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Electricity as a clean cooking option

What can we learn from cross-country comparison?

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Electricity as a clean cooking option: What can we learn from cross-country comparison[1]

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Abstract

Cooking, a ubiquitous household activity, presents a significant opportunity for energy transition. This study focuses on the transition to the understudied and under-adopted—despite high electricity access—practice of electric cooking as a clean solution by examining both demand and supply factors. Using nationally representative data from India, Nepal, Kenya, Ethiopia, and Nigeria, we highlight the role of electricity reliability as a central determinant of electric cooking adoption. Reliability consistently shows a strong positive association with adoption in India, Nepal, Ethiopia, and Nigeria, underscoring that access alone is insufficient without dependable supply. Alongside reliability, household expenditure, urban location, and education also emerge as important correlates. Qualitative evidence further reveals that while electric cooking is valued for its speed and convenience, it is predominantly used in a stacked manner and faces several barriers—poor and unreliable electricity quality, inadequate household electrical wiring and infrastructure, high upfront appliance costs, limited appliance durability, and lack of local repair services—that inhibit greater use of this fuel. These findings can be valuable for further research, data collection, and government policies to effectively scale electric cooking

Keywords: Electricity Reliability, Household air pollution, Energy Transition, Electric Cooking, Clean Cooking
JEL: O12, O13, O18, Q40, Q48, Q55.

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[1] We express our gratitude to the Environment for Development Initiative (EfD) for their financial support, provided under grant number MS 1165. Additionally, we appreciate the conversations with Sunil Mani from Council on Energy, Environment, and Water (CEEW), Vimal Kumar from Finovista (Modern Energy Cooking Solutions India partner), and other stakeholders who provided valuable input at different stages of the research

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Cooking, a ubiquitous household activity, presents a significant opportunity for energy transition. This study focuses on the transition to the understudied and under-adopted—despite high electricity access—practice of electric cooking as a clean solution by examining both demand and supply factors. Using nationally representative data from India, Nepal, Kenya, Ethiopia, and Nigeria, we highlight the role of electricity reliability as a central determinant of electric cooking adoption. Reliability consistently shows a strong positive association with adoption in India, Nepal, Ethiopia, and Nigeria, underscoring that access alone is insufficient without dependable supply. Alongside reliability, household expenditure, urban location, and education also emerge as important correlates. Qualitative evidence further reveals that while electric cooking is valued for its speed and convenience, it is predominantly used in a stacked manner and faces several barriers—poor and unreliable electricity quality, inadequate household electrical wiring and infrastructure, high upfront appliance costs, limited appliance durability, and lack of local repair services—that inhibit greater use of this fuel. These findings can be valuable for further research, data collection, and government policies to effectively scale electric cooking.

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1 Introduction

The absolute number of people primarily using polluting fuels for cooking has decreased little due to rising populations, from 3 billion in 1990 to only 2.8 billion in 2020 (Stoner et al., 2021). Air pollution is one of the major health concerns globally (Cohen et al., 2017; Lelieveld et al., 2020). Exposure to household air pollution leads to increased mortality from noncommunicable diseases such as stroke, ischemic heart disease, chronic obstructive pulmonary disease (COPD), childhood pneumonia, asthma, lung cancer, among others (Balmes, 2019; Schraufnagel et al., 2019). There is a need for cleaner and more efficient cooking solutions to mitigate the adverse health and environmental impacts associated with polluting fuels. Of the two major clean cooking technologies, gas (both piped and bottled) has been studied more intensively than electricity. In this paper, we explore the wide range of barriers and enablers to the adoption of electric cooking in multiple country settings.

Electric cooking (Figure 2) lags significantly behind electricity access (Figure 1) across low- and middle-income countries. A similar gap is prevalent in other developing countries (Kojima, 2021). This gap presents an opportunity to scale up electric cooking. We aim to understand the key factors influencing electric cooking adoption in selected countries, specifically India, Nepal, Kenya, Ethiopia, and Nigeria. We selected these countries for several reasons. First, these countries exhibit varying levels of electricity access and adoption of electric cooking technologies. Second, local researchers facilitated both access to additional country-specific datasets and made it feasible to conduct qualitative surveys to supplement the secondary data.

Furthermore, as electricity grids are becoming cleaner and more reliable, electric cooking holds increasing promise as a key component of the green transition in the medium to long term. Electric cooking with renewable electricity can be part of an innovative model to replace unclean cooking by leveraging carbon financing. This approach could be beneficial for low-income households, governments, and private sector stakeholders alike, creating a "win-win" scenario in which polluting households and businesses can benefit from reduced cost of clean cooking options, and governments as well as private entities have incentives (from monetized avoided emissions) to deliver clean cooking options.

There are limited studies across low and lower-middle-income countries on the crucial determinants of electric cooking—induction cookstoves, electric pressure cookers (EPCs), electric coil stoves, electric mitad (local cookstove for preparing staple food injera in Ethiopia), and electric rice cookers (Alem et al., 2014; Behera et al., 2016; Feyisa, 2019; Davi-Arderius et al., 2023; Rubinstein et al., 2022; Paudel et al., 2023; Bajracharya et al., 2024; Odoi-Yorke, 2024; Ossei-Bremang et al., 2024), especially those amenable to policy intervention. Our mixed-method approach, combining econometric analysis with qualitative analysis aims to significantly enhance understanding of crucial determinants of electric cooking. We utilize nationally or regionally representative energy surveys like IRES (India Residential Energy Survey), NLSS (Nigeria Living Standards Survey), and MTF (Multi-Tier Framework survey) conducted in our study countries to explore the impact of factors such as electricity access and cost, availability and cost of alternative fuels, quality of supply, income, education and perceptions, intra-household dynamics, dietary and cultural preferences, and actions undertaken by governments or other actors to promote electric cooking.

This paper makes two key contributions to the limited studies on electric cooking. First, it provides one of the few multi-country comparative analyses of electric cooking adoption, drawing on nationally representative datasets from India, Nepal, Kenya, Ethiopia, and Nigeria. By systematically linking household-level adoption to electricity reliability, affordability, and socioeconomic factors, the study offers new empirical evidence on the conditions under which electricity becomes a viable clean cooking option. Second, by combining quantitative econometric analysis with qualitative insights from household and retailer interviews, the paper advances a richer understanding of both demand- and supply-side barriers—ranging from unreliable electricity supply and appliance quality to cultural practices, information gaps, and market infrastructure.

