INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

CGIAR INITIATIVE ON NEXUS Gains

POLICY NOTE | NOVEMBER 2024

DEVELOPMENT OF THE RURAL HOUSEHOLD ENERGY INSECURITY EXPERIENCES SCALE *WITH INSIGHTS FROM ETHIOPIA*

Tiruwork Arega and Claudia Ringler

There is little evidence on how energy poverty affects rural households in low- and middle-income countries. To address this, the CGIAR NEXUS Gains Initiative developed the Rural Household Energy Insecurity Experiences Scale (RHEIES) and piloted the tool in Ethiopia using in-depth interviews. We find heterogeneous energy insecurity experiences across locations and gender dimensions.

WHY A MEASURE FOR RURAL ENERGY INSECURITY?

Energy insecurity is broadly defined as the inability to adequately meet basic household energy needs (Hernández 2016). Households may experience energy insecurity in different ways. Reliable, clean, and sufficient access to energy is a key determinant of economic development, while lack of access undermines development. Lack of access, low-quality access (including low wattage, limited service, or frequent brown- and blackouts), or unaffordability of electricity remains common in many rural areas in low- and middle-income countries (LMICs). National and selected subnational energy supply metrics are relatively easily available (Groh, Pachauri, and Rao 2016), but are often limited to electricity infrastructure being completed and do not describe the quality and quantity of service provided. As such, they might well provide a false sense of energy security that does not reflect the lived energy experiences of rural households and associated developmental challenges.

Demand-side metrics, on the other hand, are highly contextual, making comparisons across locations challenging. Measuring the lived experiences of energy situations can provide crucial input for policymaking and targeted interventions. Although a growing body of literature describes measures of microlevel energy insecurities and their association with human well-being, no universally accepted measure exists to describe rural household or individual energy insecurity. The two most commonly used measures are either unidimensional, such as the share of energy expenditures in total income, or multidimensional, where an index of several energy-related elements is constructed. The share of energy expenditure in total expenditures only captures affordability from a monetary perspective. Moreover, data for this measure of energy burden are challenging to obtain, particularly for rural households that obtain their energy through self-collection of energy sources, such as fuelwood, crop residues, or cow dung. At the same time, multidimensional metrics developed to understand several dimensions of energy deprivation carry the risk of masking important details. Moreover, while generic energy insecurity measures have been developed, none consider the dual roles of energy in rural households for both domestic and productive purposes.

Our contribution is the development and pilot application of the RHEIES, a measure to assess the extent of energy deprivation of rural households in LMICs. Such a measure can also reveal heterogeneities of experiences among different groups—for example, different household types and locations. This policy note describes the development of the RHEIES and a qualitative pilot application in rural Ethiopia.

ENERGY IN RURAL ETHIOPIA

Despite its immense energy resource endowment, Ethiopia is ranked “the world’s third-largest access-deficit country” (IEA et al. 2023). To address this, the Government of Ethiopia developed an ambitious energy expansion strategy with the goal of electrifying the entire country by 2025; while not achievable, the share of the population with some form of electricity access has increased on average by 2.5 percent per year over the last two decades (IEA et al. 2023). To complement on-grid electricity investments and accelerate access in rural areas, Ethiopia has also embarked on a Decentralized Rural Energy (DRE) strategy. DREs supply energy that is generated independently from a centralised grid and tend to use a mix of energy sources, including small hydro, biomass, solar, wind power and diesel-operated generators. One element of the DRE strategy is the “Distributed Renewable Energy – Agriculture Modalities (DREAM)” initiative, which will develop DREs to support irrigation and other energy uses in various locations across Ethiopia.

Thus far, the electricity infrastructure has reached about 55 percent of the population, with 94 percent access in urban and 43 percent access in rural areas (IEA et al. 2023). However, this metric does not provide information on what share of the population can afford or use electricity. Most importantly, in Ethiopia access is measured at village level, without considering if households are connected to the constructed infrastructure. Moreover, a considerable share of rural electricity access is at the so-called tier-1 and tier-2 levels, which only support lightbulbs and other small appliances (Padam et al. 2018). The discrepancy between electricity infrastructure and use is reflected in the lack of access of rural households to clean fuels and technologies for cooking: only 0.6 percent of rural households had access in 2022, up from 0.3 percent in 2015, according to World Bank Development Indicators (World Bank 2024).

