Etikonomi
Volume 18 (2), 2019: 169 - 184
P-ISSN: 1412-8969; E-ISSN: 2461-0771

Impact of Changes to Subsidized Electricity Tariffs on The Welfare Of Households

Andri Yudhi Supriadi[1*], Mohamad Ikhsan[2], Benedictus Raksaka Mahi[3], Montty Girianna[4]
*Corresponding author

Abstract. *The subsidized electricity tariff enjoyed by households in Indonesia with an installed capacity of 450 VA and 900 VA has not changed since mid-2003. This subsidy creates an increasing economic burden on the state budget. This study examines the impact of a subsidized electricity tariff increase on subsidized household welfare and the redistribution of subsidy allocation. The analysis divided into two stages: first, estimating household electricity demand for each household group when prices fixed; and second, measuring changes in welfare, inefficiency and the redistribution of subsidy allocations. This empirical study shows that an increase in tariffs causes the welfare of subsidized households to decline. It also demonstrates inefficiency in the allocation of subsidies to the top 20% group with an installed capacity of 450 VA. Besides, subsidized households in the lowest 40% group, which initially only enjoyed 26.26% increased to 34.16% after the tariff increase. On the other hand, the top 20% group, which initially enjoyed the electricity subsidy allocation of 28.74%, decreased to 20.40% after the tariff increase.*

Keywords: *household electricity demand, fixed price, subsidy, welfare, subsidized electricity tariff*
JEL classification: D1, D3, D6, I3

Abstrak. *Tarif listrik bersubsidi yang dinikmati oleh rumah tangga dengan kapasitas terpasang 450 VA dan 900 VA tidak berubah sejak pertengahan tahun 2003. Hal ini membebani anggaran negara. Studi ini mengkaji dampak kenaikan tarif listrik bersubsidi terhadap kesejahteraan rumah tangga bersubsidi dan redistribusi alokasi subsidi. Analisis ini dibagi menjadi dua tahap: pertama, memperkirakan permintaan listrik rumah tangga untuk setiap kelompok rumah tangga ketika harga ditetapkan; dan kedua, mengukur perubahan dalam kesejahteraan, inefisiensi dan redistribusi alokasi subsidi. Studi empiris ini menunjukkan bahwa kenaikan tarif menyebabkan kesejahteraan rumah tangga bersubsidi menurun, juga menunjukkan inefisiensi dalam alokasi subsidi untuk kelompok 20% teratas dengan kapasitas terpasang 450 VA. Selain itu, rumah tangga bersubsidi dalam kelompok 40% terendah, yang awalnya hanya menikmati 26,26% meningkat menjadi 34,16% setelah kenaikan tarif. Di sisi lain, kelompok 20% teratas, yang awalnya menikmati alokasi subsidi listrik 28,74%, turun menjadi 20,40% setelah kenaikan tarif.*

Kata Kunci: *permintaan listrik rumah tangga, tarif tetap, subsidi, kesejahteraan, tarif listrik bersubsidi*

How to Cite:

Supriadi, A. Y., Ikhsan, M., Mahi, B. R., & Girianna, M. (2019). Impact of Changes to Subsidized Electricity Tariffs on the Welfare of Households. *Etikonomi: Jurnal Ekonomi.* Vol. 18 (2): 169 – 184. doi: http//dx.doi.org/10.15408/etk.v18i2.12041.

Received: July 25, 2019; Revision: September 09, 2019; Accepted: September 15, 2019
[1,2,3]Universitas Indonesia. Jl Prof. Dr. Sumitro Djojohadikusumo, Kukusan, Beji, Depok, Indonesia
[1] BPS-Statistics Indonesia. Jl. Dr Sutomo 6-8, Jakarta, Indonesia
[4]Coordinating Ministry of Economy. Jl. Lapangan Banteng Timur, No. 2-4, Jakarta, Indonesia
E-mail: [1]andriyudhis@gmail.com, [2]ican711@yahoo.com, [3]mahi@indo.net.id, [4]girianna11@gmail.com
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

Introduction

Electricity is one of the commodities still subsidized by the Indonesian government. Tariff subsidies are provided to State Electricity Enterprise (PLN) customers with an installed capacity of 450 VA and 900 VA[1]. Households with an installed capacity of 450 VA enjoy a higher subsidy allocation per kWh than those with an installed capacity of 900 VA.

Since mid-2003, the subsidized electricity tariff has not changed. Rising input prices (mainly fuel prices) have caused the burden of subsidies[2]. A 'subsidy' is the difference between the basic cost of electricity production and tariff. In the Indonesian budget (APBN) to be more onerous as tariff increases do not accompany the basic cost of electricity production. Increasing the allocation of energy subsidies (including electricity therein) will reduce the budget allocation for other essential expenditures such as education, health, and infrastructure (Diop, 2014). Given the critical role of education, health and infrastructure in the process of poverty reduction (Kanagawa & Nakata, 2006), in the short-term, the policy of raising subsidized electricity tariffs effectively reduces the allocation of electricity subsidies in the APBN.

