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Multi-Dimensional Energy Poverty Index And Its Determinants: A Case Study In Kokrajhar District Of Assam

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Abstract

This paper highlighted the multi-dimensional energy poverty index (MEPI) in Kokrajhar district of Asssam. It analysed the factors that affect the MEPI. A total of 100 households are selected randomly, considering both rural and urban. It was found that 46 per cent of households are multidimensional energy poor. The monthly income, kutcha house and urban is only statistically significant that determined the energy poverty.

Key words: *Multi-dimensional, Poverty, Lighting, Cooking.*

I. INTRODUCTION

Energy is a crucial catalyst for promoting economic, social, and physical development, making it the most indispensable resource for progress. Energy, often known as power, is crucial for the provision of essential services such as clean drinking water, illumination, food preparation, healthcare, education, and more. Additionally, it facilitates improved quality of life and drives economic growth and income generation. Energy is the fundamental essence that drives the majority of facets in life. Energy is the primary factor that links economic growth, enhanced social equality, and an environment conducive to global progress. Having access to clean and inexpensive contemporary energy services is crucial for achieving socio-economic emancipation (Nussbaumer et al., 2012). Energy services encompass the specific energy needs of consumers, such as transportation, heating, and lighting. The term "modern" implies a high level of convenience in accessing these services, which are provided through energy sources that are not considered traditional, such as firewood, animal dung, and crop residue.

Two commonly used methods for evaluating energy poverty are household income-expenditure-based indicators and survey-based consensus indicators (Carrere, 2021). According to the expenditure technique, families' spending on energy is measured using an expenditure indicator called households' income expenditures on energy. This metric is frequently compared to a specific critical threshold to determine whether a home is considered energy poor. The assessment is based on whether the household's expenditure is more or lower than the threshold (Halkos and Gkampoura, 2021). The consensual approach to evaluate energy poverty involves obtaining information by directly asking individuals. Consensual indicators typically involve questionnaires that ask households to provide subjective appraisals of their capacity to sufficiently heat their homes and pay their utility bills promptly (Trinomics, 2016).

Energy poverty is a complex and multifaceted issue that refers to a household's failure to meet the necessary social and material standards for home energy services (Mkomba et al. 2021). While a uniform definition may be challenging, a significant number of individuals worldwide experience various forms of energy poverty. Energy poverty is a comprehensive concept that encompasses various elements such as caloric intake, life expectancy, housing quality, literacy, and access to energy. Within the non-income dimension, two indications are present: absence of electricity access and reliance on traditional cooking fuels such as firewood, charcoal, and dung (Njiru and Letema, 2018)

The Multidimensional Energy Poverty Index (MEPI) was introduced by Nussbaumer et al. (2011) and is derived from the Multi-dimensional Poverty Index developed by the Oxford Poverty and Human Development Initiative (OPHI) in collaboration with the United Nations Development Programme

(UNDP). The MEPI quantifies the range of energy deficiencies that could potentially impact an individual. The composition consists of five dimensions, which reflect fundamental energy services, together with six indicators. Each indication has been allocated distinct weights, and the total sum of the weights for all indicators is 1. An individual is classified as energy poor when the sum of the hardships they experience surpasses a predetermined threshold, denoted as k = 0.33. The MEPI is calculated by multiplying the headcount ratio with the average severity of deprivation for those who are energy poor. This research aims to calculate the Multidimensional Poverty Index (MEPI) in Kokrajhar district of Assam and determine the factors that influence MEPI.

II. METHODOLOGY

The current study utilizes both primary and secondary data sources. Nevertheless, all the research and discussion relies solely on source data. The collection of secondary data involves gathering information from sources such as the Census 2011, official websites, books, and journals. Data gathered by the sampling technique is referred to as primary data. The multi-dimensional energy poverty index (MPEI) is derived from the work of Nasbaussar et al. (2011) initially employed this approach, utilizing the Multi-dimensional Poverty Index from the Oxford Poverty and Human Development Initiative (OPHI) in collaboration with the United Nations Development Programme (UNDP) to make an estimation. The MEPI quantifies the range of energy deficiencies that can potentially impact an individual. The composition consists of five dimensions, which reflect fundamental energy services, together with six indicators. Each indication has been allocated distinct weights, and the total of the weights assigned to the various indicators is 1. A household is considered to be energy poor if the total deprivations it faces above a predetermined cut-off score, denoted as k = 0.33. The MEPI is calculated by multiplying the headcount ratio with the average severity of deprivation for individuals who lack access to energy. In this study, we employed the MPEI as utilized by Sadath and Acharya in their previous works from 2017 and 2019. The MPEI takes into account the fundamental requirements for human survival, including lighting and cooking. The energy use is comprised of eight dimensions, which can be categorized into three main groups: lighting, cooking, and supplementary measures. We allocate a uniform weight of 33.33% to each of the three categories, and furthermore distribute equal weight to the subcategories inside each of the aforementioned categories.

Table 1: Dimensions of MPEI

Dimension		Weight	Condition
Lighthing		33.33	No electricity
COOKING	LPG	16.66	NO
	Kitchen	16.66	No chimney
Additional measures	Firewood	6.66	Yes
	Cow dung	6.66	Yes
	Crop residue	6.66	Yes
	Coal	6.66	Yes
	Kerosene	6.66	Yes

Source: Sadath and Acharya (2017, 2019)

We used the following components to estimate the MEPI which is adopted by Oxford Poverty & Human Development Initiative (OPHI) with the association of United Nations Development Program (UNDP) to estimate the MPI. The following are the components of MEPI.

