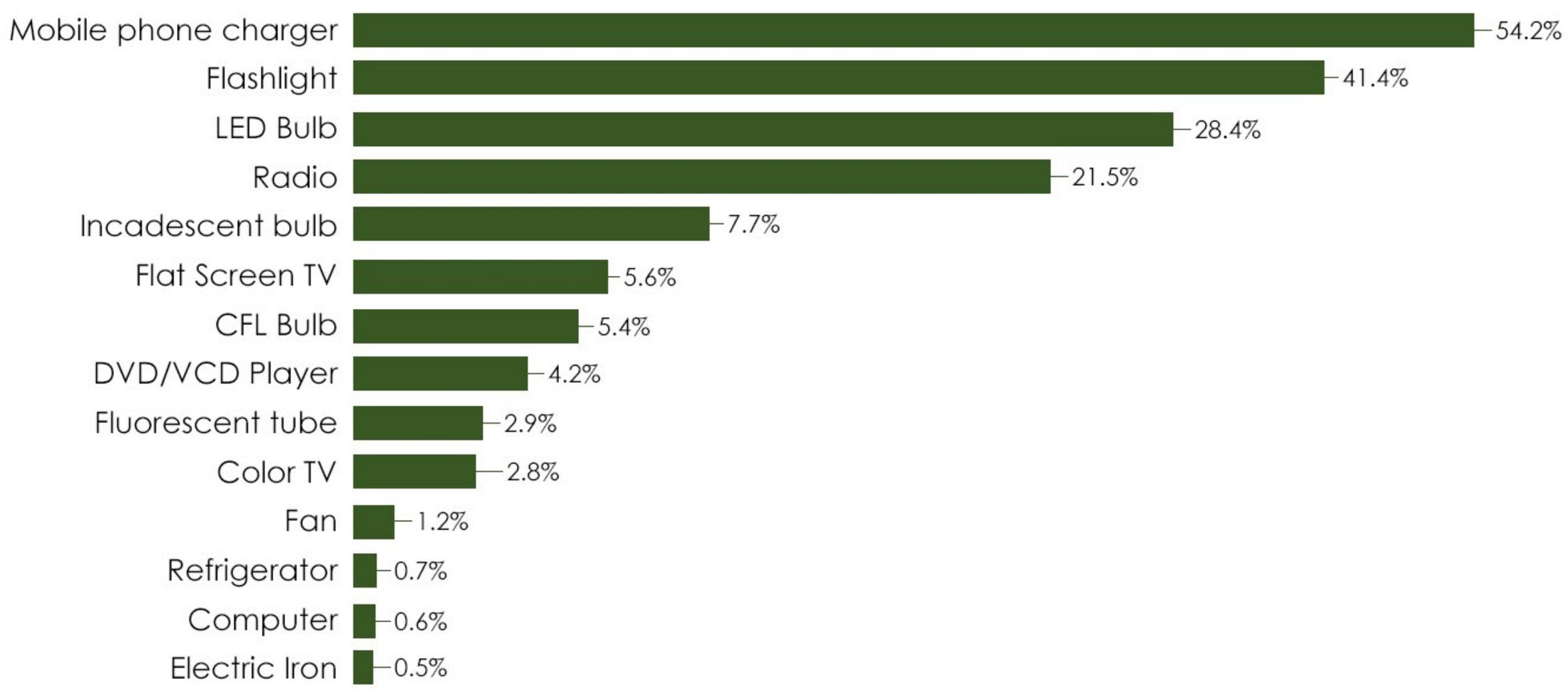


Source: Malawi MTF household survey 2023.

Improving electricity access for households with off-grid solar solutions

The capacity of the system for off-grid solar solutions is mostly defined by the type of appliances it can power, so the appliances broadly correspond to the tier for access to electricity. Households using off-grid solar solutions mostly own very low load appliances such as mobile phone charger (54.2%), flashlight (41.4%) LED bulbs (28.4%) and radios (21.5%). High or very high load appliances are very rare among households using solar as only 0.7% own a refrigerator and 0.5% own an electric iron (Figure 44).

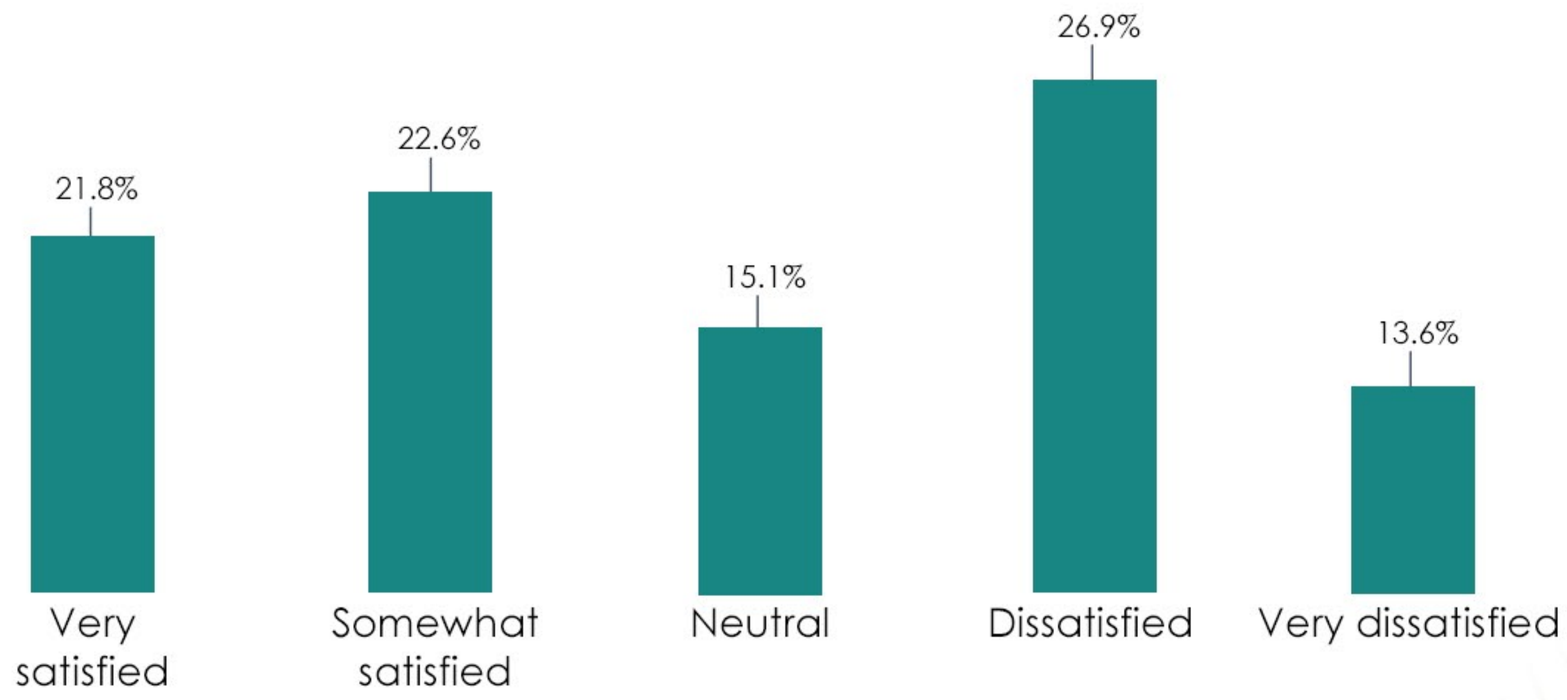
Figure 44: Ownership of appliances by off-grid households at national level



Source: Malawi MTF household survey 2023.

The quality of the solar product such as ability to power more appliances and bright lights for a longer period of time determine a household's level of satisfaction with the product. In Malawi 44.4% of households with an off-grid solar solution are satisfied with it (Figure 45). Enforcing standards of solar products that provide better service and value for money can improve households' satisfaction with off-grid solar solutions.

Figure 45: Households' Level of Satisfaction with solar device at national level



Source: Malawi MTF household survey 2023.

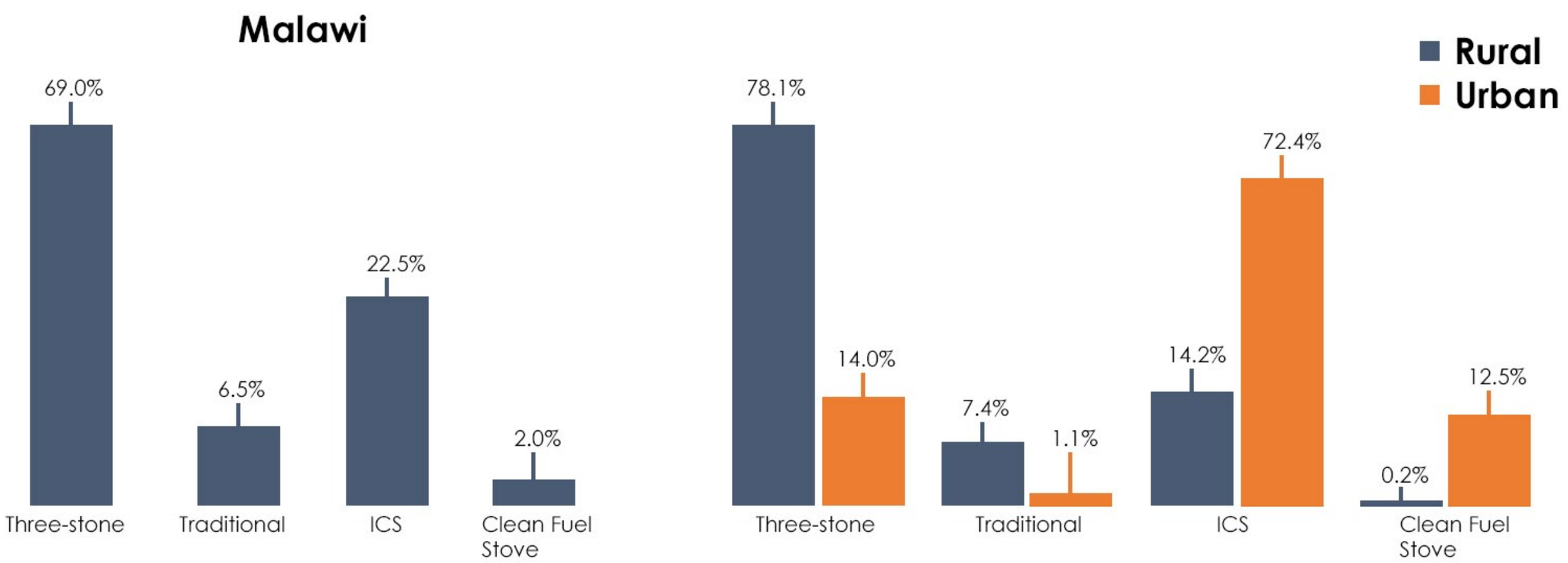
ACCESS TO MODERN ENERGY COOKING SOLUTIONS

■ Assessing access to modern cooking solutions

Technologies

In Malawi, the majority of households use three-stone stove (69%) followed by Improved cookstoves (ICS) at 22.5% and traditional stove at 6.5%. Only 2% of households use clean fuel stoves: 0.3% use Liquefied Petroleum Gas (LPG) stove and 1.7% use electric stoves. Analysis by place of residence indicates significantly large variations in use of cook stoves between rural and urban households. While the majority of households in rural areas use three-stone stove (78.1%), only 14% do so in urban areas. Conversely, the majority of households in urban areas use ICS (72.4%) compared to 14.2% in rural areas. In general, use of clean fuel stoves (LPG and electric stoves) is more common among urban households than rural households. About 1 in ten households in urban areas (11.1%) use an electric stove compared to 0.2% in rural areas (Figure 46).

Figure 46: Share of households with access to modern cooking solutions by technology at national level and by place of residence

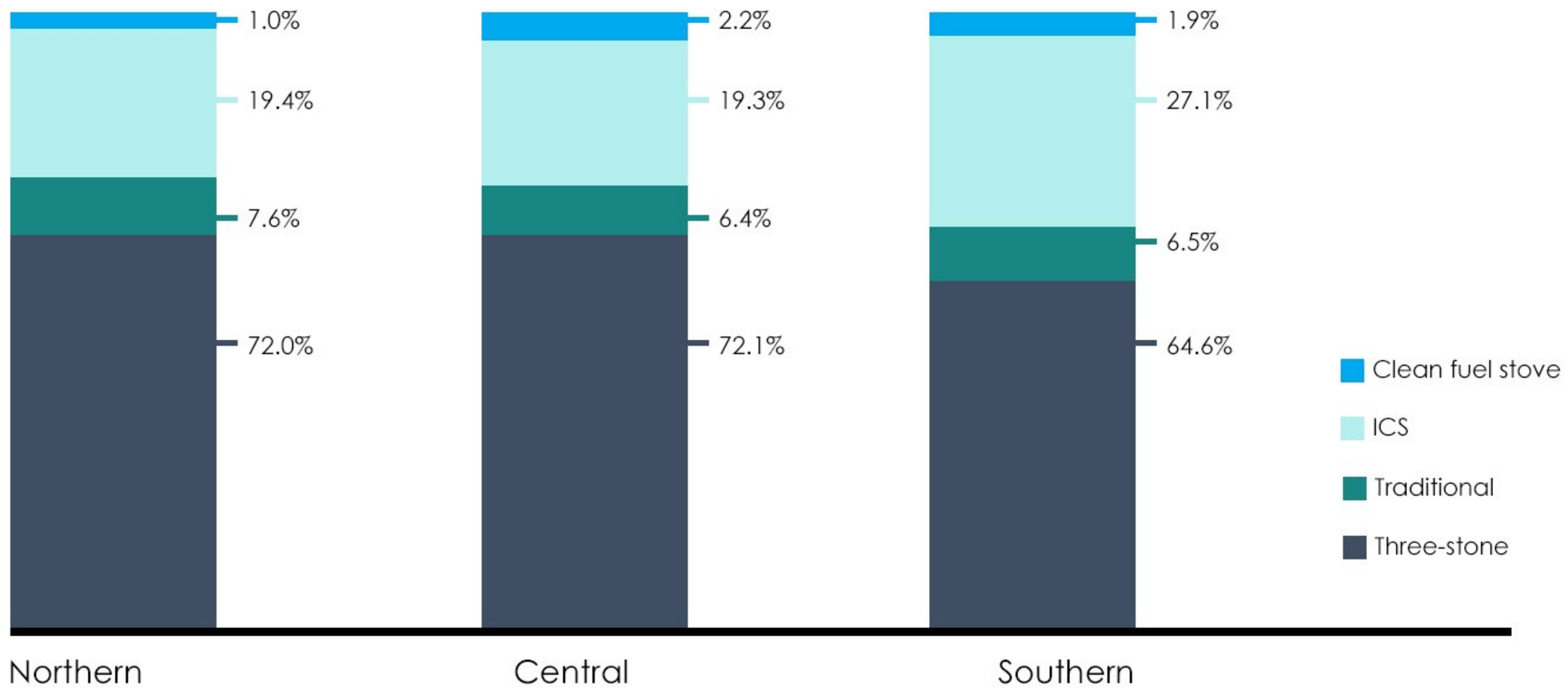


Source: Malawi MTF household survey 2023.

At regional level, similar patterns in access to modern cooking solutions exist. A lower proportion of households use three-stone stove in Southern region (64.6%) compared to Northern (72%) and Central (72.1%) regions. More households use improved cookstoves in Southern region (27.1%) than in Northern and Central regions (19.4% and 19.3%, respectively). Use of clean fuel stoves is very low across all the regions (Figure 47).

Figure 47: Share of households with access to modern cooking solutions by technology and region

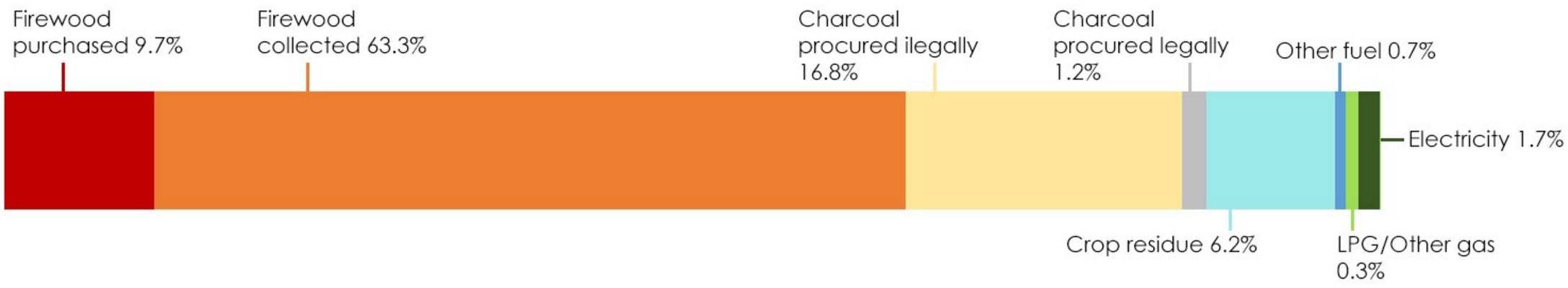
[7] *Firewood and charcoal stoves were combined in defining traditional and improved stoves (ICS)*



Source: Malawi MTF household survey 2023.

Almost all the households in Malawi (98%) use biomass for cooking (Figure 48). More than two-thirds of households (73%) use firewood followed by 18% that use charcoal and 6.2% that use crop residue. Only 2% of households use clean fuel for cooking, of which 1.7% use electricity. Other fuel comprises, animal waste or dung, saw dust, garbage or plastic, biomass briquette or pellet, coal briquette or pellet, coal or lignite. Charcoal procured illegally refers to charcoal purchased from unlicensed producers.

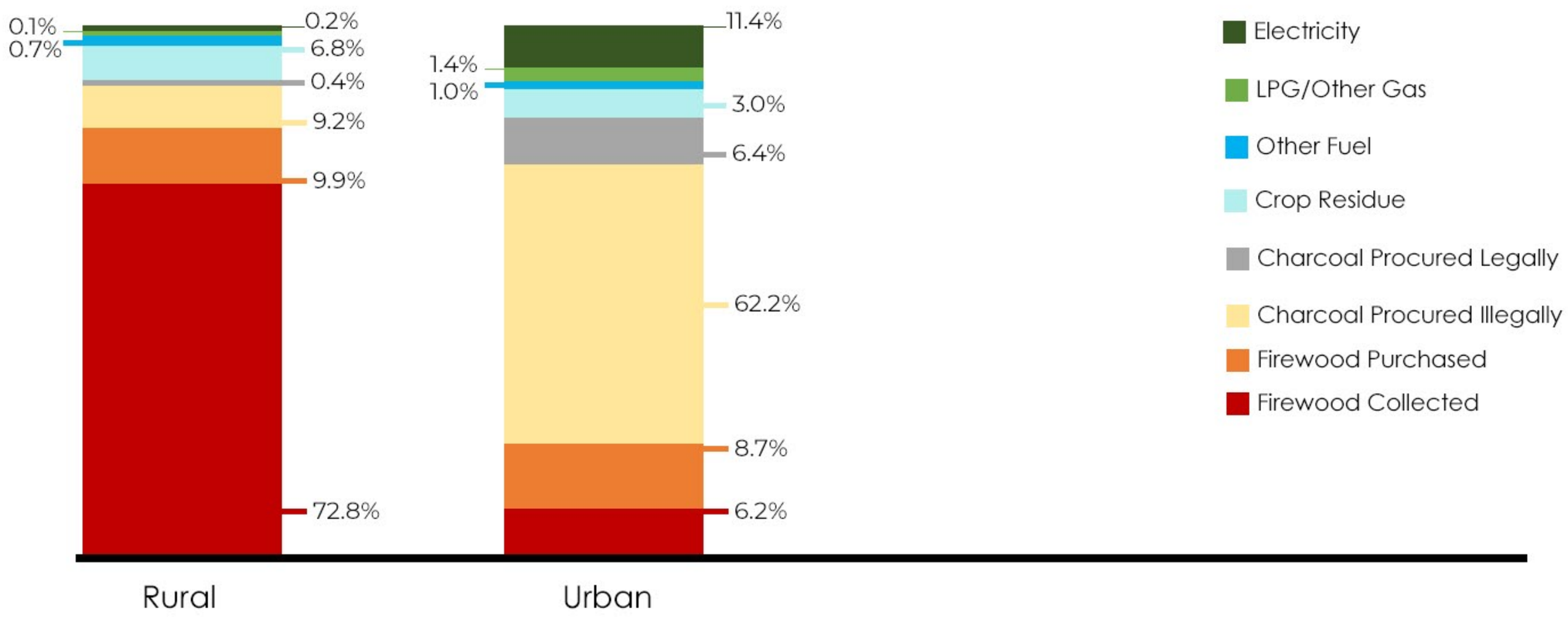
Figure 48: Share of households by type of cooking fuel at national level



Source: Malawi MTF household survey 2023.