However, changing the policy to raise the subsidized electricity tariff is not an easy thing. The study of Makmun & Abdurrahman (2003) shows that an increase in basic electricity tariffs has a negative impact on the real income of the community. The decline in real public realization causes the purchasing power of the people to decline. The decrease in purchasing power that is not accompanied by income improvements potentially increases the number of poor households (Ikhsan & Purbasari 2012). Therefore, the Government is very cautious when it comes to deciding on a tariff policy for subsidized commodities. This paper analyses the impact of subsidized tariff changes on the welfare of households receiving subsidies and the redistribution of subsidies between household groups.

Studies on the impact of price changes on welfare generally use macro data and time-series data. The data are used to construct a demand for electricity that will then be used to analyze changes in welfare due to price changes (Filippini 1999; Kamerschen & Porter 2004). The alleged parameters obtained from the macro model (elasticity of expenditure and price elasticity) are assumed to be constant and ignore the characteristics of each household/individual. The difference in characteristics will lead to different consumption behavior. Therefore, it takes a micro model to capture the characteristics of households/individuals to explain consumer behavior.

In micro studies, the impact of price changes (subsidizing) energy on household welfare generally assumes that energy prices change during the observation period (Renner et al., 2015; Araghi & Barkhordari 2012). When the price/tariff does not change during the observation period, then the pattern of demand is observed through the pattern of expenditure (Leser, 1963). BuShehri & Wohlgenant (2012) adopted the Leser model to observe electricity demand patterns in Kuwait. Furthermore, the results of the model are

[1] Households with an installed capacity of 450 VA enjoy a higher subsidy allocation per kWh than those with an installed capacity of 900 VA.

[2] A 'subsidy' is the difference between the basic cost of electricity production and the tariff.

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

used to measure changes in household welfare as a result of changes in electricity tariffs/ subsidies.

This study adopted the BuShehri & Wohlgenant models to analyze changes in household welfare due to subsidized electricity tariff increases through changes in consumer surplus (welfare loss). The analysis divided by the installed capacity (i.e., 450 VA and 900 VA), and expenditure groups (40% lower, 40% medium and 20% upper). The above distinction made with the following considerations: First, the subsidized power tariff for an installed capacity of 450 VA and 900 VA is different, and each price is unchanged; Second, the determination of subsidized electricity tariff is provided only based on installed capacity and not provided under the category of 'poor.' Besides, State Electricity Enterprise (PLN) has never verified whether each customer with an installed capacity of 450 VA and 900 VA comes under the 'poor' category or not. Thus, there are characteristic differences between expenditure groups in the same installed capacity.

The remainder of this paper is structured as follows: Section 2 explains the data and model specification. Section 3 applies the theoretical findings to Indonesia micro-level data. Section 4 summarises the results and presents concluding remarks.

Methods

$$share_{ij,G} = \alpha_{i,G} + \sum_{G=1}^{3}\sum_{j=1}^{n}\delta_{j,G}\,D_{j,G} + \beta_{i,G} ln(Expend)_{j,G} + \sum_{G=1}^{3}\sum_{j=1}^{n}\gamma_{j,G}\left[ln(expend)_{j,G} * D_{j,G}\right] + \varepsilon_{ij,G}, \quad (1)$$

Where :

i : index for commodities (food, electricity, others)

j : index for household (1, …, n)

share : the proportion of household expenditures for each commodity against total expenditure

expend: total household expenditure

G : index for expenditure groups (40% lower, 40% middle, 20% upper)
if G=1, $\delta_1 = \gamma_1 = 0$

D : *dummy variable* for expenditure groups

D_2 : 1 = if the individual in the middle expenditure group; 0 = others

D_3 : 1 = if the individual in the uppers expenditure group; 0 = others

$$\sum_{i=1}^{3} share_{ij,G} = 1 \quad \sum_{i=1}^{3}\alpha_{i,G} = 1 \quad \sum_{i=1}^{3}\beta_{i,G} = 0. \quad (2)$$

The equation 2 will use the Seemingly Unrelated Regression (SUR) method. The following equations applied for each installed capacity by expenditure group:

$$E(share_G) = \begin{cases} \alpha_1 + \beta_1\, ln(expend)_1 & for\ low\ expenditure\ households \\ (\alpha_1 + \delta_2) + (\beta_1 + \gamma_2)\, ln(expend)_2 & for\ middle\ expenditure\ households \\ (\alpha_1 + \delta_3) + (\beta_1 + \gamma_3)\, ln(expend)_3 & for\ upper\ expenditure\ households \end{cases}$$

The selection of Susenas as a source of data and information based on the consideration that Susenas able to provide complete information that is primarily related to electrical expenditure and installed capacity in each household compared with other data sources. Besides, the Susenas 2014 data are also good enough to be used because the number of households using PLN electricity between Susenas 2014 and the PLN report does not differ much, especially for an installed capacity of 450 VA and 900 VA as shown in Table 1. Thus, the authors conclude that the use of Susenas 2014 data is sufficient to analyze tariff changes (especially subsidized electricity rates enjoyed by 450 VA and 900 VA subscribers) and changes in household welfare. Changes in household welfare in this study measured by using changes in consumer surplus (welfare loss).

