A2E

ACCESS TO ENERGY INSTITUTE

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STUDY OF HOTPLATE & GRID USE IN RURAL MALAWI

Learnings from a feasibility study to pave the way for mass distribution of electric hotplates to rural households

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STUDY OF HOTPLATE & GRID USE IN RURAL MALAWI

The Access to Energy Institute (A2EI) has been part of a feasibility study to pave the way for mass distribution of electric hotplates to rural households in Malawi. This is one of many data collection activities supported by A2EI in the clean cooking sector through a research initiative that involves deploying 1,000 smart meters in Asia, Africa and South America. The data collected by A2EI will make it easier to understand the underlying behaviors and drivers that would benefit the quality of life and health of millions of people.

The study of hotplate and grid use in rural Malawi is led by the non-profit climate protection organization Atmosfair together with the mini-grid operator Mulanje Electricity Generation Agency (MEGA) and Mulanje Renewable Energy Agency (MuREA). On the scientific side, researchers from the University of Strathclyde under UK Aid's Modern Energy Cooking Services (MECS) program have been involved as well.

A2EI provided 20 households with two smart meters each. One was connected to the grid and the second one was connected to a 1,500 W hotplate. Via the smart meters, the hotplate's energy usage was monitored over a time span of four months from March to July 2021.

All households were located in the Mulanje region in Southwestern Malawi, a rural mountainous area with a hydro-powered mini-grid. The mini-grid had a low electricity tariff of only 0.07 euros per kilowatt hour, which made cooking with electricity financially competitive compared to purchased fuels such as charcoal.

The data collection part of the study has now been concluded and the distribution of electric hotplates that fit the needs of the participating households is about to begin. This next part of the study builds upon the lessons learned through the detailed analysis of our smart meter data and a couple of complementing surveys. The results suggest that the distribution of hotplates to Malawi could be more impactful if the participants would have a hotplate with a higher capacity to cook different foods simultaneously.

As the new hotplates arrive in Malawi, we are preparing to resume the data collection activities and support our partners in their analysis to verify the findings from the first part of the study.

The first scale-up phase will provide 500 to 1,000 electric hotplates. This is expected to reduce hundreds of tons of CO_2 emissions, prevent deadly respiratory tract infections and reduce the time that people, mostly women and children, spend on cooking related activities.

HOTPLATE VS. GRID USE

Here are a couple of examples which demonstrate the energy consumed by the hotplates compared to the overall grid use. Below, we have handpicked two households which represent a high-frequency user (approx. 75 cooking events per month) and a middle-frequency user (approx. 50 cooking events per month), respectively. The hotplate use is shown as round markers in the pink area underneath the grid line.

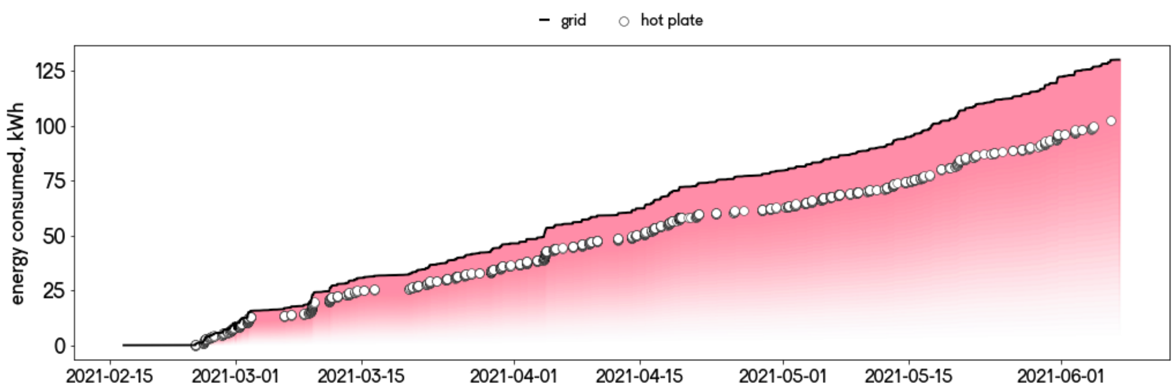

Fig. 1: This is the energy consumption of household no. 9, a high-frequency user. It has grid meter 86000010 and hot plate meter 8600036. The energy recorded by the grid meter is 130.03 kWh and the energy recorded by the hotplate meter is 102.3 kWh. Consequently, a share of 78.7% of the total household energy is attributable to electric cooking.