We supplement our statistical analysis with primary interviews with households and retailers to arrive at a richer demand and supply side understanding of the disparities in electric cooking adoption. While the absence of standard quasi-random variation for identification is anticipated, the drivers of electric cooking adoption are rarely attributable to a single factor. Our mixed-method approach offers a comprehensive understanding of the combination of crucial factors influencing electric cooking adoption. We find that quantitatively, key correlates of adoption include electricity reliability, household expenditure, urban location, and education. Qualitatively, we find that even where aggregate supply hours are high, poor electricity quality—such as low voltage and unreliability during peak or monsoon seasons—remains a critical barrier. Other household-specific barriers include inadequate household electrical wiring and infrastructure, the high upfront cost of quality appliances, and a lack of local repair services. Our findings can inform design of policies aimed at substantially expanding the use of electric cooking, and more rigorous causal evaluations of the success and impacts of those policies. This, in turn, would contribute to identifying interventions that work to reduce exposure to air pollution and the incidence of associated diseases, enhancing overall welfare, particularly among women who predominantly bear the responsibility for household cooking and fuel collection.

The structure of the paper is as follows: Section 2 describes the potential enablers and barriers to electric cooking. Section 3 describes the quantitative and qualitative data. Section 4 describes the estimation and results, identifying a list of country-specific factors correlated with the adoption of electric cooking, as well as household-specific enablers and barriers to adoption. Section 5 describes the crucial qualitative findings that we may not find using quantitative data. Section 6 discusses the results and concludes with policy implications.

2 Potential Enablers and Barriers to Electric Cooking

The transition to electric cooking is shaped by a complex set of interrelated factors spanning electricity, infrastructure, affordability, technology, knowledge, social dynamics, taste, culture, and policy. Drawing on existing literature on clean cooking—including electric cooking as well as improved biomass cookstoves, LPG, and other fuels—we classify potential enablers and barriers into multiple broad categories.

Infrastructure and Energy Access

Access to reliable electricity is a foundational prerequisite for electric cooking. Households would require not only grid connectivity but also consistent voltage levels, minimal outages, and adequate electricity infrastructure such as wiring, sockets, and circuit protection. Barriers remain where electricity is unreliable, voltage is unstable, or safety concerns are prevalent (Rubinstein et al., 2022; Coley et al., n.d.; Akter et al., 2023).

Affordability and Cost Factors

Household income, electricity tariffs, metering arrangements, and subsidies can shape decisions to adopt and sustain electric cooking. Higher income and targeted subsidies are associated with greater adoption of clean fuels (Gaur, 2018), while the high upfront cost of appliances can be a significant barrier for low-income households. The price of electricity relative to other fuels, such as firewood, charcoal, and LPG, can further affect household choices. Longitudinal studies from Ethiopia and Nepal show that electricity prices, access to credit, and monthly expenditure levels strongly influence electric cooking adoption (Alem et al., 2014; Paudel et al., 2023).

Technology and Appliance Availability

The availability and diversity of electric cooking appliances—including induction cookstoves, rice cookers, and electric pressure cookers—can play an important role. Appliance features such as speed, convenience, energy efficiency (Saha et al., 2021), and compatibility with local cooking practices can support adoption, while the absence of safety and performance standards, limited after-sales service, and poor product quality can undermine sustained use.

Knowledge and Perceptions

Education, awareness, and perceptions can significantly influence household engagement with electric cooking technologies. Concerns about high electricity bills, doubts about appliance safety and durability, and unfamiliarity with new cooking methods can hinder adoption. Social learning and peer influence have been shown to play an important role in clean cooking transitions, as demonstrated by randomized experiments on improved cookstoves (Bonan et al., 2021).

Social and Household Dynamics

Household and community-level factors can also shape adoption patterns. Female-headed, urban, and wealthier households are more likely to use modern energy sources such as electricity and LPG (Behera et al., 2016). However, intra-household decision-making power can act as a barrier: women who do the cooking may favor clean cookstoves but lack authority to make purchase decisions (Miller & Mobarak, 2013). Community norms can either accelerate or slow the transition.

Tastes and Cultural Practices

Foods requiring long cooking times, such as certain rice preparations, may be perceived as unsuitable for electric cooking appliances. Cultural attachment or taste factor to traditional cooking fuels and methods can further delay adoption (Brown et al., 2017; Couture & Jacobs, 2019). This area remains underexplored in the literature on electric cooking.

Policy and Institutional Support

Government policies, institutional support, and marketing campaigns can create an enabling environment for electric cooking transitions. Subsidies for appliances (Couture & Jacobs, 2019), tariff reforms, and infrastructure investment have been shown to support clean cooking transitions.

3 Data

Quantitative data

We utilize the India Residential Energy Survey (IRES), conducted in 2019–20 by the Council on Energy, Environment, and Water, along with the World Bank's Multi-Tier Framework (MTF) survey data, conducted in 2017–18 for Nepal, 2016–17 for Kenya and Ethiopia, and Nigeria Living Standards Survey (NLSS, 2018-19) for Nigeria. These surveys have information on our primary outcome of interest—use of electric cooking for any of the cooking purposes (any electric cooking). Additionally, they provide a comprehensive list of potential determinants of electric cooking adoption—electricity access, the reliability, quality, and predictability of electricity supply, electricity billing, and other socioeconomic factors. Leveraging these nationally or regionally representative data, we aim to identify the determinants of electric cooking adoption, including electricity reliability and quality, the use and affordability of other cooking fuels, household expenditure, gender, education, age, and other factors.

Qualitative data

While these energy surveys are comprehensive, they often fall short in capturing certain determinants of electric cooking adoption—such as household-level electricity infrastructure, perceptions of electric cooking and its associated costs, intra-household dynamics, dietary and cultural practices, and actions undertaken by governments or other actors to promote electric cooking (e.g., policies, information campaigns, and marketing efforts). To address these gaps, we conducted qualitative surveys. These included key informant interviews (KIIs), focus group discussions (FGDs), stakeholder consultations, semi-structured interviews, or a combination of these methods. Our primary focus was on KIIs and FGDs, which were conducted with primary cooks or heads of households, depending on their availability. We developed structured questionnaires for these qualitative instruments, drawing in part from the World Bank's Multi-Tier Framework (MTF) survey. These case studies were carried out in selected regions of the countries where it was possible to identify both users and non-users of electric cookstoves, allowing us to differentiate the factors that may influence electric cookstove adoption. In addition to household interactions to understand the demand side of electric cooking, we conducted interviews with retailers and wholesalers in the same areas to understand the supply side and the market for electric cooking appliances.

We present the qualitative instruments, sample sizes, and area focus for our study countries in Table 1.

