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Examining energy use and weather variability through the gender lens

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A study that analyzes energy use, weather, and gender is very relevant. One, households use different energy sources for lighting, cooking, and heating needs. It aids the pursuit of productive activities like studying and the pursuit of health and hygiene. Two, weather or climate is an integral part of our lives and certainly relevant in energy use. Electricity consumption is lower when it is raining because of the less need for cooling. Fuelwood, charcoal, and biomass consumption may also be lower due to supply constraints. The consumption of liquefied petroleum gas (LPG) may be affected due to damaged infrastructures resulting from landslides and heavy rains. Three, weather shocks and climate change affect men and women differently, likely a result of the different roles they play in the society. In the context of energy use, Charmes (2006) refutes the claim that mostly women and girls collect firewood but provides support for the widely held belief that majority of women and girls are involved in food preparations. In this case, the type of energy sources used for cooking affects the welfare and productivity of women and children. For example, the use of biomass, fuelwood, or charcoal exposes one to particulates that can cause respiratory illnesses. It also compromises the time allocated to productive activities like studying and income generation.

While substantial studies on energy use have been done in developing countries, few researches analyzed energy use in the Philippines and even fewer within the context of weather variability and gender. This *Policy Note* analyzes the change in households' energy use with different sex composition in response to weather changes. It also provides

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insights on the effects of income, prices, and other socioeconomic factors on energy use.

Household energy use in the Philippines

Based on the 2011 Household Energy and Consumption Survey of the Philippine Statistics Authority (2011), electricity is the most popular energy source in rural (75%) and urban (89%) households in the Philippines. With around 25 percent of rural and 56 percent of urban households using it, the LPG is the next most popular choice. Charcoal is also used in 6 percent and 15 percent of rural and urban households, respectively.

Electricity use is lowest among low-income households while highest among high-income households (Figure 1). Poor households consume a monthly average of 60 kilowatt-hours (kWh) while middle-income households consume around 210 kWh. High-income households consume almost twice that of the latter. Similar pattern is observed in the households' average monthly LPG use. However, middle- and high-income households' use is closer at around 40 and 45 kilograms, respectively.

Even high-income households consume charcoal. In fact, they have the highest charcoal use at around 4 kilograms per month. Low-income households consume relatively lower amount of biomass, charcoal, and firewood at around 2 kilograms.

These statistics are not consistent with the energy ladder model, where energy use is modeled such that traditional sources, like charcoal, biomass, and fuelwood, are in the lower rung and modern sources, like LPG and electricity, are in the higher rung. The model assumes that households' demand for cleaner and safer energy sources increases with income.