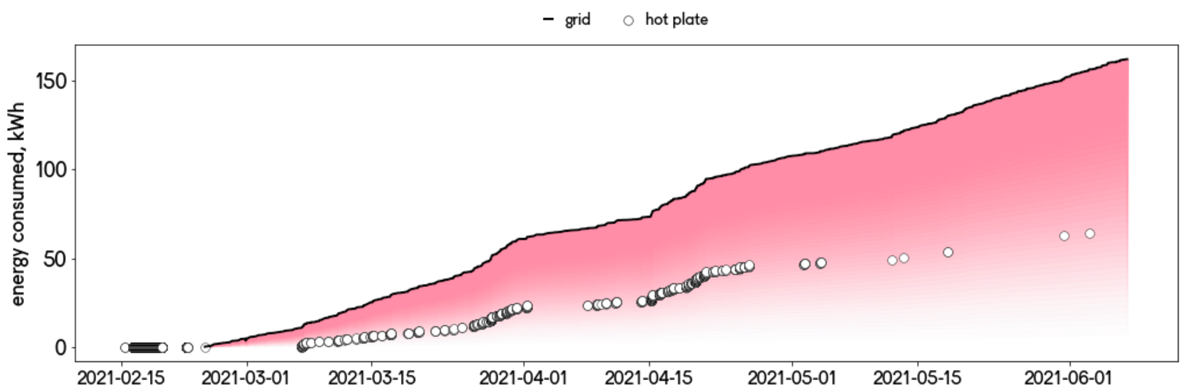

Fig. 2: This is the energy consumption of household no. 19, a middle-frequency user. It has grid meter 86000021 and hot plate meter 546166 The recorded overall household consumption was 162.3 kWh, of which the hotplate consumed 64.1 kWh. That means 39.5% of the total energy is used for cooking.

The data and the surveys that were conducted in parallel to the study have shown that cooking with a hotplate was very appreciated, but it also showed that the provided hotplate (a one-plated 1.5 kW hotplate) was too small to cook all the food for a household. This meant that a fire was kept going for cooking purposes as well. In this study the average daily hotplate consumption is 1.14 kWh. This is considerably less than the 2 kWh of daily energy consumed for cooking food in other comparative studies in East African countries and south-east Asia[1].

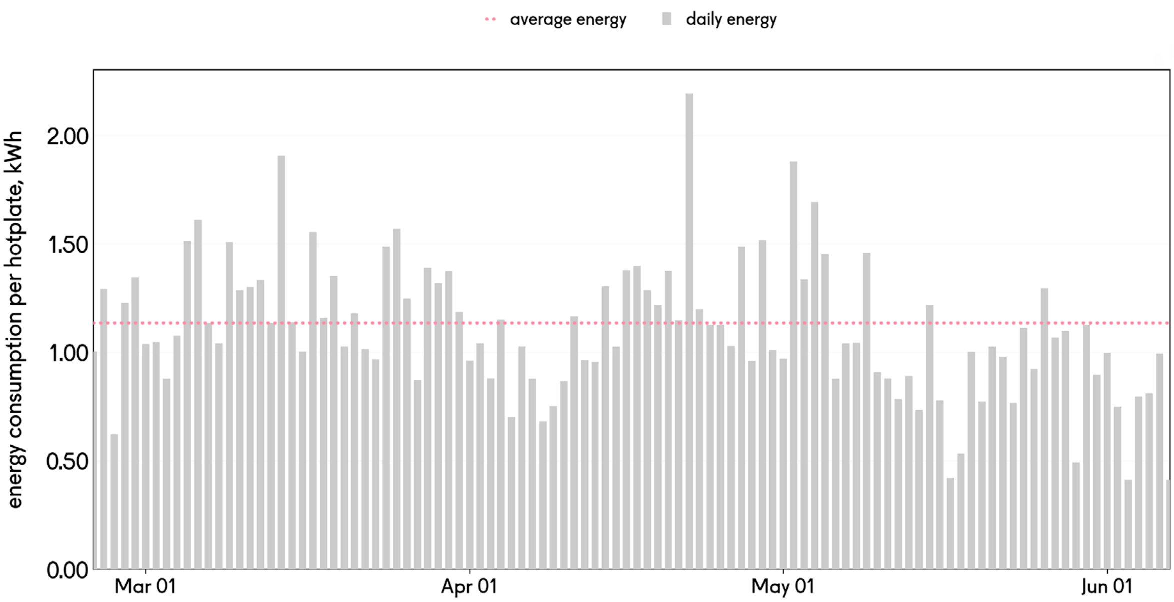

Fig. 3: The grey bars illustrate the average energy use of hotplates per day. It varies from approx. 0.5 kWh per day to 2.1 kWh per day. The average energy use is illustrated by the dotted line which corresponds to an energy consumption of 1.14 kWh per day.