Rural households are therefore critically reliant on solid biomass energy for domestic activities, and mostly rely on their own and oxen power for farm operations. The absence of dependable and clean energy sources profoundly impacts their overall livelihoods as well as their social and economic well-being and health. Investigating the extent of energy insecurity experienced by rural households can provide valuable policy insights to all actor groups concerned with improving rural livelihoods and help identify intervention areas beyond the construction of off- and on-grid solutions.

Elements of a rural energy insecurity experiences scale

To address this, we developed a rural household energy insecurity scale using nine questions (Table 1) drawing on insecurity scales developed for food [the Food Insecurity Experiences Scale (FIES) (Smith, Rabbitt, and Coleman-Jensen 2017)] and water [the Household Water Insecurity Experiences Scale (HWISE) (Young et al. 2019)]. Given the dual uses of energy for both domestic and productive uses, the scale includes generic questions about lived energy insecurity, questions focused on the domestic sphere, and questions focused on the productive sphere; the latter is further differentiated into agricultural and off-farm experiences. It is particularly important to capture these different spheres as they are interdependent, as shown, for example, by Mekonnen et al. (2017), who identified linkages between domestic energy security strategies and agricultural productivity outcomes.

Another reason for the distinction between productive and domestic energy questions, an element that distinguishes the RHEIES from the FIES and the HWISE, is the understanding that the provision of clean energy sources for productive uses can pay for energy access in both spheres, whereas the provision of energy sources only for domestic uses (for example, a tier-1 lightbulb access) is unlikely to be sufficient for households to achieve the increased income required to pay for an electricity connection.

Respondents have four response options to the nine questions: “Never” if the experience has not occurred or is not noticed; “Sometimes” if the experience occurs only a few times (less than 10 but more than 0 times over the last month); “Often” if

the respondent experiences the occurrence frequently (10 times or more over the last month); and “Always” if the experience is constantly on someone’s mind. Like other insecurity experiences scales, the RHEIES can be adjusted to ask about intra-household energy insecurity experiences, as the household energy situation is likely experienced differently by different family members. Moreover, the time scale that the questions refer to can be modified. We suggest a monthly time scale for future studies but also encourage comparative studies that use both a weekly and a monthly time scale. And, similar to other insecurity experiences scales, household energy security levels are likely seasonal, with different energy sources more or less readily available or accessible across the year, while energy demands also vary with seasonally changing productive and domestic needs.

Table 1: Energy insecurity experiences scale label and definitions

No.	Label	Definitions
1.	Worry about energy	In the last month, how often did you worry you would not have reliable energy for all of your household needs?
2.	Changes in cooking plans	In the last month, how often did you or anyone in your household have to change your cooking schedule or plans due to energy unavailability? (for example, switch to less nutritious dishes, undercook food, eat food that is not fresh)
3.	Health concerns	In the last month, how often were you or your family members sick with major and minor respiratory disease, eyesight/infections due to unavailability of improved energy sources?
4.	Disruption of domestic activities	In the last month, how many times were your domestic activities disturbed due to issues with energy unavailability? Examples include children’s learning, household cooking, etc.
5.	Disruption of agricultural activities	During the last growing season, how often did you experience interruptions in agricultural activities due to lack of energy sources such as diesel, gasoline, solar power or electricity for irrigation and other agricultural activities?
6.	Disruption of off-farm activities	In the last month, how often have you experienced interruptions to nonagricultural income-generating activities due to nonavailability of energy sources such as diesel, petrol, solar, or electricity?
7.	Frustration with energy access	In the last month, how frequently did you or anyone in your household feel frustrated or angry about your energy access situation?
8.	Dark evenings	In the last month, how frequently have you or anyone in your household gone to sleep without lighting because there was no energy source available?
9.	No food cooked	In the last month, how frequently have you or anyone in your household gone to sleep without eating dinner because there was no energy source available?

Note: Questions shaded in light grey focus on the domestic sphere.