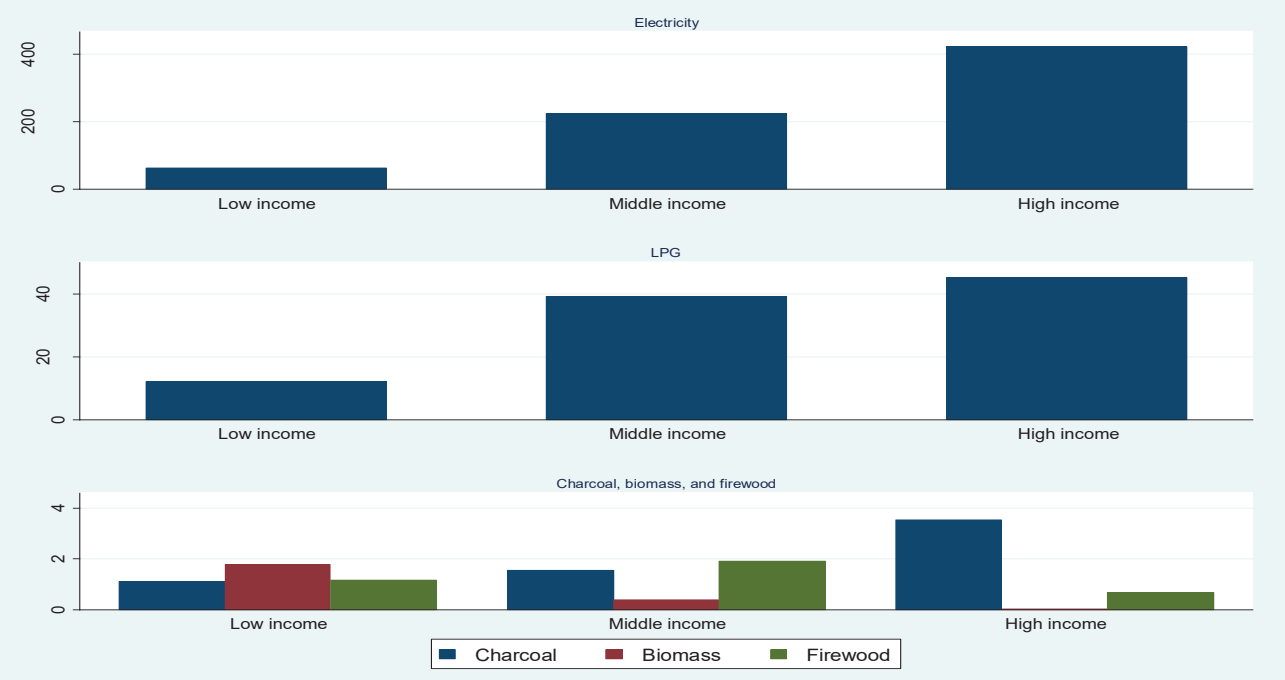
Instead, this study found that households follow the energy stacking model, where households use different energy sources from different rungs of the energy model. According to Foley (1995), energy stacking is a ladder of energy demand, not preferences that determine fuel choices driven by the services energy provides. Households use lower-rung energy sources when income is low. With increasing income, households purchase appliances that need specific energy inputs resulting in a portfolio of energy sources.

In energy stacking model, households' energy transition is not linear. Instead, they use one energy source without abandoning others (see, for example, Masera et al. 2008). Energy stacking may result from supply constraints and households find it best to keep alternative sources as backups (see, for example, Masera et al. 2008), from fluctuating energy prices (see, for example, Hosier and Kipondya 1993), and/or from culture and tradition (see, for example, Rao and Reddy 2007).

Because high temperature, high humidity, and abundant rainfall characterize the Philippine climate,[1] the heat index, which refers to the

[1] http://www.pagasa.dost.gov.ph/

Figure 1. Average monthly energy consumption



Source: Author's computation based on the 2011 Household Energy and Consumption Survey, PSA (2011)

temperature the human body perceives or feels, appears to be an ideal weather variable the study can link to consumption patterns of energy. Prolonged activity under the sun when heat index is high can have severe consequences, such as fatigue, heat cramps, heat exhaustion, and heat stroke. As such, people may be cautious to go out and this can have significant implications in households' energy choice and use.

To understand the effect of weather variability on energy consumption, the study computed heat index using temperature and relative humidity data in 2011 and *normal* heat index using the 30-year average of temperature and relative humidity data. The difference between the 2011 heat index and the normal heat index, or the heat index deviation, proxies for weather variability.

This study analyzed the monthly consumption of various energy sources by heat index deviation values for three household types, namely, male-majority, female-majority, and balanced households (Table 1). Male-majority households refer to those whose male members are at least 60 percent of the total household size. Female-majority households are similarly defined. Balanced households refer to those with male and female members consisting 41–59 percent of the total household size.

Female- and male-majority households have the highest and the lowest monthly electricity consumption, respectively. They also have higher electricity consumption when heat index is above normal. Meawhile, the electricity consumption of balanced households is similar regardless of the changes in the heat index.

The LPG consumption of the three household types is higher when heat index is below normal. Balanced and female-majority households consume around 18 kilograms each month. However, the LPG consumption of female-majority households is the highest at around 15 kilograms when heat index is above normal. The consumption of balanced and male-majority households is between 11 and 12 kilograms.