Table 1. Comparison of Number of Household Subscribers According to Installed Capacity

Installed Capacitiy	Susenas	PLN
450 VA	25,513,638	22,269,222
900 VA	20,585,327	20,896,620
1,300 VA	6,339,028	6,754,878
2,200 VA	1,325,688	2,304,515
> = 2,200 VA	587,776	998,708
No meter	7,317,783	0
Total	**61,669,240**	**53,223,943**

Sources: Susenas (2014), PLN (2014)

Results and Discussion

This study uses Susenas (2014) to obtain a total sample of 285,400 households. However, because the focus of this research is households that enjoy the electricity subsidy, i.e., households with an installed capacity of 450 VA and 900 VA, the sample size reduces to 188,266. Based on the Susenas results, not all households can respond to electricity disbursements during data collection. In the end, the number of samples treated in this study was 188,107 households, which comprised 99,515 installed households of 450 VA and 88,592 installed households 900 VA.

During the period 2003–2014, household electricity demand increased from 35,753.05 GWh to 84,086.46 GWh or an average growth of 12.29% per year. This growth rate of demand for domestic electricity far exceeds Indonesia's average economic growth during the same period (7.68% per year). The high demand is thought to be due to changes in demographics and technological factors. This condition happens because the set price is much lower than the cost of production. According to Malik & Al-Zubaedi (2006), and also Zarezadeh et al., (2010) find that electricity subsidies lead to consumption waste.

This study calculates the marginal cost of household electricity supply in 2014 as IDR 1,979/kWh and the tariff charged to households with an installed capacity of 450

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

VA and 900 VA as IDR 415/kWh and IDR 605/kWh, respectively. In other words, the electricity subsidy per kWh enjoyed by households of 450 VA and 900 VA, respectively, is approximately 79% and 69%. With electricity demand reaching 31,031 GWh and 33,796 GWh, respectively, the government must allocate electricity subsidies for non-productive activities (households use electricity for consumption activities) of IDR 94,968 billion. Compared with the realization of state expenditure, the realization of state revenues and gross domestic product of 2014, the burden of subsidies for non-productive activities represented, respectively, 5.38%, 6.18%, and 0.94%.

Table 2. Summary Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
Expend	188,266	2701981	2405937	166514.3	2.12e+08
Food	188,266	1441592	813708.9	84407.14	1.27e+07
Electricity	188,266	60842.59	56369.07	593.3333	1.10e+07
Others	188,266	1199597	1945011	18633.33	2.05e+08
Share1	188,266	0.5853103	0.1332497	0.0092706	0.9713301
Share2	188,266	0.0251507	0.0155036	0.0002345	0.712025
Share3	188,266	0.3895602	0.1329994	0.019297	0.9904645
Low	188,266	0.3844135	0.4864576	0	1
Mid	188,266	0.4363879	0.4959383	0	1
Up	188,266	0.1791986	0.3835195	0	1
Lexpend	188,266	14.60462	0.6182419	12.02284	19.17172
Lexpendlow	188,266	5.385457	6.818381	0	14.42079
Lexpendmid	188,266	6.437732	7.317452	0	15.1435
Lexpendup	188,266	2.781431	5.954708	0	19.17172
kwh	188,107	117.3699	107.1905	1.429719	26506.02
subsidy	188,107	171432.4	158528.5	2236.08	4.15e+07

Source: Data processed

Where:

expend : total monthly household expenditure (Rp)
expend = food + electricity + others
food : household food expenditure per month (Rp)
electricity : household electricity expenditure per month (Rp)
others : household other expenditure per month (Rp)
share1 : budget share for food (food/expend)

share2 : budget share for electricity (electricity/expend)
share3 : budget share for others (others/expend)
share1 + share 2 + share3 = 1
low : dummy variable for lower expenditure household
mid : dummy variable for middle expenditure household
up : dummy variable for upper expenditure household
lexpend : expend in natural logarithm
lexpendlow : expend for lower expenditure household in natural logarithm
lexpendlmid: expend for middle expenditure household in natural logarithm
lexpendlup : expend for upper expenditure household in natural logarithm
kWh : household electricity consumption per month (kWh)
subsidy : household electricity subsidy per month (Rp)
Subsidy = (BPP–$Tariff_i$) * kWh
for 450 VA, subsidy = (1979–415) * kWh
for 900 VA, subsidy = (1979–605) * kWh

This study uses Susenas 2014 in order to evaluate the impact of price changes on the household welfare of subsidized electricity subscribers. Total household expenditure used as proxy income, and subsidized households differentiated by installed capacity (450 VA or 900 VA), and expenditure group (40% lower, 40% medium and top 20%). Table 3 shows that the average total monthly household expenditures of 450 VA for the lowest 40%, the 40% medium and top 20% are, respectively, IDR 1,244,579, IDR 2,544,579, and IDR 5,671,666. Each respective expenditure group allocates IDR 29,678, IDR 47,639, and IDR 77,209 for monthly electricity expenditure. As mentioned earlier, the proportion of electricity expenditures decreases as income increases. If assumed average consumption per month as shown in Table 3, the tariff for an installed capacity 450 VA IDR 415/kWh and the marginal cost of electricity supply IDR 1,979/kWh, each spending group enjoys a monthly subsidy of IDR 112,608, -; IDR 179,860, -; and IDR 290,904.