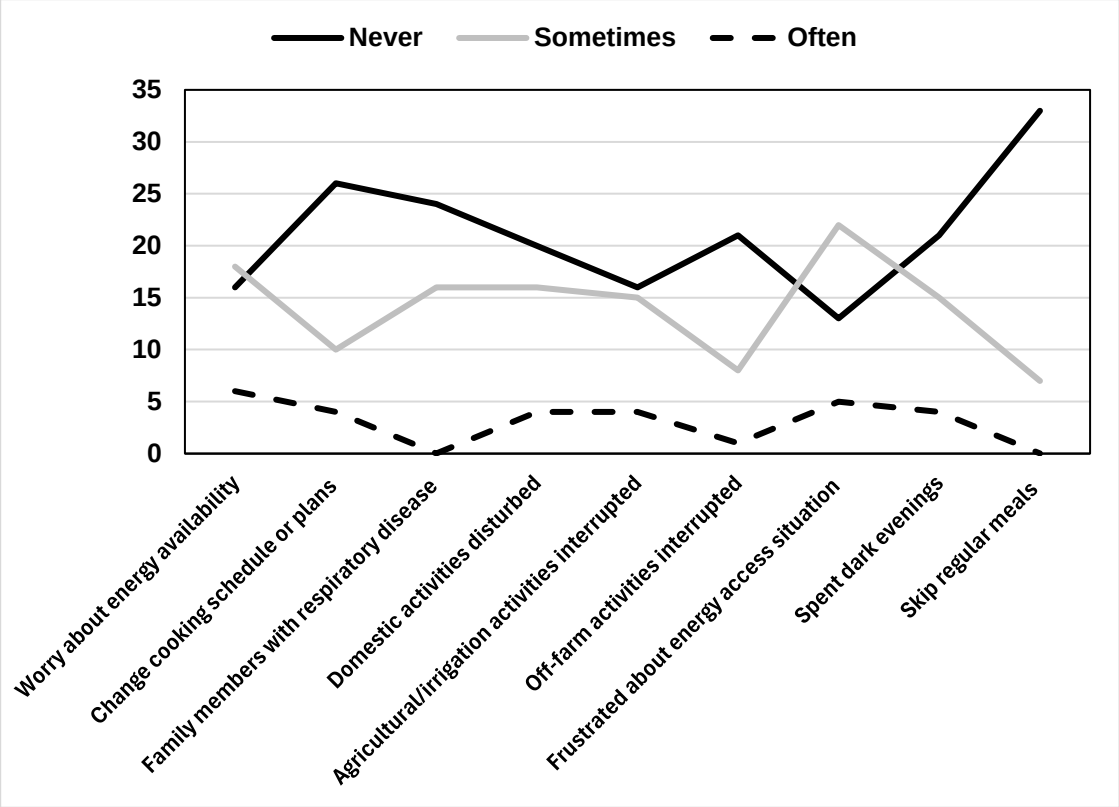
Source: Authors.

Pilot results in Ethiopia

Using the pilot energy insecurity experience scale tool, we conducted in-depth interviews with 40 male and female rural residents from different households in July 2023 in Amhara, Sidama, and Southern Nations, Nationalities and Peoples’ (SNNP) regions. The locations were purposefully chosen to include beneficiaries and non-beneficiaries of the planned DREAM investment, located in proximity to irrigated or irrigable areas, and oversampled locations in the NEXUS Gains basin focal region of Tana-Beles.

Male and female participants were asked about their energy experiences and how they affected their daily lives using an adjusted set of response options.[1] To better groundtruth and validate the questions, during the in-depth interviews, each respondent provided explanations of his/her responses to each experience, which helped explain the indicated frequencies of these experiences. Responses ranged from households being worried about their energy situation to those that were unable to cook due to their energy insecurity experience. Two out of nine questions were answered by a subsample of the respondents, as 5 and 10 respondents had no irrigation or other agricultural activities powered by motorized systems and no nonfarm income-generating activities, respectively. All respondents were using solid biomass for cooking that they collected themselves. Households also reported seasonal shortages of fuelwood and cattle dung. Respondents indicated extensive fuel collection during the dry season to ease fuel shortages during the wet season.

Figure 1 Rural household energy insecurity experience scale: Pilot results for Ethiopia



Source: Authors.