Table 1: Qualitative instruments, sample sizes, and area focus for household primary data, by country

Country	Qualitative instruments	Sample Size	Area focus
India	KIIs	Tamil Nadu: 79 Uttar Pradesh: 9 Bihar: 4	Rural and urban
Nepal	Semi-structured Interviews	Bagmati: 8	Rural
Kenya	Qualitative statements	834	Urban and semi-urban
Ethiopia	FGDs	6 FGDs (6-7member/FGD), Addis Ababa	Urban
Nigeria	KIIs	300, Lagos, Enugu, and Abuja cities	Urban and rural

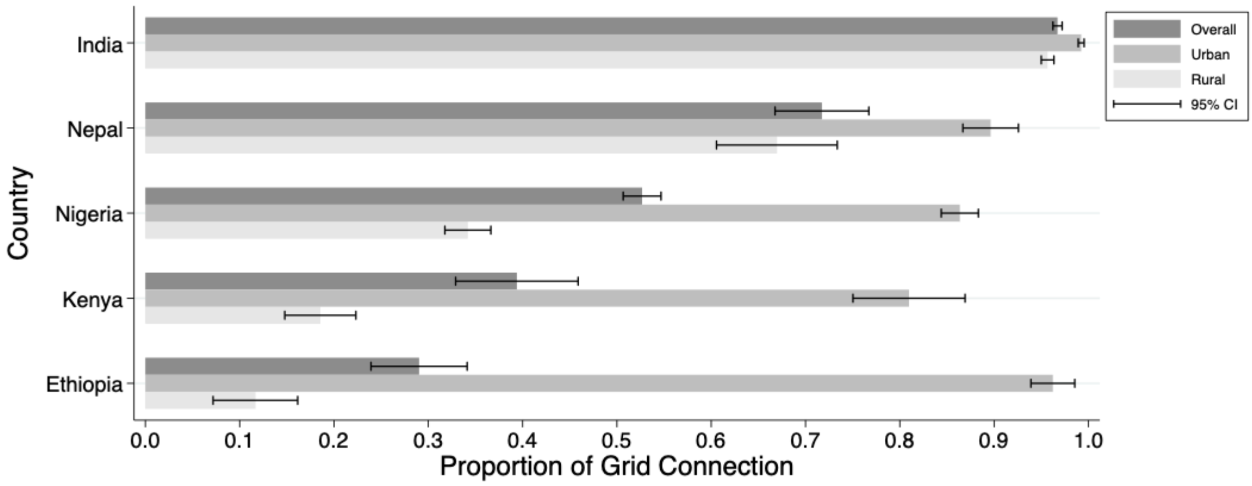
Notes: KIIs = Key Informant Interviews; FGDs = Focus Group Discussions. Sample sizes refer to the number of respondents or discussions as applicable.

4 Quantitative analysis

4.1 Descriptive statistics

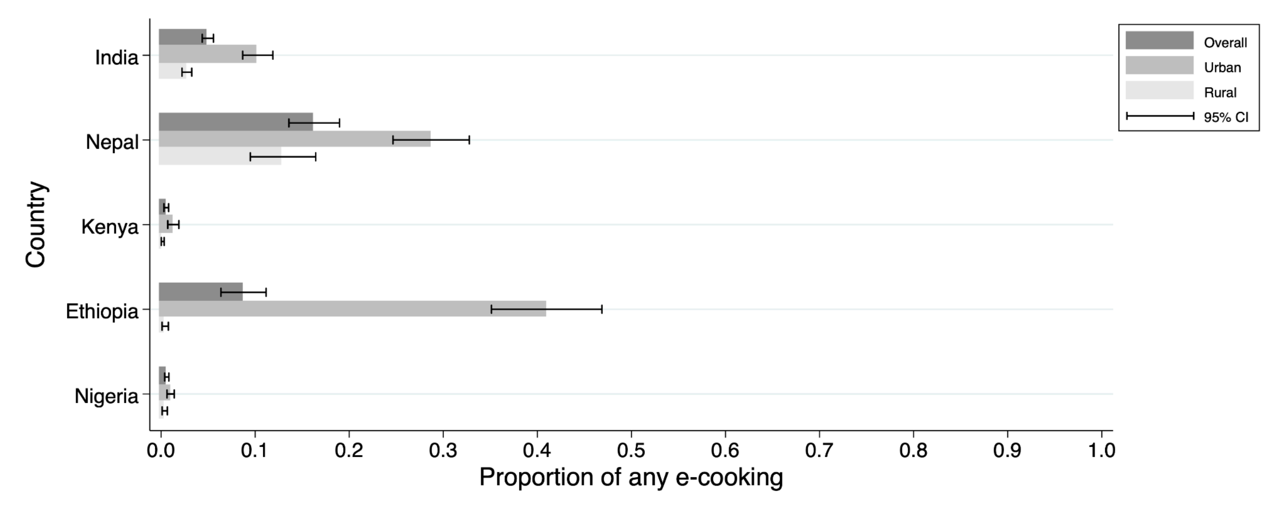
Figure 1 shows the proportion of the population connected to the grid across five countries in the survey years, highlighting very high grid connectivity in India, moderate connectivity in Nepal, while Nigeria, Kenya and Ethiopia lagged behind. Still, in all countries, urban electricity access exceeded 80% at the time of the surveys. The rural–urban gap was most pronounced in Nigeria, Kenya and Ethiopia.

Figure 1. Proportion of grid connected population, by country



Source: Authors' calculations based on the India Residential Energy Survey (IRES, 2019–20); Multi-Tier Framework (MTF) survey data for Nepal (2017–18), Kenya and Ethiopia (2016–17); and Nigeria Living Standards Survey (NLSS, 2018–19).