Different cooking patterns exist between urban and rural households. While the majority of households in rural areas cook using firewood, urban households predominantly use charcoal for cooking. The majority of rural households (82.7%) cook using firewood followed by charcoal (9.6%) and crop residue (6.8%). In urban areas, households predominantly cook using charcoal (68.5%) followed by firewood (14.9%) and electricity (11.1%). Other fuel in urban areas (1%) includes Biomass briquette or pellet, Coal briquette or pellet and saw dust. Use of clean cooking fuel is more of an issue in rural areas where only 0.2% cook using electricity and 0.1% cook using gas (Figure 49).

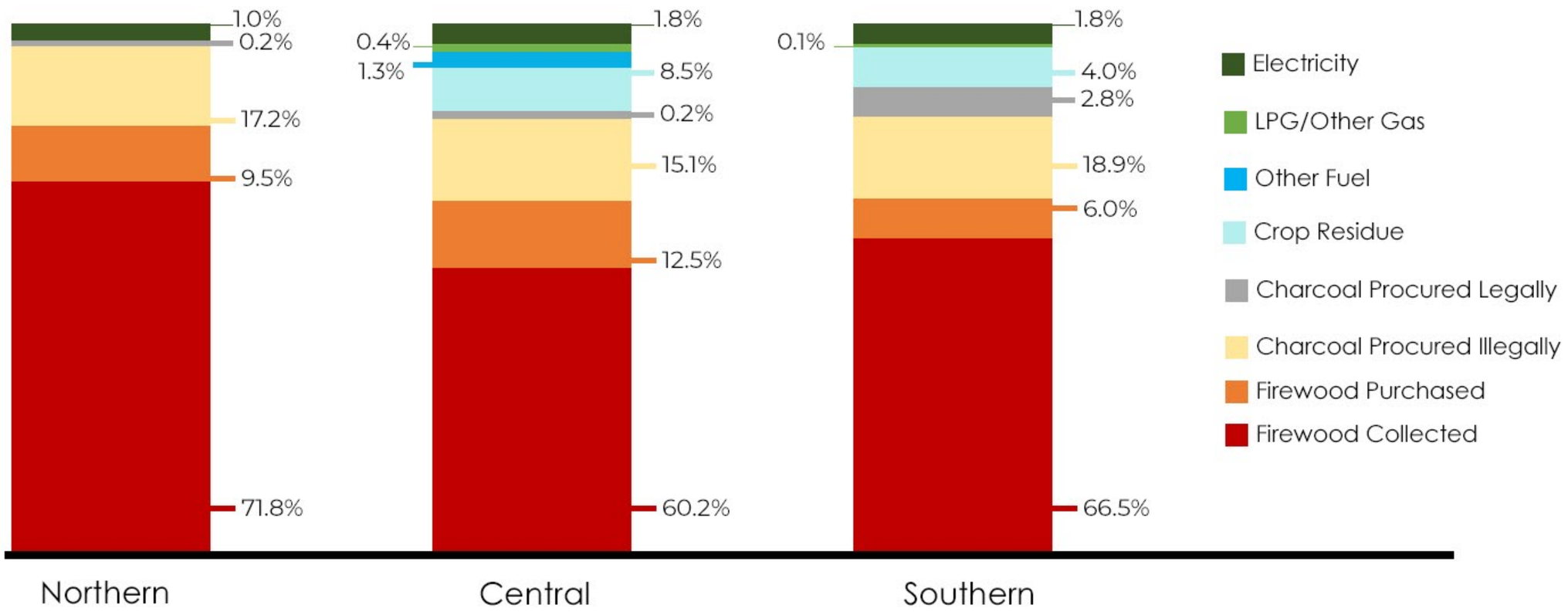
Figure 49: Share of households by type of cooking fuel by place of residence



Source: Malawi MTF household survey 2023.

Use of firewood for cooking is predominant in the Northern region (81.3%) followed by Central and Southern regions at 72.7% and 72.5%, respectively. Use of charcoal for cooking is highest in the Southern region at 21.6% compared to the Northern (17.7%) and Central (15.3%) regions. Use of clean fuel is not common across regions, only2.2% of households in Central region use clean fuel followed by Southern and Central regions at 2.2% and only 1%, respectively (Figure 50).

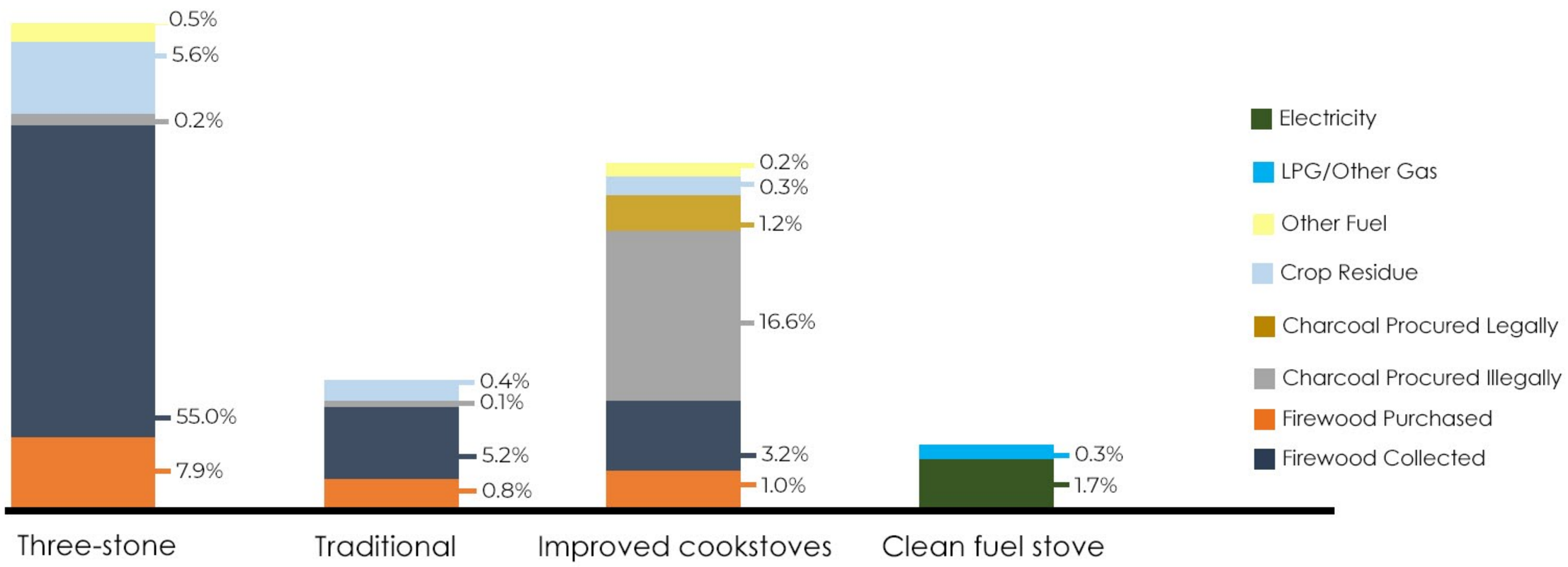
Figure 50: Share of households by type of cooking fuel and region



Source: Malawi MTF household survey 2023.

The MTF analysis looked further into usage of cooking fuel based on the various cooking solutions available in Malawi. The majority of households that use three-stone stove burn wood (62.8%) and crop residue (5.6%). For clean fuel stoves, the cooking solutions used determine the type of fuel. Thus the proportion of households using clean fuel stoves is the same as the proportion of households using clean fuel which is 1.7% for electricity and 0.3% for gas (Figure 51).

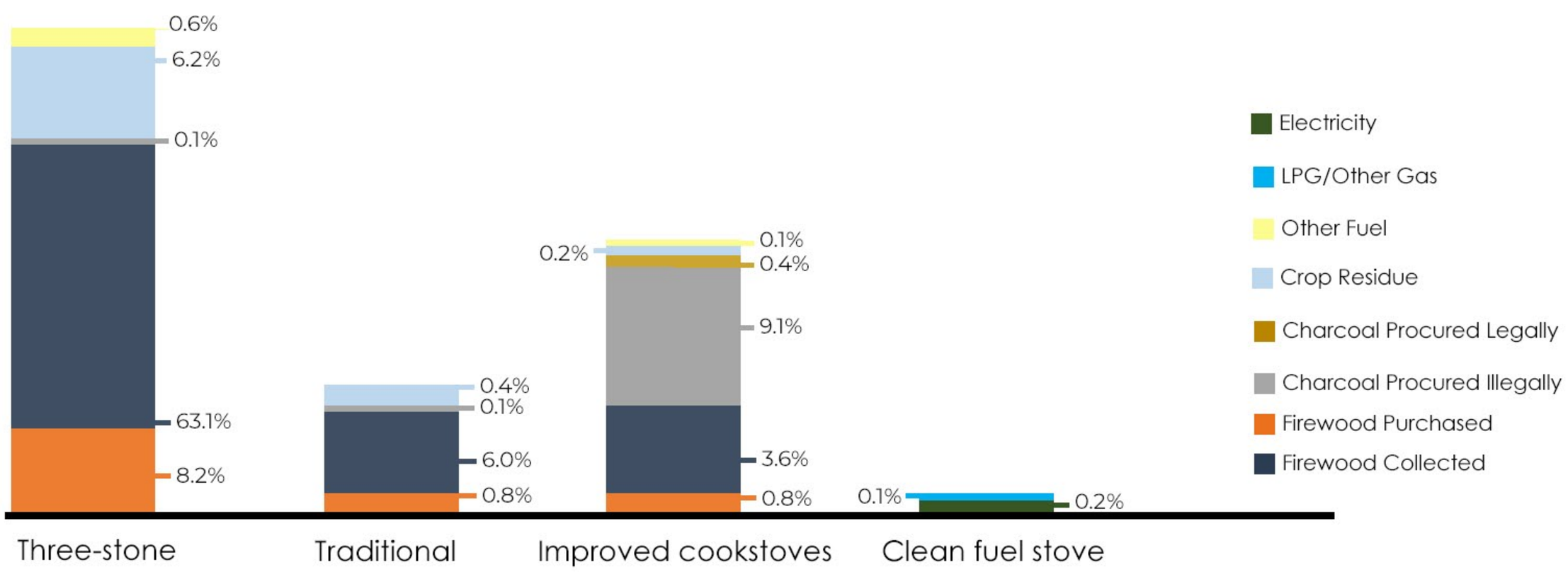
Figure 51: Share of households with access to modern cooking solutions by technology and fuel type at national level



Source: Malawi MTF household survey 2023.

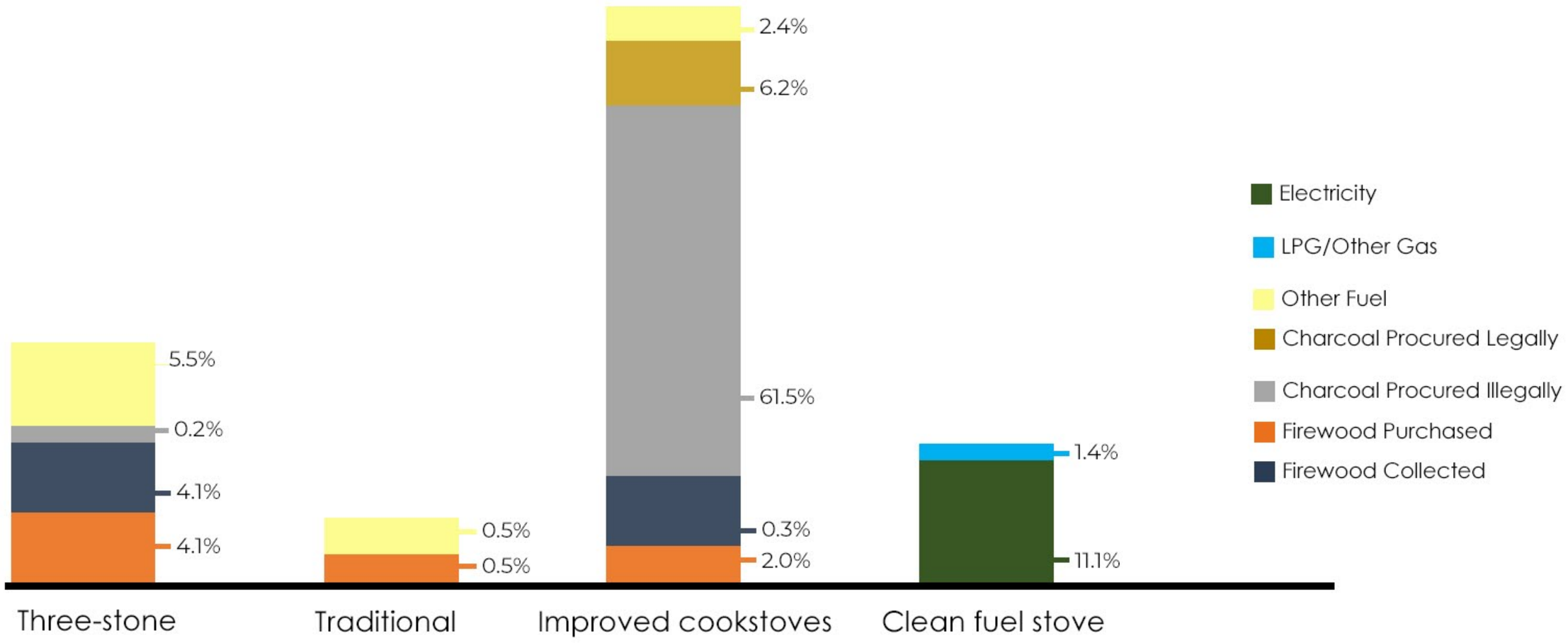
Almost all the rural households that use three-stone stove burn either firewood (71.4%) or crop residue (6.2%). Use of clean fuel is almost negligible in rural areas as only 0.2% of households use electricity and 0.1% use LPG (Figure 52). In urban areas, use of charcoal is predominant among households using improved cookstoves where about two-thirds of households use charcoal (67.6%). Clean fuel use is more common in urban areas where nearly one in ten households use electricity for cooking (11.1%) and 1.4% use LPG (Figure 53).

Figure 52: Share of rural households with access to modern cooking solutions by technology and fuel type



Source: Malawi MTF household survey 2023.

Figure 53: Share of urban households with access to modern cooking solutions by technology and fuel type



Source: Malawi MTF household survey 2023.

Stove stacking

Stove stacking refers to using multiple cookstoves and reflects households' aspiration to use higher performing solutions or the need for backup solutions. The cookstoves are often used in addition to existing cooking solutions. In Malawi, stove stacking occurs in 14.5% of households. Small differences in stove stacking patterns exist between urban and rural households. Stove stacking is slightly more common in urban areas (16%) than in rural areas at 14.2% (Figure 54).

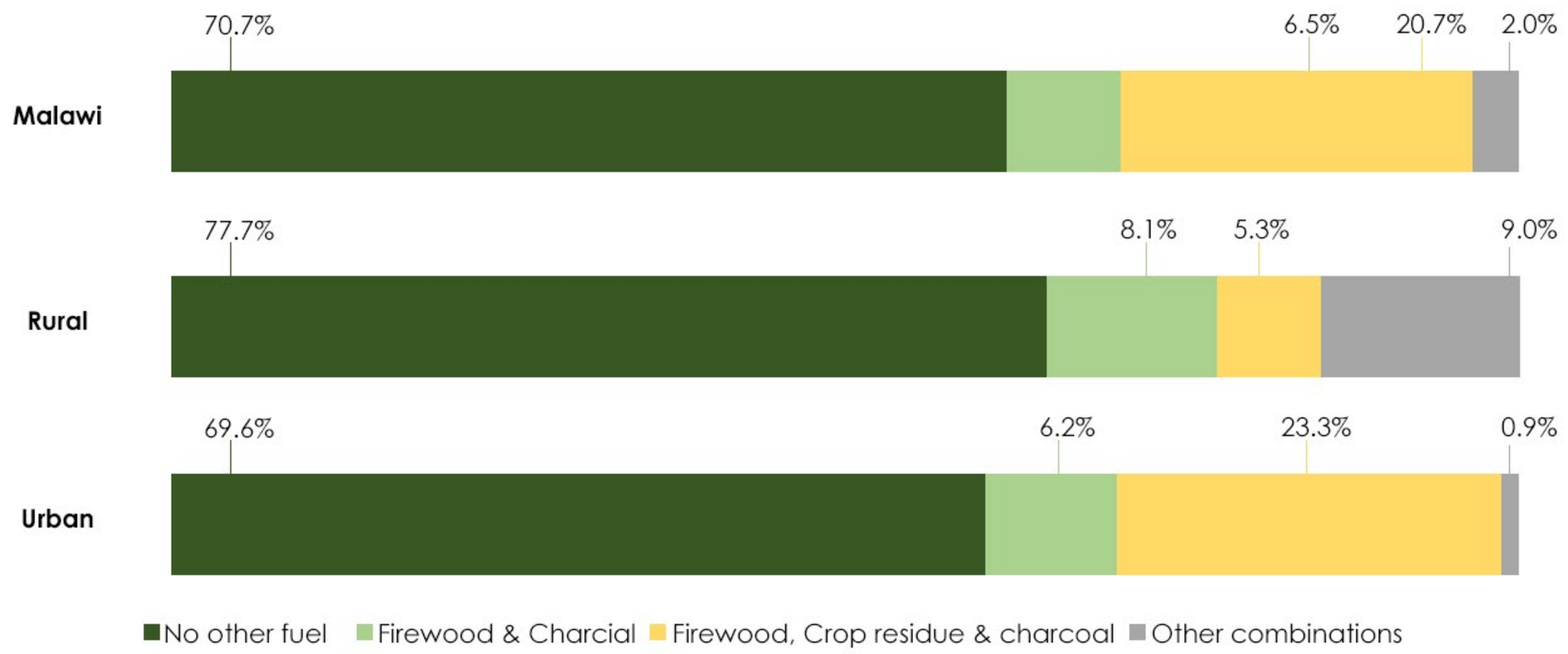
Figure 54: Share of households using multiple cookstoves at national level and by place of residence

Source: Malawi MTF household survey 2023.

Fuel stacking

Fuel stacking refers to using multiple types of cooking fuel by a household. At national level, fuel stacking occurs in 29.3% of the households (Figure 55). Fuel stacking is higher in urban areas (30.4%) than in the rural areas (22.3%). Urban households predominantly use a combination of firewood, crop residue and charcoal (23.3%) while rural households mainly use other combinations (9%).

Figure 55: Share of households using multiple fuel at national level and by place of residence

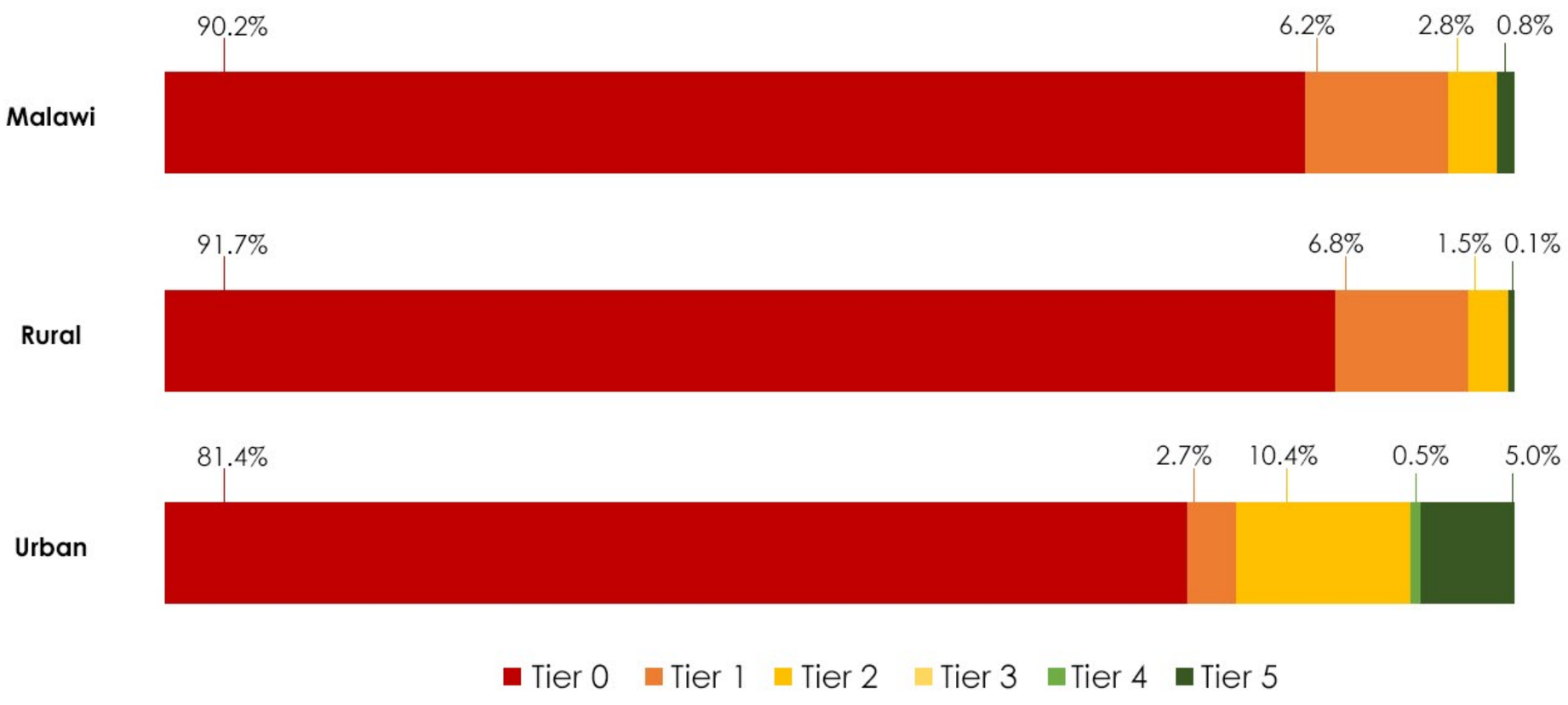


Source: Malawi MTF household survey 2023.

