

# A Study on Characteristics of Household Electricity Un-subscribers in Indonesia

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## Abstract

Household electricity un-subscribers (HEUS) cause losses to the state owned electricity company or Perusahaan Listrik Negara (PLN) which is an exclusively operating electricity sector in Indonesia. With the results of identification of HEUS under both periods of the targeted subsidy (TS) scheme in 2004 and the public service obligation subsidy (PSO) scheme in 2008, this study tries to estimate potential revenue loss to the PLN caused by the HEUS. Moreover, this paper also aims at further improving the understanding on the characteristics of the HEUS from the aspects of their economic, demographical and geographical location attributes. The comparison results show that they actually share many common characteristics. Furthermore, the results also reflect that more HEUS are located outside the Java Island and particularly in the rural areas, where the PLN services are regarded less efficient and electricity laws are not strictly enforced. In summary, the findings suggest an urgent need for stricter law enforcement and electricity connection regulations to eliminate the HEUS in a hope to improve the PLN's revenue in the future.

## 1. Introduction

Along with rapid economic development and population growth, residential electrification in Indonesia has been greatly improved. The number of electrified households in Indonesia had increased from 42.8 million out of 54.2 million total households in 2004 to 45.7 million out of 55.8 million total households in 2008 (the SUSENAS, 2004 & 2008). According to the audit reports of the PLN, the total number of the subscribers in household sector accounted 31 million in 2004 and 36 million in 2008. Therefore, there were 11.8 million households in 2004 and 9.6 million in 2008 had electricity connection without formally subscribing as customers of the PLN. We regard such households in our study as household electricity un-subscribers (HEUS). Evidence of the HEUS in Indonesia can be found in the results of a small survey funded by JICA in

Palemgede village, Pati, Central Java, which revealed the practice of HEUS in rural area in 2004 (Ikhsan, 2004). Among 781 households surveyed, all of them claimed to have access to electricity; however, only 42.38 percent of the households subscribed to the PLN, while the remaining were sharing meters with those subscribed.

The tariff structure in Indonesia is regulated by the government. There are six electricity tariff blocks for subscription options. The lowest tariff block (R-450VA) only allows for low-intensity electricity use (e.g. only for lighting). In Indonesia, the poorest households fall predominantly in the 450VA capacity group and this subsidy, which accounts for more than half of total electricity subsidy to residents, is progressive (World Bank, 2008). The electricity tariff consists of two types of charges. One is the meter rental fee (the capacity charge), progressive along the increase in electric transmission capacity that the household choose to subscribe; the other is the energy charge, also progressive with the amount of electricity consumption. The legal subscribers pay both the capacity charge and the energy charge on a monthly basis while the HEUS only pay the energy charge at the price associate with the electric transmission capacity they connect with. Their unpaid capacity charges hence represent the income loss to the PLN.

However, it is not yet clear so far that to what extent the PLN has realized the negative economic impact caused by the HEUS for the research literatures in this area still remain insufficient. To estimate the potential income loss caused by the HEUS to the PLN, detailed information on numbers of the HEUS connecting to each tariff block is essential. Up-to-date, there are no official data or reports from the PLN to quantify the number of the HEUS, so as to classify the HEUS. Sulistiyo et al. (2011) initiatively try to identify and classify the HEUS by tariff block by using data from the PLN and the SUSENAS in 2004 and 2008, when the electricity subsidy scheme changed from the targeted subsidy (TS), implemented until 2004, to the public service obligation (PSO) which started implementing in 2005. The identification of the HEUS is based on the households' expenditure level to distinguish the HEUS among the electrified households surveyed in the SUSENAS, and then by applying the indexing method the HEUS are classified by tariff block. Their study claim that the HEUS made up 28 percent and 21 percent of the total electrified households in 2004 and 2008, respectively. From our point of view, we consider that the problem of the capacity charge (meter rental fee) fraud is serious in Indonesia for that implies a large economic impact, especially a great deal of income loss to the PLN.

Table 1 summarizes the results of the classification done by Sulistiyo et al. (2011). One can observe that by 2008, the number of the HEUS decreased from 11.8 million in 2004 to 9.6 million in 2008. There was significant drop in the number of the HEUS among the low tariff blocks; especially in the tariff blocks of R-900VA and R-1350VA, which collectively decreased by 3.9 million households. In contrast with that, there was a large growth in the number of the HEUS in the high tariff blocks (R-2200VA and R>6600VA), which was approximately 794 thousand and 693 thousand households, respectively in those tariff blocks. The electricity use of the HEUS also had a shrinking trend along with the decrease in the number of the un-subscribers with one exception that the use increased largely in the highest tariff block of R>6600VA. Their results also reveal that the HEUS generally contribute relatively less income to the PLN than the subscribers do. In 2004, the share of the income (electricity expenditure) collected from the HEUS was approximately 11 percent, and later it dropped to 7 percent in 2008 (Sulistiyo et al. 2011).

