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Access to Electricity and Modern Cooking Solutions in Mozambique

Multi-Tier Framework (MTF). Impact of Access to Sustainable Energy Survey, Mozambique (IASES 2022)

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Acronyms and Abbreviations

EA	Enumeration Area
Cont	Continued
EDM	Electricidade de Moçambique, public enterprise
HH	Households
IASES	Impact of Access to Sustainable Energy Survey
INE	Instituto Nacional de Estatística/National Statistical Institute
Km²	Square kilometer
KW	Kilowatt
KWh	Kilowatt-hour
LPG	Liquefied petroleum gas
MIREME	Ministry of mineral resources and Energy
N	Total population
Norad	Norwegian Agency for Development Cooperation
Pop	Population
PSU	Primary sampling unit
SEN	Sistema Estatístico Nacional/National Statistical System
SSB	Statistisk sentralbyrå/Statistics Norway
W	Watts
Wh	Watt-hour
WB	World Bank

Symbols in tables	Symbol
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Preface

The 2022 Impact of Access to Sustainable Energy Survey (IASES) was implemented by the National Statistical Institute of Mozambique, Instituto Nacional de Estatistica, Mozambique (INE) and Statistics Norway (SSB) in collaboration with the National Electricity Authorities, Electricidade de Moçambique, Empresa Pública (EDM, EP) and the Ministry of Mineral Resources and Energy (MIREME), administrative structures at the central, provincial, district, municipal and local levels.

The funding for the 2021-22 IASES was provided by the Norwegian Agency for Development Cooperation (Norad).

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Statistics Norway, 18 September 2024

Lasse Sandberg

Abstract

Instituto Nacional de Estatistica (INE) and Statistics Norway (SSB) conducted a survey named Impact of Access to Sustainable Energy Survey (IASES) from 2019 to 2022 in Mozambique. The survey was funded by the Norwegian Agency for Development Cooperation (Norad) and received in kind support from the Government of Mozambique. The current report builds on the Sustainable Development Goal number 7 (SDG7.1) and its indicators which articulates on the need to ensure access to affordable, reliable, sustainable and modern energy and cooking solutions for all by 2030.

Summary

Background and Purpose:

- **The Statistics Agency of Mozambique (INE)** conducted a survey on access to clean energy (IASES) in collaboration with **Statistics Norway (SSB).** This is the first time the survey was conducted in Mozambique. It was funded by **Norad**. A representative sample of households in Mozambique was drawn. These households were interviewed about their access to (clean) energy in the form of electricity and heat sources for preparing food. The sample was drawn so that it is representative both at the national and regional level – Mozambique is divided into 11 provinces. In total, data were collected from **6 364 households**.
- **The study** aims to capture the multidimensional access to modern energy sources, where access is measured by, for example, quantity, stability and affordability. This is more advanced compared to the traditional statistical approach that usually only covers the "yes-no" information about the energy source for lighting and cooking.

Main findings:

- The report presents key findings from the survey on households' access to (sustainable) energy for electricity and cooking, as well as the quality of the access.

Access to power:

- **32% of households** in Mozambique are connected to the electricity grid, and there are large differences between urban (71%) and rural areas (13%).
- **The capital Maputo** differs from the rest of the country in that almost all households are connected to the power grid, while the provinces of Tete and Zambezia have the lowest connection rates.
- A general pattern is that the degree of connectivity decreases from south to north, and that there are large differences between urban and rural areas across the country**.**

Other sources of electricity:

- **Solar energy** is a major source in rural areas, with 11% of households using solar systems.
- In the province of Inhambane**, 23%** of households have solar systems, which is the highest proportion of solar cells at the provincial level.

Changes over time:

- There has been an increase in connectivity to the power grid, especially in urban areas. Here, 50 per cent of households were connected to the electricity grid in 2017 (5 years ago), while this has increased to 71 per cent in 2022.
- The corresponding increase in rural areas is more moderate, and the share of households with photovoltaic systems has increased from 4% to 11%.

Future connection to the mains:

- A large proportion of both local communities and households expect that they will be connected to the electricity grid within two years. This is particularly true in rural areas, where the degree of connectivity is currently low.

Access to electricity (Tier access):

- **57% of households** in Mozambique have no or very limited access to electricity.
- Only **3%** have full access (level 5), while **7%** are at level 4 or 5.

Reliability and quality:

- **65%** of households experience frequent power outages, placing them in Tier 3.
- **20%** report voltage problems that can damage electrical appliances.

Economic Availability:

- Many households have problems paying for their electricity consumption, which means that they fall down to level 2.

Geographical differences:

- Access to electricity is lowest in the northern parts of the country and increases towards the south.
- There are significant differences between urban and rural areas, with more households in rural areas being in Tier 0.

Chapter 4 Heat Sources for Cooking

- **70%** of households use traditional three-stone stoves. This is especially true in rural areas, where almost 90 percent use three-stone stoves.
- **20%** of all households use simple charcoal burners, while only **10%** have improved furnace solutions.

Geographical differences:

- In Maputo city, almost no one uses three-stone stoves, while in rural areas, the proportion is almost **90%.**
- Maputo province has the lowest proportion of three-stone kilns in rural areas at **50%.**

Access to clean heat sources:

- Access to clean cooking solutions is very low, with less than **3%** of the population having access to such solutions.

Chapter 5 **Access to clean heat sources for cooking**:

- **90%** of households do not get higher than Tier 0 when it comes to cooking oven solutions. This means that households' access to clean heat sources and energy-efficient stoves is very limited.
- Only **10%** of households are above Tier 0, mainly due to low-energy heaters. This is because very few

Geographical differences:

- In urban areas, **25%** of households are at Tier 1 or above, while in rural areas, almost all are at Tier 0.
- In Maputo city, over **50%** of households are on level 3, which is significantly better than other areas.

Safety and economy:

- **Almost none (2%)** households report serious accidents related to cooking.
- **64%** of households report that the cost of their cooking oven solution is affordable.

Relationships between access to electricity and furnace solutions

- Households with good access to electricity often have a better furnace solution than others. Households without electricity rarely have anything other than a three-stone oven to prepare food.
- **Geographical differences**: In urban areas, especially in Maputo, there are more households with both electricity and improved cooking solutions compared to rural areas.
- **General access to clean energy**: Access to clean energy is generally low in Mozambique, with 56% of households having neither electricity nor improved cooking solutions.

Contents

1. Introduction

Mozambique, through Instituto Nacional de Estatistica (INE), conducted the field work of the Impact of Access to Clean Energy Survey (IASES) for the first time in 2022 in collaboration with Statistics Norway (SSB). The survey was funded by the Norwegian Agency for Development Cooperation (Norad).

In the process of conducting the survey, all energy sector agencies in Mozambique were involved. This includes the National Electricity Authorities, Electricidade de Moçambique (EDM), Empresa Pública (EP) and the Ministry of Mineral Resources and Energy (MIREME), and administrative structures at the central, provincial, district, municipal and local levels.

The results from 2022 - IASES will be used to monitor the SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy for all; and Target 7.1: By 2030, ensure universal access to affordable, reliable, and sustainable energy services. It is also anticipated that, policy designing and review, including planning, as well as evidence-based decision will be made using the available data produced from IASES.

In more details, the survey is capturing the multi-dimensional access to modern sources of energy, where access is measured by e.g., amount, stability and affordability. This is more advanced compared to the traditional statistical approach which usually only cover the “yes-no” information about “the main source of energy” for lighting and cooking.

This current report is based on the 2022-IASES in Mozambique. INE published the first report from the survey in Portuguese in August 2023[1]. The current report follows the structure of the reports from the World Bank.[2] The focus is on access to sustainable energy and modern cooking solutions in detailed tiers. This report also includes analysis on impact of having access to new energy and follow a similar outline as a report from the 2021-22-IASES conducted in Tanzania.[3]

The main objective of the IASES is to measure the access to sustainable energy and the impact of such access at the national and regional level. Further, the IASES has:

i. Contributed to the Sustainable Energy for all SE4All/World Bank initiative of measuring access to energy, for evidence based National and Regional planning as well as for international comparisons;
ii. Developed a new survey module with the objective to learn and document potential impact on economic activity and human welfare when households and communities are getting access to modern energy sources;
iii. Documented the access to sustainable energy across urban and rural areas and impact observed after 5-10 years; and
iv. Developed capacity of the National Bureau of Statistics and Energy Sector Officers to measure the development in access, connectivity, availability, and impact in the years to come.

This report gives key findings on household's access to sustainable energy and cooking solutions as well as the quality of the access. The report includes an in-depth explanation of the methodology used to measure access. A report covering the wide statistical data material collected, has already been published in a Portuguese version, and will also be published in English. A report on barriers

[1] www.ine.gov.mz/web/guest/d/relatorio-de-energia-_-agosto-2023
[2] openknowledge.worldbank.org/collections/9efd823c-0788-51f8-971a-83a37b36a64f
[3] nbs.go.tz/index.php/en/census-surveys/energy-statistics/950-the-2021-22-impact-of-access-to-sustainable-energy-survey-main-report

and drivers of adapting modern energy is also planned, as well as a report on the impact of access to electricity.

1.1. The sample

The sample for the IASES in Mozambique is designed as a two-stage sample, comprising urban areas and rural areas in each of the 11 regions in Mozambique. At the first stage the enumeration areas (EAs) are selected within each domain by random systematic probability proportional to size (PPS) sampling based upon the number of households in each EA as registered in the 2012 census. At the second stage all households in each EA are listed and a fixed take of households are selected by random systematic sampling. The final sample comprised 2,478 urban households and 4,008 rural households and total of 6 486 households across Mozambique. From this sample, IASES collected data from 6 367 households. Mobile teams travelled to all regions to list all households in the selected areas and interview the sampled households from April to June 2022. Tablets with electronic questionnaires designed in CSPro and maps were used during the data collection. More on sampling and data collection can be found in Appendix A: Technical notes.

Table 1.1 The distribution of real and inflated sample by area and provinces. Absolute numbers. Households

	Real sample			Household estimates based upon census projection		
	Urban	Rural	Total	Urban	Rural	Total
Niassa	122	332	454	118 262	353 018	471 280
Cabo Delgado	98	425	523	121 405	456 586	577 991
Nampula	303	686	989	345 153	1 001 613	1 346 766
Zambezia	163	715	878	237 453	1 068 402	1 305 855
Tete	149	429	578	143 451	531 219	674 670
Manica	165	302	467	143 632	273 146	416 778
Sofala	240	287	527	231 746	307 342	539 088
Inhambane	145	332	477	122 436	241 996	364 432
Gaza	167	311	478	99 241	206 770	306 011
Maputo provincia	335	185	520	386 847	175 138	561 985
Maputo cidade	474	0	474	266 561	0	266 561
Total	**2 361**	**4 004**	**6 365**	**2 216 187**	**4 615 230**	**6 831 417**

The weights are calculated so that the numbers are of the same size as the actual numbers of households in urban and rural areas in the provinces. In the report, we refer to the inflated numbers of households.

1.2. Some notes on the geography of and population in Mozambique

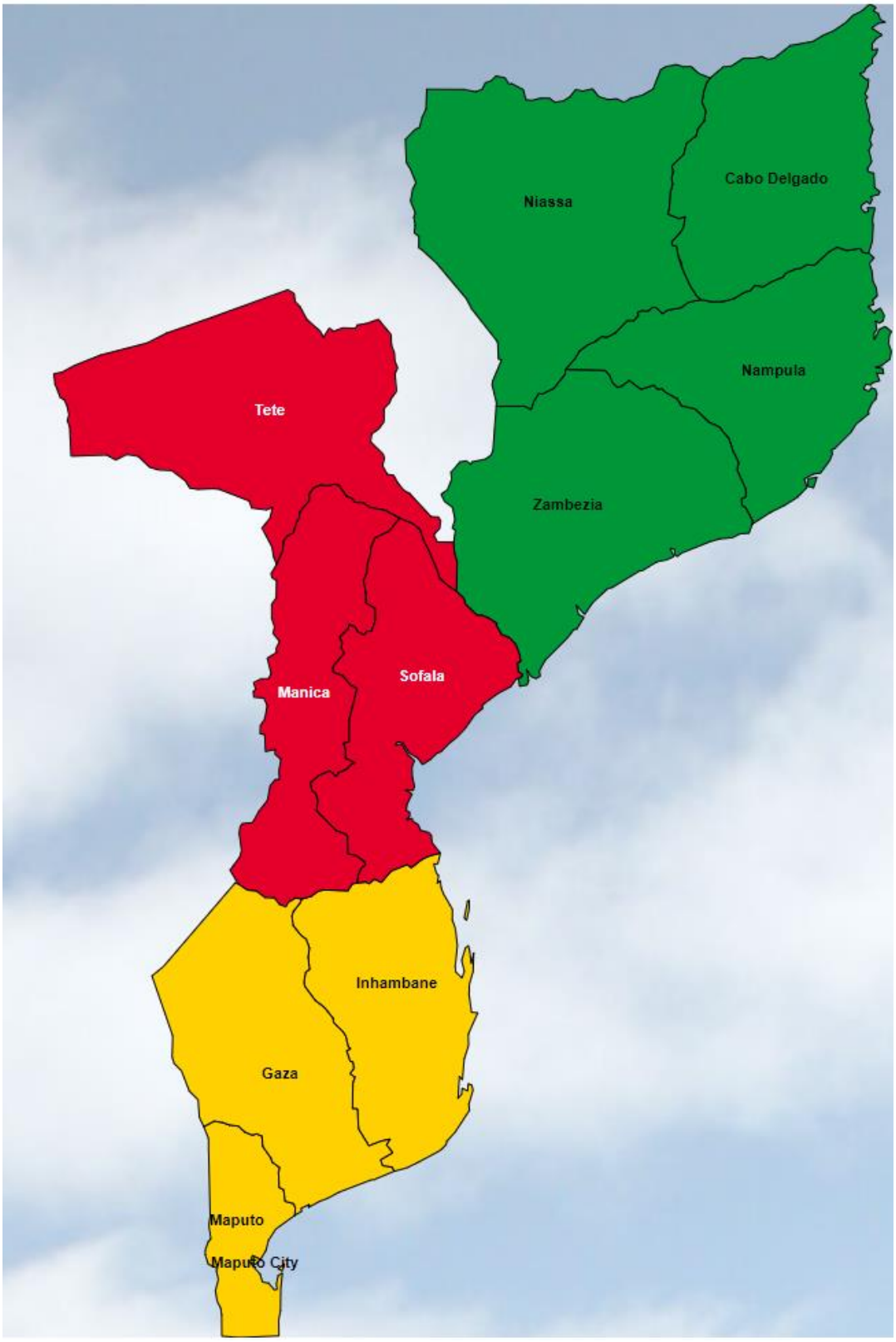
Mozambique, a country in Southern Africa is bordering South Africa and Eswatini to the south, Zimbabwe to the west, and Zambia, Malawi, and Tanzania to the north. The country has a long coast towards the Indian Ocean in the east.

