Electricity Saving Policy for Household in a Multicultural Society - Indonesia

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Abstract

The study of the influence of culture on energy consumption is important for designing the most suitable energy conservation policy to improve society's adaptation to policy. However, the development of energy policy model based on cultural approaches has been hampered by a lack of empirical research. This study investigates household electricity consumption in Indonesia, a multicultural society – case study of three cities: Bandung, Bali, and Yogyakarta. The objectives of this study are: 1) to identify electricity consumption characteristics and the local driving factors of electricity consumption, 2) to investigate consumers' choice determinant in the purchase of electrical appliances and decision-making in electricity consumption, and 3) to design the electricity saving policies based on indigenous response of electricity consumers in order to analyze the effectiveness of localized policies in the current electricity consumption.

Chapter 2 analyses characteristics of household electricity consumption and its driving factors in three cities. This study obtained primary information through questionnaire surveys. The alleged driving factors in electricity consumption were social variables such as life schedule, family size, educational background, and economic factors. In addition, the possession of electricity devices was also investigated. The results found that in Bandung and Bali, higher education level and longer duration time at home had positive effects on the monthly electricity bill. However, the results obtained for

Yogyakarta differ; higher education level and longer duration time at home had negative impacts on the monthly electricity bill.

Higher education levels have higher knowledge and consideration to select higher-efficiency appliances. However, electricity consumption is not only influenced by the rate power consumption of electrical appliances that are purchased, but is also affected by the use of electrical appliances, in which the increased time spent at home causes increasing electrical appliance use. For those issues, electricity consumers' choice determinants in the purchase of electrical appliances and decision-making in consuming electricity were then assessed in Chapter 3 through questionnaire surveys of behavioral economics and human psychosocial variables such as attitudes, beliefs and perceived benefits in the purchase and use of electrical appliances. The questions were 1) reason to replace an appliance, 2) required information of appliance characteristics and its sources, 3) influencing factor in the purchase of appliances, 4) attitude and knowledge lies on the behavioral economics of electricity consumption, and 5) technological perspectives. It was found that quality and price were the most important factors considered prior to the purchase, while energy consumption of an appliance was not main consideration. Furthermore, commercial advertisements were the primary sources of information in Yogyakarta due to their cultural characteristics which believe that self-information search about appliance characteristics without depending on others is to keep their social status, while in Bandung and Bali store's sales staff was the primary sources of information due to their believe with others is part of interaction customs in the society. In addition, related to consuming electricity, payment systems and knowledge of electrical appliance

use (power consumption and energy efficiency of appliances) acted as signal in decision-making.

Chapter 4 discusses policy design for households' electricity consumption in Indonesia – a multicultural country from results of questionnaire analysis in Chapter 3, it has been used to gather policy input from the electricity consumers' perspective. By using model simulation based on policy input in the current electricity consumption, the implementation of electricity saving policy based on local cultures has better performance in as compared to current energy policy in Indonesia.

In the conclusion, the electricity saving policy designs that suitable for three cities are as follow: 1) Related to adoption of high efficiency appliances, for Bandung and Bali, the policy promotion should be delivered through human interaction in order to get wider acceptance. Meanwhile, for Yogyakarta, it should be promoted through self-accessible information sources. 2) Related to wise electricity consumption, for Bali and Yogyakarta, policy should allow people to observe and curb their details electricity consumption. Meanwhile, for Bandung, it should be based on cumulative consumption charges. For the future study, a natural field experiment of energy-efficiency label and multi-payment system should be conducted in the actual consumer purchases and uses of electrical appliances to get the real image of energy-efficiency label and multi-payment system on consumers' decision-making.

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Chapter 1

Introduction

1. Background

Economic development and energy consumption are commonly linked. Higher levels of economic development are associated with higher consumption of energy. Therefore, energy conservation is the dominant issue in discussions of energy policy in most countries. This emphasis is due to the crisis of energy supply, increasing use of excessive energy and the increasing effect of this trend on the environment. Electricity, as a form of final energy, has played an important role in the history of human development. It has brought about many changes in human life since it was first discovered. Growth in electricity use is often correlated with quality of life improvements; increasing individual welfare leads to lifestyle changes. Therefore, the trend towards a lifestyle characterised by the use of modern conveniences is increasing the public's dependence on electricity supply; home appliances, lighting, entertainment devices, and electric cars are some examples of comfort-tools that rely on electricity to make life easier. In the near future, we expect electricity to become society's most consumed form of final energy. Some people even argue that modern humans might not survive without electricity.

The household, as the smallest unit of a community, plays a major role in electricity demand because its consumption increases over time. As noted in several

studies, household energy consumption has been studied in many countries because it generally accounts for a large percentage of total energy consumption (Ghisi *et al.*, 2007), despite the fact that the efficiency of home appliances has increased significantly. Understanding the characteristics of household electricity consumption is important for researchers and policy-makers who are concerned with the impact of households on electricity use and the environment. Therefore, there is an urgent need to raise the awareness that energy use and its impact on the environment should concern all individuals in their daily activities.

Household energy consumption has been shown to be strongly related to the cultural factors (Wilhite *et al.*, 1996; Poyer, *et al.*, 1997; Genjo *et al.*, 2005; Helbert, 2005; Wilson and Dowlatabadi, 2007; Kowsari and Zerriffi, 2011). Therefore, differences in cultural backgrounds may affect residential electricity consumption behaviour. Several researchers have studied the household energy consumption behaviours of a variety of population groups. Poyer, *et al.*, (1997) investigated residential fuel consumption and expenditures on electricity, natural gas, fuel oil, and liquefied petroleum gas (LPG) across different population groups in the United States, comparing Latino and non-Latino households using parameters such as household income, household size, urban and non-urban locations, and energy prices. The results showed that there were significant differences between the fuel consumption patterns of Latinos and non-Latinos. Helbert (2005) studied household cooking fuel choices in Guatemala and found significant differences between the energy portfolios of various ethnic groups as a result of their different cultural backgrounds.

Lutzenhiser (1992) compiled several energy research studies and found that the cultural approach in energy consumption and policy-making has promising applications on three levels, the descriptive, explanatory and predictive analysis of specific applications of energy consumption and conservation. Energy-use patterns and the resulting energy policy implications vary by cultural background. Thus, the study of the influence of culture on energy consumption is important for designing the most suitable energy conservation policy to improve society's adaptation to policy. However, the development of energy policy model based on cultural approaches has been hampered by a lack of empirical research.

Indonesia is comprised of a unique, mixed, and complex social structure. The country has a large number of ethnicities. This condition consequently will have an impact on the culture and on the people's behavior, including in electricity consumption. Generally, the research looking at cultural differences and similarity has done so at a national level (Irawanto *et al*., 2011) then the cultural profile has been used to develop a generalized national policies. However, research into culture conducted at national level does not address issues of diverse sub-cultures existing in the same national context. This study aims to understand the influence of local cultures on electricity consumption in Indonesia. The results of this study are expected to develop strategy and effort to design energy conservation policy based on local cultures to improve the success of policy implementation.

2. Literature Review

Research specific to residential electricity consumption in developing countries is rare. This may be because most energy studies on developing countries such as Indonesia focus on the development of electrical infrastructure sufficient to meet demand (Rachmatullah *et al*., 2006; Shrestha and Marpaung, 2005). A comprehensive study on household electricity demand in Indonesia was conducted by Schipper and Meyers (1991). This study, a Household Energy Study for Urban Java, was conducted under the auspices of the World Bank. The report analysed household electricity and appliance use in Indonesia, particularly on the island of Java. It found that appliances sold in Indonesia at the time were much less efficient than models typically sold in the Organization for Economic Co-operation and Development (OECD) countries. The author then provided recommendations for the adoption of higher efficiency appliances such as those available in the OECD. However, these sorts of recommendations may no longer be relevant because most manufacturers have adopted global standards.

Permana *et al*. (2008) conducted a comparative study of household energy consumption patterns under different forms urban development in a city of Indonesia. However, it did not investigate the factors driving energy consumption. The study attempted to analyse and compare the quantities of energy consumed in transport, non-cooking and cooking purposes in urban areas. The results indicated that the unplanned areas consumed more energy per unit of income than planned and controlled areas. From several studies of residential electricity consumption in Indonesia, there is no study which considers the importance of local driving factors.

Most studies on household electricity consumption have been conducted on the developed nations. Genjo, *et al*. (2005) investigated the relationship between the possession of home appliances and electricity consumption in Japanese households. The study found that the increase in residential electricity consumption was due to the use of an increased number of home appliances. Moreover, higher household economic status and their lifestyle choices lead to increased electricity consumption. Sanquist *et al*., (2011) conducted a lifestyle analysis of residential electricity consumption in United States with respect to social and behavioural patterns associated with income, local electricity price, access to natural gas, air conditioning, laundry usage, personal computer usage, climate zone of residence, and TV use. However, the study failed to link the cultural differences to electricity consumption in the country as discussed earlier by Poyer, *et al*., (1997). A study conducted on Dutch households by Biesiot and Noorman (1999) demonstrated that the main determinants of differences in household energy demand were income and household size. Weber and Perrels (2000) investigated socio-economic and household characteristics in developing a model of lifestyle effects on energy demand.

Wilhite *et al*. (1996) compared household electricity consumption in two countries, Japan and Norway, with similar levels and patterns of material culture and economic development. The results showed that there are certain significant differences in end use patterns for space heating, lighting and hot water use that were due to differences in the countries' cultures. Residential energy use was also investigated in China by Niu and Liao (2001). The study endeavoured to determine technology's impact on future Chinese household demand. The focus of the research was to analyse the impacts of energy

efficiency technologies such as indoor climate control technology, building envelopes, home appliances, and lighting.

A comprehensive literature review on the factors driving household energy consumption was conducted by Guerin *et al.* (2000). The article analysed studies on human behaviour and energy consumption conducted since 1975 to identify occupant predictors of household energy consumption behaviour and changes in energy consumption. Based on the articles reviewed, the variables that were identified as having the largest effects on energy behaviour and energy consumption were income, age, education, number of occupants, size of house, daily activity, appliance ownership, and gender.

Nevertheless, there is no comprehensive study to demonstrate the importance of local driving factors when designing energy conservation policy in framework of different cultural backgrounds. To address the gaps, this study aims to improve our understanding of how cultural factors (i.e. socio-economic differences) are driving households' electricity consumption. Further, this study aims to highlight the important role of cultural differences in the design of appropriate energy conservation policies, which are adopted by wide base of households.

3. Overview of Indonesia

3.1 Indonesian Economy and Electricity

Indonesia's economic growth demonstrates the country's potential to become one of Asia's largest economies. The country is endowed with substantial domestic resources

such as its population and numerous natural resources. The total population in 2009 was approximately 230 million people living in 58 million homes, making Indonesia one of the most populous countries, with average annual population growth of 1.3%. Gross Domestic Product (GDP) between 2001 and 2009 grew by nearly 5.1% on average (SI, 2010a; SI, 2010b). From 2008 to 2009, although Indonesia suffered severely from the global economic crisis, a substantial labour force and potential domestic potential market have created room for consistent economic growth; GDP grew by approximately 4.6%, averting a national economic collapse. Table 1 presents Indonesian economic indicators from 2001 to 2009. To strengthen the country's development in the near future, the government is attempting to grow the economy by at least 7% in 2014.

Additionally, economic development in Indonesia grows the industrial and commercial sectors and improves the people's welfare. From 2001 to 2009, GDP per capita increased sharply, with an average annual increase of nearly 15%. In 2001, GDP per capita was US$ 748, and in 2009 increased to US$ 2,698 (SI, 2010a; CDI-EMR, 2010). These trends are expected to continue in the coming years due to the revival of the world economy. Despite this encouraging economic growth, the bulk of Indonesia's economic activity is still concentrated in Jawa-Madura and Bali, otherwise known as the JaMaLi area. In 2010, this area had a total population of 141 million people, approximately 60% of the country's total population (SI, 2010b).

Table 1: Indonesian economy indicators

	Growth (%)								
	2001	2002	2003	2004	2005	2006	2007	2008	2009
GDP	3.83	4.38	4.72	5.03	5.69	5.5	6.35	6.01	4.55
GDP/Capita	19.56	8.88	6.43	12.66	20.28	18.57	16.5	23.74	12.33
Population	1.36	1.61	1.54	1.2	0.47	1.52	1.55	1.28	0.92

Source: Statistics Indonesia (2010a), and Centre for Data and Information on Energy and Mineral Resources (2010).

Increased economic development is often correlated with a rise in electricity consumption. Consequently, electricity demand has continuously risen on a year-by-year basis. In 2000, total electricity consumption was 79 TWh, which increased to 135 TWh in 2009 (CDI-EMR, 2010), nearly 78% of the electricity was consumed in the JaMali area. In 2009, national electrification ratio reached 63.75%, and this share will continue to grow rapidly as a result of economic growth (PLN, 2009). In the JaMaLi area, the industrial sector currently consumes the largest share of electricity consumption at nearly 47%, followed by the household sector with 39% (MEMR, 2008). Although the industrial sector is the largest consumer of electricity, household electricity consumption tends to increase. By 2027, in the JaMaLi area, the household sector is predicted to consume the most electricity, according to the government's projections; the household sector will account for 59% of total electricity consumption, while the commercial, industrial and public sectors will consume 22%, 12% and 7%, respectively (MEMR, 2008). Household is thus an important group when addressing energy conservation.

3.2 Demography of Indonesia

The total population in 2009 was approximately 230 million people residing in 58 million houses. Indonesia is recorded as one of the most populated countries, with an average annual population growth of 1.3%. Indonesia is a multi-ethnic society with more than 1,000 ethnic/sub-ethnic groups. Nevertheless, the size of most ethnic groups is small, and only 15 groups have more than 1 million people. An ethnic group refers to a cultural identity that involves language, beliefs, morals, laws, tradition and patterns of behavior (Lietaer and De Meulenaere, 2003). According to the 2000 Population Census, published by Statistics Indonesia, the two largest ethnic groups in Indonesia, the Javanese and Sundanese, accounted for 41.7% and 15.4% of the national population, respectively (Suryadunata, *et al.*, 2003). In addition, the Balineses is also considered as one of large ethnic group in Indonesia, although the number is less than 1% of total population in the country. Therefore, Sundanese, Javanese, and Balinese people are the largest electricity consumers in Indonesia. The populations of these ethnic groups are located on Java, Madura and Bali Islands. The distribution of population based on ethnicities is described in Figure 1.

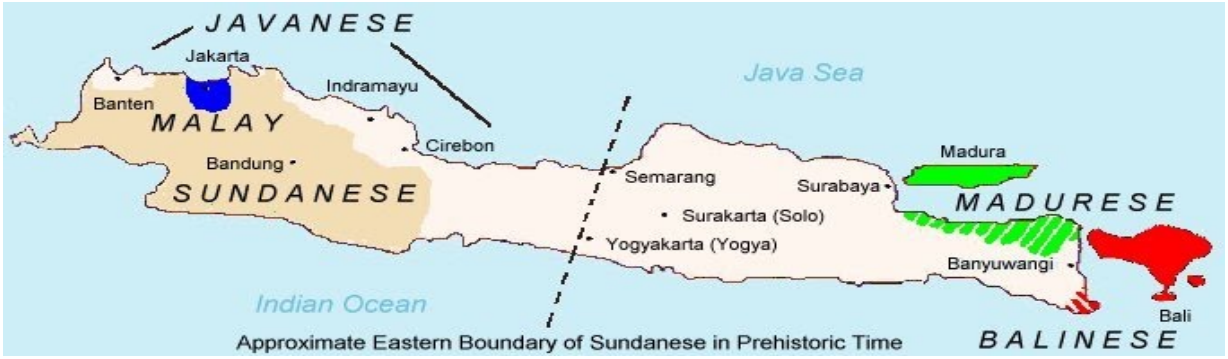

Figure 1: Distribution of population in Java-Madura-Bali Islands based on ethnicity.

Given Indonesia's unique characteristics, the importance of exploring and comparing the differences among cultures in those ethnic groups is discussed based on the latest anthropologists' studies, since the cultural values have not been static, but they have developed overtime. The detailed comparisons of cultural values between Javanese, Sundanese and Balinese are compiled in Table 2.

Javanese

A study from Irawan *et al*. (2011) investigated the development of Javanese values and social structure. The study found that Javanese personal values emerge from the ideology of a peaceful life. It is a result of a meeting of the indigenous, Hindu, Buddhism, and Islam civilizations. The ideology of life, such as: *alus* (pure, calm, polite or soft), *lair* (appropriate behavior), *batin* (inner realm of behavior), *tepo seliro* (tolerate to others), *nrimo* (acceptance), *hormat* (respect) and humble, permeates the everyday life of Javanese people.

In the social life, Mangundjaya (2010) stated that Javanese people value social hierarchy as reflected at the level of their language. According to Irawan *et al*. (2011), the level of spoken language of Javanese can be classified into *krama* or respect and *ngoko* or familiarity. The Javanese society is constructed from the interpersonal relationship in the household scope (Beatty, 2005). One of the guiding principles for interpersonal relationships within a family context as found by Irawan *et al*. (2011) is that of *bapakism*, which translates as 'father-ism'. This principle is manifested as a strong respect for the father, and permeates family boundaries into broader society. In Javanese culture, the

father in the Javanese family is not only the figure who has to be respected based on the *hormat* values, but also *nrimo*: followers have to comply with his decisions.

Table 2: Comparisons of cultural characteristics between Javanese, Sundanese and Balinese

Cultural characteristic	Javanese	Sundanese	Balinese
Assimilation	Indigenous-Hindu-Buddhism-Islam civilizations	Indigenous-Hindu-Buddhism-Islam civilizations	Indigenous-Hindu civilizations
Society structure	Family as the main purpose to build and develop the social identities. The social hierarchy is reflected at the level of Javanese language. The nature relationship within society is strongly influenced by the nature of relationships in a family context.	Similar to Javanese, but it differs by being more overtly Islamic, and has a much less rigid system of social hierarchy.	Society is organized and structured above household level; *banjar* (civil aspects of community), *subak* (irrigation societies), and *pemaksan* (organization of religious rituals).
Perceived individual characteristics and behavior	Javanese values emerge from the ideology of a peaceful life, such as: *alus* (pure, calm, polite or soft), *lair* (appropriate behavior), *batin* (inner realm of behavior), *tepo seliro* (tolerate to others), *nrimo* (acceptance), *hormat* (respect), humble, and aware of their social status in the society.	Individualistic and materialistic but also collectivist culture, interaction with other people with value of harmony and respect, fully aware of their individual rights, appreciate other people's autonomy, and try not to interfere in other people's matters unless asked.	Balinese people are aware of their social degree in the society based on level of their caste, its society structure fostering collectivist, tolerant with ambiguous condition, feminine and have a short term orientation. Individualistic and materialistic but also collectivist culture
Local language	Javanese	Sundanese	Balinese

Sundanese

Similar to Javanese, Sundanese values are also influenced from the meeting of indigenous, Hindu, Buddhism and Islamic values. However, the Sundanese structure of society differs by being more overtly Islamic, and has a much less rigid system of social hierarchy (Mangundjaya, 2010). According to study conducted by Mangundjaya (2010),

the Sundanese people can be regarded as individualistic and materialistic but also collectivist culture, interaction with other people with value of harmony and respect, fully aware of their individual rights, appreciate other people's autonomy, and try not to interfere in other people's matters unless asked.

Balinese

Balinese culture and value are influenced by the indigenous and Hindu (Beatty, 2005). Balinese people ties up on the philosophy of *Tri Hita Karana* or literally 'the three causes of goodness', or responsibility for maintaining balanced relationships between the tripartite spiritual, social and environmental domains (Waren, 2012). It was supposed to be the fundamental planning principle supporting the unique character of Bali's culture.

In contrast to Javanese and Sundanese society, Bali society is organized above household level (Beatty, 2005), and respect the caste system (*Shudras*, *Wesias*, *Ksatrias* and *Brahmins*). According to Litaer and De Meulenaere (2003), the Balinese society structure is divided into *banjar* (civil aspects of community), *subak* (irrigation societies), and *pemaksan* (organization of religious rituals). Based on their philosophy and society structure, Balinese people are aware of their social degree, collectivist, tolerant with ambiguous condition, feminine and have a short term orientation (Mangundjaya, 2010).

3.3 Energy Policy In Indonesia

3.3.1 Energy Policy Related to Household Sector

Household electricity demand in Indonesia has increased (CDI-EMR, 2010). Recent economic growth has resulted in an improvement in overall living standards in Indonesia,

which has an expanding population. A number of household energy conservation regulations have been issued by the government, but the actual influences on household electricity consumption have not been systematically analyzed.

Indonesia has one of the lowest electricity prices in Asia. The electricity prices for the household sector have remained constant from 2003 to 2012, although the cost of supply has more than doubled from US$ 0.056 to US$ 0.132/kilowatt-hour (kWh) between 2004 and 2008. In real terms, the prices have actually decreased by approximately 50% between 2003 and 2009. Over the same period, the prices for residential customers in countries throughout the local region have increased: 33% in the Philippines, 20% in Malaysia, 18% in Vietnam, and 11% in Singapore (ADB, 2010).

According to Ministry of Energy and Mineral Resources (MEMR) regulation No.7/2010, the electricity prices for the residential sector is essentially categorised into three groups of consumers: low-class households (with installed wattages of 450 to 2,200 VA), medium-class households (3,500 to 5,500 VA), and high-class households (more than 6,600 VA). The majority of respondents surveyed in this study were included in the low-class household group because this group represents the largest category of residential electricity consumers in the country. The electricity tariffs for the low-class households are ranged from US$ 0.042/ kWh to US$ 0.080/ kWh.

Low electricity prices and a subsequent lack of incentive for energy efficiency improvement have resulted in Indonesia's high energy intensity. Furthermore, although regulation about energy standards and labeling for home appliances (controlled by Government Regulation No. 70/2009), and the energy labeling standard (governed by the

Standard National of Indonesia (SNI) No. 04-6958-2003) have been enacted, however, energy labeling does not yet appear on the appliances sold on the market. Therefore, the results of energy saving are far from the consumption levels expected by policy makers.

3.3.2 National Energy Policy

Since 1999, Indonesia have shifted its style of government, from a centralistic to decentralized one, highlighted by the country's decentralization Laws No. 22/1999 and 25/1999. These laws formed the basis of radical decentralization of responsibility to local governments; districts (*kabupaten*) and municipalities (*kota*) to manage local administrative and autonomy, including to manage local natural resources and the environment (Setiawan and Hadi, 2007).

As a consequence of the imposition of decentralized governance system, the country has stipulated new energy Law No. 30/2007 and new electricity Law No. 30/2009, which authorize local governments to decide local energy planning and management, including effort to implement energy conservation. However, the legislations provide no clear guidelines for power sharing among central and local governments. It makes the local governments loss their capability to implement the regulations. In addition, the whole energy regulations have many weaknesses, such as a lack of recognition of local customs including the value of local wisdom and culture, and lack of detailed explanation regarding the appropriate role of community participation in energy conservation efforts. Therefore, until recently, no real efforts were made to increase the capacities of local government to design and manage local energy supply and demand.

Having an understanding of the characteristics of household electricity consumption and its driving factors can play a very important role in designing proper regulations related to energy saving in households. This may help facilitate the adoption of general energy policies. Therefore, there is an urgent need to study the cultural impact on the pattern of electricity consumption in each region with regard that Indonesia consists of many different cultural backgrounds in order to optimize the management of power consumption with different strategies of energy conservation policies in accordance with the local culture.

4. Study Hypothesis

Considering that culture involves the patterns of people behavior (Lietaer and De Meulenaere, 2003), variety of cultural backgrounds in Indonesia may affect residential electricity consumption behaviour. Lutzenhiser (1992) argued that there is a need to understand the relationships between human groups (culture, ethnics or races) and their technologies and that these relationships can be used to account for and manage electricity consumption. Therefore, the hypothesis of this study is as below:

Electricity consumption is influenced by cultural factors. Therefore, strategy and effort to design electricity saving policy in Indonesia – a multicultural country, should be based on local cultures in order to improve the success of policy implementation.

4.1. Questions related Hypothesis

To easily help that the hypothesis will be answered by this study, several questions related to hypothesis are developed, as below:

1. What is the relative contribution to electricity demand from different cultural groups?
2. What would be the electricity implications of specific shifts in consumer behaviors and practices of different cultural groups?
3. What would be the relative impacts of various policy options to electricity demand on different cultural groups?

5. Study Objective

In order to design localized electricity saving policies based on local cultures to improve success of policy implementation in the multicultural society, the following objectives of study are needed:

1. To identify electricity consumption characteristics and the local driving factors of electricity consumption in Indonesia.
2. To investigate consumers' choice determinant in the purchase of electrical appliances and decision-making in electricity consumption.
3. To design the electricity saving policies based on indigenous response of electricity consumer.

6. Steps in the Study

The study is categorized into two main steps:

1) *Identification of techno-socioeconomic and behavioral characteristics of electricity consumption under influence of local cultures.*

In the beginning of this study, the differences of characteristics between major cultures in Indonesia have been identified through several anthropologists' studies. From those differences, the characteristics of electricity consumption under influence of different cultures background will be investigated. Through a very deep understanding on its characteristics, the driving factors of electricity consumption could be identified as input for designing the most suitable energy conservation policy in Indonesia.

The identify characteristics of electricity consumption starts from at the high level of techno-socioeconomic identification such as: the household characteristics, the possession of electricity devices, electricity consumption and house characteristics are investigated to obtain the relationships between electricity consumption and its driving factors. Moreover, human psychosocial variables, behavioral economic variables, and policy and technological perspectives of household electricity consumers are also identified in the different cultural background as the complementary of techno-socioeconomic analysis.

The exploration on driving factors of electricity consumption in perspective of electricity consumer could lead to the entire understanding on how the culture influenced to the people on their electricity consumption behavior. These patterns

could be a starting point to design the most suitable energy conservation policies in the household sector.

2) *Development of residential electricity conservation policy based on consumer perspective under influence of local cultural factors*

The identification results as found from the previous step, gives some conclusion about the dominant factors influencing to the electricity consumption based on indigenous response of each cultural group. Thus, these factors could be considered to develop several alternative policies in order to manage electricity consumption in the household sector more optimally. A new concept of energy efficiency and energy saving policies that integrates consumer decisions and behaviors within a framework of the local cultures will be proposed based on input obtained in the previous step. It consists of a new national policy and specific policy based on different indigenous responses. The proposed policies will be constructed through aims to influence the human psychosocial factors in consuming electricity.

The proposed alternative policies will be evaluated through complex bottom-up model of current electricity consumption in order to obtain effectiveness of policy in promoting electricity saving, quantitatively. The time horizon in this study will be from 2010 to 2020. Finally the results of this research would be expected to give recommendations on design of localized electricity saving policy based on its indigenous culture to be implemented in Indonesia.

7. Objects of Study

Since approximately 60% of the country's total population and nearly 78% of the electricity was consumed in the Jawa-Madura and Bali Islands, or known as JaMali area, this study will be focused in these areas. Furthermore, Sundanese Balinese, and Javanese people are the largest electricity consumers in Indonesia. The populations of these ethnic groups are located on Java and Bali Islands. Therefore, three cities are selected as objects for this study:

1) Bandung as representative of Sundanese culture,
2) Denpasar (hereafter called as Bali) as representative of Balinese culture,
3) Yogyakarta as representative of Javanese culture.

These cities were selected due to the cultural density that each city represents for its respective culture. The cultural differences between these cities are presented in sub-section 3.2 of this chapter (Demography of Indonesia).

Bandung

Bandung is widely known as *Paris Van Java* because luxurious hotels, restaurants, cafes and European boutiques were opened in this city during the period of Dutch colonisation. Today, the city is still regarded a centre of fashion in Indonesia. Bandung is approximately 180 kilometres southeast of Jakarta and is the capital of West Java province. Rapid urban development in recent years has increased the temperature in Bandung significantly, the average temperature ranges from 24 to 29 degrees Celsius (Tursilowati, 2005). Most of the population is Sundanese.

Bali

Denpasar is located in Bali Island and the capital city of the Bali province. The average temperature is around 29.8°C with the lowest average is around 24.3°C. It has a rapidly expanding population of 788,445 in 2010, up from 533,252 in the previous decade (SI, 2010). Most of the population is Balinese.