Since the households still kept a fire going, the CO_2 savings for the participating households were lower than the potential savings. The conclusion was therefore that the next phase of the study will involve the distribution of 2-plated hotplates. These larger hotplates are currently on their way to Malawi and the households in the study.

We invite other individuals and entities in the sector to discuss data-driven clean cooking research with us. The smart meter data from the grid meters and the hotplate meters can be studied in its entirety in this data release.

We also welcome you to share and discuss any additional observations and measurements on hotplates or other clean cooking devices from other parts of the world with us.

1 Cooking with Electricity - A Cost Perspective Report: https://documents1.worldbank.org/curated/en/920661600750772102/pdf/Cooking-with-Electricity-A-Cost-Perspective.pdf

ACCUMULATED DATA FROM THE USE OF HOTPLATES

The data shows that the hotplate use did not increase over time, but rather stayed at a constant level during the entire study period.

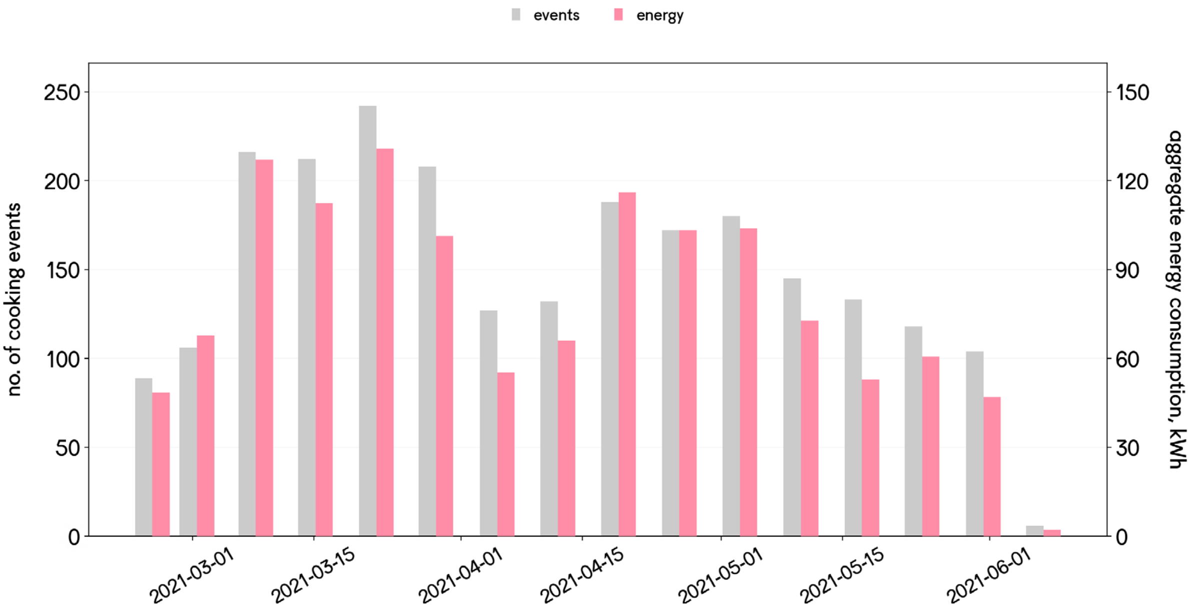

Fig. 4: This is the weekly hotplate use. The primary y-axis matches the grey bars which corresponds to the total number of cooking events per week and the secondary y-axis matches the pink bars which corresponds to the total energy consumption per week (kWh).

The graph below depicts the distribution of the average use of the hotplate. It shows us that the participating households cooked breakfast, lunch and dinner. It also tells us that most meals started at 17:00 and that it coincided with the time when the most energy was being used.