https://www.census.gov/programs-surveys/international-programs/data/population-vulnerability/mozambique.html

The area of Mozambique is 801 560 sqm, which makes it the 35th largest country in the world. Water covers 2.2 percent of the interior, and the shoreline is 2300 km long – from South Africa to Tanzania. Most of the land is lowland, and along the coast floods and tropical cyclones are clearly representing challenges for farmers and the population in general. In terms of the economy, the GNP is 48 billion USD, which equals 1 457 USD per capita, which places Mozambique among the poorest countries in the world.

The map below shows where the provinces are and refers to a common regional division of the country, a southern region (yellow), a central region (red), and a northern region (green). Sometimes Zambezia are put in the central region. However, that is not so important here as the intention is not to aggregate statistics at regional levels, but more to have short way to refer to the location of the province.

Figure 1.2 The provinces and regional division of Mozambique



The homesite of EDM provides information on the electrification of Mozambique.[4] There are several power plants in Mozambique.[5] Three of these are hydro-electric, and they are all run by EDM. Two of these are dams - Cahora Bassa Hydroelectric Station way up in Tete and Chicamba Hydro Power Plant in Manica – and one run by the river – Mavuzi Hydroelectric power station in the Revue River, Manica.

The population in Mozambique

The last census in Mozambique was held in 2017. For Mozambique as a whole, the population increased more than 40 per cent from 2007 to 2017. The increase is largest in North, second largest in South, and lowest in South except for Maputo province. The increase of inhabitants in the capital may be due to migration.

Table 1.2 Population data 2007 and 2017

	Capital	Region	Area (km2)	Pop. (c2007)	Pop. (c2017)	Increase 2007 – 2017 in %	Density (2017)
Maputo City		South	347	1 094 628	1 101 170	0,6	3 155
Maputo	Matola	South	26 011	1 205 709	2 507 098	107,9	46
Gaza	Xai-Xai	South	75 709	1 228 514	1 446 654	17,8	16
Inhambane	Inhambane	South	68 615	1 271 818	1 496 824	17,7	19
Sofala	Beira	Central	68 018	1 642 920	2 221 803	35,2	24
Manica	Chimoio	Central	61 661	1 412 248	1 911 237	35,3	23
Tete	Tete	Central	100 724	1 783 967	2 764 169	54,9	18
Zambezia	Quelimane	North	105 008	3 849 455	5 110 787	32,8	37
Nampula	Nampula	North	81 606	3 985 613	6 102 867	53,1	49
Cabo Delgado	Pemba	North	86 625	1 606 568	2 333 278	45,2	19
Niassa	Lichinga	North	129 056	1 170 783	1 865 976	59,4	9
Mozambique	Maputo		801 590	2 0366 795	28 861 863	41,7	25

Source: INE.GOV.MZ

When compared to the rest of the world, the population of Mozambique is growing quicker, due to a high fertility rate, is less urban (38 percent urban in 2021), less densely clustered, has lower life expectancy (57.1 years in 2022), and lower levels of education (3.5 mean years of schooling in 2019). Substantial disparities are observable between genders, among provinces, and between urban and rural areas. For 2023, the size of the population is estimated to 32,4 million persons.[6] That is an increase of 12 per cent since 2017 and makes Mozambique's population the 45th largest worldwide. The population density is 28,7 persons per square meter.

Against this demographic background, it is interesting to look at access to clean energy and modern cooking solution for the population of Mozambique.

[4] https://www.edm.co.mz/en

[5] https://openinframap.org/stats/area/Mozambique/plants

[6] https://www.ine.gov.mz/en/inicio/-/blogs/estatisticas-econonomicas

2. Access and connection to electricity – overall measures

The current report follows international and national measures and indicators as far as household data allows. The main international goals and indicators are the overarching Sustainable Development Goal number 7 (SDG7[7]) which aim for affordable, reliable, sustainable, and modern energy for all by 2030. In this report survey access to energy is also measured in further detail by the degree and quality of access to energy, a multi-dimensional Tier-classification.

At the national level in Mozambique, a main policy focus is on extending the benefit from electricity to an increasing share of the population by increased access to electricity. A household may benefit from access to electricity by being connected to the grid, by access to solar based and other sources of electricity, or by interacting with neighbours within and next to the community. National indicators presented below include households connected to electricity and community access to electricity.

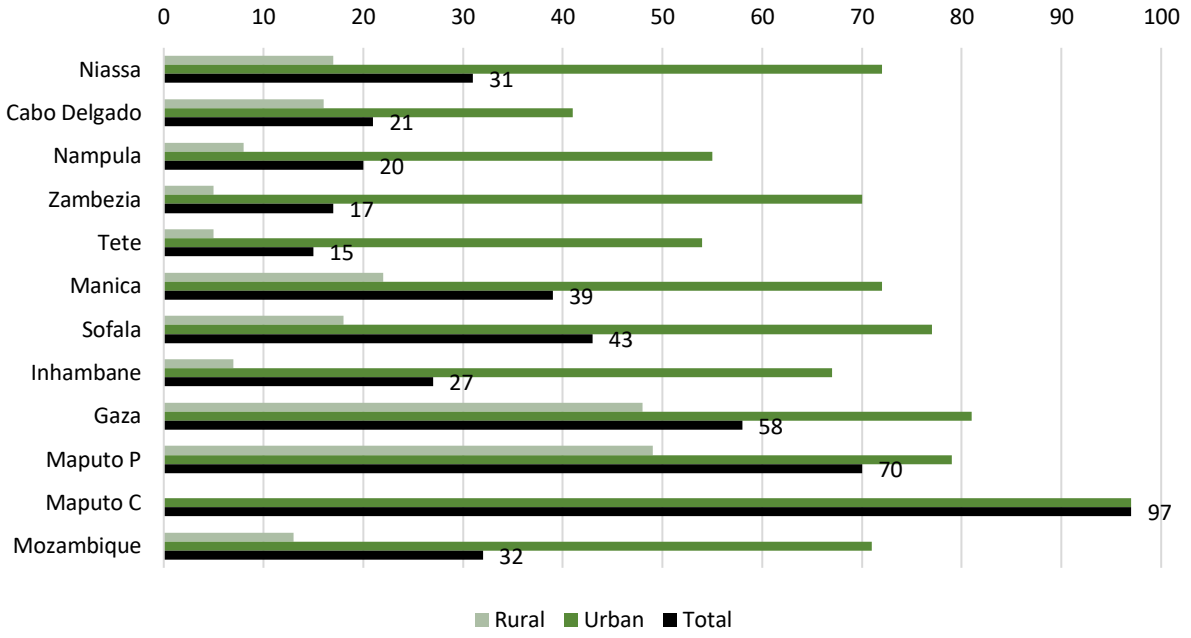
National and international indicators are presented below. The sample is designed to give accurate estimates for the national level of Mozambique, and for urban areas and rural areas. In the analyses that we present here, we found it useful to keep the city of Maputo apart from other urban areas, as the results suggest that status on energy stands out in Maputo. The sample is designed also to give estimates for each of the eleven provinces of Mozambique but estimates for each province will be less accurate than for the national level, and urban and rural levels. The regional distribution is still presented to show trends across the country for groups of regions such as between regions close to large urban areas versus remote regions.

2.1. Households connected to power grid (electricity)

In the survey, we found how many households that were connected to the electric grid. This will give an indication on the prevalence of the electric grid throughout Mozambique. All households were asked if they were connected to the grid, and the distribution is shown in figure 2.1a. We have broken the numbers down on urban and rural areas, while the capital area is treated as a separate area. The reason for doing that is that the capital area in general is considerably better positioned than other parts of the country.

[7] SDG TARGET 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
INDICATOR 7.1.1 Proportion of population with access to electricity. In meta-data: Access rates are only considered if the primary source of lighting is the local electricity provider, solar systems, mini-grids and stand-alone systems. Light on average for at least 4 hours per day and 1 hour at night.
INDICATOR 7.1.2 Proportion of population with primary reliance on clean fuels and technology
Clean is defined by the emission rate targets and specific fuel recommendations and in some circumstances by adopting advanced combustion cook stoves.

Figure 2.1 Households Connected to Electricity grid by province and area. Percentages



At the national level, we notice that only 32 % of all households in Mozambique are connected to the grid, which provides them with electricity at 230 V. Almost 70 percent of all households are not connected to the grid. It is also obvious that connection to the grid is not equally distributed over the country. There are large differences between provinces and between rural and urban areas within provinces. Rural areas are clearly less connected than urban areas. At the national level, only 13 per cent are connected in rural areas, compared to 71 per cent in urban areas. This pattern is found in all provinces. In four provinces, less than 10 per cent of rural households are connected. Maputo city stands out as almost every household is connected. Still, the share of connected varies from 70 per cent in Maputo province to only 15 per cent in Tete. The difference becomes even larger if we also take degree of urbanisation into account; almost 80 are connected in urban areas of Maputo province, while the equivalent in rural Tete and Zambezia is only 5 per cent.

The figures also reveal that there seem to be a gap between north and south. Except for Niassa, all the lowest shares are in the North. Both Tete and Zambezia are rather way up north, and both have low total figures (15 and 17). Then there is an increase in the middle as Manica and Sofala have shares around 40. Inhambane is an exception in the South as only 27 per cent of the households are connected. In the most southern provinces, the per centage increase to 58 and 70.

Almost every household in Maputo city are connected. In urban areas outside the capitol two out of three households are connected to the grid. We also register a solid gap between the capitol and its surrounding province. The degree of connection is only 79 per cent in urban areas of Maputo province, compared to 97 in Maputo city. The share of households connected to the grid are only below 60 in the provinces of Tete, Nampula and Cabo Delgado.

In conclusion, we can say that there seem to be a tendency that access to electricity decreases from south to north, and from urban to rural areas.

Looking only at connection rates give us just a part of the picture, as the actual number of households connected also give important information. Zambezia, the province with the largest number of residents, has approximately 1,250,000 households. Even if only 17 per cent of them are connected to the grid, it implies that more than 200 000 households are connected.

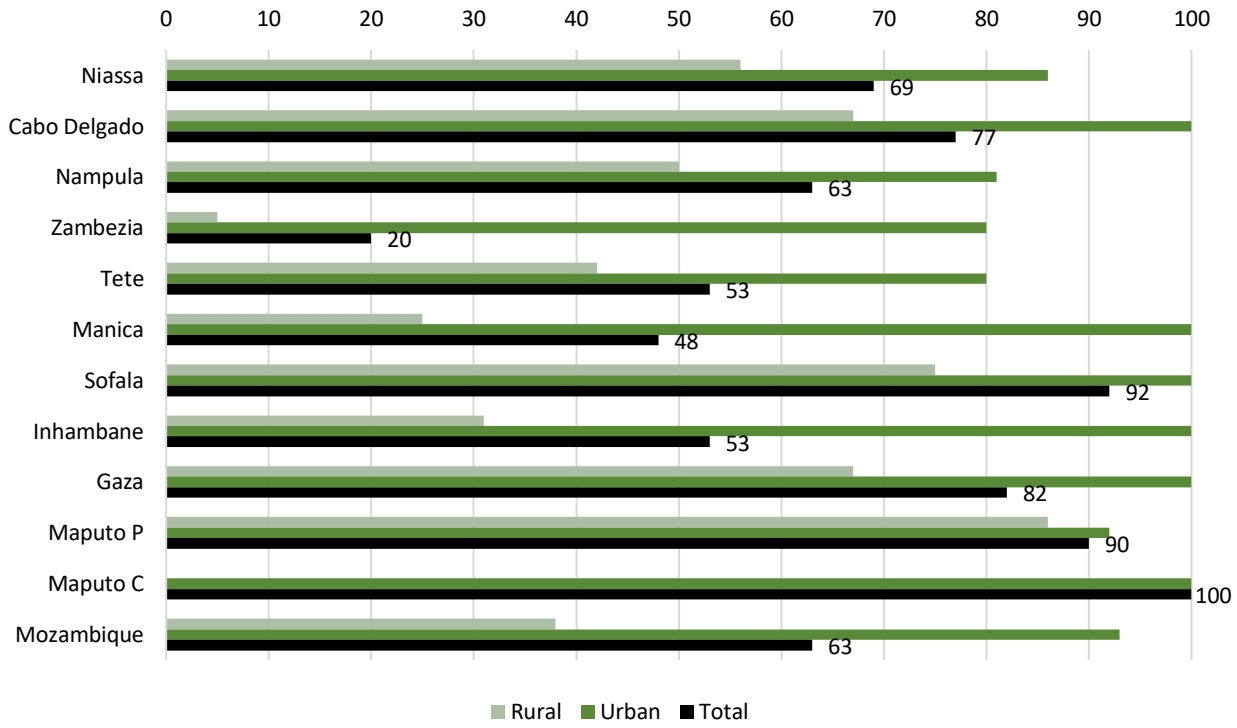
Another objection to the story above, is that it tells the story of uneven connections between urban and rural areas and between north, central and south. The question is if the North – South dimension is due to different degrees of rurality in the provinces, or if the differences between north and south will still be there when we take rurality into account when comparing provinces.