Yogyakarta

This city was the capital of Indonesia from 1945 to 1949. At present, it is one of the county's special provinces and the centre of Javanese culture. Geographically, it is located in the southern part of Central Java area. The average daily temperature ranges from 26 and 28 degrees Celsius, and Yogyakarta is bathed in tropical sunshine throughout the year. In addition to its culture, Yogyakarta is known as the student city because a large proportion of its inhabitants are students, while most of the population is Javanese.

8. Organization of the Dissertation

The dissertation begins with explanation on the background of this study, literature review, overview of Indonesia and its multicultural society, study hypothesis, objectives, step of study and objects of study in Chapter 1.

Techno-socioeconomic analysis of electricity consumption as part of the assessment to identify the influence of local culture in electricity consumption is presented in Chapter 2. This chapter looks at the high level of techno-socioeconomic variables such as household size, income, resident characteristics and household

electrical devices. The electricity consumption patterns and its driving factors in different cultures are obtained and explored in this study.

Continuing discussion in the previous chapter, Chapter 3 explores in details of assessment of household electricity consumers in term of behavioral economics and human psychosocial variables such as attributes, psychosocial, behavioral economic variables, policy and technological perspectives. By exploring perspective of electricity consumers, some most suitable policy framework and policy ideas for the society under different cultural background are concluded in the end of this chapter.

The effectiveness of localized electricity saving policies obtained in the previous chapters is examined in Chapter 4 through current electricity saving projection. Finally, in the conclusion, recommendation of the optimal design of electricity saving policy for multicultural society and future study are presented in Chapter 5.

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Chapter 2

Households' Electricity Consumption Characteristics in Indonesia: A Techno-Socioeconomic Analysis

Understanding the characteristics of household electricity consumption and its driving factors is important for designing proper regulations related to household energy savings. Such an understanding will ensure that policies are more broadly adopted by society. Hence, the main purposes of this chapter are to provide important and useful initial information on Indonesian household end-use electricity consumption characteristics and present a comparative analysis of electricity consumption characteristics in three cities with different cultural backgrounds to demonstrate the importance of local driving factors when designing energy conservation policy.

1. Data Collection

To accurately predict household electricity consumption, this study obtained primary information through a survey conducted in three cities, Bandung, Bali, and Yogyakarta. The survey was conducted from January to February 2011, to understand techno-socioeconomic analysis of electricity consumption. In addition, in Bandung, only Sundanese people were recruited as respondents, while in Bali and Yogyakarta, only

Balinese and Javanese people were selected, respectively. The selected sample was validated with the statistics of both cities published by Statistics Indonesia in order to avoid sampling bias. The total sample size was rounded to 100 respondents in each city according to the income level distribution.

Despite the low number of sample, the reasons to include particularly these households were based on the following considerations:

1) Currently, there is no available data in the country about residential electrical appliances. Therefore, initial information about the characteristics of Indonesian household electricity consumption was developed by using small sample size from resident in Bandung, Denpasar (Bali), and Yogyakarta cities. This study is the first time that collected data of residential electrical appliances in Indonesia.
2) Since this study is the first time, there are several barriers such as time constrains, financial limitation and low participatory response from respondents. The respondents were recruited through a door-to-door solicitation procedure in which they were asked to consent to a survey of their home appliances, review of their monthly electricity bill, and an in-depth interview regarding household members and their typical electricity use behaviour. A lot of prospective respondents rejected to participate in this survey due to their own privacy.

1.1 Questionnaire Design

The household's lifestyle can be reflected in its electricity consumption (Sanquist, *et al.*, 2011). It is influenced by climate characteristics, economic circumstances, housing

equipment, and resident characteristics (Guerin *et al.*, 2000, Genjo *et al.*, 2005, Ghisi *et al.*, 2007, Sanquist, *et al.*, 2011). However, as Bandung, Denpasar, and Yogyakarta have similar climate conditions, we ignore the effect of climate on electricity consumption.

To obtain a clear image of how the household consumes electricity, the driving factors should be identified. The alleged driving factors in electricity consumption are social variables such as life schedule, family size, educational background, and economic factors. In addition, the possession of electricity devices is also considered to give a significant contribution in driving electricity consumption in the households. These factors are considered as driving factors in electricity consumption since these are closely influencing to the habits on the electricity consumption.

Table 3 presents details on the items investigated in the questionnaire of this study. The household characteristics include household size, income, and resident characteristics (size, education, employment, and living schedule). To discover the relationship between the monthly electricity bill and electricity consumption, the possession of electricity devices and lighting are also included in the investigation. The relationships between electricity consumption and its driving factors are evaluated using multivariate data analysis.

Table 3: Investigated items in the questionnaire

No.	Criteria	Contents
1.	Household characteristics	Household size, education, employment, living schedule, and monthly income
2.	Possession of electricity devices	Type of device, number of devices, power consumption, and daily use
3.	Electricity consumption	Average monthly electricity bill paid by the household

Table 4: Household electricity devices and lighting included in this research

No.	Category	Devices
1.	Cooling	Air-conditioners and electric fans.
2.	Cooking	Microwave ovens, rice cookers, juice blenders, hand mixers, refrigerators, toasters, water dispensers, and coffee makers
3.	Lighting	CFLs, fluorescent bulbs, and incandescent bulbs
4.	Entertainment and Information	Televisions, radios, CD/DVD players, computers, video game consoles, and laptops
5.	Others	Washing machines, water pumps, hair dryers, and irons

Household electrical devices and lighting were categorized into five types based on the typical use: cooling, cooking, lighting, entertainment and information, and others. In a tropical country, such as Indonesia, heating devices are not required, but cooling devices are widely used. Table 4 presents the details of electricity devices for each house. The cooling devices consist of air-conditioners and electric fans. For cooking purposes, only the most commonly used devices in Indonesia are included: refrigerators, rice cookers, water dispensers, juice blenders, hand mixers, and microwave ovens. Regarding lighting, Indonesian households typically use compact fluorescent bulbs (CFL), fluorescent bulbs, and incandescent bulbs, although incandescent bulbs are used less frequently than the other two bulbs. More advanced lamps such as light-emitting diode lamps (LED lamps) are currently not widely used in the country due to the high initial cost. The entertainment and information devices generally consist of televisions, computers, laptops, radios and CD/DVD players. Finally, devices such as washing machines, water pumps and irons are included in other devices.

2. Socio-Economic Characteristics of Households in Indonesia

2.1 Economy Characteristics

The first component of the analysis comparing household welfare between the three cities is income level. In Bandung, the largest income category is households with monthly incomes below US$ 300, approximately 46%. Similar to Bandung, in Bali and Yogyakarta, households with monthly incomes below US$300 was also the largest income group, but this group's share was substantially larger in this case, representing more than 65% and 75% of total respondents, respectively. In general, the trends in income level were similar across the cities, where households in the lowest income group were the most common. However, households in Bandung had higher average incomes than Bali and Yogyakarta households. Figure 2 shows the details of the income level comparison between households in Bandung, Bali and Yogyakarta.

The average number of residents per household was four persons in Bandung, Bali and Yogyakarta, and nearly all investigated householders were couples and couples with children. The number of residents per household is then compared to income levels in both cities to determine the income distribution (see details in Figure 3). At the lowest income level (less than US$ 300), three cities were similar, where households with three to four persons were the most common, followed by households with one to two persons. Similarly, for incomes ranging between US$ 300 to 500, households with three to four persons were still the most common. In Bandung, households with five to six persons were the most common for income levels between US$ 501 and 1,000, and over US$ 1,000. In Bali, households with one to two persons were the most common for income levels

between US$ 501 and 1,000, flowed by households with five to six persons. In Yogyakarta, an income level between US$ 501 and 1,000 had a larger share of households with five to six persons, while for an income level above US$ 1,000, households with five to six persons and seven persons accounted for equal shares.

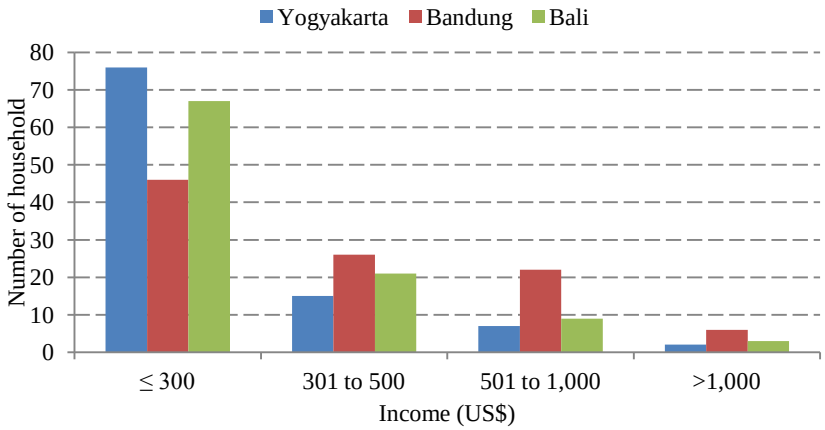

Figure 2: Comparison of household income levels in Bandung, Bali, and Yogyakarta.

Respondents in Bandung and Bali usually have a house that is relatively more extensive than those in Yogyakarta. The survey results (see Table 5 for additional details) revealed that the majority of people in Bandung and Bali are likely to live in homes with floor areas of approximately 100 to 179 m^2. Nearly all houses in three cities had brick walls, while only a few houses had walls composed of wood or combination of wood and brick. In Yogyakarta, as land is expensive, although the city is not a business centre, residents tended to build houses with floor areas ranging from less than 100 m^2 and from 100 to 179 m^2.

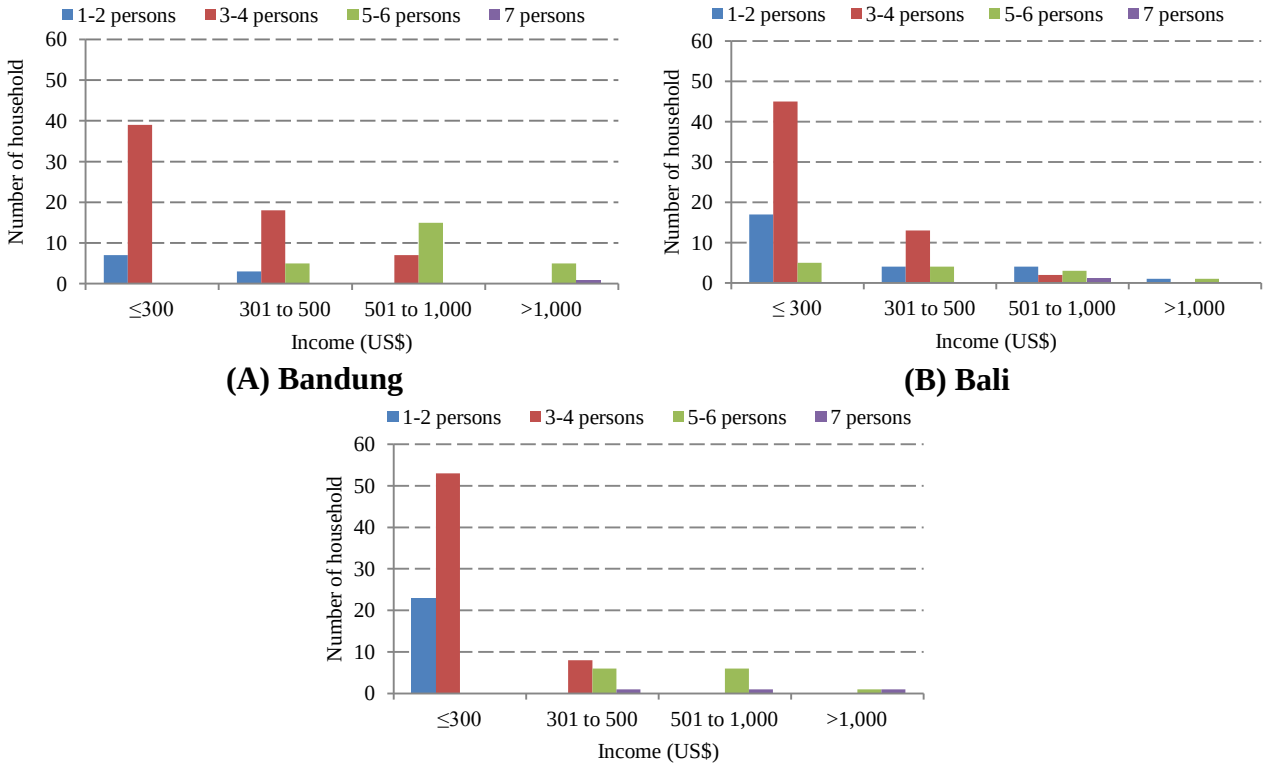

Figure 3: Relationship of household size and income level in (A) Bandung, (B) Bali, and (C) Yogyakarta.

Table 5: House characteristics

City	Number of houses based on floor area				House structure		
	<100 m^2	100 to 179 m^2	180 to 259 m^2	>260 m^2	Brick wall	Wooden	Mix wall
Bandung	23	50	16	11	94	0	6
Bali	22	48	18	12	83	5	12
Yogyakarta	40	40	9	11	93	2	5

2.2 Social Characteristics

Bandung and Yogyakarta are widely known as centers of education in Indonesia and tourism, while Bali is famous as a tourism city. Each city has a number of public and private educational institutions. Thus, the residents of both cities were familiar with the importance of education. Education in Indonesia includes preschool, elementary school (six years), junior high school (three years), senior high school (three years) and higher

education. The government mandates nine years of compulsory education, which includes six years of elementary school and three years of junior high school. The research findings demonstrated that the respondents' education levels ranged from preschool to doctoral degrees, and the average education level of all respondents was senior high school.

The average daily amount of time spent at home from Bandung and Yogyakarta was similar, approximately 7.2 hours per day excluding sleeping time. Meanwhile in Bali, it took a bit longer, which was approximately 7.6 hours/day. Children and housewives accounted for the bulk of daily time spent at home. The average amount of time workers spent at home was 4.5 hours per day during working days in three cities. On weekend days, approximately 76% of respondents in Bandung chose to stay at home and 24% of respondents spent time outside. In Bali and Yogyakarta, nearly all respondents preferred to spend weekend days at home, approximately 94% and 91% respectively. Respondents in Bandung represented several sectors such as civil service (20%), entrepreneurs (15%), private employees (65%), and pensioners (10%). In Bali, most respondents were private employee (56%) and followed by entrepreneurs (32%), civil servant (10%), and pensioners (2%). The composition was slightly different in Yogyakarta, where approximately 30% were civil servants, 25% entrepreneurs, 30% private employees, and 15% pensioners.

3. End-use Electricity Consumption of Households in Indonesia

3.1 Lighting

The most widely used bulbs in Bandung, Bali and Yogyakarta households were CFLs, followed by fluorescent bulbs, and incandescent bulbs. However, in our survey, incandescent bulbs are generally only used for certain purposes such as in bathrooms and bedside lamps. For Bandung households, on average, 78% were CFLs, 15% were florescent bulbs, and 7% were incandescent bulbs. In Bali, 67% were CFLs, 22% were florescent bulbs, and 11% were incandescent bulbs. In Yogyakarta, 82% of households used CFLs, 12% used florescent bulbs, and 6% used incandescent bulbs. The average power of CFLs and florescent bulbs ranged from 8 to 40 Watts, while incandescent bulbs ranged from 5 to 10 Watts.

3.2 Electrical Devices Ownership

Individual welfare in many situations can also be reflected in the ownership of electrical appliances. An increase in appliance ownership leads to a high growth rate in household electricity consumption. Hence, the identification and analysis of home appliances would be helpful for understanding electricity consumption characteristics in households. Moreover, it would also assist in the development of energy conservation strategies. This study also investigated home appliance ownership in both cities categorized into cooling, cooking, lighting, entertainment and information, and others. Detailed results of the survey of home appliance ownership are shown in Table 6. Currently, modern cooking devices such as toasters, juice blenders and microwaves are not popular in Indonesia. However, in the near future, these devices will be widely used in Indonesia due to

people's increasing welfare and changes in lifestyles as shown in Malaysia (Saidur, *et al*., 2007), Ireland (Leahy and Lyons, 2010), and Austria (Haas, *et al*., 1998).

Table 6: The possession of electrical devices in Bandung, Bali and Yogyakarta

City	Appliance	Number of household based on the appliance possession			
		1 Item	2 Items	3 Items	≥4 Items
Bandung	**Cooking**				
	Rice cooker	90	5	0	0
	Refrigerator	77	6	0	0
	Water dispenser	19	1	0	0
	Microwave oven	19	0	0	0
	Juice blender	7	0	0	0
	Toaster	2	0	0	0
	Handy Mixer	1	0	0	0
	Coffee maker	1	0	0	0
	Electric stove	1	0	0	0
	Cooling				
	Electric fan	38	6	3	0
	Air conditioner	7	3	1	1
	Entertainment/Infotainments				
	Television	33	29	20	18
	Computer	42	7	1	0
	Radio with CD/DVD player	41	5	0	0
	CD/DVD player	34	4	1	1
	Laptop	28	6	0	0
	Game machine	6	0	0	0
	Others				
	Washing machine	78	0	0	0
	Water pumps	58	1	2	0
	Iron	60	0	0	0
	Hair dryer	2	0	0	0
Bali	**Cooking**				
	Rice cooker	89	3	0	0
	Refrigerator	80	3	0	0
	Water dispenser	4	0	0	0
	Microwave oven	16	0	0	0
	Juice blender	15	1	0	0
	Toaster	17	0	0	0
	Handy Mixer	3	0	0	0
	Coffee maker	4	0	0	0
	Electric stove	0	0	0	0
	Cooling				
	Electric fan	31	22	4	1
	Air conditioner	12	2	0	0

	Entertainment/Infotainments				
	Television	66	12	5	1
	Computer	23	6	0	0
	Radio with CD/DVD player	30	4	0	0
	CD/DVD player	37	2	0	0
	Laptop	21	3	0	0
	Game machine	6	0	0	0
	Others				
	Washing machine	63	0	0	0
	Water pumps	42	0	0	0
	Iron	59	5	1	0
	Hair dryer	9	0	0	0
Yogyakarta	**Cooking**				
	Rice cooker	81	4	1	0
	Refrigerator	77	8	3	0
	Water dispenser	9	0	1	0
	Microwave oven	6	0	0	0
	Juice blender	21	2	0	0
	Toaster	0	0	0	0
	Handy Mixer	12	0	0	0
	Coffee maker	0	0	0	0
	Electric stove	1	0	0	0
	Cooling				
	Electric fan	47	18	11	4
	Air conditioner	9	4	2	2
	Entertainment/Infotainments				
	Television	57	28	13	1
	Computer	47	7	0	0
	Radio with CD/DVD player	26	1	2	0
	CD/DVD player	23	3	0	0
	Laptop	15	7	6	1
	Game machine	4	0	0	0
	Others				
	Washing machine	52	0	0	0
	Water pumps	81	6	0	0
	Iron	51	1	1	
	Hair dryer	2	0	0	0

In general, the ownership of entertainment and information devices in Bandung was much higher than in Bali and Yogyakarta. Television was the major entertainment and information devices owned by almost all respondents in both cities. The total number of televisions in Bandung was about 223; 33 households had 1 television, 29

households had 2 televisions, 20 households had 3 televisions, and 18 households had more than 3 televisions. Meanwhile, the number of televisions in Yogyakarta was about 156, and more than 57% of households only owned 1 television. Otherwise, 28%, 13%, and 1% of households owned 2, 3, and more than 3 televisions respectively. In Bali, the number of television was much lower than in Bandung and Yogyakarta, it was only about 109 televisions. It was found that in three cities, the majority televisions owned by respondents were CRT (Cathode Ray Tube) types which accounted for around 90% of the total, while only about 8% were LCD (Liquid Crystal Display) sets. The television sizes ranged from 14 to 52 inches, but the most common was 21 and 29 inches.

After television, the computer took second place as most commonly owned entertainment and information device. Total computer in Yogyakarta was slightly higher than in Bandung and Bali, about 61 items compared to 59 and 35 items. The numbers of computers and laptops in Yogyakarta was also higher than in Bandung and Bali. In terms of radio, CD/DVD player, and game machines, Bandung was ahead of Bali and Yogyakarta. Entertainment and information devices play an important role in electricity consumption since their usage is based on the satisfaction of the owner. The more the need for entertainment or information, the more people will use the devices without any stopping unless the user needs are fulfilled.

The most preferred devices in the kitchen, in Bandung, Bali and Yogyakarta, were rice cookers (including the rice warmer) and refrigerators. However, in Bandung the ownership of rice cookers was slightly higher than in Bali and Yogyakarta, while the ownership of refrigerators in Yogyakarta was higher than in Bandung and Bali.

Interestingly, the study in Yogyakarta found that some households were more likely to buy refrigerators rather than rice cookers, since cooling food and water was so necessary and rice could be cooked on the gas stove. One-door refrigerator was the most favored type of refrigerator owned by people in Bali and Yogyakarta, while two-door refrigerator was the most favored refrigerator in Bandung.

As a tropical country, Indonesia has abundant sunshine throughout the year. Therefore, cooling devices are necessary. The possession of cooling devices in Yogyakarta was much higher than in Bali and Bandung, both for electric fan and air conditioner. Electric fans appeared to be used by 80% of respondents in Yogyakarta. In fact, more than 30% of households had more than 2 electric fans. The reason to select electric fans than air conditioning was the cheaper price and lower electricity consumption.

The appliances categorized as "others" in three cities were dominated by irons, water pumps and washing machines. However, washing machines in Bandung were owned by 78 households while in Bali and Yogyakarta only by 63 and 58 households respectively. Water pump in Yogyakarta was owned by 87 households while in Bandung and Bali about 66 and 42 households. Iron in Bali was owned by 72 households while in Bandung and Yogyakarta by 60 and 56 households. The high ownership of water pumps by households in those cities was an indicator that there was a lack of water infrastructure in the cities.

3.3 Monthly Electricity Consumption

The average electricity consumption per household in Bandung, Bali and Yogyakarta is calculated based on the typically owned appliances. The average daily

duration in operating electrical appliances in Bandung, Bali and Yogyakarta is presented in Table 7. For cooling devices, air conditioner was used for about 3.5 hours/day in Bandung and Yogyakarta, while in Bali was about 4.1 hours/day. Meanwhile, electric fan in Yogyakarta was much longer operated than in Bandung and Bali. For cooking devices, in Bandung and Bali, people normally cook rice for 2 times a day, while in Yogyakarta people tend to cook rice for once a day. Television as one of major entertainment and information devices was used longer in Bali than in Bandung and Yogyakarta; it was used for about 7.2, 6.5 and 4.7 hours/day in Bali, Bandung and Yogyakarta, respectively. However, the average electricity consumption from television in Bandung was the highest since the ownership of television was the largest. Refrigerator in Bandung consumed electricity very high as compared to Bali and Yogyakarta, since the most popular refrigerator type in Bandung was two-door refrigerator.

There was a significant difference in using laptop between people in Bandung, Bali and Yogyakarta (see details on Table 8). In Bandung, laptop was operated for about 10.9 hours/day and consumed 26.6 kWh/month. While in Bali and Yogyakarta was operated only for about 3.1 and 3.5 hours/day and consumed 5.1 and 12 kWh/month. The reason of why laptop in Bandung was used longer is because it was used for work and entertainment, while in Bali and Yogyakarta was more for work than for entertainment. The frequent use of radio in Bandung was also longer than in Bali and Yogyakarta. It shows that people in Bandung requires more entertainment in their lifestyle.

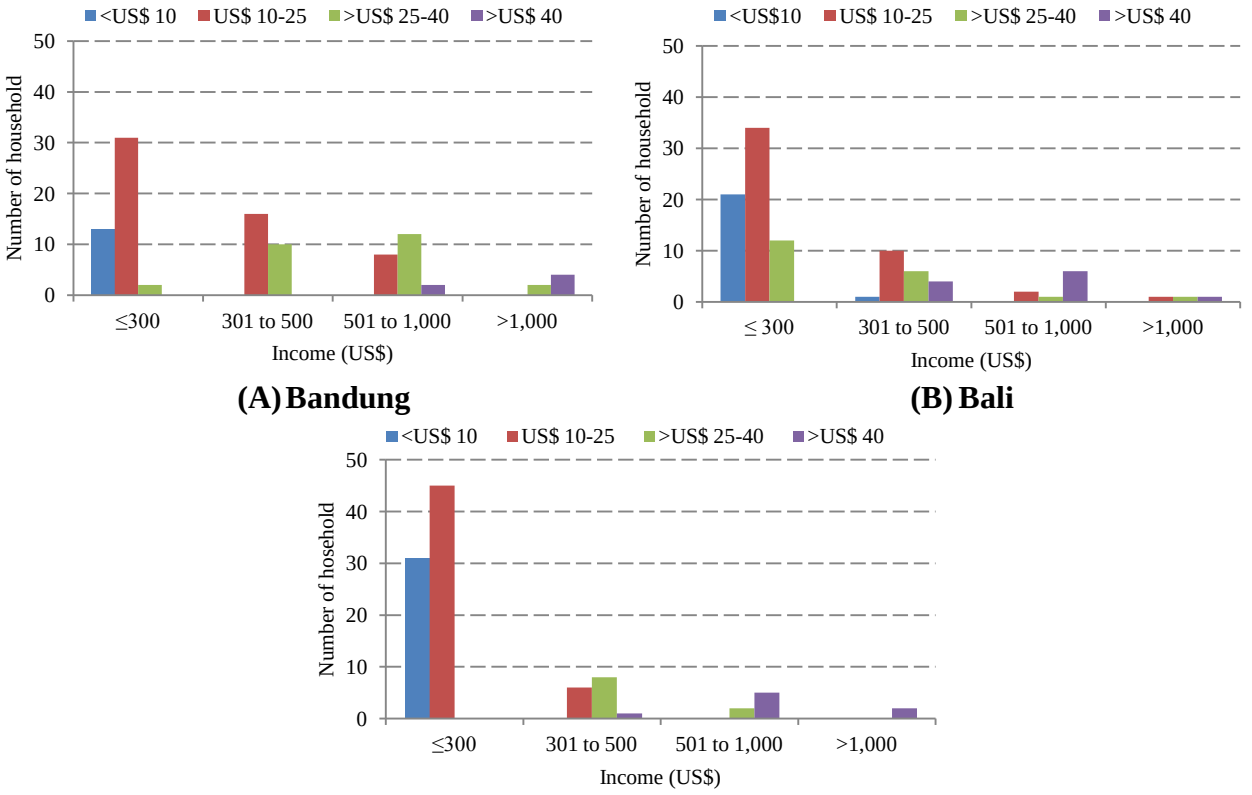

Figure 4: Distributions of monthly electricity bill by income level of (A) Bandung, (B) Bali, and (C) Yogyakarta.

