#### Miscounting the Poor: How Survey Data Overstates Electricity Spending in Rwanda Joel Mugyenyi and Vijay Modi e-GUIDE

## **Executive Summary**

This study investigates discrepancies between household electricity expenditures reported in Rwanda's national survey (EICV5, 2016/2017) and billing records from the Rwanda Energy Group, focusing on low-income households. Using a two-step matching algorithm based on GPS proximity and household head names, we matched 650 grid-connected households to compare survey and utility data. Key findings include:

- 1) **Survey data significantly overstate electricity spending by low-income households**, largely due to infrequent purchasing behaviors that standard survey reporting fails to capture.
- 2) Adjusting survey data for months without purchases narrows this gap substantially, revealing that reported electricity burdens are overstated among poorer households.
- 3) **Policy implications**: Energy affordability assessments and subsidy programs must account for irregular purchase patterns to avoid misrepresenting the financial strain on low-income households and misallocating support.

### **Study Overview**

This study investigates discrepancies between household electricity expenditures as reported in national surveys and as recorded by utility data, with a focus on low-income households in Rwanda. Misestimating household electricity spending can lead to misguided policy decisions, particularly in infrastructure planning and subsidy design.

We use data from Rwanda's national household survey, EICV5<sup>1</sup> (2016/2017), and utility billing records<sup>2</sup> from the Rwanda Energy Group. Of the 14,580 households surveyed in EICV5, approximately 3,600 were connected to the grid.

#### **Matching Algorithm**

To compare survey-reported and utility-recorded data at the household level, we develop a two-step matching algorithm based on (1) GPS location proximity (within 40 meters) and (2) matching household head names. A household was considered a successful match only if it met both criteria. Out of 3,600 grid-connected households, 650 meet our matching criteria.

## Survey vs Utility: A Comparative Analysis

After matching the data, we analyzed the share of household budgets allocated to electricity based on survey responses and utility billing records. Figure 1 presents a scatterplot of the share of a household's monthly budget allocated to electricity (y-axis) versus total monthly expenditure (x-axis), using the 650 matched households.

Survey-reported data (light red points) and utility-measured data (light blue points) are overlaid, with LOESS<sup>3</sup> smoothing lines fitted for each. The figure reveals that, according to survey data, lower-income households (spending less than 100,000 RWF per month, or approximately \$ 125<sup>4</sup>) allocate a much higher share of their budget to electricity than wealthier households. However, this pattern is not observed in the utility data, highlighting a potential overstatement of electricity expenditures among poorer households in surveys.

<sup>&</sup>lt;sup>1</sup> EICV5 Survey Details: For more information on the EICV5 (2016/2017) household survey, see our paper: Electricity Consumption: The role of grid reliability in appliance ownership in Rwanda

<sup>&</sup>lt;sup>2</sup> Utility Billing Records: Details on the utility billing data are provided in our paper: Post-connection electricity demand and pricing in newly electrified households: Insights from a large-scale dataset in Rwanda

<sup>&</sup>lt;sup>3</sup> LOESS Smoothing: LOESS (Locally Estimated Scatterplot Smoothing) is a non-parametric regression method that fits a smooth curve through a scatterplot, helping to visualize trends in noisy data

<sup>&</sup>lt;sup>4</sup> Nominal Values: All monetary values are presented in nominal terms unless otherwise specified

Households in the survey data frequently round their reported electricity expenditures to common values—typically 500, 1000, or 2000 RWF—which creates visible clusters in the scatter plot. This "rounding" is shown in Figure 1.



Figure 1: Electricity budget share versus total household expenditure, comparing survey and utility data

## Accounting for Infrequent Purchase Behavior

Irregular purchasing patterns may explain the survey overestimation observed above. Figure 2 shows the distribution of electricity purchasing frequency (number of months households made a purchase) by expenditure bracket. As expected, wealthier households tend to purchase electricity more consistently each month, while lower-income households exhibit sporadic purchasing behavior.

For instance, among households spending less than 50,000 RWF per month, only 18.6% made regular monthly purchases, compared to 40.6% in the 50,000–100,000 RWF bracket, 69% in the 100,000–500,000 RWF bracket, and 84% in the over 500,000 RWF bracket.



Figure 2: Frequency of electricity purchases by household expenditure brackets

When adjusting for this infrequent purchasing behavior—normalizing survey expenditures based on the number of purchase months—the observed mismatch between survey and utility data narrows substantially (Figure 3).

After adjustment, the electricity budget share of poorer households no longer appears disproportionately high relative to higher-income brackets, suggesting that infrequent purchasing behavior significantly biases survey-reported expenditures.



*Figure 3: Boxplots comparing the proportion of household budgets spent on electricity across expenditure brackets, using survey and utility data. The survey data is adjusted to account for purchasing frequency.* 

# Conclusion

This analysis highlights the challenges of relying on household surveys to accurately measure energy expenditures. Infrequent purchasing behavior among low-income households introduces systematic biases that overstate their electricity burden when using survey data alone.

Failing to adjust for purchasing frequency may lead to overestimation of energy burdens among the poor, resulting in inefficient targeting of subsidies and affordability interventions.