Another important factor is of course if there is a grid in the community. In the following paragraph we will first look at the connection of the communities, then we will look at households connected to the grid, limited to communities that are connected to the grid.

2.2. Community Access to Electrical Grid/ Electricity

In the former paragraph, we described the shares of grid connection in the households of Mozambique in provinces and urban and rural areas. Here we describe the situation in the communities where the households live. The data are from the questionnaire that were addressed to the head of communities. The number of communities in the sample is 347.

Figure 2.2 Grid connection in provinces by urban and rural areas. Percentages



The numbers tell almost the same story as the households, apart from that the numbers now are higher. The electrification regarding grid connection is clearly better in urban than rural areas. We find urban areas that are not connected to the grid in the Northern provinces, end even here it is never less than 80 per cent.

In rural areas, the degree of grid connection is rather diverse. In Zambezia, electrification is very low, but the numbers are also low in Manica and Inhambane. …

There are other sources to electricity than grid, and the communities were asked which sources of electricity they had.

Table 2.2.1 Sources of energy reported in community. Absolute numbers

	Maputo	Other urban	Rural	
No electricity	0	2	39	41
Solar lantern, multi light	0	34	136	170
Solar home system*	0	27	104	116
Grid	29	100	64	193

* Including generators (only one household reported that they had generator)

None of the communities in Maputo city report that they have solar systems, while it is quite common in other urban communities. In rural areas, solar system is the most common source. We also counted how many communities which had solar sources, but not grid. Only 10 urban communities had solar systems as only source for electricity, while corresponding numbers in rural communities are 103.

Communities that were not connected to the grid, were asked if they expected to be connected within the two next years.

Table 2.2.2 Grid connection in the future. Absolute numbers

	Maputo	Other urban	Rural	Total
Expect to be connected within next two years	-	12	95	107
Number of communities	-	12	142	154

The communities seem to be optimistic about getting connected to the grid in the near future. All urban communities expect to be connected to the grid within two years, and 2/3 of the rural communities expect to be connected within two years.

Another question is how long the communities have been connected to the grid. In the table below it is shown how long the communities have been connected.

Table 2.2.3 How many years has the community been connected to the grid? Absolute numbers

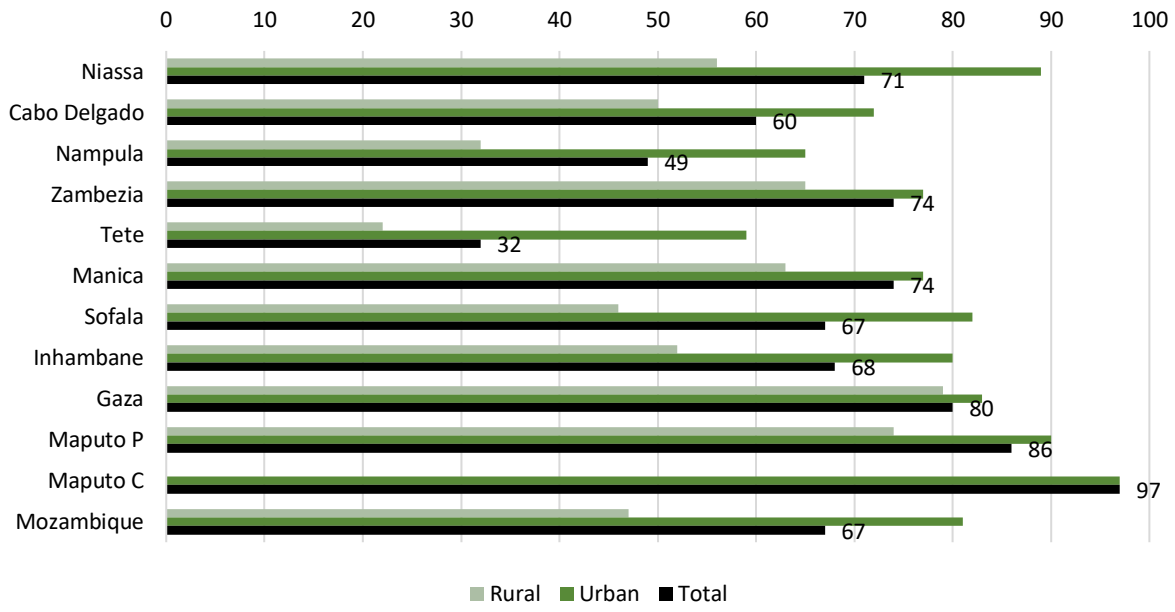
	Maputo	Other urban	Rural	Total
Still no grid	0	12	142	154
Less than 5 years	0	5	13	18
Less than 20 years	0	41	41	82
20 years or more	29	54	10	93
Number of communities	29	112	206	347

Communities in Maputo all became electrified more than 20 years ago. In other urban areas, most communities have been connected more than 5 years, and almost 50 per cent of these communities have been connected more than 20 years. The situation regarding grid connection is worse in rural communities, where almost 70 percent of the communities are not connected to the grid today.

2.3. Connection of households in communities with grid

Obviously, connection to the grid requires that the community is connected to the electric grid. On the other hand, the fact that the community is connected, does not mean that the household is connected. The household may live too far away from the transformer, or they may not afford electricity. To say something about the relation of having grid access, we present the distribution of access to electricity in households in communities that are connected to the grid.

Figure 2.3 Households connected to the grid in communities that are connected to the grid. Percentages



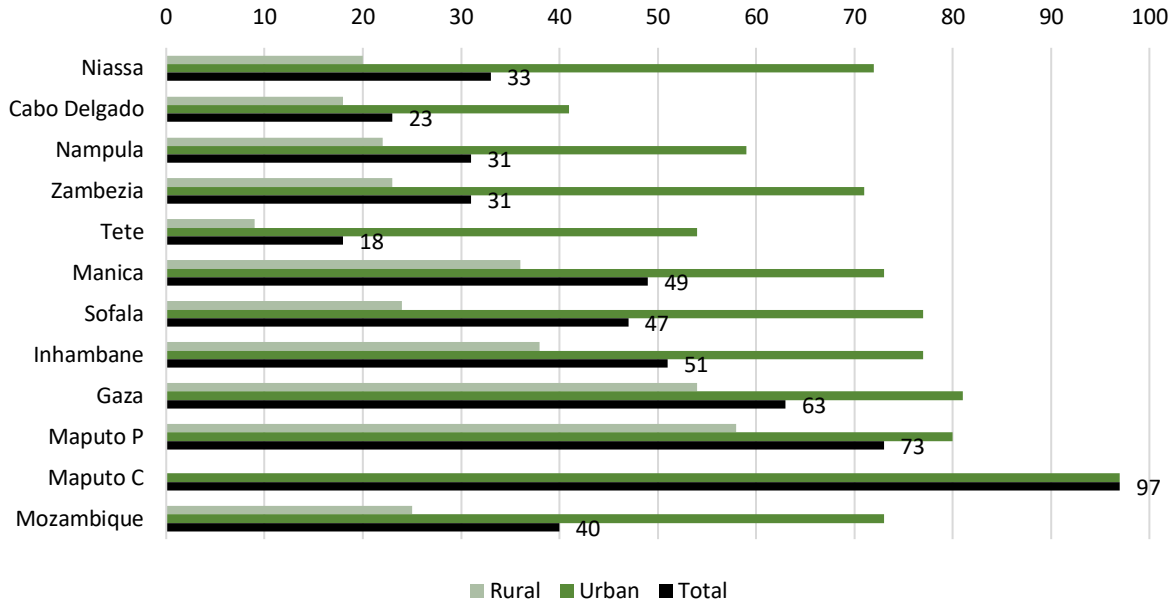
The picture drawn in figure 2.3 are of course more positive than figure 2.1. Still, 50 per cent of the households in rural Mozambique are not connected, while the equivalent in urban areas is 80 per cent. The bias between provinces is somewhat evened out, even if the figures are higher in the South. Especially Tete and Nampula stands with low figures in rural areas.

2.4. Sustainable Development Goal 7 (SDG7)

Sustainable Development Goal 7 (SDG7) aims to increase access to affordable, reliable, and modern energy services[8]. The SDG 7 addresses three dimensions of energy services, affordable, reliable and modern energy services. These dimensions are covered in detail in the paragraphs on Tier access to electricity. Here the SDG 7.1.1 indicator is presented as an introduction, requiring access to a minimum supply of electricity being able to on average provide light for at least 4 hours a day and at least 1 hour at night.

[8] SDG TARGET 7.1
By 2030, ensure universal access to affordable, reliable and modern energy services INDICATOR 7.1.1
Proportion of population with access to electricity. In meta-data: Access rates are only considered if the primary source of lighting is the local electricity provider, solar systems, mini-grids and stand-alone systems. Light on average for at least 4 hours per day and 1 hour at night

Figure 2.4 Proportion of population with access to electricity in Mozambique, as defined by SDG 7.1.1. Percentages



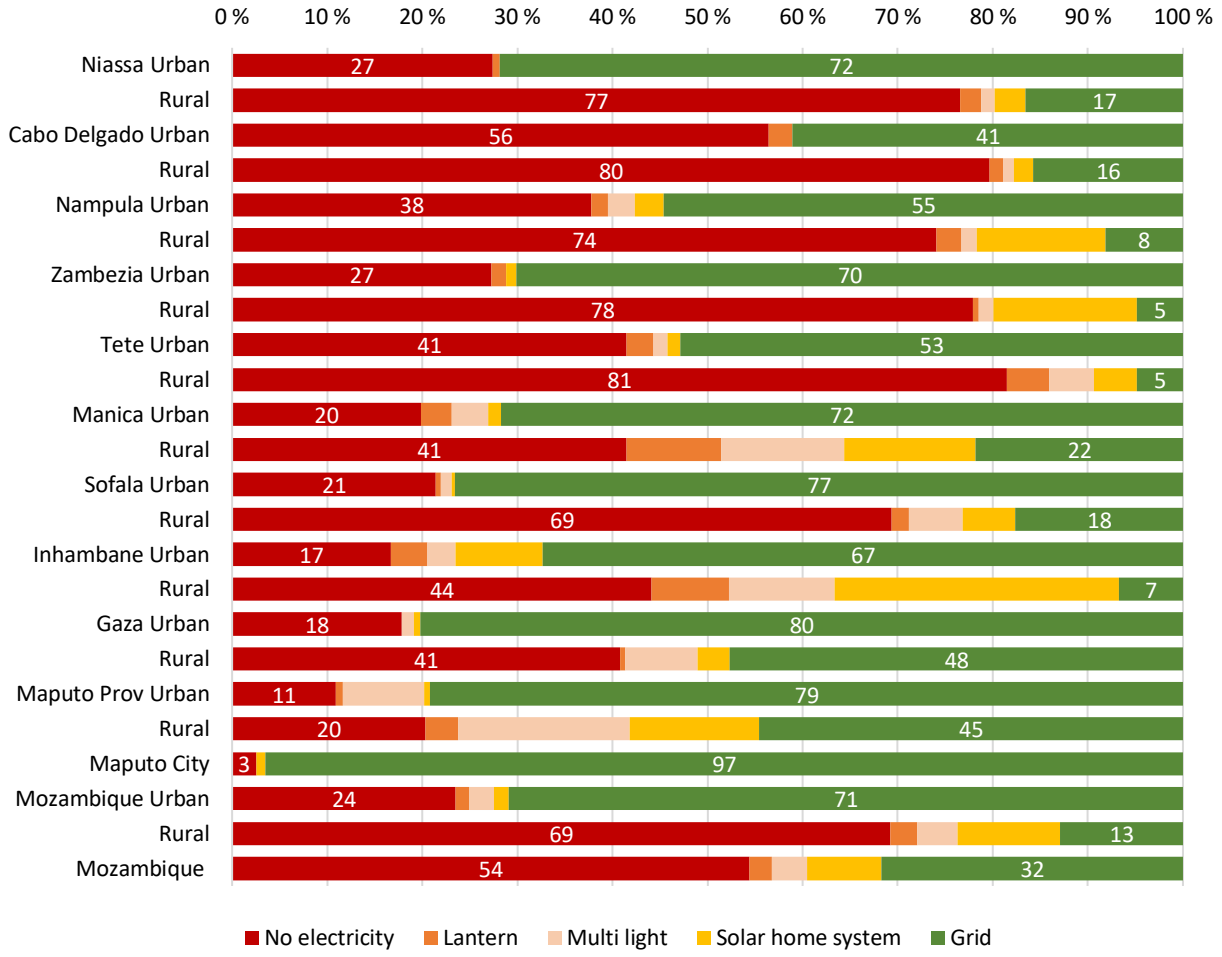
In general, this figure basically tells the same story as the figure on connection to the grid (figure 2.1). However, as the SDG-indicator focuses on supply of energy to provide light, the numbers are significantly higher in rural parts of Mozambique. Especially in rural parts of Nampula, Zambezi, Manica and Inhambane the access is much higher with the SDG-indicator. It also goes for urban parts of Inhambane. That indicates that households in rural parts rely on other sources for electricity than the grid. This is explored further in chapter 3.