Figure 2. Proportion of users of electric cooking for any purpose, by country



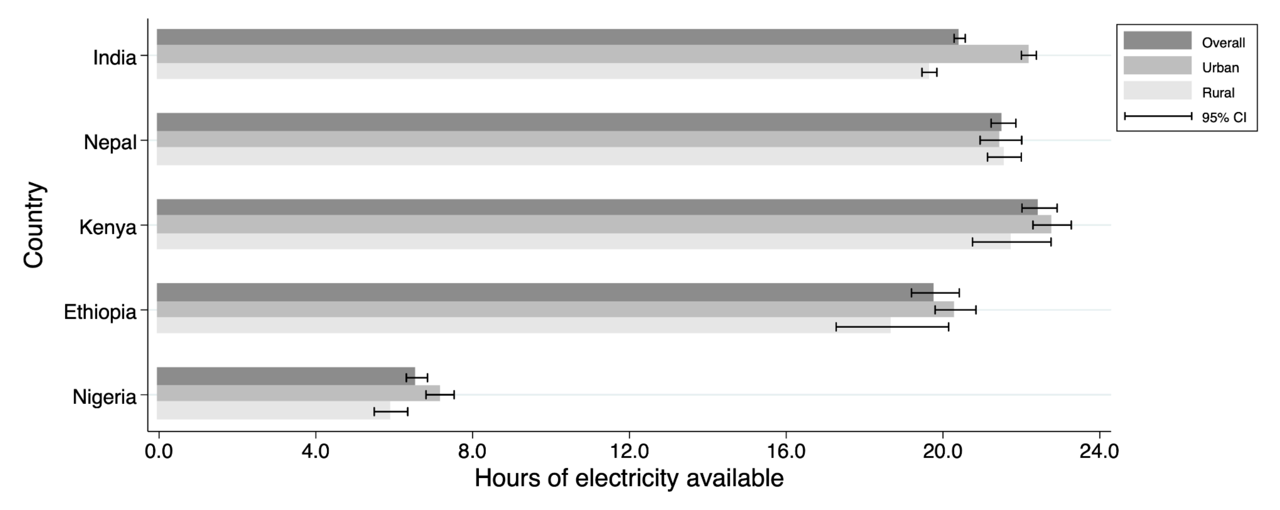
Source: Authors' calculations based on the India Residential Energy Survey (IRES, 2019–20); Multi-Tier Framework (MTF) survey data for Nepal (2017–18), Kenya and Ethiopia (2016–17); and Nigeria Living Standards Survey (NLSS, 2018–19).

Figure 2 shows the use of any electric cooking only among the grid-connected households in the five countries at the time of the surveys—India, Nepal, Kenya, Ethiopia, and Nigeria—and highlights wide urban and rural differences. In India, about 7% of grid-connected households use some form of electric cooking, with higher uptake in urban areas (12%) compared to rural areas (3%). Nepal had the highest electric cooking adoption rate among grid-connected households , with about 17% of such households using electric cooking—29% in urban areas and 13% in rural areas. Kenya showed very low adoption, near 2% overall, with rural use almost negligible. Ethiopia had a sharp urban–rural divide, with overall adoption close to 10% but driven almost entirely by urban households. Nigeria also recorded very low use, around 1% of households. These findings suggest that while urban areas are at the forefront of electric cooking adoption, there is considerable potential to expand usage there and in rural areas.

One of the crucial determinants of electric cooking—hours of electricity supply in a day—is shown in Figure 3, highlighting variation across countries. All countries except Nigeria had at least 20 hours of electricity for grid-connected households at the time of the surveys. Urban households had higher electricity availability in all the countries except Nepal in the study year, possibly driven by high population pressure in urban Nepal as well as insufficient generation capacity at the time of the survey (an issue that has improved considerably in the last few years). Kenya had the highest electricity availability, with most households receiving close to

24 hours of power daily.

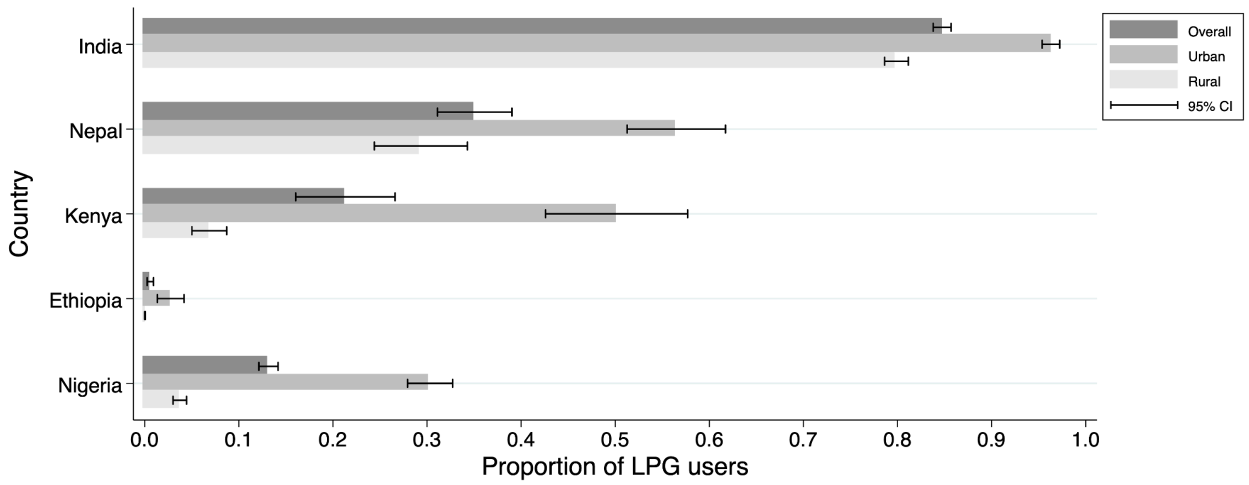
Figure 3. Hours of electricity available, by country



Source: Authors' calculations based on the India Residential Energy Survey (IRES, 2019–20); Multi-Tier Framework (MTF) survey data for Nepal (2017–18), Kenya and Ethiopia (2016–17); and Nigeria Living Standards Survey (NLSS, 2018–19).

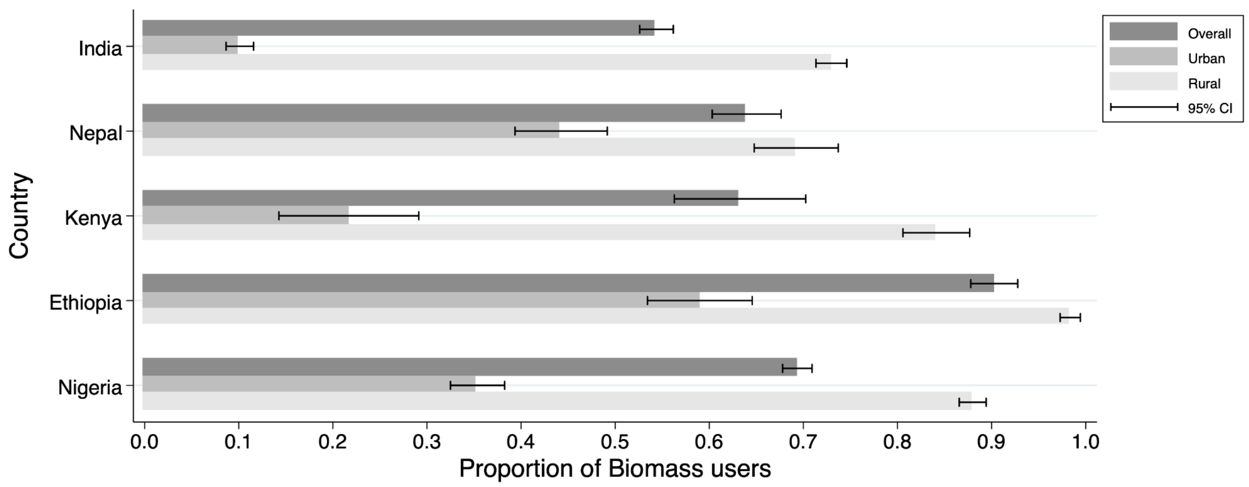
We present the proportion of LPG (clean fuel) users and biomass (dirty fuel) users for any cooking purpose separately in Figure 4 and Figure 5, respectively. While electric cooking can complement the use of LPG as an additional clean option, it has the potential to serve as a substitute for biomass, offering a cleaner alternative for households currently relying on dirty fuel.