**Table 1.** Classification of the HEUS in 2004 and 2008

| Tariff Blocks | 2004           |                           |                                     |                                      | 2008           |                           |                                     |                                      |
|---------------|----------------|---------------------------|-------------------------------------|--------------------------------------|----------------|---------------------------|-------------------------------------|--------------------------------------|
|               | Number of HEUS | Share of HEUS in total HH | Total Electricity Consumption (GWH) | Electricity Expenditure (billion Rp) | Number of HEUS | Share of HEUS in total HH | Total Electricity Consumption (GWH) | Electricity Expenditure (billion Rp) |
| R-450         | 3,869,009      | 9.05%                     | 701                                 | 347.06                               | 1,534,141      | 3.36%                     | 173                                 | 86                                   |
| R-900         | 341,717        | 0.80%                     | 83                                  | 41.01                                | 1,135,138      | 2.49%                     | 212                                 | 105                                  |
| R-1350        | 1,772,205      | 4.14%                     | 491                                 | 243.10                               | 197,656        | 0.43%                     | 41                                  | 20                                   |
| R-2200        | 2,637,589      | 6.17%                     | 997                                 | 493.69                               | 3,041,949      | 6.66%                     | 813                                 | 402                                  |
| R-2200-6600   | 2,003,698      | 4.69%                     | 1,018                               | 529.38                               | 1,860,874      | 4.08%                     | 742                                 | 367                                  |
| R>6600        | 1,179,816      | 2.76%                     | 917                                 | 569.45                               | 1,873,510      | 4.10%                     | 1,461                               | 723                                  |
| All           | 11,804,034     | 27.60%                    | 4,207                               | 2,223.69                             | 9,643,268      | 21.12%                    | 3,442                               | 1,704                                |

Source: Analysis results by Sulistiyo et al. (2011).

As mentioned earlier, the existence of the HEUS represents the potential income loss to the PLN. However, Sulistiyo et al. (2011)'s study does not provide detailed discussion on how much the referred potential loss would be; and what might be the

possible factors that motivate and encourage the HEUS to practice capacity charge fraud. To provide more detailed information on these knowledge gap, the aim of this research is to continue Sulistiyo et al. (2011)'s study to improve understanding on the potential economic impact to the PLN that the HEUS are responsible for. In addition to that, this study applies the observation data from the National Socio-economic Survey (SUSENAS) to conduct a descriptive investigation on the characteristics of the HEUS in comparison to the subscribers, as well as the changes of those characteristics within a period of time when there was changes in the electricity subsidy regimes. Description on various socio-economic aspects such as wealth (or poverty), geographical location, living location will be provided in this paper in a hope that the results can contribute the first hand information on the profile of the HEUS for enabling further economic analyses relating to the HEUS issues, which is currently unavailable elsewhere in the literature.

Due to limitation of data and information of the un-subscribers, this research is challenging, not even to mention the attempt to estimate the revenue loss to the PLN accounted by the HEUS. To overcome the data limitation, this study will mainly conduct the analysis based on the results newly and originally produced by Sulistiyo et al. (2011). Hence, this paper will be organized as following. Section 2 will cover the explanation on the methodology used to calculate the revenue loss to the PLN and various characteristics to be compared among the HEUS in two periods, as well as the data employed in the analysis. The results of estimation on the loss caused by the HEUS and detailed characteristic comparisons will be presented in section 3. The final section will provide conclusion and discussion relating to the results obtained from the analysis.

## 2. Methodology and data

### 2.1 Estimate the potential loss caused by the HEUS

Based on the number and the classification of the HEUS, the annual potential loss cause by the HEUS can be simply estimated by multiplying the annual capacity charge to the number of the HEUS by tariff block. If there is strict regulation to remove the HEUS, then the HEUS must choose a suitable tariff block to connect to the grid and pay the capacity charge (meter rental fees). In this study, we assume that there are two situations that the HEUS would choose the tariff block. One is under a voluntary assignment scenario which means the HEUS can freely decide the tariff block they would like to connect to the grid based on their demand for the electricity. The other scenario is a penalty assignment scenario which is imposed by the government that regardless their electricity consumption demand, the HEUS have to install the meter with the same capacity as their previous provider's did. Meanwhile, since 1997, when the PLN was severely affected by the Asian financial crisis, it has been difficult to increase number of connections. At that time, the PLN had policy to limit new connections to the lower tariff block of R-450VA. For this reason, new customers were suggested to select their subscriptions between the tariff blocks of R-900VA to R>6600VA. Hence, in estimating the potential capacity charge loss, we will assume all the HEUS would have the same options as mentioned above although many of them have electricity consumption more or less parallel with the subscribers in the lowest tariff block.

#### *Voluntary assignment scenario*

Voluntary assignment scenario is considered the *most likely* scenario. In deciding which tariff block they would like to choose, the HEUS refer and compare their electricity consumption with that of the subscribers. If they have less demand for electricity, then they would be more likely to contract with the lower tariff block, vice versa, they would contract with the higher tariff block. To estimate the probable tariff block that each HEUS is likely to choose, we compare the HEUS' electricity consumption with the average electricity consumption of the subscribers in each tariff block, and then decide the tariff block they would subscribe to.

#### *Penalty assignment scenario*

Under penalty assignment scenario, the HEUS have to subscribe to the same tariff block as the households (subscribers), who give them access to electricity, subscribe to. This scenario is proposed to give penalty to the HEUS by not allowing them to choose the tariff block they want to for punishing the fraud they have made. By this scenario, the HEUS will be punished to pay the same capacity charge as the subscribers whom they share the meters with usually pay.

