



Cost Burden and Accessibility: Analysis of Indonesian Household Energy Expenditure

Audhi Ahmad Balya¹, Marcella Alike Hutabarat², Djoni Hartono³✉

Department of Economics, Faculty of Economics and Business, Universitas Indonesia^{1,2}

Research Cluster of Energy Modeling and Regional Economic Analysis, Department of Economics, Universitas Indonesia³

Article Info

History of Article

Received October 2018

Accepted December 2018

Published February 2019

Keywords:

accessibility and affordability, household energy, energy cost burden

Abstract

The main objectives of this study are to check whether Indonesian households suffer from energy poverty, which described as having to spend more than 10% of income for obtaining household energy, or not. This study also investigates the accessibility to certain modern energy accesses (LPG and Electricity) and the energy cost burden that Indonesian households must bear. Using data from SUSENAS 2014, this research is conducted by utilizing descriptive statistics analysis and Ordinary Least Square (OLS) estimation method to achieve the objectives. It was found that there is no single Island Cluster in Indonesia suffered from what is called energy poverty, as the average energy expenditure only vary between 4.47% (Bali and Nusa Tenggara Cluster) and 4.98% (Maluku-Papua Cluster). There are also significant differences in accessibility of modern energy and its relation to energy expenditure, especially in Maluku-Papua Cluster.

INTRODUCTION

Households in developing countries tend to spend higher amount of money proportionately to their total income compared to their counterparts in developed countries. For example, British households, spend around 4.4% of their income for the energy purpose, but households in other countries such as Bangladesh and India, respectively spend greater than 10% and 13.2% of their income to afford household energy (Barnes et al., 2010; Alkon et al., 2016). The difference of spending is an interesting issue to learn as people's decision to spend income could give information regarding their household economy.

In the United Kingdom, Fuel Poverty (or Energy Poverty) is defined as the need to spend more than 10% of household income for all energy use to maintain a satisfactory heating regime and other energy services (Rosenow et al., 2013). This 10% rule was previously introduced by Broadman (1991) as a specific definition of energy poverty. Thus, if majority of people in a country have to bear 10% or more, by Broadman standard they can be considered as people who suffer from energy poverty.

This also raises a concern in many developing countries; the distribution of government services is often not spread evenly. A state or a province could have abundant public services provided by the government while the other areas, especially the far away, could have none of it. Indonesia, classified as a developing country, also has that problem. Bhinadi (2003) stated that in sense of capital, provinces in Java Island are developing faster than those outside the island. This phenomenon could lead to disparity in many aspects, including people welfare. There are several reasons why people's decision to allocate and distribute their income to acquire energy should not be ignored. For instance, Alkon et al. (2016) described that there would be a huge opportunity cost for people to use modern energy if the cost was too high. If energy cost is considered too high for Indonesian people, which notably is a developing country with medium-to-low GDP per capita, policy

makers should consider creating a policy which could improve energy affordability. This topic is intriguing as households, in this case is Indonesian households, must decide how much they spend on energy. The consumers' preferences would have a significant impact on their socioeconomic benefits of energy access. For instance, if the energy is accessible yet the level of energy expenditure is low, then it could be assumed that people will not appraise modern energy even though the energy is accessible, except if a government subsidy is present and would lower the price heavily. On their side, if the people expenditure is high, it could be assume people will undergo numerous opportunity cost as they prefer to acquire such modern energy rather than spend it anywhere else.

Indonesian government has quite successfully introduced the modern energy such as electricity and LPG; and there are several researches showing that electrification is generally perceived as necessary commodity that has clear benefits (Bernard, 2010), and Kerosene to Liquid Petroleum Gas (LPG) conversion program result is socio-economically pleasing (Adadari, 2014). There is small to none research showing how consumption behavior had changed as modern energy came in. Modern energy is more efficient and usually more expensive than the less-modern alternatives, which means there is more opportunity cost if one decides to acquire them. While off-grid-electricity does increase household energy expenditure directly as they do not directly substitute other goods and have specific mean of usage, LPG's presence directly substitutes less-sophisticated energy sources such as kerosene and firewood; this means there will be a change of how a household will allocate their budget. As energy is considered as a basic need, it would be interesting to understand how people allocate their money, and how people's preference in allocating money changes over time. Plenty of research discussed how modern energy access could improve society life of both developing and developed countries, but only few discussed how people faced problems of accessibility and affordability of energy. Alkon et al. (2016) did