MTF tiers

In Malawi, most households (90.2%) are in Tier 0 for access to modern energy cooking solutions and only 9.8% are in Tier 1 or above. Slightly more households are in Tier 1 or above in urban areas (18.6%) than in rural areas (8.3%). More urban households fall in higher tiers for access to modern cooking solutions than in rural areas. Specifically, 5% of households in urban areas are in Tier 5 compared to 0.1% in rural areas. This is mainly because more households use clean fuel stoves in urban areas than in rural areas. However, using a clean fuel stove does not automatically categorize these households into higher tiers. For instance, while 11.4% of urban households and 0.2% of rural households use a clean-fuel stove as their primary stove, only 5.5% of urban households and 0.1% of rural households are in Tier 4 or 5 for access to modern energy cooking solutions (Figure 56).

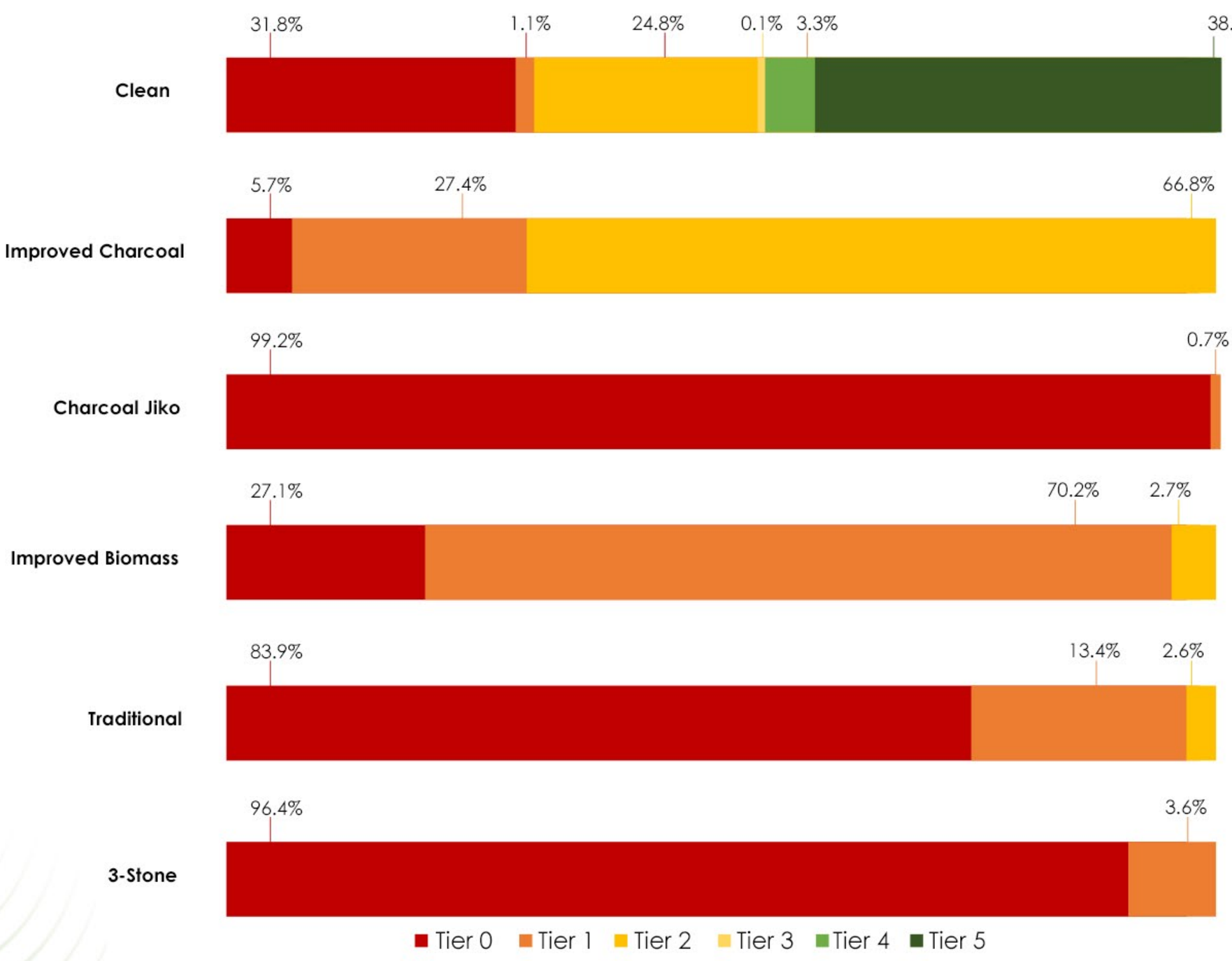
Figure 56: MTF tier distribution of households' access to modern-energy cooking solutions at national level and by place of residence



Source: Malawi MTF household survey 2023.

Households that primarily use three-stone stove, traditional stove, and charcoal Jiko are concentrated in Tiers 0 and 1. More households using clean-fuel stove are in Tiers 3 or above with 38.8% in Tier 5. Thus, clean-fuel stove users are more likely to be in higher tiers for access to modern energy cooking solutions than in lower tiers (Figure 57).

Figure 57: MTF tier distribution of households' access to modern energy cooking solutions at national level by primary stove type



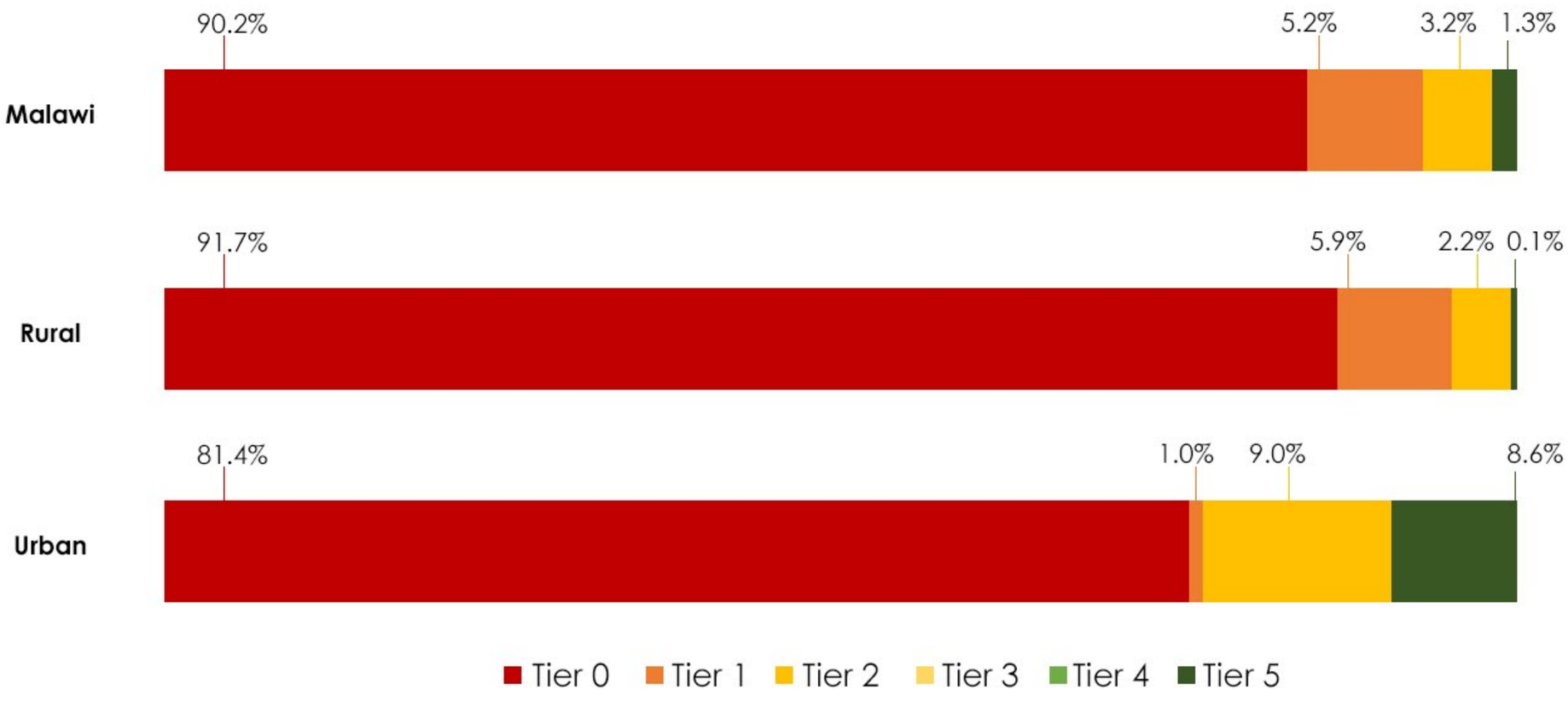
Source: Malawi MTF household survey 2023.

MTF attributes

Cooking Exposure

Cooking exposure is a proxy estimate for measuring the health impacts of cooking activity based on emissions of cooking and ventilation. Poor ventilation and high exposure to emissions may expose the primary cook to short-term and long-term respiratory diseases. At national level, most households (90.2%) are in Tier 0 for the cooking exposure attribute due to predominant use of three-stone stoves and traditional biomass stoves which are associated with high emissions and poor ventilation structure. Some of the households that use three-stone stoves are in Tier 1 due to better ventilation and 8.4% of households are in Tiers 1 or 2 because they use self-built or manufactured biomass stoves. Only 1.3% of households are in tier 5 because they use clean fuel stoves. Cooking exposure is more an issue in rural areas where nearly all households (97.6%) are in Tiers 0 or 1, than in urban areas at 82.4%. Further, 8.6% of households in urban areas are in Tier 5 compared to 0.1% in rural areas (Figure 58).

Figure 58: Distribution of households based on Cooking Exposure at national level and by place of residence

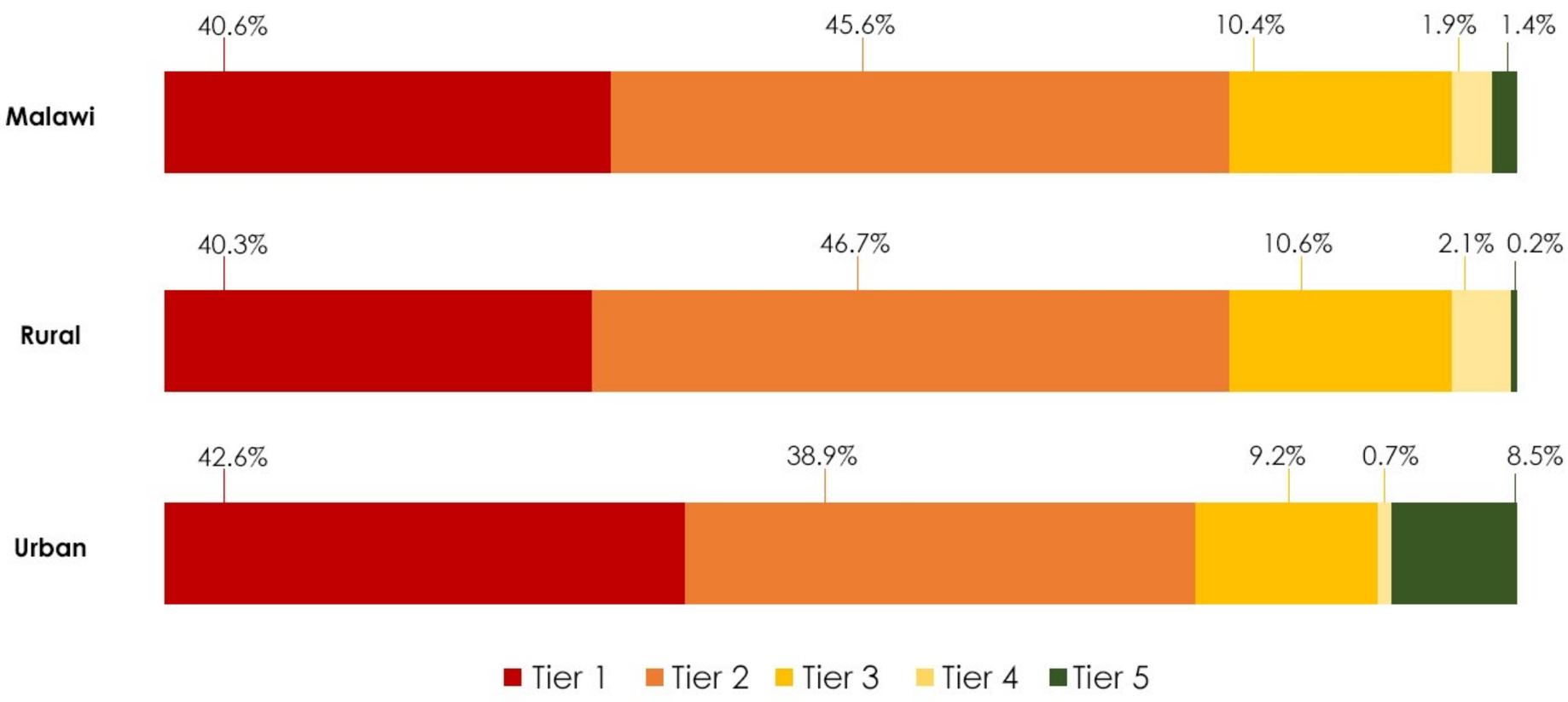


Source: Malawi MTF household survey 2023.

Convenience

The Convenience attribute consists of two components: the amount of time a household spends acquiring and preparing fuel each week and the amount of time a household spends preparing a stove for cooking before each meal. In Malawi, 40.6% of households spend more than 7 hours per week collecting and preparing fuel, or at least 15 minutes preparing a stove before each meal. Households in lower convenience tiers primarily use three-stone stoves or mbaulas, which require more effort to prepare and are less efficient than clean-fuel stoves. There are more households in higher Tiers of convenience in urban areas than in rural areas. Specifically, 8.5% of urban households spend less than 30 minutes per week collecting or preparing fuel or less than 2 minutes preparing the stove before each meal compared to only 0.2% in rural areas (Figure 59).

Figure 59: Distribution of households based on total Convenience at national level and by place of residence

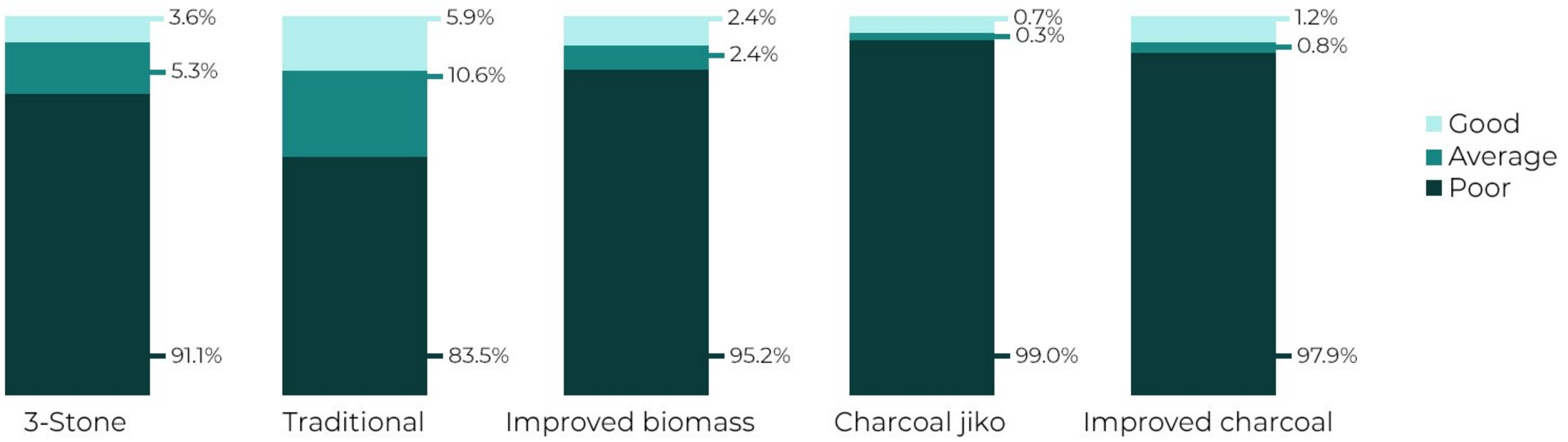


Source: Malawi MTF household survey 2023.

Ventilation

Ventilation attribute concentrates on households that cook indoors and whose primary stove is a biomass stove. Poor ventilation is most common among households that use charcoal Jiko (99%), followed by improved charcoal (97.9%) and improved biomass stove (95.4%). Notably, more households that are using traditional stove have good or average ventilation at 5.9% and 10.6%, respectively (Figure 60).

Figure 60: Distribution of households based on ventilation of modern cooking solutions by technology at national level

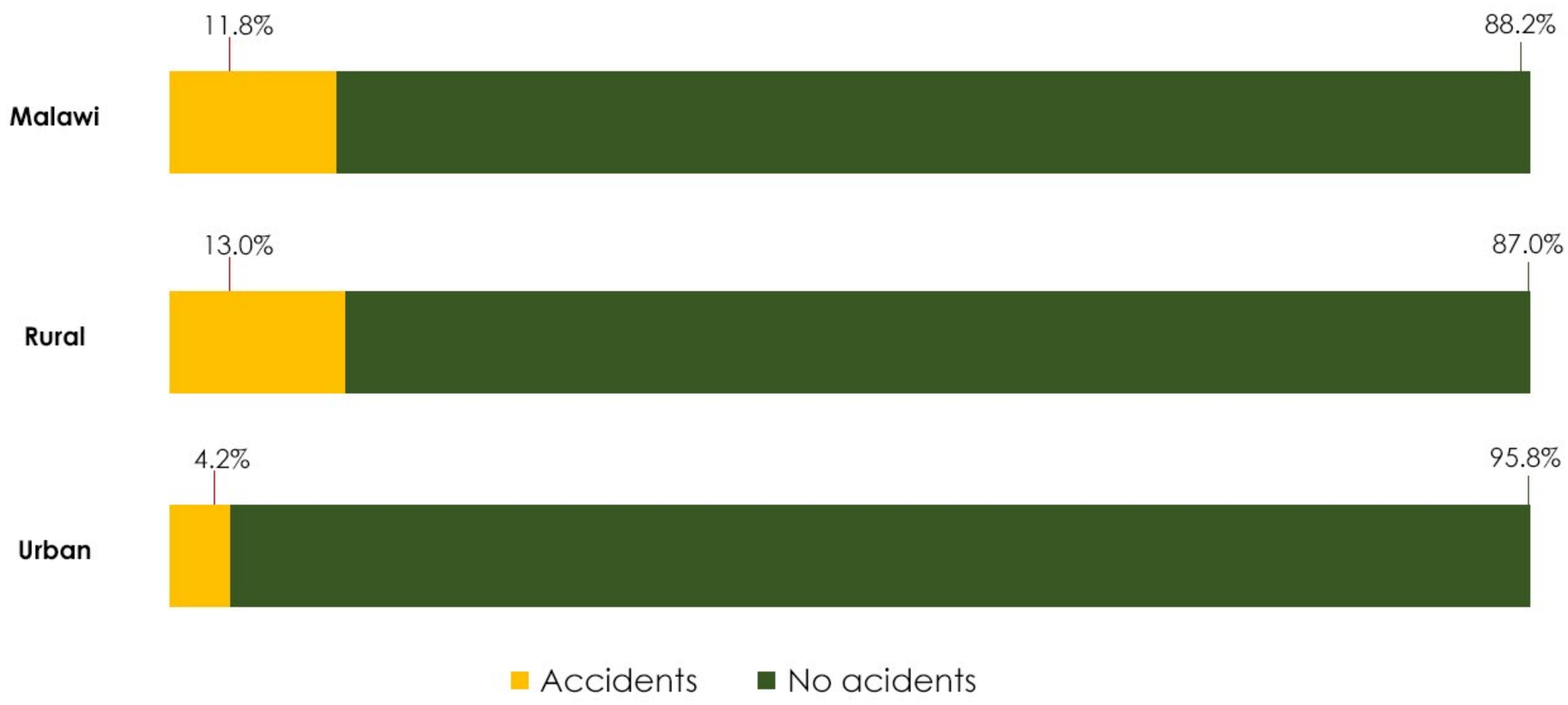


Source: Malawi MTF household survey 2023.