First, we asked if households ***worried about the energy situation*** in their house. Worries were experienced sometimes by 18 respondents, and often, that is more than 10 times per month, by 6 respondents, jointly accounting for close to half of all respondents (Figure 1). Respondents did not consider themselves energy-poor if they were able to access solid biomass through self-collection from a nearby location or from their own farm, as they did not incur out-of-pocket expenses for

[1] For the Ethiopia pilot, "Never" included occurrences of less than 3 times; "Sometimes" included occurrences of 3 to 10 times; and "Often" included experiences above 10 times per month. The category "Always" was not used. This change was made during the pretest specifically for Ethiopia, as farmers were not inclined to select extreme indicators, such as never (zero times) or always. Enumerators also noted confusion between the "Often" and "Always" categories.

obtaining fuel. This is because they did not consider time spent gathering fuel and preparing cooking areas as "costs" associated with securing energy supplies.

Second, we asked about experiences related to ***shifting cooking schedules*** and meal types due to the energy situations experienced by households. More than one-half of respondents (26 out of 40) noted that they had never changed their cooking schedule. However, when they were asked about details, several households noted critical changes to meal plans, particularly when their stock of solid biomass did not allow them to prepare meals that required a longer time to cook. Changes in cooking plans and dietary choices are strained when seasonal biomass shortages occur. Respondents reported two reasons for compromised meal types that affect dietary diversity in the main rainy season (winter). On the one hand, due to the time constraint imposed by critical farming activities in which both women and men are engaged, households opt for simple and less nutritious meals that can be prepared quickly. At the same time, with the scarcity of fuelwood and time and the reduced ignition power of solid biomass during the wet season, households choose to cook less nutritious meals that require both less fuel and less time.

Third, we asked about household cooking-induced ***health issues***, such as respiratory illnesses or eye infections. Sixteen out of the 40 respondents reported incidences of respiratory diseases affecting household members, which they believed were caused by indoor air pollution.

Fourth and fifth, we asked about ***disruptions to domestic and productive agricultural activities,*** respectively, due to the energy situation. Of the 40 respondents, 16 and 15 reported occasional domestic and irrigation activity disruptions, respectively. Irrigator households emphasized the scarcity of fuel (diesel or petrol) during the farming season. This also affected access to motor pump services (that is, the renting in of motor pumps).