similar research on how population in India endured the burden of energy expenditure. This research was conducted in India using National Sampling Survey data from 1950 to 2010; it showed that generally in rural areas, energy cost burden was increasing while in urban areas the energy cost burden was decreasing. In Indonesia, Budya and Arofat (2011) showed that LPG program generated substantial benefit for the government as they no longer need to subsidize kerosene, which led them to save almost US\$ 3 Billion by May 2010; the business community – as this policy – created new jobs; the environment – as this conversion – lowered the gas house emission; and the end users – as in the long run – lowered the energy economic price, and fact that the majority of users perceived the use of LPG as positive in term of safety, ease of use, and expectations about future availability.

Therefore, this study attempts to acquire information of energy cost burden and to understand relationships between modern energy access, household expenditure, and energy cost burden at households' level in Indonesia.

While this research is heavily based on the study of Alkon et al. (2016), there will be several distinguishing features in this paper. First, in addition to using rural and urban classifications, this study also adds Island Cluster classification, which is classification of Island and Province in Indonesia into six main Clusters, namely Sumatera Cluster (all Province in Sumatera Island, including Province of Kepulauan Riau and Province of Bangka Belitung); Java Cluster; Balnusra Cluster (which stand for Bali and Nusa Tenggara Island); Kalimantan Cluster; Sulawesi Cluster, and Maluku-Papua Cluster. This clustering is intended to simplify the result, since to some extent, the socio economy between each urban and each rural area in those clusters are similar, furthermore, the SUSENAS database itself is using similar approach to group their data.

Another distinguish feature from study of Alkon et al. (2016) is instead of using India, the study takes Indonesia as the main research subject. Moreover, there is a limitation in this

study, as SUSENAS data are used, the study does not capture the energy that is produced at home and the transportation cost. Hence this paper output might be understatement in sense of the opportunity cost that the people must sacrifice to create a house-made energy source. This study also does not capture the fix cost of household energy, such as electricity installment or LPG tube initial purchase, as the SUSENAS did not capture such data.

RESEARCH METHODS

National Socioeconomic Survey (SUSENAS) is a series of socioeconomic survey in Indonesia which is annually conducted from 1963. SUSENAS consists of questionnaires which question information such as sex, age, marital status, and education of a household member, as well as economic-related questions such as source of income and expenditure both in total and, while only conducted triennially, also expenditure in each goods category. For this research purpose, this study is using SUSENAS 2014, with data sourcing from both income and expenditure dataset.

To measure the energy cost burden of Indonesian households, this study analyzed data regarding numbers of energy consumed, price being paid, and total expenditure from respondents. Then, using those previous mentioned data, the energy cost burden was calculated by following equation directly derived from Alkon et al. (2016) equation.

$$\text{Energy Cost Burden} = \frac{\text{Energy Expense}}{\text{Total Expense}}$$

The result of previous equation will be between 0 and 1. As energy cost burden is described as a percentage of energy expenditure to the total expenditure, it could be inferred that a high value of energy burden means that the affordability of those households' energy goods is low. Changes in energy cost burden could be explained by two ideas; if the cost burden is low, it could be because the energy expenditure has lowered, or because the total expenditure has increased, vice versa.

The second equation below is directly derived from Alkon et al. (2016) study, which aimed to understand the function of Energy Expenditure from the described dependent variable. However, the previous results showed that the energy cost burden could not be used as a dependent variable and the household total expenditure as an independent variable, because both variables are directly tied to household expenditure function.

On the other hand, this present study can use energy expenditure as a dependent variable and a function of non-energy expenditure, which makes the non-energy expenditure can be used as independent variable. The reason why household energy expenditure is a function of non-energy expenditure is that the energy expenditure is a part of total expenditure, while the non-energy expenditure provides an insight on a household degree of welfare. Another idea is that this study wants to identify energy expenditure to accessibility of modern energy sources, such as LPG and Electricity. As well as several obsolete energy source such as kerosene, charcoal, and firewood, and other less widely used energy sources such as city gas network and electricity from diesel-fueled generator.