Safety of Primary Cookstove

The type of cookstove and fuel used determine the degree of safety risk experienced by households when using cookstoves or fuel. Risks may include death, permanent health damage, burns or severe respiratory problems. The attribute of Safety of primary cookstove is assessed using the incidence of serious injuries from the use of the main cookstove for one year preceding the survey. In Malawi, 11.8% of households reported death or serious injury of a household member—including permanent health damage; burns, fire, or poisoning; severe cough or respiratory problem; or other major injury associated with use of a cookstove in one year preceding the survey. Safety is more of a concern in rural areas where 13% reported accidents than in urban areas at 4.2% (Figure 61).

Figure 61: Distribution of households based on Safety at national level and by place of residence



Source: Malawi MTF household survey 2023.

Affordability

Computation of the Affordability attribute uses two components: total monthly household expenditure and a household's expenditure share on cooking fuel. Cooking fuel is defined as affordable if a household's expenditure on cooking fuel does not exceed 5% of its total monthly expenditure. In Malawi, only 4.3% of households find their current cooking solutions affordable as they spend less than 5% of their total monthly household expenditure on cooking fuel. Affordability issues of cooking solutions are similar among rural and urban households (Figure 62).

Figure 62: Distribution of households based on Affordability at national level and by place of residence

Source: Malawi MTF household survey 2023.

Fuel Availability

Fuel Availability is a major constraint for over one-third of the households as 42% reported that fuel is rarely or sometimes available throughout the year. No major differences in fuel availability exist between rural and urban households (Figure 63).

Figure 63: Distribution of households based on Fuel Availability at national level and by place of residence

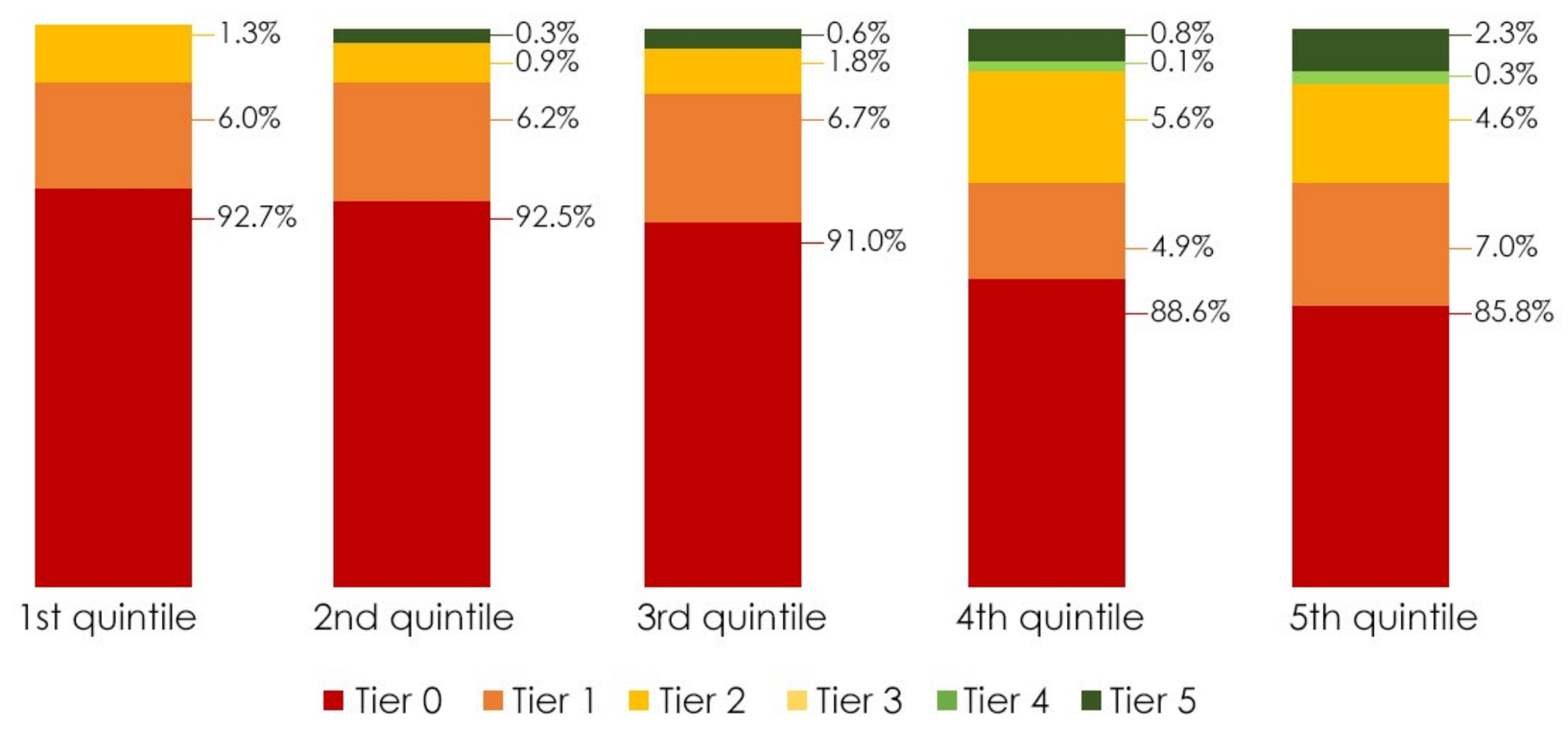
Source: Malawi MTF household survey 2023.

Improving access to modern energy cooking solutions

Increasing adoption of improved cookstoves as primary cooking solutions

As presented earlier, most households in Malawi cook with a three-stone stove or a traditional stove. Most of these households do not have grid connection and are over-represented in the lower quintiles (Figure 64). Thus, improved biomass cookstoves may be the most feasible cooking solutions able to move such households into higher tiers (most likely Tiers 1 through 3) in the short term. Shifting to improved cookstoves will result in minimal disruption in cooking practices and households can rely on existing fuel such as wood or charcoal. Therefore, adoption of improved biomass stoves can be faster than clean fuel stoves.

Figure 64: MTF tier distribution of households' access to modern energy cooking solutions by expenditure quintile at national level

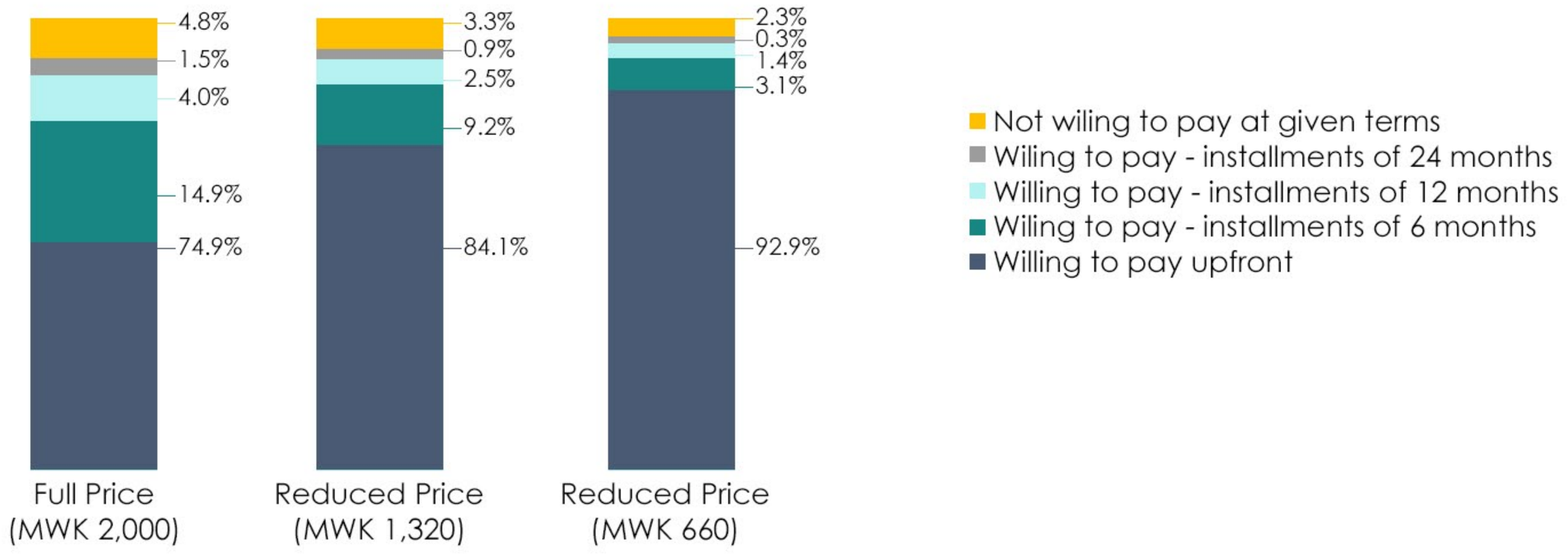


Source: Malawi MTF household survey 2023.

Various cookstoves were offered to households depending on their current cooking solutions and place of residence. Willingness to pay for improved cookstoves was measured using different prices and payments options offered to households. In rural areas, households that were using three-stone or traditional stove were offered Chitetezo Mbaula, a locally manufactured biomass stove which is designed to burn biomass in a cleaner and more efficient way. Rural households that were already using a manufactured biomass stove were offered Ceramic Jiko, an improved cookstove which is commonly available in Malawi. In urban areas, households that were not using a clean cookstove were offered an LPG stove. All the stoves were offered at full price and subsidized prices with various payment options that included installments of 6, 12 and 24 months.

In rural areas, the majority of households (74.9%) that are using three-stone stove or traditional stove are willing to pay full price (MWK2,000 or US$1.18) for Chitetezo Mbaula upfront with an additional 20.4% who are willing to pay in installments of 6,12 and 24 months. Household's willingness to pay upfront increases to 92.9% when offered 33% of the full price (MWK660 or of US$0.4). Taking advantage of the high willingness to pay upfront for more efficient and cleaner manufactured biomass stove and existing predominant use of biomass, there is potential to move most households away from three-stone and traditional stoves (Figure 65).

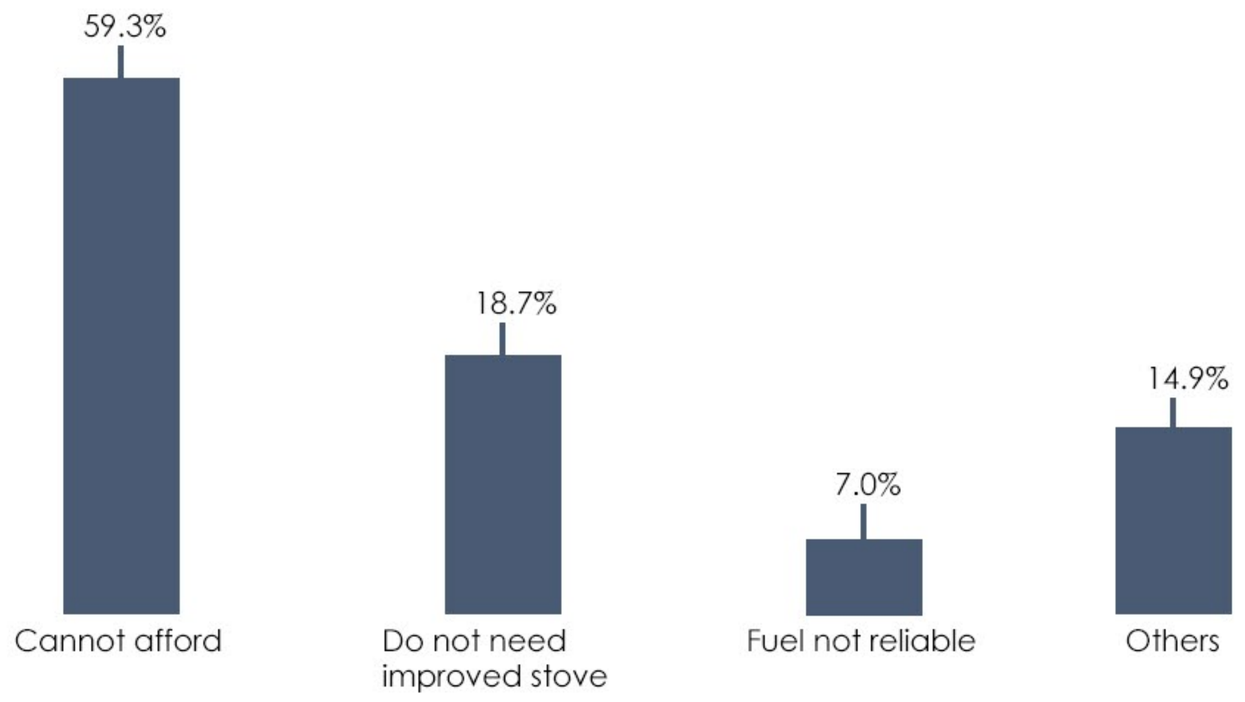
Figure 65: Rural households' willingness to pay for Chitetezo Mbaula biomass stove



Source: Malawi MTF household survey 2023.

Most common reasons cited by households who were not willing to pay for chitetezo mbaula under any of the payment options provided are that they cannot afford the cost of the stove (59.3%) while 18.7% do not need an improved stove (Figure 66).

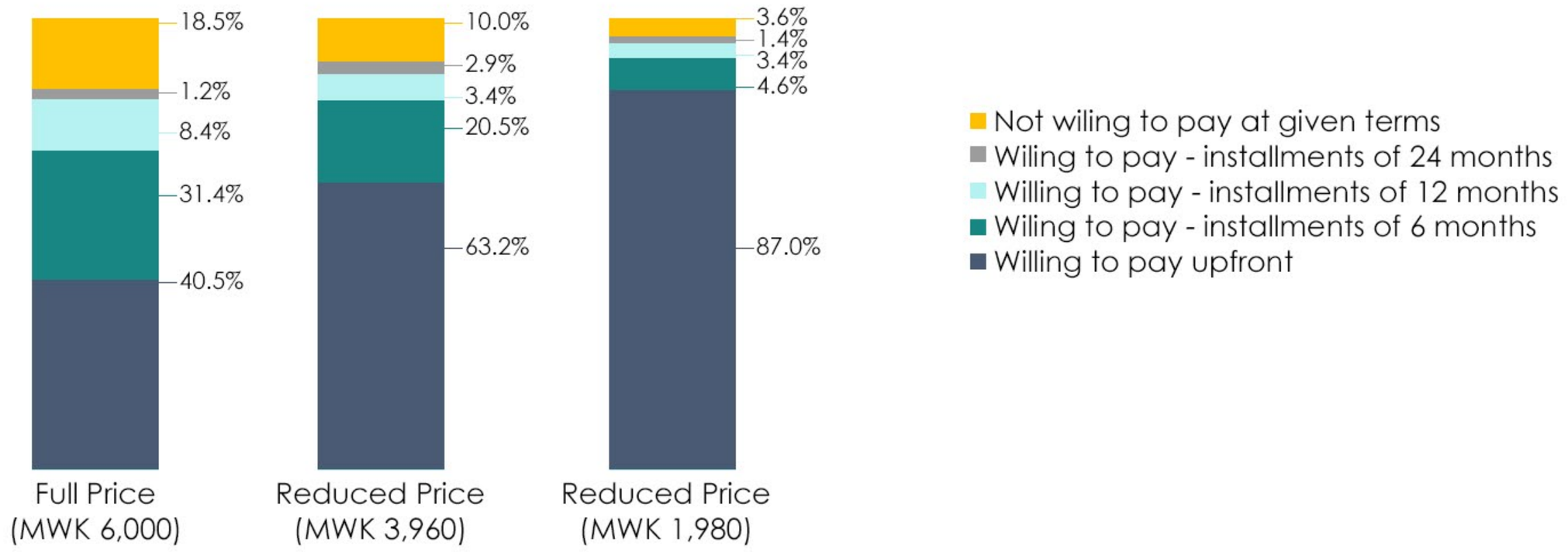
Figure 66: Reasons for rural households' unwillingness to pay for Chitetezo Mbaula



Source: Malawi MTF household survey 2023.

Rural households that were using manufactured stove were offered Jiko Ceramic stove, an improved charcoal cookstove which is widely available in Malawi. Similarly, different prices and payment options for Jiko Ceramic stove were offered to measure households' willingness to pay. About one-third of households (40.5%) are willing to pay for Jiko Ceramic stove upfront when offered the full price of MWK6,000 (US$3.5) while 41% are willing to pay in installments of 6, 12 and 24 months. More households are willing to pay as the price reduces. When offered 33% of the full price (MWK1,980 or US$2.3), the proportion of households willing to pay upfront increases to 87% (Figure 67).

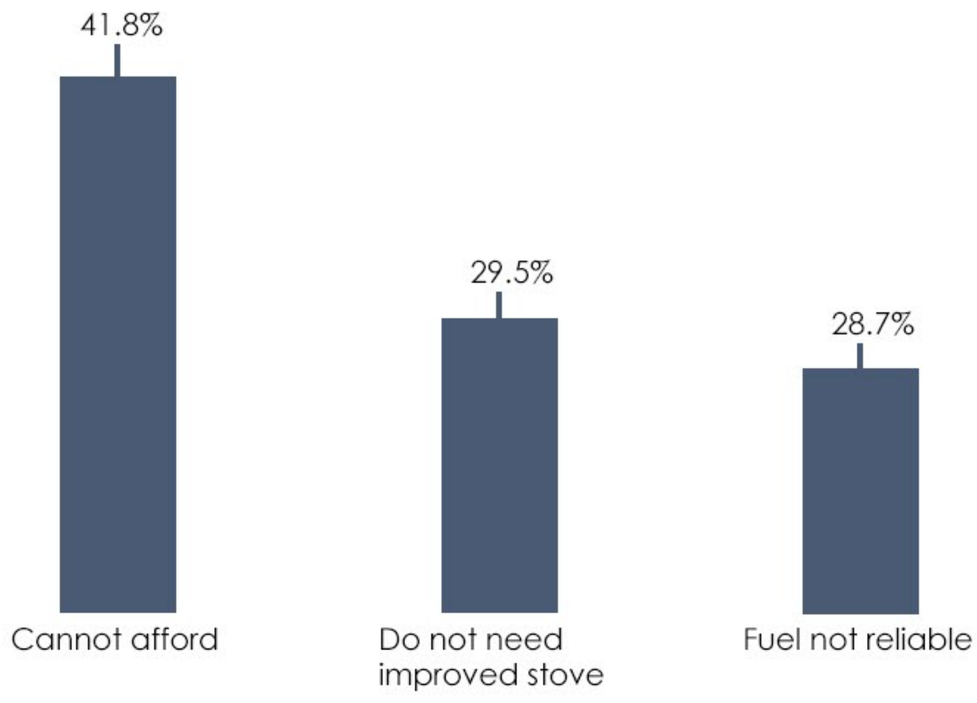
Figure 67: Rural households' willingness to pay for Jiko Ceramic stove



Source: Malawi MTF household survey 2023.

About 41.8% of rural households who are not willing to pay for Jiko Ceramic under any price or payment plan offered cannot afford it, while 29.5% believe that they do not need an improved cookstove (Figure 68).

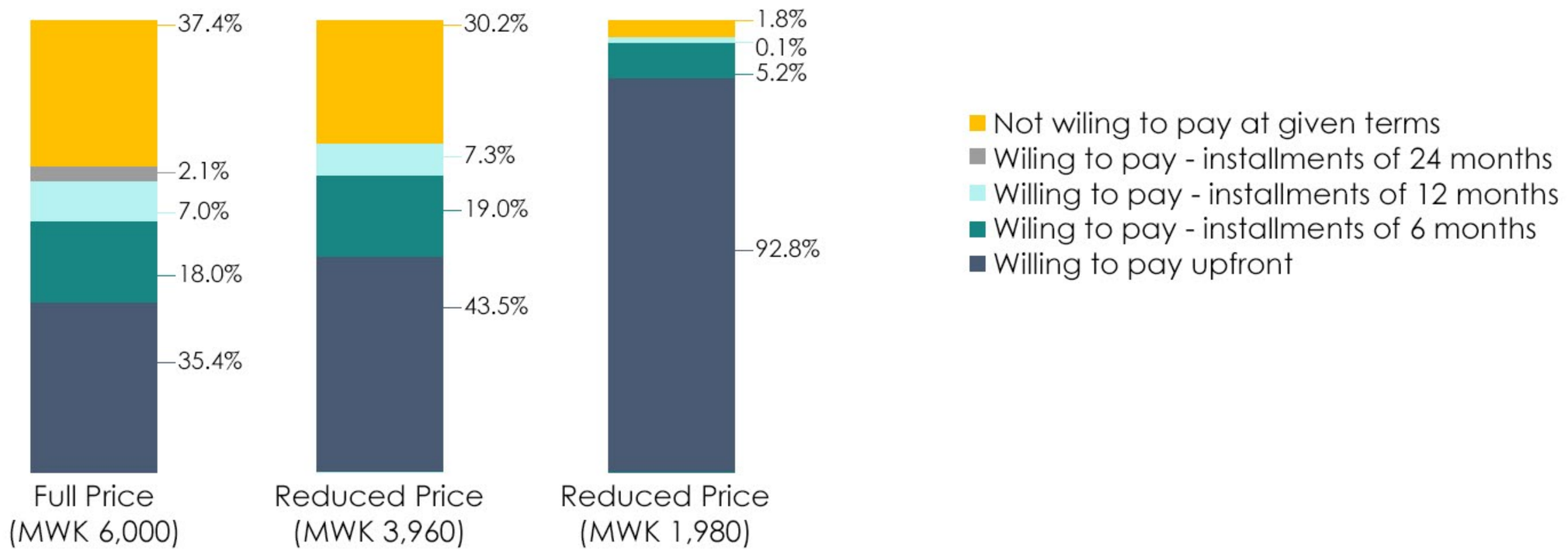
Figure 68: Reasons for rural households' unwillingness to pay for Jiko Ceramic stove



Source: Malawi MTF household survey 2023.