### 2.2 Characteristics of the HEUS by tariff block

Factors that affecting the HEUS's motivation to make electricity capacity charge fraud will be separately discussed from two main aspects, the economic aspects (relating to poverty), and the other is from demographic and geographical location aspects. The economic factors cover per capita total household expenditure (as proxy of income), electricity consumption, floor

space of dwelling, and the share of electricity expenditure to total expenditure. On the other hand the characteristics on the demographic aspect include the education level of the head of household. Lastly, the geographical location characteristics cover the differences in urban/rural residence and regional locations (households are distinguished across 5 main islands namely Sumatera Island, Java Island, Sulawesi Island, Kalimantan Island and rest part of the country). Table 2 concludes the characteristics of the HEUS to be compared with the subscribers and the HEUS in 2004 and 2008.

**Table 2.** List of characteristics of the HEUS

| No | List of variables                                     | Unit           | Source  |
|----|---|----------------|---|
| 1  | Monthly per capita expenditure (nominal)              | Rupiah         | The SUSENAS Core 2004 and the SUSENAS Module 2008                                     |
| 2  | Monthly electricity consumption                       | KWH            | Estimated by Sulistiyo et al. (2011)  |
| 3  | Floor space   | m <sup>2</sup> | The SUSENAS Core 2004 and the SUSENAS Module 2008                                     |
| 4  | Share of electricity expenditure in total expenditure | Percent        | Estimated by the authors  |
| 5  | Age of household head                                 | Years          | The SUSENAS Core 2004 and the SUSENAS Module 2008                                     |
| 6  | Educational attainment                                | Years          | The SUSENAS Core 2004 and the SUSENAS Module 2008                                     |
| 7  | Islands   |                | Converting from location codes from the SUSENAS Core 2004 and the SUSENAS Module 2008 |
| 8  | Urban/ rural areas                                    |                | Converting from location codes from the SUSENAS Core 2004 and the SUSENAS Module 2008 |

Source: The SUSENAS Core 2004 and the SUSENAS Module 2008

### 2.3 Data

Data used in this study was mainly collected from two sources. On electricity consumption data side, we used data from the National Socio-economic Survey (SUSENAS) conducted by the Central Bureau of Statistics (BPS) of Indonesia to identify the un-subscribers. The SUSENAS are a series of large-scale multi-purpose socio-economic surveys initiated in 1963-1964 and fielded every year or two since then. Since 1993, the SUSENAS surveys cover a nationally representative sample typically composed of 200,000 households. Each survey contains a core questionnaire which consists of a household roster listing the sex, age, marital status, and educational attainment of all household members, supplemented by modules covering about 60,000 households that are rotated over time to collection additional information such as health care and nutrition, household income and expenditure, and labor force experience. In line with the similar study done by Sulistiyo et al. (2011), to assess the revenue loss that the HEUS are responsible for and the interested characteristics of the HEUS, we selected two time periods when the electricity subsidy scheme changes, they are the SUSENAS Core 2004 (covering approximately 42.8 million electrified households, enlarged with weights) and the SUSENAS Module 2008 (covering approximately 45.7 million electrified households, enlarged with weights) from the BPS.

## 3. Results

### 3.1 Estimate the revenue loss caused by the HEUS

Tables 3 and 4 show the calculation results under the voluntary scenario and the penalty assignment scenario in 2004 and 2008, respectively. According to the PLN, in order to increase the revenue, in the recent years, the PLN no longer accepted the subscription to the lowest tariff block of R-450VA (the PLN Report, 2009). For this reason many new subscribers had to choose to subscribe from the second low tariff block of R-900VA. Therefore, under the voluntary assignment scenario, no HEUS will be able to subscribe to the tariff block of R-450VA. Consequently, in 2004 among the total 11.8 million identified HEUS, almost all households (11.78 million households) were likely to subscribe to the tariff block of R-900VA by inference drawn from their electricity consumption was close to that of the subscribers in that tariff block. Likewise, in 2008, 9.58 million out of 9.64 million households were likely to subscribe to the designated lowest tariff block of R-900VA. As a result, under the voluntary assignment scenario the HEUS in the tariff blocks of R-900VA made up the most proportion of the loss, which was 2,799 billion rupiah and 2,275 billion rupiah and they accounted for 13.49% and 9.31% of the PLN's revenue in 2004 and 2008, respectively. In 2008, after the electricity subsidy regime changed, we observe an increase in potential subscription at higher tariff blocks as compared to 2004.

On the other hand, the estimated revenue loss under the penalty assignment scenario were much higher than that under the voluntary assignment scenario, which reached 42.7% and 41.9% of the PLN's revenue in 2004 and 2008, respectively. In 2004 the loss was progressive along the tariff blocks and the in the highest tariff block alone it just accounted for 15.4% of the PLN's revenue. In 2008, the total amount of the loss increased even larger as compared to 2004. For instance, the loss associated with the tariff block of R>6600VA accounted for 20.9% of the PLN's revenue. It is worth mentioning that under the penalty assignment scenario, dislike the voluntary assignment scenario, the loss was clustered in the middle and high tariff blocks.