2.5. Main source of electricity in households

The grid generally supplies a good source of electricity, but there are also other sources to electricity. Generators, driven by gas or diesel, have been important in earlier days, but are expensive and not for everyone. In recent years, the development of solar technology has become important to supply electricity in areas without grid, and even still not for everyone, it has made it easier to get access to energy for many people. The figure below, shows the main sources of electricity of the Mozambican households.

The households were classified in five different categories describing their main source of electricity. The first was having no source of electricity. The second was having access to a solar lantern, a small lamp that can be charged by exposure to sunlight. The third and fourth categories are a multilight solar system and a solar home system respectively, with gradual increasing capacity. Generators are few in numbers, and have high capacity, though not comparable to grid connection. Hence, we have categorized them as solar home systems. The fifth category was households with grid connection.

Figure 2.5 Households by Main source of electricity and by Province and Area. Percentages



Compared with the numbers for connection to grid (figure 2.1), we observe that there are fewer households with no electricity at all, although the difference is not all that big. As many as 12 per cent of the household have a solar system that can operate more than one appliance at a time (multilight or home system). Eight per cent have a solar home system – which is a system that are rather advanced regarding capacity of charging batteries and operating equipment. The multilight system is less advanced, while the solar lantern is limited to light a bulb. Anyway, it is a step up from candle lights. The figure reveals that the solar solutions are most frequent in rural areas – 11 per cent have the solar home system there; implying that most of these systems are found in rural areas.

We may look at the prevalences over the provinces. In the southern region with the lowest feature of household connected to the grid, one province – Inhambane - have the highest share of solar home systems. Almost 1 of 4 households (23 per cent) have a solar home system in this province. In fact, in rural areas of Inhambane, the share of households having a solar home system, was 30 per cent (table not shown here). The contribution of solar home system is rather high also in Manica, Zambezia and Nampula. In the remaining provinces, we mainly find solar home systems in rural areas.

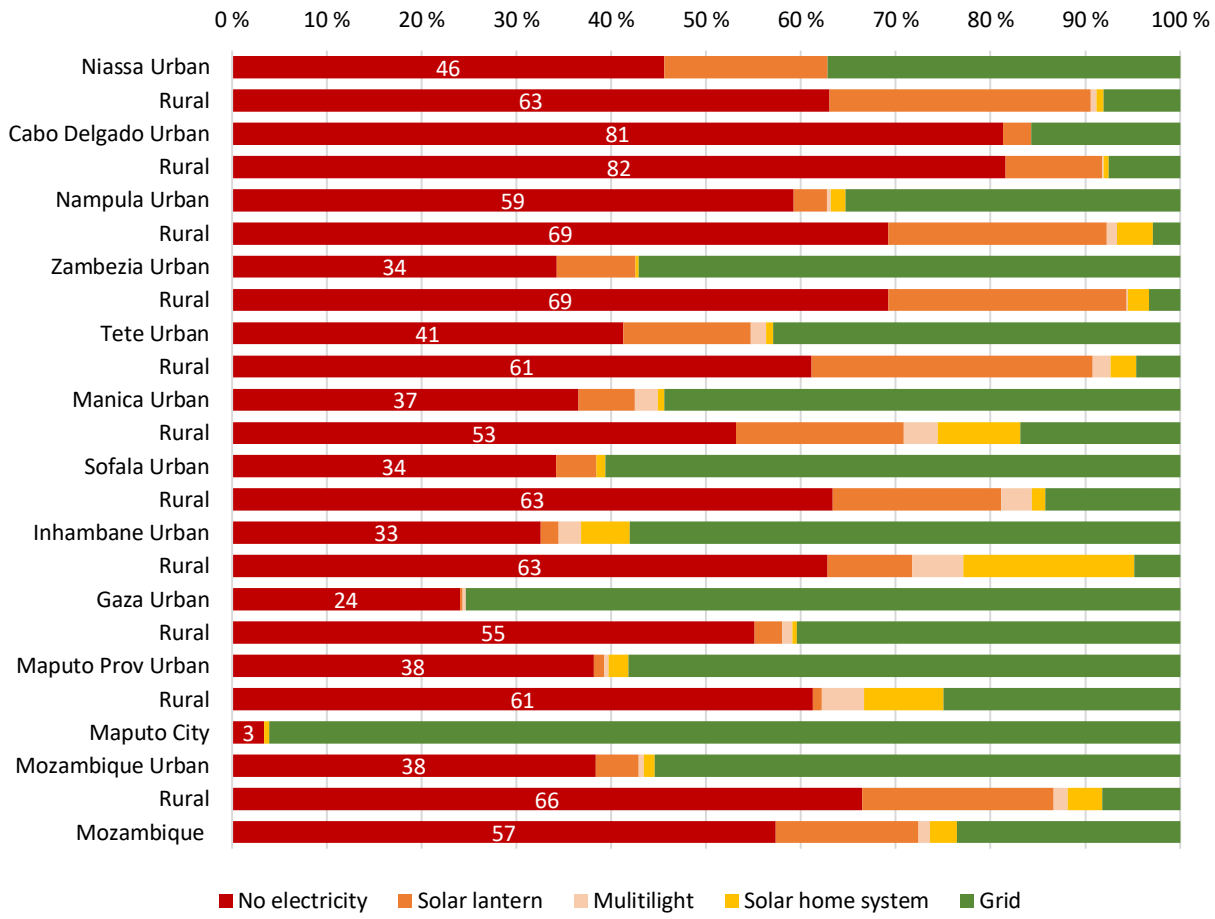
In conclusion, when other sources than grid are included as sources to electricity, the situation looks better for the country. We still notice differences between south, central, and north regions. Except for Tete, more than 50 per cent of household in central and south have access to electricity when solar energy is considered.

2.6. Changes in access over time

In the IAES-survey, all households were asked about what their main source of energy for light were 5 years ago. That means that the information given in the survey are in line with the numbers above.

We coded the variables such that either they had no electricity at all 5 years ago, they had a solar lantern, a multilight solar system, a solar home system or they were connected to the grid.

Figure 2.6 Households by Main source of electricity 5 years ago by Province and Area. Per cent



Figures for the whole country indicate that even if the share of households with no electricity has not decreased much (3 per cent points), the development has been positive. The solar lantern is losing ground as main source for lighting, and there is a significant increase in solar home systems and grid connection.

The increase of grid has been especially large in urban areas – from 50 per cent five years ago to 67 today. In rural areas, the connection to grid have risen from 8 to 13. However, the share of solar home systems has increased from 4 to 11 in rural areas. We register a small increase in "no electricity" for rural areas, but it is negligible due to its minimal and insignificant size. In urban areas, the shares of multi light and solar lantern shows a declining trend. In Maputo, the level of grid connectivity was sky-high already five years ago, which explains why nothing has changed much related to household's main source of energy.

Another way to look at the development is to look at the changes in households; what is the main source of energy used in the household today, and what source did the household use five years ago. By this method, we can calculate the net changes (the figure above indicates the gross change).

Table 2.6.1 Main source of light today and five years ago. Percent (of grand total) 6 831 413 =100 %

		Today				
		No electricity	Solar lantern	Mulitilight	Solar home system	Grid
5 years ago	No electricity	**41,8**	1,5	2,5	3,9	7,6
	Solar lantern	11,5	**0,7**	0,3	1,4	1,2
	Mulitilight	0,2	0	**0,8**	0,2	1,2
	Solar home system	0,2	0,1	2,3	**0,2**	2,8
	Grid	0,7	0	0	0,1	**22,8**

Households with the same main source at both times is in the diagonal from upper left to bottom right; 66 per cent have the same main source today as they had 5 years ago. Household without electricity are clearly the largest group altogether, and their share is twice as big as stable grid holders.

Among those who have changed main source, 15 per cent have a reduced access to electricity today than 5 years ago. These can be found below the diagonal in table 2.6.1. We also see that 23 per cent of households have improved access over the last five years. These can be found above the diagonal in table 2.6.1.

Several households have reduced access to electricity from having a solar lantern five years ago to currently having no electricity at all. There are probably a range of explanations to this, a common reason could be that the solar lantern stopped working, and the household could not afford to buy another.

On the other side, 1 of 4 households have improved their access in five years (22,6 per cent). More than 10 per cent have moved from having no electricity to have a solar home system or grid. The electrification by grid has been far larger in urban than rural areas, while the solar home system has become more frequent in rural than in urban. However, not to the same degree as the grid connection has increased in urban areas (numbers not shown here).

We also broke the numbers into areas, which are shown in table 2.6.2.

Table 2.6.2 Stability and changes in main source of light by area. Percent

	Worse	Stable	Improved	N=100 %
Maputo City	0,2	98,7	1,1	266 561
Other urban	3,6	72	23,4	971 739
Rural	17,1	65	17,9	3 915 365
Total	12,9	68,3	18,8	6 831 413

In table 2.6.2 we observe there has been a huge improvement in the quality of the sources of electricity used in urban areas outside the capital. One of 4 households have an improved source now compared to 5 years ago. Almost 4 per cent experience a worse situation, which is a small share compared to those who have experienced improvement. In rural areas, the situation is not that positive. Numbers indicate that change of sources are balancing each other, so that there are as many households who have experienced improvement as there are households who have experienced that their electric source has become worse. The stability category in rural areas is mostly containing households with no electricity at both times.

In general, however, there has been an upgrading of sources to electricity in Mozambique over a period of five years; the access to clean energy has improved.

3. The multi-Tier approach to electricity (Tier access)

As a response to the first major global energy crisis at the end of the 1970s, the global Energy Sector Management Assistance Program (ESMAP) was established to provide global knowledge and technical assistance. ESMAP, administered by the World Bank, developed a partnership program with 18 partners to assist low and middle-income countries to reduce poverty and boost growth through environmentally sustainable energy solutions. The approach was laid out and documented in the Beyond Connections report from ESMAP in 2015[9]. This approach has identified 7 dimensions of access to electricity and identified the level of access for each dimension in 5 Tiers.

The 7 dimensions are capacity, availability (duration), reliability, quality, affordability, legality, and health and safety. The level of every dimension contributes to the overall level of access to electricity; and it is the sum of the dimensions that counts. Being connected to the grid is not so attractive if the grid is unreliable, or if the household cannot afford to pay for electricity. Thus, the tier approach gives more information than just asking about connection to grid (or other sources of electrical power). Further, it provides information such as where the problem lies so that something can be done about it.

3.1. The multi-Tier framework

Table 3.1 illustrates how Access to electricity Tiers is measured by the seven dimensions as well as how they are aggregated to the overall Tiers. Households have been classified into a Tier for each dimension, and the overall Tier is calculated based on the lowest level of any subdimension.

[9] https://www.esmap.org/node/56715

Table 3.1 Multi-Tier Framework for measuring access to electricity*

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Capacity	Power capacity ratings (W or daily Wh)	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 kW
		Less than 12Wh	At least 12 Wh	At least 200 Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2 kWh
	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 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	
Reliability		Not applicable	Not applicable	More than 14 disruptions per week		At most 14 disruptions per week or at most 3 disruptions per week with total duration of more than 2 hours	At most 3 disruptions per week with total duration of less than 2 hours
Quality		Not applicable	Not applicable	Household experiences voltage problems that damage appliances		Voltage problems do not affect the use of desired appliances	
Affordability		Not applicable for overall Tiers, but as a separate measure	Not applicable for overall Tiers, but as a separate measure	Cost of a standard consumption package of 365 kWh per year is more than 5 per cent of household income	Cost of a standard consumption package of 365 kWh per year is less than 5 per cent of household income		
Legality		Not applicable	Not applicable	No bill payments made for the use of electricity		Bill is paid to the utility, prepaid card seller, or authorized representative	
Health & Safety		Not applicable	Not applicable	Serious or fatal accidents due to electricity connection		Absence of past accidents	

* In this and all other Tier charts, the Tiers are listed in 6 groups from Tier 0 to Tier 5.

3.2. Empirical figures to the Tier dimensions of access to electricity

We recall that the Tier approach to access to energy is based upon seven dimensions: Capacity, availability, reliability, quality, affordability, legality, and health and safety. Below the empirical numbers for these seven dimensions in Mozambique are shown.