Table 7: Average duration in operating electrical appliances in Bandung, Bali and Yogyakarta (in hour/day)

City	Cooling Devices		Cooking Devices								Entertainment Devices					
	AC	Fans	Rice Cooker[1]	Refrigerator	Water Dispenser	Microwave	Blender	Toaster	Coffee Maker	Stove[2]	TV	PC	Radio	CD/DVD Player	Laptop	Game Machine
Bandung	3.5	7.4	24	24	24	1	0.5	0.25	0.5	-	6.5	4.7	4.3	1.3	10.9	2
Bali	4.1	7.6	24	24	24	1	0.5	0.25	0.5	-	7.2	2.3	1.5	1	3.1	2
Yogyakarta	3.5	9.8	24	24	24	0.6	0.5	-	-	-	4.7	4.1	1	1.5	3.5	1.5

City	Lighting	Other Devices			
		Washing Machine	Water pumps	Iron	Hair Dryer
Bandung	5.5	0.5	0.9	1	0.17
Bali	5.5	0.5	0.5	0.5	0.17
Yogyakarta	5.5	0.5	0.5	0.6	0.17

Notes: [1]In Bandung and Bali, cooking time takes about 2 hours and warming time takes about 22 hours. In Yogyakarta, cooking time takes about 1 hour and warming time takes about 23 hours.
[2]Electric stove is used very rare for special event only

Table 8: Average end-use electricity consumption of households in Bandung, Bali and Yogyakarta (kWh/month)

City	Cooling Devices		Cooking Devices								Entertainment Devices					
	AC[1]	Fans	Rice Cooker	Refrigerator	Water Dispenser[2]	Microwave[3]	Blender[4]	Toaster[5]	Coffee Maker[6]	Stove	TV	PC	Radio	CD/DVD Player	Laptop	Game Machine[7]
Bandung	108.5	14.55	65.68	112.92	54.9	11.97	6	6.38	10.5	-	43.49	24.22	6.84	0.48	26.57	13.8
Bali	70.29	17.89	54.52	55.26	50.4	11.97	6.37	6.38	10.5	-	23.54	7.39	1.49	0.47	5.1	13.8
Yogyakarta	95.73	24.26	56.48	65.92	60.48	7.18	6.52	-	-	-	28.43	22.97	1.41	0.50	12	10.35

City	Lighting	Other Devices			
		Washing Machine	Water pumps	Iron	Hair Dryer[8]
Bandung	41.2	6.55	10.22	8.93	1.53
Bali	35.2	6.55	5.61	4.51	1.53
Yogyakarta	33.2	6.55	5.61	5.24	1.53

Notes: [1]Electricity consumed by air conditioner is calculated from the average usage of air conditioner in 12, 14, and 17 households in Bandung, Bali, and Yogyakarta, respectively.
[2]Calculated from the average usage of water dispenser in 20, 4 and 10 households in Bandung, Bali, and Yogyakarta, respectively.
[3]Calculated from the average usage of microwave in 19, 16, and 6 households in Bandung Bali, and Yogyakarta, respectively.
[4]Calculated from the average usage of blender in 7, 16, and 23 households in Bandung Bali, and Yogyakarta, respective.
[5]Calculated from the average usage of toaster in 2 and 17 households in Bandung and Bali, respectively.
[6]Calculated from the average usage of coffee maker in 1 and 4 households in Bandung and Bali, respectively.
[7]Calculated from the average usage of game machine in 6, 6, and 4 households in Bandung Bali, and Yogyakarta, respectively.
[8]Calculated from the average usage of hair dryer in 2 households both in Bandung and Yogyakarta, and 9 households in Bali.

Figure 4 presents the distribution of monthly electricity bills based on income level for both cities. The lowest income level group (less than US$ 300) in Bandung tended to pay monthly electricity bills ranging from US$ 10 to 25, representing as much as 31 households, while about 13 households paid less than US$ 10. In Bali, 12 households had electricity bills ranging from US$ 25 to 40, while 34 and 21 households had electricity bills ranging from US$ 10 to 25 and less than US$ 10, respectively. The situation was the same in Yogyakarta; 45 and 31 households had electricity bills ranging from US$ 10 to 25 and less than US$ 10, respectively. This study found that average household electricity consumption in Bandung is slightly higher than in Bali, but much higher than in Yogyakarta. In Bandung, trends in electricity consumption revealed that high electricity bills increased in income level. Similar to Bandung, in Bali and Yogyakarta high electricity bills tended to be paid by high-income level households, however the trend is not as smooth as in Bandung.

Households in Bandung with three to four persons in Bandung were the most likely to have monthly electricity bills of less than US$ 10 and from US$ 10 to 25, while households with five to six persons were the most common for monthly electricity bills above US$ 25. This indicated that having more residents per household resulted in higher electricity bills (see Figure 5a). Similar results were found for Bali, households with three to four persons were the most common for monthly electricity bills and from US$ 10 to 25 (see Figure 5b). However, their electricity payment spread till above US$ 40. Likewise in Bandung and Bali, in Yogyakarta; increasing household size appeared to lead to higher electricity consumption. This can be observed in Figure 5c, where households with one or

two persons were the most likely to be in the lowest electricity bill category (less than US$ 10), households with three or four persons were the most common in the US$ 10 to 25 category, and households with five or six persons were the most common in the US$ 25 to 40 category. Thus, these results suggest further investigations regarding how resident characteristics affect to electricity consumption.

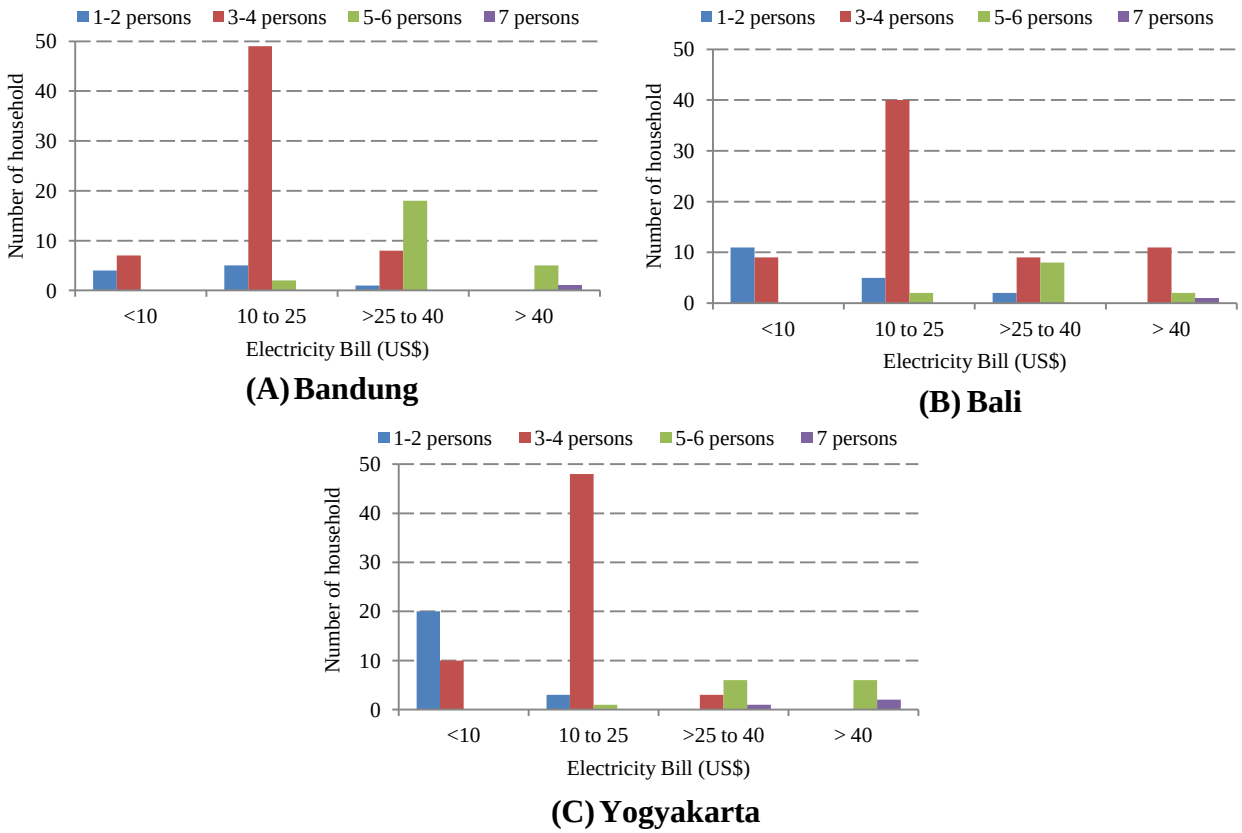

Figure 5: Effects of household size on monthly electricity bills in (A) Bandung, (B) Bali and (C) Yogyakarta.

4. Relationship between Electricity Consumption and Its Driving Factors

A number of studies link monthly electricity consumption or electricity bills with income, home appliances, lighting, family size, duration time at home, floor area and education level (Genjo *et al.*, 2005 and Guerin *et al.*, 2000). Multiple linear regression analysis was employed to investigate the relationship between the monthly electricity bill and its driving factors to determine the contributions of the factors.

The initial analysis was conducted for Bandung households, and the multiple linear regressions in Eq. (1) was obtained. The explanatory variables were income (x_1) is the accumulation of monthly revenue from all family members in the house, family size (x_2) is counted based on the number of family member (parent, children, and other family members) and maid (if any) in the house, education level (x_3) is measured from the average of education level of all family members in the house, duration time at home (x_4) is calculated from the average daily amount of time spent for doing activity from all family members at home excluding sleeping time, floor area (x_5) is measured from the total area taken up by house building, including on the second floor and third floor (if any), while y is the monthly electricity bill (US$/month).

The model confirmed that all factors were statistically significant predictors of the monthly electricity bill, where the p-value was less than 0.05, and Variance Inflation Factor (VIF) was less than 10. According to Bowerman and O'Connell (1990) and Myer (1990), the VIF value of this model indicates that there was no multicollinearity issue

within the data. Details of the predictors' correlation coefficients can be observed in Table 9, while the statistical estimation analysis can be seen in Table 12.

All factors exhibited a positive relationship with the monthly electricity bill. Thus, as income, family size, education level, duration time at home, and floor area increase, the monthly electricity bill increases. The monthly electricity bill per household would increase by US$ 0.016 with a one unit increase in income if the effects of all other factors were held constant. With a similar assumption, if the effects of all other factors are held constant, the monthly electricity bill per household would increase as follows: US$ 1.839 for a one person increase in family size; US$ 2.999 with an increase in education level; US$ 1.133 per additional hour spent at home; US$ 0.039 per additional m² in floor area.

$$y = (0.016 \times x_1) + (1.839 \times x_2) + (2.999 \times x_3) + (1.133 \times x_4) + (0.039 \times x_5) - 17.960 \quad \textbf{(1)}$$

Similar to Bandung, in Bali all factors exhibited positive relationships with the monthly electricity bill (see details in Table 10). The multiple linear regressions model is shown in Eq. (2), and the explanation of the variables is as in Eq. (1). The model confirmed that all factors were statistically significant predictors (see in Table 12). The monthly electricity bill per household would increase by US$ 0.016 with a one unit increase in income if the effects of all other factors were held constant. With a similar assumption, if the effects of all other factors are held constant, the monthly electricity bill per household would increase as follows: US$ 5.166 for a one person increase in family

size; US$ 6.362 with an increase in education level; US$ 2.595 per additional hour spent at home; US$ 0.036 per additional m² in floor area.

$$y = (0.016 \times x_1) + (5.166 \times x_2) + (6.362 \times x_3) + (2.595 \times x_4) + (0.036 \times x_5) - 47.614 \quad \textbf{(2)}$$

The last analysis was conducted for Yogyakarta households. The multiple linear regressions model is shown in Eq. (3), and the explanation of the variables is as in Eq. (1) and (2). The model also confirmed that all factors were statistically significant predictors (see in Table 12). Unlike in Bandung and Bali, in Yogyakarta some factors such as education level and duration time at home, exhibited negative relationships with the monthly electricity bill (see details in Table 11). Therefore, the monthly electricity bill would decrease by US$ 0.563 with an increase of education level if the effects of all other factors were held constant. The monthly electricity bill would also be reduced by US$ 0.942 at one hour increase in the amount of time spent at home, provided the effects of the other factors are held constant.

$$y = (0.040 \times x_1) + (2.192 \times x_2) + (-0.563 \times x_3) + (-0.942 \times x_4) + (0.021 \times x_5) + 5.087 \quad \textbf{(3)}$$

Meanwhile, the factors that had positive impacts were income, and family size. If the effects of all other factors are held constant, the monthly electricity bill per household would increase as follows: US$ 0.04 with an increase in income; US$ 2.192 per additional person in the household; US$ 0.021 per additional m² in floor area.

Table 9: Multiple linear regression analysis of monthly electricity bills in Bandung

Model	Unstandardized Coefficients		Standardized Coefficient	*t*	*p*-value	VIF
	B	Std. Error				
(Constant)	-17.960	3.289		-5.461	.000	
Income (US$)	.016	.002	.488	9.040	.000	1.868
Family Size (Person)	1.839	.879	.142	2.092	.039	2.962
Education (Level)	2.999	.982	.215	3.053	.003	3.186
Duration time at home (hours)	.327	.327	.139	3.468	.001	1.035
Floor Area (m^2)	.271	.007	.271	5.844	.000	1.385

Note: VIF stands for Variance Inflation Factor

Table 10: Multiple linear regression analysis of monthly electricity bills in Bali

Model	Unstandardized Coefficients		Standardized Coefficient	*t*	*p*-value	VIF
	B	Std. Error				
(Constant)	-47.614	8.592		-5.541	.000	
Income (US$)	.016	.004	.309	4.421	.000	1.300
Family Size (Person)	5.166	1.273	.283	4.059	.000	1.291
Education (Level)	6.362	1.374	.327	4.629	.000	1.331
Duration time at home (hours)	2.595	1.024	.163	2.535	.013	1.107
Floor Area (m^2)	.036	.018	.131	2.000	.048	1.149

Note: VIF stands for Variance Inflation Factor

Table 11: Multiple linear regression analysis of monthly electricity bills in Yogyakarta

Model	Unstandardized Coefficients		Standardized Coefficient	*t*	*p*-value	VIF
	B	Std. Error				
(Constant)	5.087	4.887		1.041	.031	
Income (US$)	.040	.004	.639	9.832	.000	4.477
Family Size (Person)	2.192	.566	.207	3.876	.000	3.022
Education (Level)	-.563	.433	-.042	-1.301	.016	1.079
Duration time at home (hours)	-.942	.507	-.078	-1.859	.046	1.878
Floor Area (m^2)	.021	.009	.108	2.266	.026	2.409

Note: VIF stands for Variance Inflation Factor

Table 12: Statistical estimation analysis of the multiple regression models

City	R^2	F	Std. Error of the Estimate
Bandung	.854	109.649	5.562
Bali	.628	34.534	10.289
Yogyakarta	.707	193.314	4.348

5. Discussion

5.1 Understanding Local Electricity Consumption Characteristics

Based on the statistical analysis described in section 4 of this chapter, the effects of each driving factor on the monthly electricity bill in each city can be measured and compared. There were several differences in the electricity consumption characteristics of the three cities. In Bandung and Bali, education level and duration time at home had positive effects on the monthly electricity bill. However, the results obtained for Yogyakarta differ; education level and duration time at home had negative impacts on the monthly electricity bill. These differences are related to the socio-cultural characteristics of each city.

As is generally argued, increases in education level lead to higher income, improve quality of life and to increased electricity consumption. This is the case in Bandung and Bali. Households in Bandung and Bali tended to enjoy their prosperity by owning more electricity devices and consuming more electricity to make their lives more convenient. A higher education level implies a better job with higher income; it also leads to individuals spending less time at home due to the high workload. However, in Bandung and Bali, while the time spent at home was short, its impact on electricity consumption was quite high. It seemed that households in Bandung and Bali were inclined towards a consumer

lifestyle. Moreover, the expectation that highly educated people may be more concerned with saving electricity was not observed in Bandung and Bali. This suggested that social characteristics such as family size and residents' daily activities should be the key concern in promoting energy conservation. An educational campaign on promoting adoption of high-efficiency appliances and electricity consumption saving behavior should be reintroduced in Bandung and Bali to increase educated individuals' awareness of electricity consumption, in the hope that educated individuals will spread good electricity consumption habits and concern about this issue to others.

In Yogyakarta, education level and duration time at home had negative impacts on the monthly electricity bill because households in Yogyakarta typically live the modest, practical lifestyles imparted by Javanese tradition. Individuals with higher education levels not only had higher incomes but also planned for the future better by saving money and did not use electricity devices and lighting excessively. These cultural attitudes need to be fostered to ensure that electricity consumption in Yogyakarta is manageable. Interestingly, higher education levels for individuals in Yogyakarta, who spent similar amounts of time at home to their counterparts in Bandung, resulted in a significantly negative impact on their electricity consumption. This difference is because respondents in Yogyakarta preferred to use the time at home after work with their families rather than using electrical appliances such as entertainment devices, this was supported by the results of respondents' interview about their living schedule.

The impacts of home appliances and lighting in Bandung, Bali and Yogyakarta reveal differences in the consumption patterns of the residents of the two cities. In

Bandung, items in the other devices category and lighting had the greatest impact on the monthly electricity bill among all of the electricity devices and lighting categories. Washing machines, water pumps and irons were identified as the largest contributors among devices in the other devices category. However, the intensive use of irons was the main cause of high electricity consumption in the other devices category. The introduction and promotion of high efficiency washing machines, water pumps, and LED (Light-Emitting Diode) lamps might produce significant electricity savings in Bandung. Moreover, in Yogyakarta, electric fans had the largest impacts on the monthly electricity bill among the home appliance and lighting categories; this was due to the small floor area and also unsuitable housing design for tropical climate have increased the indoor temperature, leading to more frequent in using electric fans. In Bali, the overall electricity consumption was lower than in Bandung and Yogyakarta. However, since Bali is the primary tourism destination in Indonesia, there is several potential of excessive electricity consumption for lighting, cooling devices, and entertainment and information devices. In addition, the high ownership of water pumps by households in all cities was an indicator that there was a lack of water infrastructure in the cities. It highlights the opportunity of improving water infrastructure in the city, reduce household use of water pumps in households and finally reduce electricity consumption in both cities.

5.2 Policy Options

In a society with diverse cultural backgrounds, a generalized energy conservation policy that is national in scope may not address the different sensitivities of local factors driving household electricity consumption in each area. This could mean that energy

savings targets in the household sector are not achieved because of the heterogeneity of potential local factors affecting the reduction efforts of electricity consumption across areas. Such a policy could also reduce policy adoption in the society due to rules or approaches that are unsuitable or unacceptable to local cultures. By understanding the patterns of energy consumption associated with lifestyle factors reflecting social and behavioral variations, it may be possible to develop more tailored policy interventions (Sanquist, *et al.*, 2011), thus a localized energy conservation policy might be applied to address the differences in driving factors in terms of the impacts of socio-cultural aspects, such as family size, education level and duration time at home, on electricity consumption in Bandung and Yogyakarta. The local authorities could adopt their own energy conservation policies to suit to the factors driving electricity consumption locally to improve the likelihood of increased electricity saving. Policies and interventions aimed at addressing broader societal levels of energy consumption are fewer and more aspirational than those based on individual choice (Sanquist, *et al.*, 2011).

The discussion section presents two basic findings of this study for increasing the desire to achieve energy savings in the household sectors of three cities: education level and duration time at home. As argued by Wilson and Dowlatabadi (2007), education level is a somewhat inconsistent predictor of pro-environmental behavior in terms of residential energy use. Therefore, it is suggested that improving the available information can support positive attitude formation and potentially reinforce or influence beliefs that activate values and hence create personal norms. Information and education-based interventions from multiple sources or channels should be targeted, personalized, and

timed to take advantage of windows of opportunity and combined with other interventions. Promotion of pro-environmental behavior in terms of residential electricity use then can be conveyed through integrating this knowledge in the formal education system in both cities. Although in Yogyakarta education level had negative impacts on the monthly electricity bill, the education is one of best means to foster pro-environmental behavior to the society.

Increased time spent at home causes increased electrical appliance use. However, electricity consumption is not only influenced by the use of electrical appliances but is also affected by of the efficiency levels of the appliances that are purchased. Prior to purchasing an appliance, people generally gather information on the characteristics of the appliance, where the store's sales staffs are usually a primary source of information regarding appliance characteristics. According to Gaspar and Antunes (2011), the store's sales staff are present and available immediately before and/or at the time of purchase. It is probable that the sales staff have the greatest positive impact on individuals' choices of energy-efficient types of appliances. Therefore, the staff should be trained to adapt their promotional messages to persuade people to purchase high-efficiency appliances to improve energy conservation in the household sector. Another means of improving individuals' knowledge an appliance's technological characteristics and to increase the adoption of higher-efficiency appliances is the implementation and promotion of an energy labeling scheme. Energy labeling schemes have been implemented in many countries (Harrington and Wilkenfeld, 1997; Mahlia, *et al*., 2005; Mills and Schleich, 2010) as a key component of efforts to increase the diffusion of energy efficient household

appliances. Although it has been regulated, energy labels do not yet appear on appliances sold on the Indonesian market. Assistance of store sales staff and information appeared on energy label, will not only help people with consumerist lifestyle such in Bandung and Bali in order to choose the higher-efficiency appliance, but also useful for people in Yogyakarta in order to keep their electricity use modestly by using low-consumption appliances.

Another promising intervention technique is to change electricity payment systems in ways that are suitable to the local culture to increase awareness of electricity consumption. Yamamoto *et al*. (2008) investigated decision-making in electrical appliance use in Japan. The study found that the price of electricity did not function as a signal in the decision-making processes of electrical appliance users. Rather, decision-making was dependent on the characteristics of particular electrical appliances and the electricity payment system. A further study to investigate the awareness of respondents in their monthly electricity use between prepaid and post-paid systems should be conducted in order to find the most proper electricity payment system based on local characteristics in order to raise the awareness of electricity use.

To be successful in energy conservation policy, interventions aimed at persuading people to initiate new behaviors/choices and change existing ones should be adapted to the specificities of different cultural characteristics. This indicates that interventions should be made through more tailored policy to strengthen the association between these energy use characteristics and cultural aspects. Examples of ways to achieve this in three cities would be through: 1) increasing information that supports positive attitude

formation and can reinforce or influence beliefs that activate values and thus create personal norms based on local wisdom, 2) changing the electricity payment system in a way that suits the local cultures and improves awareness of electricity consumption, and 3) persuasive interventions regarding the adoption of high-efficiency appliances to reduce electricity consumption.

This discussion of policy approaches in Indonesia illustrates the challenges of addressing the complex social background of energy consumption, particularly in a multicultural society. Therefore, further discussions on the social and technological construction of behavior should be provided to inform intervention design in electricity consumption under the influence of cultural factors. An example of such a study was proposed for New Zealand by Stephenson *et al* (2010), providing a framework to understand the factors that influence energy consumption behavior and an aid in the identification of opportunities for behavioral change has been developed by taking culture-based approach to behavior, while also drawing on lifestyle and systems based thinking.

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Chapter 3

Choice Determinant in the Purchase of Appliances and Decision-making in Electricity Consumption

The previous Chapter presents basic findings for increasing the desire to achieve energy savings in the household sectors of three cities: education level and duration time at home. It is argued that population with higher education levels not only had higher incomes, but also high knowledge and consideration to select higher-efficiency appliances. However, electricity consumption is not only influenced by the power rate of electrical appliances that are purchased, but is also affected by the use of electrical appliances. The increased time spent at home causes increased electrical appliance use. For those issues, this Chapter examines the influence of cultural backgrounds on Indonesian household electricity consumption within the perspective of electricity consumers' choice determinants in the purchase of electrical appliances and decision-making in consuming electricity.

Several researchers have studied household energy consumption as it relates to various population groups (Poyer *et al*., 1997; Helbert, 2005). Nevertheless, there is no comprehensive analysis that combines the consumer choice determinants in the purchase of appliances and behavior in the use of appliances in a framework of different cultural

backgrounds and ethnicities to improve the energy conservation in the household sector. To address these gaps, this Chapter proposes to achieve energy conservation in the household sector with regards to its cultural backgrounds, both an increase in energy efficiency (through the adoption of higher-efficiency class appliance types) and the promotion of environmental consumer behaviors (through better use of electrical appliances) should be analyzed and promoted.

1. Data Collection

Although an understanding of the technological use, social and economic characteristics of electricity consumers is important for improving energy conservation, it is not sufficient. Such knowledge should be complemented by the assessment of behavioral economics and human psychosocial variables such as attitudes, beliefs and perceived benefits in the purchase and use of electrical appliances. In order to examines the influence of cultural backgrounds on Indonesian household electricity consumption within the perspective of electricity consumers' choice determinants in the purchase of electrical appliances and decision-making in consuming electricity, a second field study through questionnaire survey was conducted from October to November 2011 with the sample of respondents as similar to the first survey.

1.1 Outline of the Questionnaire Survey

In fact, electricity consumption is affected not only by the use of electrical appliances but also by choice determinants of the efficiency of appliances upon purchase (Yamamoto *et*

all, 2008; Gaspar and Antunes, 2011). Understanding the behavioral economics and human psychosocial variables of electricity consumers in different cultures will give in-depth knowledge on how to influence the human habits in consuming electricity. Therefore, this study desires to investigate the electricity consumers' perspective on the following: 1) choice determinants of appliance purchases and 2) decision-making in appliance use.

The questions concerning the choice determinants of appliance purchases as shown in Table 13 were categorized into two parts: 1) lifetime use of appliances, and 2) the choice determinants of appliance purchases. The reason to include the lifetime use of appliances in the question is to know the replacement of an old electrical appliance with a new appliance, since it allows a process of adoption of higher-efficiency appliances. The rate at which households replace various appliances has important implications for the realization of household energy demand saving in response to technological improvements (Young, 2007). The content of the questionnaire about lifetime use covered the following: 1) lifetime use of appliances, and 2) reason to replace an appliance.

Table 13: Questions related to choice determinants in the purchase of electrical appliances

No.	Criteria	Question
1.	Lifetime use of appliances	After how long do you replace electrical appliances?
		What is the reason to replace an electrical appliance?
2.	Choice determinants of appliance purchases	What is the necessary information about the appliance that you want to know?
		How do you get information on the appliance?
		What are the consideration factors when you buy an electrical appliance?

Meanwhile, the choice determinants of appliance purchases are investigated based on the following questions: 1) required information of appliance characteristics and its sources; 2) influencing factor in the purchase of appliances; and 3) knowledge of electricity price. The questions are developed to obtain the information prior to people's choice of purchasing an appliance. This information helps people make a decision about the purchase of the appliance(s).

Table 14: Questions related to decision-making in the use of electrical appliances

No.	Criteria	Question
1.	Attitude and knowledge	How do you understand the electricity prices?
		How do you remember the monthly electricity bill?
		How do you remain aware of changes in the monthly electricity bill?
		How do you remain aware of the change of the electricity prices?
		How do the electricity payment systems affect your awareness of the monthly use?
2.	Technological perspective	How do you remain aware of the price of electricity consumed by appliances?
		How do you remain aware of the energy efficiency of appliances?

The questions related to decision-making in the use of electrical appliances were centered on two aspects; attitude and knowledge, and technological perspectives as presented in Table 14. The assessment on the decision-making in the use of electrical appliances is emphasized to obtain the reason behind of people's habits in using electrical appliances. The attitude and knowledge lies on the behavioral economics analysis which tends to have a close relationship with price variable. Price is often considered to be an

important signal in individuals' decision-making concerning electricity consumption (Yamamoto *et al*, 2008). Therefore, the analysis of attitude and knowledge is focused on electricity price and its payment system. The content of the questionnaire covered the following: 1) knowledge of electricity prices; 2) memory of electricity payment; 3) awareness of the changes of electricity bill; 4) response to the change of electricity price; and 5) effects of payment system.

Furthermore, electrical appliances consume electricity during use, and electricity costs are calculated based on the amount of electricity consumed by appliances. The efficiency of an appliance influences its electricity consumption; higher rates of efficiency are associated with lower electricity consumption. Hence, people's perspectives on technological aspects can be an indication of decision-making in the use of appliances. The analysis of technological perspectives is underlying on 1) awareness of electricity consumed by electrical appliances; and 2) awareness of the energy efficiency.

Respondents were provided many options related to influencing factors in the purchase of appliances and knowledge of electricity price and rated their level of agreement or disagreement on a Likert scale[1]. Two analyses will be conducted in this step:

1) Descriptive analyses; after receiving the responses from respondents, the average scores for every question were calculated. For each question, the option with the higher average score was the first-ranked option and so on. The descriptive

[1] Likert scale is a psychometric scale that is commonly employed in research with questionnaires. It is the most widely used approach to scaling responses in survey research. Respondents indicate their level of agreement with the statement that is posed. This scale measures either positive or negative responses to a statement.

analysis will explore the variation of respondents' response in different cities under different cultural backgrounds.

2) Comparative analysis; to compare decision-making in the purchase and use of electrical appliances in the three cities. A statistical analysis called ANOVA[2] test will be employed to find the differences of respondents' response.

2. Analysis of Choice Determinants in the Purchase of Electrical Appliances

2.1 Lifetime Use of Appliances

The replacement of an old electrical appliance with a new appliance allows a process of adoption of higher-efficiency appliances. In addition, improvements in the energy efficiency of appliances have the potential to decrease households' energy use. Therefore, the rate at which households replace various appliances has important implications for the realization of household energy demand saving in response to technological improvements (Young, 2007). The present study began with the assessment of lifetime use of the following eight frequently used appliances in Bandung, Bali, and Yogyakarta: washing machine, water pump, rice cooker, lighting, electric fan, air conditioner, refrigerator, and television.

[2] ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes T-test to more than two groups. ANOVAs are useful in comparing two, three, or more means.

