

# Assessing Household Energy Savings and Consumer Behavior in Padang City

Prima Fithri, Lusi Susanti, and Karin Bestarina

**Abstract—** Indonesia's electrification ratio is still around 80.1%, which means that approximately 19.9% of households in Indonesia have not been getting the flow of electrical energy. Household electricity consumptions in Indonesia are generally still dominated by the public urban. In the city of Padang, West Sumatera, Indonesia, about 94.10% are power users of government services (PLN). The most important thing of the issue is human resources efficient energy. Consumer behavior in utilizing electricity becomes significant. Intensive questioner survey, in-depth interview and statistical analysis are carried out to collect scientific evidences of the behavioral based changes instruments to reduce electricity consumption in household sector. The questioner was developed to include five factors assuming affect the electricity consumption pattern in household sector. They are: attitude, energy price, household income, knowledge and other determinants. The survey was carried out in Padang, West Sumatra Province, Indonesia. About 210 questioner papers were proportionally distributed to households in 11 districts in Padang. Stratified sampling was used as a method to select respondents. The results show that the household size, income, payment methods and size of house are factors affecting electricity saving behavior in residential sector. Household expenses on electricity are strongly influenced by gender, type of job, level of education, size of house, income, payment method and level of installed power. These results provide a scientific evidence for stakeholders on the potential of controlling electricity consumption and designing energy policy by government in residential sector.

**Keywords—** Electricity, Energy Saving, Household, Behavior, Policy.

## I. INTRODUCTION

THE energy need of Indonesian country is directly proportional to its population. It is proved by the increase ratio of Indonesia's population which is followed by the increase of final energy consumption [1]. This fact is a challenge, since most of the energy derived from non-renewable sources and in a limited numbers. In this case, the electrical energy deserves serious attention as one of the energy used. The electricity placed as the highest

ranks fourth of energy consumed after fuels, biomass energy, and coal. Although the use of electricity continues to rise, according to the data from the Directorate General of Electricity Ministry of Energy and Mineral Resources in 2013, Indonesia's electrification ratio is still around 80.1%. Indonesian Government strives for the electrification ratio reached until 100% in 2020 through a national energy policy. This target would have to be balanced with the ability to supply electricity to the customers by the Power Users of Government Services, here in after referred to PLN.

Many solutions have been formulated to meet the demand of PLN power, including power generation, periodic maintenance of equipment, intensification, and energy conservation. According to existing literatures, occupant behaviour plays a major role on the amount energy used in house [2-12]. In relation to the savings program, user's habit must be changed in using the energy wisely which will provide a sustainable impact [13]. Some advantages of the user's behavior changes to use energy efficiently: the effectiveness can be felt faster than the improvement of the supporting infrastructure which takes years, it is very efficient in terms of costs and the savings impact can be felt directly by the people [14].

Households can be the basic of the changes in the use of energy-saving behavior of electricity in urban areas because it is the sector which has the largest user of electricity. If the electrical energy uses in this sector can be reduced then, the overall electricity savings can be significant visible. Fig. 1 shows the percentage of PLN's customers based on the segmentation in Padang.

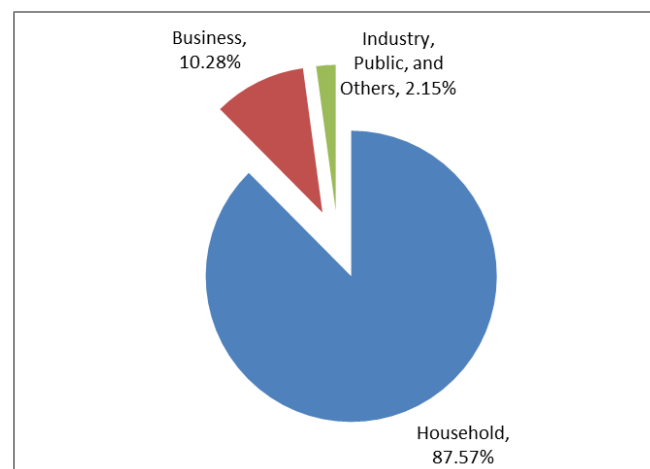


Fig 1. Percentage of PLN's Customer Based on Segmentation of March 2014

Research on energy-saving behavior of households in urban areas has been done before. The potential for energy saving in household electricity can be conducted through