In urban areas, households using three-stone, traditional or manufactured biomass stove were offered Jiko Ceremic stove. About one-third of households (35.4%) are willing to pay for Jiko Ceramic cookstove upfront when offered the full price of MWK6,000 (US$3.5) while 27.1% are willing to pay in installments of 6, 12 and 24 months. Notably, 37.4% are not willing to pay for the cookstove when the full price is offered. Just as in rural areas, willingness to pay increases as the price is reduced (Figure 69).

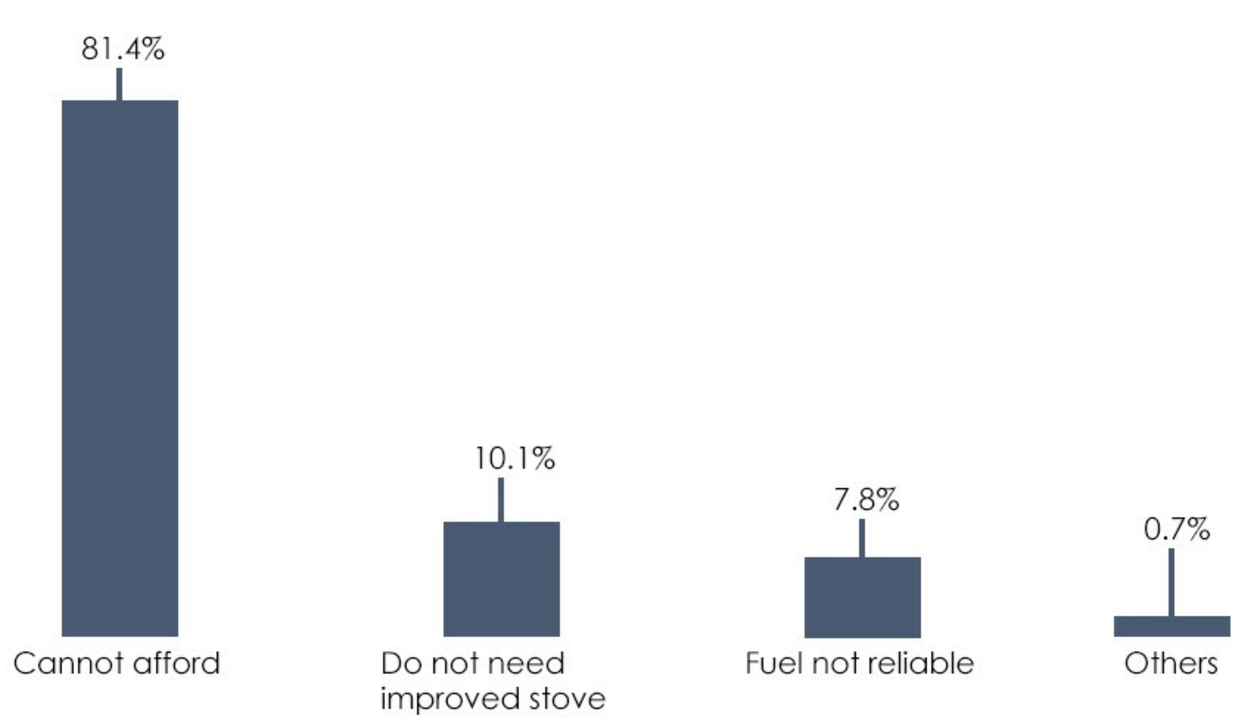
Figure 69: Urban households' willingness to pay for Jiko Ceramic stove



Source: Malawi MTF household survey 2023.

Affordability is an even larger issue in urban areas where 81.4% of households who are not willing to pay for Jiko Ceramic cookstove cannot afford it, while 10.1% do not need an improved stove (Figure 70).

Figure 70: Reasons for urban households' unwillingness to pay for Jiko Ceramic stove



Source: Malawi MTF household survey 2023.

Increasing penetration of clean fuel stoves

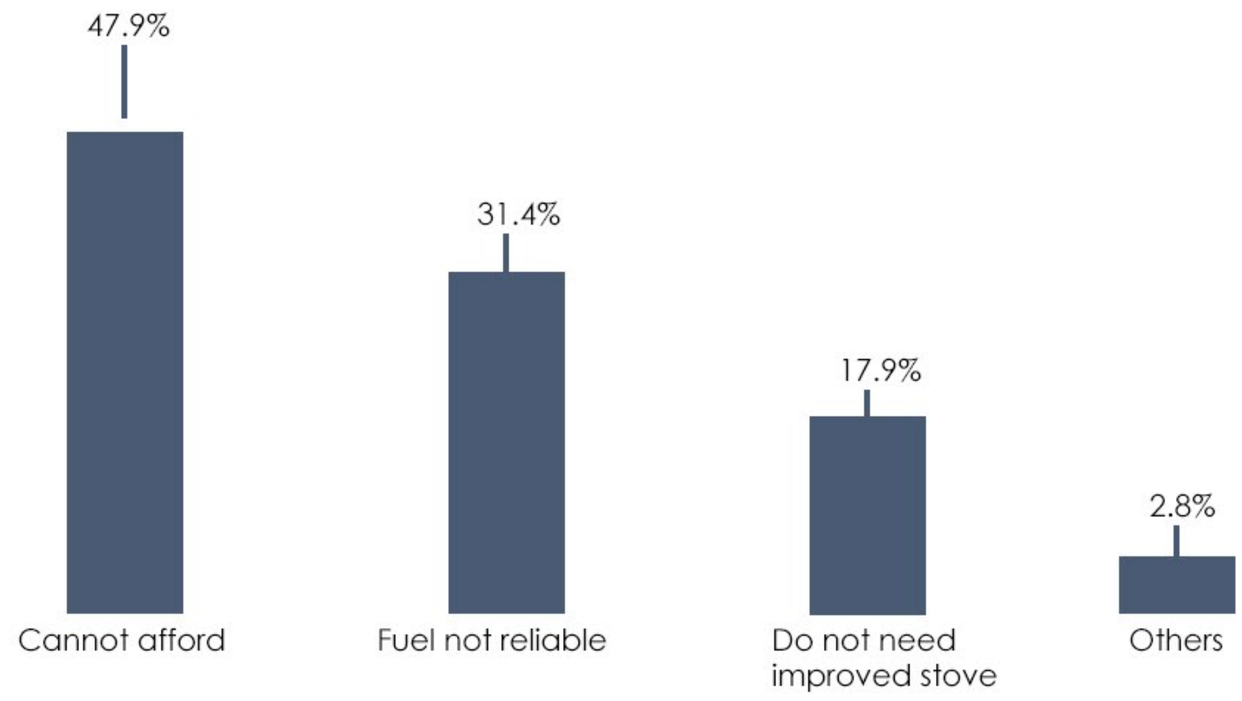
Urban households that were not using a clean cookstove were assessed on their willingness to pay for an LPG cookstove, a clean and very efficient cookstove. The survey did not measure willingness to pay for other clean fuel cookstoves such as electric stoves. A 6 kg afrox handipack gas stove with accessories was offered to urban households at a cost of MWK109,000 (US$61.12). Only 18% of households are willing to pay the full price of an LPG stove upfront while half of the households (50.1%) are willing to pay the full price in installments of 6, 12 and 24 months. Almost one-third of the households are not willing to pay the full price of an LPG cookstove under the payment options provided. More households are willing to pay as the price reduces with twice as many households (48.2%) willing to pay upfront when 33% of the full price is offered (MWK35,970 or US$21.16) and only 16% are not willing to pay (Figure 71).

Figure 71: Urban households' willingness to pay for an LPG stove

Source: Malawi MTF household survey 2023.

Some households are not willing to pay for an LPG stove because they cannot afford (47.9%) while 31.4% consider LPG as not reliable fuel and 17.9% do not need an improved stove (Figure 72).

Figure 72: Reasons for urban households' unwillingness to pay for an LPG stove



Source: Malawi MTF household survey 2023.

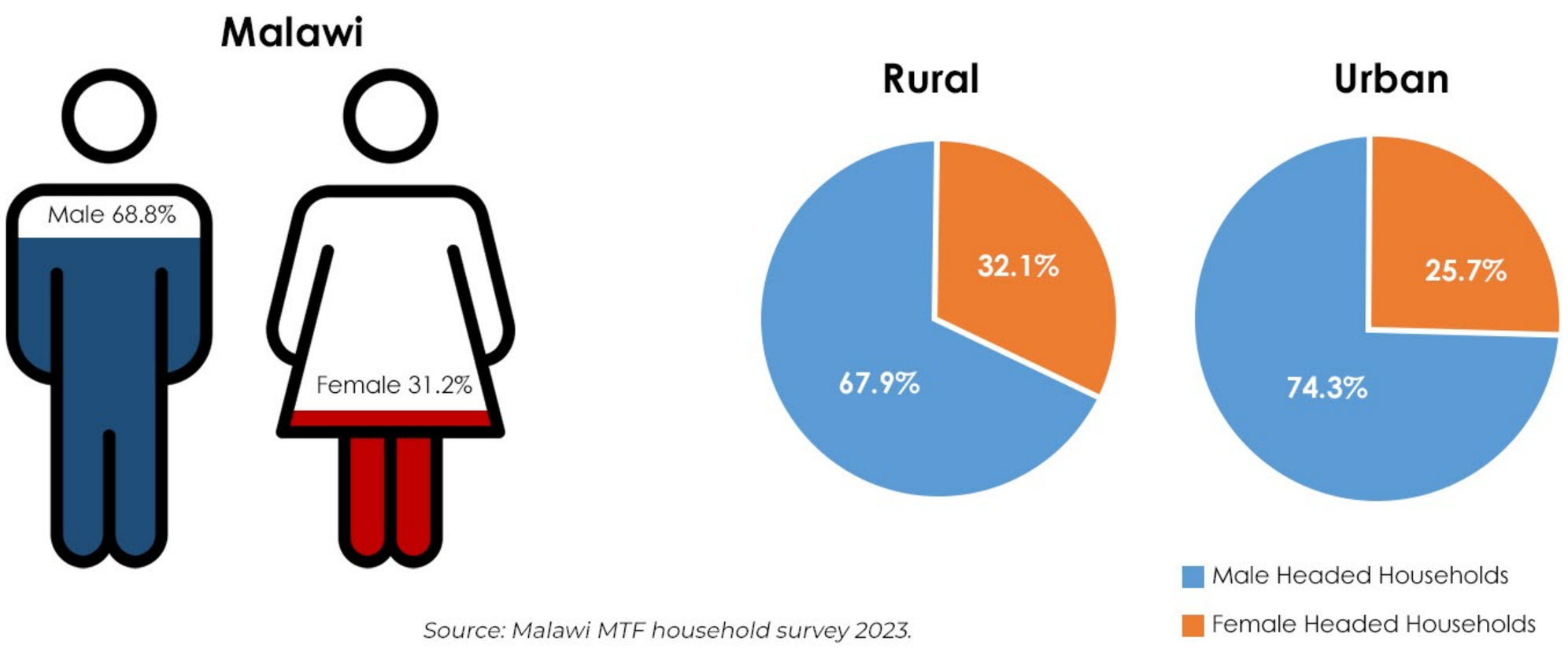
GENDER DIMENSION OF ENERGY ACCESS

Women usually spend a lot more time at home and are more engaged in household chores than men (ILO 2018; Habimana 2017; Chamie 2018; Haque 2016). Access to energy may affect men and women differently in terms of quality of life, education, and economic welfare. Unfortunately, this is often not taken into consideration in energy intervention projects. As a result, women's traditional responsibilities at home are affected adversely. This is exacerbated when women do not have a say in decision making on energy access. In the circumstances, it is important to know what roles, if any, women play in household energy-related decisions and how their welfare is affected by household energy access. This also helps formulation of policies to reduce gender inequality, which is better for the society and the country. In this section, access to energy is examined in terms of the ways it is affected by gender of household head; moreover, any behavioral changes shown by women who may have differential access to energy solutions is examined.

How do households differ by gender of the head?

At national level, a very large share of the households is male-headed (68.8%), and the share of male-headed households is even lager in urban (74.3%) than rural areas at 67.9% (Figure 73).

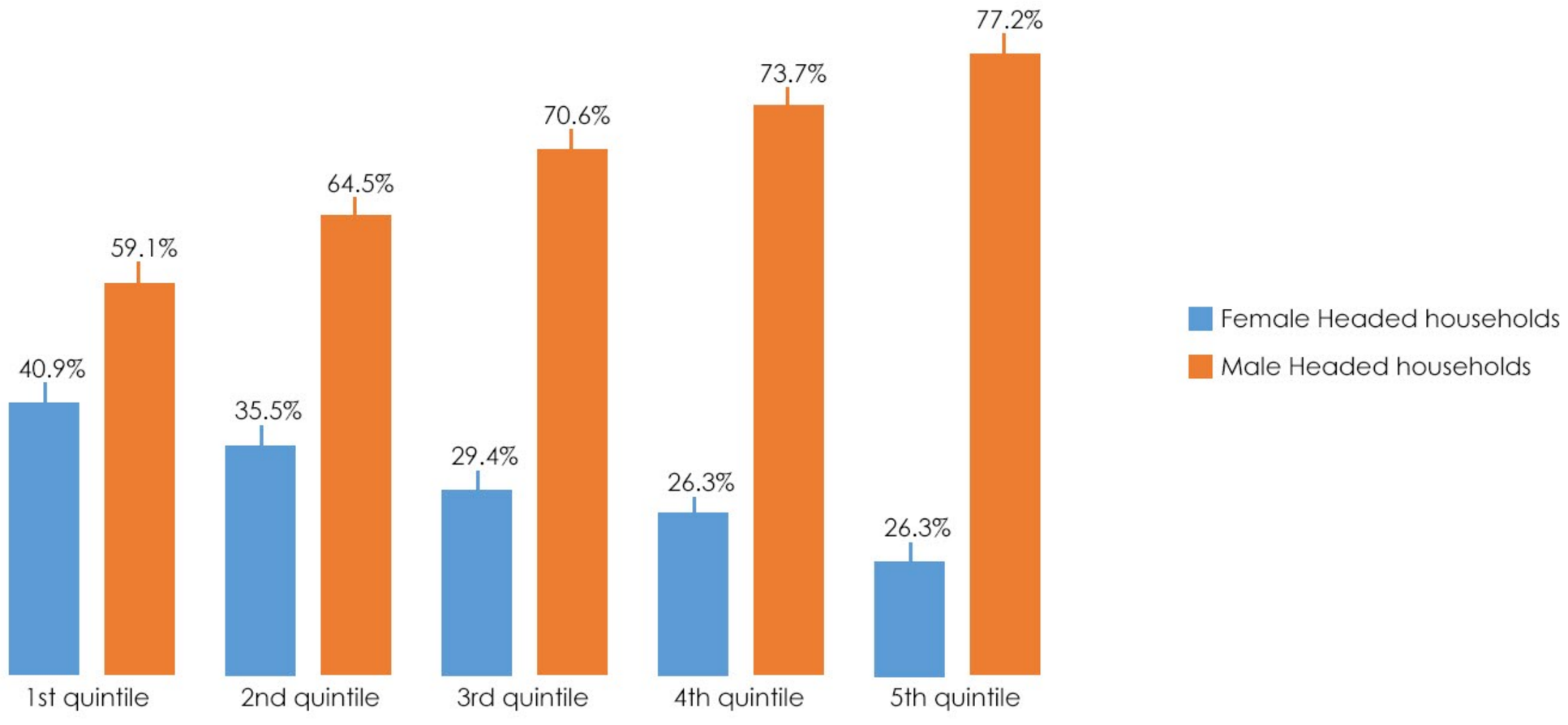
Figure 73: Distribution of male- and female-headed households at national level



Source: Malawi MTF household survey 2023.

The share of female-headed households goes down as households moves from lower to higher quintiles. For example, share of female-headed households is 40.9% in the lowest quintile and 22.8% in the highest quintile. However, the trend is opposite for male-headed households—male-headed households are concentrated more in the higher quintiles than in the lower quintiles. This means that male-headed households are better-off than female-headed households (Figure 74).

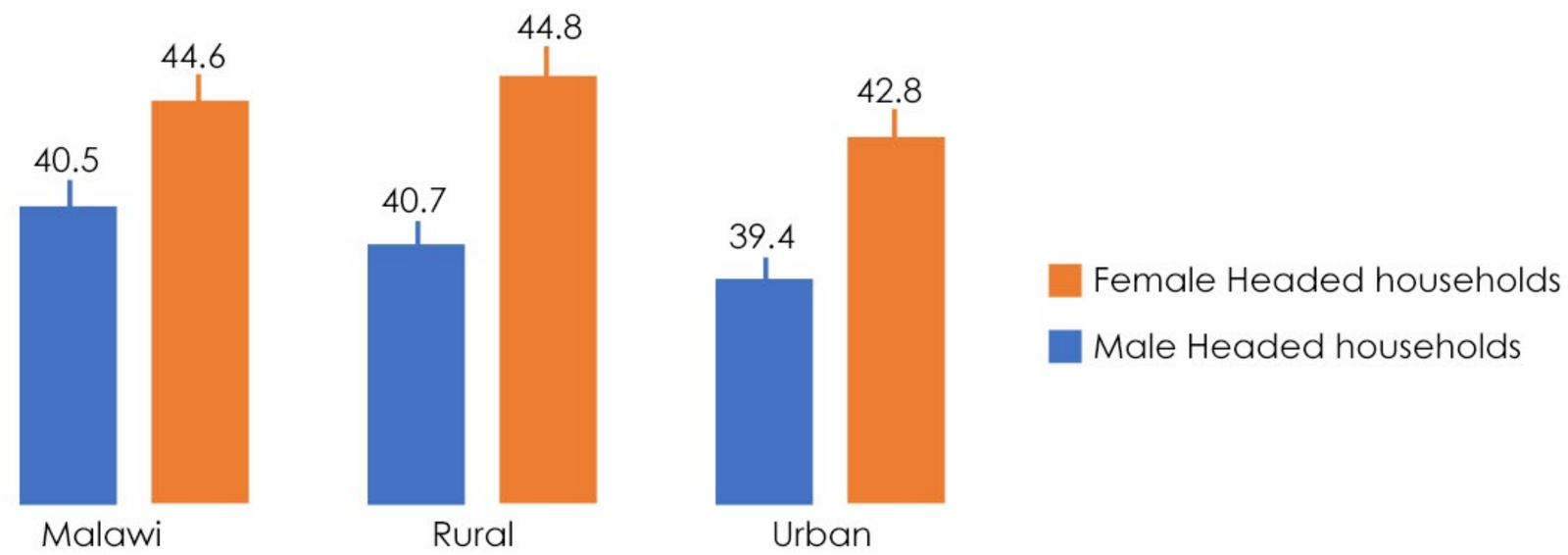
Figure 74: Distribution of male- and female-headed households by expenditure quintile



Source: Malawi MTF household survey 2023.

The average age of female heads is higher than that of male heads by about 4 years and this does not vary between urban and rural areas (Figure 75).

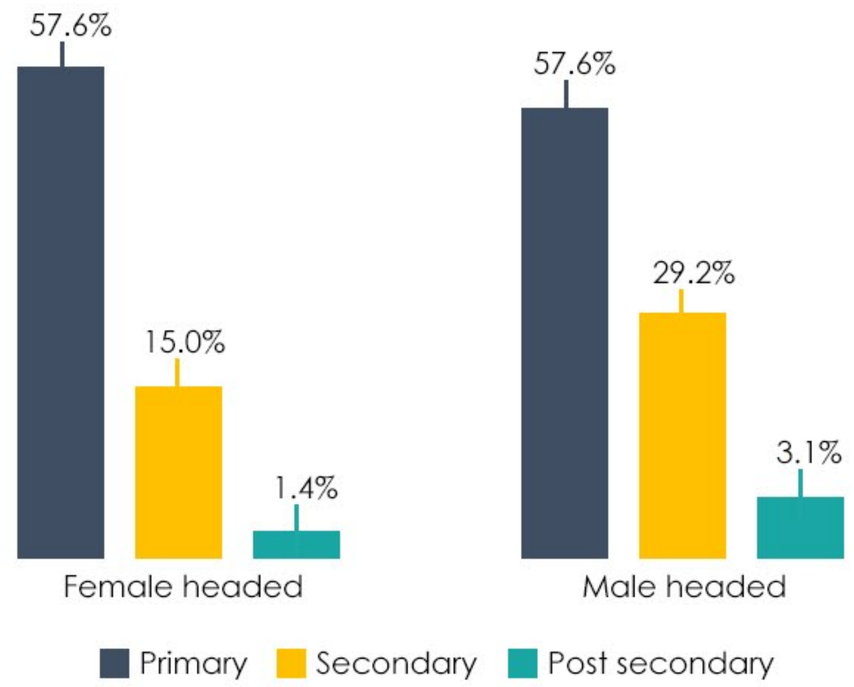
Figure 75: Average age of head for male- and female-headed households



Source: Malawi MTF household survey 2023.