Table 3.2.1 Distribution of sources for electricity. N = weighted numbers

	Frequency	Per cent	Number for Tier calculation
No electricity	3 715 001	54,4	-
Solar lantern	161 643	2,4	161 643
Solar multi light	253 277	3,7	253277
Solar home system	532 816	7,8	532 816
Grid	2 170 812	31,8	2 170 812
Total	6 833 550	100	3 118 549

Having a source of electricity is a prerequisite for not ending up at Tier 0. That means that the dimensions have no relevance. Hence, we exclude all households with no electricity at all, from the empirical review of the dimensions below.

From table 3.1 it follows that Tier calculation is not needed for 54,4 percent of the households; by default, they belong in Tier 0. On the other hand, a household connected to the grid will always have electricity with a capacity of at least 10A or 2300 Watt, which is in Tier 5. But if the other dimensions are at lower levels, they will end up with a summary access at lower levels.

The empirical distributions on each dimension are represented in table 3.2.2. We review these numbers dimension by dimension below, then we merge them into the overall Access to Electric Tier.

Table 3.2.2 Households by Access to Electricity in Tiers – 7 dimensions. Percentages within each attribute

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5	Number of households (in millions)
Capacity	Power capacity ratings (W or daily Wh) including service used	0,2	0,1	7,4	10,2	3,6	78,5	2,96
Availability	Availability during day and night	0	1,2	2,4	3,0	0	93,5	2,17
Reliability	Disruptions			65,9		27,2	6,9	2,17
Quality	Voltage problems			21,4		78,6		2,17
Affordability	< or > 5 of income (total consumption as proxy)			37,0	63,0			1,97
Legality	Payment registered			3,3		96,7		2,17
Health & Safety	Accidents			1,0		99,0		2,17

3.2.1 Capacity

Capacity may be measured directly, as the amount of energy accessible, measured in watts. This is the standard option if the household is connected to the grid. The alternative option is to measure the amount of power which may be used per day. This is the standard option if the source is a generator. A solar cell system is measured either according to the capacity of the solar panels or by the amount of electricity available from the battery. The highest level of these indicators will determine the overall capacity. If neither of these information types on capacity are available, a summary of available appliance service, "the service capacity" may serve as a proxy indicator. In the following paragraphs the capacity for each of the main sources of electricity are presented.

The capacity by the grid is regulated either by the main fuse or by the electricity meter. It will be at least 2000 watts (or 2 kW) which is above the requirement for Tier 5.

Thus, all households connected to the grid, are placed in the highest Tier (Tier 5) on capacity. However, even some solar systems have high capacity. Consequently, 6,5 per cent in Tier 5 capacity have a solar system. We notice further that the capacity for most solar systems is in Tier 2 and 3. Further, 8 per cent with solar energy have capacity lower than 3 W (12 Wh), which locates them in Tier 0.

Table 3.2.1 Electric capacity by main source for light. Numbers are weighted, estimating the number of households in different categories

	Capacity					
	1	2	3	4	5	Total
Grid	0	0	0	0	2 170 812	2 170 812
Solar Home System	1 195	154 295	218 650	35 449	117 431	527 020
Electric generator	0	0	2 928	0	0	2928
Rechargeable Battery	0	45 643	2 760	636	5 908	54 947
Solar Multi-Light Product	0	18 544	77 048	70 359	10 698	176 649
Dry-cell battery	0	0	0	0	10 021	10 021

3.2.2 Availability

Availability, or the duration of the period where electricity is available, is measured in hours for the main source of electricity and recorded both for “day” defined as 24 hours as well as for “night” (after dark). This dimension is not relevant for households with electricity from any kind of solar sources. Thus, the number of observations is reduced to 2,17 million households.

From table 3.1a above we see that availability is good in Mozambique; availability of the grid locates 94 percent of households in Tier 5.

3.2.3 Reliability

Reliability of electricity from grid is more of a problem than availability. A substantial share of households experience disruptions of the energy supply like every second day or at least 2 hours per week. Accordingly, 2 of 3 households are placed in Tier 3. Only 7 percent do not experience disruptions at all.

3.2.4 Quality

This dimension measures the quality of the power being delivered from grid. The quality is indicated by whether large voltage fluctuations may harm any appliances. For most households, grid access qualifies for Tier 4 and 5, while 20 per cent – or 1 in 5 – state that they have some problems with the quality. For these households it might be a risk to buy and use electric equipment, as it might be broken by too low or too high voltage.

3.2.5 Affordability

In 2020[10] it became free of charge to get connection to the grid in Mozambique. The internal wiring inside the housing does however have to be paid by the household. Hence, even if connection was free, many households may not have access to the grid because they cannot afford internal wiring. Further, even if the households have installed electricity, they must pay for the consumption of electricity, which may be a significant cost for poor households.

[10] https://furtherafrica.com/2020/12/14/mozambique-electricity-now-free-of-connection-charges/

Affordability is assessed for all households, irrespective of whether they currently have access to electricity or not. This dimension records whether a household may afford to buy one kWh of electricity per day, every day.[11]

3.2.6 Legality

The indicator for legality is relevant only for households connected to grid. Households can either be legally connected or illegally hooked up to the grid. It is measured indirectly and is assessed as legal if the household is paying for the electricity or may be able to explain why they get it without direct payment themselves.

Only 3 of 100 households with a grid access cannot document legal or free payment for the electrical supply and are therefore placed in Tier 3/2. Hence, legality is only a minor problem.

3.2.7 Health and safety

Health and safety are relevant for grid connection only. Electricity is a safe source of energy at the household level when installed by authorized staff. But mistakes in instalment or repair may lead to an electric shock. Such injuries are not common, but there still are 1 per cent that report serious accidents. These households are placed in Tier 3.

3.3. Summarizing the 7 dimensions of access to electricity

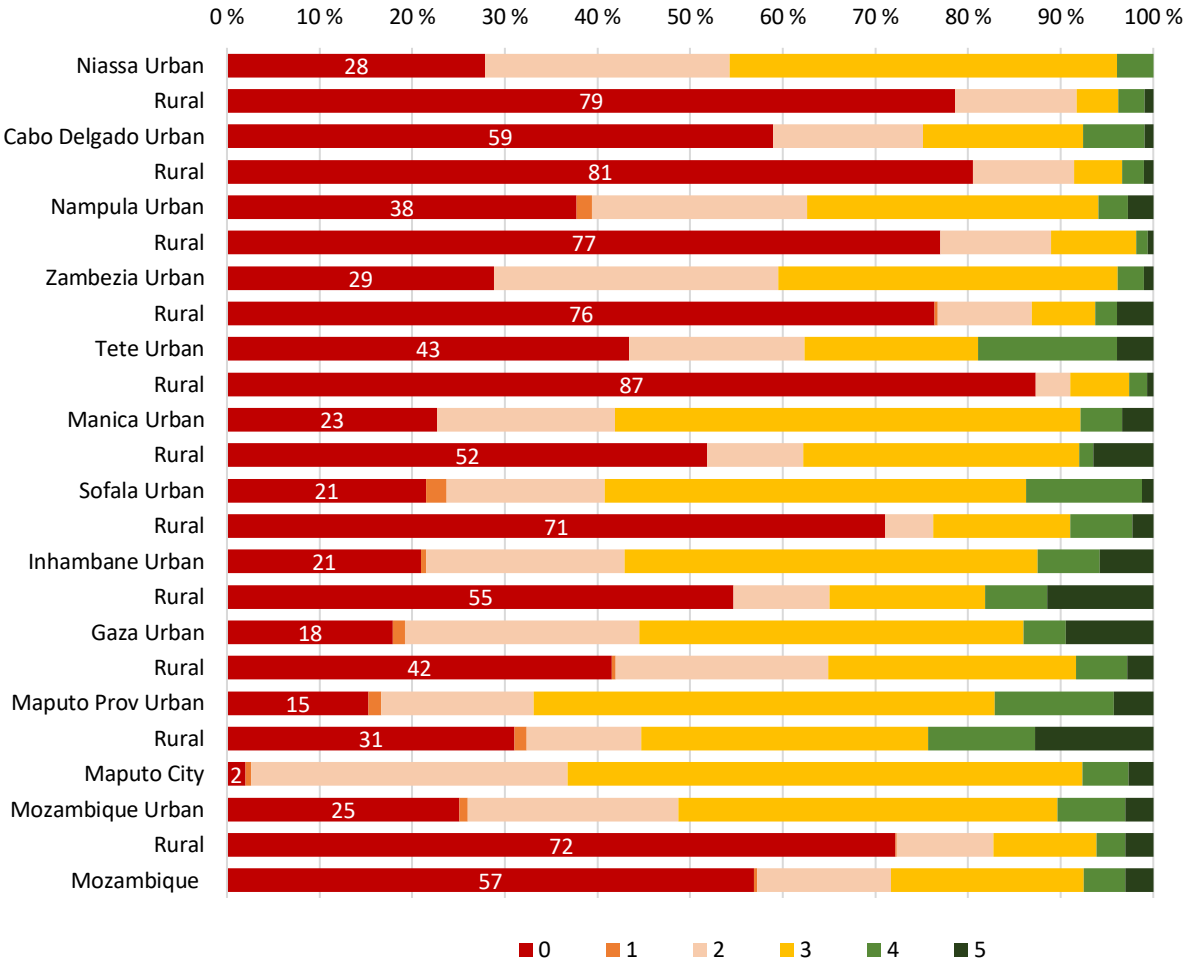
The lowest Tier level across the 7 dimensions should give the overall Tier level. This is however not always a straight comparison since information on some dimensions may be missing. Hence a stepwise approach is chosen to avoid reducing the overall level due to missing information. To be moved up to a higher Tier, certain conditions must be fulfilled. If information is missing, households are remaining at the achieved Tier rather than being moved to a lower Tier.

- **Step 0**. All households start at Tier 0.
- **Step 1**. If a household has both the capacity and duration at Tier level 1 or above, it is moved up to overall Tier 1.
- **Step 2.** If a household has both the capacity and duration at Tier level 2 or above, it is moved up to overall Tier 2.
- **Step 3.** If a household has both the capacity and duration and affordability at Tier 3 or above, it is moved up to overall Tier 3.
- **Step 4.** If a household has both the capacity, duration, reliability, quality, legality, and health & security at Tier 4 or above and affordability at Tier 3 or above, it is it moved up to overall level 4.
- **Step 5.** If a household has both the capacity, duration, and reliability at Tier 5 and quality, legality, and health & security at Tier 4 or above and affordability at Tier 3 or above, it is moved up to overall level 5.

Following this procedure, the overall distribution ends as shown in table 3.3.

[11] https://www.edm.co.mz/en/website/page/electricity-tariffs

Figure 3.3 Overall Access to Electricity in Tiers by Area. Percentage



The total distribution tells us that 57 per cent of all households have no, or a very limited, access to electricity. Only 3 per cent have access at level 5, while 7 per cent are at level 4 or 5.

As we recall from the review above, disruptions are frequent in Mozambique, and the main reason that many households end up in Tier 3. The main reason for not getting higher than Tier 2 is affordability. The impact of these factors is clearly visible in Maputo and other urban areas. Almost all households in Maputo are connected, but disruptions make many households not getting higher than Tier 3. Further, many households have problems with paying for the consumption of electricity, which makes them end up at level 2. A similar pattern is observed in other urban and rural areas too. However, outside the capital the share of households having no electricity are much larger.

We recognize the south – north pattern from above. Access to electricity is lowest in the Northern parts and rises as we move southwards. Truly, access to energy is lowest in Tete, which belong to the Central part, but the province covers rather remote parts of Mozambique. In general, access to electricity is lowest in the North, somewhat better in the Central parts, and much better in the Southern part.

It is interesting to combine the provincial perspective with the urban rural perspective, and we do that by showing the shares of Tier 0 in urban and rural areas for each province. Maputo city is included, but the city has only urban areas.