Table 15: Descriptive statistics of appliances lifetimes

Appliance	City	Number	Mean (year)	Standard deviation
TV	Bandung	100	10.16	4.76
	Bali	100	9.83	2.68
	Yogyakarta	100	9.86	4.85
Refrigerator	Bandung	75	9.96	3.29
	Bali	69	13.65	2.53
	Yogyakarta	72	11.54	3.33
Air Conditioner	Bandung	11	12.45	2.58
	Bali	12	11.42	2.47
	Yogyakarta	10	11.10	3.11
Electric Fan	Bandung	75	7.95	2.84
	Bali	71	9.48	3.41
	Yogyakarta	75	5.71	3.38
Lighting	Bandung	100	1.25	1.16
	Bali	100	1.71	0.93
	Yogyakarta	100	1.56	0.79
Rice Cooker	Bandung	80	7.90	2.93
	Bali	78	5.87	2.40
	Yogyakarta	86	6.04	3.47
Water Pump	Bandung	50	9.80	5.58
	Bali	64	9.34	3.61
	Yogyakarta	76	8.30	4.60
Washing Machine	Bandung	38	7.68	2.31
	Bali	35	8.91	2.58
	Yogyakarta	41	7.71	3.73

The survey results indicate that the average lifetimes of the appliances were similar in the three cities (see Table 15). However, these values are lower than those of developed countries, such as the USA and Canada, where the average lifetime for refrigerators and washing machines is 16 and 12 years, respectively (Young, 2007). This difference, however, does not indicate that the adoption of more efficient appliances is

more likely in Indonesian households than in the developed countries. Indeed, the values of the standard deviation for most appliances were quite large in both cities. This variation might stem from two sources, technical aspects and cultural aspects. The technical aspects of the problem include several issues. First, the quality of the electrical appliances sold in Indonesia is low. These appliances show low durability. Second, the reliability of the power supply in Indonesia is poor. Due to this quality problem, the electrical appliances are more easily damaged. The cultural aspect of the problem could reflect the way that people use electrical appliances and people's lack of knowledge about operating the appliances. These arguments are strengthened by the respondents' reasons for replacing their appliances (see Figure 6). In the three cities, the most frequent reason to replace an appliance was because it was broken (97%, 94% and 92% in Bandung, Bali and Yogyakarta, respectively).

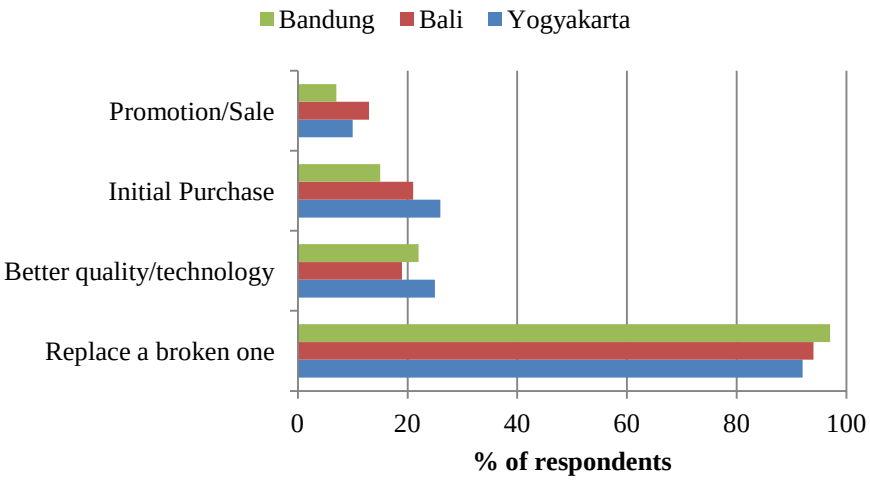


Figure 6: The reasons to replace electrical appliances (Because some respondents selected two or more reasons, the totals may exceed 100%).

2.2 Required Information of Appliance Characteristics

Prior to purchasing an appliance, people typically gather information on the characteristics of the appliance. This information helps them make a decision about the purchase of the appliance(s). In this study, several frequently considered characteristics of appliances were assessed. These characteristics include the price, quality, energy consumption, warranty, user friendliness, technology, safety, accessories, type, brand, and country of origin. The respondents could select more than one answer. The results for the information required by the respondents prior to purchasing the appliance are shown in Figure 7.

The price of the appliance was the most frequently required type of information prior to purchase; 99% of the respondents in Bandung, 87% in Bali, and 85% in Yogyakarta. The quality of the appliance was the next most frequent response, provided by 90% of the respondents in both Bandung and Yogyakarta, and 85% in Bali. Information related to energy consumption and the appliance's technology was not a priority the people in either city. This lack of emphasis might be due to a lack of available information on these topics. It might also result if the people are not in the habit of receiving information of this type.

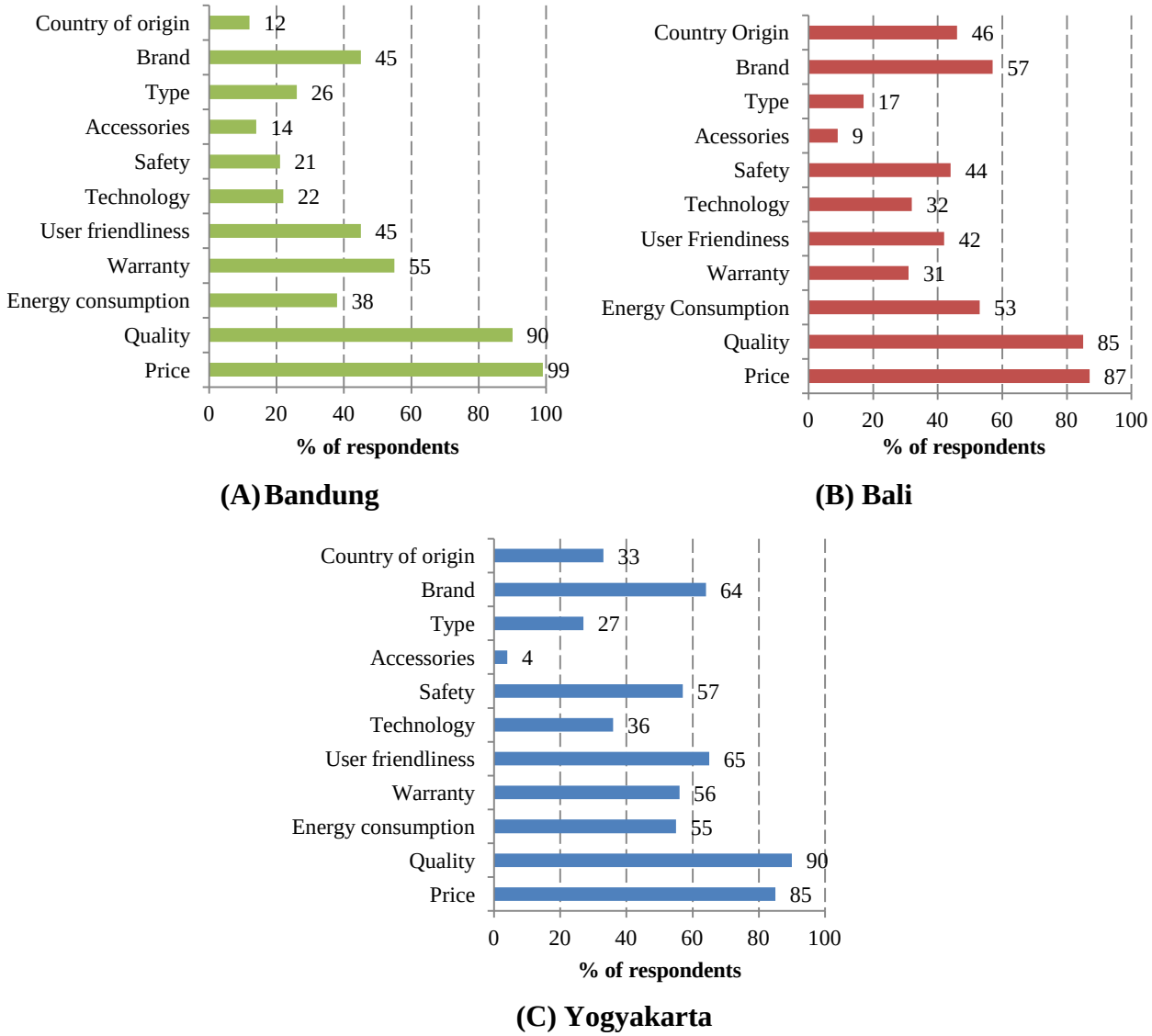


Figure 7: Required information prior to the purchase of an appliance in (**A**) Bandung, (**B**) Bali, and (**C**) Yogyakarta.

In addition, several media were used to access the information that people sought prior to purchasing an appliance (see Figure 8). In Bandung, most respondents obtained information regarding appliance characteristics from the store's sales staff as a primary source due to their belief with others which is a part of interaction customs in the society. Similar to Bandung, in Bali most respondents obtained information regarding appliance

characteristics from the store's sales staff as a primary source, followed by commercial advertisements in newspapers, magazines, on the Internet or in public spaces. According to Gaspar and Antunes (2011), the store sales staff is present and available immediately before and/or at the time of choice. It is likely that the sales staff has the greatest positive impact on people's choice of energy-efficient appliances. Therefore, the staff should be trained to adapt their promotional messages to persuade people to purchase high-efficiency appliances. In Yogyakarta, commercial advertisements in newspapers, magazines, on the Internet or in public spaces were the primary sources of information due to their cultural characteristics which believe that self-information search about appliance characteristics without depending on others is to keep their social status. The prevalence of these sources indicates that commercial advertisements play a key role in facilitating the consideration of matters related to energy consumption.

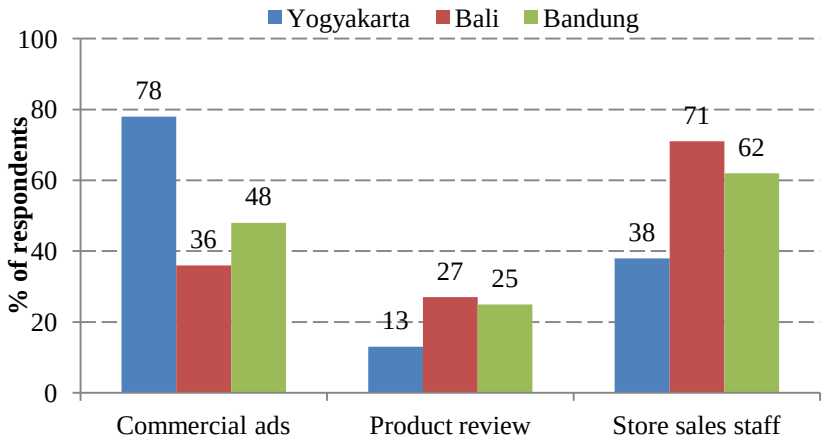
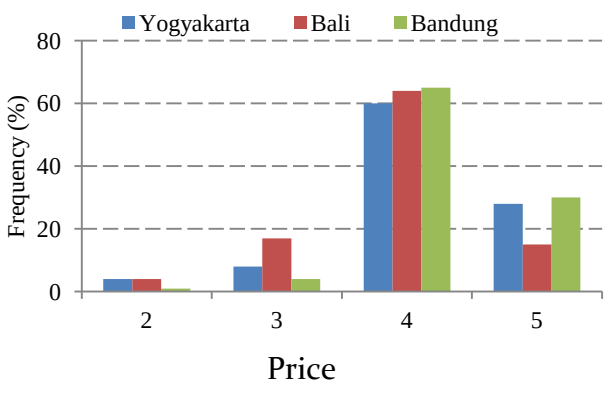


Figure 8: Sources of information prior to purchasing an appliance.

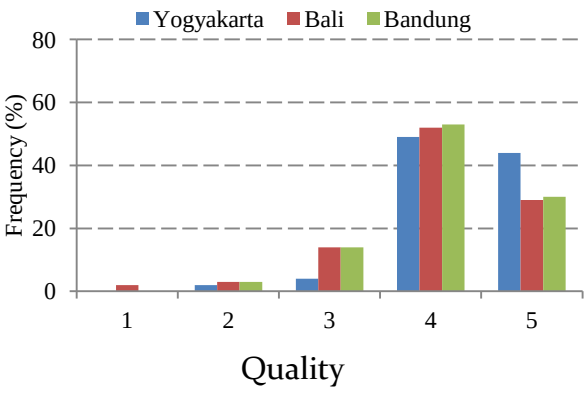
2.3 Factors that Influence the Purchase of Appliances

After obtaining the information required about the appliance characteristics, the purchaser's next step is to select the electrical appliance that is most strongly preferred. The analysis of this step is important because it reveals the relationship between the factors that influence the purchase of an appliance and the information required prior to purchasing the appliance. Following this analysis, a further strategy can be formulated to improve Indonesian households' adoption of higher-efficiency appliances. In the survey, the respondents were asked to rank their awareness of the factors to consider in purchasing an electrical appliance. The question was scaled from 1 (not at all), 2 (slightly), 3 (moderately), 4 fairly), and to 5 (highly).

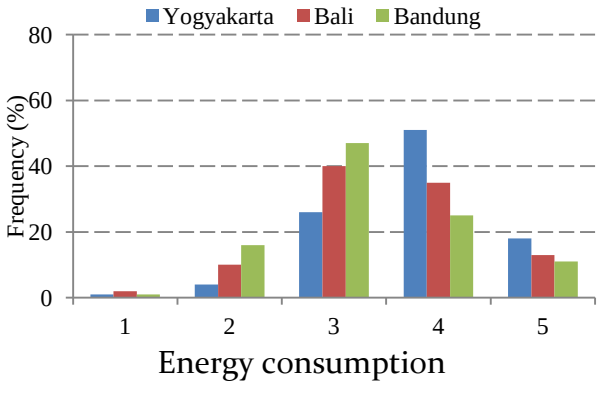
The results show that price was mostly considered fair to high factors that influence the purchase of appliances for respondents in all cities, counted for more than 60%. Quality was also mostly considered fair to high for respondents in all cities (≥49%), but about 44% of respondents in Yogyakarta considered quality as highly significant factor that influence the purchase of appliances. Energy consumption of appliances seemed not to be considered as the high significant factor, since the results show that in Bandung and Bali only about 25% and 35% respondents, respectively considered energy consumption as fair to high. In contrast, energy consumption of appliances was considered fair to high for respondents in Yogyakarta (>50%). A detailed respondent's considered factors that influence the purchase of appliances is presented in Figure 9.



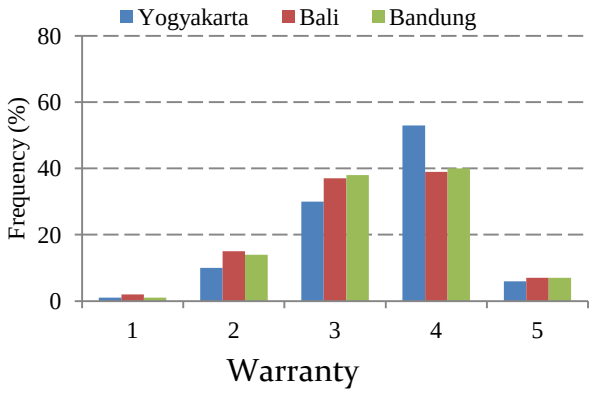
Price



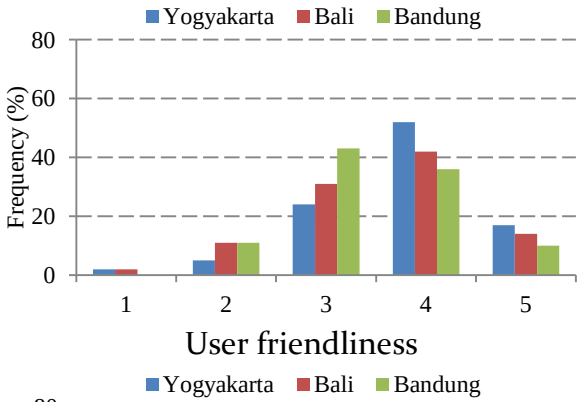
Quality



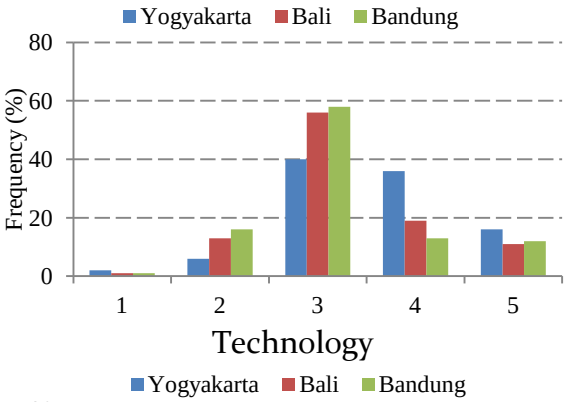
Energy consumption



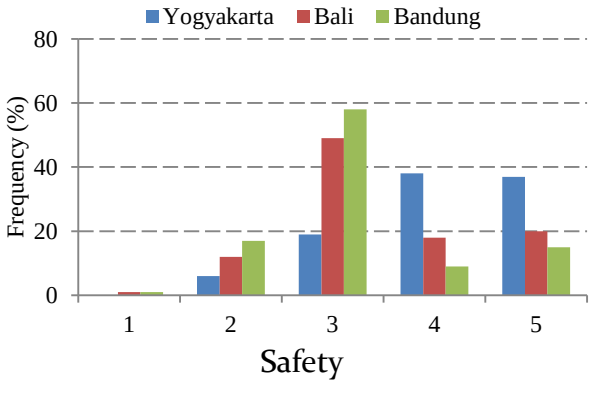
Warranty



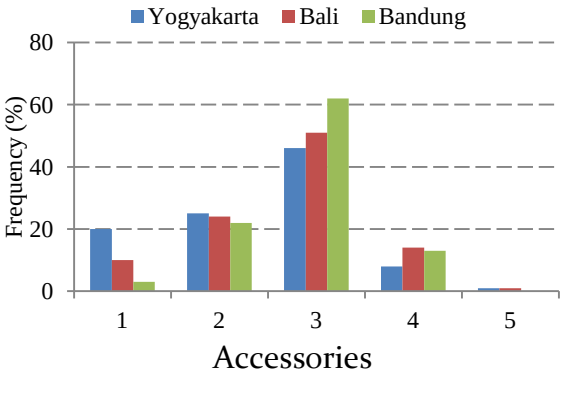
User friendliness



Technology



Safety



Accessories

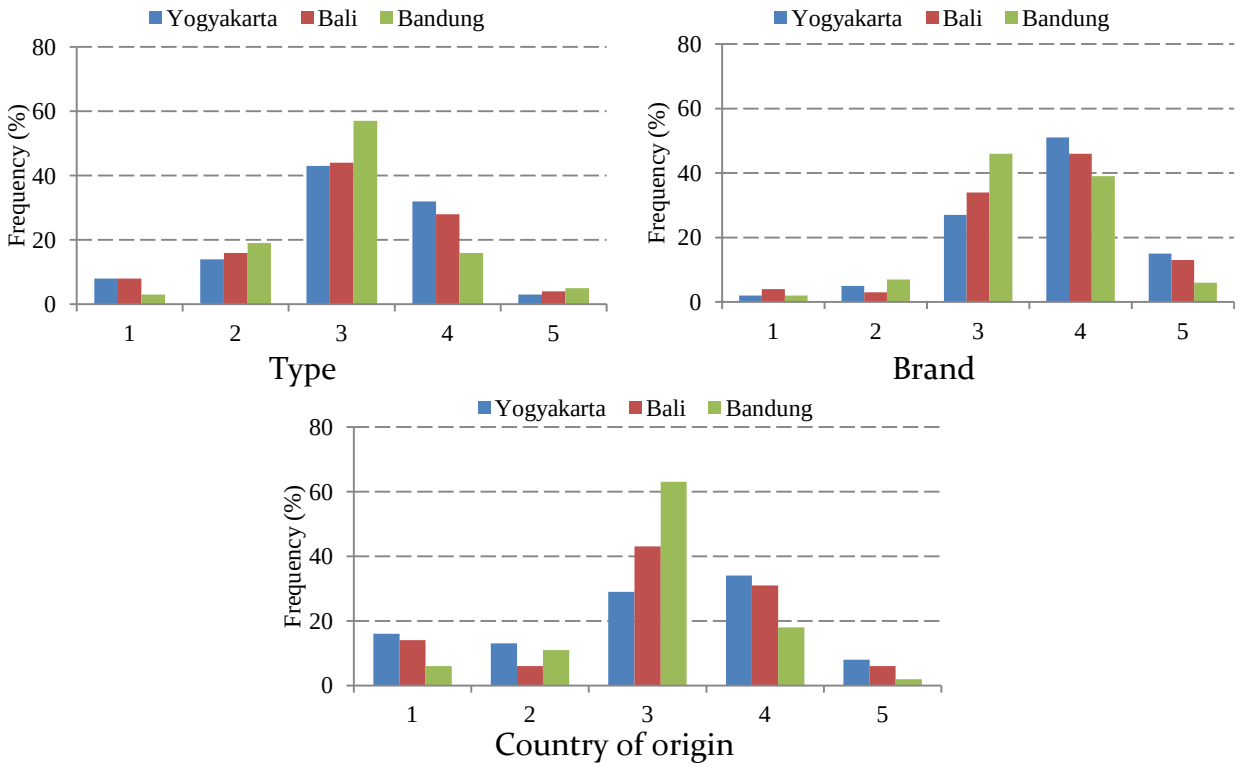


Figure 9: Distributions of respondent's considered factors that influence the purchase of appliances.

Table 16: Average respondents' response on factors that influence the purchase of appliances

Factor	Bandung	Bali	Yogyakarta
Price	4.24	3.90	4.12
Quality	4.10	4.03	4.34
Energy Consumption	3.29	3.17	3.81
Warranty	3.38	3.34	3.53
User Friendliness	3.45	3.55	3.77
Technology	3.19	3.26	3.58
Safety	3.20	3.44	4.06
Accessories	2.85	2.72	2.45
Type	3.01	3.04	3.08
Brand	3.40	3.61	3.72
Country of Origin	2.99	3.09	3.05

In average, respondents in Bandung primarily considered price, quality, user friendliness, and warranty, respectively. Slightly different, in Bali most primarily considered factors were quality, price, brand, and user friendliness. Meanwhile, quality, price, safety and energy consumption were the most frequently considered factors in the purchase of an appliance by the respondents in Yogyakarta. Table 16 shows the average respondents' responses on the factors that influence the purchase of appliances in Bandung, Bali, and Yogyakarta.

These results, together with those obtained in sub-section 1.2, show that in Yogyakarta, the quality of an appliance was the primary type of information considered as being necessary in the decision process prior to making a purchase. Price was similar to quality as important information for the respondents in Yogyakarta and was the second factor considered. Surprisingly, the third type of information considered when making a purchase was data on energy consumption, although this information was seldom required prior to the purchase. Furthermore, this result indicates that the respondents in Yogyakarta showed a better awareness of energy consumption. The results for Bandung and Bali also showed that price and quality were the primary factors considered as necessary information prior to the purchase and as aids in decision-making regarding the purchase. However, the information on energy consumption was given a comparable priority. There is a substantial opportunity to promote the adoption of more energy-efficient appliances in Bandung and Bali via store sales staff and commercial advertisements.

3. Analysis of Decision-Making in Electrical Appliances Use

3.1 Understanding of Electricity Price

In daily life, behavioral economics tend to have a close relationship with price variable. Therefore, price is often considered to be an important signal in individuals' decision-making concerning electricity consumption (Yamamoto *et al*, 2008). In this survey, the behavioral economics of the respondents in reference to electrical consumption was investigated by questions concerning the following: 1) understanding of the government's electricity prices; 2) memory of their monthly electricity bill (both questions are scaled 1 (not at all) to 4 (highly)); and 3) awareness of the changes in their monthly electricity bill on a scale of 1 (not at all) to 5 (highly). The difference of the point scale in the assessment of awareness of the changes of their monthly electricity bill is more subjective than the two previous questions.

The results show that in terms of understanding of electricity prices, 55% of people in Bandung answered 1 (not at all) or 2 (slightly), and 45% answered 3 (fairly well) or 4 (highly). In Bali, about 34% of respondents answered 3 (fairly well) or 4 (highly), while the rest about 56% answered 1 (not at all) or 2 (slightly). Meanwhile, 58% people in Yogyakarta answered 1 (not at all) or 2 (slightly) and 42% answered 3 (fairly well) or 4 (highly). A detailed respondent's considered factors that influence the purchase of appliances is presented in Figure 10. In the average, price of electricity was not well understood by the respondents in three cities as shown in Table 17.

In contrast, in terms of remembering the monthly electricity bill, over 80% of respondents in three cities answered 3 (fairly well) or 4 (highly). The average response of respondents indicate that people had a good memory of electricity expenditure in three cities (Bandung (2.99), Bali (2.96), and Yogyakarta (2.98) on a 4-point scale), even though the people in both cities had little knowledge of electricity prices.

People's awareness of changes in the monthly electricity bill in Bandung was investigated on a scale of 1 (not at all) to 5 (highly). About 52% of respondents answered 3 (moderately), and 45% answered 4 (fairly well) or 5 (highly). Similarly, in Bali about 47% of respondents answered 3 (moderately), and 49 % answered 4 (fairly well) or 5 (highly). In Yogyakarta, about 60% of respondents of 45% answered 4 (fairly well) or 5 (highly). In average, most of responses in three cities indicate that people in Bandung, Bali, and Yogyakarta devoted considerable attention to their monthly electricity expenditure, even though their knowledge of the prices of electricity set by the government was sparse.

Table 17: Average respondents' response regarding their understanding of the electricity price in Bandung, Bali and Yogyakarta

Question	City	Mean
How much do you understand with the electricity prices	Bandung	2.42
	Bali	2.31
	Yogyakarta	2.15
How much do you remember the monthly electricity bill	Bandung	2.99
	Bali	2.96
	Yogyakarta	2.98
How much do you aware of changes in monthly electricity bill	Bandung	3.50
	Bali	3.58
	Yogyakarta	3.69

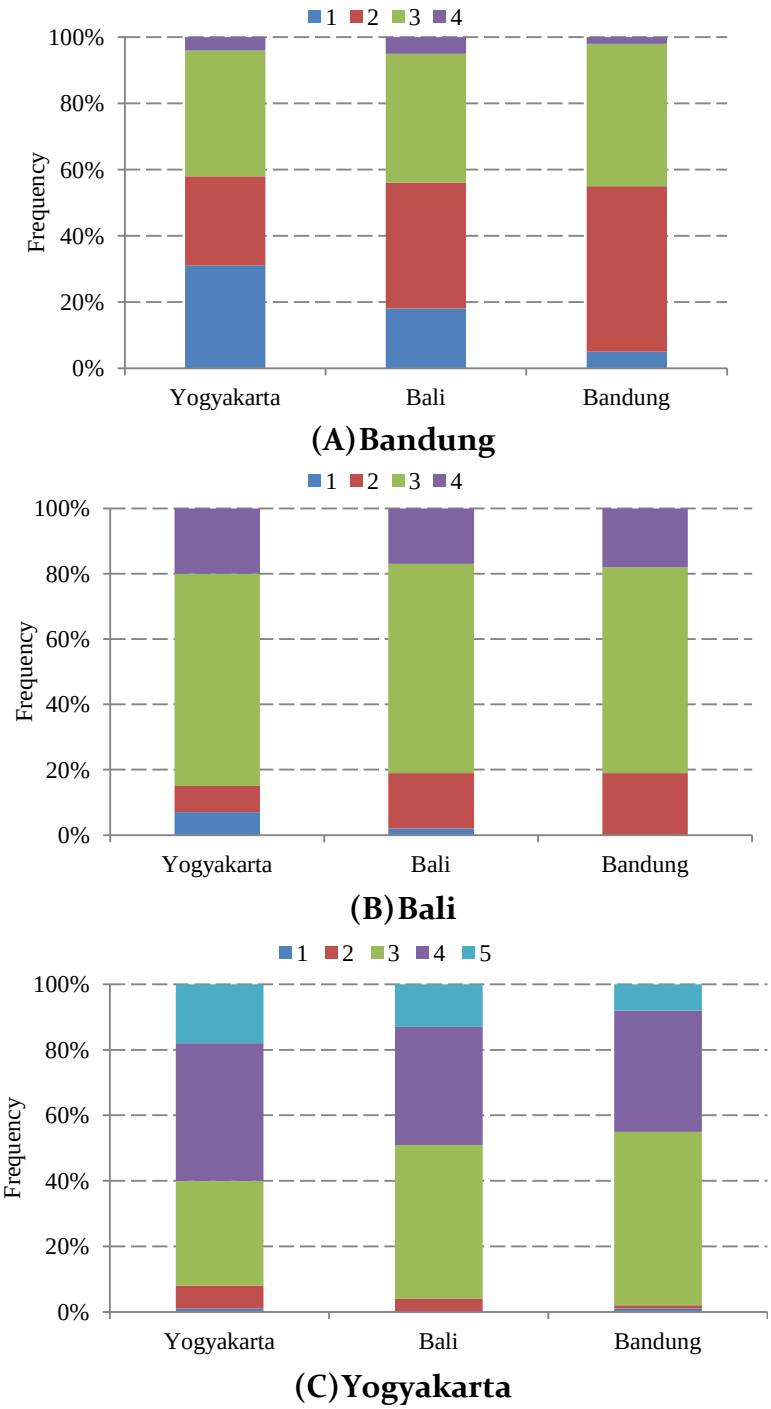


Figure 10: Distributions of respondent's response regarding (A) understanding of the electricity price, (B) remembering the monthly electricity bill, and (C) awareness of changes in monthly electricity.