**Table 3.** The revenue loss caused by the HEUS in 2004

| Tariff Block   | Capacity Charge (1000 Rp/year) | Classified HEUS | Voluntary Assignment Scenario |                            |                  | Penalty Assignment Scenario |                  |
|----------------|--------------------------------|-----------------|-------------------------------|----------------------------|------------------|-----------------------------|------------------|
|                |                                |                 | Potential HEUS Subscription   | Total Loss (in billion Rp) | % of PLN Revenue | Total Loss (in billion Rp)  | % of PLN Revenue |
| R-450 VA       | 59                             | 3,869,009       | -                             |                            |                  | 230                         | 1.1%             |
| R-900 VA       | 238                            | 341,717         | 11,778,584                    | 2,799                      | 13.5%            | 81                          | 0.4%             |
| R-1350 VA      | 470                            | 1,772,205       | 18,199                        | 9                          | 0.0%             | 832                         | 4.0%             |
| R-2200 VA      | 797                            | 2,637,589       | 6,506                         | 5                          | 0.0%             | 2,103                       | 10.1%            |
| R 2200-6600 VA | 1,204                          | 2,003,698       | 396                           | 0                          | 0.0%             | 2,412                       | 11.6%            |
| R >6600 VA     | 2,713                          | 1,179,816       | 349                           | 1                          | 0.0%             | 3,201                       | 15.4%            |
| All            |                                | 11,804,034      |                               | 2,813                      | 13.6%            | 8,860                       | 42.7%            |

Source: Estimation by the authors based on the SUSENAS Core 2004.

**Table 4.** The revenue loss caused by the HEUS in 2008

| Tariff Block   | Capacity Charge (1000 Rp/year) | Classified HEUS | Voluntary Assignment Scenario |                            |                  | Penalty Assignment Scenario |                  |
|----------------|--------------------------------|-----------------|-------------------------------|----------------------------|------------------|-----------------------------|------------------|
|                |                                |                 | Potential HEUS Subscription   | Total Loss (in billion Rp) | % of PLN Revenue | Total Loss (in billion Rp)  | % of PLN Revenue |
| R-450 VA       | 59                             | 1,534,141       | -                             |                            |                  | 91                          | 0.4%             |
| R-900 VA       | 238                            | 1,135,138       | 9,576,259                     | 2,275                      | 9.3%             | 270                         | 1.1%             |
| R-1350 VA      | 470                            | 197,656         | 41,774                        | 20                         | 0.1%             | 93                          | 0.4%             |
| R-2200 VA      | 797                            | 3,041,949       | 23,607                        | 19                         | 0.1%             | 2,425                       | 10.0%            |
| R 2200-6600 VA | 1,204                          | 1,860,874       | 1,628                         | 2                          | 0.0%             | 2,240                       | 9.2%             |
| R >6600 VA     | 2,713                          | 1,873,510       | -                             |                            |                  | 5,084                       | 20.9%            |
| All            |                                | 9,643,268       |                               | 2,316                      | 9.5%             | 10,203                      | 41.9%            |

Source: Estimation by the authors based on the SUSENAS Module 2008.

### 3.2 Comparison between the characteristics of the subscribers and the HEUS

The following comparisons of economic and demographic and the geographical location attributes of both the subscribers and the HEUS across six tariff blocks, aim to provide an in-depth investigation on the HEUS's motivation, particularly the high income HEUS's motivation to commit capacity fraud. The discussed attributes include the monthly per-capita expenditure (as proxy of income), monthly electricity consumption and the share of electricity expenditure, as well as the floor space of the dwelling represent the economic status of the electrified household. The monthly per-capita expenditure implies the income level of both the subscribers and the HEUS. Figure 1 shows the overall picture that households with higher per capita expenditure are likely to subscribe to high-capacity electricity supply. Besides, one can notice that the HEUS have relatively small amount of monthly per capita expenditure as compared to the subscribers and such gaps grew even bigger in 2008. Generally we found that higher tariff blocks exhibited larger expenditure gaps between the subscribers and the HEUS.