Headcount Ratio

$$H=q/n$$

Where q is the total number of multi-dimensionally energy poor households identified and n is the total household. In this report, the headcount ratio has been reported as a percentage

Intensity of Energy Poverty

The intensity of energy poverty (A) is the average proportion of deprivations which is experienced by multi-dimensionally energy poor households. It is the average deprivation score of all multi-dimensionally energy poor households. Intensity of Energy Poverty-

$$A=\frac{1}{q}\sum_{i=1}^{q} c_i(k)$$

Where c_i (k) is the deprivation score of multi-dimensionally energy poor households up to the ith household and q is the number of multi-dimensionally energy poor house

The Multidimensional Energy Poverty Index reflects both the incidence and the intensity of multidimensional energy poverty. The index is the product of the two partial indices, the headcount ratio (H) and intensity (A) of multidimensional energy poverty. This can also be defined as the share of households that is multi-dimensionally energy poor adjusted by the intensity of deprivation.

$$MEPI= H \times A=\frac{q}{n} x\frac{1}{q}\sum_{i=1}^{n} c_i(k)=\frac{1}{q}\sum_{i=1}^{n} c_i(k)=\sum_{i=1}^{n}\sum_{j=1}^{d} w_j\, g^0_{ij}(k)$$

The binary logistic regression is used to find out the factors that effecting the MPEI. The following regression line is considered where MPEI is dependent variable having two values 1 and 0.

$MPEI= Y=\beta_0 + \beta_1 InX_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + U$~~~~~~~~~~(i)
MPEI= 1, if poor and 0, if non poor
X_1= Family monthly income
X_2 = Family members
X_3 = Age of Head
X_4 = Occupation (1, if salary and 0, if non salary)
X_5= Head of gender (1, if female and 0, if male)
X_6 = House (1, if pucca and 0 if kutcha)
X_7 = 1, if rural and 0, if urban
X_8 = Head's education
U= Random term

The present study is based on primary as well as secondary data. The present study area is confined only to the Kokrajhar district of Assam. It is considered only energy poverty and factors that determine the MPEI. Kokrajhar district is part of the Bodoland Territorial Region (BTR) of Assam, which is the headquarters of the BTR. About 100 households were selected randomly as a sample by using a multistage sample of 50 from rural areas and 50 from urban areas. Among the 11 community development blocks, three blocks were selected as samples: Kokrajhar, Dotma, and Kachugaon. Four villages were selected from each block as a sample, and 4 or 5 households were selected randomly from each village, which turned into 50 sample units. Regarding the urban area, Kokrajhar town was selected, and 50 households were randomly selected as samples. The sample size was taken only 100 due to lack of time and convenient for the study selected. The sample was surveyed in October 2023.

III. RESULTS AND DISCUSSION

We estimate MEPI Kokrajhar district on basis of sample size 100. The cut off of poverty is considered 33.33. The calculated value of head count ratio H is 46 and the intensity of energy poverty A is 0.62. The MEPI is H x A = 46 x 0.62 = 28.52. Thus the in Kokrajhar district of Assam around 46 per cent of

households is energy poverty i.e. 46 per cent of households is multi dimensionally deprived in accessing the energy.

Since dependent variable is dummy variable we need to use the binary logistic regression to the capture the factors that affect MEPI. The factors like monthly income, family members, head's age, head's occupation, gender of head, type of house, rural-urban and head's education are considered as impendent variables and MEPI is dependent dummy variable. The Table 3 shows the estimated binary logistic regression line.

Table 2: Binary logistic regression estimators

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Monthly_income	-2.039*	.923	4.882	1	.027	.130
Family_members	.221	.267	.683	1	.409	1.247
Age_Head	-.074	.046	2.581	1	.108	.928
Salaried	-1.973	1.522	1.680	1	.195	.139
Female_head	-1.665	1.447	1.324	1	.250	.189
Kutcha house	2.857*	1.431	3.987	1	.046	17.406
Urban	-4.827*	1.389	12.082	1	.001	.008
Education	-.103	.096	1.142	1	.285	.902
Constant	26.489	10.197	6.748	1	.009	3.190E11

*p value < 0.05

The table 3 shows the estimated binary logistic regression. Only 3 factors are statistically significant i.e. monthly income, kutcha house and urban are statistically significant that determined the energy poverty. The remaining factors like family members, age of the head, salaried, female head and education of head are not statistically significant. If the monthly income (B = -2.039) increases 1 unit, the energy poverty likely to reduce 2 times. The probability of energy poverty increases around 3 times (B= 2.85) if the 1 unit of kutcha house increase. Again if the 1unit household increases in urban area the energy poverty likely to reduce around 5 times (B= -4.827). Urban house is the highest effect on reducing energy poverty and secondly, the kutcha house lead to increase energy poverty. Thirdly, monthly income increase lead to decrease the energy poverty.

IV. CONCLUSION

This paper is attempted to apprehend the level of energy poverty and its determinants in Kokrajhar district of Assam. It is found that multi-dimensional energy poverty exists in Kokrajhar. The few factors affecting the MEPI has identified like monthly income, kutcha house and urban household. Increase in income of household and urban household lead to reduce energy poverty while the increase in kutcha house the probability of energy poverty also increases. We observed that most the rural household are don't know clean fuels. They primarily used the traditional solid fuels for cooking meals due to availability of solid fuels even they have ability finance to use LPG. Even in the urban area, the households are not use the electricity for cooking due to lack of information and avoid of high electricity bill. Thus the government should organise the awareness program about the practice clean energy and efficient use of it frequently. The income generating opportunities creation and housing construction must be done rapidly in rural area which will lead to reduce energy poverty. Through this paper the energy poverty is captured and can

tackle down the energy poverty through effective policy of government as well as all stakeholders' responsibility.

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