The charcoal consumption across household types is relatively similar at around 1.1 kilograms each month when heat index is above normal. When it is below normal, the charcoal consumption of households is almost similar, with male-majority households at 1.4 kilograms, balanced households at 1.3 kilograms, and female-majority households at 1.2 kilograms.

The biomass consumption of male-majority households is the highest at around 2.5 kilograms when heat index is below normal. The consumption of balanced households is at 2.3 kilograms and the female-majority households at 1.6 kilograms.

The firewood consumption of balanced households is around 1.3 kilograms while that of male- and female-majority households is around 1.1 kilograms when heat index is below normal.

Energy use, weather variability, and gender

Based on the estimations of a discrete-continuous modeling approach, this study computed the marginal effects of key variables for three household types (balanced, male majority, and female majority) and for four head sex-location configurations (female headed and male headed in rural areas, female headed and male headed in urban areas). Using scenarios on electricity and the LPG price increases, it also predicted the total consumption for representative profiles and analyzed the consumption with heat index deviation relative to the consumption.

Based on this methodology, the study found the following:

1. The effect of weather variability is most evident on electricity consumption. Its impact on energy consumption differs across household types and differs in direction as well. Its impact is highest in female-headed households in rural areas.
2. Own-price effects differ across energy sources, household types, and weather changes. The effects are higher in female-headed households in rural areas and in male-headed households in urban areas.
3. Cross-price effects differ across energy sources, household types, and weather changes. The effects are higher in female-headed households in rural areas.
4. Income effects differ across energy sources and across household types. The effects are higher in female-headed households in rural areas and male-headed households in urban areas.
5. The consumption of specific energy source is affected by the use of other energy sources for various purposes.

Table 1. Average monthly energy consumption, by household type and heat index deviation

	Heat Index<Normal Heat Index		Heat Index>Normal Heat Index	
	Observations	Mean	Observations	Mean
Balanced households				
Electricity (in kilowatt-hours)	2826	80.3	2969	81.2
LPG (in kilograms)	2826	17.8	2969	11.5
Charcoal (in kilograms)	2826	1.3	2969	1.1
Biomass (in kilograms)	2826	2.3	2969	1.3
Firewood (in kilograms)	2826	1.5	2969	0.95
Male-majority households				
Electricity (in kilowatt-hours)	2923	65.2	3005	71.5
LPG (in kilograms)	2923	14.7	3005	10.7
Charcoal (in kilograms)	2923	1.4	3005	1.1
Biomass (in kilograms)	2923	2.5	3005	1.1
Firewood (in kilograms)	2923	1.7	3005	0.9
Female-majority households				
Electricity (in kilowatt-hours)	2842	87.5	2922	96.3
LPG (in kilograms)	2842	18.7	2922	14.8
Charcoal (in kilograms)	2842	1.2	2922	1.1
Biomass (in kilograms)	2842	1.6	2922	1.1
Firewood (in kilograms)	2842	1.4	2922	0.8

Source: Author's computation based on data obtained from PAGASA's Climate and Agromet Data Section and 2011 Household Energy and Consumption Survey, PSA (2011)

Results also suggest the importance of weather deviations in energy use. Heat index fluctuations above the normal value affect the usage of appliances, which electricity mostly powers. The study predicts charcoal use to increase but not as much.These suggest that increases in electricity consumption are likely results of an effort to mitigate the bodily impact of weather changes.

Households use electricity on the basis of routines established over time. When faced by shocks, these routines and associated energy use will adjust. Hence, in the face of persistent above normal heat index, households will prefer to use airconditioning units all day, instead of electric fan on certain hours.

One can view charcoal as a supplementary to electricity use because its usage is limited to cooking food and heating water. As such, it may not adequately address the immediate physical needs like the reduction of perceived heat. The increase in electricity use and the complementarity of electricity and charcoal likely explain the decrease in the LPG consumption when heat index is above normal.