Table 3 also shows that the average total monthly household expenditure of 900 VA for the lowest 40%, the medium 40%, and the top 20% are IDR 1,345,040, IDR 2,665,018 and IDR 6,134,353, respectively. Each expenditure group allocates, respectively, IDR 46,408, IDR 77,249, and IDR 126,904 for a month's electricity expenditure. Following the previous assumption, the proportion of electricity expenditure decreases with the increase in income. Table 3 shows the monthly consumption. Assuming the tariff for a household with an installed capacity of 900 VA is IDR 605/kWh and the marginal cost of electricity is IDR 1,979/kWh, each spending group, respectively, enjoys a monthly subsidy of IDR 105,028, IDR 174,592, and IDR 286,440.

In general, the Government allocates electricity subsidies for households with an installed capacity of 450 VA around IDR 48,532 billion: IDR 17,623 billion for the lowest

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

40%, IDR 22,190 billion for the 40% medium, and IDR 8,719 billion for the top 20%. The Government allocates IDR 46,436 billion for an installed capacity of 900 VA: IDR 7,314 billion for the lowest 40%, IDR 20,543 billion for the 40% medium, and IDR 18,579 billion for the top 20%. In total, the bottom 40% enjoyed a subsidy allocation of 26.26%, the 40% medium enjoyed 45% of the subsidy allocation, and the top 20% enjoyed a 28.74% subsidy allocation. This comparison shows that the distribution of subsidies is not favorable to the poor households represented by the 40% lowest expenditure group.

To measure changes in household welfare (changes in consumer surplus and inefficiency) requires that the elasticity of expenditure and price elasticity for each expenditure group should base on installed capacity. The electricity demand system in this study uses the proportion of expenditures for three commodities (food, electricity, and others) as dependent variables and valid relationships as defined in Equation 2. Thus, when estimates use the SUR model, as shown in Table 4. The number of equations will be two (see Appendix A and B for detailed results).

The estimation results in Table 4 show that based on the t-test, each coefficient is significant with 99.99% confidence level. Furthermore, based on the F-test, the model obtained significantly explained the variation in the proportion of expenditure with a 99.9% confidence level. Test results using Breusch–Pagan test independence also showed a residual relationship between equations (chi2_bp value > chi_tabel = 10.83). The results of this test mean that the SUR model is more precise than OLS.

Table 3. Distribution of Consumption and Subsidy on Household Electricity

Household Indicator	450 VA				900 VA				Total
	40% lower	40% mid	20% upper	Mean	40% lower	40% mid	20% upper	Mean	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Household representative									
Monthly expenditure (IDR)	1,244,579	2,544,157	5,671,666	2,235,664	1,354,040	2,665,018	6,134,353	3,225,926	
Monthly electricity expenditure (IDR)	29,678	47,639	77,209	41,973	46,408	77,249	126,904	82,039	
Monthly electricity consumption (kWh)	72	115	186	101	77	128	210	136	
Budget share electricity (%)	2.38	1.87	1.36	1.88	3.45	2.90	2.07	2.54	
Monthly subsidy (IDR)	112,608	179,860	290,904	157,964	105,028	174,592	185,504	185,504	
Total Household				Total				Total	Total
Electricity consumption (million kWh)	11,268	14,188	5,575	31,031	5,323	14,951	13,522	33,796	64,827
Subsidy (IDR billion)	17,623	22,190	8,719	48,532	7,314	20,543	18,579	46,436	94,968
Subsidy allocation (%)	40% lower		26.26	40% mid		45.00	20% upper		28.74

Source: Susenas (processed)

Table 4. Summary of the Leser Model

Variable	450 VA	900 VA
Share2		
mid	-0.10423825***	-0.10883197***
up	-0.09403191***	-0.04425544***
lexpend	-0.01289656***	-0.01395443***
lexpendmid	0.00731319***	0.00760721***
lexpendup	0.00664478***	0.00335053***
_cons	0.20542745***	0.2318614***
Statistics		
N	99515	88592
r2	0.14588209	0.10933198
F	3399.4034	2174.983
chi2_bp	2811.7833	3691.0929

Note: ***Confidence level 99.99%

To measure the responsiveness of household electrical demand, we used the elasticity of expenditure and price elasticity. The elasticity of expenditure obtained, as shown in Table 5. Based on the value of elasticity of expenditure being positive and less than one, we construe that electricity is a normal good and a daily necessity. The elasticity of expenditure on the installed capacity of 450 VA for the 40% lowest expenditure group is 0.4882. This fact means that every 10% increase in total household expenditure will increase electricity expenditure by approximately 5%.

Table 5 Elasticity of Expenditure and Price Elasticity

Installed capacity	Expenditure elasticity			Price elasticity		
	40% lower	40% mid	20% upper	40% lower	40% mid	20% upper
450 VA	0.4882	0.7046	0.5718	-0.0605	-0.1871	-0.2919
900 VA	0.6069	0.7826	0.5349	-0.0809	-0.2140	-0.2764

Source: Data processed

Next, the assumed money flexibility for the bottom 40%, the top 40% and the top 20% (respectively, –10.00, –4.00, and –2.00) in order to calculate price elasticity. The marked negative value and an absolute value of less than one mean that the demand for electricity is inelastic for all expenditure groups. The calculation of the elasticity of electricity prices is not much different from previous studies, as shown in Table 6. Although electricity is inelastic in the short-term, in the long-term electricity is more elastic (Okajima & Okajima 2013; Bernstein & Griffen 2005; Halicioglu 2007; Ziramba 2008; Alberini & Filippini 2011; Narayan & Smyth 2005).