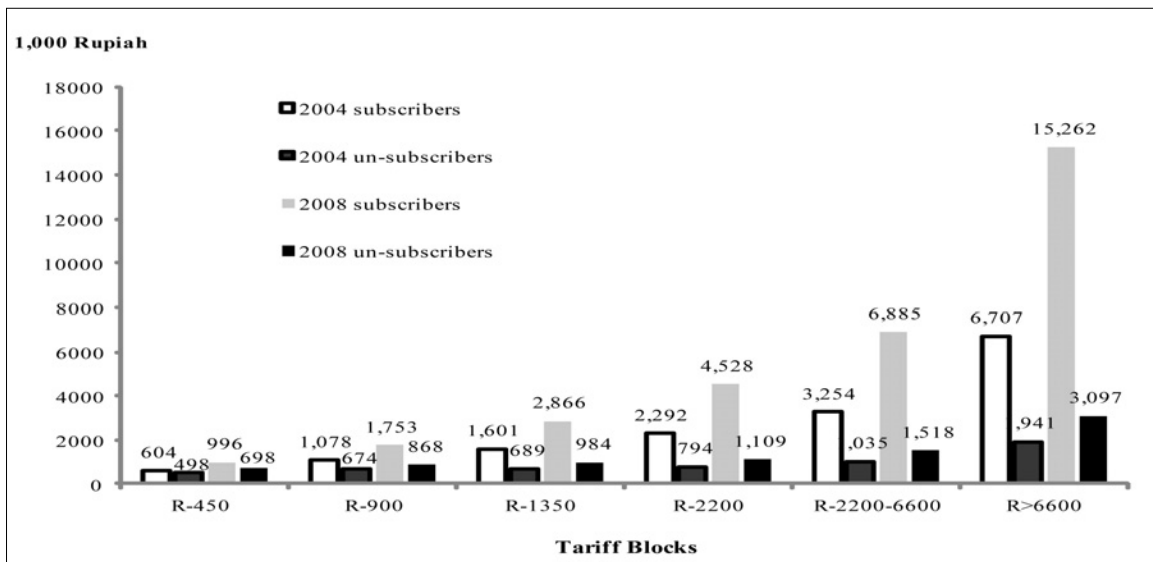


Figure 1. Monthly per-capita expenditure between the subscribers and the HEUS

The subscribers and the HEUS had largely different level of electricity consumption. Despite the monthly electricity consumption of the subscribers was progressive along the tariff blocks in 2004 and 2008; the HEUS' consumption had very mild changes. In fact, the monthly electricity consumption by the HEUS was much lesser than that of the subscribers which less than 65 KWH in all tariff blocks (see Figure 2). For instance, the average consumption of the HEUS subscribed to the tariff block of R-450VA was merely 15 KWH and 9 KWH in 2004 and 2008, respectively. Base on this finding we could estimate that the energy charge associate to those amounts of electricity use are lesser than the capacity charge (meter rental fees), and it becomes obvious that how the illegal electric power connection helps those families avoid the relatively high capacity charge.

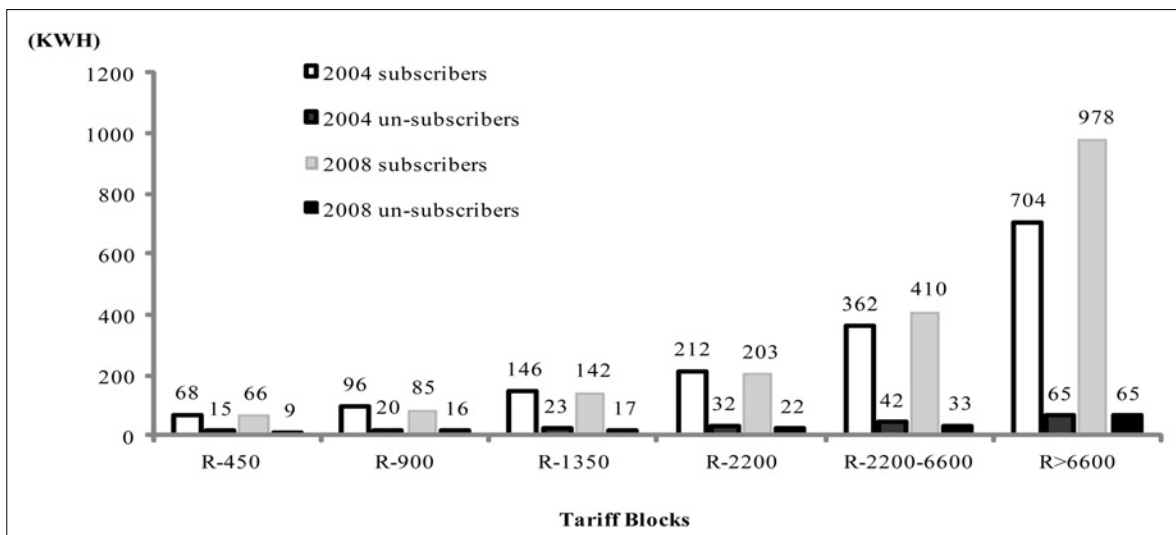


Figure 2. Monthly electricity consumption between the subscribers and the HEUS

Besides the expenditure level, several studies claim that electricity consumption is related to floor space (Pachauri, 2004 and Phillipini., et al. 2004). If a household lives in a bigger house, it demands more for electricity use. Figure 3 confirms the similar finding to those previous studies. As can be seen in the figure, the HEUS lived in smaller house as compare to the subscribers, so it is not difficult to imagine that they had lesser electricity consumption. Averagely, the HEUS lived in the houses with the size less than 108 square meters. The gaps of housing condition in terms of the house size become even more obvious among the HEUS subscribed to high tariff blocks.

