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Path Towards Energy Sustainability: A Multidimensional Analysis of Energy Poverty in Philippine Households

Measuring energy poverty to meet one's basic needs is vital for household assessments concerning accessibility of energy, affordability of energy prices, usage of energy resources, and sufficiency of energy consumption. In this Policy Brief, we have listed recommendations and rationale to improve the energy conditions of Philippine households.

POLICY RECOMMENDATIONS

Improving family planning and education. Given the dense populations and their large contribution to income and energy consumption disparities, this policy would stabilize growth and income levels within working populations. Improving education curricula, on the other hand, would resolve concerns regarding smart household energy practices.

Allocating necessary resources to rural areas. Inaccessibility in rural areas has remained prevalent with the rising commercialization of available energy resources in urban areas. As such, this policy focuses on gauging the needed energy resources per area and providing subsidies. Gathered data also prevails shifts within the market towards affordable energy pricing.

Providing more job opportunities. Resourceful energy consumption could come from livelihood improvements through policy changes in incentives, health benefits, and upskilling workers to retain productivity and generate income. These create accessibility towards market mechanisms for greater demand and regularized prices.

Crafting sustainable and affordable energy alternatives. This policy shall center on lessening pollution through investments in cleaner energy and energy infrastructures within vulnerable communities. It is supplementary to providing job opportunities and revitalizing research towards energy.

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INTRODUCTION

The United Nations (n.d.) described energy poverty as the lack of accessible and renewable modern energy resources, wherein deprivation among energy consumption is prevalent. Energy poverty and its underlying factors are not entirely new concepts, though their functions in the poverty eradication field are embodied in a modern dimensional perspective (Organisation for Economic Co-operation and Development, 2011). The immobility and insufficiency of proper energy resources have impeded the ability of various countries to implement sustainability. Its eradication is always perceived as an economic challenge, and in response, there are legislated government policies that revolve around it to develop the economic and social conditions of individuals, especially the marginalized.

Reiche et al. (2000) emphasized a correlation between electricity access and people's welfare. It is seen when they investigated the access of electricity in rural areas and its social impact on individuals using it. Barnes et al. (2010) also discussed how the reduction in energy spending could be affected by

access to electricity. It is so because when there is a decrease in the relative price of energy, then the expenditures, other than food expenses, are more likely to be energy intensive. Due to energy poverty's result, it is estimated that more than 70% of the people living in rural areas depend on charcoal and fuelwood for their household energy needs, especially in developing countries (Maren et al., 2013).

The analysis of energy poverty and consumption is also directed towards household energy consumption and affordability. It is argued by Holdren and Smith (2000) that energy poverty is related to the energy ladder. An energy ladder is when there is an increase in energy consumption and efficiency, which is from energy transformation caused by a traditional fuel system shifting to a modern fuel economy. Most attention to the behavior of households who are energy-deprived is given depending on the efficiency of energy policy interventions. The introduction of indexes and indicators of energy poverty plays a vital role in determining the household behavior in a particular country, apart from energy prices, energy income, and energy efficiency (Kearns et al., 2019).

ANALYSIS

The assessment of Philippine energy deprivation requires judgment towards inquiry on energy poverty amongst households. As such, the Policy Brief is supported by two models: the multidimensional energy poverty index (MEPI) by Nussbaumer et al. (2011), and the study's regression model in testing energy deprivation with other household characteristics.

Nussbaumer et al.'s (2011) MEPI represents the weights of energy deprivation based on its incidence from the household headcount $(\frac{q}{n})$ and the intensity from the summated deprivation score $(\sum_{i=1}^{n} c_i(k)/q)$. The results of the MEPI indicate the severity of energy deprivation at the regional and national settings. Moreover, the values for each region are gathered from the principal component analysis (PCA) computations of each energy dimension provided in Table 1.

$$MEPI = \frac{q}{n} * \sum_{i=1}^{n} c_i(k)/q$$

The ordinary least squares (OLS) regression model, on the other hand, tests the relationship of the computed energy deprivation with the household attributes – namely the number of household members, the reduction of energy consumption, the rurality of the household area, and the average household income, respectively.

$$ED = \beta_0 + \beta_1 mem + \beta_2 reduce + \beta_3 rural + \beta_4 income + u$$

The variances shown in Table 1 indicate moderate weights in each dimension. The *cooking* dimension, based on the usage of LPG, has the greatest share, which was followed by the *refrigeration* dimension. These imply that households highly use LPG and electricity and serve as great determinants to each household's capacity to consume energy resources. Thus, it calls for sustainable and affordable energy use to reduce energy deprivation. The *lighting* dimension has the lowest weight, and when compared to Mendoza et al.'s (2019) study, there were evident overestimations in determining the *lighting*'s contribution to energy consumption and deprivation.