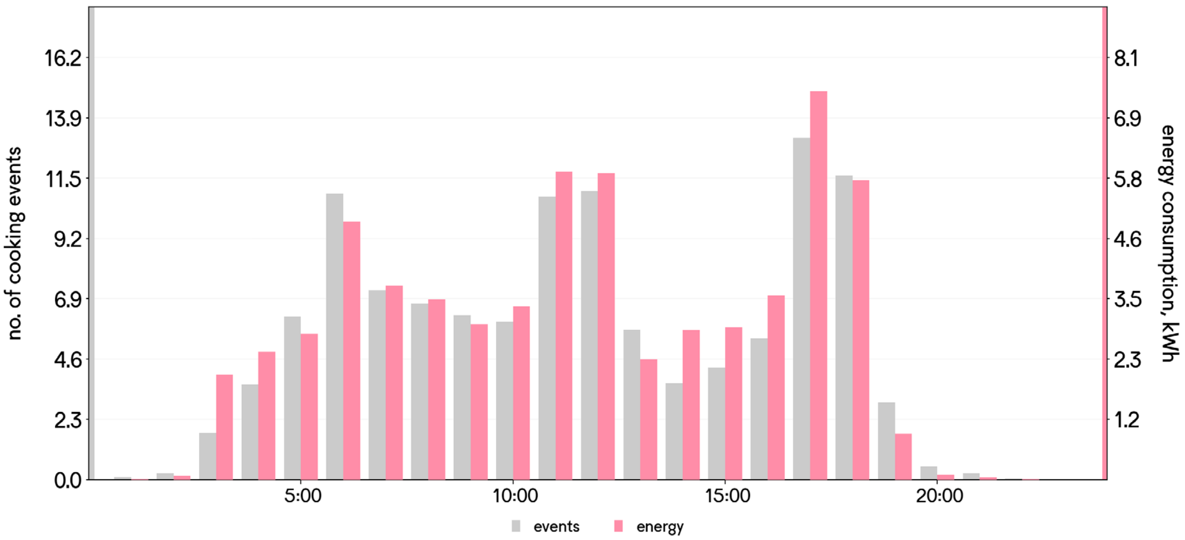

Fig. 5: Profile of average hotplate use during 24 hours. The grey bars are the total number of cooking events divided by the amount of participating households (20 households). The pink bars are the total amount of energy (kWh) used divided by the amount of participating households.

Figure 6 illustrates the distribution of energy use per cooking event. This tells us that most of the events had a power consumption of 0.15 to 0.30 kWh. It shows as well that the distribution has a long tail, which means that there were many cooking events that were significantly longer. The average cooking event had an energy consumption of 0.53 kWh.

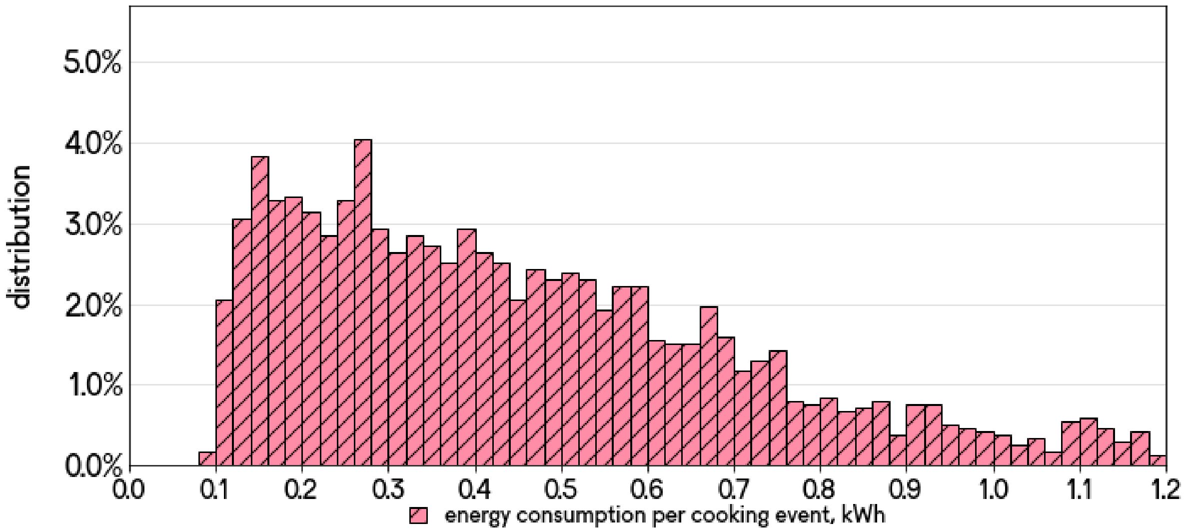

Fig. 6: Distribution of all hotplate events based on the cooking event energy in kilowatt hours (kWh).