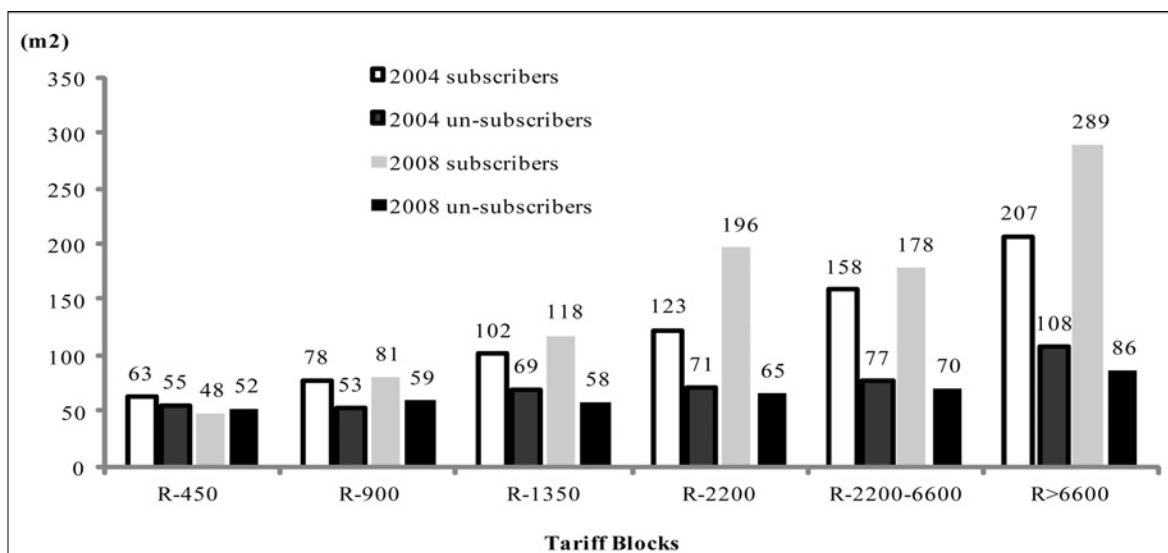


Figure 3. Housing condition in terms of floor space between the subscribers and the HEUS

Figure 4 depicts the burden of electricity expenditure to households having access to electricity across six different tariff blocks reflecting by the monthly electricity expenditure as a share of total monthly expenditure. One can observe that the electricity expenditure share of the HEUS was much smaller than the subscribers in all tariff blocks. In general speaking, their electricity expenditure covered less than 2.5 percent of their total expenditure. If we compare between two different regimes, the electricity expenditure share of both the HEUS and the subscribers in 2008 was lower than 2004. One possible explanation to that phenomenon is that the price of electricity remained unchanged while their expenditure continued growing. Another significant finding is that it appeared that the subsidy shift in 2008 had released the electricity expenditure burden of all the electrified households to a large extent.

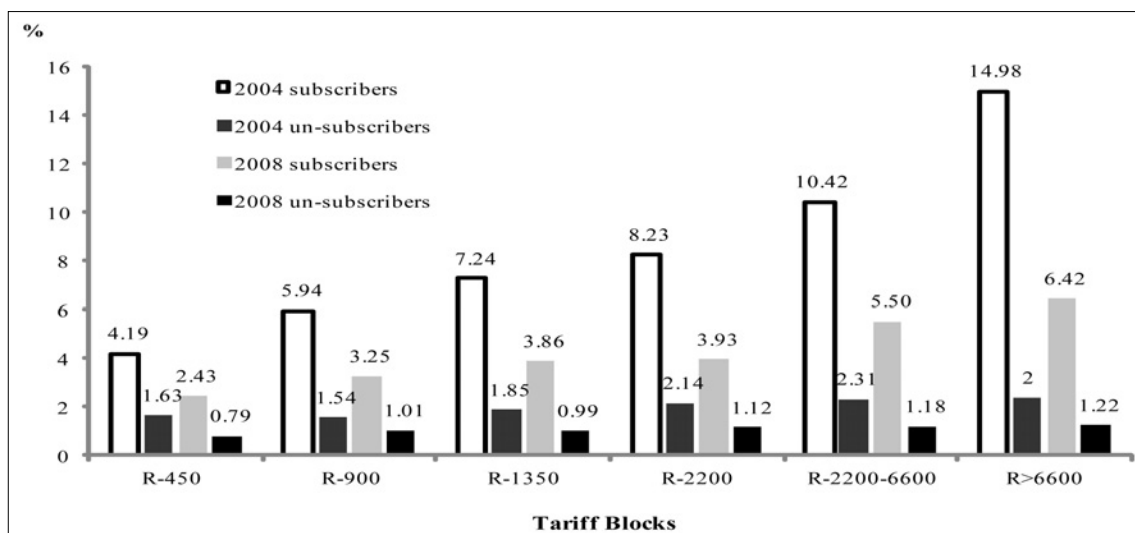


Figure 4. Share of electricity expenditure between the subscribers and the HEUS

The demographical attributes such as education level is one of the important factors to reflex households' awareness of the capacity charge fraud. In this study, six benchmarks were used to measure the education level of the head of household by looking at if they had attained following education qualifications: (1) not finish elementary education; (2) elementary education; (3) junior high school, (4) senior high school; (5) diploma; and (6) bachelor or higher level education. Figure 5 illustrates the education level of the head of household subscribed to six different tariff blocks. As presented in the figure, in 2004 and 2008 the HEUS's education level was apparently lower than the subscribers. The proportion of households unable to finish elementary school (lowest category) and merely finish elementary school (second lowest) was relatively high among all the HEUS groups.