Figure 3.3.2 Tier 0 in Provinces by urban and rural areas. Percentages

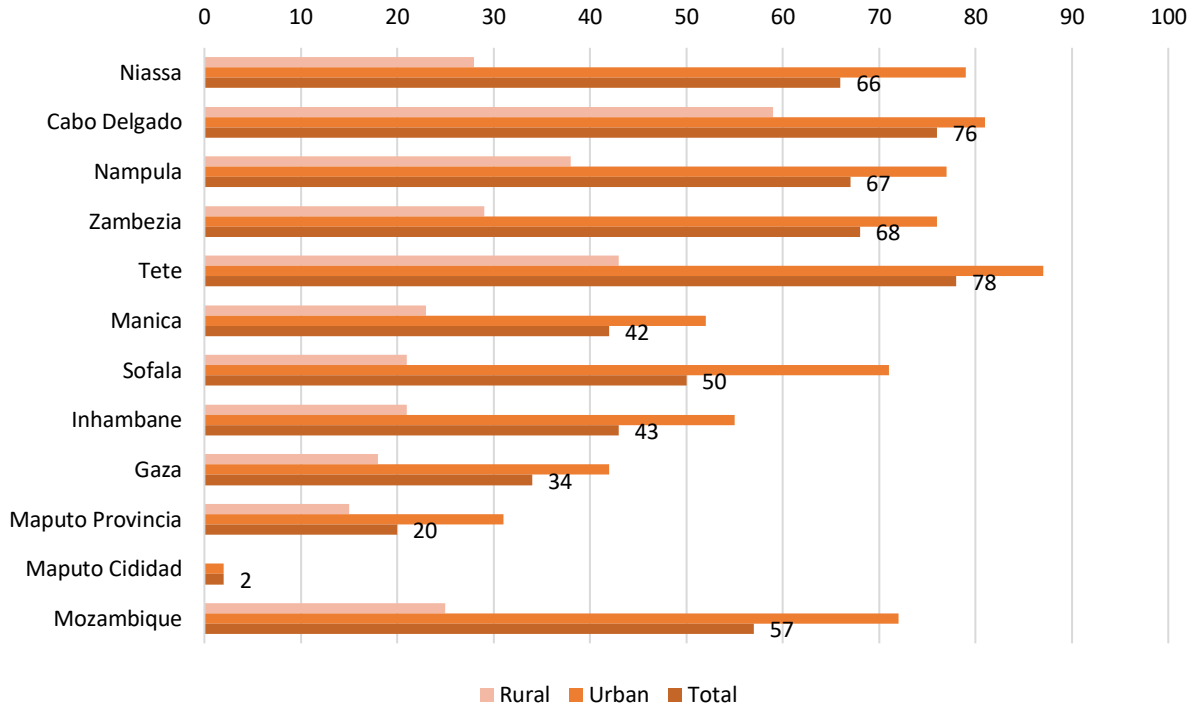


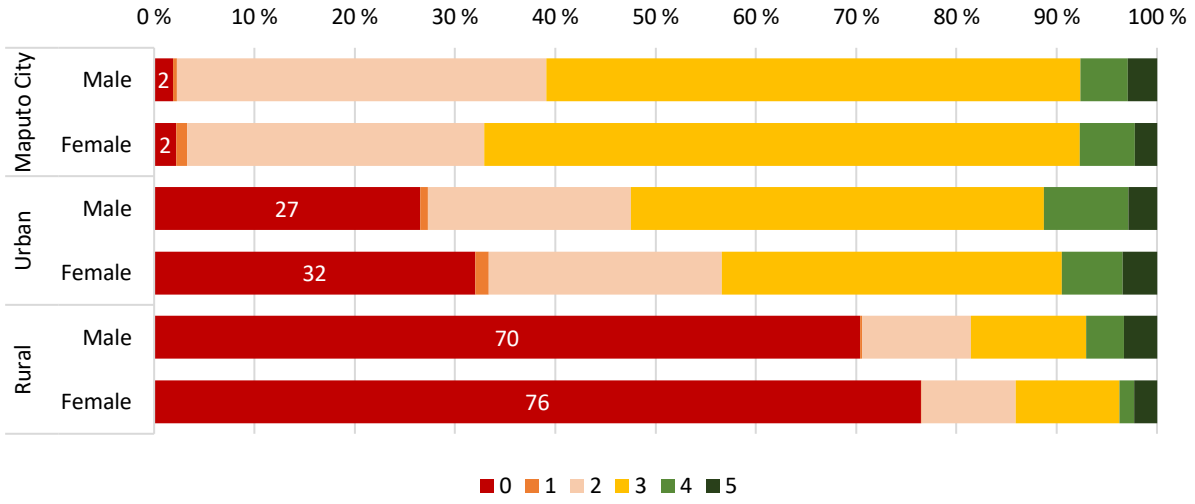
Figure 3.2.2 show us that two to three times as many households are in Tier 0 in rural areas, compared to urban areas.

3.4. The impact of gender and income

We have seen that there are huge geographical differences in access to the electricity. In this paragraph we investigate whether there is a gap in access attributed to gender and income. We will not go very deeply into the matter but will also take the urban – rural dimension into account and treat the capital as a separate category.

Gender is measured as the gender of the head of household, and how access to electricity varies between male and female headed household is shown in figure 3.4.1.

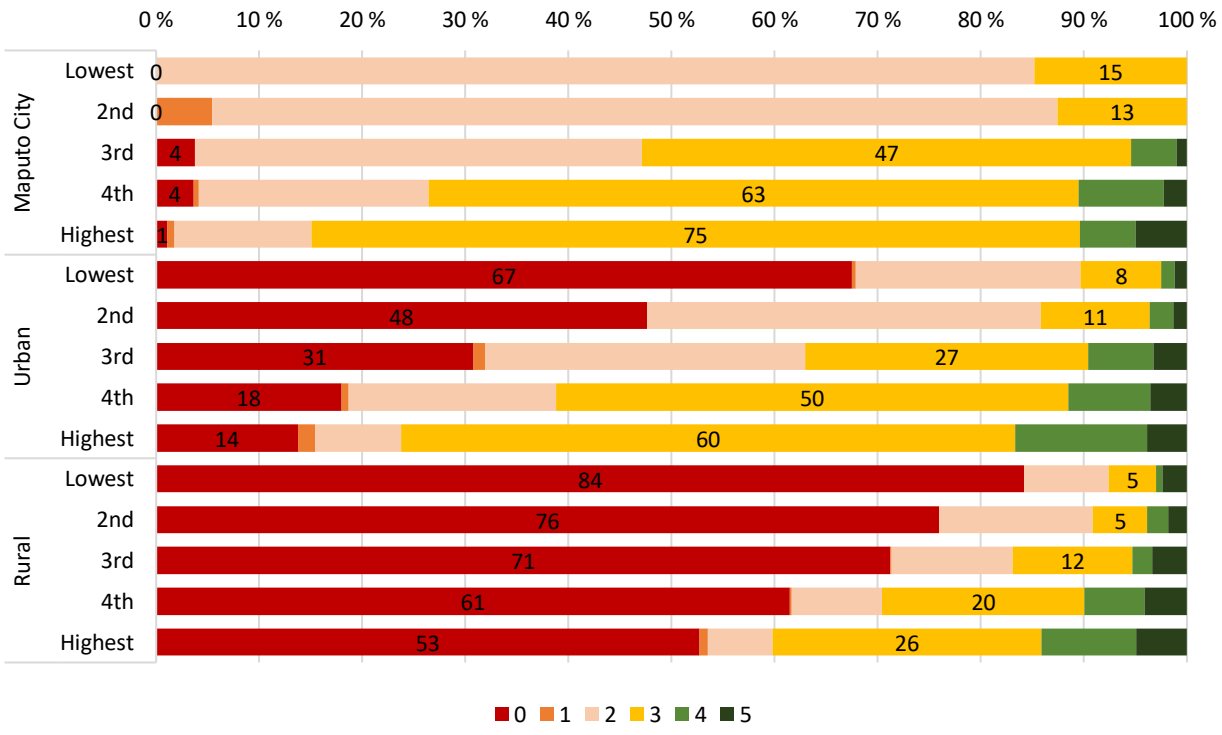
Figure 3.4.1 Access to electricity by male and female headed households in different areas. Percentages



Female headed households have slightly less access to electricity in rural and urban areas except for Maputo city. The female shares in Tier 0 are about five percentage point higher than for male headed household. With the caveat that our approach may not be the best way to capture gender differences, the figures does not reveal any serious differences on having access to electricity in Mozambique.

One would expect that income makes a difference in having access to electricity, and figure show access to electricity by income in rural and urban Mozambique with Maputo as a category of its own. Income is measured by expenditures of the household during a whole year; and then these numbers are categorized into quintiles.

Figure 3.4.2 Access to electricity by income quintiles in different areas. Percentages



Income reveals a rather clear relationship between income and access to electricity outside Maputo. In both urban and rural areas, we register a monotonous decrease in shares in Tier 0 from low to high income. In addition, we notice that the gap is larger in urban than in rural areas. In urban areas, it decreases with more than 50 percentage point (67 to 14), while in rural areas it decreases only with 30 percentage points (84 to 53). That is related to presence of grid in the community. We also note that it is Tier 3 that makes the biggest differences in urban areas including Maputo city.

3.5. Main lessons on Tier Access to electricity

The Tiers approach to access to electricity demonstrates that 57% of households in Mozambique have no or very limited access to electricity, while only **3%** have full access to electricity. One major reason for not having full access is that 6**5%** of households experience frequent power outages. These households are connected to the grid, but as the access is not reliable, they do not have full benefit from being connected to the grid. Some households (20 per cent) report voltage problems, which can damage electrical appliances. Many households have problems paying for their electricity consumption, which means that they access is limited as consequence of economy.

Geographically there is tendency that access to electricity is lowest in the northern parts of the country and increases towards the south. There are significant differences between urban and rural areas, with more households in rural areas being in Tier 0.

4. Access to modern cooking solutions (Tier access)

The first focus when addressing SDG goal 7 on "affordable, reliable, sustainable and modern energy for all within 2030" may be on electricity. But this is just a sub-dimension of the goal.

The goal addresses access to energy in general. Energy is needed in the form of electricity for several technical issues, but usually energy for transport, heating and cooking are provided by other means. At household level the main non-electrical energy consumption is for cooking and in some countries also for heating. The energy carriers for cooking are usually solid fuel, gas (liquid gas and biogas) or liquid fuel but may also be covered by solar energy or electricity.

To develop and present a national energy strategy, it is essential to document the access to electricity and cooking solutions in a joint manner. Traditional energy solutions based upon solid fuel, either firewood or charcoal provides energy for both light and cooking. Access to electricity allows for a wider approach for cooking by closed and more efficient ovens.

Traditional three stone fireplace

LPG- stove

The main international goal and indicators are the overarching SDG 7 of affordable, reliable, sustainable, and modern energy for all within 2030. All these dimensions relate to multiple sub-dimensions within the household and in the wider society context.

In this survey the main focus is on access to household cooking solutions as presented in the reference report "*Beyond Connections: Energy Access Redefined*"[3].

The cooking solutions in Mozambique are presented in three steps:

- First, an overview of fuel and main types of cooking ovens.
- Second, a comprehensive list of the main cooking ovens used.
- Third, a more detailed presentation on emissions and efficiency of the main cooking ovens used by the range of households.

4.1. Fuel and stove types used for cooking

Based upon emission and efficiency level standards, the main types of cooking stoves in each country are identified, classified, and documented by photos, using groups of stove design, fuel, and ventilation. This survey builds upon the typology from Rwanda and Ethiopia, such as documented in the Rwanda report: Rwanda, Beyond Connections, Energy Access Diagnostic Report Based on the Multi-Tier Framework (2018), Table 4.2 below is a copy of table 6 in that report.

Table 4.1 Detailed description of draft cooking stove typology

Type of fuel	Description of level	Tier
Firewood, dung, twigs, and leaves	Three-stone, tripod, flat mud ring	0
	Conventional improved cooking solutions (ICS)* (closed oven with separate openings for firewood etc. and pots)	1
	ICS with Chimney (as conventional ICS plus chimney), rocket stove with conventional material for insulation	2
	Rocket stove with high insulation, rocket stove with chimney (not well sealed)	3
	Rocket stove with chimney (well-sealed), rocket stove gasifier (rocket stove with two chambers, one for firewood and one for the burning gas), batch feed gasifier (burning solid fuel which is added to the burning chamber in batches)	4
Charcoal	Traditional charcoal stoves	0
	Old generation ICS (with open chamber for charcoal)	1
	Conventional ICS (closed oven with separate chambers and openings for charcoal and pots)	2
	Advanced insulation charcoal stoves, kerosene oven	3
	Advances secondary air charcoal stoves (tightly closed burning chamber with controlled entry of air)	4
Rice husks, pellets, and briquettes	Natural draft gasifier (only pellets and briquettes)	3
	Forced air	4
LPG and biogas, electricity (grid or solar), solar oven (non-electric)		5

*ICS: Improved Cooking Stove may be improved in several steps, separate intake of air and fuel, regulate the air flow, insulate the burning chamber, forced flow of burning gases and smoke.

4.2. Empirical figures on stoves in Mozambique

Households were asked about what kind of main stove they used for cooking. They were presented a list of different types that are used in Mozambique: Three-stone stove, round mud stove, improved cooking solutions (ICS) with ceramic fire chamber, Rocket stove with high insulation, Charcoal stove - Open access for air, Charcoal stove - Regulated air, Charcoal - Ceramic lined, Charcoal - Ceramic lined & insulated, Charcoal stove with controlled airflow, Biogas stove, Multiple LPG stove and Electrical stove. We collapsed these stoves into five categories. Three stone makes a category of its own, while the stoves round mud stove, ICS w/ceramic fire chamber, Rocket stove with high insulation are collapsed into "other firewood burner." Charcoal stove - Open access for air and traditional charcoal stove - are merged into "Basic charcoal burners," while Charcoal stove - Regulated air, Ceramic lined, Ceramic lined & insulated with controlled airflow were merged into "Improved charcoal burners. [12] The rest were merged into "other stoves".