Male heads tend to have a better education than female-heads—share of secondary or post-secondary completers is higher among male-headed households than among female-headed households (Figure 76).

Figure 76: Education of head for male- and female-headed households

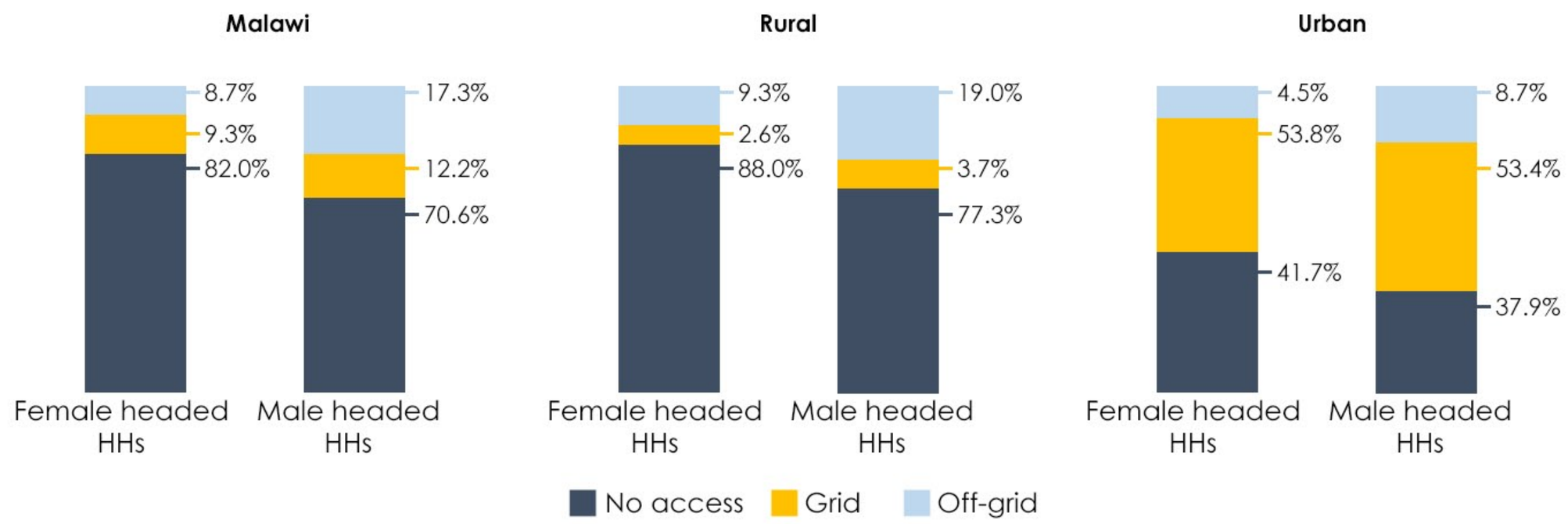


Source: Malawi MTF household survey 2023.

■ Access to electricity

Nationwide, female-headed households are less likely to have access to electricity than male-headed households (18% versus 29.4%) (Figure 77). This is mainly due to the lower access of female-headed households to off-grid electricity—more in rural areas (9.3% versus 19% for male-headed households) than in urban areas (4.5% versus 8.7% for male-headed households). Grid access is similar for both groups in urban areas (about 53%). In rural areas, female-headed households have slightly less access to grid solutions.

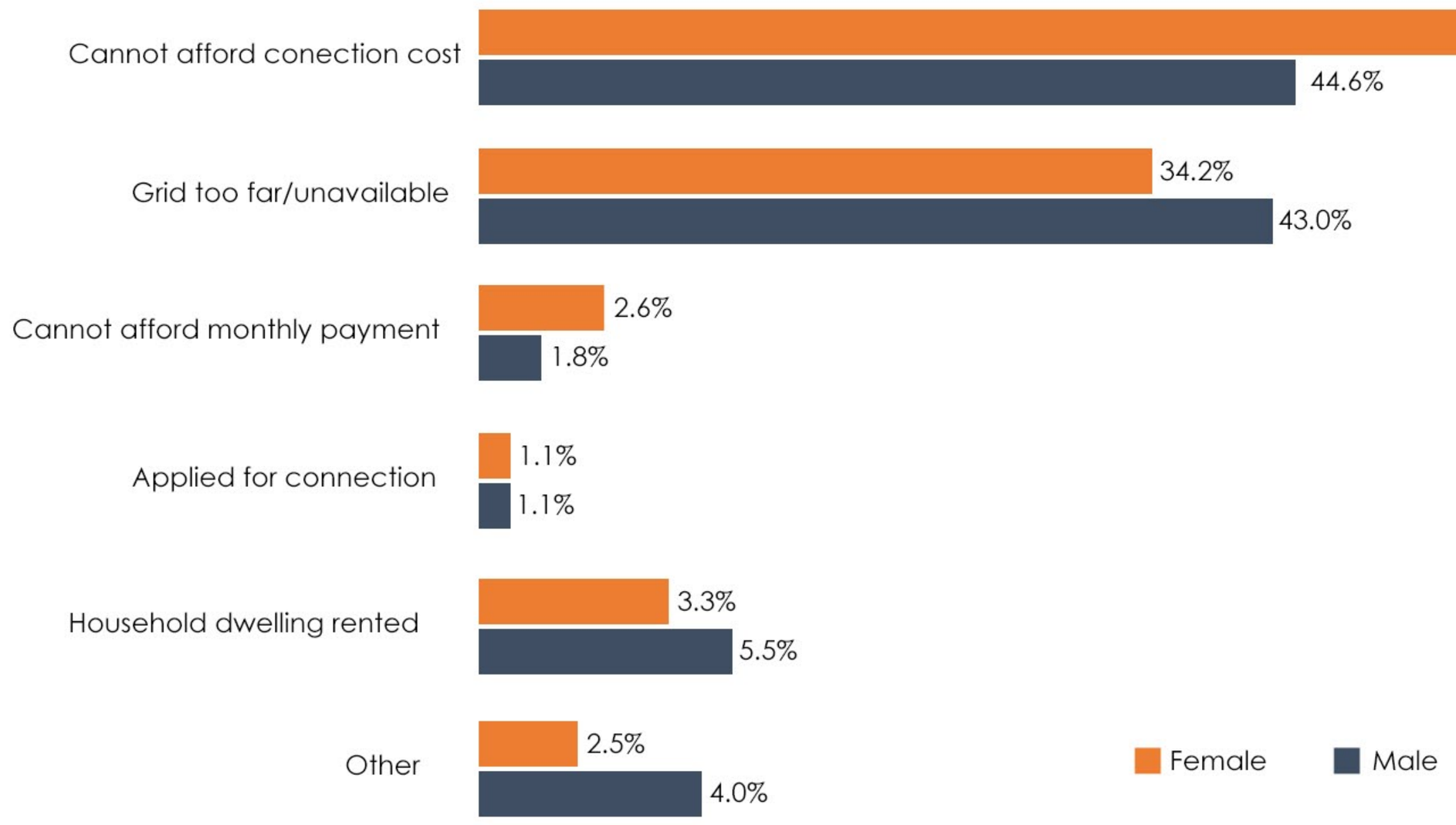
Figure 77: Main source of electricity by sex of the head at national level and by place of residence



Source: Malawi MTF household survey 2023.

Figure 78 shows that male- and female-headed households vary on reasons for households not being connected to the grid. Female-headed households are less likely than male-headed households to report distance from the grid network (34.2% versus 43%), and more likely to report connection cost (56.3% as opposed to 44.6%) as reasons for not being connected. Other factors such as monthly cost and rented dwelling contribute little to not connecting to the grid.

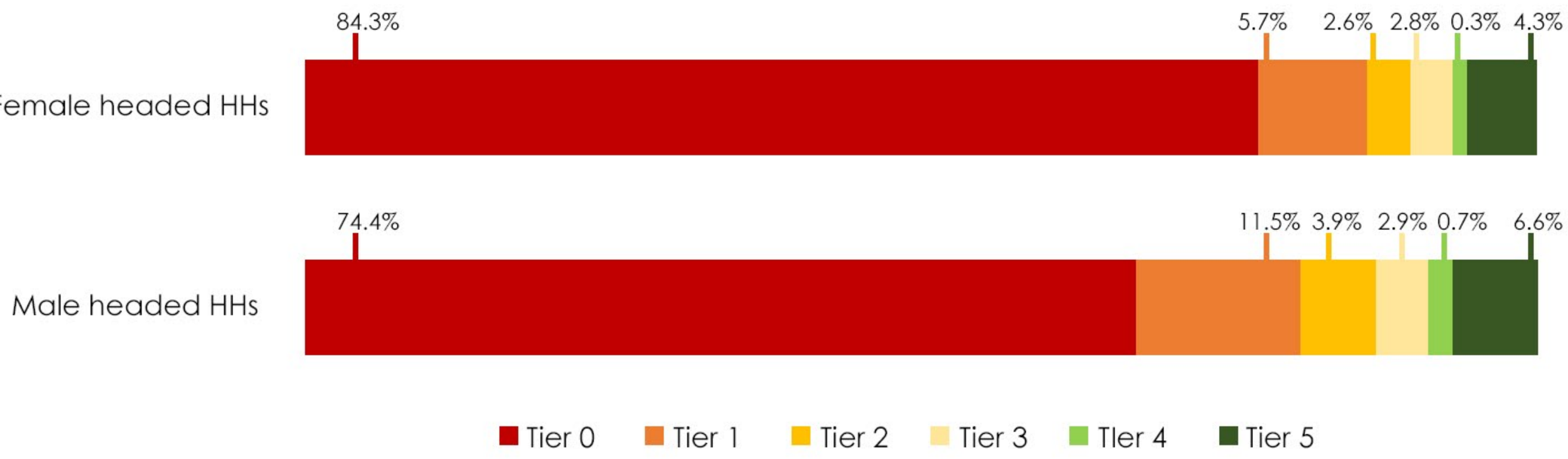
Figure 78: Reasons for not connecting to the grid by male- and female-headed households



Source: Malawi MTF household survey 2023.

The gendered pattern in binary access to electricity does not change in tiered access. As shown in Figure 79, the share of Tier 0 households among female-headed households (84.3%) is higher than that among male-headed households (74.4%). Consequently, among the male-headed households, shares of higher tiers are higher than those tiers among female-headed households.

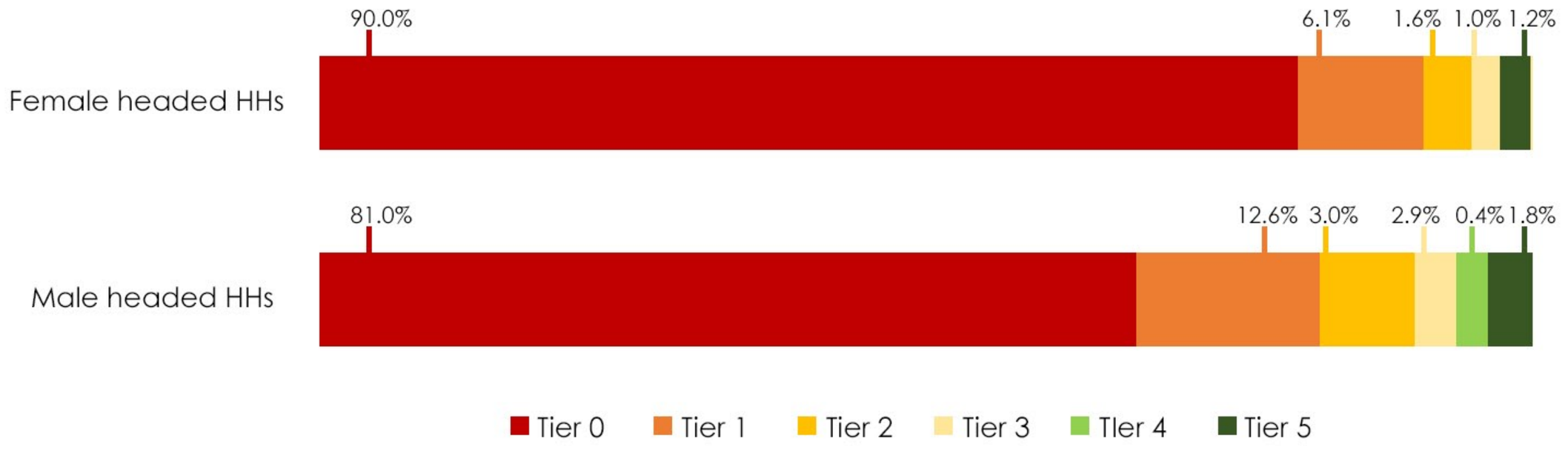
Figure 79: MTF tier distribution for electricity access by gender of the household head at national level



Source: Malawi MTF household survey 2023.

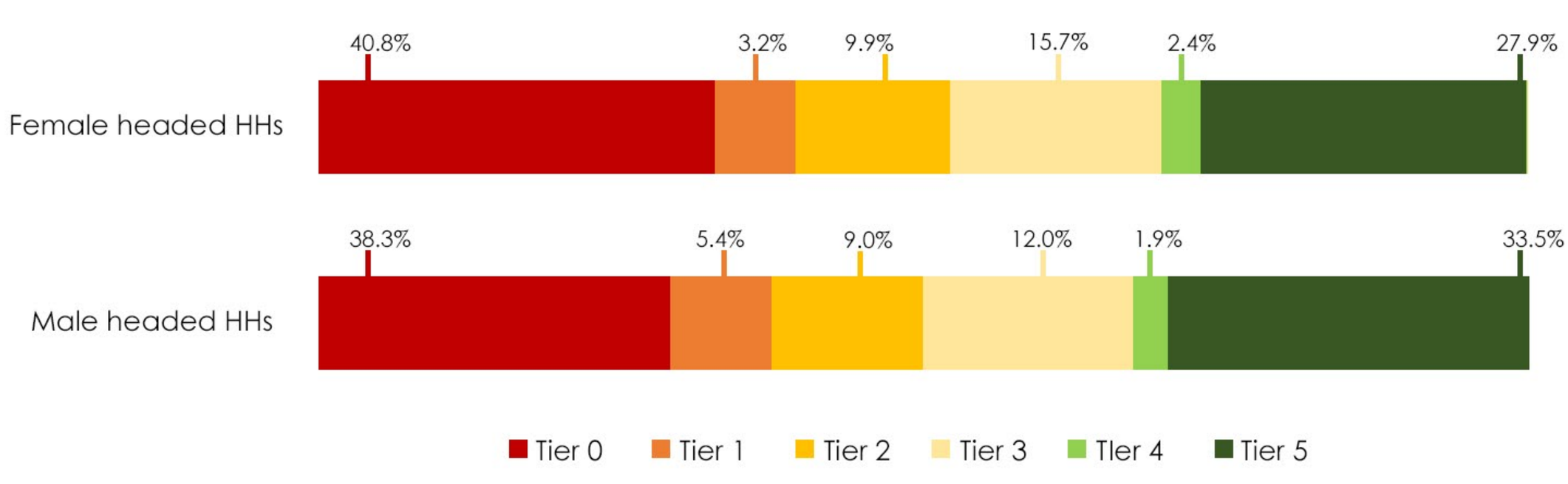
The disparity between the two types of households is mostly contributed by the disparity in rural households (Figure 80). In urban areas, access to higher tiers is higher for both female- and male-headed households and disparity is less (Figure 81).

Figure 80: MTF tier distribution for electricity access by gender of the head (Rural)



Source: Malawi MTF household survey 2023.

Figure 81: MTF tier distribution for electricity access by gender of the head (Urban)

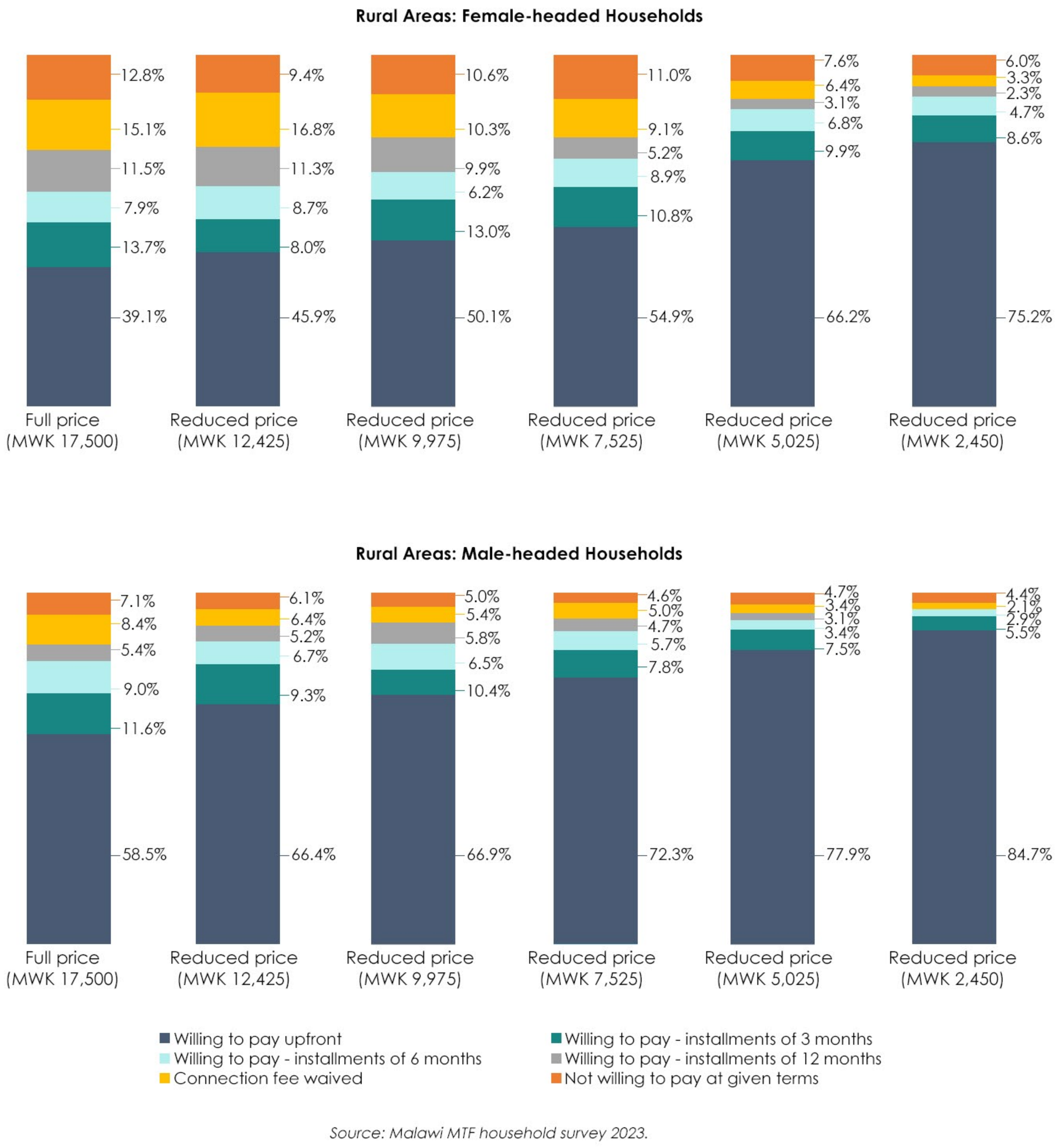


Source: Malawi MTF household survey 2023.