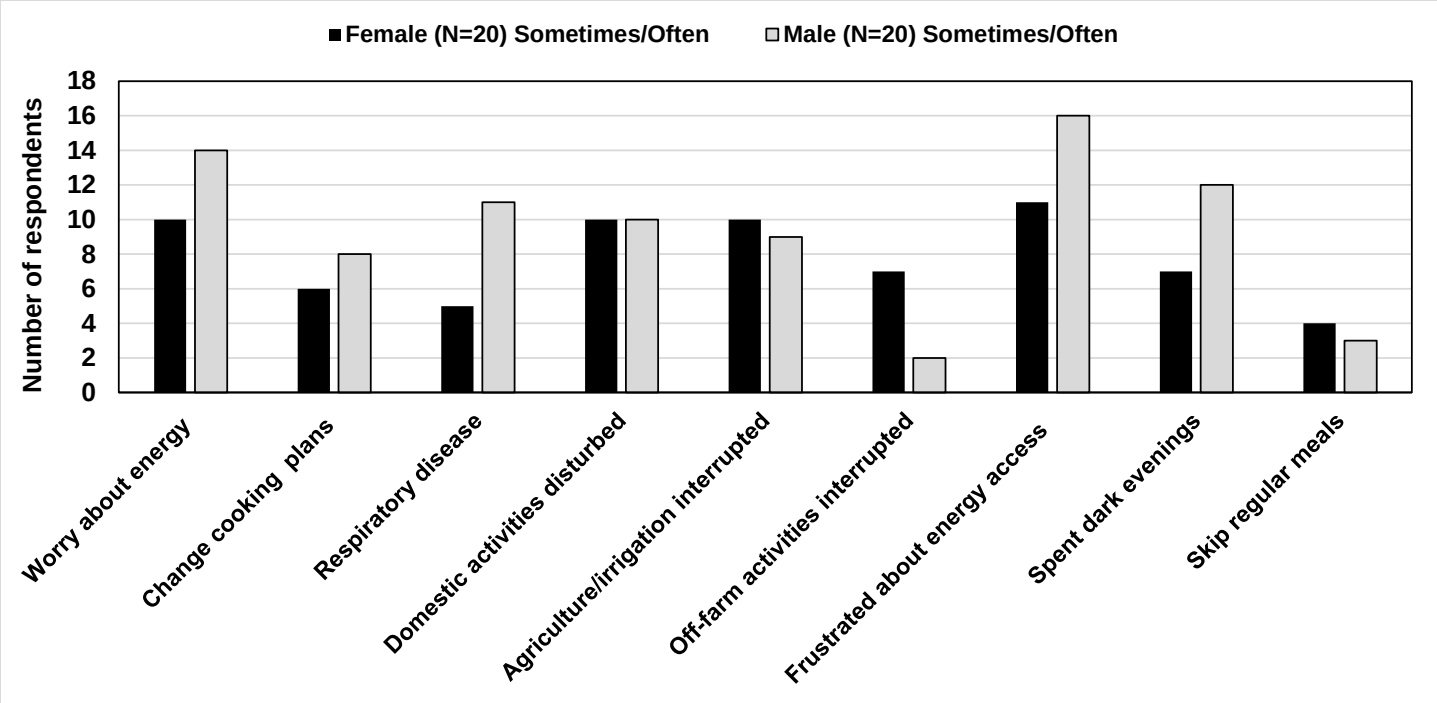
Sixth, experiences of ***disruption to nonfarm income-generating activities*** were modest; only 8 respondents reported occasional interruptions and one respondent noted frequent disruptions. Experiences of ***frustration linked to the energy situation*** and ***spending dark nights*** were noted to occur sometimes (that is, 3 to 10 times for the pilot study) by 22 and 15 respondents, respectively. Five and four respondents (around 10 percent of respondents), respectively, noted these experiences occur often (more than 10 times per month). Frustrations are caused by a multitude of energy situations, such as the unaffordability of improved energy products, appliances, or services. Additionally, the labor- and time-demanding nature of fuel collection, preparation, and cooking time coupled with seasonal fuel scarcities put severe pressure on households. This particularly affects women, who are primarily responsible for this drudgery.

Living through dark evenings without a lightbulb or kerosene lamp can affect cooking, educational, income, and leisure activities. And if there is only a single light source, this might well be used by the male household head, even if the result is that cooking activities are undertaken in the dark (see also Arega et al. 2023, and the section on gendered insights below). While around one-third of respondents noted that they sometimes or often had to change their meal plans to align with available energy sources, a smaller share of respondents (18 percent) stated that they had to sometimes, that is 3 to 10 times a month, ***skip a regular meal*** due to their precarious energy access situation, highlighting the transcending effects of energy impoverishment on wellbeing. This suggests that investments in affordable, clean energy access can improve nutrition outcomes and warrants more research in this area.

Gendered and regional insights

We interviewed rural women and men to understand to what extent they experience energy insecurity differently. In our small pilot sample, men reported a larger number of "Sometimes" experiences than did women. On the other hand, for the smaller number of "Often" responses, women are more likely to express this experience, particularly in relation to changing cooking schedules, disruption of agricultural/irrigation activities, and for overall frustration with the energy situation. Men use "Often" more readily only for living through dark evenings.

Figure 2 Rural household energy insecurity experience scale: Gendered pilot results for "sometimes" and "often"



Source: Authors.

Figure 2 presents gendered results across the two response categories. Compared to women respondents, more men expressed worries and frustrations about their energy situation and reported mostly limited experiences of spending dark evenings, household respiratory disease and changes in cooking plans. In contrast, women were more likely than men to report experiences, including frequent experiences, about interrupted on-farm and off-farm activities. They also reported skipped meals linked to energy insecurity more often than men.

Spatially, respondents' energy insecurity experiences differ across regions. In the Amhara region, experiences related more to fuel quality, smoke, and drudgery for cooking and related domestic and agricultural activities. Diesel and petroleum products used for irrigation were a critical problem among irrigator households, possibly because irrigation is more prevalent in this region. In the southern parts of the country (Sidama and SNNP regions), households reported fuel scarcity and lack of cooking fuel alternatives. Compromised meal quality due to fuel and time scarcity were mentioned across all regions.