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

Suppose that the subsidized electricity tariff for each expenditure group increase by 50%, 75%, and 100% (as shown in Table 7). Thus, for an installed capacity of 450 VA, the lowest 40% of the tariff increases to IDR 623/kWh, the 40% intermediate rate increases to IDR 726/ kWh and the top 20% tariff increases to IDR 830/kWh. The increase in tariffs implies a decrease in consumption by 3.03% for the lowest 40%, 14.03% for the 40% medium, and 29.19% for the top 20%. The logical consequence is that households belonging to the lowest 40% should allocate a month's electricity expenditure of IDR 43,464, the 40% intermediate group should allocate IDR 71,798 and the top 20% IDR 109,233.

Table 6. Summary of Study Results of Elasticity of Household Demand Price

Authors/Year	Country	Period	Elasticity
Zhou & Teng (2015)	Prov. Sichuan, China	2007-2009	$-0.50 \leq \in \leq -0.35$
Okajima & Okajima (2013)	Japan	1990-2007	SR: -0.397 LR: 0.487
BuSheri & Wohlgenant (2012)	Kuwait	2008	40% low: -0.152 40% mid: -0.201 20% up: -0.265
Albeirini & Filipini (2011)	USA	1995-2007	SR: $-0.15 \leq \in \leq -0.08$ LR: $-0.21 \leq \in \leq -0.19$
Nakajima & Hamori (2010)	USA (regional level)	1993-2008	LR: -0.33
Ziramba (2008)	South Africa	1978-2005	SR: -0.02 LR: -0.04
Halicioglu (2007)	Turkey	1968-2005	SR: -0.33 LR: -0.52
Bernstein & Grifin (2005)	USA (regional level)	1997-2004	SR: $-0.31 \leq \in \leq -0.04$ LR: $-0.60 \leq \in \leq -0.1$
Narayan & Smith (2005)	Australia	1959-1972	SR: -0.26 LR: -0.54
Kamerschen & Porter (2004)	USA	1973-1998	$-0.95 \leq \in \leq -0.85$

Source: Writer compilation

*)SR: short-run; LR: long-run

As for the installed capacity of 900 VA, the lowest 40% of the tariff increases to IDR 908/kWh, the 40% intermediate rises to IDR 1,059/kWh, and the top 20% rises to IDR 1,210/kWh. The increase in tariffs implies a decrease in consumption for the lowest 40% by 4.05%, the 40% medium of 16.05% and the top 20% of 27.64%. The logical consequence is that the bottom 40% of households should allocate a month's electricity expenditure of IDR 67,050, the 40% intermediate should allocate IDR 113,765 and the top 20% IDR 183,869. Overall, the proportion of electricity expenditure on total expenditure for each installed power and expenditure group is still relatively low at less than 5%.

The increase in subsidized electricity tariffs has an impact on the reduction of subsidies received by households in each expenditure group. For an installed capacity of 450 VA, electricity subsidies 40% lower down IDR 17,896 (–15.89%), IDR 56,012 (–31.14%) for the 40% medium and IDR 139,564 (–47.98%) for the top 20%. As for the installed capacity of 900 VA, subsidies received in each expenditure group decreased by IDR 26,631

(–25.17%) for the lowest 40%, IDR 76,989 (–43.78%) for the 40% medium and IDR 171,685 (–59.50%) for the top 20%.

Regarding welfare loss measured as a change in consumer surplus, for installed capacity of 450 VA it is IDR 14,714 (82.22%) for the lowest 40%, IDR 33,282 (59.42%) for the 40% medium, and IDR 65,926 (47.24%) for the top 20%. The reduction of inefficiency in each expenditure group per month is IDR 3,182 (17.78%) for the lowest 40%, IDR 22,730 (40.58%) for the 40% medium, and IDR 73,639 (52.76%) for the top 20%. Furthermore, for the installed capacity of 900 VA, welfare loss in each expenditure group is IDR 22,821 (85.69%) for the lowest 40%, IDR 53,418 (69.38%) for the 40% medium, and IDR 109,492 (63.78%) for the top 20%. The reduction of inefficiency in each expenditure group per month is IDR 3,810 (14.31%) for the lowest 40%, IDR 23,571 (30.62%) for the 40% medium, and IDR 62,192 (36.22%) for the top 20%.