Results provide limited support for the energy ladder model. While all income intervals

According to United Nations Development Programme (2007), women are disproportionately vulnerable to climate change than men due to the social roles they play. While women are more likely to stay at home, men are more likely to go out to work or play. During weather fluctuations, the response of balanced and female-majority households to increase electric consumption more than male-majority households is not surprising. (Photo by Asian Development Bank.)

significantly affect electricity consumption, only lower income intervals affect LPG consumption. Charcoal consumption is not significantly affected at all.

Based on the effects of using alternative energy sources, energy stacking is observed in different weather changes scenario. Similar to Hosier and Kipondya (1993), results indicate that households consume a portfolio of energy sources spanning different stages of the energy ladder model. For example, LPG consumption increases with the use of charcoal for heating water when heat index is below normal. Presumably, households use these two energy sources more when the need to mitigate bodily discomfort from heat and humidity is less. On the other hand, electricity consumption increases with charcoal use when heat index is above its normal value. Presumably, this is when electricity is more expensive (i.e., during summer time) and the need to address bodily discomfort is higher.

Electricity powers most appliances. The use of other energy sources for heating water or

cooking food allows the households to reallocate resources toward electricity consumption to address bodily needs arising from above normal heat index. This study offers the similar explanation why electricity consumption increases with the use of LPG for cooking when heat index is above normal. These results can help explain the puzzle in the literature regarding nonpoor households' continuing use of traditional fuels despite having the means to afford modern energy sources. Heltberg (2004) explains this puzzle can sometimes be attributed to preferences for cooking using a specific energy source to achieve certain taste or texture. It can also sometimes be attributed to the shortages in supply. Our results illustrate that households use combinations of energy sources in different weather fluctuation scenarios.

This study also considered household composition as a factor of energy use. For example, given a 2-degree Celsius heat index fluctuation, the study found that high consumption of female-majority households with female heads in urban areas drives the maximum value of the predicted change in electricity consumption. On the other hand,high consumption of male-majority households with female heads in urban areas drives the maximum value of the predicted change in LPG consumption. Meanwhile, high consumption of balanced households with female heads drives the maximum value of the predicted change in charcoal consumption.

Consistent with the literature, results indicate that men and women have different needs. While women are more likely to stay at home, men are more likely to go out to work or play. During weather fluctuations, the response of balanced and female-majority households to increase electric consumption more than male-majority households is not surprising. Higher changes in male-majority households' LPG use possibly suggests that men's energy use is concentrated on food preparation or heating water.

Women are disproportionately vulnerable to climate change than men due to the social roles they play (UNDP 2007; Chikulo 2014). Based on the result of this study, heat index variability has the highest effects on the electricity consumption of balanced and female-majority households that are female headed and in rural areas. It also has the highest effect on the charcoal consumption of female-headed households in balanced households. While it cannot provide concrete evidence on the channels, the study alludes to the combined effects of traditional gender roles and headship as a source of strong bargaining power in the household as plausible reasons regarding the effects of weather variability on female-headed households. Women are possibly more attuned to the needs of their household members and their headship gives them traction to address these needs.

In addition, women in female-headed households are likely to have more decisionmaking power relative to women in male-headed households. While not related to

The government should also support alternative projects to generate electricity given that households located in geographically isolated and disadvantaged areas are highly unlikely to have the appropriate infrastructures to attract service providers. One possible project is the saline solution that can power lamps.

energy use, several studies provide evidence on the positive effects of female heads on various children's outcomes (see, for example, Chudgar 2011). These effects can plausibly spill over to energy use, which has welfare effects as well. Weather changes affect rural households more than those in urban areas, where malls and recreation centers provide alternative ways to reduce energy consumption. Taken together, these can explain why heat index fluctuation seems to affect most of the female-headed households. Consistent with the literature, the demand for cleaner and safer energy sources moves positively with income. The study also found that income's impact on households' electricity consumption is higher in female-headed households in rural areas and in male-headed households in urban areas and when the weather fluctuation is higher than normal.