Willingness to pay for grid connection

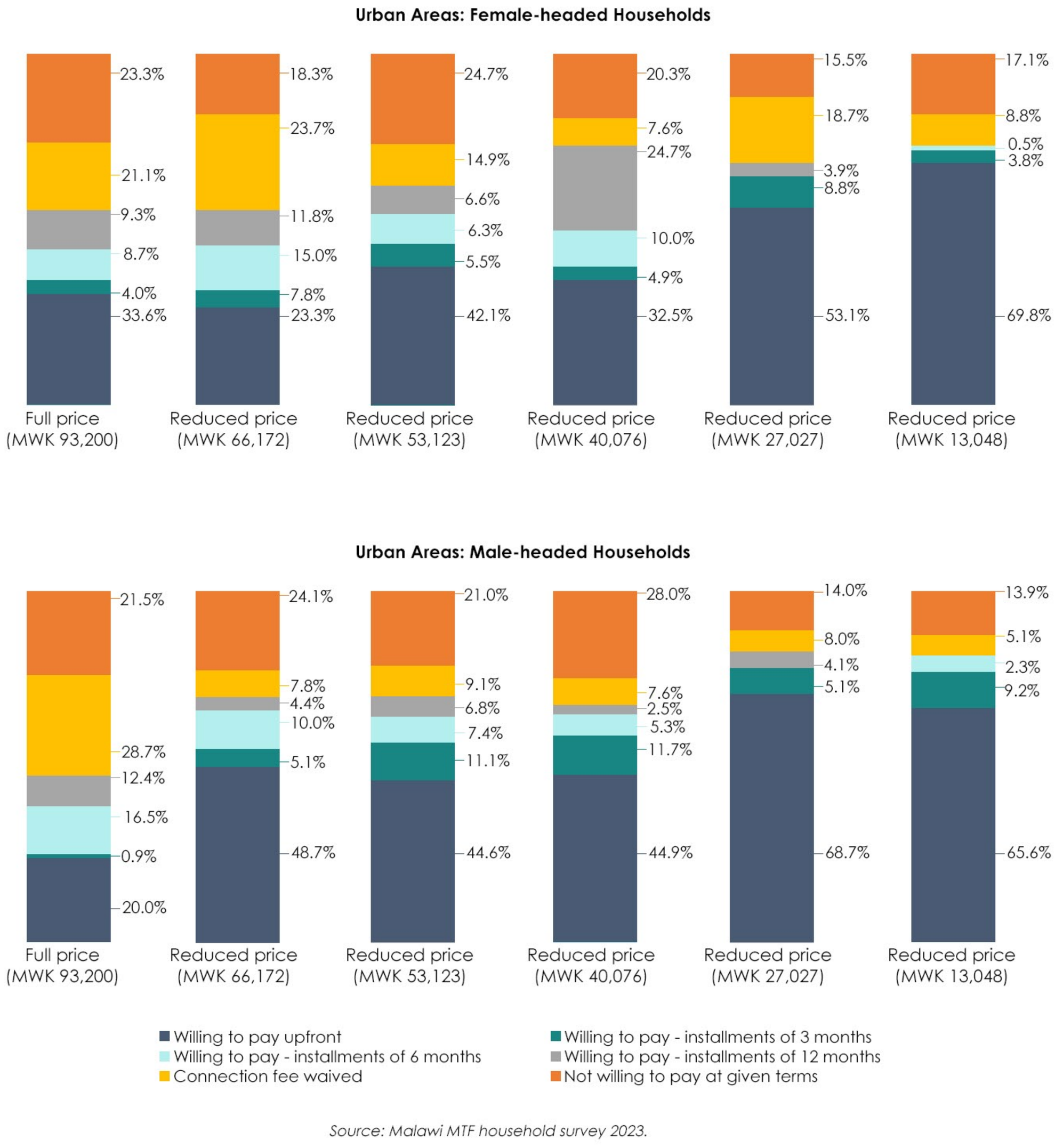
Willingness-to-pay for grid connection by male- and female-headed households was examined for rural and urban households separately as the connection cost is different between the two areas. Figure 82 shows that in rural areas, as offered cost for grid connection decreases, households are more willing to pay upfront for the connection cost. However, shares of male-headed households are higher than those of female-headed households willing to pay upfront for all offered costs. When connection fee is waived, female-headed households are more likely than male-headed households to connect for all prices. Moreover, higher shares of female-headed households report that they would never accept the offered price regardless of the payment terms. The pattern does not vary much in urban areas (Figure 83).

Figure 82: Share of male- and female-headed households willing to pay for grid connection cost (rural areas)



Source: Malawi MTF household survey 2023.

Figure 83: Share of male- and female-headed households willing to pay for grid connection cost (urban areas)

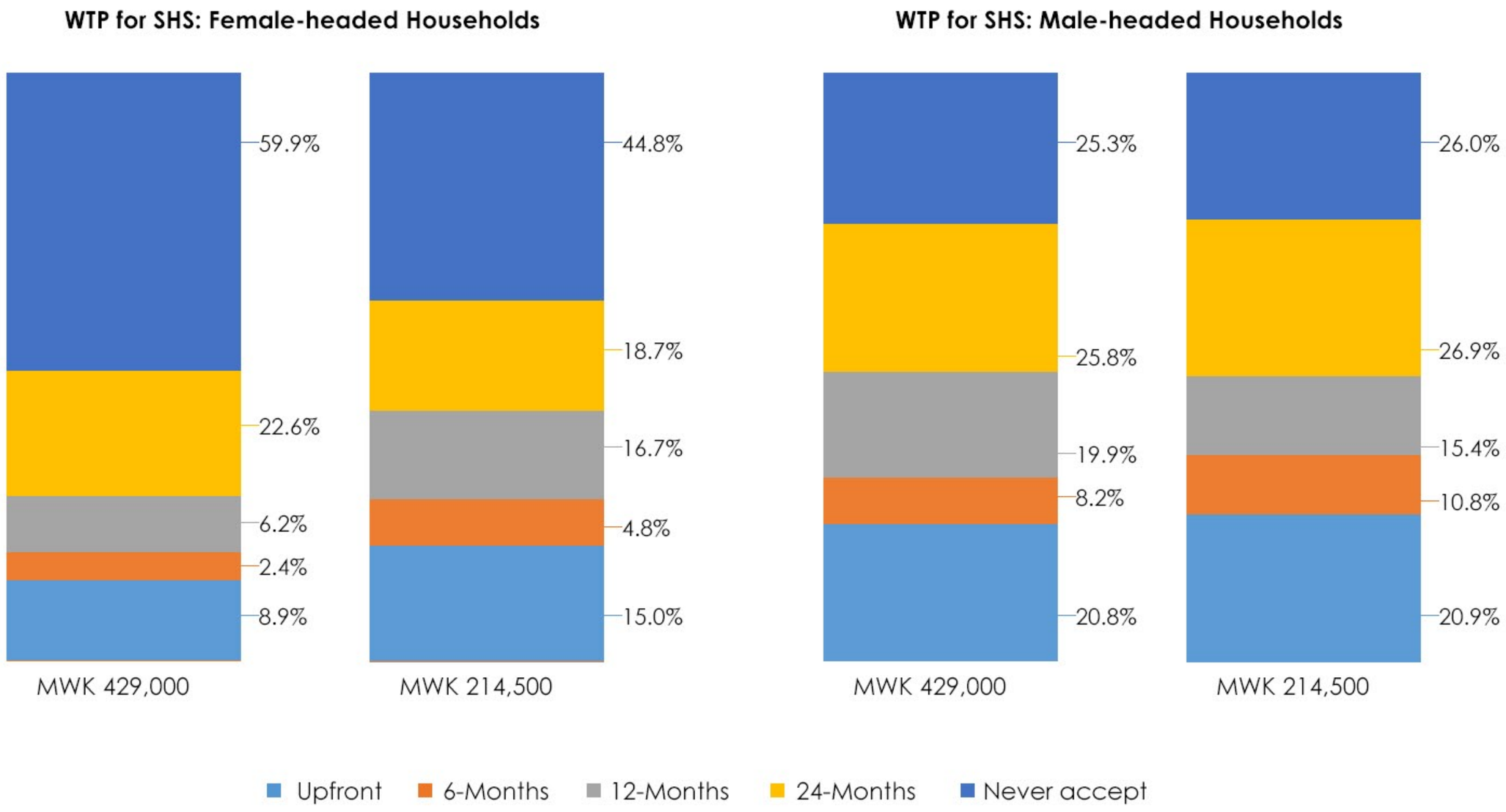


Source: Malawi MTF household survey 2023.

Willingness to pay for solar devices

Willingness-to-pay for Solar Home System (SHS) is analyzed and presented for male- and female-headed households (Figure 84). Male-headed households are more likely than female-headed households to pay upfront and for almost all the payment terms. On the other hand, female-headed households have a higher share of those not willing to accept SHS at any price.

Figure 84: Share of male- and female-headed households willing to pay for Solar Home System

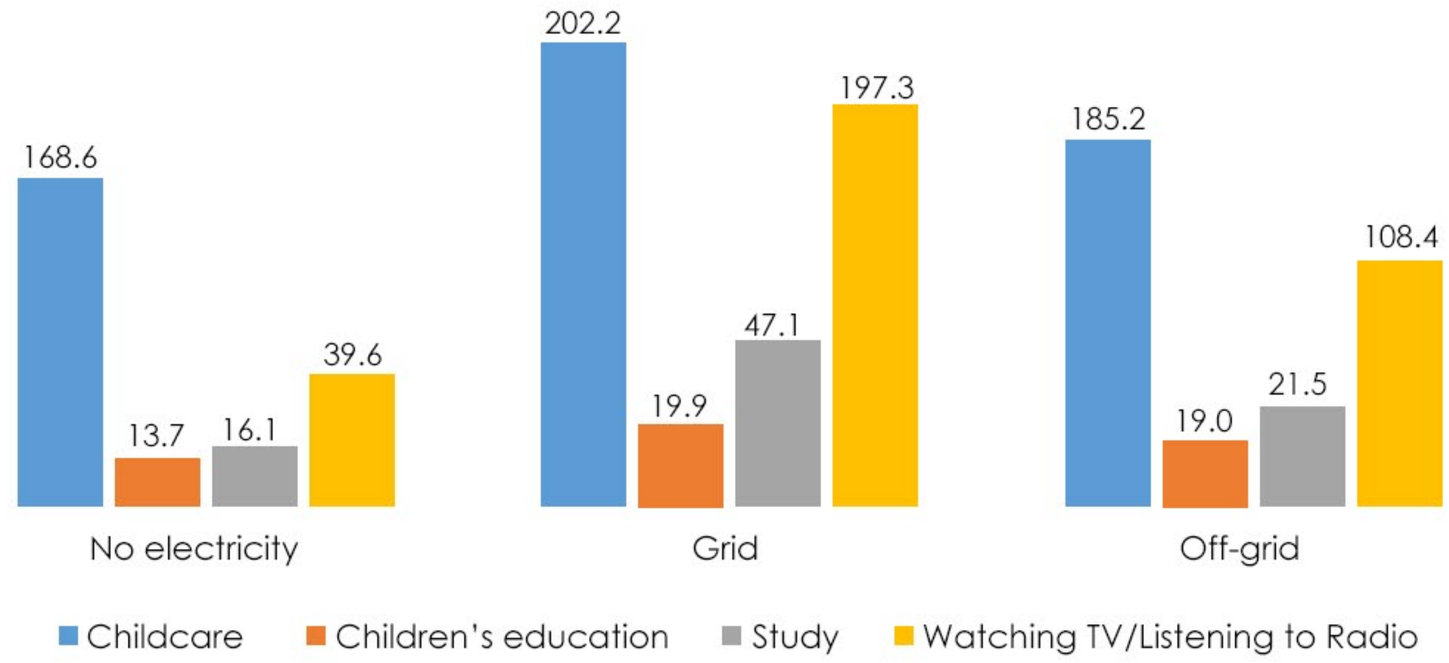


Source: Malawi MTF household survey 2023.

Women's time use and empowerment

Women's time use seems to vary by access to electricity (Figure 85). Those with access to electricity spend more time in general than others taking care of the children, helping the children with studies, and listening to the radio or watching TV. For example, women in households with grid access, off-grid access, and no electricity spend 197.3 minutes per day, 108.2 minutes per day, and 3965 minutes per day in listening to radio or watching TV, respectively.

Figure 85: Women's time use by main source of electricity (minutes per day)

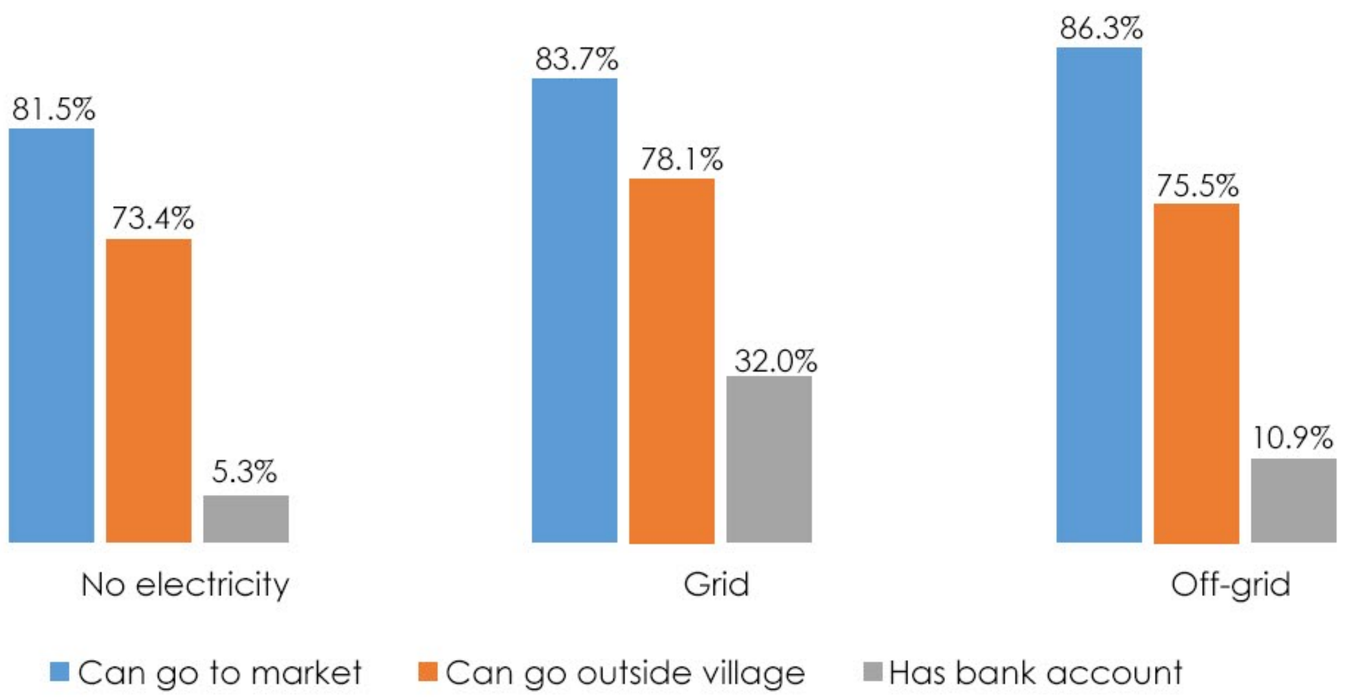


Source: Malawi MTF household survey 2023.

[8]*Households without electricity are much less likely to own a radio or a TV (it is not impossible, however, as they can have battery-operated radios or TVs), and accordingly, they do not have much of an option to enjoy those appliances. A benefit of having electricity is that it opens up ways to have entertainment or information access.*

Women in households with access to grid or off-grid sources seem to have more mobility than their counterparts in households with off-grid access, although the difference is small (Figure 86). For example, 83.7% of the women from grid-connected households and 86.3% of the women from off-grid households in Malawi can go to market places on their own, while 81.5% of the women without access to any source of electricity can do so. When it comes to having a bank account, women in grid-connected households are most likely to have it (32%), followed by those in off-grid households (10.9%) and those without access to electricity (5.3%).

Figure 86: Women's mobility and access to finance by main source of electricity

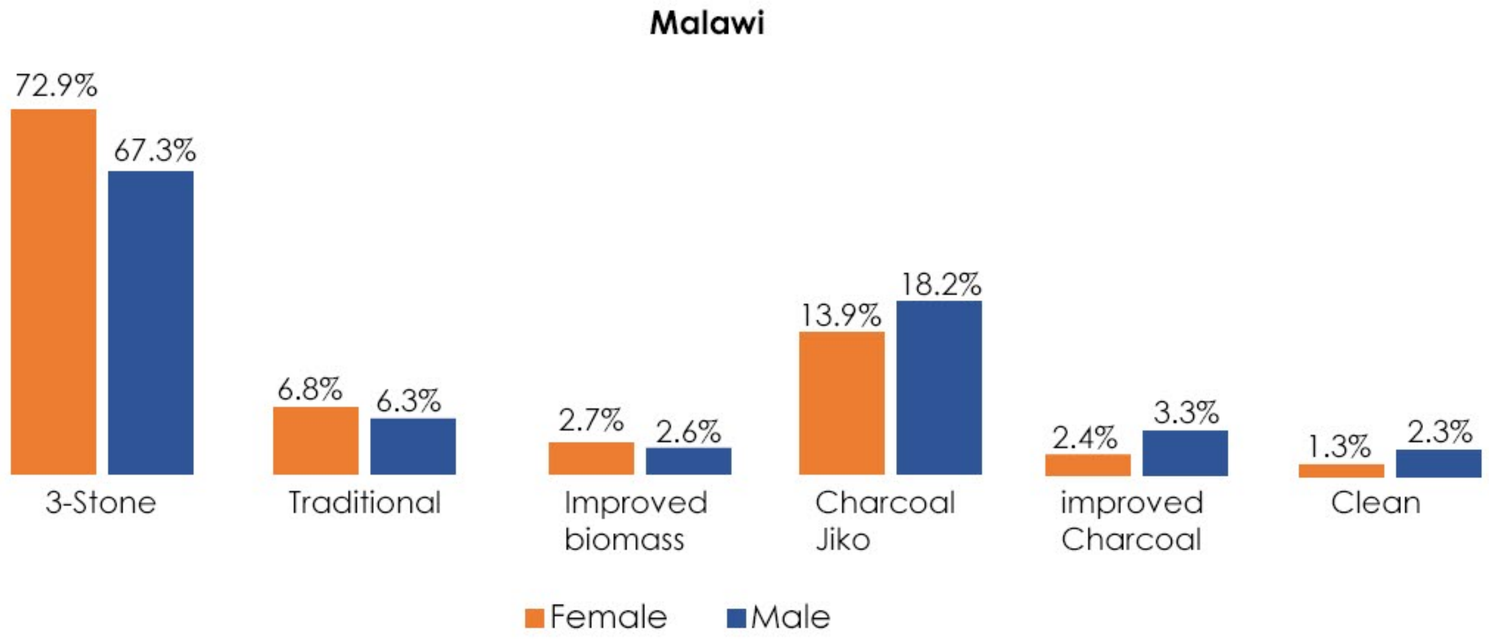


Source: Malawi MTF household survey 2023.

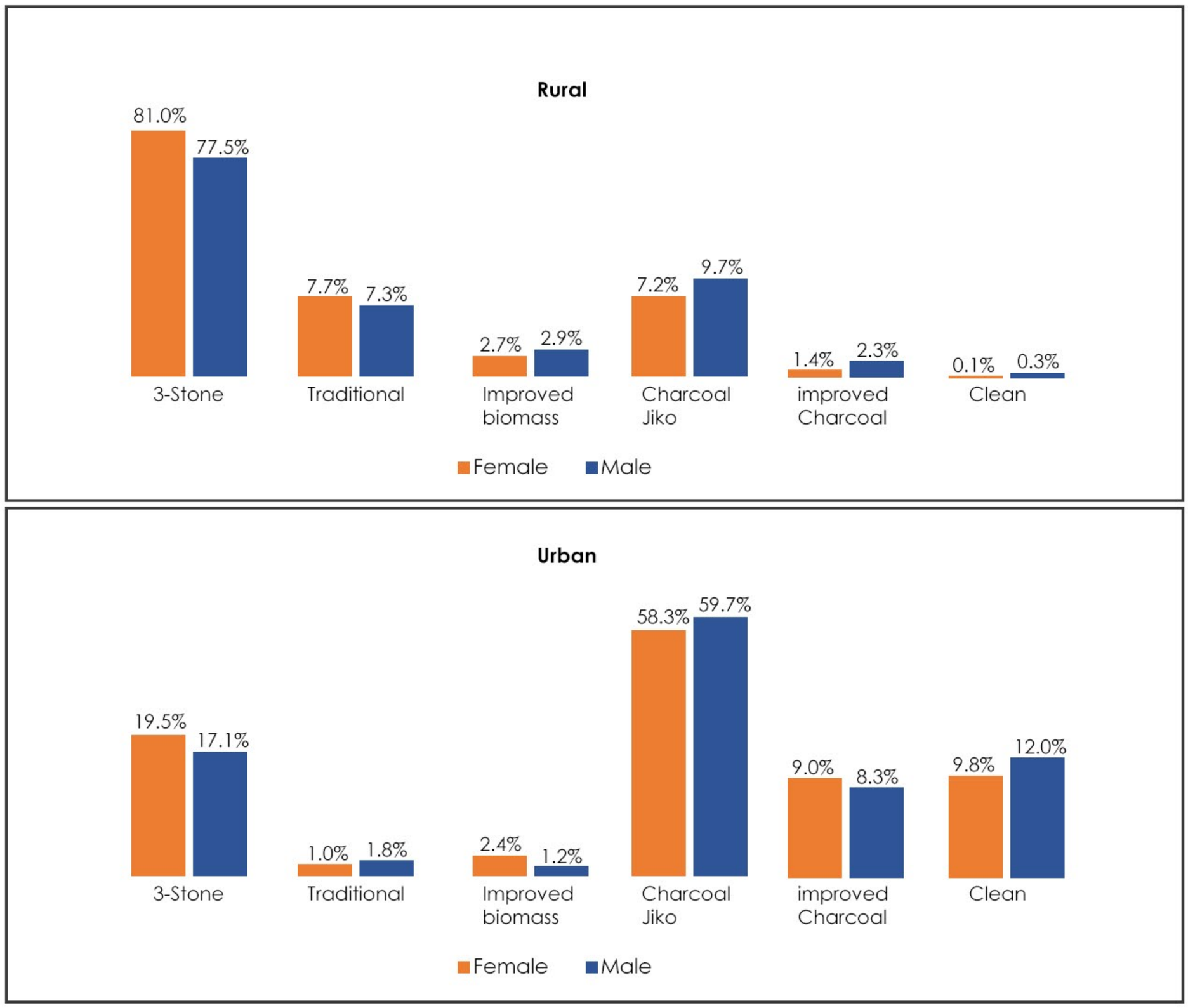
Access to cooking solutions

Female-headed households are more likely than male-headed households to use 3-stone and traditional biomass stoves, while male-headed households are more likely to use charcoal and clean stoves (Figure 87). The trend remains about the same in rural and urban areas, and use of charcoal and clean stoves is higher in urban areas than that in rural areas for both female- and male-headed households.