Figure 7 shows the distribution of cooking time. Here we discover that most of the cooking events were only 10 minutes long. However the average cooking time was 44 minutes.

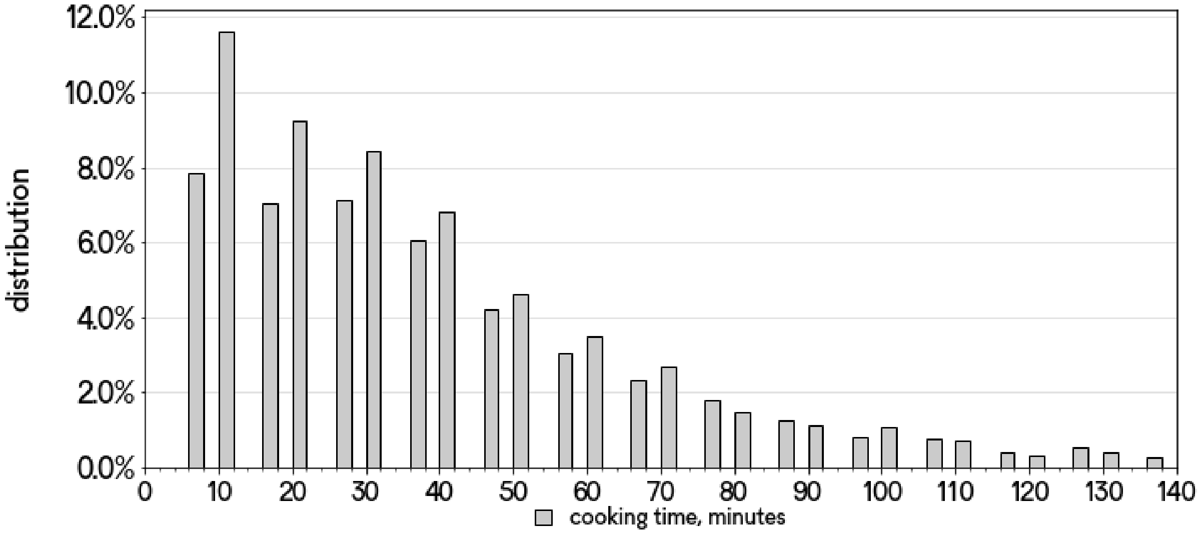

Fig. 7: Distribution of all hotplate events based on the cooking event duration in minutes.

STABILITY OF THE GRID VOLTAGE VS. CURRENT & FREQUENCY

Here we investigate the stability of the grid by looking at the voltage, current, and frequency over time. We first present a case of unstable voltage, with data taken from another project, and then present the Malawi project data.

The following graph displays data collected from the national grid of Nepal. The voltage curve in black tells us that the voltage can be very unstable in some regions. Apart from the obvious drawbacks from blackouts and other concerns for the infrastructure and industry of a country, an unstable grid can cause damage in connected appliances.

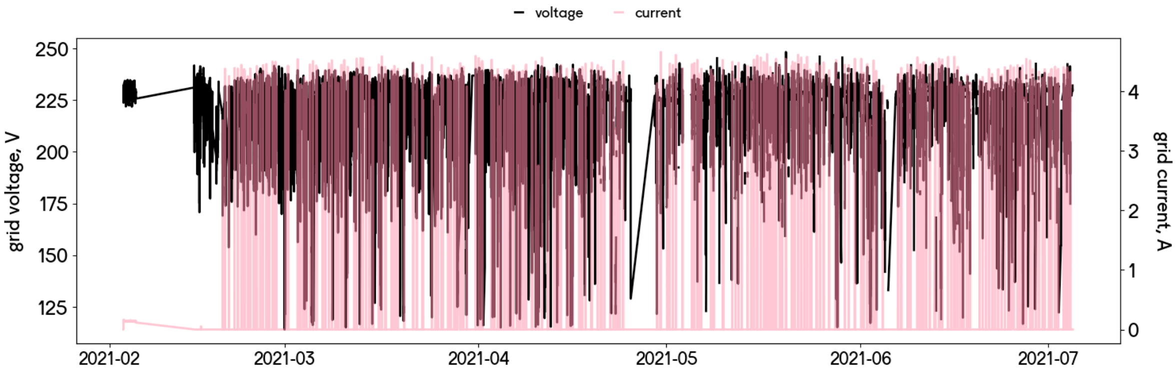

Fig. 8: This is a graph that is showing the data from a grid meter in a project in Nepal. It is showing the voltage and current values from February 2021 to July 2021.