Finally, the model to be used is listed as follow:

$$\begin{aligned} \text{Log}(EE)_i &= \beta_0 + \beta_1 * \text{Log}(NEE)_i + \beta_2 * LpA_i \\ &+ \beta_3 * ELA_i + \beta_4 * CGA_i + \beta_5 * KEA_i + \beta_6 * GEA_i \\ &+ \beta_7 * CCA_i + \beta_8 * FWA_i + \beta_9 * HHM_i + \beta_{10} \\ &* HHA_i + \beta_{11} * HHG_i + \beta_{12} * \text{Log}(IFS)_i + \epsilon_i \end{aligned}$$

Energy Expenditure is gathered from the amount of money spent by a family yearly, to gather modern energy such as Electricity & LPG, as well as considerably less-sophisticated energy sources as firewood and kerosene. Since the data are there, the study put the amounts of gasoline or diesel purchased that were used exclusively for Local Generator. Non-Energy Expenditure is a variable gathered from the number of total expenditure that a family had for a year and subtracted them with the number of energy expenditure. Later, both of these variables were

turned into log function to make the data smoother.

Energy Accessibility is a set of data capturing whether a family uses a certain household energy source or not as one of their energy sources. Hence, 1 is used as an indicator that this family is using the mentioned energy sources. The reason why this study uses Household members of a Nuclear family, or a family that consists of only pair of parents and their offspring, is due to the theory telling it consumes smaller amount of energy than the extended family, or a family that is not only consist of couple and its descendant but might as well parents and siblings of the couple.

Another explanatory variable, Head of Household's Age, can be described that households with older average age might stay with older technology such as kerosene and firewood, unlike their younger counterparts that tend to use more modern energy such as electricity and LPG. Gender of the Household's head could also lead to different form and composition of expenditure that might also affect energy expenditure as well.

Lastly, in-House Floor Size, which reflects the actual size of the house itself, is used as explanatory variable since there is tendency that when the house is larger, the amount of energy that consumed by the household is likely to increase compared to those who have average sized house. Table 1 below describe each variable with its own explanation and unit that is used in this research, it should be noted that table below also explain the subscript *i* that in the model is used to mark identity of household that included into the equation. This research entirely utilizes multiple regressions using Ordinary Least Square (OLS). OLS is a parameter estimation method by minimizing number of quadratic values between real data and the estimated data. It should be noted that Variable of Energy Expenditure (EE), Non-Energy Expenditure (NEE) and In-floor Size (INF) is converted into log function in order to make more symmetric distribution. On the other hand, Accessibility variable is kept in binary form of 0 and 1, which the reason was previously described.

Table 1. Explanatory of Variable for Regression Model

Variable	Explanation	Units	Variable	Explanation	Units
EE	Energy expenditure	IDR	HHM	Household members	Person
NEE	Non-energy expenditure	IDR	HHA	Head of Household's Ages	Years
LpA	LPG Accessibility	Indicator	HHG	Head of Household's Gender	Indicator
EIA	Electricity Accessibility	Indicator	IFS	In-house floor size	m2
CGA	City-Gas Accessibility	Indicator	ϵ	Error term	
KEA	Kerosene Accessibility	Indicator			
GEA	Fuel Accessibility	Indicator	Subscript	Explanation	
CCA	Charcoal Accessibility	Indicator	i	Household Identity	
FWA	Firewood Accessibility	Indicator			

Source : Primary Data

RESULTS AND DISCUSSION

Using Broadman standard, this paper analyze whether Indonesia or any of its Clusters suffer from Energy Poverty. To answer those question, Figure 1 illustrates the cost burden in every Island Cluster in Indonesia, while Table 2 explain the data more precise.

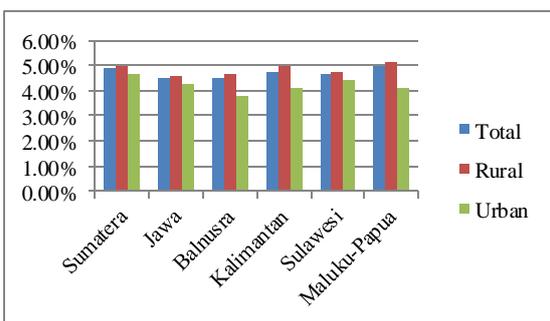


Figure 1. Energy Cost Burden in Indonesia
Source: Author Calculation

Figure 1 shows how each Island Cluster bears their energy cost. With average of 4.72%, the energy cost burden for each Island Cluster in

Indonesia is more or less the same. Balnusra Cluster bears the least energy cost burden (4.47%) while Maluku-Papua Cluster bears the most (4.98%). Furthermore, when observations are divided into urban and rural levels, it was found that there is difference is not that notorious, with average of 4.84% for rural areas and 4.23% for urban areas.