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three approaches : the efficiency of household appliances, the energy saving campaign, and the government policies [15]. In line with these studies, Sukarno (2013) explained that the lifestyle and the household appliances become the main factor of electrical energy consumption in the household sector [16]. Wang et al., 2011; Li et al., 2009; Ouyang and Hokao, 2009; Zhou et al., 2008; Xiaohua and Zhemnin, 2005 also have surveys about household energy consumption in Asia, which there are several factors that affect households energy-saving behaviors [17-21]. Padang city with the population of 765,450 and the wide area of 694.96 km<sup>2</sup>, being one of the cities with a rapid growth rate. The development of infrastructure and facilities are done continuously which followed by the increase in electricity consumption. Febrizal (2012), has been conducting research to predict a large escalation in the consumption of electrical energy in Padang city in 2012-2020 [22]. The prediction can be seen in Fig 2.

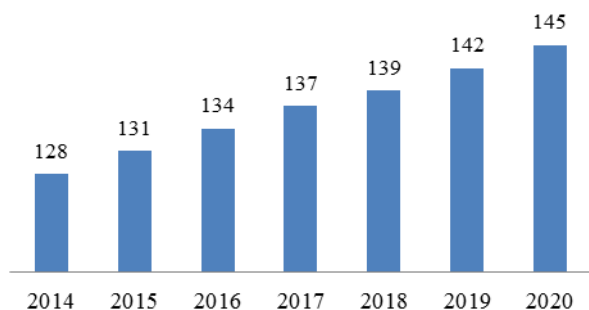


Fig 2. Prediction of Electricity Consumption Padang City 2014-2020 (million KWh)

Therefore, this study is aimed to investigate the current behavior that related to the energy savings in the household sector in Padang, what factors encourage energy savings behavior, and the possible potential savings. The results of this study are expected to be one of the PLN's references for interested parties in setting the policy.

## II. RESEARCH METHODS

The study design determines the sort of questions that can be asked in a structural interview. There were 210 households randomly selected to be investigated. The population of the data was the PLN's customers which belong to West Sumatra Region. The samples were chosen randomly to represent 11 sub-districts. The respondents were recruited through a door-to-door way. Data were collected in April 2014.

List of questions consist of two parts : household's characteristics and electricity saving behavior. The following household characteristics are assumed to have an influence on energy-saving behavior including sex, age, occupation, floor area, household income, family number, education level, method of payment of electricity, number of appliances and customer class. The trigger factors of energy-saving behavior, namely:

### *Attitude*

Most of the literature that discusses the energy savings in households suggests that there is a relation between attitudes and behavior. The influence of behavior is on micro-personal level. The government policies will not run properly if each individual does not align with their own policy. Individual attitudes in using the energy are triggered by socio-economic factors. In this study, the attitudes which is investigated is related to the action in the peak load hours, the action of discharge the electrical equipment when not in use, and the action to encourage energy saving habits to the family members.

### *Household Income*

The most dominant factor of energy saving electrical household income is the sum of household, but in the form of a complex relationship. Several previous studies suggested that the steeper rate of household income the lower level of concern for the environment. But, it still has a relationship with an individual's basic attitude. There is a theory that is commonly used to determine the correlation between energy consumption with household income, the theory of the Kuznets relationship. The relationship can be shown from Fig 3.

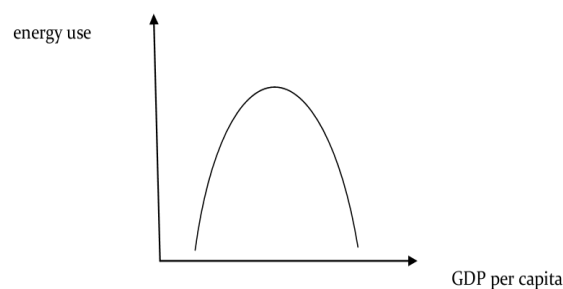


Fig 3. Kuznets Curve

### *Prices*

Price does not have very significant impact. These factors may affect the patterns electricity consumption at household followed by the number of family members, age, socio-economic situation of the family members, the number and types of household appliances. This research will be investigated the response of the family member to the household electricity tariffs and the actions taken when electricity rates have increased or decreased.