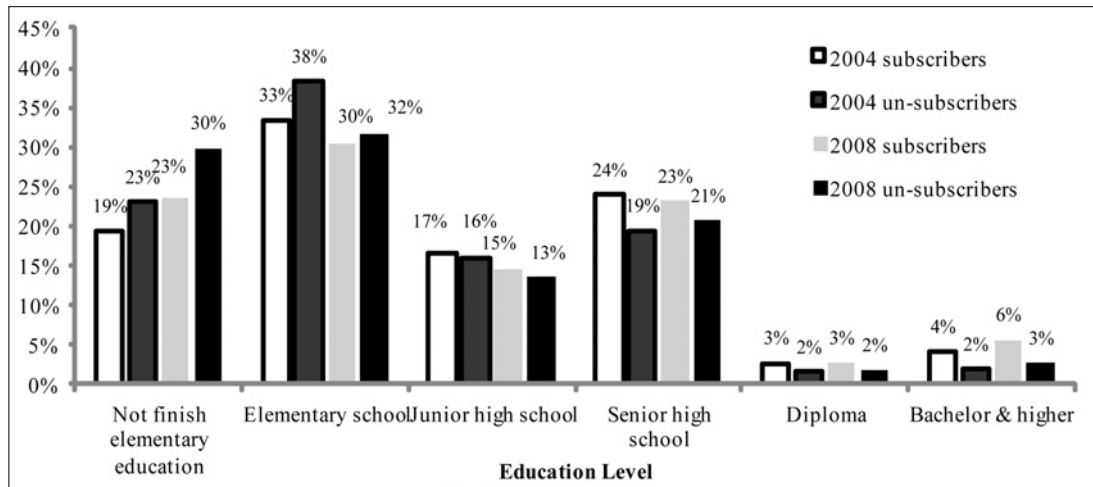


Figure 5. Education level of the head of household of the subscribers and the HEUS

Figure 6 demonstrates how the behavior of capacity charge fraud is related with households' geographical and urban/rural location. The figure displays the proportion of the HEUS in total electrified households spreading in Indonesia's five main islands namely Sumatera, Java, Sulawesi, Kalimantan and the rest part of the country, as well as the urban and rural areas. As shown in the figure, the distribution of the HEUS in the Java Island, which is the richest island in the country, was the smallest among all islands. On the contrary, those outside-Java Islands, which their electrification infrastructures were still left behind, had more HEUS existence. That means besides the pressure from the high cost of connection, it is more likely that limited power supply and lagged subscription services in those islands triggered households, the low-income in particular, to seek easier ways to have electric connection by sharing the meter with their neighbors. The similar findings were found in the case of urban/rural HEUS classification, which there were more HEUS identified to be located in the rural areas than in the urban areas. This can be supported by the authors' knowledge that in the rural areas, it is very common that families living near to each other share electric connection with the same meter. In other words, the inconvenient access to the grid services may induce the households' motivation to be the HEUS. If the households find it is too difficult or time consuming to apply for the grid connection, then they are more likely to directly get the electric power access from their neighbors for convenience.

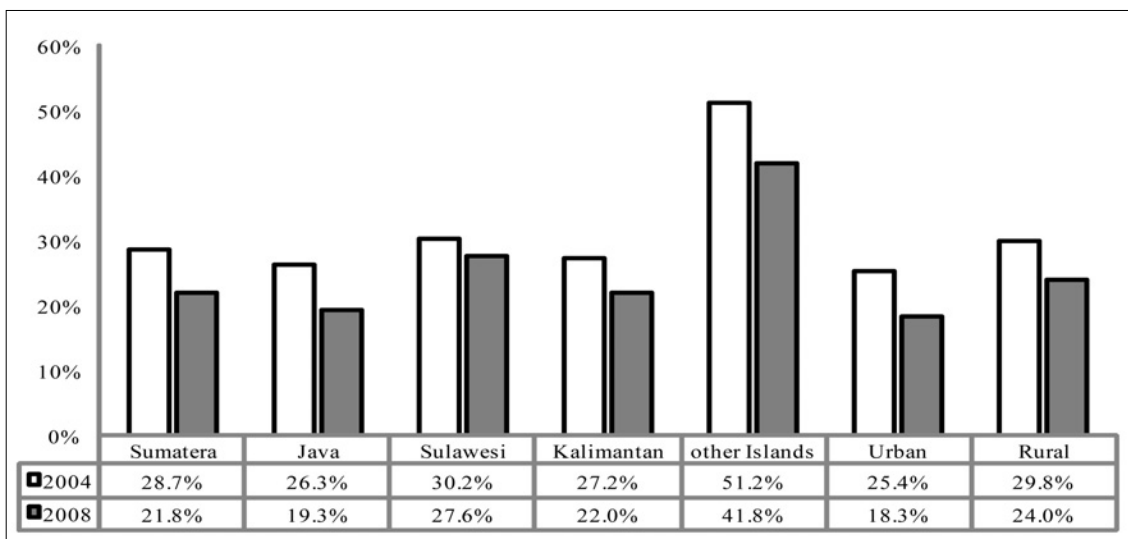


Figure 6. The distribution of the HEUS to the total electrified households by region in 2004 and 2008

#### 4. Discussion and conclusion

The HEUS is prevailing in all levels of tariff block, where legally subscribed households allow other households to connect with their line. Up-to-date, the economic impacts brought by the HEUS still remain unclear due to the information



regarding the HEUS is not available. Thus, aiming to clarify the economic impacts accounted by the HEUS to the electricity utility such as the PLN, by extending from the similar study done by Sulistiyo et al. (2011), this study further estimates the PLN's potential revenue loss on collecting the capacity charge with the HEUS base on the voluntary and penalty assignment scenarios.