The above figure clearly shows that none of any cluster suffers from what is called as energy poverty based on Broadman definition, or the 10% rule. The explanation for this phenomenon, as argued by Hidetoshi, Chiharu, & Yumiko (2008) is that people in tropical country such as Indonesia does not consider heating furniture (fireplace or electrical heating tools) to warm the house as necessary, since winter is practically non-exist in such countries. It is true some of the household in tropical countries also utilize several temperature-changer tools such as hot water shower or air conditioner that notoriously require a lot of energy.

However, the number of people that utilize such tools is relatively small compare to the population itself since such facilities is not necessary, as well as a fact that those tools mostly

used by people that can afford such lifestyle. Therefore, it can be inferred that most of the energy demand is come from necessity for cooking.

Table 2. Detailed Data of Energy Cost Burden in Indonesia

Region Classification	Sumatera	Java	Bali - Nusa Tenggara	Kalimantan	Sulawesi	Maluku -Papua
Total	4.92%	4.51%	4.47%	4.76%	4.68%	4.98%
Rural	5.01%	4.6%	4.46%	4.95%	4.73%	5.25%
Urban	4.68%	4.29%	3.79%	4.12%	4.39%	4.10%

Source: Author Calculation

Table 3 shows a breakdown on how much people in each island cluster spend their energy expenditure on each item of energy source. For instance, average household in Sumatera cluster allocate 2.79 % of their total expenditure to afford on-grid electricity, while household in Balnusra cluster spend only 1.83% of their total expenditure to afford on-grid electricity.

Even though it looks simple, the above table has a quite strong message: whilst the average of energy expenditure is not quite different from each island clusters, the

composition itself can be vary. For example, average household in Balnusra cluster only need to allocate 1.83% of their expenditure for purchasing on-grid electricity, while their counterpart in Java cluster have to allocate 2.68% of their expenditure to enjoy electricity. However, the contrast is applied to Kerosene, as average household in Java cluster only allocate 0.03% of their expenditure for purchasing Kerosene, while Balnusra cluster allocate 0.65% of their expenditure to afford energy source in form of Kerosene.

Table 3. Household Budget Share for 2014

Budget Share	Sumatera	Java	Bali - Nusa Tenggara	Kalimantan	Sulawesi	Maluku-Papua
Non-Energy	95.08%	95.49%	95.53%	95.24%	95.32%	95.02%
Electricity	2.79%	2.68%	1.83%	2.39%	2.26%	1.86%
LPG	0.95%	1.20%	0.48%	0.82%	0.81%	0.03%
City Gas	0.00%	0.01%	0.00%	0.01%	0.00%	0.00%
Kerosene	0.40%	0.03%	0.65%	0.67%	0.65%	1.22%
Generators' fuel	0.13%	0.01%	0.03%	0.43%	0.06%	0.24%
Charcoal	0.01%	0.00%	0.00%	0.00%	0.04%	0.00%
Firewood	0.63%	0.58%	1.48%	0.44%	0.86%	1.64%

Source: Author Calculation

There are several other variables that affecting the decision to allocate energy expenditure on certain energy sources, such as accessibility to those

energy source as well as lack of accessibility to other alternative energy source. The aforementioned phenomenon will later be explained by Table 4.

Table 4. Energy Accessibility 2014

Budget Share	Electricity	LPG	City Gas	Kerosene	Generator s' fuel	Charcoal	Firewood
Sumatera	95.08%	64.23%	0.39%	23.12%	2.57%	1.04%	40.04%
Java	99.69%	77.82%	0.32%	1.62%	0.17%	0.14%	34.28%
Balnusra	90.75%	38.10%	0.07%	38.22%	0.55%	0.23%	59.24%
Kalimantan	89.53%	57.49%	0.37%	39.41%	5.09%	0.68%	38.41%
Sulawesi	93.06%	53.57%	0.17%	35.46%	1.18%	2.59%	59.68%
Maluku-Papua	60.83%	0.75%	0.08%	64.69%	2.39%	0.04%	66.78%

Source: Author Calculation

There is certain link on how accessibility affecting expenditure. Since household, or people at general, need to able to access goods first before they decide to purchase. Therefore, deconstructing the accessibility of various energy sources in each Island cluster, as described in Table 4, would provide important explanations since it shows how much sample in the data that has access to such energy source. The parameter of accessibility itself is when a household are spending money to purchase particular energy source, therefore they have access to those energy source. For example, value 95.08% of electricity accessibility in Sumatera cluster mean that 95.08% of household in those cluster regularly allocate some of their expenditure to purchase electricity.