Figure 4. Proportion of LPG users for any cooking purpose, by country



Source: Authors' calculations based on the India Residential Energy Survey (IRES, 2019–20); Multi-Tier Framework (MTF) survey data for Nepal (2017–18), Kenya and Ethiopia (2016–17); and Nigeria Living Standards Survey (NLSS, 2018–19).

Figure 5. Proportion of Biomass users for any cooking purpose, by country



Source: Authors' calculations based on the India Residential Energy Survey (IRES, 2019–20); Multi-Tier Framework (MTF) survey data for Nepal (2017–18), Kenya and Ethiopia (2016–17); and Nigeria Living Standards Survey (NLSS, 2018–19).

4.2 OLS regression

We use cross-sectional regression analysis to examine the correlates of electric cooking separately for each country. We use the following specification, and add a comprehensive list of control variables that can explain our outcome variables for a robust correlation analysis.

$$Y_i = \beta_k X_k + \alpha_s + e_i \tag{1}$$

where, Y_i is the outcome variable—the use of electric cooking for any purpose (any electric cooking), for household i. X_k are a list of explanatory variables—fraction of the day with electricity supply, log of household expenditure per capita, urban dummy, household size, gender of head or prime income earner, age of head or prime income earner, and highest education of any member in the household. Data are available for other correlates of electric cooking, but these are not available across all datasets, and thus, across our study countries. Given this, we retain the common set of variables for each country in our main specification to ensure comparability. Nevertheless, we include additional explanatory variables that may influence our outcome variables to check the robustness of our results. In equation 1, α□ denotes a fixed effect for states, provinces, or region. We do not control for lower administrative units, such as enumeration areas (or villages), because electricity reliability is likely to be uniform within enumeration areas as they are most likely connected to the same electricity feeder, leaving negligible variation to exploit for identification. Because electricity reliability also varies across states—for example, in India we observe high variability across states (Appendix Figure A1)—we also estimate a specification without state fixed effect. We cluster at the enumeration area level, to account for correlation of errors within an enumeration area.

The prices of electric cooking and other alternative fuels—important determinants of electric cooking—are not available in the data. We are able to calculate the average price of electricity and the average price of LPG (for India) based on monthly expenditure and consumption. However, this can be done for only a negligible fraction of households due to missing data points, and hence we are unable to control prices directly. Instead, we assume that the prices of cooking fuels such as electricity and LPG, as well as other time-invariant factors, are absorbed into the state, province, or region fixed effects, implying that these would be uniform within administrative regions. The prices of these fuels may vary across households due to subsidies and tariff structure, which remains a limitation. We show the determinants of electric cooking using equation 1 in Table 2. The fraction of the day with electricity supply—a proxy for reliability—shows a strong positive association with electric cooking in Ethiopia, Nepal, and Nigeria, but is insignificant in India and Kenya. Household expenditure per capita (log), which indicates socio-economic status, is positively associated with electric cooking in all countries except Nigeria, suggesting that affordability remains a key determinant. Urban households are more likely to adopt electric cooking in India, Nepal, and Ethiopia, reflecting better infrastructure and appliance access. Larger households are also more likely to use electric cooking in India, Nepal, and Ethiopia, but not elsewhere. Education is a robust predictor: households with members having secondary or higher education exhibit higher adoption rates, especially in Nepal and Ethiopia. Gender of the household head has little consistent influence across contexts, while age shows a weak nonlinear relationship, indicating that middle-aged heads may be slightly more inclined to adopt electric cooking. Overall, the results highlight the critical roles of electricity reliability, income, urban residence, and education in shaping household transitions to electric cooking, with notable cross-country heterogeneity.

Table 2. Dependent variable: Use of any electric cooking (with state fixed effects)

	India	**Nepal**	**Kenya**	**Ethiopia**	**Nigeria**
elec_frac_day	−0.017	0.167**	−0.001	0.241***	0.038***
	(0.014)	(0.080)	(0.027)	(0.069)	(0.011)
lconspc	0.034***	0.171***	0.022**	0.088***	0.004
	(0.005)	(0.015)	(0.009)	(0.017)	(0.003)
urban_dummy	0.051***	0.113***	−0.003	0.171***	0.000
	(0.008)	(0.025)	(0.009)	(0.028)	(0.003)
hh_size	0.006***	0.022***	0.002	0.031***	−0.001**
	(0.001)	(0.004)	(0.002)	(0.009)	(0.000)
female_head_dummy	−0.006	0.018	−0.006	0.050**	−0.004*
	(0.007)	(0.018)	(0.007)	(0.020)	(0.002)
age_head_dec	0.022	0.024	0.031**	0.090***	0.003
	(0.016)	(0.030)	(0.013)	(0.032)	(0.004)
age_head_dec_sq	−0.002	−0.002	−0.003**	−0.007**	0.000
	(0.002)	(0.003)	(0.001)	(0.003)	(0.000)
edu_sec_plus_dummy	0.000	0.055***	−0.002	0.063***	0.000
	(0.004)	(0.020)	(0.008)	(0.016)	(0.002)
edu_highsec_plus_dummy	0.028***	0.108***	0.007	0.115***	0.006**
	(0.004)	(0.016)	(0.005)	(0.028)	(0.003)
Num.Obs.	14342	4042	1677	2612	10034
Fixed Effects	State	Province	Province	Region	State

Notes: any_electric_cooking – equal to 1 if the household reports using any electric cooking appliance; elec_frac_day – fraction of a day with electricity supply; lconspc – logarithm of per capita household consumption in local currency; urban_dummy – equals 1 for urban households; hh_size – household size; female_head_dummy – equals 1 if the household head or prime income earner is female; age_head_dec and age_head_dec_sq – age of the household head or prime income earner in decades and its square; edu_sec_plus_dummy – equals 1 if any household member has completed secondary education or higher; edu_highsec_plus_dummy – equals 1 if any household member has completed higher secondary education or above. Standard errors are clustered at the enumeration area level (comparable to a village).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We show that the results without state fixed effects (Table 3) differ from those with fixed effects (Table 2) in several important ways. The fraction of the day with electricity supply becomes significant and positive for India, suggesting that part of the variation in electric cooking associated with reliability operates across states. Similarly, the magnitudes of the coefficients for Nepal and Ethiopia increase notably, indicating that regional differences in electricity access and reliability drive part of the observed relationship. In contrast, results for Kenya and Nigeria remain largely unchanged, implying less spatial heterogeneity in these contexts. Overall, the comparison underscores the importance of regional infrastructure disparities—both within and between states—in explaining electric cooking adoption. Table 3 results are consistent with the logit model (Table A.1).