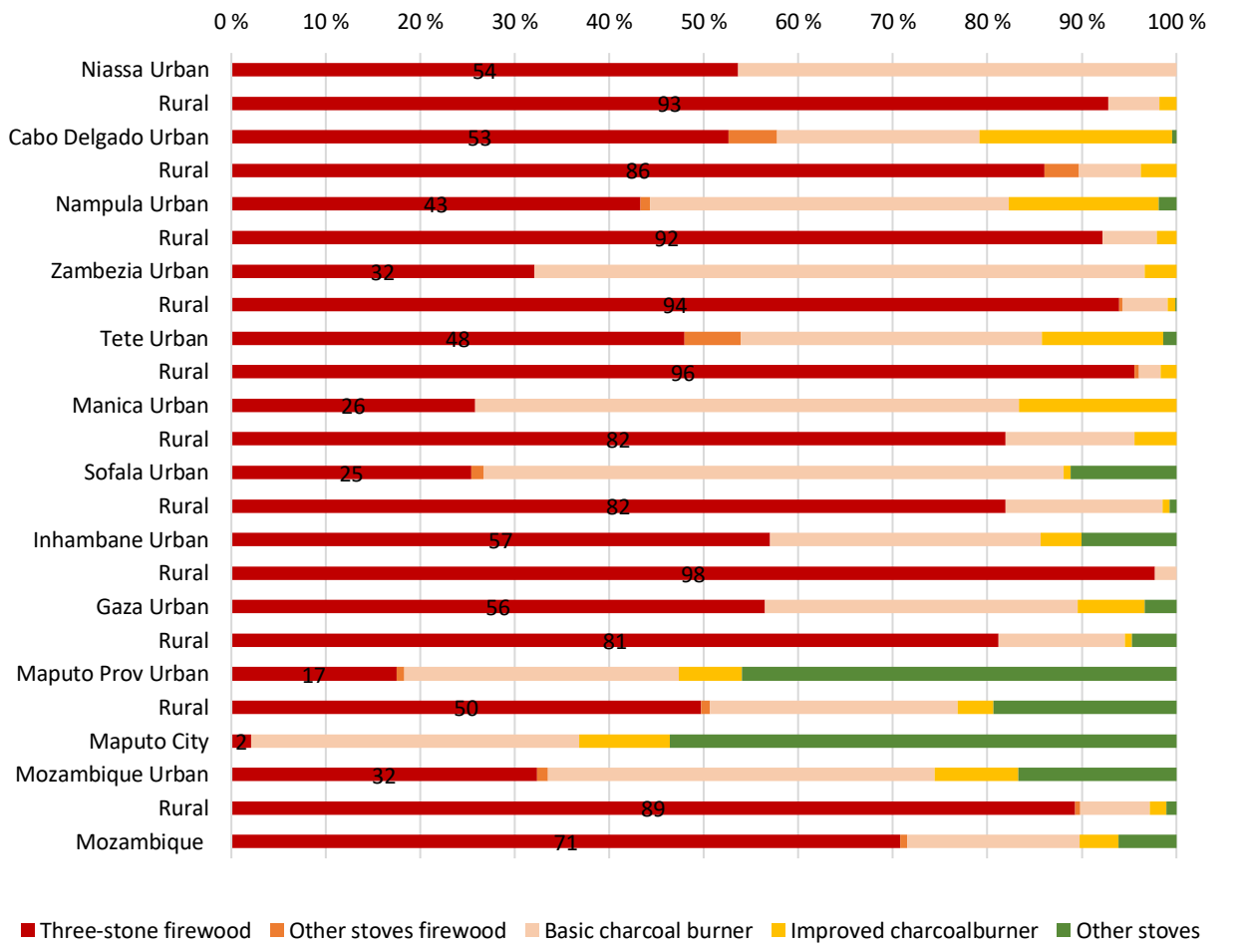
Most charcoal burners that are reported in the survey are for two pots and we are not able to split between simple burners with no air control to improved cook stoves (ICS) with air regulation and possibly insulated burning chambers. Hence our tables to show who have moved to ICS will focus on rural households using solid fuel and on Maputo households moving from charcoal burners to LPG ovens.

It may be unfortunate (or unjust) in clean energy perspective that all the two posts charcoal burners are classified as "Basic charcoal burners." Unjust because many of them probably are "improved charcoal burners." In that way the two pots charcoal burners represent a problem as they are quite wide-spread in Mozambique – 15,5 percent of the households have that one. It is most frequent in urban areas; 33 percent in Maputo, 36 percent in other urban areas, an only 6 percent in rural areas. It is second most popular stove and especially in urban areas. In urban areas in Zambezi, Manica and Sofala it the most frequent stove of all.

[12] Unfortunately, all two pot charcoal burners, whether open air or regulated air, had to be collapsed into one category.

Having said that, it is beyond doubt that clean cooking access is low in Mozambique.[13]

Figure 4.2 Type of cook stove by area. Percentages



The cook stoves used in Mozambique are mainly the traditional three stone firewood oven. The oven does not cost anything, so anyone can have one. More than 70 percent do have it as their main cook stove at the national level in Mozambique. Almost 20 per cent have a basic charcoal burner, while only 10 per cent have some kind of improved cook stove.

When we break the material down into areas, we recognize the pattern from electricity; three stones have a much higher prevalence in rural areas – almost 90 per cent. Maputo city is a sharp contrast to the rural areas as almost none have this type of oven, while in other urban areas about 35 percent uses a three stone oven.

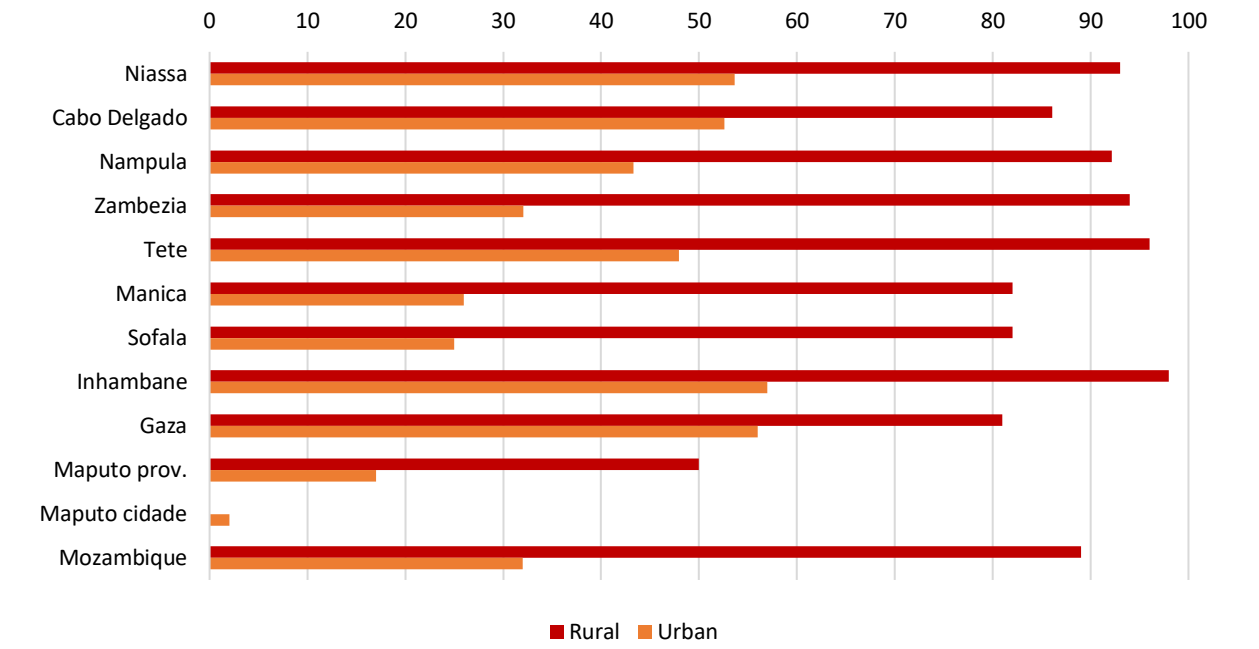
At the regional level, Maputo city stands out by being the only region with only a very small share of three stone cook stoves. The share is also small in Maputo province – just over 25 percent. With one exception, in all other provinces the share is above 60, and mostly around 80. The basic charcoal burner is the second most used cook stove except way down south, i.e. in Maputo city and Maputo

[13] MIREME report that less than 3 per cent of the persons in Mozambique have clean cooking access in http://sdg7mozambique.org/Landing/Status#contact

province. In addition, it is only here that “other stoves” are common. More than 50 percent in Maputo city, and close to 40 per cent in the province.

Figure 4.2.2 below shows the share of three stone stoves in rural and urban areas in each province.

Figure 4.2.2 Three stone cook stoves in Provinces by urban and rural areas. Percentage



Three stone cook stoves are much more frequently used in rural than urban area in all provinces in Mozambique. About 90 per cent of the households in rural parts use three stone cook stoves, while the equivalent in urban parts is 30. The share of three stone cook exceeds 50 per cent in four provinces, but it is typically considerably lower in urban areas. In rural areas, the Maputo province has the lowest share with 50 per cent. In all other provinces, the share is above 80.

So, the differences are huge between the rural and the urban. The variation between provinces is mostly related to urban areas, as the shares of three stone cook stoves in rural areas are more equally distributed across the provinces.

5. Six attributes of modern cooking solutions (tier access)

The reference report "Beyond Connections: Energy Access Redefined"[14] presents six dimensions on how cooking ovens contribute to a sustainable and clean access to energy. As for the access to electricity, each of these dimensions are measured and classified in Tiers from 0 to 5, where 5 represents the highest degree of access.

The module on access to Household Cooking Solutions is designed to measure the 6 cooking related dimensions ranging from health impact to economic impact such as efficiency and convenience. The global set of measurement dimensions is designed to serve any country based upon a multi-tier approach, each ranging from tier 0 to 5. Initially fuel quality was also included, but it is not efficient to include it in a household survey since the measurement requires a technical survey at the local level. The final tier of access is determined by the lowest tier for any of the 6 dimensions. Emissions, indoor emissions, and efficiency all ideally require professional measurement and analysis. The approach would then be to measure all types of stoves in a lab for emissions, indoor emissions, and efficiency, store this information in a database[15] and then record which of these stoves is used by each household. With such information plus information on time use, cooking area and accidents, the tier may be estimated for each household. This ideal approach is designed for research on emission etc. for each type of stoves and is far too demanding for a survey. Hence for the current project a proxy system has been designed. This system is comparable with the global system as defined in "Beyond Connections: Energy Access Redefined". This proxy system can also be used in other national projects to serve national users.

An adapted table for the reference report presents the conceptual dimensions.

Table 5.1. Multi-Tier Framework for Cooking solutions

	TIER 0	TIER 1	TIER 2	TIER 3	Ter 4	Tier 5
Indoor air quality		Concentration of PM2.5 and CO; Tiers aligned with WHO guidelines				
Efficiency		Draft Tier benchmarks have been developed. But the process to reach ISO standards is still pending.				
Convenience			Stove preparation time and fuel collection and preparation			
Safety			Absence of accidents and alignment with the ISO process			
Affordability					Levelized cost of cooking solution < 5 percent of household income	
Quality and availability of fuel					Cooking not affected by seasonal variations in fuel quality and availability	

5.1. Requirements for all Tiers and Dimensions for Cooking Solutions

The global database contains a large number of cooking stoves that have been tested by the producing companies and the technical team of the global database. However, there is a need to supplement the database with cooking stoves which are common in each country. The surveys on multi-tier access supported by the World Bank developed a simplified Adapted Multi-Tier Framework for measuring access to modern energy cooking solutions for countries like Cambodia, Rwanda, and Ethiopia, using broader groups of stove design, fuel, and ventilation. This adapted version is also used for this survey and is reproduced in table 5.2 below.

[14] When the volume of the kitchen and the ventilation structure are combined, the number of Tiers are collapsed from seven to six as recommended in the Beyond Connection Report (https://www.worldbank.org/en/topic/energy/publication/energy-access-redefined)

[15] http://catalog.cleancookstoves.org/

Table 5.2 Classification of tiers for cook stoves

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Cooking Exposure	Emission: Fuel	Firewood, dung, twigs, leaves, rice husks, processed biomass pellets or briquette, charcoal, kerosene				Biogas, ethanol, high quality processed biomass pellets or briquettes	Electricity, solar, LPG
	Emission: Stove Design	Three-stone fire, tripod, flat mud ring, traditional charcoal stove	Conventional or old generation Improved cooking solutions (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 stove, 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/above door-height	Veranda or a hood is used to extract the smoke	Open air
	Alternative proxy: Ventilation level	Bad			Average	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
Cookstove Efficiency	ISO's Vol. Performance Targets (TBC)	Less than 10	More than 10	More than 20	More than 30	More than 40	More than 50
Convenience	Fuel acquisition (collection or purchase) and preparation time (h/w)	More than 7 hours		Less than 7 hours	Less than 3 hours	Less than 1.5 hours	Less than 0.5 hour
	Stove preparation time (minutes per meal)	More than 15 minutes		Less than 15 minutes	Less than 10 minutes	Less than 5 minutes	Less than 2 minutes
Safety of Primary Cookstove		Serious accidents over the past 12 months				No serious accidents over the past 12 months	
Affordability		Levelized cost of cooking solution (fuel) more than 5 % of household income				Levelized cost of cooking solution (fuel) less than 5 of household income	
Fuel Availability		Primary fuel available less than 80 days of the year				Primary fuel is readily available 80 days of the year	Primary fuel readily available throughout the year

5.2. Empirical figures for all Tiers for Cooking Solutions

The module on access to Household Cooking Solutions is designed to measure the 6 dimensions of cooking – exposure, efficiency, convenience, safety, affordability, and fuel availability. In table 5.3, the empirical figures from the survey are reproduced together with the overall measure for Cook Stove Tier.