Accessibility of on-grid electricity across island clusters is remarkably the highest among other energy sources, with exception of Maluku-Papua cluster. This implies that while Java cluster has almost 100% accessibility to the electricity, the same could not be said for Maluku-Papua Cluster, as the accessibility of electricity only 60.83%. Hence we could assume that there is a striking disparity between on-grid electricity accessibility

Disparity between LPG accessibility across island clusters is even worse, as Java cluster has more than 77% accessibility to the electricity; the same could not be said for Maluku-Papua Cluster, as the accessibility of electricity only 0.75%. City Gas Network, a

relatively quiet modern energy source, has not readily accessible to the most household across all island cluster in Indonesia. This was shown by the fact none of the cluster has accessibility beyond 0.5%. The highest is Sumatera cluster with accessibility of 0.39%, followed by Kalimantan cluster with accessibility of 0.37%

While Kerosene is supposedly replaced by LPG by convention programmed in 2008 (Budya and Arofat, 2011), most of household in island cluster but Java cluster have a high accessibility to the Kerosene. Thus, this implies that while Maluku-Papua has low accessibility for LPG, they still have a quite high accessibility for Kerosene, vice versa.

Diesel-fueled Generator have relatively low accessibility across island cluster with the highest accessibility is Kalimantan, followed by Sumatera cluster, and the least is Java Cluster and Balnusra Cluster. The assumption is that due to vast land that exist in both Kalimantan cluster and Sumatera Cluster, some isolated household still rely on Diesel-fueled Generator to access electricity, but future study is needed to clarify this assumption.

Charcoal in other hand is very vary between island clusters. Maluku-Papua cluster accessibility to this particular energy source is 0.04%, while their neighbor, Sulawesi cluster, has as much as 2.59% accessibility toward charcoal. This condition is quite odd since both clusters has close geography location. Lastly, while the modern energy source such as on-grid

electricity and LPG are available, this energy source still unable to substitute firewood availability as energy source. For example, despite household in Java cluster are having highest accessibility to LPG and on-grid

electricity, their accessibility to Firewood is still as high as around 34%. However, Maluku-Papua that has worst modern energy source accessibility in both of on-grid electricity and LPG, still rely heavily to firewood with accessibility of 66.78%.

Table 5. Regression Analysis in Island Clusters and National

Independent Variable	Sumatera	Java	Bali – Nusa Tenggara	Kalimantan	Sulawesi	Maluku-Papua	National
NEE	0.5500*** (0.005)	0.5595*** (0.004)	0.5890*** (0.010)	0.5897*** (0.008)	0.6237*** (0.006)	0.8480*** (0.012)	0.5728*** (0.003)
LpA	0.1741*** (0.006)	0.2751*** (0.006)	0.1264*** (0.010)	0.2233*** (0.012)	0.2280*** (0.009)	0.4661*** (0.065)	0.2230*** (0.004)
EIA	0.2047*** (0.013)	0.5182*** (0.052)	0.1730*** (0.014)	0.2080** (0.018)	0.1978*** (0.014)	0.0833*** (0.017)	0.1627*** (0.007)
CGA	0.2897*** (0.039)	0.4657*** (0.036)	0.2416*** (0.015)	0.4470*** (0.040)	0.2733*** (0.068)	0.3744** (0.016)	0.3951*** (0.026)
KEA	0.2086*** (0.005)	0.4262*** (0.019)	0.2459 -0.152	0.2533*** (0.011)	0.3943*** (0.009)	0.0228 -0.017	0.2698*** (0.004)
GEA	0.6453*** (0.019)	0.6438*** (0.058)	0.5461*** (0.046)	0.9848*** (0.025)	0.6034*** (0.034)	0.7600*** (0.034)	0.7311*** (0.013)
CCA	0.2175*** (0.022)	0.0547 -0.04	0.1366*** (0.047)	-0.0453 -0.035	0.0598*** (0.016)	0.1141*** (0.188)	0.1410*** (0.013)
FWA	0.0077 (0.005)	0.1242*** (0.005)	0.1630*** (0.013)	-0.0873*** (0.008)	-0.0621*** (0.007)	0.0424*** (0.015)	0.0703*** (0.003)
HHM	-0.0036* (0.002)	0.0093*** (0.001)	0.0020 -0.003	-0.0014 -0.003	-0.0014 -0.002	-0.0365*** (0.003)	0.0025*** (0.001)
HHA	0.0018*** (0.000)	0.0037 (0.000)	0.0031 (0.000)	0.0027 (0.000)	0.0027 (0.000)	0.0040 (0.000)	0.0031 (0.000)
HHG	-0.0398*** (0.007)	0.0040 -0.005	-0.0163 -0.01	0.0043 -0.007	0.0043** (0.010)	-0.0356* (0.018)	-0.0112*** (0.004)
IFS	0.1674*** (0.005)	0.1841*** (0.003)	0.1953*** (0.009)	0.1697*** (0.008)	0.1697*** (0.006)	-0.0337*** (0.010)	0.1778*** (0.002)
Observation	81616	93160	22,248	28,041	37237	20293	282595
R ²	0.4717	0.543	0.5117	0.5196	0.503	0.447	0.527