Table 3. Dependent variable: Use of any electric cooking (without state fixed effects)

	India	**Nepal**	**Kenya**	**Ethiopia**	**Nigeria**
elec_frac_day	0.045***	0.590***	0.005	0.253***	0.035***
	(0.013)	(0.069)	(0.024)	(0.072)	(0.009)
lconspc	0.030***	0.186***	0.021**	0.101***	0.001
	(0.005)	(0.014)	(0.009)	(0.016)	(0.003)
urban_dummy	0.052***	0.121***	−0.004	0.292***	0.001
	(0.008)	(0.026)	(0.008)	(0.024)	(0.003)
hh_size	0.002	0.018***	0.002	0.030***	−0.001***
	(0.001)	(0.004)	(0.002)	(0.008)	(0.000)
female_head_dummy	−0.001	0.037**	−0.006	0.094***	−0.004*
	(0.007)	(0.018)	(0.007)	(0.022)	(0.002)
age_head_dec	−0.009	0.015	0.032**	0.144***	0.002
	(0.017)	(0.030)	(0.015)	(0.035)	(0.004)
age_head_dec_sq	0.001	−0.001	−0.003**	−0.010***	0.000
	(0.002)	(0.003)	(0.001)	(0.003)	(0.000)
edu_sec_plus_dummy	0.006	0.057***	−0.002	0.094***	0.000
	(0.004)	(0.020)	(0.008)	(0.019)	(0.002)
edu_highsec_plus_dummy	0.044***	0.125***	0.007	0.119***	0.006**
	(0.005)	(0.017)	(0.005)	(0.028)	(0.003)
Num.Obs.	14342	4042	1677	2612	10034

Notes: any_electric_cooking – equal to 1 if the household reports using any electric cooking appliance; elec_frac_day – fraction of a day with electricity supply; lconspc – logarithm of per capita household consumption in local currency; urban_dummy – equals 1 for urban households; hh_size – household size; female_head_dummy – equals 1 if the household head or prime income earner is female; age_head_dec and age_head_dec_sq – age of the household head or prime income earner in decades and its square; edu_sec_plus_dummy – equals 1 if any household member has completed secondary education or higher; edu_highsec_plus_dummy – equals 1 if any household member has completed higher secondary education or above. Standard errors are clustered at the enumeration area level (comparable to a village).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The drivers of electric cooking adoption are rarely attributable to a single factor. The quantitative analysis may still fall short of capturing certain important determinants—such as household-level electricity infrastructure, perceptions of electric cooking and its associated costs, intra-household dynamics, dietary and cultural practices, and actions by governments or other actors to promote electric cooking (e.g., policies, information campaigns, and marketing efforts). So, we follow a mixed-method approach. In the following section, we supplement our quantitative analysis with qualitative insights to better understand the factors that may affect the adoption of electric cooking in a comparative framework.

5 Qualitative analysis

Electric cooking adoption is shaped by a combination of factors, including the types of electric cooking options available to households, electricity pricing and reliability, perceptions and awareness of the costs and benefits of electric cooking, cultural determinants influencing cooking practices and preferences, technological know-how, and whether adopters continue or discontinue use over time. Many of these aspects require complementary qualitative analysis. Accordingly, we collected qualitative data using questions related to the correlates of electric cooking. In Kenya and Ethiopia, our focus was on urban and semi-urban areas, as households using electric cooking are rare in rural regions.

We summarize the key qualitative findings in Table 4. The most commonly used and available electric cooking devices vary across countries—induction cookstoves are most common in India and Nepal, electric pressure cookers in Kenya, and electric coil stoves in Ethiopia and Nigeria. Electricity prices are generally perceived as low in India and Nepal but high in Kenya, Ethiopia, and Nigeria. In addition to high prices in Kenya, electricity costs fluctuate significantly across months due to changes in the variable cost linked to the international market. Reliability remains a major barrier: Ethiopia faces frequent and sudden outages with low voltage during rainy seasons; Nigeria experiences severe supply interruptions averaging 14 hours per day; and parts of India also report reliability issues. In India's Nilgiris sample, around 50% of users have maintained consistent electric cooking practices since the 2011–14 electric cooking program, indicating a strong potential for scaling up electric cooking programs.

Perceptions and awareness of electric cooking differ across contexts. In India, users typically have prior LPG experience, and households perceive fast cooking with electric appliances as the primary benefit, while in Nepal, awareness is largely associated with the young, mobile population. In Kenya, adoption is constrained by both familiarity with LPG and a substantial gap between awareness and ownership. In Ethiopia, electric cooking is perceived as time-saving, safe, economical, and healthy, whereas in Nigeria, high electricity costs and unreliable supply limit uptake. Cultural and technological factors further shape preferences: traditional biomass cooking remains favored in India and Nigeria; local dishes in Kenya are often incompatible with imported electric pressure cookers; and Ethiopia's coffee rituals continue to favor charcoal. Older individuals in India face additional challenges related to technological familiarity.

Across all countries, fuel stacking is prevalent, with LPG, biomass, or charcoal commonly used alongside electric cooking. Additional barriers include inadequate household electrical infrastructure (especially in poorer households) (Figure 6), poor appliance quality, limited availability of spare parts, counterfeit products, and aging or poorly maintained electricity systems.