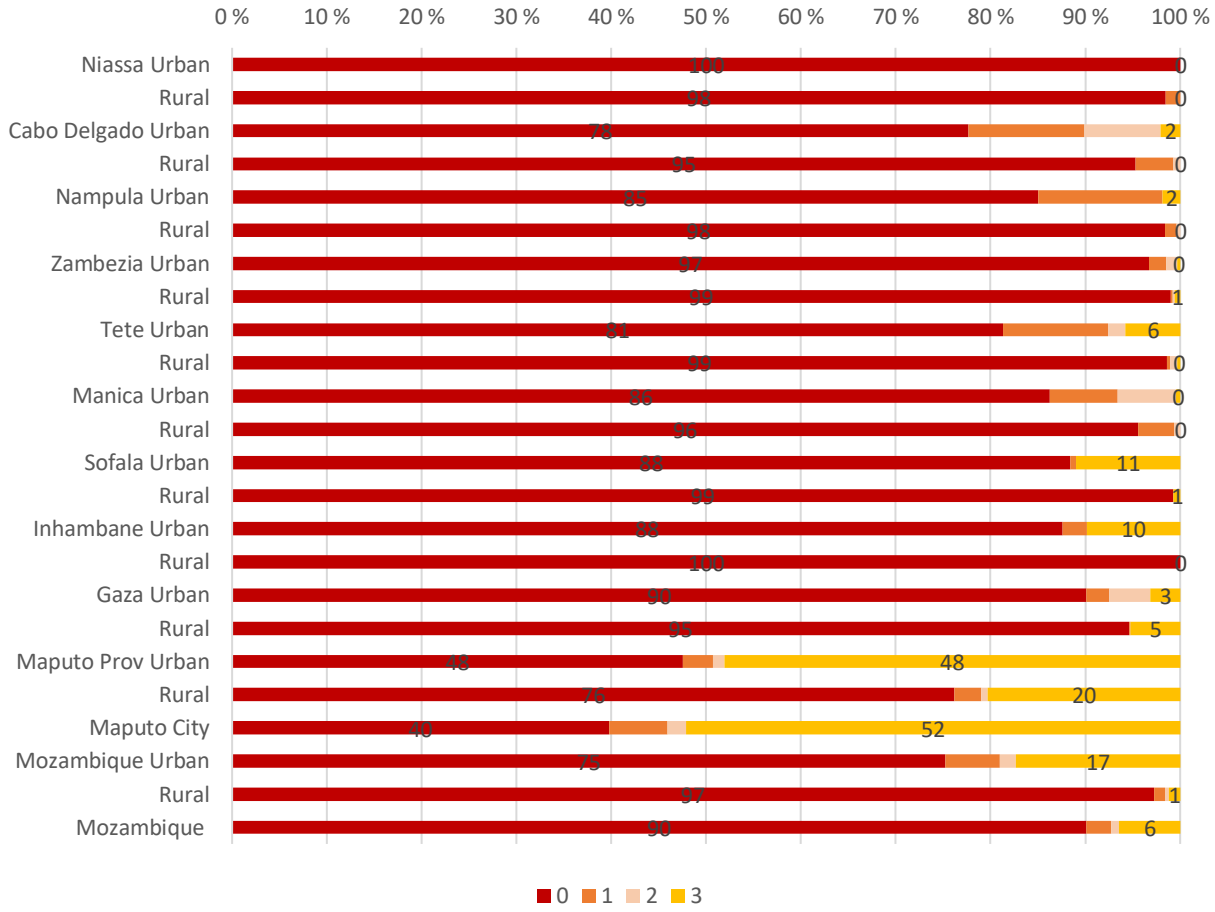
Table 5.2 Households by Access to Cook Stoves in Tiers – 6 dimensions. Percentages

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Exposure	**Emission: Fuel**	75	16	2	1	1	5
Effiency	**Design and ventilation**	90	3	1	1	0	6
Convenience	**Structure, ventilation level, contact time**	27		26	29	9	9
Safety	**Serious accidents**	2				98	
Affordability		36				64	
Fuel availability		91				1	8
Overall cooking solution	**Households, Percent**	90	3	1	6	0	0

Regarding access to clean cooking the figures are not uplifting. Overall, only 10 per cent of the households are above Tier 0, and the reason is efficiency. If it was only about emission, the numbers in Tier 0 would have been somewhat lower - 75 per cent. But, as the weakest link determines the overall position, 90 per cent end up in Tier 0.

In the next figure, the overall Tier is distributed over the provinces and areas.

Figure 5.4 Access to cook stoves in Tiers by Province and area. Percentages



There is not so much variation in Tiers for clean cooking as it was for clean energy. However, there are some. At the national level, cooking solutions are cleaner in urban than rural areas. In urban areas, almost no household are above Tier 0, only 3 per cent are at a higher Tier. In urban areas, 25 per cent passes Tier 0, and 17 per cent are level 3.

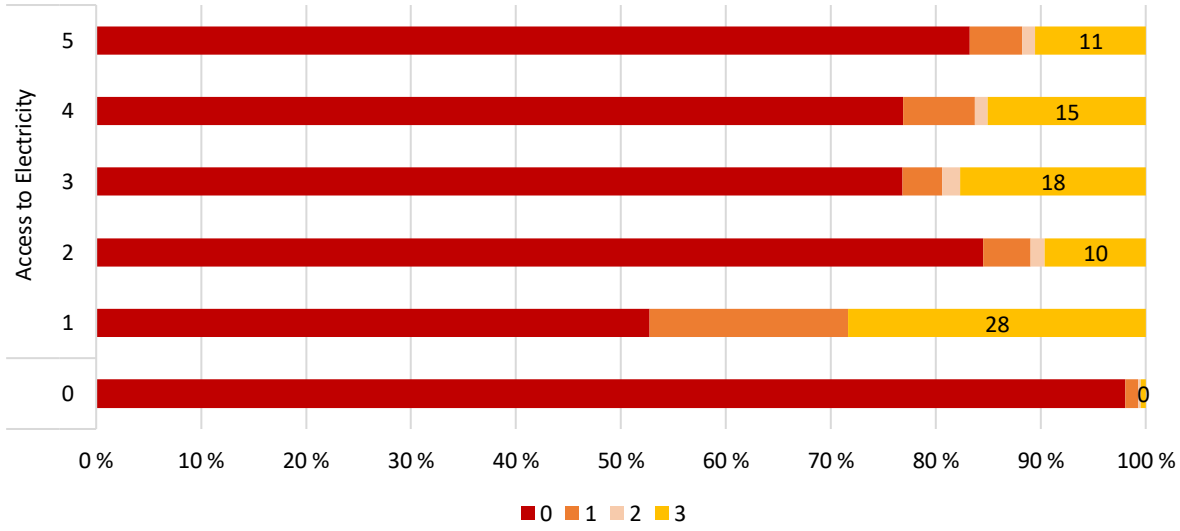
In Maputo city, the situation is a lot better than elsewhere, and more than 50 per cent are at level 3. Urban parts of Maputo province are almost at the same level as Maputo city while 20 per cent of households in rural parts of Maputo province are at level 3. In addition, in urban parts of Sofala and Inhambane the share of households at level 3 exceeds 10 per cent. Otherwise, Tier 0 is the dominating status of access to clean cooking.

6. Joint distribution of Electricity and Cooking solutions

Access to clean energy is based on two dimensions; electricity and cook stoves (fuel and design of oven). Above they are treated separately. In this chapter we look at how electricity and cook stoves are related. Is it households with electricity that use improved cook stoves, or are the two dimensions independent of each other? In other words, is there a Matthew effect[16] on having access to clean energy.

6.1. How is the cook stove situation in different Tiers of electricity?

Figure 6.1 Level of Tier on cooking solution by level of Tier on electricity. Percentages

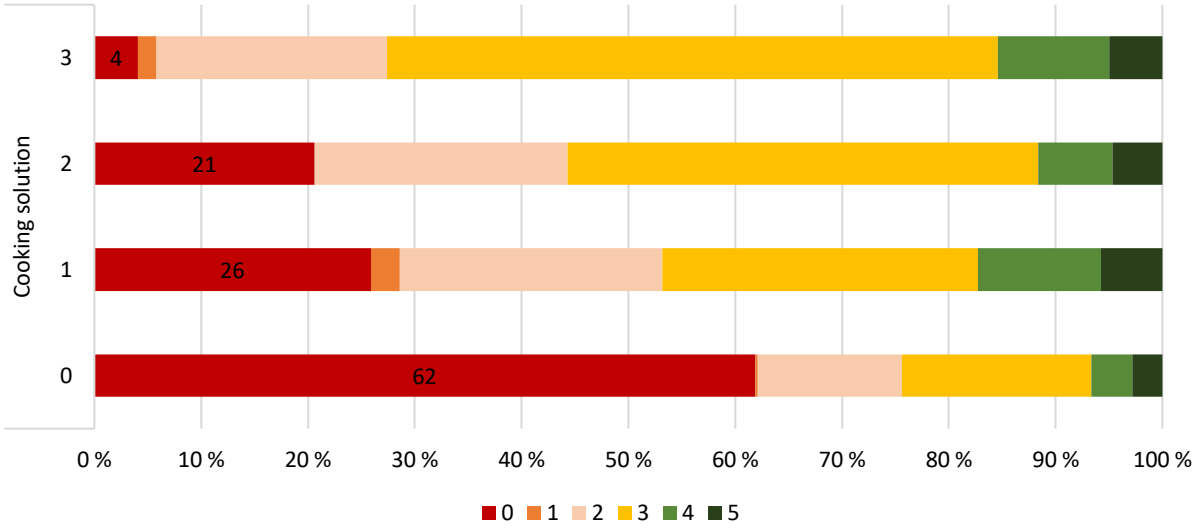


From figure 6.1 we register that almost none of the households without any access to electricity, have a cook stove "better" than three stones. The variation in stoves is to be found among those who have electricity. The lowest element of three stones is among Tier 3 and 4, where 25 percent of the household have a stove qualifying to a Tier above 0. The shares are not highest in Tier 5 though, but in Tier 1. The reason for that is probably the number of observations in Tier 1 is very low, which imply a high uncertainty.

[16] I.e. a pattern in which those who begin with advantage accumulate more advantage over time and those who begin with disadvantage become more disadvantaged over time.

6.2. How is the cook stove situation in different Tiers of access to electricity?

Figure 6.2 Level of Tier on access to electricity by level of Tier on cooking solution. Percentages



As there are only 10 per cent of the sample that are above 0 on cook stoves, we must be careful to draw strong conclusions. However, it seems like there is a rather strong tendency that access to electricity rises with Tier of cook stove. We register that more than 60 per cent of those at level 0 on cook stoves, do not have any access to electricity, while the same number is around 25 in Tier 1.

6.3. Joint distribution of electricity and cook stoves across urban and rural areas

In order to try to give an overall picture of access to clean energy in Mozambique using the Tier approach on electricity and cook stoves, we calculated the percentages with basis in the grand total. Then we can find out what proportion of the households that do not have electricity and use a three-stone oven, and how many people have good access to electricity and an improved oven. To make the table clear, we combined two and two categories on electricity. For cook stoves, three stone ovens represents a category on its own, Tier 1 and 2 are merged, while Tier 3 stands alone. Table 6.1 shows the distribution for Mozambique as a whole, and by degree of urbanization. We do not expect that story will differ from what we have already seen above, so it is added to confirm the picture already given.

Table 6.1 Simultaneous distribution of electricity Tiers and cook stove Tiers

		Cook stove		
	Electricity	Tiers 0	Tiers 1 2	Tiers 3
Maputo (= 100 %)	Tiers 0 1	1,5	3	8
	Tiers 2 3	34,9	4,7	48,8
	Tiers 4 5	3,4	1,3	3
Urban (= 100 %)	Tiers 0 1	26,4	1,4	1
	Tiers 2 3	46,1	3,5	9,4
	Tiers 4 5	7,5	0,6	2,3
Rural (= 100 %)	Tiers 0 1	71,5	0,5	0,1
	Tiers 2 3	20,3	0,3	0,8
	Tiers 4 5	5,4	0,4	0,3
Mozambique (= 100 %)	Tiers 0 1	56	1	0,4
	Tiers 2 3	28,2	2	5,1
	Tiers 4 5	5,9	0,1	1

The picture on access to clear energy in Mozambique is very clear: Access to clean energy is rather low. 56 per cent of the households do not have any electricity at all and keep a three stone oven. We have seen these ovens dominate the country, and households with middle and high range access to energy also mainly keep a three stone oven.

However, the picture of the entire country obscures underlying differences across urban and rural areas. We have treated the capital as an area in its own here, and the access to clean energy are different here compared to the rural areas and in other urban areas. Of course, the three stone oven is not common in a big city.

We see that almost none of the households in the capital area find themselves in the situation that is the most prevailing throughout the country; no electricity cooking on a three stone oven.

6.4. Main findings

Households with good access to electricity often have a better furnace solution than others. Households without electricity rarely have anything other than a three-stone oven to prepare food.

In urban areas, especially in Maputo, there are more households with both electricity and improved cooking solutions compared to rural areas.

Access to clean energy is generally low in Mozambique, with 56% of households having neither electricity nor improved cooking solutions.

References

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