Dependent Variable: Energy Expenditure (in natural logarithms)

Standard errors are reported in parentheses

*, **, *** indicates significance level at 90%, 95% and 99%, respectively

As previous Table describing both profile of accessibility and expenditure of household across island cluster in Indonesia. Table 5 shows the result of Regression Analysis in Island Clusters and National, which show on how

accessibility to particular energy source will affect the household expenditure as a whole. The numbers of observation vary for each cluster. The coefficient of R² or the ability of independent variable variance in explaining the dependent

variable variance also varies, with the lowest coefficient is 44.7% for Maluku-Papua cluster, and the highest coefficient is 54.3% for Java cluster. There will be explanations for each independent variable to better explain about energy expenditure in Indonesia.

First, Non-Energy Expenditure, in this case, is consistent in all areas which is positive and statistically significant. However, Maluku-Papua cluster have higher value coefficients than other islands (0.848), followed by Sulawesi Cluster (0.624). This could mean that in Maluku-Papua cluster and Sulawesi cluster, the value of non-energy expenditure is more affecting the energy expenditure than their counterparts in the other islands. However, this statement must be taken with caution as the coefficient of R^2 in Maluku-Papua Cluster is smaller (0.447) than their counterparts in other islands cluster or the national average itself (0.527).

Next, LPG accessibility is also consistent in all areas; it is positive and statistically significant. Yet, the LPG accessibility coefficient indeed varies across areas. In Maluku-Papua Cluster, using LPG will increase the Energy expenditure as much as 46.6%; while in Balnusra cluster, using LPG will only increase the energy expenditure by 12.64%. This result imply that utilization of LPG in Maluku-Papua cluster is rather more expensive and tend to greatly affecting the composition of energy expenditure and non-energy expenditure than other island clusters. It should be noted that for people that lived in Java cluster, which often considered as most developed cluster in Indonesia, utilization of LPG is more likely to increase their level of energy expenditure than in Balnusra Cluster, which has more scattered region due to its geographic condition

Electricity Accessibility is consistent in all areas, which is positive and statistically significant. But Electricity accessibility coefficient indeed varies across areas. Even though in Kalimantan Cluster, accesibility to energy is only significant in confidence level of > 0.05 , it is still statistically significant. Java Cluster should be given a special attention as when its people are using electricity, the energy

expenditure will likely to increase as much as more than 50% compared than those who do not, and Maluku-Papua Cluster has the lowest with only increase of 8.33%. This phenomenon might be explained by the fact that while people in Java cluster have high accessibility to electricity, they might use numerous of electronic device such as Television, Refrigerator, Air Conditioner as well as other goods that drain electricity tremendously, compared to those who lived in Maluku-Papua cluster which only use basic electrical tools such as light and electronical device charger. However, a further research is required to explain this phenomenon more comprehensively

The next variable is City Gas. In Maluku-Papua Cluster, the City gas seems significant only on confidence level of > 0.05 , compared to the other of > 0.01 . This might due the fact that city gas network is not well developed and well utilized in those clusters, since infrastructure that needed to made city gas network available is quite tremendous and require great amount of investment. Nevertheless, City gas is still considered as positive and statistically affects significantly on the energy expenditure on every cluster as well as in national level. This variable seems quite vary in number, but not notoriously different from each other. The lowest coefficient is Balnusra Cluster with 0.2415, The number could be perceived as that if a household is using City Gas then the energy expenditure will likely to increase more than around 24% and the highest coefficient is Kalimantan Cluster, with coefficient of 0.4470, meaning that if a household is using City Gas then the energy expenditure will likely increase around 44%.