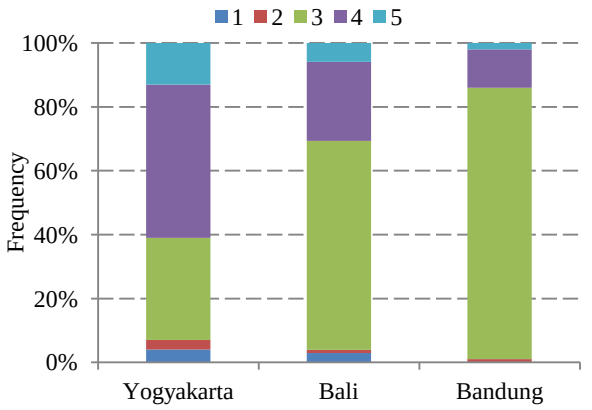
These results, linked with the results obtained in sub-sections 1.2 (Required Information of Appliance Characteristics) and 1.3 (Factors that Influence the Purchase of Appliances), indicate that a lack of understanding of the prices of electricity could be the reason that energy consumption was not selected as the first factor considered in decision-making about the purchase of an appliance in either city. In fact, a component of price that is often overlooked in the purchase of an appliance is the price of the energy consumed by the appliance. If the overall price of the appliance includes an overview of the price of the energy consumed by the appliance during its lifetime, people's awareness of higher-efficiency appliances could be increased significantly. This argument is supported by the results in Figure 10 and Table 16. These results show, for three cities, that respondents' awareness was higher for the overall price of the monthly consumption of electricity than the unit price of electricity.

Attention to their monthly electricity expenses can mean different things to three cultures. For the Javanese, remembering and pay attention to their monthly electricity payment are needed to evaluate the overall household expenditure, as part of a modest lifestyle and wise. For the Sundanese and Balinese, this awareness means that they are always concerned with something related to the material, however, does not mean it will be an evaluation to consume electricity lower than before.

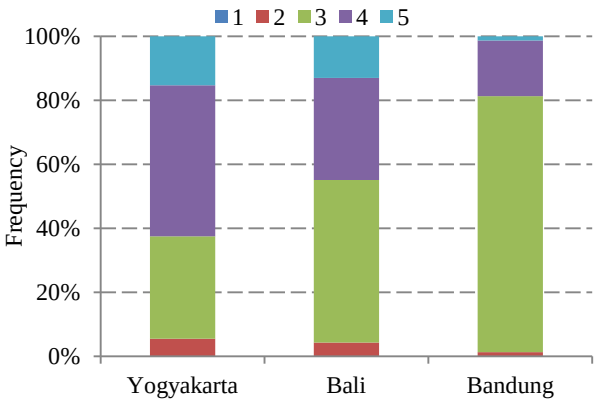
3.2 Electricity Consumed by Appliances

Electrical appliances consume electricity during use, and electricity costs are calculated based on the amount of electricity consumed by appliances. Hence, knowledge of the

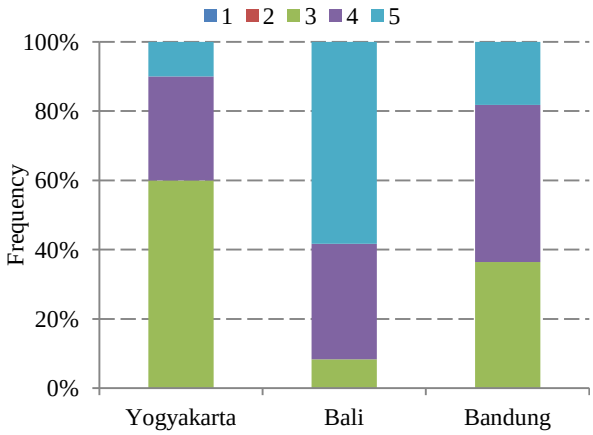
power consumed by appliances can be an indication of decision-making in the use of appliances. It is important to note that the rate of power consumed by appliances could be a consideration in electrical appliance purchases and use. From this point, respondents in the three cities were assessed for their awareness of the electricity consumed by the eight appliances on a scale of 1 (not at all) to 5 (highly).



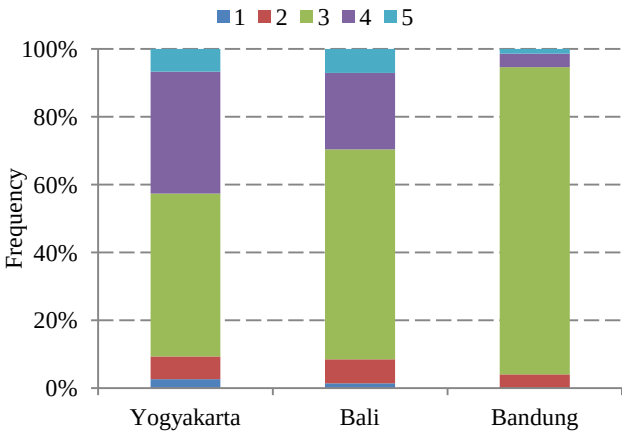
TV



Refrigerator



Air conditioner



Electric fan

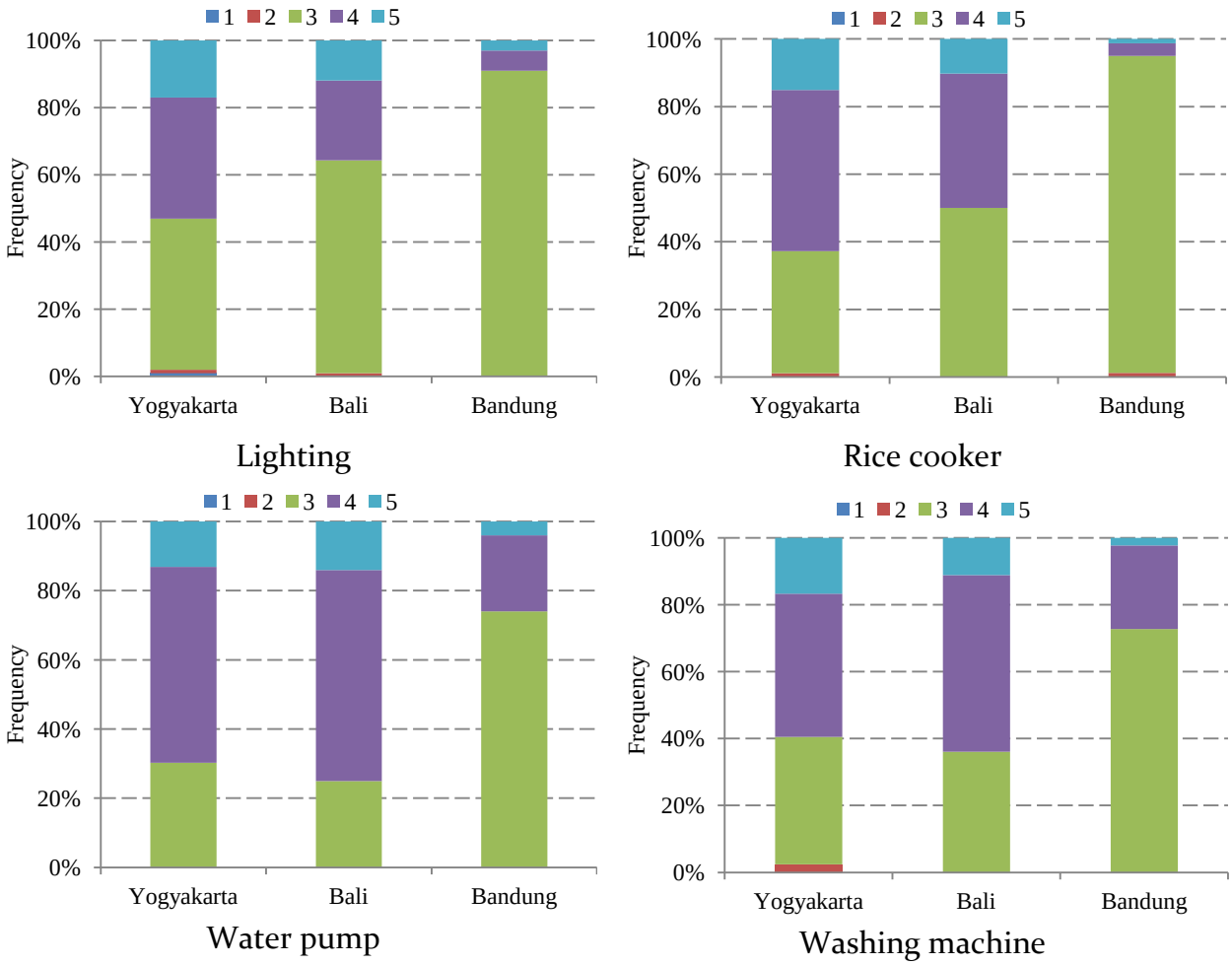


Figure 11: Distributions of respondent's response regarding awareness of the rate of power consumed by appliances.

Table 18: Average respondents' awareness of the rate of power consumed by appliances

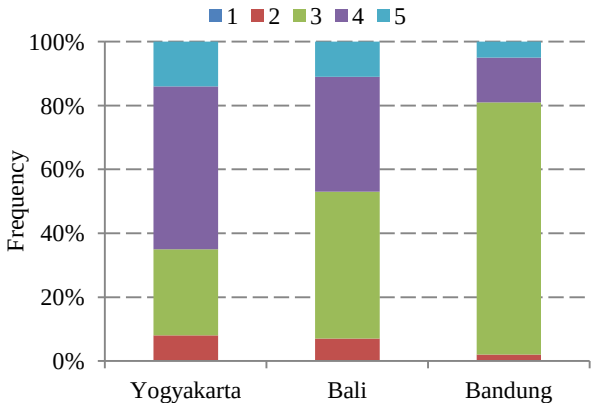
Appliance	Bandung	Bali	Yogyakarta
TV	3.15	3.30	3.63
Refrigerator	3.18	3.56	3.72
Air conditioner	3.56	4.38	3.50
Electric fan	3.02	3.26	3.36
Lighting	3.12	3.47	3.67
Rice cooker	3.05	3.59	3.76
Water pump	3.26	3.88	3.83
Washing machine	3.30	3.75	3.74

The survey results (see Figure 11) show that people awareness of the rate of power consumed by appliances in Yogyakarta was higher as compared to other cities which preferred to answer 4 (fairly well) or 5 (highly) for TV (62%), refrigerator (62%), electric fan (43%), lighting (53%), rice cooker (63%), and washing machine (60%). Bali had slight better awareness than Yogyakarta for respondent who preferred to answer 4 (fairly well) or 5 (highly) for air conditioner (92%) and water pump (75%). Meanwhile, in Bandung, respondent who preferred to answer 4 (fairly well) or 5 (highly) were 14% (TV), 18% (refrigerator), 64% (air conditioner), 15% (electric fan), 9% (lighting), 5% (rice cooker), 26% (water pump), and 27% (washing machine). In the average, these results are presented in Table 18, in which Yogyakarta had higher average response in most of all appliances expect air conditioner and water pump. The people's awareness concerning air conditioner, water pump and washing machine is because these appliances are considered to consume a large amount of power. Meanwhile, the rice cooker and refrigerator are always switched on.

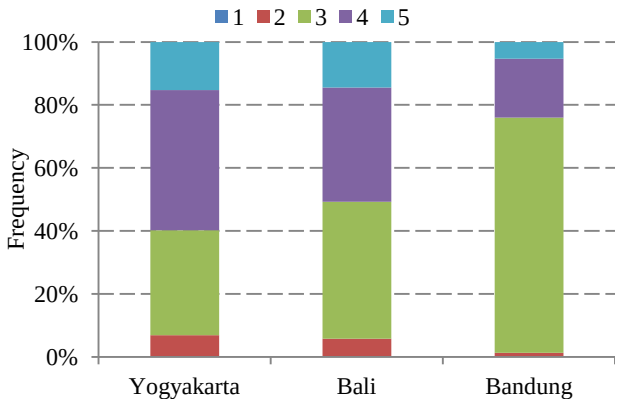
3.3 Awareness of Energy Efficiency of Appliances

The efficiency of an appliance influences its electricity consumption; higher rates of efficiency are associated with lower electricity consumption. Therefore, the knowledge and awareness of the energy efficiency of appliances are important in measuring the costs of electricity. The awareness of the energy efficiency of appliances was analyzed to determine whether people utilize this knowledge in using electrical appliances in their home to reduce the electricity consumption and monthly electricity bill. From the survey

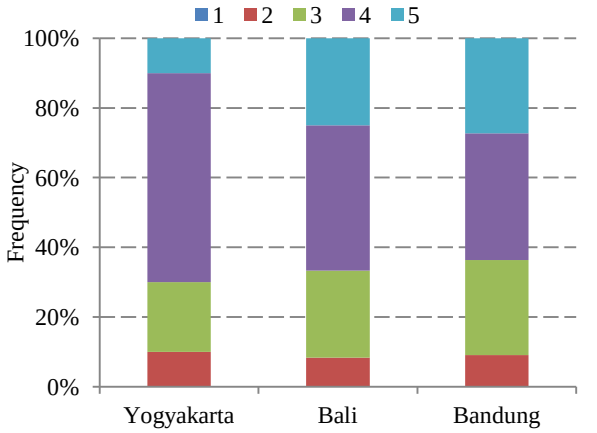
in both cities, respondents were asked to rate their awareness of the energy efficiency of eight appliances. The question was scaled from 1 (not at all), 2 (slightly), 3 (moderately), 4 fairly), and to 5 (highly).



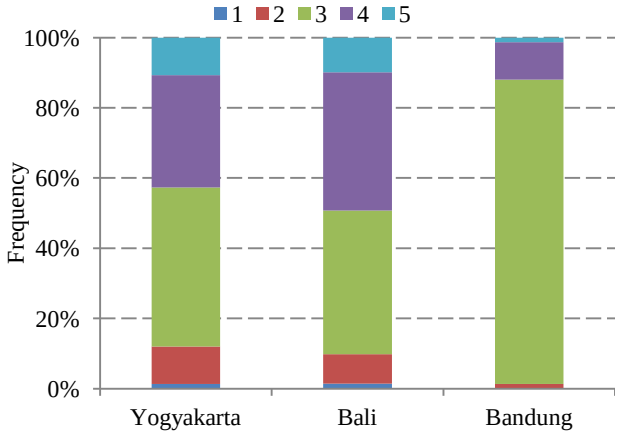
TV



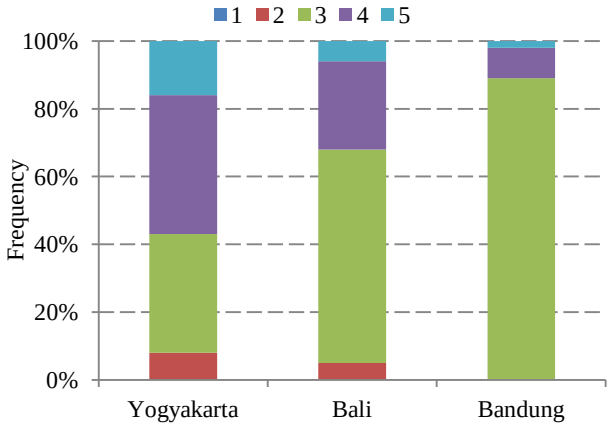
Refrigerator



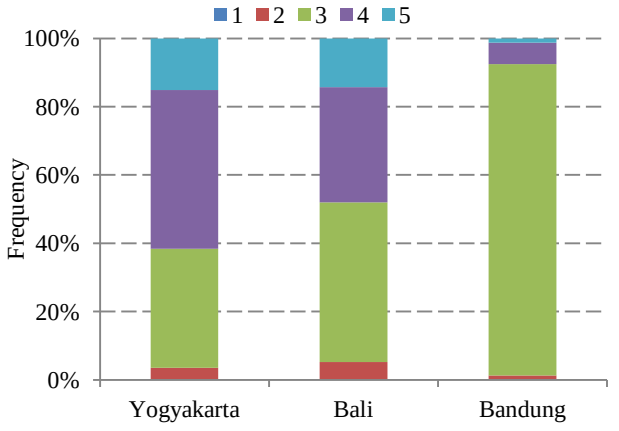
Air conditioner



Electric fan



Lighting



Rice cooker

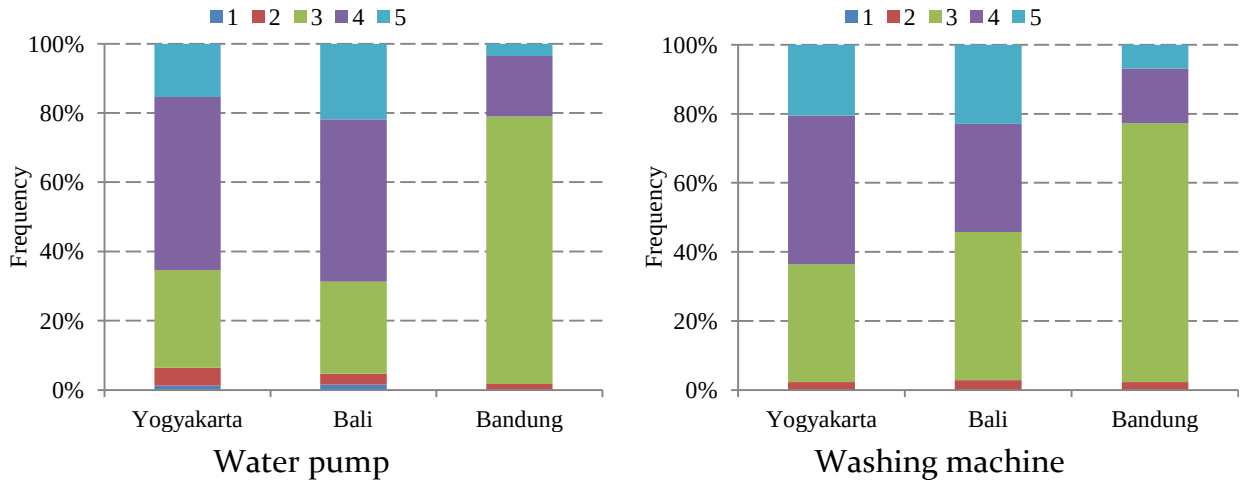


Figure 12: Distributions of respondent's response regarding awareness of appliances' energy efficiency.

Table 19: Average respondents' awareness of appliance's efficiency

Appliance	Bandung	Bali	Yogyakarta
TV	3.22	3.51	3.71
Refrigerator	3.27	3.59	3.68
Air conditioner	3.56	3.83	3.70
Electric fan	3.11	3.48	3.40
Lighting	3.13	3.33	3.65
Rice cooker	3.07	3.57	3.72
Water pump	3.23	3.84	3.73
Washing machine	3.27	3.74	3.82

The results indicate that, respondents in Yogyakarta had awareness of appliances' energy efficiency highest among three cities. For respondent who preferred to answer 4 (fairly well) or 5 (highly), the responses were TV (65%), refrigerator (60%), air conditioner (70%), lighting (57%), rice cooker (62%), and washing machine (64%). While for electric fan and water pump, the responses were slightly lower than in Bali, about 43% and 66% respectively. Meanwhile, in Bali, respondent who preferred to answer 4 (fairly well) or 5

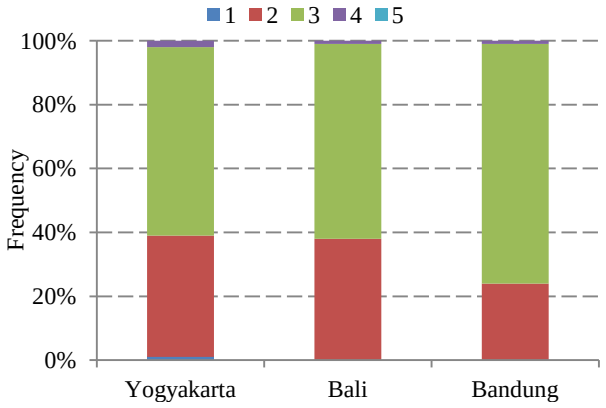
(highly) were 47% (TV), 51% (refrigerator), 37% (air conditioner), 49% (electric fan), 32% (lighting), 48% (rice cooker), 69% (water pump), and 54% (washing machine). In contrast, most of respondents in Bandung had low awareness of appliances' energy efficiency. It was only for air conditioner that received over 30% of answer 4 (fairly well) or 5 (highly). A detailed respondent's response is given in Figure 12. In the average, Yogyakarta had highest response on awareness of appliances' energy efficiency in most of all appliances expect air conditioner, electric fan, and water pump (see Table 19).

From this finding and the results obtained in sub-section 2.2 (Electricity Consumed by Appliances), indicate that respondents in Yogyakarta give greater attention to electrical appliance use (power consumption and energy efficiency of appliances) than respondents in Bandung and Bali. In addition, the results show that awareness of energy efficiency and electricity consumed by appliances could be a decision-making signal for electricity consumption in the home. This result is surprising because energy consumption was not considered as the priority factor in the choice determinants of appliance purchases (as demonstrated in sub-section 2.1 (Understanding of Electricity Price)).

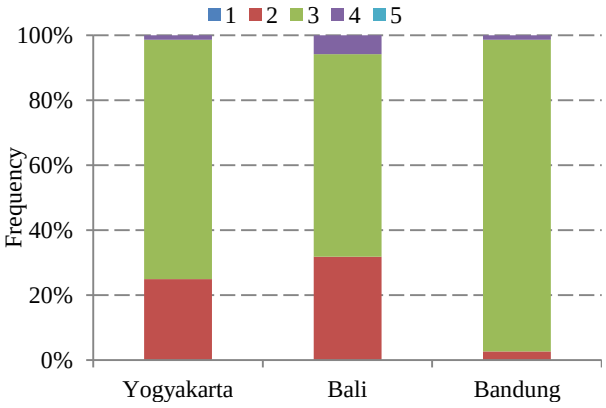
3.4 Response to the Change of Electricity Price

The price is suspected to be an important indicator in decision-making concerning electrical appliance use. Thus, consumers' response to the change in prices was assessed. Respondents in each city were asked how their use of each appliance would change if the

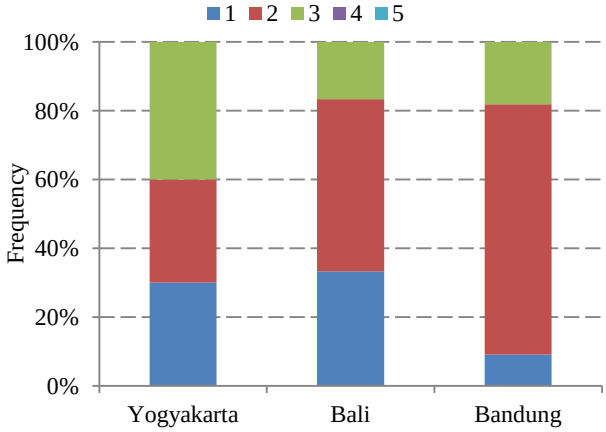
current electricity price increased by 10%. The question was scaled in 1 (large decrease), 2 (slightly decrease), 3 (normal), 4 (fairly increase) and 5 (large increase).



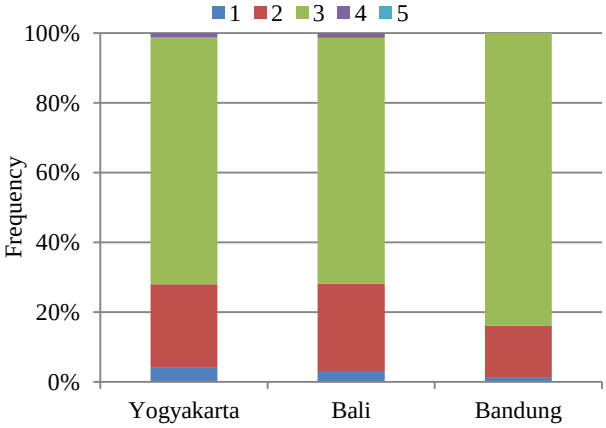
TV



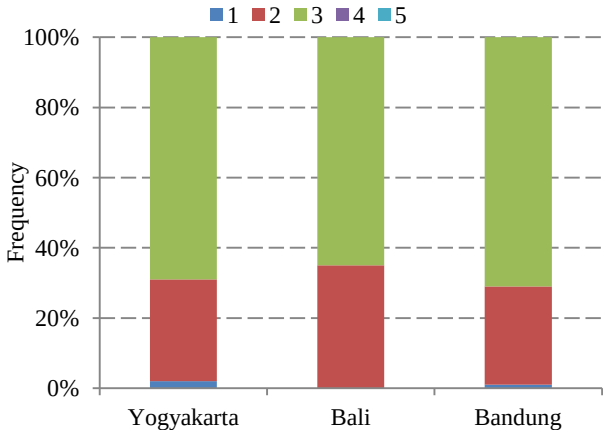
Refrigerator



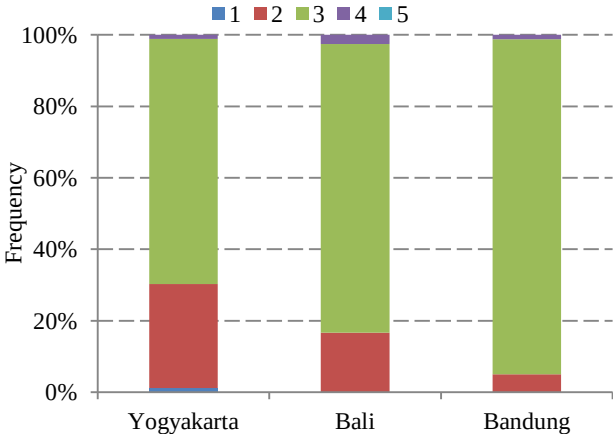
Air conditioner



Electric fan



Lighting



Rice cooker

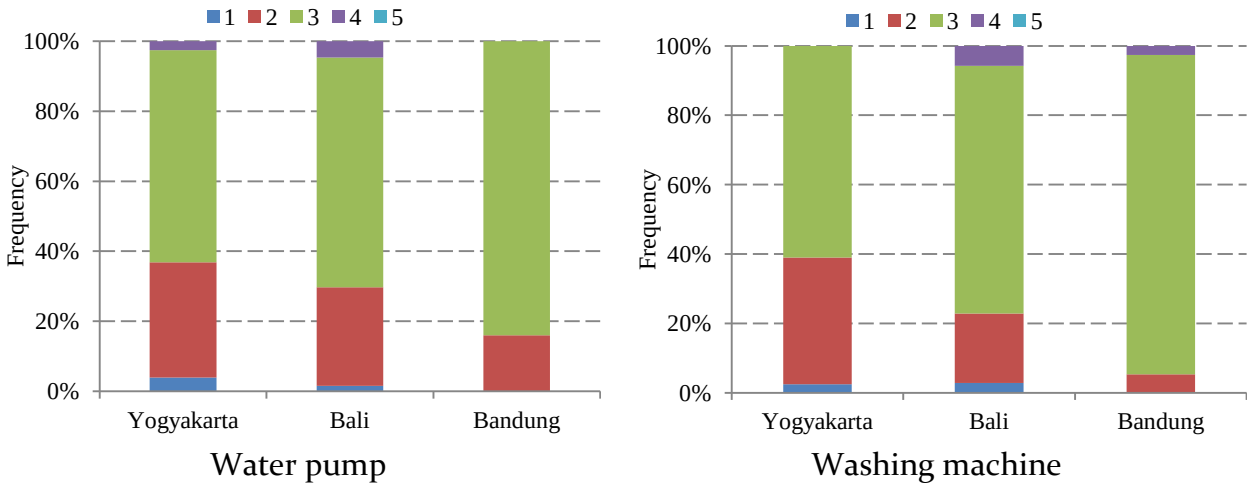


Figure 13: Distributions of respondent's responses to change in electricity price.