Figure 87: Main cookstoves by male- and female-headed households



Source: Malawi MTF household survey 2023.



Source: Malawi MTF household survey 2023.

As for MTF tier of cooking solutions, female-headed households do not vary much from male-headed households (Figure 88). Female-headed households have a slightly higher share of Tier 0 than male-headed households.

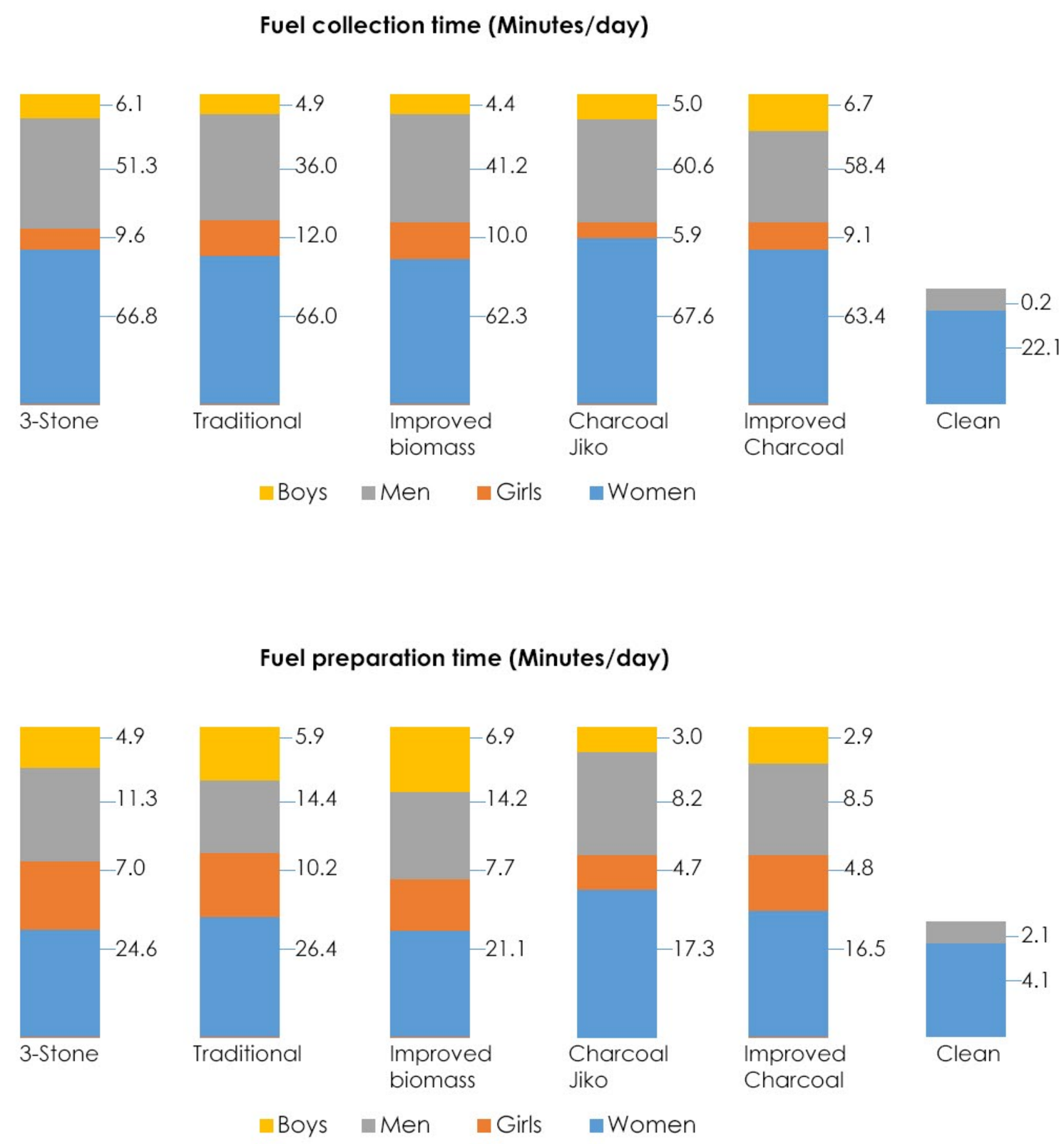
Figure 88: MTF tier of cooking solutions by male- and female-headed households

Source: Malawi MTF household survey 2023.

Time use in cooking-related activities

Except for clean cookstoves, women's fuel collection time is substantially higher, which is not surprising (Figure 89a). In Malawi, among men, women, boys and girls, women spend the highest time in fuel collection as they are the main cook. Fuel collection for clean stoves should be very low; however, clean fuel includes LPG which takes some time to procure. We see about similar pattern in fuel preparation time too (Figure 89b); however, there is a decreasing trend in fuel preparation time as main cookstoves get cleaner.

Figure 89: Time spent in cooking-related activities by women

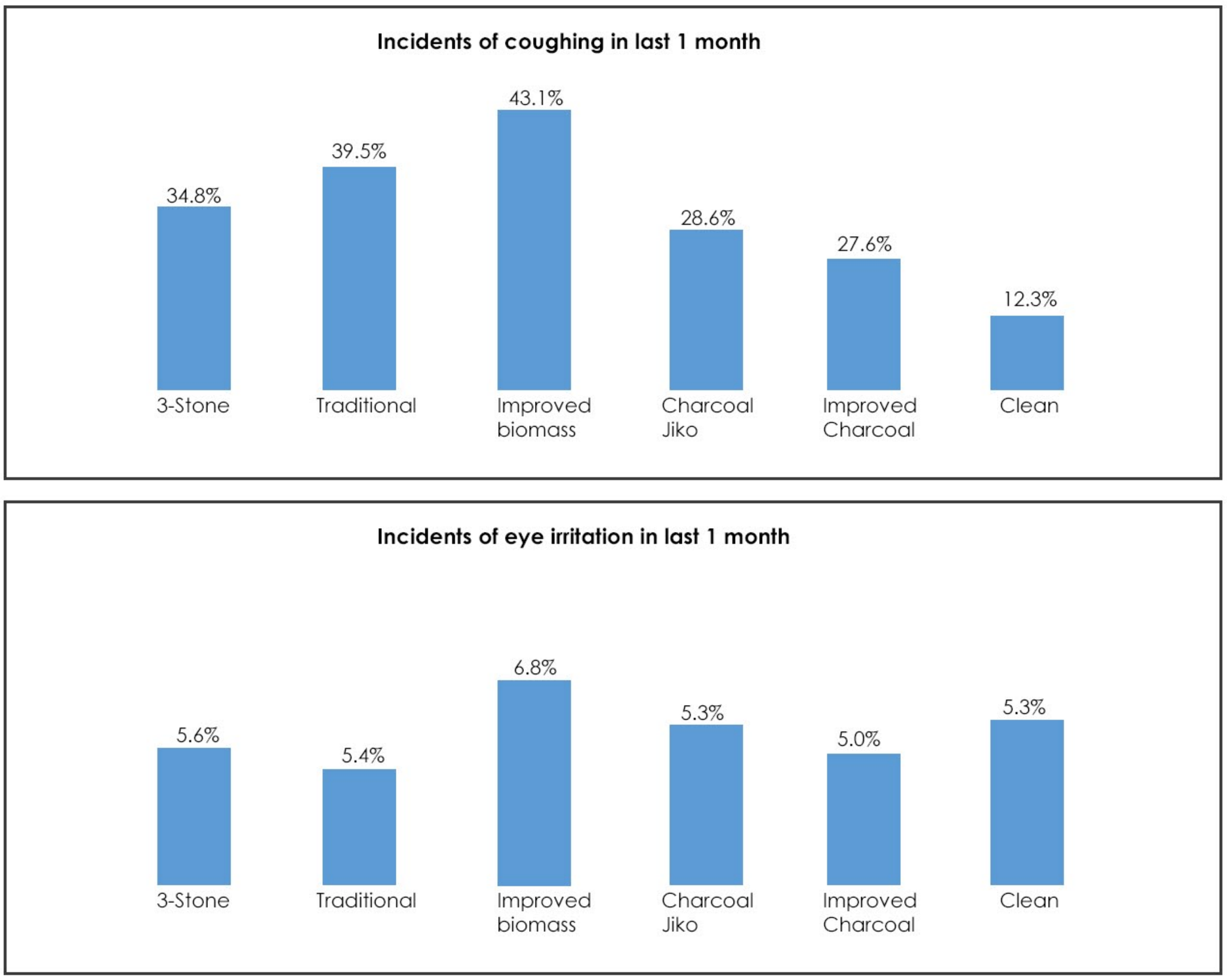


Source: Malawi MTF household survey 2023.

Health impacts

Finally, we find that women in households that use clean cookstoves report less incidence of coughing than those in households that use inferior stoves (Figure 90a). More specifically, about 12.3% women in households with clean cookstoves report having had a cough in a month before the survey, while 43.1% of women in households that use an improved cookstove and 39.5% of women in households that use traditional stoves report similar incidence of coughing. However, the pattern of eye irritation is not so consistent as the incidents are fairly similar across cookstove types.

Figure 90: Incidence of coughing and eye irritation among women by main cookstove type (percent)



Source: Malawi MTF household survey 2017.

Female-headed households have less access than male-headed households to modern cooking solutions. And in terms of access to electricity, female-headed households are also lagging behind male-headed households. Women in households with grid connectivity spend more time in rewarding activities and have more freedom in mobility and decision making than their counterparts in households with off-grid or no access to electricity. Finally, women in households that use clean cookstoves spend less time in cooking or fuel collection and have had less incidences of coughing than those in households that use biomass stoves. While we have not established any causality, such findings are illuminating. Policy makers have to ensure that while improving access to modern energy, women must not fall behind.

ANNEX 1. MULTI-TIER FRAMEWORKS

Table A1.1. Multi-Tier Framework for measuring access to electricity

Attribute		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Power capacity ratings (W or daily Wh)	Less than 3W	At least 3W	At least 50W	At least 200W	At least 800W	At least 2kW
		Less than 12Wh	At least 12Wh	At least 200Wh	At least 1kWh	At least 3.4kWh	At least 8.2kWh
	Services		Lighting of 1,000 lmhr per day	Electrical lighting, air circulation, television and phone charging are possible			
Availability	Daily availability	Less than 4 hours	At least 4 hours	At least 4 hours	At least 8 hours	At least 16 hours	At least 23 hours
	Evening availability	Less than 1 hour	At least 1 hour	At least 2 hours	At least 3 hours	At least 4 hours	At least 4 hours
Reliability						At most 14 disruptions per week	At most 3 disruptions per week with total duration of less than 2 hours
Quality							Volatage problems do not affect the use of desired appliances
Affordability							Cost of a standard consumption package of 365kWh per year is less than 5% of household income
Formality							Bill is paid to the utility, prepaid card seller or authorized representative
Health & Safety							Absence of past accidents and perception of high risk in the future

a. Previously referred to as "Duration" in the 2015 Beyond Connections report, this MTF attribute is now referred to as "Availability", examining access to electricity through levels of "Duration" (day and evening).

Source: Bhatia and Angelou 2015.

ANNEX 1. MULTI-TIER FRAMEWORKS

Table A1.2. Multi-Tier Framework for measuring access to modern energy cooking solutions

Attribute		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Cooking exposure	Emission: Fuel	Determined by ciombination of fuel and stove design, ventilation of cooking space & contact time					
		Firewood, dung, twigs, leaves, rice husks, processed biomass pellets or briquettes, charcoal, kerosene				Biogas, ethanol, high quality processed biomass pelletes or briquettes	Electricity, solar, LPG
	Emission: Stove design	3-Stone fire, tripod, flat mud ring, traditional charcoal stove	Conventional or old generation ICS	ICS + chimney, rocket stove or ICS + insulation	Rocket stove with high insulation or with chimney, advanced insulation charcoal stoves	Rocket stove with chimney (well sealed), rocket stove gasifier, advanced secondary air charcoal, forced air	
	Ventilation: Volume of kitchen	Less than 5 m3	More than 5 m3	More than 10 m3	More than 20 m3	More than 40 m3	Open air
	Ventilation: Structure	No opening except for the door	1 window	More than 1 window	Significant openings (large openings below or above height of the door)	Veranda or a hood is used to extract the smoke	Open air
	Ventilation Level	Bad	Bad	Bad	Average	Good	Good
	Contact time	More than 7.5 hours	Less than 7.5 hours	Less than 6 hours	Less than 4.5 hours	Less than 3 hours	Less than 1.5 hours
		Bad	Bad	Bad	Average	Good	Good
Cookstove efficiency	ISO's Voluntary Performance targets (TBC)	Less than 10%	More than 10%	More than 20%	More than 30%	More than 40%	More than 50%
Convenience	Fuel acquisition (through collection or purchase) and preparation time (hours per week)			Less than 7 hours	Less than 3 hours	Less than 1.5 hours	Less than 0.5 hour
	Stove preparation time (minutes per meal)			Less than 15 minutes	Less than 10 minutes	Less than 5 minutes	Less than 2 minutes
Safety of primary cookstove							No serious acidents over the past year
Affordability							Levelized cost of cooking solution (cookstove plus fuel) less than 5% of household income
Availability						Primary fuel fuel is readily available 80% of the year	Primary fuel is readily available throughout the year

a. Not used in the analysis of Cooking Exposure in Malawi.
b. Not used to calculate an individual stove's tier for Cooking Exposure for individual stoves but used to weight each stove's tier for Cooking Exposure in the calculation of a household's tier for Cooking Exposure.

Source: Malawi MTF household survey 2023.

ANNEX 2. SAMPLING PROCEDURE

Sampling strategy

The sample size was designed to obtain precise estimates that are representative at national level, rural and urban areas, regional level and district level. However, due to the low electrification rate in Malawi, presenting district level electricity access results using the MTF required oversampling in the rural areas which was costly. Therefore, the MTF electricity access results are robust and presented at national level, rural and urban areas and at regional level.

Malawi has three administrative regions, 28 districts and 4 cities. The administrative areas were further subdivided into Census Enumeration Areas (EAs) by the NSO for purposes of conducting the Population and Housing Census (PHC). An Enumeration Area is a smallest demarcated geographical statistical unit which is a group of a number of adjacent households which can be covered by 1 enumerator during the Population and Housing Census. It mostly consists of 200 to 250 households, however, depending on the terrain and population density, the number of households can be fewer or more. In the 2018 PHC, a total of 18,463 Enumerations Areas were demarcated. These EAs are used as Primary Sampling Units (PSU) for sample surveys.

The sample frame for the Malawi MTF survey is based on the 2018 Malawi Population and Housing Census as it has the most recently updated Enumeration Areas. A sampling frame is a complete list of distinct and distinguishable units in a target population from which a sample is selected.

Stratification

All 28 districts in Malawi were selected for the survey. Districts where the four cities of Malawi are located were split into urban and rural, resulting into 4 additional survey districts. In total, the survey covered 32 survey districts or strata. The sample of households was proportionally distributed with respect to number of households in the district. Probability proportional to size (PPS) was used to determine sample size for the district and for rural and urban. The households were selected using a two-stage sampling procedure. The first stage involved selection of primary sampling units (PSUs) which are the census enumerations areas defined for the 2018 PHC. The second stage involved selection of households in each selected EA. A total of 20 households were selected from each EA using simple random sampling (SRS). It has to be noted that oversampling of rural households was required to capture specific issues on energy in more granular strata such as district level.

Urban and Rural stratification

In this survey, urban areas were only the four designated cities of Blantyre City, Lilongwe City, Mzuzu City, and Zomba City. All other areas were considered rural.

Household listing

Although the sample was drawn from the most recent census, the 2018 Population and Housing Census, households may have moved in and out of the enumeration areas at the time of the survey. As such, a listing of households was conducted in all the selected EAs prior to selecting households to have a more recent number of households in the enumeration areas.

Household selection

A total of 20 households were selected per EA. These households were randomly selected from the list of all households in an EA from the listing exercise.

Sample size calculation

Sample size calculation was done using the formula below.

$$n = \frac{z^2 r(1-r)[1+\rho(m-1)]k}{e^2}$$

Where n is the sample size in terms of number of households to be selected, z is standardized z-score (normal variate) corresponding to 95% confidence interval. Estimate of the indicator of interest to be measured by the survey is denoted by r and is taken to be 0.5 using MTF suggested prevalence rate to achieve minimum margin of error and the intra-cluster correlation coefficient ρ=0.45 selected using knowledge of the characteristics of infrastructure. The number of households to be selected per EA, m, and 16 households are proposed. The factor accounting for non-response, k, is calculated to be 1.1 considering that in developing countries the non-response rate is typically 10% or less. The margin of error,e, is taken to be 0.030 (97% confidence). Using these values, the sample size is 9,200 households and Table 3.1 provides a summary of the sample distribution.

Sample weighting calculations

Sample weights are important in analysing household survey data. Due to this fact, sample weighting was conducted to reduce bias due to imperfections in the sample. Considering that a two-stage stratification was used, the sample design weight was calculated as $w_i = 1/p$ where p is the probability of a unit to be included in the sample. We will focus on design weight, weight attributable to the compensation for non-coverage and weight attributable to compensation for non-response. Although sample weights calculation complicates the survey process, they were incorporated in this survey. Calculation of the design weight was done as follows.

- Firstly, the probability of selecting a certain EA in a district was computed, which is the first stage probability calculated as: the number of EAs selected in a district multiplied by the measure of size of the EA divided by the total number of households in that district.

- Then the probability of selecting the household within the EA was calculated, which is stage 2. This is simply the number of households selected in the EA in a certain district divided by the total number of households listed in the EA in that district.

- Then the overall selection probability of each household in an EA of a certain district was calculated as a product of values found in (a) and (b).

- The design weight as for each household in an EA of a certain district was calculated as the inverse of the overall selection probability.

Correction for non-response was done at EA and household levels. EA response rate, N_EA, was calculated as the number of EAs selected, n_hi^* in stratum h, divided by the number of EAs interviewed, n_hi, in stratum h. Equation (1) represents EA response rate calculation. Household level response rate, N_HH, was the number of households selected in a specific EA, m_hi^*, of stratum h, divided by the number of households interviewed in that specific EA, m_h, of stratum h. Equation (2) represents household response rate. The design weight, w_hij, in stratum h is calculated by using Equation (3) where p_1 " and " p_2 are the probabilities of selection of an EA and household, respectively.

1) $N_{EA} = \frac{n^*_{hi}}{n_{hi}}$

2) $N_{HH} = \frac{m^*_{hi}}{m_{hi}}$

3) $w_{hij} = \frac{m^*_{hi} \times n^*_{hi}}{p_1 \times p_2}$

National household sample size distribution

No	District	Population	Sample	No. of EAs
1	Balaka	490,804	240	12
2	Blantyre City	858,076	420	21
3	Blantyre Rural	497,589	240	12
4	Chikhwawa	615,685	300	15
5	Chiradzulu	383,559	180	9
6	Chitipa	251,830	140	7
7	Dedza	908,487	440	22
8	Dowa	857,510	400	20
9	Karonga	397,097	220	11
10	Kasungu	928,471	420	21
11	Likoma (Over Sampled)	15,691	80	4
12	Lilongwe City	1,126,143	460	23
13	Lilongwe Rural	1,791,821	800	40
14	Machinga	845,076	400	20
15	Mangochi	1,305,432	540	27
16	Mchinji	658,470	300	15
17	Mulanje	749,359	340	17
18	Mwanza	147,976	80	4
19	Mzimba	1,001,929	420	21
20	Mzuzu City	261,578	160	8
21	Neno	150,211	80	4
22	Nkhata Bay	304,556	160	8
23	Nkhotakota	428,355	200	10
24	Nsanje	321,535	160	8
25	Ntcheu	735,941	360	18
26	Ntchisi	356,232	160	8
27	Phalombe	477,929	220	11
28	Rumphi	248,930	140	7
29	Salima	535,981	280	14
30	Thyolo	770,860	380	19
31	Zomba City (over sam)	114,464	160	8
32	Zomba Rural	814,315	320	16
	TOTAL	**19,351,892**	**9200**	**460**

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