Kerosene is an insignificant variable in two island clusters; they are Balnusra Cluster and Maluku-Papua Cluster. On the other hand, in other places, this variable is positive and statistically significant associated with energy expenditure. The highest coefficient is Java Cluster with 0.4262. The number means that if a household is using kerosene then the energy expenditure will likely increase 42.62%. In Sumatera Cluster the coefficient is 0.2086. This means that, in Sumatera Cluster a household will

only likely to suffer 20.86% increase of energy expenditure. This also implies that somehow using kerosene in Java cluster is more expensive and less economical. This might be because of the government's previous intervention to substitute kerosene and change it with LPG, thus made the kerosene more expensive as described in Andadari, Mulder, and Rietveld (2014).

Table 5 describes that if a household is using generator as their source of energy, it will be financially exhaustive, while the entire model shows that its association with energy expenditure is positive and statistically significant. The lowest coefficient is 0.5461 in Balnusra Cluster, which means that if a family uses diesel-fueled generator as their energy source, their energy expenditure will likely to jump to 54,6% more than it used to be, while the highest one is in Kalimantan Cluster, with a coefficient of 0.9848, with the same explanation/

Charcoal accessibility (CCA) is insignificant in two Island Clusters – Java Cluster and Kalimantan Cluster; while in other Island Clusters, this variable is positive and statistically significant associated with the energy expenditure. The highest coefficient is Sumatera Cluster with 0.2175. The number indicates that if a household in Sumatera Cluster is using charcoal then the energy expenditure will increase by 21.75%, while in Sulawesi Cluster a household will only suffer for 5.98% increase of Energy Expenditure. The national coefficient for charcoal is 0.1410.

Next variable is Firewood. Surprisingly, Firewood is a variable which generally only affects the energy expenditure in small or even negative ways. While it is not statistically significant in Sumatra, it is statistically significant affecting the energy expenditure in other Clusters. Balnusra Cluster, for example, has a coefficient of 0.1630, meaning that if a household in Balnusra Cluster uses firewood, the energy expenditure will increase by 16.3%. However, there are two Islands Clusters with negative signs; they are Kalimantan Cluster and Sulawesi Cluster. The negative significant coefficient means that when a household uses firewood as the energy source, their energy expenditure is lower

than before they use it. For example, if a household in Kalimantan Cluster uses firewood, then the energy expenditure will decrease by 8.73%. In other hand, if, if a household in Sulawesi Cluster uses firewood, then the energy expenditure will decrease by 6.21%.

The difference of coefficient and statistical significance quite vary when describing the control variable in each island. First, the number of household members does give significant positive results in Sumatera Cluster, Java Cluster, Balnusra Cluster and Kalimantan Cluster; while it gives a significant negative result in Maluku-Papua Cluster; meaning that an addition of 1 household member will eventually increase energy expenditure in Sumatera Cluster, Java Cluster, Balnusra Cluster, and Kalimantan Cluster but decrease the energy expenditure in Maluku-Papua Cluster. However, it is entirely different story for Sulawesi Cluster, as the variable here does not give any significant result. The result is also different in the variables of average household age, household head gender, and in-floor size. The average household age is only significant in Sumatera Cluster. Household head gender is only significant in Sumatera Cluster, Sulawesi Cluster, Maluku-Papua Cluster, also with varying effects and significance levels. Last, in-floor size is significant in all island clusters with almost all of it have positive effect except for Maluku-Papua Cluster.

This study found several things that are inherently different from Alkon et al. (2016) on similar research in India. Indonesian Households, on average, must spend 4.7% of their income to afford household energy. Provincial average of energy cost burden for Indonesian families, at its highest, is only about 5.89% which occurred in the Province of East-Java. On the level of Island Cluster, Java Cluster population happened to bear the highest cost burden which is 5.48%. It can be concluded that cost wisely, energy poverty is not a chronic phenomenon that occurred in Indonesia as it does not pass the Boardman's energy poverty threshold of 10%.