Table 7. Estimates of the Impact of Changes on Rates on Household Welfare

	450 VA						**Total**
				40% low	**40% mid**	**20% up**	
Representative household							
Monthly expenditure	1,244,579	2,544,157	5,671,666	1,345,040	2,665,018	6,134,353	
Price elasticity	-0.0605	-0.1871	-0.2919	-0.0809	0.2140	-0.2764	
Target price increase (%)	50	75	100	50	75	100	
Expected new price (IDR/kwh)	623	726	830	908	1,059	1,210	
Monthly electricity consumption (kwh)	70	99	132	74	107	152	
Monthly electricity expenditure (IDR)	43,464	71,798	109,323	67,050	113,765	183,869	
Monthly electricity subsidy (IDR)	94,712	123,848	151,340	79,167	98,883	116,855	
Monthly subsidy reduction (IDR)	17,896	56,012	139,564	26,631	76,989	171,685	
Consumer surplus reduction (IDR)	14,714	33,282	65,926	22,821	53,418	109,492	
Inefficiency reduction (IDR)	3,182	22,730	73,639	3,810	23,571	62,192	
Total household							Total
Consumption before rising price (IDR billion)	11,268	14,188	5,575	5,323	14,951	13,522	64,827
Subsidy before rising price (IDR billion)	17,623	22,190	8,719	7,314	20,543	18,579	94,968
Subsidy allocation before rising price (%)	**40% lower**		**26.26**	**40% mid**	**45.00**	**20% upper**	**28.74**
Consumption after rising price (GWh)	10,927	12,197	3,948	5,108	12,551	9,785	54,515
Reduction electricity consumption (GWh)	341	1,991	1,627	215	2,400	3,737	10,312
Subsidy after rising price (IDR billion)	14,848	15,376	4,606	5,508	11,692	7,551	59,582
Reduction electricity subsidy (IDR billion)	2,775	6,814	4,113	1,806	8,851	11,028	35,387
Consumer surplus reduction (IDR billion)	2,281	4,049	1,943	1,548	6,141	7,033	22,995
Inefficiency reduction (IDR billion)	493	2,765	2,170	258	2,710	3,995	12,392
Subsidy allocation after rising price (%)	**40% lower**		**34.16**	**40% mid**	**45.43**	**20% upper**	**20.40**

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

The policy to raise the subsidized electricity tariff reduced the total electricity consumption of subsidized households by 10,312 GWh (–15.91%) and reduced the electricity subsidy allocation by IDR 35,783 billion (–37.26%). The reduction of the subsidy allocation came from the reduction of household welfare, amounting to IDR 22,995 billion (64.98%), and reduction in the inefficiency of IDR 12,392 billion (35.02%). It can conclude that no inefficiency in the subsidy scheme for an installed capacity of 450 VA and 900 VA is appropriate. However, inefficiency still occurs in installed capacity of 450 VA of the top 20% expenditure group, where the above policy can reduce inefficiency by IDR 2,170 billion (52.76%). It is, therefore, necessary to verify households with an installed capacity of 450 VA in order to obtain better target subsidies.

The policy to raise the subsidized electricity tariff could reduce the imbalance of subsidy allocation among expenditure groups. There is a redistribution of the subsidy allocation from the top 20% expenditure group, especially to the lowest 40% expenditure group. The lowest 40% expenditure group that initially enjoyed a 26.26% subsidy allocation rose to 34.16%, the 40% intermediate expenditure group which initially enjoyed a 45% subsidy allocation rose to 45.43%, and the top 20% expenditure group that formerly enjoyed 28.74% of the subsidy allocation fell to 20.40%.

Conclusion

During the period 2003–2014, average household electricity consumption per year almost doubled compared with Indonesia's average economic growth rate in the same period. With subsidized electricity tariffs unchanged, and the cost of providing electricity continuing to increase, the allocation of electricity subsidies for non-productive activities continues to swell and burden the State Budget (APBN). Besides, there is an imbalance in electricity subsidy allocation because the lowest expenditure group of 40% only enjoys 26.26%. The policy to raise subsidized electricity tariffs could reduce the total electricity consumption of subsidized households by 15.91% and reduce the electricity subsidy allocation by 37.26%. The reduction of the subsidy allocation arises from a reduction of household welfare by 64.98%, and the reduction of inefficiency by 35.02%. The subsidy scheme for an installed capacity of 450 VA and 900 VA did not show inefficiency, whereas for an installed capacity of 450 VA in the top 20% expenditure group there was inefficiency. It is, therefore, necessary to verify the households with an installed capacity of 450 VA in order to obtain better target subsidies.

The policy to raise the subsidized electricity tariffs is also able to reduce the imbalance in the allocation of subsidies between expenditure groups. There is a redistribution of the electricity subsidy allocation from the top 20% spending group to the lowest 40% expenditure group. The lowest 40% expenditure group that initially enjoyed a 26.26% electricity subsidy allocation rose to 34.16%. On the other hand, the top 20% expenditure group that initially enjoyed the electricity subsidy allocation of 28.74% decreased to 20.40%.

Based on the findings, considering that the allocation of household electricity subsidies used for non-productive activities, the policy to raise electricity tariffs with specific

compensation needs to be taken into consideration so that the purchasing power of subsidized households does not decrease. In order for the policy to more precisely target, it is necessary to verify 450 VA-installed households as entitled to receive subsidies. With a more detailed analysis compared to previous studies where households distinguished according to their installed capacity and expenditure groups, the policy implications that need to take are more targeted.

Acknowledgment

BPS-Statistics Indonesia supported this research. We thank our colleagues from the Department of Economics, Universitas Indonesia, who provided insight and expertise that greatly assisted the research. We are also immensely grateful to Dr. Arie Damayanti, M.Sc. as a former Director of Graduate Program in Economics Faculty of Economics and Business, Universitas Indonesia for their comments on an earlier version of the manuscript, although any errors are our own and should not tarnish the reputations of these esteemed persons.