### *Knowledge*

Most of the studies in energy use assumes that the public are aware of the amount and the type of energy used. In fact, most of the households do not really know what kind of energy they pay when using a number of tools to support their daily activities, due to the lack of information received. Basically, people need information in order to have knowledge about saving energy consumption. Consistent information through social interaction within the community is able to trigger an effective energy-saving behavior. So that, it is important to study further the knowledge of households in using electricity.

### Other Determinants

There are many other factors that influence energy-saving behavior of households, one of those factors is the size and the composition of the household, as well as the design of the house. The design of the house is related to the building area, the ventilation, and the lighting systems, as well as the room condition.

## III. RESULTS AND DISCUSSION

### A. Characteristics of Respondents

Data of demography shows that the majority of respondents are female with a percentage of 63% and 37% men. Most of the respondents are people aged >50 years (40%), aged 41-50 years (40%), aged 31-40 years (15%), aged 21-30 years (3%), and aged <21 years (2%). Respondents are in various kinds of jobs such as, 23% are government/private employees, 21% are housewives, 19% are self-employment, 15% are traders, 10% are teachers, 6% are retired, 2% are laborers, 1% are farmers, and 2% are others.

Based on the education level of family members, 1% graduates doctor degree, 10% graduates master degree, 59% graduates bachelor/undergraduate degree, 24% graduates high school, 5% graduates junior high school graduates, and 1% graduates primary school. Based on income per month (in Indonesian Rupiah, 1 USD  $\approx$  12,000 IDR), 7% has income >10 million, 15% has income 5-10 million, 38% has income 3-5 million, 24% has income 1.5-3 million, and 16% has income <1.5 million.

Based on the method of electricity payment, 89% using post paid electricity and the remaining 11% have used a prepaid electricity. Based on the classification of the installed power, 47% registered as a customer with 900 VA power, 27% power 1300 VA, 2200 VA power 12%, 12% and 450VA power, and as much as 2% was recorded using the power > 2200 VA.

### B. Characteristics of Appliances

The use of electronic equipment can provide information on the implications of household electricity consumption. In addition, the type and amount of electronic equipment used reflects the attitude and behavior patterns of the households. It can be targeted to potential electrical energy savings. Based on the interview, it is known that most of electronic equipment used by households is used for cooking purposes. Each of the household has at least one unit of Rice cooker, water dispenser, refrigerator, blender juice. The need for air conditioning equipment is quite large, considering the city of Padang is in the tropical region crossed by the equator. A total of 61 among 210 homes have both AC and electric fan.

For lighting needs, 63 households still do not use energy-saving lamps. The majority argues that the price for energy saving lamps is too high while it does not necessarily have significant benefits in reducing electricity bills. Almost all of the households have supporting machines in doing their activities such as iron, machine washing. Television became the primary source of entertainment for the respondents, the total number of television households in the sample that is 280 units. For example, one of the respondents has at least 1

to 5 television units. Most respondents have started to use laptop than computer (see Table I).

TABLE I.  
THE PROPORTION OF THE USE OF ELECTRONIC  
EQUIPMENT

Appliance	Number of household based on the appliance possession			
	1 items	2 items	3 items	>3 items
Rice cooker	186	16	0	0
Water dispenser	153	2	0	0
Refrigerator	186	13	0	0
Juice blender	144	4	0	0
Electric stove	8	0	0	0
Handy mixer	87	0	0	0
Microwave	24	0	0	0
Coffee maker	6	0	0	0
Toaster	32	0	0	0
Food processor	2	0	0	0
Air conditioner	38	12	0	0
Electric fan	93	59	27	11
Television	141	41	16	2
Personal Computer	54	5	0	0
Laptop	68	53	15	7
DVD/CD Player	90	2	0	0
Video game	31	1	0	2
Handphone	26	33	33	85
Washing machine	142	5	0	0
Iron	191	9	0	0
Water pumps	106	3	0	0
Har dryer	14	1	0	0
Vacuum cleaner	27	1	0	0
CFL	61	20	7	59
Incandescent bulb	11	24	9	51