The following graphs are from the study in Malawi and display the voltage of the grid compared to the current and the frequency. They show that the grid is quite stable and able to supply power during the whole study period.

Fig. 9: This is the voltage and current values from the grid meter with no. 86000005 in household no. 4.

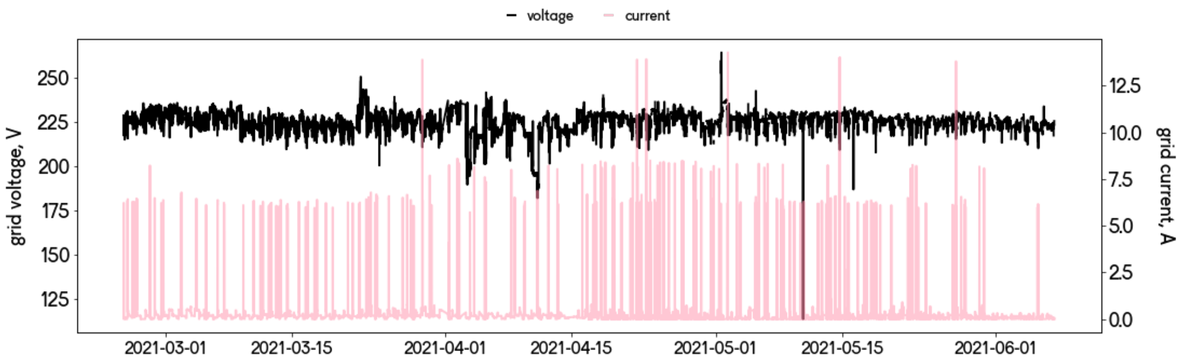

Fig. 10: This is the voltage and current values from the grid meter with no. 86000006 in household no. 5.

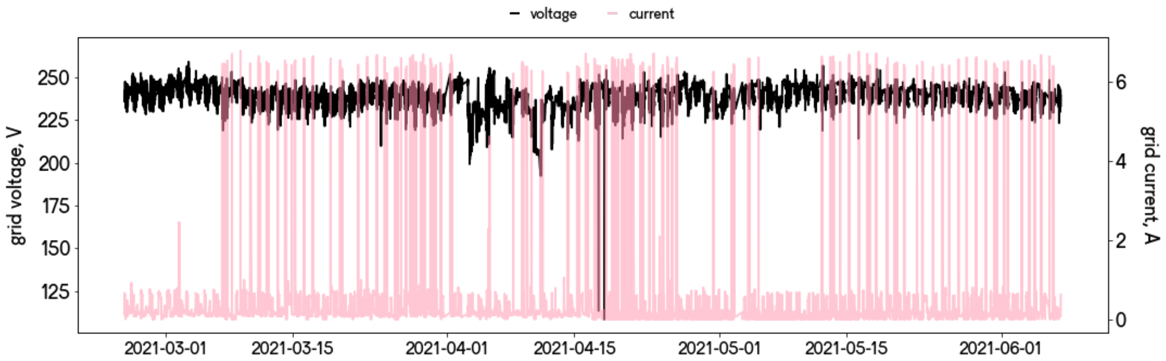

Fig. 11: This is the voltage and current values from the grid meter with no. 86000021 in household no. 19.

The following graphs are examples of the voltage compared to the frequency of the grid meters.