References

Alberini, A., & Filippini, M. (2011). Response of Residential Electricity Demand to Price: The Effect of Measurement Error. *Energy Economics*, 33(5), 889-895. https://doi.org/10.1016/j.eneco.2011.03.009.

Araghi, M. K., & Barkhordari, S. (2012). An Evaluation of the Welfare Effects of Reducing Energy Subsidies in Iran. *Energy Policy*, 47, 398-404.

Bernstein, M. A., & Griffin, J. (2006). *Regional Differences in the Price-Elasticity of Demand for Energy*. Rand Corporation: Santa Monica, California.

Diop, N. (2014). *Why is Reducing Energy Subsidies a Prudent, Fair, and Transformative Policy for Indonesia?* Jakarta: World Bank.

Filippini, M. (1999). Swiss Residential Demand for Electricity. *Applied Economics Letters,* 6(8), 533-538. https://doi.org/10.1080/135048599352880.

Halicioglu, F. (2007). Residential Electricity Demand Dynamics in Turkey. *Energy Economics,* 29(2), 199-210. https://doi.org/10.1016/j.eneco.2006.11.007.

Ikhsan, M., & Purbasari, D. (2012). *Determination of Electricity Tariffs in Indonesia: Integrating Efficiency and Poverty Reduction Goals*. In The Plenary Session of The Indonesian Economist Association, July 17 2008, In Lombok, West Nusa Tenggara.

Kamerschen, D. R., & Porter, D. V. (2004). The Demand For Residential, Industrial and Total Electricity, 1973-1998. *Energy Economics*, 26(1), 87-100. https://doi.org/10.1016/S0140-99883(03)00033-1.

Kanagawa, M., & Nakata, T. (2006). Assessment of Access to Electricity and the Socio-Economic Impacts in Rural Areas of Developing Country. *Energy Policy*, 36(6), 2016-2029. https://doi.org/10.1016/j.enpol.2008.01.041.

Leser, C. E. V. (1963). Form of Engel Function. *Econometrica,* 31(4), 694-703.

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

Makmun., & Abdurrahman. (2003). Dampak Kenaikan Tarif Dasar Listrik Terhadap Konsumsi Listrik dan Pendapatan Masyarakat (Impact of Electricity Tariff Increase on Electricity Consumption and Community Income). *Jurnal Keuangan Dan Moneter*, 6(2), 63-83

Malik, A. S., & Al-Zubaedi, S. (2006). Electricity Tariffs Based on Long Run Marginal Costs for Central Grid System of Oman. *Energy,* 31(12), 1703-1714. https://doi.org/10.1016/j.energy.2005.11.010.

Nakajima, T., & Hamori, S. (2010). Change in Consumer Sensitivity to Electricity Prices in Response to Retail Deregulation: a Panel Empirical Analysis of the Residential Demand for Electricity in The United States. *Energy Policy*, 38(5), 2470-2476. https://doi.org/10.1016/j.enpol.2009.12.041.

Narayan, P. K., & Smyth, R. (2005). The Residential Demand for Electricity in Australia: an Application of The Bound Testing Approach to Cointegration. *Energy Policy*, 33(4), 467-474. https://doi.org/10.1016/j.enpol.2003.08.011.

Okajima, S., & Okajima, H. (2013). Estimation Of Japanese Price Elasticities Of Residential Electricity Demand. *Energy Economics*, 40, 433-440. https://doi.org/10.1016/j.eneco.2013.07.026.

Renner, S., Lay, J., Schleicher, M., & Nuryartono, N. (2015). Poverty and Distributional Impacts of Energy Subsidy Reform in Indonesia. *The Green Growth Knowledge Platform (Ggkp's) Third Conference*.

Zarezadeh, M., Azadeh, M., & Ghaderi, S. (2010). Analyzing Effects of Electricity Subsidy on Social Welfare in Iran by Integrated System Approach and Artifical Neural Network. *Ieee International Conference On Social Computing*, 630-635.

Zhou, S., & Teng, F. (2015). Estimation Of Urban Residential Electricity Demand in China Using Household Survey Data. *Energy Policy*, 61, 394-402. https://doi.org/10.1016/j.enpol.2013.06.092

Ziramba, E. (2008). The Demand for Residential Electricity in South Africa. *Energy Policy*, 36(9), 3460-3466. https://doi.org/10.1016/j.enpol.2008.05.026.

Appendix A

The general form of the Engel curve for homogeneous households and commodities (assuming that each household is charged the same price for the same commodity) is as follows: $w_{ij} = \alpha_i + \beta_i ln x_j,\ i = 1,2,\dots,m;\ j = 1,2,\dots,n$

where

w_{ij} : budget share of j^{th} household for i^{th} commodity

x_j : total expenditure of j^{th} household

$\sum_{i=1}^{m} w_i = 1,\ \sum_{i=1}^{m} \alpha_i = 1,\ \sum_{i=1}^{m} \beta_i = 0$

Expenditure elasticity $\left(\pi_{ij} = \frac{dx_{ij}}{dx_j}\frac{x_j}{x_{ij}}\right)$