Table 20: Average respondents' responses to change in electricity price

Appliance	Bandung	Bali	Yogyakarta
TV	2.77	2.62	2.62
Refrigerator	2.99	2.76	2.76
Air conditioner	2.19	2.10	2.10
Electric fan	2.85	2.69	2.69
Lighting	2.70	2.67	2.67
Rice cooker	2.96	2.70	2.70
Water pump	2.86	2.63	2.63
Washing machine	2.98	2.61	2.61

Figure 13 presents a detailed respondent's responses to change in electricity price. Most of respondents in Bandung, Bali and Yogyakarta tended to maintain their normal electricity use, except for air conditioner use (see also Table 20, all average frequencies of respondents' responses are over 2.5, except for air conditioner use). In terms of air conditioner, about 82%, 83% and 60% of respondents answered 1 (largely decrease) or 2 (slightly decrease) in Bandung, Bali and Yogyakarta, respectively. Even, if the electricity

price increased by 10%, the people in Bandung, Bali tended not to change their appliances use in average.

According to these findings, change in electricity prices did not serve as a signal in decision-making about electricity consumption in the home. The reasons are that electricity is the necessities of life and routinely used by people in their daily life. In this case, the traditional characteristic of people with both modest lifestyle (Javanese) and materialistic lifestyle (Sundanese and Balinese) did not work since the electricity has changed the way of people life. The development or evolution of Indonesian cultures was realized by Irawanto (2012) as influenced by modernity, although most of the traditional culture still exists today.

3.5 Effects of Payment Systems

Yamamoto *et al*, (2008) argued that the payment system for home electricity consumption plays an important role in decision-making. Faruqui *et al,* (2010) reviewed 12 pilot studies that investigated the effect of in-home displays that showed electricity use on consumer behavior and found that prepayment metering increased awareness of electricity use. In Indonesia, two payment systems have been enacted; the post-paid system and the prepaid system. With the post-paid system, the consumers are charged a load fee and usage fee. The consumers can view the total amount of electricity use during a month on their bill. Meanwhile, with the prepaid system, the consumer does not pay a load fee, but must purchase a voucher through an Automated Teller Machine or specific designated kiosks for an amount that they select. The prepaid system shows the amount

of electricity consumed in real time and the remaining electricity that can be used by the consumer. Approximately 30% of households from three cities in this survey used a prepaid system for their electricity payment.

The next assessment determined differences in the respondents' awareness of their monthly electricity use based on the prepaid and post-paid systems on a scale of 1 (not at all) to 5 (highly). The results are presented in Figure 14. In Bandung, 90% of postpaid respondents answered 4 (fairly well) or 5 (highly) and 73% of pre-paid respondents answered 4 (fairly well) or 5 (highly). In Bali, about 56% and 77% gave answer 4 (fairly well) or 5 (highly) for postpaid and pre-paid respondents, respectively. Slightly different, in Yogyakarta, the respondents who answered 4 (fairly well) or 5 (highly) were 70% and 77% for postpaid and pre-paid respondents, respectively. The results of average responses are presented in Table 21. In Bandung and Bali, there was a significant difference between post-paid and prepaid systems (p-value ≤ 0.01). However, in Yogyakarta, there was no significant difference in respondents' awareness of their electricity payment between the two systems (p-value > 0.05).

Table 21: Statistical comparison results of effects of electricity payment systems on monthly electricity use.

City	Payment system	Mean	*p*-value
Bandung	Post-paid	4.37	0.01
	Prepaid	3.97	
Bali	Post-paid	3.71	0.00
	Prepaid	4.30	
Yogyakarta	Post-paid	4.14	0.63
	Prepaid	4.23	

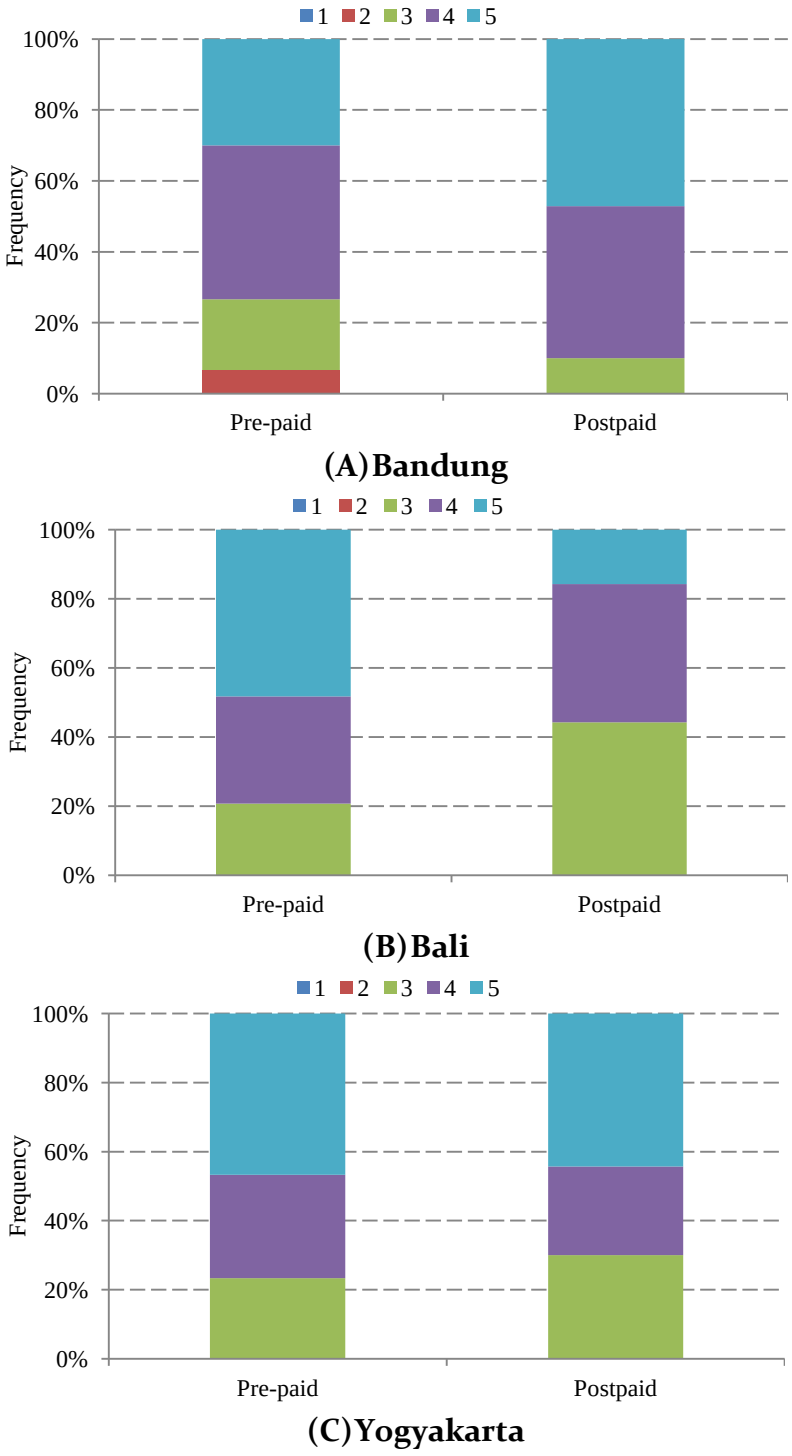


Figure 14: Distributions of effects of electricity payment systems on monthly electricity use in (**A**) Bandung, (**B**) Bali, and (**C**) Yogyakarta.

According to the respondents' responses, both payment systems in Bandung, Bali and Yogyakarta served as a signal in decision-making about electricity consumption (Mean of all payment systems > 3.90). These results are in line with the findings in sub-section 2.1 (Understanding of Electricity Price), that people in Bandung, Bali and Yogyakarta give great attention to monthly electricity expenditure, although the knowledge of government's electricity prices is low.

4. Policy Implications

Most policies tend to be designed to affect appliance production and distribution or to influence consumer decision and behaviors (Gaspar and Antunes, 2011). This conventional approach in energy efficiency and energy saving policies should be replaced by a new paradigm that integrates consumer decisions and behaviors within a framework of the local cultures. In this section, several policies input can be summarized based on results of analysis obtained from field survey.

As presented in the results and discussion section, a choice determinant in the purchase of electrical appliances and decision-making in the purchase of electrical appliances originate from three internal factors, economic motives (particularly profit and loss reasons), human psychology (awareness, habit, attitude, and norm), and perspective or knowledge of the technology of appliances. Meanwhile, culture indirectly influences the internal factors in making a decision concerning the purchase of electrical appliances or consumption of electricity. Thus, when developing policy, local cultures

should be considered as a source of sensitivity. Such consideration will result in the public's wider acceptance of policy.

The findings of this study show that policy-makers should utilize differences approaches in three cities to successfully implement energy conservation policy. However, there is a general policy framework that could be implemented in three cities based on the analysis of the respondents' responses. A policy recommendation has been developed for three cities to show how the policies of energy efficiency and energy saving can result in interventions that aim to manage electricity consumption in the household sector. To address the sensitivity influenced by cultures, the policy recommendation is proposed to improve success in the implementation of energy saving and energy efficiency, is designed based on the society's perspectives. Details of the policies that aim to manage electricity consumption in the three cities are presented below:

1. *Displaying the total lifetime cost of appliances use*.

   The price of appliances is the first factor considered prior to purchase; the lower the price, the more attractive the sales. In contrast, based on the current findings, the change in electricity prices policy to increase people's awareness of their electricity consumption will not result in a significant electricity saving. Therefore, in order to bring around people that high-efficiency appliances are lower cost than low-efficiency appliances (which the initial costs are lower), the total lifetime cost of appliances use should be displayed and informed to consumers. This will realize people to adopt high-efficiency appliances.

2. *Energy labelling scheme in the appliances commercial advertisements*.

The study found that commercial advertisements play a key role in facilitating the consideration of matters related to energy consumption. Therefore, a policy that might be used to enrich the commercial advertisements with information related to the energy consumption and price of electricity consumed by appliances is the standardization of energy labeling. Such labeling assists people in understanding the rate of energy consumption of selected appliances. The officially mandated directive on the energy standards and labeling for appliances is controlled by government regulation no. 70/2009, and the energy labeling standard is governed by the Standard National of Indonesia (SNI) No. 04-6958-2003. However, energy labeling does not yet appear on the appliances sold on the market.

The energy labeling scheme has been realized in many countries, such as European Union countries, U.S., Iran, Brazil, Thailand, Australia and India (Harrington and Wilkenfeld, 1997; Mahlia, *et al*., 2005; Mills and Schleich, 2010), as a key component of efforts to increase the diffusion of energy efficient household appliances. In addition, the energy labeling scheme is expected to indirectly improve the quality of appliances sold in domestic market, as the standard of energy labeling requires a minimal efficiency that should be obtained by an appliance. Thus, the durability and reliability of appliances being sold in Indonesia could be improved.

3. *Promotional messages to persuade people to adopt high-efficiency appliance*.

Promoting the adoption of high-efficiency appliances is an important way to improve awareness of electricity use. The approaches could be delivered through and

training for sales staff to persuade people to purchase high-efficiency appliances, since the study found that the sales staff has the greatest positive impact on people's choice of energy-efficient appliances.

4. *Implementation and enhancement of multi-payment system*.

Technology policies are one of the options available for the reduction of carbon emissions and the usage of energy. However, gains in the efficiency of energy consumption will result in an effective reduction in the energy per unit price of energy services. As a result, consumption of energy services should increase (Greening, *et al*., 2000). In the literature, this impact is often called the "rebound effect of energy efficiency".

Doubts have recurrently been raised concerning the extent to which energy efficiency can reduce the demand for energy (Nässén and Holmberg, 2009). The level of the rebound effect for household sectors varies depending on consumer awareness during consumption of appliances. As one of the findings in this chapter is that effective payment system served as a signal in decision-making about electricity consumption. Therefore, the implementation of multi-payment systems that suitable to consumers' preference is important to improve people awareness in their electricity consumption.

Overall, the results of this study have presented a strategy to improve the adoption of higher-efficiency appliances in Indonesia to manage the energy use of households. For this strategy to succeed, policy improvement and a strong willingness to carry out these

strategies are required. A further study that integrates the consumer decision and behaviors in the purchase and use of electrical appliances in the electricity system in the framework of different cultures should be conducted to determine the effectiveness of intervention policies in the future long-term electricity consumption.

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Chapter 4

Policy Design for Households Appliances-related Electricity Consumption in Indonesia

Most policies tend to be designed to affect appliance production and distribution or to influence consumer decision and behaviors (Gaspar and Antunes, 2011). In a multicultural society, like Indonesia, this conventional approach in energy efficiency and energy saving policies should be replaced by a new paradigm that integrates consumer decisions and behaviors within a framework of the local characteristics. The previous chapter explores the choice determinant of consumers in the purchase of appliances and decision-making in electricity consumption, it was found that policy-makers should address the sensitivity of cultural influences on society's perspectives in the implementation of energy efficiency adoption and energy saving. Four initial policies recommendation have been purposed on previous chapter based on the analysis results. Therefore, in this chapter, the effectiveness of policies recommendations will be examined based on people's response through questionnaire survey. In order to that, projection of diffusion of high-efficiency appliances and electricity savings will be modeled and discussed in this chapter.

1. Methodology of Electrical Appliances' Diffusion and Electricity Consumption Models

1.1 Electrical Appliances Population

For analyzing more accurate policies that aim to manage electricity consumption, a detailed end-use electricity demand projection should be modeled and analyzed. The general form of appliance ownership as a function of household income follows an S curve (WB, 2008; McNeil and Letschert, 2010). The simple logistic model as proposed by McNeil and Letschert (2010) is employed in this study, which is appropriate for econometric modeling of simple market share model in developing country, as follows:

$$Ownership(y) = \frac{\alpha}{1 + \gamma \times \exp\left(\beta_1 \times I(y) + \beta_2 \times U(y) + \beta_3 \times E(y)\right)} + \varepsilon \quad \textbf{(4)}$$

In this equation, the *Ownership(y)* is the diffusion of an appliance in the country in year (y), α is the saturation level, $I(y)$ is the household income in the country in year (y), $U(y)$ is the urbanization rate in year (y), $E(y)$ is the electrification rate in the year (y), and ε is the error term. Meanwhile, γ, β_1, β_2, and β_3 are defined from model parameters. The logistic diffusion function can be converted to a linear function, allowing linear regression analysis. Rearranging and taking the logarithm of both sides gives:

$$\ln\left(\frac{\alpha}{Ownership} - 1\right) = \ln\gamma + \left(\beta_1 \times I(y) + \beta_2 \times U(y) + \beta_3 \times E(y)\right) + \varepsilon \quad \textbf{(5)}$$

In the case of fans, cooling degree days (CDD) are used as a driving variable of ownership. Air conditioner ownership is also highly climate dependent. To model this, the diffusion equation for air conditioners is multiplied by a *climate maximum* parameter ranging from 0 to 1. Climate maximum is given by the following equation, as determined in (McNeil et al, 2009)

$$\text{ClimateMaximum} = 1.0 - 0.949 \times \exp\left(-0.00187 \times \text{CDD}\right) \quad (6)$$

Shipments of electrical appliances are driven by the increase in households owning appliances, or by the replacement of retired appliances. In developing countries, the combined effect of rapid economic growth, urbanization, electrification and number of household (population is growing whereas the households become smaller), the "first purchase" component is the dominant driver of sales. Shipments due to increased ownership are given by

$$FP(y) = \frac{Pop(y) \times Ownership(y)}{HHSize(y)} - \frac{Pop(y-1) \times Ownership(y-1)}{HHSize(y-1)} \quad (7)$$

where *FP* stands for first purchase, *Pop(y)/HHSize(y)* is the number of households in each year, *Ownership(y)* is the function presented in Eq. 4.

In addition to first purchases, the model describes the replacement of an appliance in terms of an annual retirement probability that varies as a function of the appliance age, given by:

$$P_R(age) = \frac{1}{1 + e^{(age - age_0)/D_{age}}} \quad (8)$$

where $P_R(age)$ is the probability of retirement at a given appliance age, age_o is the average lifetime of the product, and where D_{age} is the mean deviation of replacement ages. Replacements in each year are given by the relationship:

$$REP(y) = \sum_{age=1}^{L} Stock(y-1, age) \times P_R(age) \quad (9)$$

where *Stock(y,age)* is the number of products of vintage *age* remaining in each year. Finally, the total shipments for the current year are:

$$S(y) = FP(y) + REP(y) \quad (10)$$

The final step in stock accounting is to update the number of remaining older products in the stock, according to:

$$Stock(y, age) = Stock((y-1, age-1) \times (1 - P_R(age-1)) \quad (11)$$

1.2 Final Electricity Demand and Savings

The final electricity demand could be calculated according to quantity of electricity service *i* (Q_i) in year y, and intensity of electricity use for electricity service *i* (I_i) in year y, as shown in this relationship:

$$E_{Demand}(y) = \sum_{i=1}^{i=n} Q_i(y) \times I_i(y) \quad (12)$$

The quantity of electricity service could be calculated according to unit energy consumption of equipment sold in previous years, it is given by the relationship:

$$Q_i(y) = \left(S_i(y) + Stock_i(y, age)\right) \times \left(M_i\right) \quad \textbf{(13)}$$

where $S_i(y)$ is obtained from Eq. 10, and $Stock_i(y, age)$ is obtained from Eq. 11. Meanwhile, M_i is the frequency of use of appliance i.

The energy saving could be derived by comparing Business as Usual (BAU) of energy demand and Scenario based of energy demand as shown in this relationship:

$$\Delta E(y) = E_{BAU}(y) - E_{Scenario}(y) \quad \textbf{(14)}$$

2. Population of Electrical Appliances

Household electricity consumption is largely determined by the ownership of individual appliances (McNeil and Letschert, 2010). In the actual case, electricity consumption in the household sector is not only considered from power consumption and energy efficiency of appliances, but also duration of operating the appliances. Table 22 presents basic assumption for modeling population of residential electrical appliances. Data of population in three cities are obtained from population census in 2010 by Statistics Indonesia, while the projection of future population is based on national population growth forecast by United Nations (see details of population projection in Table 23).

Table 22: Basic Assumption for modeling residential appliances

Variable	Assumption	Source
GNI/Capita growth	7.6% p.a	Statistics Indonesia, 2010b
Urbanization rate	1.94% p.a	United Nations, 2012
Discount rate	7.2%	Bank Indonesia, 2013
Electrification ratio	100% by 2020	Ministry of Energy and Mineral Resources, 2008
Population growth	0.75% p.a	United Nations, 2012

Table 23: Population in Bandung, Bali, and Yogyakarta

City	2010	2015	2020
Bandung[1]	1,513,634	1,571,253	1,631,066
Bali[2]	788,589	818,608	849,770
Yogyakarta[3]	388,627	403,421	418,778

Source:

[1]2010 Population Census-Statistics of West Java Province, 2010c and author calculations based on national population growth.

[2]2010 Population Census-Statistics of Bali Province, 2010d and author calculations based on national population growth.

[3] 2010 Population Census-Statistics of Yogyakarta Province, 2010e and author calculations based on national population growth.

Table 24: Residential model diffusion parameters for all appliances

Appliance	α	$\ln \gamma$	β_1	β_2	β_3	β_{CDD}	Obs.	R^2
TV	3	3.710	-2.5E-05	-2.36	-	-	48	0.86
Refrigerator	1.4	4.485	-1.3E-05	-3.57	-2.28	-	66	0.94
Air Conditioner	1	4.485	-6.9E-05	-	-	-	24	0.69
Electric Fan	3	0.798	9.79E-07	-1.13	-	3.41E-04	11	0.79
Lighting	35	5.124	-2E-05	-	-	-	81	0.32
Rice Cooker	1.3	5.538	-6.2E-04	-4.63	-	-	66	0.77
Water Pump	1	3.101	-4.8E-04	-	-	-	32	0.58
Washing Machine	1	7.982	-3.2E-04	-8.74	-	-	24	0.70

By using average data of current appliances' population as obtained in Table 6 (Chapter 2), and using model as presented in Eq. (4) the details of the residential model

diffusion parameters are presented in Table 24. Since lighting has low R^2, therefore, it will not be considered in this projection. This model has been proved by McNeil and Letschert (2010), gives an error of lower than 4%.

Determination of economically driven appliance ownership rates allows for the calculation of total product sales (first purchase sales and replacement sales), and finally total population of appliances in three cities. Sales are driven by the increase of number of household and households owning appliances, or by the replacement of aged appliances. In developing country such Indonesia, the first purchase is the dominant driver of sales. While to calculate the replacement sales, the average lifetime of appliances is necessary and obtained from the average lifetime on Table 15.

Projections of appliances total sales in three cities are presented in Table 25 to 31. Television is the most favored sales in all cities, and followed by washing machine and refrigerator. Meanwhile, sales of air conditioner are increasing rapidly due to the increasing of people's income, although the appliance is relatively considered as expensive and luxury product. Another reason behind of vast increase of air conditioner is that in tropical country like Indonesia, air conditioner might be considered among the most desirable appliances due to its climate. In all cases, the replacement sales always increase to replace the aged appliances.

Table 25: Total sales of TV (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	57.36	26.53	38.01	16.09	21.89	9.39
2015	89.15	43.44	57.12	31.61	37.20	17.69
2020	113.53	61.77	79.29	52.83	52.62	37.08

Table 26: Total sales of refrigerator (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	16.16	5.47	8.42	2.85	4.15	1.40
2015	14.15	13.31	7.37	6.93	3.63	3.42
2020	15.37	19.65	8.01	10.24	3.95	5.05

Table 27: Total sales of air conditioner (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	3.30	0.68	1.72	0.36	0.85	0.18
2015	4.58	1.84	2.39	0.96	1.18	0.47
2020	8.86	3.42	4.62	1.78	2.28	0.88

Table 28: Total sales of electric fan (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	14.34	6.75	7.27	3.74	4.08	1.96
2015	25.37	9.83	9.13	3.98	4.84	2.42
2020	23.48	11.04	8.91	4.53	5.74	2.78

Table 29: Total sales of rice cooker (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	14.17	6.25	7.21	2.28	4.05	1.43
2015	13.12	8.43	8.46	3.87	3.47	2.88
2020	14.53	12.75	8.77	6.32	3.81	4.92

Table 30: Total sales of water pump (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	8.40	5.48	2.27	0.96	1.36	0.88
2015	10.61	4.87	2.41	1.78	1.09	1.74
2020	13.54	6.44	3.13	2.67	2.57	2.86

Table 31: Total sales of washing machine (in thousand units)

Year	Bandung		Bali		Yogyakarta	
	First Purchase	Replacements	First Purchase	Replacements	First Purchase	Replacements
2010	18.00	8.03	9.38	4.18	4.62	2.06
2015	13.35	19.35	6.95	10.08	3.43	4.97
2020	13.06	25.99	6.80	13.54	3.35	6.67

Total population of electrical appliances in three cities is defined from the total sales and the number of remaining older appliances in each city. Table 32 to 34 presents population of electrical appliances from 2010 to 2020 in all cities. The population of most favored appliances in all cities increases rapidly from 2010 to 2020, accounted for double. Furthermore, air conditioner seems to be the most demanded appliance. Their population in 2030 increased triple than in 2010, which was about 69,203, 36,055, and 17,768 in Bandung, Bali and Yogyakarta, respectively.

Table 32: Projection of total electrical appliances in Bandung (in thousand units)

Year	Electrical appliances						
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine
2010	484.66	164.91	23.68	372.82	149.13	186.41	136.65
2015	712.41	231.82	40.79	593.67	257.26	237.47	202.69
2020	959.45	297.27	69.20	834.30	375.44	292.01	260.50

Table 33: Projection of total electrical appliances in Bali (in thousand units)

Year	Electrical appliances						
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing machine
2010	252.50	85.91	12.34	194.23	77.69	97.12	71.19
2015	371.16	120.78	21.25	309.30	134.03	123.72	105.60
2020	499.86	154.87	36.05	434.66	195.60	152.13	135.72

Table 34: Projection of total electrical appliances in Yogyakarta (in thousand units)

Year	Electrical appliances						
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing machine
2010	233.08	42.34	6.08	217.54	116.54	94.98	35.09
2015	329.92	59.52	10.47	268.06	148.46	117.53	52.04
2020	486.82	76.32	17.77	391.20	190.69	145.61	66.88

3. Input of Policy Recommendation for Households Appliances-related Electricity Consumption

Diffusion of electrical appliances is important to determine the adoption of high-efficiency appliances and energy savings. However, energy consumption and savings are also significantly determined by behavior in using electrical appliances. Therefore, findings in population of electrical appliances together with results obtained in Chapter 3 give evidence to policy-makers that strategy integrates the consumer decision and behaviors in the purchase and use of electrical appliances in the electricity system in the framework of different cultures should be conducted to determine the effectiveness of intervention policies in current electricity consumption.

A tool named questionnaire survey has been used to gather policy input from the electricity consumers' perspective. Additional questions in the field survey on October to November 2011 have been asked to respondents in order to confirm the selection of the information they had previously answered on the questions related to required information of appliance characteristics, factors that influence the purchase of appliances, and factors that influence the awareness in using appliances.

3.1 Design of Questionnaire Survey

3.1.1 Controlling Information related to Electrical Appliances Characteristics

According to Furaji, *et al*. (2012), consumer buying decision process is started with recognizes a problem or need or responds on a good (see consumer buying decision process in Figure 15). Next, consumer needs to decide how much information is required to make the decision through the information search obtained from several sources such as personal sources, commercial sources (advertisement, and retailers), and public sources (newspaper, magazine, radio, television, and internet). The usefulness and degree of influence of each of these sources of information will vary by product and by consumer as obtained in the Figure 8. For the most complex products such as electrical appliances, consumers spend substantial amounts of time researching a large number of potential options before they buy. It makes important for controlling over the information that is provided to consumers and the manner in which this information is presented in order to pursue consumer with high efficiency appliances.

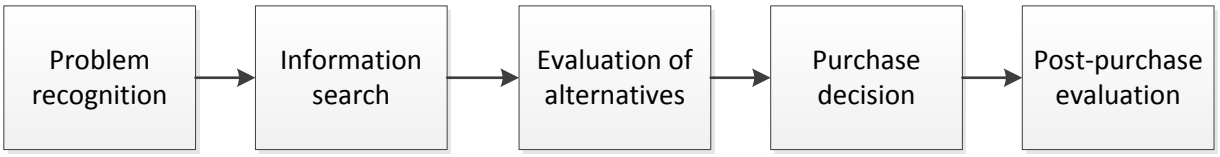

Figure 15: Consumer buying decision process (Furaiji, *et al*., 2012).

In the evaluation stage, the customer must choose between alternative products. An important determinant of the extent of the evaluation is whether the customer feels "involved" in the product. A buyer's level of involvement determines why s/he is motivated to seek information about a particular product while virtually ignoring others

(Furaji, *et al.*, 2012). Linking with the results obtained in Chapter 3 that the quality and price of an appliance was the primary type of information considered as being necessary in the decision process prior to making a purchase.

However, the information on energy consumption was given a comparable priority. In the real case, most of good quality appliances correspond to high price and low energy consumption. Therefore, consumers should not be worse off that an increase in product price would be compensated by the decrease of other costs, especially lower energy costs (Siderius, 2013). Figure 16 shows the relationship of price, quality and energy consumption of electrical appliance, and its influence on consumers' decision-making. Thus, total life time cost of use should be informed to consumers to encourage them in adopting high-efficiency appliances, instead of only showing initial price of its appliances. If lifetime energy costs are not salient to consumers at the point of purchase, they might not fully account for these costs when making their decision and end up purchasing less efficient products than what is optimal for the individual, given a reasonable discount rate (Kallbekken, *et al*, 2013).