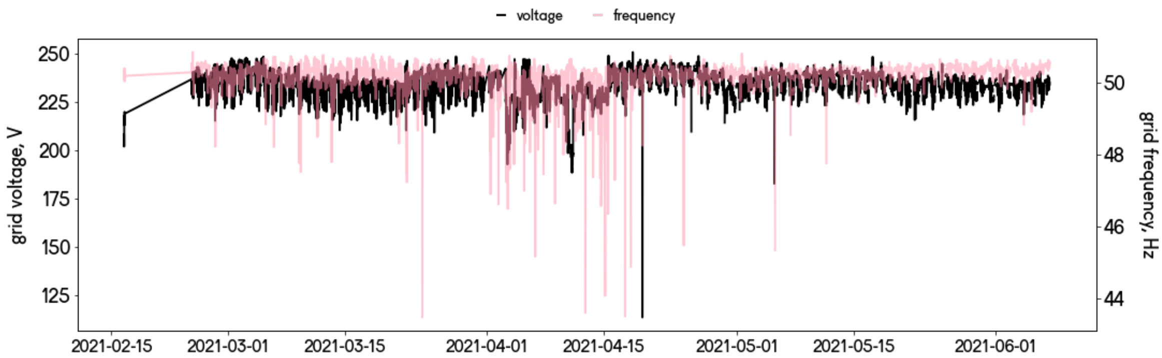

Fig. 12: This is the voltage and frequency values from the grid meter with no. 86000002 in household no. 1.

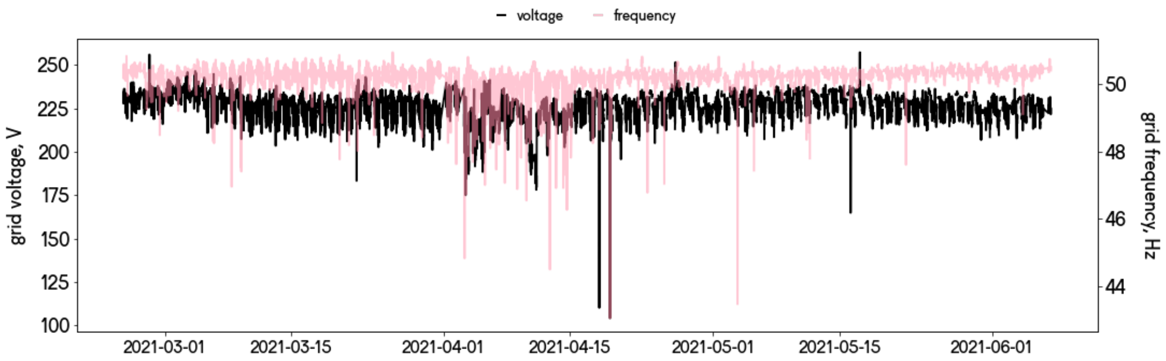

Fig. 13: This is the voltage and frequency values from the grid meter with no. 86000005 in household no. 4.

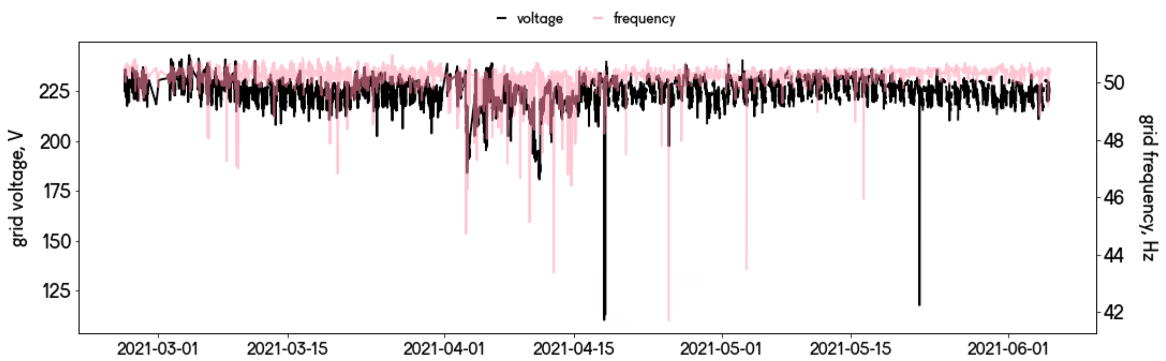

Fig. 14: This is the voltage and frequency values from the grid meter with no. 86000013 in household no. 11.

DOWNLOAD THE FULL DATA RELEASE

Interested to get the raw data? Dowload it here:
a2ei.org/news/study-of-hotplate-grid-use-in-rural-malawi

Are you interested in future data releases?
Do you have input, thoughts or ideas you would like to share with us?
Please email us at datadatadata@a2ei.org.

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