$w_{ij} = \frac{x_{ij}}{x_j}$

$\frac{dw_{ij}}{dx_j} = \frac{d\left(\frac{x_{ij}}{x_j}\right)}{dx_j} = \frac{d(\alpha_i + \beta_i ln x_j)}{dx_j}$

$\frac{\frac{dx_{ij}}{dx_j}x_j - x_{ij}\frac{dx_j}{dx_j}}{x_j^2} = \beta_i \frac{1}{x_j}\frac{dx_j}{dx_j}$

$\frac{dx_{ij}}{dx_j}x_j - x_{ij} = \beta_i x_j$

$\frac{dx_{ij}}{dx_j}x_j = \beta_i x_j + x_{ij}$

Perform mathematical manipulation by multiplying both sides by $\frac{1}{x_{ij}}$:

$\frac{dx_{ij}}{dx_j}\frac{x_j}{x_{ij}} = \beta_i \frac{x_j}{x_{ij}} + \frac{x_{ij}}{x_{ij}}$

$\pi_{ij} = \frac{\beta_i}{w_{ij}} + 1$

If the elasticity above is evaluated at its mean value, then

$\pi_i = \frac{\beta_i}{\overline{w}_i} + 1, \quad \overline{w}_i = \sum_{j=1}^{n} \frac{w_{ij}}{n}$

Own Price Elasticity

If it is assumed the desire to consume between independent goods $\frac{\partial\left(\frac{\partial u}{\partial q_i}\right)}{\partial q_j} = u_{ij} = 0$ (utility function $v = u\ (q_1, q_2, \dots, q_n)$, then *own price elasticity* $\varepsilon_i = -\pi_i\left[\overline{w}_i - \frac{1-\overline{w}_i\pi_i}{\widehat{\omega}}\right]$

where $\widehat{\omega}$ is *flexibility of marginal utility of money (money flexibility)* and can be calculated by equation $\widehat{\omega} = \frac{\pi_i[1-\overline{w}_i\pi_i]}{\varepsilon_i + \overline{w}_i\pi_i}$

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041

Appendix B

Seemingly Unrelated Regression (SUR) Model

SUR with an installed capacitiy of 450 VA

Equation	Obs	Parms	RMSE	R-sq	F-stat	P
Share1	99,515	5	0.114119	0.1780	4310.17	0.0000
Share2	99,515	5	0.0121904	0.1459	3399.40	0.0000
	Coef	Std.Err	t	P > |*t*|	[95% Conf. Interval]	
Share1						
mid	1.005328	0.0465122	21.61	0.000	0.9141655	1.096491
upper	3.679776	0.0560714	65.63	0.000	3.569877	3.789674
lexpend	-0.0136506	0.0014453	-9.44	0.000	-0.0164834	-0.0108178
lexpendmid	-0.0696388	0.0031901	-21.83	0.000	-0.0758912	-0.0633863
Lexpendup	-0.2461471	0.0036748	-66.98	0.000	-0.2533495	-0.2389447
_cons	0.8288173	0.0202097	41.01	0.000	0.7892068	0.8684278
Share2						
mid	-0.1042382	0.0049688	-20.98	0.000	-0.113977	0.0944995
upper	-0.0940319	0.00599	-15.70	0.000	-0.1057722	0.0822916
lexpend	-0.0128966	0.0001544	-83.53	0.000	-0.0131992	-0.0125939
lexpendmid	0.0073132	0.0003408	21.46	0.000	0.0066452	0.0079811
Lexpendup	0.0066448	0.003926	16.93	0.000	0.0058754	0.0074142
_cons	0.2054275	0.002159	95.15	0.000	0.201959	0.209659

SUR with an installed capacitiy of 900 VA

Equation	Obs	Parms	RMSE	R-sq	F-stat	P
Share1	88,592	5	0.1178655	0.2469	5808.66	0.0000
Share2	88,592	5	0.0158883	0.1093	2174.98	0.0000
	Coef	Std.Err	t	P > |t|	[95% Conf. Interval]	
Share1						
mid	1.033967	0.0554424	18.65	0.000	0.9253015	1.142633
upper	2,633615	0.0485114	54.29	0.000	3.538534	2.728697
lexpend	-0.020863	0.0025347	-8.23	0.000	-0.025831	-0.015895
lexpendmid	-0.0716977	0.0038305	-18.72	0.000	-0.0792054	-0.0641901
Lexpendup	-0.1767459	0.0033009	-53.35	0.000	-0.1832156	-0.1702763
_cons	0.9078763	0.0356789	25.45	0.000	0.8379466	0.9778061
Share2						
mid	-0.108832	0.0074737	-14.56	0.000	-0.1234802	-0.0941838
upper	-0.0442554	0.0065394	-6.77	0.000	-0.0570724	-0.0314385
lexpend	-0.0139544	0.0003417	-40.84	0.000	-0.0146241	-0.0132847
lexpendmid	0.0076072	0.0005163	14.73	0.000	0.0065952	0.0086192
Lexpendup	0.0033505	0.000445	7.53	0.000	0.0024784	0.0042226
_cons	0.2318614	0.0048095	48.21	0.000	0.2224348	0.2412879

http://journal.uinjkt.ac.id/index.php/etikonomi
DOI: htttp://dx.doi.org/10.15408/etk.v18i2.12041