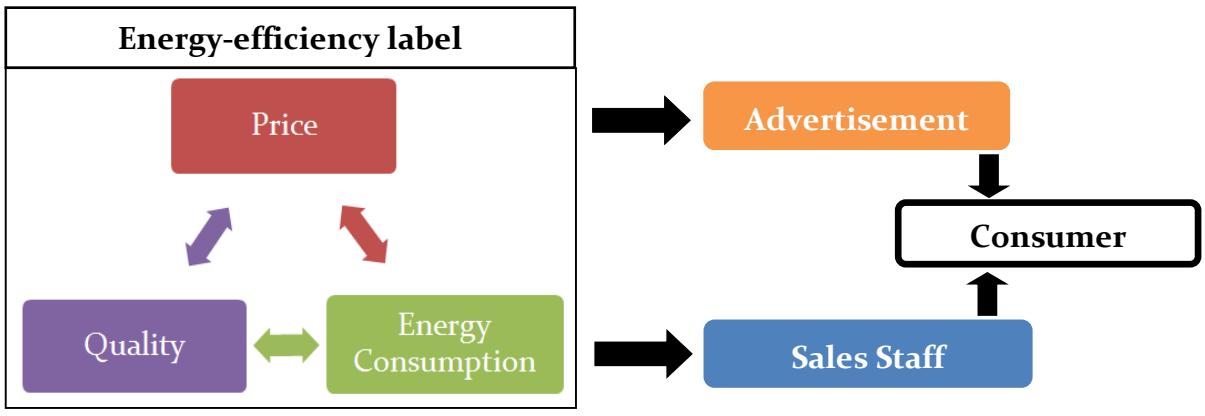

Figure 16: Relationship between price, quality and energy consumption of electrical appliance, and its influence on consumers' decision-making.

Should be there is an information tool that contains information of energy consumption and lifetime costs of use that could be used by consumers to influence decision in adopting high-efficiency appliances in their purchase, which is called energy-efficiency label. Energy-efficiency label is informative label that is affixed to manufactured products and describe a product's energy performance (usually in the form of energy use, efficiency, or energy cost) to provide consumers with the data necessary for making informed purchases. Energy label provides information that allows consumers who care to select efficient models. Labels also provide a common energy-efficiency benchmark that makes it easier for utility companies and government energy-conservation agencies to offer consumers incentives to buy energy-efficient products (Wiel and McMahon, 2003). Energy-efficiency label are often promoted as a cost-effective measure to overcome barriers related to information and search cost, or to bound rationality on the part of appliance purchasers (Mills and Schleich, 2010).

Based on these rationales, some questions have been designed based on respondents input as analyzed in Chapter 3. Respondents in each city were asked their response to purchase or adopt high-efficiency appliances before and after energy-efficiency label being applied on the market. Table 35 presents details of questions in the survey.

Table 35: Questions to investigate the influence of energy-efficiency label on adoption of high-efficiency appliances

No.	Criteria of Respondent	Question
1.	All respondents	Would you want to purchase or adopt high-efficiency appliances?
2.	Respondents who select sales staff as source of information	If the energy-efficiency label which contains information of energy consumption and lifetime costs of use is appeared in the appliances and promoted by store sales, then would you want to purchase or adopt high-efficiency appliances?
3.	Respondents who select commercial ads as source of information	If the energy-efficiency label which contains information of energy consumption and lifetime costs of use is appeared in the commercial ads of appliances, then would you want to purchase or adopt high-efficiency appliances?
4.	All respondents	If the energy-efficiency label is appeared in the appliances and promoted by store sales and in the commercial ads of appliances, then would you want to purchase or adopt high-efficiency appliances?

2.2.2 Electricity Payment System for Improving Awareness on Electricity Use

One of findings on previous Chapter is that effective payment system served as a signal in decision-making about electricity consumption. The payment systems succeed to raise people's awareness on their electricity consumption. Currently, electricity payment system being enacted in Indonesia for new subscriber houses is not based on consumers' preference, but it is based on PLN's (State Electricity Company) decision as single electricity provider in Indonesia. Meanwhile, for old subscriber houses, there is an option to choose pre-paid or postpaid payment system. However, PLN is likely to encourage

their consumers to adopt pre-paid system. It soon will become the only payment system in Indonesia.

Look at the results in Chapter 3, there were various respondents' responses on the payment system that currently being used by them. These then raise an argumentation that consumers should be offered various payment systems that were designed based on their preferences, although there was a cultural pattern on the awareness of electricity payment in three cities. Yamamoto *et al*, (2008) argued that the payment system for home electricity consumption plays an important role in decision-making. Thus, in this study, respondents who had lower awareness on their monthly electricity use was offered to change their payment system, then their awareness on monthly electricity use was asked again. Detailed questions are presented in Table 36.

Table 36: Question to assess the effect of multi-payment systems to monthly electricity consumption

No.	Criteria of Respondent	Question
1	All respondents	How do the electricity payment systems affect your awareness of the monthly use?
2.	Pre-paid respondents who answered 3 (moderately aware) to 1 (not aware at all)	If your payment is changed to **postpaid** system, how does the payment system affect your awareness of the monthly electricity use?
3.	Postpaid respondents who answered 3 (moderately aware) to 1 (not aware at all)	If your payment is changed to **pre-paid** system, how does the payment system affect your awareness of the monthly electricity use?
4.	All respondents	**If you can select your payment system**, does the payment system affect your awareness of the monthly electricity use?

3.2 Results and Discussion

Before introduction of energy-efficiency label, respondents in Yogyakarta had the highest willingness to adopt high-efficiency appliances as much as 8.83% of total respondents. This fact is supported by indication that respondents in Yogyakarta showed better awareness of energy consumption, and gave greater attention to electrical appliance use (power consumption and energy efficiency of appliances) than respondents in Bandung and Bali as found in the analysis on Chapter 3. First scenario, the introduction of energy-efficiency label was addressed according to the most preferable source of information in each city as presented in Figure 8, which was through store sales staff for Bandung and Bali, and through commercial advertisements for Yogyakarta. After introduction of energy-efficiency label, respondents increased their willingness to adopt high-efficiency appliances by 21.64%, 22.15% and 24.05% for respondents in Bandung, Bali, and Yogyakarta, respectively. Table 37 shows respondent's response to adopt high-efficiency appliances. Second scenario, energy-efficiency label was introduced together through store sales staff and commercial advertisements in all cities. The results show that, energy-efficiency label had greater effect to increase willingness of respondents in Bandung, Bali and Yogyakarta by 39.91%, 37.28%, and 40.86%, respectively.

Table 37: Respondents' response on willingness to adopt high-efficiency appliances

City	Before	Energy Label-Sales staff		Energy Label-Ads		Energy Label Sales staff & Ads
		Staff	Ads	Staff	Ads	
Bandung	4.60%	21.64%	1.20%	-	-	39.91%
Bali	5.46%	22.15%	1.42%	-	-	37.28%
Yogyakarta	8.83%	-	-	2.46%	24.05%	40.86%

Controlling information through energy-efficiency label resulted in low rate of improvements in adopting high-efficiency appliances. This might because of there was no real form or design of energy-efficiency label could be shown to respondents during survey. Similarly, a study conducted by Banerjee and Solomon (2003) found that very low levels of understanding of the label cannot necessarily tell consumers as to which product is actually more energy-efficient based on the label. They had difficulty in understanding different energy-efficiency features or designs. A consumer will use a label (as intended) in decision-making only if he or she understand and trusts the message it conveys (Thøgersen, 2000).

Enhancing options to consumers to select electricity payment systems according to their preferences showed an increase in awareness on their electricity use if they have freedom to select type of payment according to their preferences. In Bandung, 96% of postpaid respondents answered 4 (fairly well) or 5 (highly) (or increased about 6% from the previous results) and 87% of pre-paid respondents answered 4 (fairly well) or 5 (highly) (or increased by 14%), or in total of electricity respondents who answered 4 (fairly well) or 5 (highly) was increased to 8%. In Bali, it increased about 10% and 13% who gave answer 4 (fairly well) or 5 (highly) for postpaid and pre-paid respondents, respectively, in total of respondents who answered 4 (fairly well) or 5 (highly) was increased to 11%.

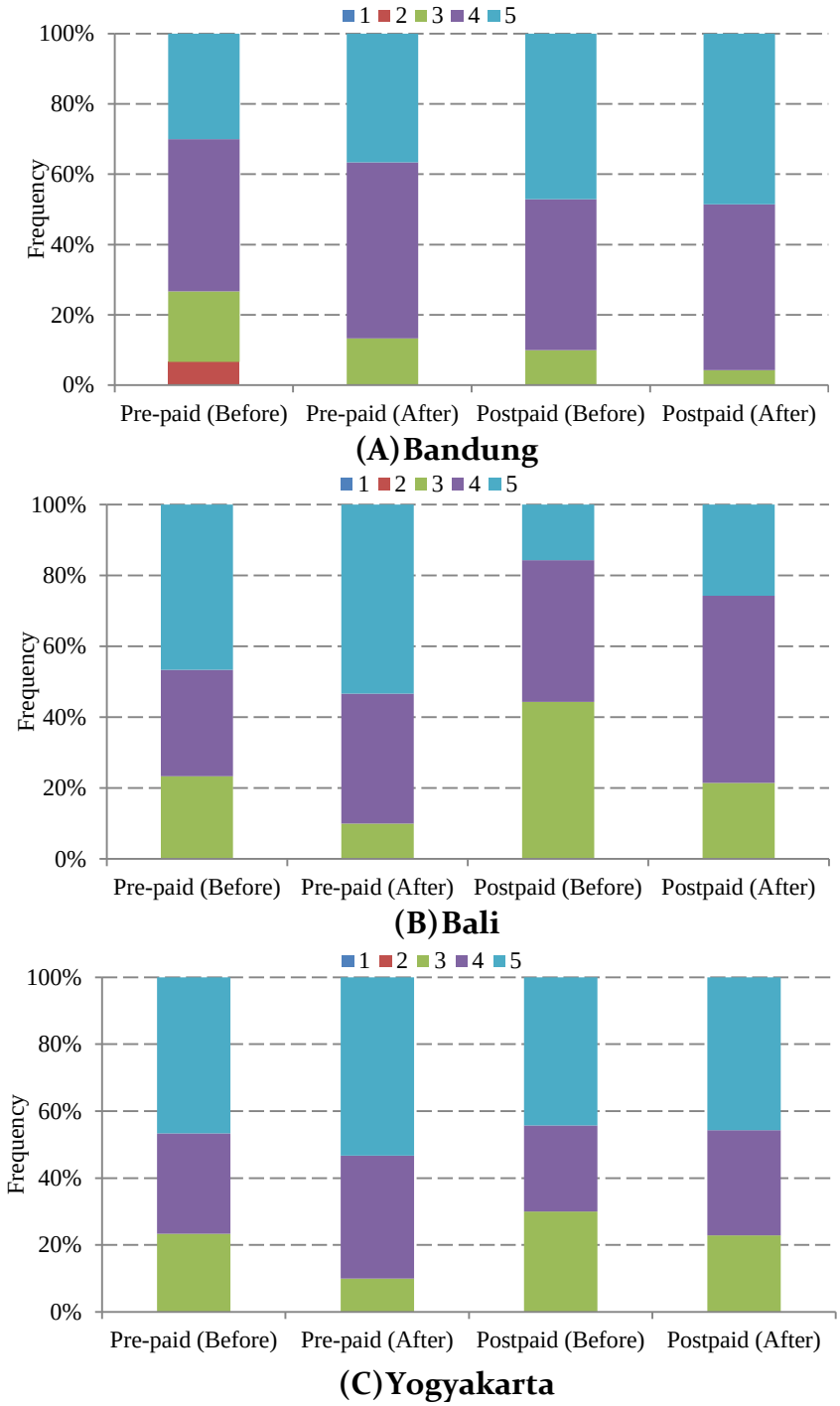

Figure 17: Respondents' changes in awareness of electricity use due to payment systems.

Likewise, in Yogyakarta, total respondents the respondents who answered 4 (fairly well) or 5 (highly) was increased by 9%. The details were by 7% and 13% for postpaid and pre-paid respondents, respectively. Respondents' response due to options to select their

electricity payments to the awareness of electricity payment is presented in Figure 17. The finding for pre-paid system is linear to study conducted by Faruqui, *et al.* (2010) at several households in Canada and US that pre-paid system could reduce electricity consumption by about 7% to 14% in average. Meanwhile, Yamamoto (2008) and Hahn, *et al.* (2013) argued that postpaid payment increases spending on electricity consumption. However, this argument is not true at all, since a lot of respondents felt more convenience and got their awareness on electricity consumption by using postpaid payment.

4. Evaluation of Effectiveness Policy Recommendation

4.1 Projection of Electricity Demand in Business as Usual (BAU) Scenario

As consequence of increasing population of electrical appliances, electricity demand in all cities increased proportionally. By using data of average electricity consumption obtained from field survey in each city (see Tables 7 and 8), total electricity consumption in the planning horizon could be estimated. Table 38 shows the typical characteristics of electrical appliances sold in Indonesian market, and the penetration rate based on results in questionnaire survey (see sub-section 3.2 of this chapter).

Tables 39 to 41 present projection of electricity consumption by appliances in Bandung, Bali and Yogyakarta from 2010 to 2020. The most significant changes in electricity demand structure come from air conditioner. In Bandung, Bali and Yogyakarta, air conditioner increased 200% in 2020. However the most dominant electricity consumption in all cities is contributed by TV, refrigerator, and rice cooker. These are due

to the reason that entertainment device (TV) is important for daily lifestyle, while refrigerator and rice cooker always operate in 24 hours/day.

Table 38: Electrical appliances in Indonesian market and rate of high-efficiency appliances

Appliances	Power Rate[1]	High-efficiency appliance[2]	Penetration of High-efficiency appliances
Television	100 W	Reduced by 25.7%	
Refrigerator	80 W (One Door) 140 W (Two Doors)	Reduced by 21%	
Air conditioner	1000 W	Reduced by 22.4%	Bandung = 4.6% Bali =5.46% Yogyakarta =8.83%
Electric Fan	50 W	Reduced by 20%	
Rice cooker	380 W (Cooking) 55 W (Warming)	Reduced by 11.1 %	
Water pump	350W	Reduced by 15%	
Washing machine	480 W (Wash) 210 W (Spin)	Reduced by 20 %	

Note:
[1]Rate of power is taken from current electrical appliances in Indonesia, the data taken from various manufacturer's website (i.e., Sharp Indonesia, Panasonic Indonesia, Samsung Indonesia)
[2]Source: Ministry of Economy, Trade and Industry (METI), Japan and Lawrence Berkeley National Laboratory

Table 39: Projection of electricity demand by appliances in Bandung

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	252.93	223.45	30.84	65.09	117.54	22.86	10.74	723.46
2015	371.79	314.13	53.11	103.66	202.76	29.12	15.93	1,090.50
2020	500.72	402.81	90.10	145.67	295.90	35.81	20.48	1,491.50

Table 40: Projection of electricity demand by appliances in Bali

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	71.33	56.97	10.41	41.70	50.83	6.54	5.60	243.37
2015	104.84	80.09	17.93	66.40	87.69	8.33	8.30	373.58
2020	141.20	102.70	30.41	93.31	127.97	10.24	10.67	516.51

Table 41: Projection of electricity demand by appliances in Yogyakarta

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	79.52	33.49	6.99	63.33	78.99	6.39	2.76	271.46
2015	112.55	47.08	12.03	78.04	100.62	7.91	4.09	362.33
2020	166.09	60.38	20.41	113.89	129.24	9.80	5.26	505.06

4.2 Performance Analysis of Localized Energy Savings Policy

By considering local customs and characteristics in consuming electricity in a multicultural society, localized energy policy is one of the options to give opportunities to local authority in managing their local energy consumption. Based on findings in Chapter 3, localized policy for households' electricity consumption is design based on their own local characteristics. In localized policy scenario, the policy design is as follows: 1) in Bandung and Bali, in order to integrate price, quality and energy consumption of electrical appliance to be more attractive for consumers, energy-efficiency label was purposed through store sales staff. Meanwhile, in Yogyakarta, energy-efficiency label was purposed through commercial advertisements, and 2) electricity multi-payment systems; in Bandung through post-paid system, while in Bali and Yogyakarta through pre-paid system. Details of policy design are described in Table 42.

Table 42: Policy design of localized energy policy for households' electricity consumption

City	Policy	
	Related Appliances Purchase	**Related Appliances Use**
Bandung	Energy-efficiency label through store sales staff	Electricity post-paid system
Bali	Energy-efficiency label through store sales staff	Electricity pre-paid system
Yogyakarta	Energy-efficiency label through commercial advertisements	Electricity pre-paid system

Table 43: Results of respondents' measures as effect of localized energy policy

City	Penetration of High-efficiency appliances	Energy Savings due to Electricity payment systems
Bandung	22.84%	-6%
Bali	23.57%	-4%
Yogyakarta	26.51%	-4%

Each of policy is expected to be enforced to society by 2015. Within 5 years of the implementation, society's adoption is expected to achieve respondents' response as presented in the results of sub-section 3.2 of this chapter, and redraw in Table 43. In the early implementation of energy-efficiency label, in 2015, penetration rate of high-efficiency appliances is started from 4.57%, 4.71%, and 5.30% per year, in Bandung, Bali, and Yogyakarta, and then the penetration is increased linearly until 2020 become 22.84%, 23.57%, and 26.51%, respectively. In addition, power consumption rate of high-efficiency appliances is as in Table 38.

Table 44: Performance of localized energy policy in Bandung

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	252.93	223.45	30.84	65.09	117.54	22.86	10.74	723.46
2015	365.91	310.27	52.19	102.32	201.26	28.88	15.74	1,076.57
2020	464.72	378.59	81.59	136.99	286.86	34.49	19.32	1,402.57

Table 45: Performance of localized energy policy in Bali

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	71.33	56.97	10.41	41.70	50.83	6.54	5.60	243.37
2015	103.57	79.30	17.74	65.77	87.23	8.27	8.22	370.10
2020	132.65	97.62	28.81	88.92	124.62	9.88	10.16	492.65

Table 46: Performance of localized energy policy in Yogyakarta

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	79.52	33.49	6.99	63.33	78.99	6.39	2.76	271.46
2015	111.02	46.56	11.89	77.21	100.03	7.85	4.05	358.60
2020	154.77	57.01	19.20	107.85	125.44	9.41	4.98	478.66

Simulation results of localized energy policy are presented in Tables 44 to 46, while the energy savings performance as compared to BAU Scenario is shown in Table 47. In Bandung, localized energy policy results in reducing electricity consumption for 13.93 GWh and 88.93 GWh in 2015 and 2020. In Bali, localized energy policy reduces electricity consumption by 3.48 GWh and 23.86 GWh in 2015 and 2020. Meanwhile, in Yogyakarta, the program gains electricity savings by 3.73 GWh and 26.40 GWh.

Table 47: Estimation of electricity savings compared to BAU Scenario (in GWh)

City	Scenario	Electricity consumption	
		2015	2020
Bandung	BAU	1090.50	1491.50
	Localized Policy	1076.57	1402.57
	Reduction	**-13.93**	**-88.93**
Bali	BAU	373.58	516.51
	Localized Policy	370.10	492.65
	Reduction	**-3.48**	**-23.86**
Yogyakarta	BAU	362.33	505.06
	Localized Policy	358.60	478.66
	Reduction	**-3.73**	**-26.40**

4.3 Performance Analysis of New National Electricity Saving Policy

Diffusion of high-efficiency appliances and awareness on electricity consumption through energy savings behavior are important keys to achieve energy savings effort. Penetration of high-efficiency appliances will not give significant impact on energy savings, unless the society put awareness on their electricity consumption through energy savings behavior. In new national policy scenario, policy is designed as combination of localized policy design, as follows: 1) energy-efficiency label was purposed through store sales staff and store sales staff in all cities, and 2) electricity multi-payment systems according to consumers' preference. In this section, results of questionnaire survey in sub-section 3.2 of this chapter are used as policy tools in the projection of electricity consumption in Bandung, Bali and Yogyakarta. The results are then summarized in Table 48.

Table 48: Results of respondents' measures as effect of energy-efficiency label and multi-payment systems

City	Penetration of High-efficiency appliances	Energy Savings due to Electricity multi-payment systems
Bandung	38.91%	-8%
Bali	37.28%	-11%
Yogyakarta	40.86%	-9%

Similar to the localized policy, each of policy is expected to be enforced to society by 2015. Within 5 years of the implementation, society's adoption is expected to achieve respondents' response as presented in the results of 3.2 of this chapter, and redraw in Table 48. In the early implementation of energy-efficiency label, in 2015, penetration rate of high-efficiency appliances is started from 8.78%, 7.46%, and 8.17% per year in Bandung, Bali, and Yogyakarta, and then the penetration is increased linearly until 2020 become

38.91%, 37.28%, and 40.86%, respectively. Following suggestions in the Chapter 3, the implementation of multi-payment system according to consumer's selection are then evaluated in the current electricity consumption. Effects of multi-payment system are the increasing of people's willingness to use their electricity consumption wisely. In the early implementation of multi-payment system, in 2015, energy savings due to awareness of electricity consumption is started from 1.6%, 2.2%, and 1.8% in Bandung, Bali, and Yogyakarta. The energy savings is increased linearly until 2020 and becomes 8%, 11%, and 9%, respectively, in each city.

Table 49: Performance of new national electricity saving policy in Bandung

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	252.94	223.45	30.84	65.09	117.52	22.86	10.74	723.46
2015	329.26	283.85	47.70	94.06	190.90	26.98	14.46	987.21
2020	414.60	340.31	75.67	123.59	260.47	31.02	17.37	1263.03

Table 50: Performance of new national electricity saving policy in Bali

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	71.33	56.97	10.41	41.70	50.83	6.54	5.60	243.37
2015	100.57	77.10	17.24	63.97	85.05	8.05	7.99	359.98
2020	113.63	84.25	24.84	76.86	109.18	8.61	8.77	426.11

Table 51: Performance of new national electricity saving policy in Yogyakarta

Year	Electricity consumption by appliances (in GWh)							Total (GWh)
	TV	Refrigerator	Air conditioner	Electric fan	Rice cooker	Water pump	Washing Machine	
2010	79.52	33.49	6.99	63.33	78.99	6.39	2.76	271.46
2015	108.21	45.44	11.60	75.40	97.91	7.67	3.95	350.17
2020	135.27	50.23	16.87	95.17	112.28	8.37	4.39	422.58

The projection results of electricity demand based on new national electricity saving policy from 2010 to 2020 are presented in Tables 49 to 51. Implementation of multi-

payment system based on consumers' preference together with implementation of energy-efficiency label in new national electricity saving policy results in significant energy savings (See Table 52). In Bandung, about 103.29 GWh and 228.47 GWh are reduced in 2015 and 2020 respectively as compared to BAU Scenario, while compared to localized policy results in electricity savings for 89.36 GWh and 139.54 GWh. In Bali, new national policy reduces electricity consumption by 13.59 GWh and 90.39 GWh as compared to BAU Scenario, and 10.12 GWh and 66.54 GWh as compared to localized policy, in 2015 and 2020. Meanwhile, in Yogyakarta, the program gains electricity savings by 12.16 GWh and 82.48 GWh as compared to BAU Scenario and by 8.43 GWh and 56.08 GWh as compared to localized policy.

Table 52: Estimation of new national policy electricity savings compared to BAU Scenario and Localized Energy Policy (in GWh)

City	Comparison Scenario	Electricity Savings	
		2015	2020
Bandung	BAU	-103.29	-228.47
	Localized Policy	-89.36	-139.54
Bali	BAU	-13.59	-90.39
	Localized Policy	-10.12	-66.54
Yogyakarta	BAU	-12.16	-82.48
	Localized Policy	-8.43	-56.08

By looking on the simulation results in Tables 47 and 53, it clearly shows that implementation of electricity saving policy based on local culture (the best preference culture or the comprehensive culture) resulting better electricity saving as compared to current energy policy in Indonesia as reflected by the BAU scenario.

5 Implications and Recommendations

Providing consumers with information that can lead to more energy-efficient choices can help reduce energy use while reducing costs to consumers. In the same time, since the electricity payment system is one of the tools that served as a signal in decision-making about electricity consumption (as results in Chapter 3), utilizing and modifying electricity payment system as consumers' preference could be a potential tool in energy conservation efforts.

In a multicultural society like Indonesia, selecting energy conservation policy should be emphasized on local culture. Although multi-policy approaches could be implemented in all societies, however, cost-effective measures should be considered by policy-makers. Results in this Chapter shows that localized energy policy gives effective contribution to energy savings in three cities; however, new national energy policy which comprises of comprehensive local energy policies gives more significant energy savings.

Energy-efficiency label is considered as cost-effective measures to help people in adopting high-efficiency appliances, as also found in several studies (Wiel and McMahon, 2003; Mills and Schleich, 2010). Chances for success in implementing energy-efficiency label are best if the process of making the decision and preparing to establish a labeling or standards program includes assessing how local cultural, institutional, and political factors are likely to influence the adoption and effectiveness of such programs. The initial effectiveness of the approach selected on label design will likely depend on cultural preferences and many other factors (Wiel and McMahon, 2003). Nevertheless, since this study is a simulation based, a further natural field experiment should be conducted in the

actual consumer decision-process as suggested by Kallbekken, *et al.* (2013) to get the real image of consumers' decision-making in purchase and using electrical appliances.

5.1 Criteria of Policy Design for Household Electricity Consumption in a Multicultural Society

Since 1999, Indonesia have shifted its style of government, from a centralistic to decentralized one, highlighted by the country's Decentralization Laws No. 22/1999 and 25/1999. These laws formed the basis of radical decentralization of responsibility to local governments; districts and municipalities to manage local administrative and autonomy, including to manage local natural resources and the environment (Setiawan and Hadi, 2007). Changes of political systems in Indonesia from centralistic or top-down policies to decentralized or bottom-up policies, gives an umbrella to recognize local unique characteristics in policy developments. As a consequence of the imposition of decentralized governance system in energy policy, the country has stipulated new Energy Law No. 30/2007 and new Electricity Law No. 30/2009, which authorizes local governments to decide local energy planning and management, including effort to implement local energy conservation. Analysis results in Chapter 3 to Chapter 5 have shown evidences that in a multicultural country, policy-makers should address the sensitivity of different cultures in consuming electricity and utilize differences approaches to successfully implement energy conservation policy.

Although there is a room for developing bottom-up energy policy in Indonesia, the legislations provide no clear guidelines for power sharing among central and local

governments. It makes the local governments loss their capability to implement the regulations. In addition, the whole energy regulations have many weaknesses, such as a lack of recognition of local customs including the value of local wisdom and culture, and lack of detailed explanation regarding the appropriate role of community participation in energy conservation efforts. As results, until recently, no real efforts were made to increase the capacities of local government to design and manage local energy supply and demand. The current energy conservation policy seems back to centralized style. Therefore, the results are far from the consumption levels expected by policy makers.

In this situation, the 'integrated framework' becomes a common ground for both top-down and bottom-up policy actions. Bottom-up and top-down policies are governed by different political processes and collective action dynamics involving a different balance between efficiency and equity issues: while top-down regional policies have been traditionally concerned with a mixture of aggregate efficiency and territorial equity, bottom-up approaches have been essentially concerned with local efficiency. However, increasing constraints in terms of public acceptance have emphasized efficiency considerations in top-down policies while increasing interconnectedness between local areas (and their communities) has favored local actors' awareness of the impact of external conditions on local performance, making coordination between different policy actions and the reconciliation of top-down and bottom-up development policies increasingly relevant and necessary (Crescenzi and Rodríguez-Pose, 2011). Figure 18 presents an integrated policy between top-down and bottom-up approaches.

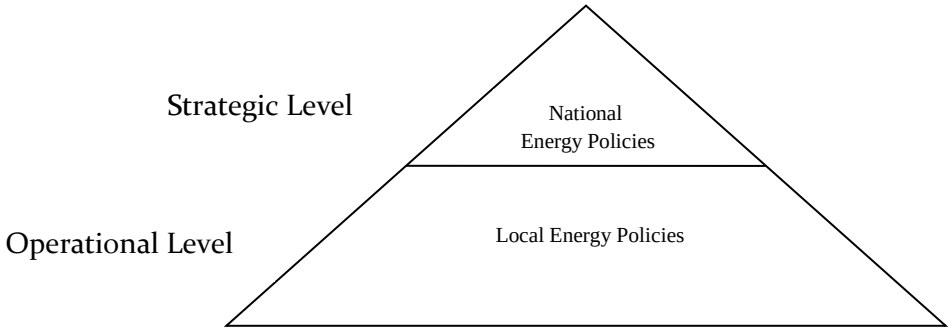

Figure 18: Level of energy policies design.