Policy recommendations

Review the Rural Electrification Program

Persistent and increasingly above normal heat index can have severe health implications. With the patterns of weather fluctuations changing due to climate change, the government should make energy sources accessible to the greater population. It should not only continue but also evaluate programs on rural electrification and identify the barriers to electricity subscription. The government should also support alternative projects to generate electricity given that households located in geographically isolated and disadvantaged areas are highly unlikely to have the appropriate infrastructures to attract service providers. One possible project is the saline solution that can power lamps. The government should improve and upscale it to widen its scope and application.

If price is the barrier to subscription and subsidy is feasible, the government should carefully identify subsidy recipients to minimize leakages. This study found that weather fluctuations affect female-majority households with female heads most in terms of electricity consumption. The study not only provides support for the widely held belief that weather fluctuation and climate change affect women more but also identifies possible additional requirement for eligibility to subsidies.

Address the gaps in employment policies

Some information on gender equality in the country become relevant to a conversation that attempts to speak to policies on gender in the context of energy use and weather shocks. While the government has achieved substantial progress toward gender equality in education, labor market returns are still lower for female. The Asian Development Bank (2013) finds that the gender–wage

gap that takes into account human capital gender differences is between 23 percent and 30 percent, an indication of high gender inequality. Female labor force participation rate is consistently lower than male labor participation rate as well.

Based on the 2016 Central Intelligence Agency World Factbook, the country has the highest fertility rate in the Southeast Asian region at three children born per woman. Evidence shows that low labor force participation rate is correlated with high fertility rate (Orbeta 2005). Child-bearing and child-nurturing responsibilities that typically fall under the women's sphere of responsibility likely result in the gap on women's labor market participation and in women choosing informal labor market arrangements that are likely to have lower returns.

Despite the passage of the Magna Carta for Small, Micro and Medium Enterprises, gaps in access to credit and technical skills to support entrepreneurs, who are mostly composed of women, are still apparent. The government should look into the issue of sustainability and upscaling of these enterprises. This study asserts that programs that can address these gaps can also be alternatives to intervention on energy prices. These have far-reaching implications on mitigation and adaptation to weather shocks and climate change because these can speak to the empowerment of men and women alike.

While evidence on the negative effects of poverty in female-headed households is thin and the results of the paper do not focus directly on this issue, poverty is a binding constraint to the adoption of cleaner, safer, and more efficient energy sources. In this respect, the internal and external convergence strategy of the Department of Social Welfare and Development is worth mentioning. This strategy intends to unify existing social protection programs, such as the *Kapit-Bisig Laban sa Kahirapan*–Comprehensive and Integrated Delivery of Social Services–National Community-Driven Development Program, the *Pantawid Pamilyang Pilipino* Program, and the Sustainable Livelihood Program, which has the microenterprise developments and employment facilitation tracks. The government should carefully evaluate this strategy in terms of its planning, implementation, and monitoring processes and impact.

Ensure availability of alternative energy sources

Van der Kroon et al. (2013) argue energy stacking is an inherent strategy of poor households especially in the rural areas, where irregular income flows deter the regular consumption of modern energy sources. As such, households' consumption of modern

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energy sources adjusts with income variability. In this regard, inadequate income appears to be a constraint for rural households' full transition to sophisticated modern energy sources. Weather deviations, however, are external challenges that households can address by the energy stacking strategy. This paper found links between electricity and charcoal consumption.

One possible policy concerning charcoal is to make it accessible by ensuring its steady supply. The government should support small enterprises related to charcoal making in rural areas.

Given the health concerns on charcoal use, the government can also explore addressing the constraints on supply and demand side of LPG use. It can address stove barriers or the issue of affordability of appropriate equipment by ensuring the presence of markets selling durable and affordable equipment related to LPG use.

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