### C. Household's Characteristics and Behavior Correlation

#### Attitude

Household characteristics that influence the attitude of energy saving in the household are the income, the number of family members, and the building area of the house. The area of the house and the family income influence significantly. When the peak load, 39% of households turning off two or more lights while 11% of non-lethal electrical equipment while power is still adequate dominated by households with middle to upper incomes. The action of turn off the electronic equipment during the peak load was motivated by the hope of cheaper electricity bills. The results showed that most of the respondents (98%) suggested energy-saving habits to their family members.

#### Electricity Price

The household response to the energy price is influenced by the head of household's occupation, the level of education, and the income. The level of education and household income has significant influence. The households with the highest education level of family members is in high school, but has arrange of 3-5 million income considered that the electricity rates is cheap. The households with level of education is undergraduate degree with 1-3million income per month also found the electricity rates is cheap. 51% of the households choose to reduce power consumption when the electricity rates increase. However, only 11% of households who choose to replace equipment with more energy efficient.

#### Household Income

Gender, housing size, jobs, education level, household income, electricity bill payment method, and customer class influence household spending on electricity and electronic equipment. 20% of respondents said replacing electronic equipment with more energy efficient when getting more income. From the survey 15% of households know not to use energy saving lamps (CFL). The level of education greatly affects the choice. Average household that does not use energy-saving light is the highest level of junior and senior high school education. They argued that the price of the energy-saving lamps are more expensive.

#### Knowledge

Household knowledge about energy saving attitude is influenced by gender, age, house size, number of family members, income, utility bills payment method, and customer class. Age very significant influence on the probability of respondents informed electrical energy saving. Media is considered to be a potential for energy-efficient information dissemination is a television, chosen as much as 91% of respondents.

#### Other Determinants

Home building design influence on power consumption, especially lighting needs. 35% of households do not pay attention to the house design in an effort to save electricity. Mostly, because they do not have knowledge of it, while other households have limited fund for the re-design of the house. Other factors include the priority of respondents in choosing electronic equipment. Fig 4 shows that 39% households purchase electric appliances because of the quality of the equipment. Only 3% households think that electric power in watt is important factor on choosing the electric appliances.

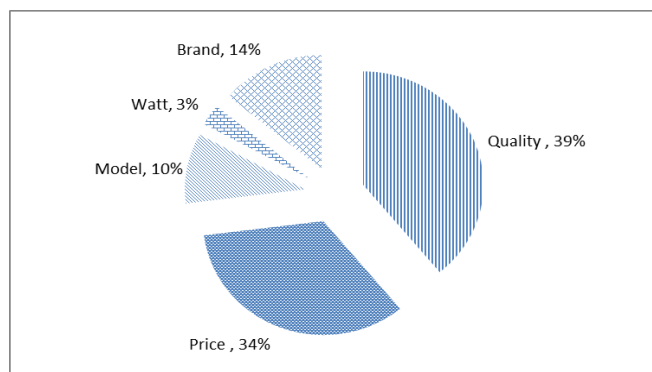


Fig 4. Factor's driving in purchase electric appliances

## IV. CONCLUSION

This research observes the behavior patterns of electrical energy saving in households and seeks the potential of electricity saving through behavioral changing in this sector. Padang demography related to the number of samples participated in this study are classified into the social, economic, and use of technology aspects. The results of the interviews show that households tend to unconcern about their electricity saving habit because the energy prices are reasonably cheap so that in range of affordability of the households to pay, especially for households who have middle to high income. The households tend to consume more electricity as long they afford to pay the electricity bills. The households in Padang are not so well informed

about energy efficient equipment, so it is not a priority in their effort to control power consumption. Households need to be more educated through sufficient information primarily from broadcast media to help them taking action in behaviorally change in electricity energy saving. These findings will provide a scientific evidence for stakeholders on the potential of controlling electricity consumption and designing energy policy by government in residential sector.

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