Table 4: Barriers and enablers for electric cooking adoption, by Country

	India	Nepal	Kenya	Ethiopia	Nigeria
Popular e-cooking appliance	Induction cookstove	Induction cookstove	Electric pressure cooker	Electric coil stove	Electric coil stove
Electricity price	Generally low	Generally low	High and volatile	High	High
Electricity reliability	Good in TN (~24hr SS); Poor in UP (2–12 hr cuts); Bihar (4–7 hrs cuts); Unreliable in monsoon and summer	Surprisingly good	Good, 1–4 outages/month for 78% HHs; Outages during peak hours	Bad; Frequent and sudden power outages; Worse in rainy season; Peak hour drops; Low voltage issues	Severe outages, ~14 hrs/day of supply,
Perception and awareness	Past familiarity with LPG, Fast cooking with electric appliances is the main benefit	Aware because of mobile young population	Preference for LPG for ease and familiarity; Large gap between awareness and ownership	Time-saving, safe, economical, healthy	High electricity costs and unreliable supply
Cultural/technological factors	Craving for food cooked on biomass (UP, TN); Tech barrier for elderly (TN)	Mostly young people used electric cooking	Local menus not programmed in imported EPCs; EPCs often used uncovered like regular pans	Coffee rituals favor charcoal	Traditional Fuel Cooking Habits
Fuel Stacking	Yes	Yes	Yes	Yes, Charcoal is a prevalent backup	Yes
Other barriers	Incompatible HH electricity infrastructure	Cockroach inside the induction cookstove	Variable EPC prices, poor quality, unavailable parts, counterfeit products online	Old electricity infrastructure and corrupt maintenance personnel	

Notes: UP – Uttar Pradesh; TN – Tamil Nadu; HHs – Households; EPC – Electric Pressure Cooker; LPG – Liquefied Petroleum Gas

Figure 6. Inadequate electricity infrastructure in households

Source: Picture taken by the first author in Tamilnadu, June 2023

In addition to assessing demand-side enablers and barriers, we capture retailers' perspectives, summarized in Table 5. In India, retailers reported coil and glass burn issues with induction cookstoves, which are typically covered by a one-year warranty. In Nepal, a retailer in a prominent Kathmandu electrical market noted past preferences for infrared appliances and frequent damage from cockroaches. Kenyan retailers highlighted concerns over appliance power ratings, price, and brand. In Ethiopia, high costs of electric cooking appliances were reported. The availability of local, unbranded electric mitad was also reported. These observations underscore the role of appliance quality, design, availability, and pricing in shaping adoption, complementing household-level findings. Across all countries, we also observed the prevalence of online marketing platforms with local delivery, suggesting an emerging supply channel for electric cooking.

Table 5:Retailer Sample and perspectives on electric cooking, by Country

	India	Nepal	Kenya	Ethiopia	Nigeria
Retailers	KIIs with 10 retailers in nearby markets (0–10 km)	1 KII in prominent Kathmandu electrical market	Qualitative discussions with a few retailers	18 KII	140 KII
Retailer's perspective	On induction cookstoves- coil/glass burn issues; 1-yr warranty on induction (TN)	Infrared preferred in past; cockroach damages induction cookstoves	Concerns: power rating, price, brand	High prices; local unbranded electric mitad available	Growing demand for electric cooking; warranty builds customer trust

Notes: We observe the prevalence of online marketing platforms with local delivery in each country.

Other stakeholders, including think tanks, NGOs, and policymakers, play a critical role in shaping the electric cooking landscape. Discussions with these actors provided insights across multiple levels, enriching our understanding of the adoption environment in the study countries.

6 Discussion and policy implications

Air pollution is a global concern that leads to the deterioration of health and the environment, causing non-communicable diseases, disability, and death. Household cooking, a daily activity for many, still relies on polluting fuels as the primary mode for 2.8 billion people. Shifting to clean cooking methods would offer significant personal and social benefits. Although LPG has made substantial progress, it may not be sufficient on its own. Given high electricity access, electric cooking can be another clean solution. While the determinants of clean cooking have been extensively studied, only a few studies have focused on the determinants of electric cooking.

This study examines the determinants of electric cooking both quantitatively and qualitatively. Quantitatively, we find that electricity reliability, household expenditure, urban location, and education are key correlates of adoption. Specifically, the fraction of the day with electricity supply shows a strong positive association with e-cooking in Ethiopia, Nepal, and Nigeria, while higher household expenditure is a robust predictor in nearly all study countries. Additionally, our qualitative instruments complement these findings. We find that even where aggregate supply hours are high, poor electricity quality—such as low voltage and unreliability during peak or monsoon seasons—remains a critical barrier. Other household-specific barriers include inadequate internal wiring, the high upfront cost of quality appliances, and a lack of local repair services.

To scale electric cooking, it must be accompanied by increased generation capacity and high-quality transmission and distribution infrastructure. Policies must move beyond measuring grid access to ensuring grid quality and reliability. Similarly, the identified enablers and barriers can be leveraged to inform policy and decision-making. This includes addressing supply-side constraints by developing markets for high-quality, affordable appliances and after-sales support. While this study does not employ a counterfactual design, it provides a comprehensive view of multiple factors that may not be captured in a causal study. We identified a list of demand- and supply-side factors that could be further explored for research, included in data collection surveys, and considered by governments to effectively scale electric cooking.

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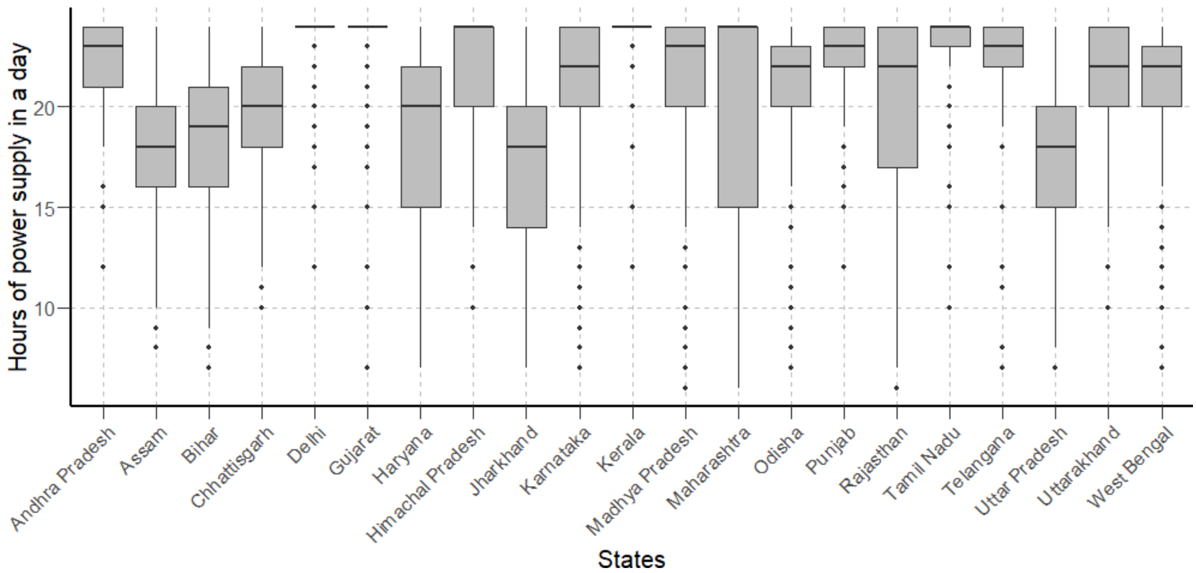
Appendix

Figure A1. Reliability variation across states in India



Source: IRES conducted in 2019-20

Notes: The box shows the interquartile range (IQR), with its edges indicating the third (Q3) and first quartiles (Q1). The horizontal line inside the box is the median. Whiskers extend to the smallest and largest values within 1.5 times the IQR. Dots outside the whiskers are outliers.