In estimating the PLN's potential capacity charge related income loss, the voluntary assignment scenario projects the loss under the assumption that the un-subscribers can choose to subscribe to the tariff block that satisfies their electricity demand. Given the fact that most of the un-subscribers have relatively small demand for electricity, almost all the HEUS were assumed to subscribe to the lowest designated tariff block of R-900VA, so the loss was found to concentrate in this tariff block accordingly. This scenario provides the reference of the minimum revenue loss that the PLN might be able to recover, which were 13.6% and 9.5% of the PLN revenue in 2004 and 2008, respectively. Different from the voluntary scenario, the penalty assignment scenario provides the highest ceiling of the financial loss that the PLN could recover, that were 42.7% and 41.9% of the total revenue in 2004 and 2008, respectively. Under this scenario, the PLN can collect most unpaid capacity charges from the un-subscribers connected to high tariff blocks for more HEUS existence and more expensive capacity charge to be collected.

From several comparisons of different attributes of the HEUS, we could identify that most of the HEUS in Indonesia were from lower income class. Their average education level, monthly expenditure, size of dwelling, electricity consumption, and even their electricity expenditure share were relatively smaller than the subscribers. Based on those findings, we can conclude that the economic motivation is dominant to encourage the HEUS. For instance, poorer households may have smaller demand for electricity. For this reason, the energy charge associates with their electricity consumption is usually lower than the capacity charges or the meter rental fee they are supposed to pay; therefore, their intention to commit capacity charge fraud is merely to avoid capacity charge, or simply, just because they could not afford to pay for new connection (new installation) cost and the capacity charge. Thus, the most likely action for those families to have electricity use is by asking help from their neighbors to get electricity access. This kind of behavior is regarded very common, especially in the rural areas where despite a severe poverty, the relationship among people is still strong and close.

We should also understand that electricity demand could change along the time as people's life styles change. If income increases and living standards improve while electricity tariffs remain unchanged, pushing by the urge for better living quality, households may purchase more electronic home appliances. As a result the demand for electricity is very likely to grow. When the households providing the low-medium capacity meters could no longer satisfy the HEUS' increasing electricity demand, the HEUS probably would seek to get a higher-capacity electric connection. Here, we should be reminded that it is widely known that the PLN has very slow electricity connection application processing speed. It is usually very time consuming for a new subscriber to get the electricity connection with the PLN service agent. On the contrary, it is more speedy and convenient to directly attain the electric connection via a nearby neighbor whose meter has sufficient capacity to provide extra connections. Against such fact, unfortunately, the then electricity laws were not yet strict with this kind of meter rental fee fraud. A combination of all the mentioned conveniences may give us some clues to the drastic increase in the number of the HEUS among the high tariff blocks in 2008.

The evidence from the findings also suggests that household's living location is another matter that triggers different level of capacity charge fraud. The results present that there tended to have less percentage of the HEUS in the urban areas and the economically developed island. For instance, the Java Island is regarded as the most economically developed island in Indonesia and it has the most widest connected electricity systems in east Java, central Java and west Java. On the contrary, the situation is quite different outside the Java Island, which the electricity supply are still decentralized and limited, so the regional branches of the PLN could not efficiently provide the grid connections to all the households. In addition to that, the regional PLN branches usually have slow and inefficient electricity connection services, so that it is more fast and convenient for new dwellings to get electric connection from their legal subscribed neighbors. Furthermore, the fact that the electricity law enforcement is considered relatively loose outside the Java Island, suggests that it is very difficult to manage the wide spread illegal electric connections in a short time.

To sum up, this study has significant contributions by providing the first hand approach to study the recent capacity charge avoidance fraud in Indonesia, and assess the PLN's potential income loss caused by the HEUS using the SUSENAS data combining with the information from the PLN report. Although the number of the HEUS and the consequential revenue loss to the PLN was spotted high, there is still a lack of sufficient measures and policies to reduce the HEUS. It appears that the PLN has failed to detect and manage the illegal electric connection issues for a long period. To reduce such large potential income loss, the PLN ought to revise its electricity regulations and the law enforcement. Furthermore, imposing high penalty to the HEUS and providing them with special discounts on new connections may create positive alternatives to gradually reduce

the number of the HEUS. Last but not least, it is also expected that faster and well responded services from the PLN would reduce the households' motivation of committing to the illegal electric connection fraud.

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### References

- Central Bureau of Statistics (2004); *SUSENAS Core in 2004*. Jakarta, Indonesia.
- Central Bureau of Statistics (2008); *SUSENAS Module in 2008*. Jakarta, Indonesia.
- Fillipini, M., et al. (2004). Elasticities of electricity demand in urban Indian households. *Energy Policy*, 32, 429-436.
- Ikhsan., et al. (2004). Designing a new subsidy system for infrastructure: A case of electricity subsidy, (a JICA project report), *JICA*.
- Pachauri, S. (2004). An analysis of cross sectional variation in total household energy requirements in India using micro survey data, *Energy Policy*. 32, 1723-1735.
- Sulistiyo., et al. (2011). Identifying household electricity un-subscribers under two electricity subsidy regimes in Indonesia, *the International Development Journal of IDEC*, Vol.18, No.1. (in press).
- The State Owned Electricity Company (PLN). (2005). *PLN Annual Report 2004*, Jakarta, Indonesia.
- The State Owned Electricity Company (PLN). (2009). *PLN Annual Report 2008*, Jakarta, Indonesia.
- The World Bank. (2008). *Spending for development-Making the most of Indonesia's new opportunity*, Washington, D.C., The World Bank.