Table 1

PCA Weights at the National Level (2004, 2011, 2011 w/o Communication - WC) vs. Mendoza et al.'s (2019) Study

	2004	2011	2011 WC	Mendoza et al.
Variance (%)	**40.77**	**34.65**	**34.58**	**-**
Cooking	0.2413	0.2219	0.2850	0.20
Indoor Pollution	0.1413	0.0807	0.1209	0.20
Lighting	0.1166	0.0010	0.0018	0.20
Refrigeration	0.2200	0.2304	0.2769	0.10
Entertainment/ Education (TV/radio)	0.2113	0.1010	0.1536	0.10
Space Cooling	0.0694	0.1648	0.1619	0.10
Communication (Computer Activity)	-	0.2002	-	0.10

The weights of the energy dimensions also helped indicate the higher levels of energy poverty in the Philippines through the MEPI methodology. With the 7-year difference, the disparities show the worsening energy deprivation and inaccessibility in the country. With the increase in population over the years, the greater numbers indicate higher energy poverty incidence. From the regional perspective,

Region II and ARMM remain the most energy-deprived, whereas Region IV and NCR remain the least energy deprived. The former regional pair has many rural areas, with the latter pair residing in the more urbanized areas, implicating the characteristic of household residences in a household's ability to consume affordable energy goods.

Table 2

National and Regional MEPIs (2004, 2011, 2011 w/o Communication - WC) vs. Mendoza et al.'s (2019) Study

	2004	2011	2011 WC
Philippines	**0.3544**	**0.441**	**0.3922**
Region I	0.3398	0.5608	0.4520
Region II	0.4089	0.6047	0.5233
Region III	0.3535	0.3815	0.2817
Region IV-A	0.3103	0.2502	0.1727
Region IV-B	0.4638	0.6023	0.6017
Region V	0.4708	0.5600	0.5605
Region VI	0.4648	0.5038	0.4484
Region VII	0.4190	0.4874	0.4701
Region VIII	0.4418	0.5961	0.5531
Region IX	0.4474	0.5273	0.5411
Region X	0.4178	0.5614	0.4852
Region XI	0.4237	0.5045	0.4897
Region XII	0.4351	0.5319	0.5275
NCR	0.2026	0.2543	0.1732
CAR	0.3520	0.4132	0.3423
ARMM	0.5297	0.4458	0.5403
Caraga	0.4202	0.5665	0.4958

Following this, statistical significance is shown in the relationship between energy deprivation scores and household attributes. Rising population numbers are reflected in the number of household members. With each unit shift, it represents increased vulnerability towards energy deprivation. The same result is reflected in a household's rurality wherein inaccessibility and unavailability to purchase energy resources are evident. On the other hand, the opposite is shown in the increasing household income and practiced reduction of energy consumption, indicating that available job opportunities and effective education are relevant to finance their energy consumption, which can lessen energy inefficiencies within households. As such, it is important that the socioeconomic state of the households is upheld to improve the overall energy access and consumption in the Philippines.

Table 3

Regression Equations (2004, 2011, 2011 w/o Communication)

Variables	2004	2011	2011 w/o Comm
No. of Household Members	0.004***	0.004***	0.005***
Reduction of Energy Consumption	-0.035**	-0.110***	-0.105***
Rural Household Residence	0.097***	0.076***	0.074***
Average Household Income	-0.166***	-0.183***	-0.175***
Constant	0.631***	0.828***	0.803***

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

CONCLUSION

This study mainly proposes a more superior methodology than the estimations of Mendoza et al. (2019) because the weights used to compute MEPI are more specific to the Philippine setting. Because of this, we were able to uncover some major implications regarding

the energy situation in the Philippines. From the results discussed in this paper, it can be seen how most of the MEPI scores amongst the Philippine regions are still increasing at an alarming rate, instead of observing an improvement in those said scores, as estimated by Mendoza et al. (2019).

The findings are highly significant to policymakers because it gives more attention to the proportion of households upset by a specific dimension of energy poverty in evaluating energy access and security. Given that more households use LPG in cooking, it is important to consider the adverse environmental effects and resource variability in markets. In accordance with the UN Sustainable Development Goals, policies investing in the promotion of clean energy and research for technological developments can be vital to improving energy infrastructures. Moreover, the shifts in an average household income explain the vulnerability of individuals to the changing market demand with its prices. By evaluating the available jobs and giving more health benefits, these new opportunities can surely help build up consumption security, which has a direct effect on the level of energy deprivation.

The rising number of household members and lack of education can lead to vulnerability in energy consumption, affecting the distribution and utilization of energy resources. Thus, conducting family planning and other sex education-related policies and educational reforms on household energy practices can be vital to enacting sustainability. Furthermore, acknowledging urbanity and rurality can help better understand energy accessibility based on household income and demand. Thus, governments must craft policies and make regular constituency check-ups to vulnerable areas with financial struggles in energy consumption. Finally, highlighting the geographic variations in multidimensional energy poverty in the Philippines, and understanding its determinants, will provide an empirical basis for designing, targeting, and prioritizing interventions.

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