Discussion of policy approaches in a multicultural society, such as Indonesia, illustrates the challenges of addressing the complex social background and its driving factors in energy consumption. In sum, policy design for household electricity consumption in Indonesia should be able to cover:

1. *Recognition of local customs related to electrical appliances purchase*;

   Technological perspective and penetration become important in energy saving effort. By recognizing local customs in electrical appliances purchase behavior, policy-makers will be able to stipulate the most suitable regulations or actions for local community to adopt high-efficiency appliance.

2. *Recognition of local customs related to electricity consumption.*

   High-efficiency appliance will less contribute to energy saving unless society actively improve their awareness in using its appliances. Different society has different perspective in their way of consuming electricity. Therefore, policy-makers should be able to help in raising people's awareness in their consumption behavior by considering local characteristics in policy design, including knowledge regarding the operation of the appliances.

3. *Sensitivity on technical and financial barriers*

   Local specific policy requires a policy umbrella to be successfully applied in society. For instance, technical-root obstacles related to quality and reliability of appliances being sold and electricity supply in Indonesia as found in Chapter 3, needs strong regulations to improve quality standards for appliance manufacturers and electricity producers' service. In addition, financial barriers also become important issue that should be covered in effort of energy conservation policies, as results in this study found that prices of adopting electrical appliances became the main concern of people.

4. *An integrated policy for best mix of energy conservation efforts.*

   As common findings in a developing country; lack of recognition of local customs, lack of coordination among central and local governments, and lack of human resources in local government, result in less than optimal of policy application and adoption in society. Therefore, should be there is an integrated approaches between centralized and decentralized policies to address those problems. Central government regulates main objectives of policy targets by considering local inputs and guides local government to designing local regulations related to energy conservations. Meanwhile, local government contributes in giving input of necessary local customs need to be considered in the regulation. Local inputs act as pillar in developing energy conservation policies in a multicultural country.

5.2 Policy Design for Household Electricity Consumption in Indonesia

As findings in this study, differences in the cultural backgrounds results in differences characteristics and behavior in electricity consumption. Several driving factors in electricity consumption, and the influence of cultural backgrounds on Indonesian household electricity consumption within the perspective of electricity consumers' choice determinants in the purchase of electrical appliances and decision-making in consuming electricity were then investigated in order to design suitable policy for managing electricity consumption in the household sector.

However, current energy policy at national level does not address issues of diverse sub-cultures existing in the same national context. Thus, when developing policy, it was realized that local cultures should be considered as a source of sensitivity. Such consideration will result in the public's wider acceptance of policy. Based on information obtained from questionnaire survey, and its analysis results, policy design for household electricity consumption in Indonesia is shown in Table 53.

Table 53: Proposal of policy design for household electricity consumption in Indonesia

Scope	Policy
Strategic level/National Policy	Decentralized governance system in energy policy, particularly on energy conservation measures (currently this policy has been enacted in Indonesia, but no further implementations).
Strategic level/National Policy	Regulations to improve quality standards for appliance manufacturers (mandatory on energy efficiency and reliability standards) and electricity supply service.
Operational level/Local Policy	Electricity multi-payment system allows the consumers to select their most preferable payment system as their custom to improve awareness to their monthly electricity consumption.
Operational level/Local Policy	Energy-efficiency label with design that suits to local custom to attract consumers' intention and improve their knowledge in adopting high-efficiency appliances. Furthermore, this also could integrate the relationship information of price, quality and energy consumption of electrical appliance.
Operational level/Local Policy	Controlling information through commercial advertisements and store sales staff (depends on the most preference based on local customs) to deliver promotional messages to persuade people to purchase high-efficiency appliances, since the study found that the sales staff and commercial advertisements have the greatest positive impact on people's choice of energy-efficient appliances.

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Chapter 5
Conclusion and Future Work

1. Conclusion

In a society with diverse cultural backgrounds or often said as a multicultural society, there is an urgent need to raise the awareness that energy use and its impact on the environment should concern all individuals in their daily activities. This study investigates household electricity consumption in Indonesia, to develop strategy and effort to design electricity saving policy based on local cultures to improve the success of policy implementation. The results of this study can be concluded as below:

1. In a society with diverse cultural backgrounds, a generalized energy conservation policy that is national in scope may not address the different sensitivities of local factors driving household electricity consumption in each area. Analyses on characteristics of household electricity consumption and its driving factors in three cities found that in Bandung and Bali, higher education level and longer duration time at home had positive effects on the monthly electricity bill. However, the results obtained for Yogyakarta differ; higher education level and longer duration time at home had negative impacts on the monthly electricity bill.
2. Education levels have higher consideration to select higher-efficiency appliances. While time spent at home closely-related to electrical appliance use. Therefore,

perspective of electricity consumers' on choice determinants in the purchase of electrical appliances and decision-making in consuming electricity were then investigated. The results show that the quality and price of an appliance are the most important factors considered prior to the purchase and decision-making concerning the purchase. However, energy consumption of appliances was given a low priority as a factor to be considered. Meanwhile, sales staff and commercial advertisement have the greatest potential of positive impact on people's choice of energy-efficient appliances in three cities with different level of influences due to different cultures. The results show payment systems in Bandung, Bali and Yogyakarta served as a signal in decision-making about electricity consumption, even though people have little knowledge of the government's electricity prices.

3. To address the sensitivity influenced by cultures, the policy recommendation is proposed to improve success in the implementation of energy saving and energy efficiency, is designed based on the society's perspectives. The energy saving policy designs that suitable for three cities are as follow: 1) Related to adoption of high efficiency appliances, for Bandung and Bali, the policy promotion should be delivered through human interaction in order to get wider acceptance. Meanwhile, for Yogyakarta, it should be promoted through self-accessible information sources. 2) Related to wise electricity consumption, for Bali and Yogyakarta, policy should allow people to observe and curb their details electricity consumption. Meanwhile, for Bandung, it should be based on cumulative consumption charges. A simulation of current electricity consumption based on policy input was conducted and

showed that policy based on local cultures has better performance in electricity saving.

2. Future Work

In order to get more accurate and comprehensive assessment of energy savings in household sector from energy efficiency programs with regards on cultural backgrounds, in the future study, a natural field experiment of energy-efficiency label and multi-payment system should be conducted in the actual consumer purchases and uses of electrical appliances as suggested by Kallbekken, *et al.* (2013) to get the real image of energy-efficiency label and multi-payment system on consumers' decision-making. The evaluation could be done to get information about the design of label, and also the psychological model explaining the consumer attention on the label and their decision-making based on local customs.

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References

ADB, 2010, Proposed Loan and Administration of Loan and Grant Republic of Indonesia: Java-Bali Electricity Distribution Performance Improvement Project, Asian Development Bank, Manila, The Philippines.

Banerjee, A., Solomon, B.D., 2003, Eco-labeling for energy efficiency and sustainability: A meta-evaluation of US programs, Energy Policy, 31, 109-123.

Beatty, A., 2005, Feeling your way in java: an essay on society and emotion, Etnos: Journal of Anthropology, 70 (1), 53-78.

BI, 2013, 2012 Economic report on Indonesia, Bank Indonesia, Jakarta, Indonesia

Biesiot, W., Noorman, K.J., 1999, Energy Requirements of household consumption: A case study of the Netherlands, Ecological Economics 28, 367-383.

Bowerman, B. L., O'Connell, R. T., 1990. Linear statistical models: an applied approach (2nd edition). Duxbury, Belmont, CA.

CDI-EMR, 2010, Handbook of Energy and Economic Statistics of Indonesia, Center for Data and Information on Energy and Mineral Resources, Jakarta, Indonesia.

Crescenzi, R., Rodríguez-Pose, A., 2011, Reconciling top-down and bottom-up development policies, Working Papers Series in Economics and Social Sciences, Madrid Institutes of Advanced Research, Madrid, Spain.

Faruqui, A., Sergici, S., Sharif, A., 2010, The impact of informational feedback on energy consumption – A survey of the experimental evidence, Energy, 35, 1598-1606.

Furaiji, F., Łatuszyńska, M., Wawrzyniak, A., 2012, An empirical study of the factors influencing consumer behaviour in the electric appliances market, Contemporary Economics, 6(3), 76-86.

Gaspar, R., Antunes, D., 2011. Energy efficiency and appliance purchase in Europe: Consumer profiles and choice determinants. Energy Policy. 39, 7335-7346.

Ghisi, E., Gosch, S., Lamberts, R., 2007, Electricity end-uses in the residential sector of Brazil, Energy Policy, 35, 4107-4120.

Genjo, K., Tanabe, S., Matsumoto, S., Hasegawa, K., Yoshino, H., 2005, Relationship between possession of electric appliances and electricity for lighting and others in Japanese households, Energy and Buildings, 37, 259-272.

Greening, L.A., Greene, D. L., Difiglio, C., 2000, Energy efficiency and consumption – the rebound effect – a survey. Energy Policy, 28, 389-401.

Guerin, D.A., Yust, B.L., Coopet, J.G., 2000, Occupant Predictors of Household Energy Behavior and Consumption Change as Found in Energy Studies Since 1975, Family and Consumer Science Research Journal, 19 (1), 48-80.

Hahn, L., Hoelzl, E., Pollao, M., 2013, The effect of payment type on product-related emotions: evidence from an experimental study, International Journal of Consumer Studies, 37, 21-28.

Harington, L., Wilkenfeld, G., 1997. Appliance efficiency program in Australia: Labeling and standards. Energy and Buildings. 26, 81-88.

Helbert, R., 2005, Factors determining household fuel choice in Guatemala, Environment and Development Economics, 10, 337-361.

Irawanto, D.W., Ramsey, P.L., Ryan, J.C., 2012, Challenge of leading in Javanese culture, Asian Ethnicity, 12 (2), 125-139.

Kallbekken, S., Saelen, D., Hermansen, E.A.T., 2013, Bridging the energy efficiency gap: a field experiment on lifetime energy costs and household appliances, J. Consum Policy, 36, 1-16.
Kowsari, R., Zerriffi, H., 2011, Three dimensional energy profiles: A conceptual framework for assessing household energy use, Energy Policy, 39, 7505-7517.
LBNL, 2012, Bottom-up energy analysis system, Lawrence Berkeley National Laboratory, California, US.
Lietaer, B., De Meulenaere, S., 2003, Sustaining cultural vitality in a globalizing world: the Balinese example, International Journal of Social Economics, 30 (9), 967-984.
Lutzenhiser, L., 1992, A cultural model of household energy consumption, Energy, 19 (1), 47-60.
Mangundjaya, W.L.H., 2010, Is there cultural change in the national cultures of Indonesia?, the 2010 Congress of the International Association for Cross-Cultural Physiology, 59-68.
Mahlia, T.M.I., Masjuki, H.H., Taha, F.M., Rahim, N.A., Saidur, R., 2005. Energy labeling for electric fans in Malaysia, Energy Policy, 33, 53-68.
McNeil, M.A., Letschert, V.E., 2010, Modeling diffusion of electrical appliances in the residential sector, Energy and Buildings, 42, 783-790.
MEMR, 2008, National Electricity Master Plan 2008-2027, Ministry of Energy and Mineral Resources, Jakarta, Indonesia.
METI, 2010, Top runner program: Developing the world's best energy-efficient appliances, Ministry of Economy, Trade and Industry, Tokyo, Japan.
Mills, B., Schleich, J., 2010, What's driving energy efficiency appliance label awareness and purchase propensity?, Energy Policy, 38, 814-825.
Myers, R. 1990, Classical and modern regression with application (2nd edition), Boston, MA: Duxbury.
Nässén, J., Holmberg, J., 2009, Quantifying the rebound effects of energy efficiency improvements and energy conserving behavior in Sweden, Energy Efficiency, 2, 221-231
Niu, J., Liao, Z., 2002, Forecasting Residential Energy Demand in China: An approach to technology impacts, Journal of Asian Architecture and Building Engineering 1(1), 95-103.
Permana, A.S., Perera, R., Kumar, S., 2008, Understanding energy consumption pattern of households in different urban development forms: A comparative study in Bandung City, Indonesia, Energy Policy, 36, 4287-4297.
PLN, 2010, Annual Report 2009: Brightening the Nation in Harmony, PT. Perusahaan Listrik Negara (State Electricity Enterprise).
Poyer, A.D., Henderson, L., Teotia, A.P.S., 1997, Residential energy consumption across different population groups: comparative analysis for Latino and non-Latino households in USA, Energy Economics, 19, 445-463.
Sanquist, T.F., Orr, H., Shui, B., Buttner, A.C., 2011, Lifestyle factors in U.S. residential electricity consumption, Energy Policy, 42, 354-364.
Schipper, L., Meyers, S., 1991, Improving Appliance Efficiency in Indonesia, Energy Policy, 19, 575-588.
Setiawan, B., Hadi, S.P., Regional autonomy and local resource management in Indonesia, Asia Pasific Viewpoint, Vo. 48 (1), 2007.
SI, 2010a, Strategic Data 2010, Statistics Indonesia, Jakarta, Indonesia.
SI, 2010b, Population Census 2010, Statistics Indonesia, Jakarta, Indonesia.
SI, 2010c, Population Census 2010 West Java, Statistics of West Java Province, Bandung, Indonesia
SI, 2010d, Population Census 2010 Bali, Statistics of Bali Province, Denpasar, Indonesia
SI, 2010e, Population Census 2010 Yogyakarta, Statistics of Yogyakarta Province, Yogyakarta, Indonesia.
Siderius, H.-P., 2013, The role of experience curves for setting MEPS for appliances. Energy Policy, http://dx.doi.org/10.1016/j.enpol.2013.04.032

Stephenson, J., Barton, B., Carrington, G., Gnoth, D., Lawson, R., Thorsnes, P., 2010, Energy cultures: A framework for understanding energy behaviors, Energy Policy. 38, 6120-6129

Suryadunata L, Arifin EN, Ananta A., 2003, Indonesia's population: ethnicity and religion in changing political landscape. Singapore: Institute of Southeast Asian Studies.

Thøgersen, J., 2000, Psychological determinants of paying attention to eco-labels in purchase decisions: model development and multinational validation, Journal of Consumer Policy, 23, 285-313.

UN, 2012, World Urbanization Prospects: The 2011 Revision, The United Nations, New York, U.S.

Waren, C., 2012, Risk and the sacred: environment, media and public opinion in Bali, Oceania, 82, 294-307.

WB, 2008, Residential Consumption of Electricity in India; Strategies for Low Carbon Growth, The World Bank, Washington, US.

Weber, C., Perrels, A., 2000, Modeling lifestyle effects on energy demand and related emissions, Energy Policy, 28, 549-566.

Wiel, S., McMahon, J.E., 2003, Governments should implement energy-efficiency standards and labels—cautiously, Energy Policy, 31, 1403-1415.

Wilhite, H., Nakagami, H., Masuda, T., Yamaga, Y., Haneda, H., 1996, A cross-cultural analysis of household energy use behavior in Japan and Norway, Energy Policy, 24 (No.9), 795-803.

Wilson, C., Dowlatabadi, H., 2007, Models of decision making and residential energy use, Annual Review of Environment and Resources, 32, 169-203.

Yamamoto, Y., Suzuki, A., Fuwa, Y., Sato, T., 2008, Decision-making in electrical appliance use in the home, Energy Policy, 36, 1679-1686.

Young, D., 2007, When do energy-efficiency appliances generate energy savings?, Energy Policy, 36, 34-46.

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Appendix I

Questionnaire of 1st Field Survey

Name	:	.....
Religion	:	.....
Ethnic	:	.....
Career	:	.....

FAMILY

1.	How many people in your house?	.....
2.	Please mention the age and the last education	
	1. ..... 2. ..... 3. ..... 4. ..... 5.	Education ..... Education ..... Education ..... Education ..... Education .....
3.	How much your family income monthly?	Rp. .....
4.	How much your family outcome monthly?	Rp. .....
5.	How much you pay electricity monthly in average?	Rp. .....

LIFE SCHEDULE

For Father		
1.	What is your working time?	From..... to.....
2.	What is your sleeping time?	From.....to.....
3.	Where do you spend most of your weekend time?	(Home/Outside)
4.	How do you spend most of your time at home?	
For Mother		
1.	Are you a housewife or a career woman?	(Housewife/Career)
2.	If you are a career woman, what is your working time?	From.....to.....
3.	What is your sleeping time?	From.....to.....
4.	How do you spend most of your time at home?	
For Children		
1.	What is your school time?	From.....to.....
2.	What time you will be at home after school time?	
3.	What is your sleeping time?	From.....to.....
4.	How do you spend most of your time at home?	

DEVICES TECHNOLOGY

No.	Devices	Power (Watt)	Daily Use (hour)
1.	Television		
2.	Computer		
3.	Air Conditioner		
4.	Lighting, please specify: a. Fluorescence b. Compact Fluorescent c. Incandescent		
5.	Washing Machine		
6.	Rice Cooker		
7.	Fan		
8.	Entertainment, please specify: a. ..... b. ..... c. ..... d. ..... e. ..... f.		
9.	Refrigerator		
10.	Water Pumps		
11.	Microwave		
12.	Others: a. ..... b. ..... c. ..... d. ..... e. ..... f.		

HOUSE

1.	Area of your house	.....m^2
2.	How many floor of your house?	.....floor(s)
3.	Material of your house	Wooden/Brick wall/mix
4.	Material of Floor	Ceramics floor/cement brick/soil
5.	High of wall	.....m
6.	Wall thickness	.....cm
7.	Roof	Roof tile/zing roofing/ceramic/steel roof

PERSONAL

1.	What is your consideration to buy an electricity device? (please select according to the rank)	Rank
	1. The price	
	2. The power consumption	
	3. The utility	
	4. The model	
	5. Prestige	
	6. Environmental Friendly	

2.	When you are using an entertainment device, such as TV, what is the usage limitation? (please select according to the rank)	Rank
	1. The happiness	
	2. The need on the information (news)	
	3. Only for fulfilling free time	
	4. Electricity Price	

3.	When you are using an air conditioner device, such as AC or fan, what is the usage limitation? (please select according to the rank)	Rank
	1. The comfortability	
	2. Electricity Price	
	3. Unlimited	

4.	Do you apply energy saving at your house? If yes, please answer the following questions:	(Yes/Not)
	1. Is one of your main reasons to do energy saving to save your money?	(Yes/Not)
	2. Is one of your main reasons to do energy saving to save environment?	(Yes/Not)

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Appendix II

Questionnaire of 2nd Field Survey

General Characteristics of Respondent

Age	:	years
Gender	:	Male Female
Last Education	:	Elementary Junior HS Senior HS University
Number of Family	:	persons
Family's monthly Income	:	Rp.
Monthly electricity bill	:	Rp.
Electricity contract	:	VA
Payment System	:	(Pre-paid/Postpaid)

Decision-making in Electrical Appliance Use

I. Price awareness

No.	Question	Not at all	Slightly	Moderately	Fairly	Highly
1.	How familiar you are with the electricity price?					
2.	How well you remembering the amount of your monthly electricity bill?					
3.	How aware you are of changes in electricity price?					

II. Price of Service by Electrical Device

No.	Question	Not at all	Slightly	Moderately	Fairly	Highly
1.	How aware you are of the price of various services produced by electrical appliances?					
2.	How **aware** you are of the energy efficiency of your appliance?					
	TV					
	Refrigerator					
	Electric fan					
	Lighting					
	Rice cooker					
	Water pumps					

III. Changes in price of service

No.	Question	**Large decrease**	**Slightly decrease**	**Normal**	**Fairly increase**	**Large increase**
1.	If the **electricity price increases**, how your use of each appliance would change?					
	TV					
	Refrigerator					
	Electric fan					
	Lighting					
	Rice cooker					
	Water pumps					
2.	If the **efficiency of appliance increases**, how your use of each appliance would change?					
	TV					
	Refrigerator					
	Electric fan					
	Lighting					
	Rice cooker					
	Water pumps					

No.	**Question**	**Large decrease**	**Slightly decrease**	**Normal**	**Fairly increase**	**Large increase**
1.	If the government **increasing subsidy** for electricity price**, then the price will be decreased or even zero**, how your use of each appliance would change?					
	TV					
	Refrigerator					
	Electric fan					
	Lighting					
	Rice cooker					
	Water pumps					

IV. Attitudes and decision-making

No.	Question	**Least**	**Slightly**	**Moderate**	**Fairly**	**Most**
1.	Which do you think the most consumed electricity among appliances?					
	TV					
	Refrigerator					
	Electric fan					
	Lighting					

	Rice cooker					
	Water pumps					
2.	How strongly you care about the expenses of electricity consumption for each of appliance?					
	TV					
	Refrigerator					
	Electric fan					
	Lighting					
	Rice cooker					
	Water pumps					
3.	How much you cared about your electricity expenses?					

For those who do not answer **Most**, then please ask the reason as bellows: (you may select more than one)

	Question	**Check**
a.	Because routinely use electricity every day	
b.	Because using electricity is necessities of life	
c.	Because the electricity price is cheap	
d.	Because I do not know the detail information of electricity price at the time I use an appliance	

Decision-making in Purchasing an Electrical Appliance

No	**Question**	**Year**
1.	How long you normally replace your electrical devices	
	TV	
	Refrigerator	
	Electric fan	
	Lighting	
	Rice cooker	
	Water pumps	

No.	**Question**	**Check**
2.	What is the reason to replace an electrical device?	
	a. Replace a broken one	
	b. Replace the old one for better quality/technology	
	c. Buy one for the first time	
	d. Promotion/sale	
3.	Prior to buy or choice an appliance, what is the necessary information from the appliance that you want to know?	
	a. Cost of the appliance	
	b. Quality of appliance	
	c. Energy consumption	
	d. Warranty	
	e. User friendliness	

	f. Technology	
	g. Safety	
	h. Accessories	
	i. Model	
	j. Brand	
	k. Country of origin	
4.	How do you get information of the appliance?	
	a. Commercial at TV, newspaper or internet	
	b. Product review at TV, newspaper or internet	
	c. Seller at shop	
5.	When you want to buy an appliance, do you set a price limit?	
	a. Yes	
	b. No	
	c. Sometime	

No.	**Question**	**Not at all**	**Slightly**	**Moderate**	**Fairly**	**Highly**
6.	How aware these consideration factors when buy an electrical device?					
	a. Cost of the appliance					
	b. Quality of appliance					
	c. Energy consumption					
	d. Warranty					
	e. User friendliness					
	f. Technology					
	g. Safety					
	h. Accessories					
	i. Model					
	j. Brand					
	k. Country of origin					

Policy Evaluation

I. Energy-efficiency Label

No.	Question	Not at all	Slightly	Moderate	Fairly	Highly
1.	Would you want to purchase or adopt high-efficiency appliances?					
2.	**For respondents who select sales staff as source of information**					
	If the energy-efficiency label which contains information of energy consumption and lifetime costs of use is appeared in the appliances and promoted by store sales, then would you want to purchase or adopt high-efficiency appliances?					
3.	**For respondents who select commercial ads as source of information**					
	If the energy-efficiency label which contains information of energy consumption and lifetime costs of use is appeared in the commercial ads of appliances, then would you want to purchase or adopt high-efficiency appliances?					
4.	If the energy-efficiency label is appeared in the appliances and promoted by store sales and in the commercial ads of appliances, then would you want to purchase or adopt high-efficiency appliances?					

II. Payment System

No.	Question	Least	Slightly	Moderate	Fairly	Most
1.	How do the electricity payment systems affect your awareness of the monthly use?					
2.	**For pre-paid respondents who answered 3 (moderately aware) to 1 (not aware at all)**					
	If your payment is changed to **postpaid** system, how does the payment system affect your awareness of the monthly electricity use?					

3.	**For postpaid respondents who answered 3 (moderately aware) to 1 (not aware at all)**					
	If your payment is changed to **pre-paid** system, how does the payment system affect your awareness of the monthly electricity use?					
4.	**If you can select your payment system**, does the payment system affect your awareness of the monthly electricity use?					

List of Publications

Chapter 1: Introduction

Chapter 2: Households' Electricity Consumption Characteristics in Indonesia: A Techno-Socioeconomic Analysis

Journal Paper:

[1] Muhammad Ery Wijaya, Tetsuo Tezuka, A Comparative Study of Households' Electricity Consumption Characteristics in Indonesia: A Techno-Socioeconomic Analysis, Energy for Sustainable Development (Accepted, 2013).

[2] Muhammad Ery Wijaya, Tetsuo Tezuka, Understanding Socio-Economic Driving Factors of Indonesian Households Electricity Consumption in Two Urban Areas. In: Yao T, Editor. Zero-Carbon Energy Kyoto 2011, Springer, pp. 55 – 60.

International Conference:

[3] Muhammad Ery Wijaya, Tetsuo Tezuka, Electricity Saving Potential in Indonesian Households: A Techno-Socio-Economic Analysis, The 4th International Conference on Sustainable Energy and Environment, February 27 – 29, 2012, Bangkok, Thailand

[4] Muhammad Ery Wijaya, Tetsuo Tezuka, Understanding Socio-Economic Driving Factors of Indonesian Households Electricity Consumption in Two Urban Areas. The 3th International Symposium of Kyoto University G-COE of Energy Science

"Energy Science in the Age of Global Warming–Toward CO_2 Zero-emission", August 18 – 19, Suwon, South Korea

Chapter 3: Choice Determinant in the Purchase of Appliances and Decision-making in Electricity Consumption

Journal Paper:

[1] Muhammad Ery Wijaya, Tetsuo Tezuka, Measures for Improving the Adoption of Higher Efficiency Appliances in Indonesian Households: An Analysis of Lifetime Use and Decision-Making in the Purchase of Electrical Appliances, Applied Energy, Vol. 112, pp. 981 – 987, 2013.

[2] Muhammad Ery Wijaya, Tetsuo Tezuka, Policy-making for Households Appliances—related Electricity Consumption in Indonesia – a Multicultural Country, Open Journal of Energy Efficiency, Vol. 2 (No.2), pp. 53 – 64, 2013.

[3] Muhammad Ery Wijaya, Tetsuo Tezuka, Measures to Promote Energy Conservation in Indonesian Households with Different Cultural Backgrounds: An Analysis on Electricity Prices Perspective. In: Yao T, Editor. Zero-Carbon Energy Kyoto 2012, Springer, pp. 65 – 71.

International Conference:

[4] Muhammad Ery Wijaya, Tetsuo Tezuka, Measures for Improving the Adoption of Higher Efficiency Appliances in Indonesian Households: An Analysis of Lifetime Use and Decision-Making in the Purchase of Electrical Appliances, the 4^{th} International Conference on Applied Energy, July 5-8, 2012, Suzhou, China.

[5] Muhammad Ery Wijaya, Tetsuo Tezuka, Measures to Promote Energy Conservation in Indonesian Households with Different Cultural Backgrounds: Analysis of Choice Determinant in the Purchase of Appliances and Decision-making in Electricity Consumption, The 8th UK Energy Research Center–Energy Summer School, June 17-22, 2012, Coventry, UK. (Poster)

[6] Muhammad Ery Wijaya, Tetsuo Tezuka, Measures to Promote Energy Conservation in Indonesian Households with Different Cultural Backgrounds: An Analysis on Electricity Prices Perspective, The 4th International Symposium of Kyoto University G-COE of Energy Science "Energy Science in the Age of Global Warming–Toward CO_2 Zero-emission", May 22 – 23, 2012, Bangkok, Thailand. (Poster)

[7] Muhammad Ery Wijaya, Tetsuo Tezuka, Analysis of Decision-making in Electrical Devices Use in Indonesian Households, The 3rd International Association for Energy Economics – Asian Conference, February 20 – 22, 2012, Kyoto, Japan.

Chapter 4: Policy Design for Households Appliances-related Electricity Consumption in Indonesia

Journal Paper:

[1] Muhammad Ery Wijaya, Tetsuo Tezuka, Policy Design for Households Appliances-related Electricity Consumption in a Multicultural Country: Case Study of Indonesia, Energy, (Submitted)

Chapter 5: Conclusion