Table A1. Logit model, dependent variable: use of any electric cooking (without state fixed effects)

	India	Nepal	Kenya	Ethiopia	Nigeria
elec_frac_day	1.418***	4.036***	0.302	1.360***	3.081***
	(0.460)	(0.639)	(1.632)	(0.408)	(0.450)
lconspc	0.564***	1.032***	0.968***	0.493***	0.074
	(0.105)	(0.095)	(0.266)	(0.079)	(0.261)
urban_dummy	0.925***	0.677***	−0.117	2.477***	0.221
	(0.142)	(0.174)	(0.513)	(0.464)	(0.337)
hh_size	0.034	0.099***	0.097	0.147***	−0.189**
	(0.027)	(0.022)	(0.087)	(0.042)	(0.075)
female_head_dummy	0.027	0.199**	−0.528	0.460***	−0.643*
	(0.127)	(0.097)	(0.693)	(0.109)	(0.377)
age_head_dec	−0.118	0.041	2.807**	0.750***	1.010
	(0.311)	(0.175)	(1.372)	(0.188)	(0.635)
age_head_dec_sq	0.010	−0.001	−0.293*	−0.056***	−0.120*
	(0.033)	(0.017)	(0.155)	(0.017)	(0.063)
edu_sec_plus_dummy	0.553***	0.578***	−0.140	0.549***	0.170
	(0.203)	(0.188)	(0.827)	(0.120)	(0.389)
edu_highsec_plus_dummy	1.432***	0.665***	0.553	0.486***	0.640**
	(0.191)	(0.094)	(0.447)	(0.129)	(0.268)
Num.Obs.	14342	4042	1677	2612	10034

Notes: any_electric_cooking – equal to 1 if the household reports using any electric cooking appliance; elec_frac_day – fraction of a day with electricity supply; lconspc – logarithm of per capita household consumption in local currency; urban_dummy – equals 1 for urban households; hh_size – household size; female_head_dummy – equals 1 if the household head or prime income earner is female; age_head_dec and age_head_dec_sq – age of the household head or prime income earner in decades and its square; edu_sec_plus_dummy – equals 1 if any household member has completed secondary education or higher; edu_highsec_plus_dummy – equals 1 if any household member has completed higher secondary education or above. Standard errors are clustered at the enumeration area level (comparable to a village).
* p < 0.1, ** p < 0.05, *** p < 0.01

Table A2. Urban sample, dependent variable: use of any electric cooking, without state fixed effects

	India	Nepal	Kenya	Ethiopia	Nigeria
elec_frac_day	0.120**	0.691***	−0.006	0.284***	0.041***
	(0.047)	(0.080)	(0.034)	(0.085)	(0.015)
lconspc	0.050***	0.223***	0.022**	0.107***	−0.005
	(0.013)	(0.018)	(0.010)	(0.017)	(0.003)
hh_size	0.005	0.021***	0.004*	0.036***	−0.002**
	(0.003)	(0.005)	(0.002)	(0.009)	(0.001)
female_head_dummy	−0.010	0.043*	−0.005	0.103***	−0.010***
	(0.013)	(0.022)	(0.009)	(0.025)	(0.003)
age_head_dec	0.006	0.005	0.006	0.042***	−0.001
	(0.006)	(0.007)	(0.004)	(0.010)	(0.001)
edu_sec_plus_dummy	0.025***	0.053*	−0.004	0.109***	−0.003
	(0.009)	(0.027)	(0.012)	(0.024)	(0.004)
edu_highsec_plus_dummy	0.091***	0.126***	0.000	0.126***	0.009***
	(0.011)	(0.022)	(0.006)	(0.029)	(0.003)
Num.Obs.	4991	2692	1225	2326	5509

Notes: any_electric_cooking – equal to 1 if the household reports using any electric cooking appliance; elec_frac_day – fraction of a day with electricity supply; lconspc – logarithm of per capita household consumption in local currency; hh_size – household size; female_head_dummy – equals 1 if the household head or prime income earner is female; age_head_dec and age_head_dec_sq – age of the household head or prime income earner in decades and its square; edu_sec_plus_dummy – equals 1 if any household member has completed secondary education or higher; edu_highsec_plus_dummy – equals 1 if any household member has completed higher secondary education or above. Standard errors are clustered at the enumeration area level (comparable to a village).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A3. Rural sample, dependent variable: use of any electric cooking, without state fixed effects

	India	Nepal	Kenya	Ethiopia	Nigeria
elec_frac_day	0.029**	0.250*	0.036**	0.074	0.031***
	(0.012)	(0.132)	(0.015)	(0.044)	(0.010)
lconspc	0.016***	0.090***	0.022**	0.011	0.007*
	(0.004)	(0.020)	(0.009)	(0.011)	(0.004)
hh_size	0.000	0.013***	0.002	0.001	−0.001
	(0.001)	(0.005)	(0.002)	(0.004)	(0.000)
female_head_dummy	0.008	0.019	−0.006	−0.047*	0.003
	(0.006)	(0.028)	(0.005)	(0.022)	(0.003)
age_head_dec	−0.006*	0.010	−0.004	−0.004	−0.002***
	(0.004)	(0.009)	(0.003)	(0.007)	(0.001)
edu_sec_plus_dummy	0.002	0.063**	0.004	0.058	0.003
	(0.004)	(0.029)	(0.003)	(0.034)	(0.002)
edu_highsec_plus_dummy	0.025***	0.102***	0.028***	−0.070	0.003
	(0.005)	(0.026)	(0.010)	(0.056)	(0.004)
Num.Obs.	9351	1350	452	286	4525

Notes: any_electric_cooking – equal to 1 if the household reports using any electric cooking appliance; elec_frac_day – fraction of a day with electricity supply; lconspc – logarithm of per capita household consumption in local currency; hh_size – household size; female_head_dummy – equals 1 if the household head or prime income earner is female; age_head_dec and age_head_dec_sq – age of the household head or prime income earner in decades and its square; edu_sec_plus_dummy – equals 1 if any household member has completed secondary education or higher; edu_highsec_plus_dummy – equals 1 if any household member has completed higher secondary education or above. Standard errors are clustered at the enumeration area level (comparable to a village).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$