Concluding remarks

This study introduces the development and pilot application of the Rural Household Energy Insecurity Experiences Scale (RHEIES), drawing on qualitative data from rural Ethiopia. We find severe energy insecurity experiences, with most households worrying sometimes or often about their energy availability situation. Additionally, 40 percent of respondents linked their energy security situations with household health problems; 30 percent noted that they had to sometimes of often change meal plans and almost 18 percent energy insecurity experiences included skipping meals. Energy insecurity disproportionately affects women, who have multiple roles in securing and managing energy supplies, including as fuelwood collectors, agricultural laborers, cooks, and general caretakers of the household.

The RHEIES can be used to describe the relative deprivation of households in a specific geography and to assess the relationship of energy deprivation with other household outcomes that might well be correlated with energy insecurity, such as household water and food insecurity experiences. Future research should jointly assess linkages between the RHEIES, the HWISE, and the FIES to identify integrated interventions for those most affected by all three insecurities: the poor in rural areas in LMICs.

References

Arega, T., M. Yami, R.D. Bekele, C. Ringler, and M. Jeuland. 2023. "Closing the Gendered Energy Technology Gap in rural Ethiopia: A Qualitative Study." IFPRI Discussion Paper 2224. Washington, DC: IFPRI. https://doi.org/10.2499/p15738coll2.137070

Groh, S., S. Pachauri, and N.D. Rao. 2016. "What Are We Measuring? An Empirical Analysis of Household Electricity Access Metrics in Rural Bangladesh." *Energy for Sustainable Development,* 30: 21–31. https://doi.org/10.1016/j.esd.2015.10.007

Hernández, D., 2016. "Understanding 'energy insecurity' and why it matters to health." *Social Science & Medicine*, *167:* 1-10. https://doi.org/10.1016/j.socscimed.2016.08.029

IEA, IRENA, UNSD, World Bank, and WHO. 2023. *Tracking SDG 7: The Energy Progress Report.* World Bank, Washington DC. © World Bank. https://www.irena.org/Publications/2023/Jun/Tracking-SDG7-2023

Mekonnen, D., E. Bryan, T. Alemu, and C. Ringler. 2017. "Food Versus Fuel: Examining Tradeoffs in the Allocation of Biomass Energy Sources to Domestic and Productive Uses in Ethiopia." *Agricultural Economics,* 48(4): 425–435. http://dx.doi.org/10.1111/agec.12344

Padam, G., D. Rysankova, E. Portale, B.B. Koo, S. Keller, and G. Fleurantin. 2018. "Ethiopia–Beyond Connections: Energy Access Diagnostic Report Based on the Multi-Tier Framework." Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/30102

Smith, M.D., M.P. Rabbitt, and A. Coleman-Jensen. 2017. "Who Are the World's Food Insecure? New Evidence from the Food and Agriculture Organization's Food Insecurity Experience Scale." *World Development*, 93: 402–412. https://doi.org/10.1016/j.worlddev.2017.01.006

Young, S.L., G.O. Boateng, Z. Jamaluddine, J.D., Miller, E.A. Frongillo, T.B. Neilands, S.M. Collins, A. Wutich, W.E. Jepson, and J. Stoler. 2019. "The Household Water InSecurity Experiences (HWISE) Scale: Development and Validation of a Household Water Insecurity Measure for Low-Income and Middle-Income Countries. *BMJ Global Health*, 4(5): e001750. https://doi.org/10.1136/bmjgh-2019-001750

World Bank. 2024. World Bank Development Indicators. Washington DC: World Bank. World Development Indicators | DataBank

Tiruwork Area is a PhD student at UNU Merit, Maastricht University and a former IFPRI staff; **Claudia Ringler** is Director, Natural Resources and Resilience Unit at IFPRI.

This policy note was developed with support of the CGIAR Initiative on NEXUS Gains. It has not been independently peer reviewed. The opinions expressed here belong to the authors, and do not necessarily reflect those of the organizations contributing to the study.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

A world free of hunger and malnutrition

1201 Eye Street, NW, Washington, DC 20005 USA | T. +1-202-862-5600 | F. +1-202-862-5606 | Email: ifpri@cgiar.org | http://www.ifpri.org/