Based on the information revealed in Table 4, the top energies that Indonesians have

the accessibility are Electricity, LPG, Firewood, and Kerosene. While the rest, such as fuel for Generator, City Gas and Charcoal are only used by around 1% of population. Although Firewood and Kerosene are not considered as modern energies, they are still used by respectively, 39.56% and 14.05% of population. In Java Cluster only few people use kerosene, but in virtually every other place but Java Cluster, the accessibility of kerosene is high, even in Maluku-Papua the accessibility is still as high as 64.69%. Looking upon the pattern of accessibility of LPG and kerosene, the study can confirm Budya and Arofat (2011) research that indirectly stated Kerosene and LPG as Substitute goods.

Kerosene, LPG, and Electricity are among the most expensive energy sources, as in Indonesia data, when someone uses kerosene as a source of household energy, the addition energy cost that they must bear is an additional 26.98% of Energy burden; while cost for LPG accessibility is additional 22.3% of energy burden. Moreover, electricity is just an additional of 16.27% from the energy cost burden. With considerations that LPG and Kerosene are substitute goods, but electricity is not substitutable by neither LPG nor Kerosene. Improving the accessibilities of modern energy source such as LPG and Electricity is an efficient option for the people.

CONCLUSION

It was found that Indonesia households - cost wisely - do not suffer from the energy poverty. With national average of energy cost burden just lurking at 4.72%, there is still tremendous gap between the current conditions to the Boardman's 10% threshold for energy poverty. However, while energy poverty does not happen in Indonesia, there are differences regarding energy accessibility in every Island Cluster. As for modern energy, there are striking differences in LPG accessibility between households in Maluku-Papua Cluster and in other Island Clusters, as Maluku-Papua Cluster bears more cost burden than other Island Clusters. However, for electricity, Java Cluster as

the most developed Island Cluster in Indonesia bears the highest cost burden while Maluku-Papua Cluster is the least.

Speaking about modern energy access, despite the monetary cost of purchasing LPG and Electricity is more expensive than traditional energy sources such as firewood, but the trend of using those modern energy sources is increasing overtime. The less sophisticate energy such as kerosene starts to be abandoned overtime due to fact that it increases the energy cost burden heavily when it is being used.

A further step that the government should consider is to increase modern energy accessibilities of electricity or LPG, which might include the City Gas. Although the city gas is considered expensive, but Indonesia still has a wide gap of energy expenditure to be filled before the energy is considered too expensive, since it is widely agreed that accessibility to modern energy source will improve the household live quality and overall prosperity. Hence, any effort of energy modernization is necessary and has no issue in term of the expenditure since the Indonesia household still have relatively low burden on energy expenditures and its allocation.

REFERENCES

- Alkon, M., Harish, S., & Urpelainen, J. (2016). Household energy access and expenditure in developing countries: Evidence from India, 1987-2010. *Energy for Sustainable Development*, 25-34.
- Andadari, R. K., Mulder, P., & Rietveld, P. (2014). Energy poverty reduction by fuel switching. Impact evaluation of the LPG conversion program in Indonesia. *Energy Policy*, 436-449.
- Bernard, Tanguy. "Impact Analysis of Rural Electrification Projects in Sub-Saharan Africa." *The World Bank Research Observer* (2010): 33-51.
- Bhinadi, Ardito. (2003). Disparity in Java's Economic Growth with Outside Java. *Journal of Development Economics*. UII Yogyakarta, 39-48
- Broadman, Brenda (1991) *Fuel Poverty: From Cold Homes to Affordable Warmth*. John Wiley & Sons Ltd.
- Budya, H., & Arofat, M. Y. (2011). *Providing cleaner*

- energy access in Indonesia through the megaproject of kerosene conversion to LPG. *Energy Policy*, 39(12), 7575-7586
- Hidetoshi, N., Chiharu, M., & Yumiko, I. (2008). International Comparison of Household Energy Consumption. ACEEE Summer Study on Energy Efficiency in Buildings, 214-224
- Pye, S., Dobbins, A., Baffert, C., Brajković, J., Deane, P., & Miglio, R. D. (2015). Addressing Energy Poverty and Vulnerable Consumers in the Energy Sector Across the EU. *LEurope en Formation*, 64.
- Rosesnow, Jan, Reg Platt and Brook Flanagan. (2013). Fuel poverty and energy efficiency obligations – A critical assessment of the supplier obligation in the UK. *Energy Policy* 62 1194–1203.
- Schuessler, Rudolf. (2014). Energy Poverty Indicators: Conceptual Issues - Part I: The Ten-Percent-Rule and Double Median/Mean Indicators. Center for European Economic Research Discussion Paper No. 14-0371.