An Analysis of Household Transition to Modern Fuel Under Indonesia's Energy Conversion Programme

by

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Abstract

The reliance on firewood leads people to be affected by indoor air pollution, which has negative impact on human health. Hence, a reduction on households using traditional fuels, through providing cleaner fuels, is imperative. Indonesia was before 2007 one of the Asian countries with a high proportion of people relying on traditional energy for cooking. However, in 2007, the government of Indonesia aimed to increase the usage of LPG for cooking through the Energy Conversion Program from Kerosene to LPG (ECPKL) policy. The aim of this study is to investigate the impact of the policy on the development of access to modern energy between 2007 and 2011. Data from Statistics Indonesia and interviews with government and members of the public were collected. The statistical data was obtained to analyse the broader pattern of use of modern energy and traditional fuel in Indonesia over 2007-2011. Thematic maps of fuel use were produced and analysed in Geographical Information Systems (GIS). The effect of the policy on the change of fuel use in Indonesia was investigated through non-parametric statistical analyses. The effects of household income and rural-urban location on change in fuel use were also investigated. Interviews with central government and local government were conducted to identify the role of government in ECPKL policy and their aims in instigating the change in fuel use from kerosene to LPG. Interviews with members of society were also conducted to investigate societal acceptance of LPG and the factors that influence willingness or reluctance to use LPG.

Results of the study show that, in terms of quantity of energy, share of expenditure and source of energy measures, the number of households using firewood in Indonesia from 2007 to 2011 was reduced. In 2011, more households had access to LPG in comparison to 2007, and households using kerosene in 2011 were in smaller number than those in 2007. This indicates that the implementation of policy to replace kerosene with LPG had achieved the target of improving LPG use and reducing kerosene on one hand and only had a small influence on the reduction of traditional fuel for cooking use on the other hand, because there was no attempt from the government through the ECPKL to reduce firewood and other traditional fuel use. It was also found that injustice in the distribution of cleaner fuel for cooking use in Indonesia was apparent, but it reduced from 2007 to 2011. Similarly, the policy implementation led to a reduction in the difference between rural and urban areas in proportions of modern and traditional users, between 2007 and 2011. Interview analysis revealed that there are three levels of adoption of LPG, i.e. full adopters, partial adopters and non-adopters. The factors affecting adoption of LPG include price and the market for LPG and kerosene; trust; the

tangible and intangible characteristics of appliances; the campaign for LPG by family and neighbours, and kitchen architecture. Some people decided not to adopt LPG and continued to rely on firewood. There are four main factors that were connected with continuing firewood use: behaviour and life style, economic reasons, being elderly in a rural area, and living in a location that had plentiful firewood resources.

This thesis is dedicated to

my mother, Sadiyah

to my (deceased) father, Likoen

my husband, Eko Setiawan

and sweet sons and daughter, Ahmad ‘Qolbi’ Hanifurrohim (Obi), Zahra Nafisa Syu’la Laili (Asa) and Ahmad Muttaqin Suluh Dolbu (Elo)

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List of Abbreviations and Acronyms

AGECC	Advisory Group on Energy and Climate Change
BPS	*Badan Pusat Statistik* (Statistics Indonesia)
BOE	Barrel of oil equivalent
CSD	Commission on Sustainable Development
DESDM	*Dinas Energi dan Sumber Daya Mineral* (Department of Energy and Mineral Resources)
DESEAR	*Desarrollo Social y Económico del Área Rural* (Social and Economic Development of the Rural Area)
DJMGB-KESDM	*Direktorat Jendral Minyak dan Gas Bumi, Kementerian Energi dan Sumber Daya Mineral* (Directorate General of Oil and Natural Gas, Ministry of Energy and Mineral Resources)
DPI	*Dinas Perdagangan dan Industri* (Department of Trade and Industry)
DPP	*Dinas Perdagangan dan Perindustrian* (Department of Trade and Industry)
DPPKSME	*Dinas Perdagangan dan Perindustrian, Koperasi dan Usaha Kecil dan Menengah* (Department of Trade and Industry, Cooperative & Small Medium Enterprises)
DSDEMP-BAPENAS	*Direktorat Sumber Daya Energi, Mineral dan Pertambangan - Badan Perencanaan Pembangunan Nasional* (Directorate of Energy, Mineral Source and Mining, National Advisory Board)
DPR	*Dewan Perwakilan Rakyat* (People's Representative Council)
EEA	European Environment Agency
ECPKL	Energy Conversion Programme: from Kerosene to LPG
EDI	Energy Development Index
ESMAP	Energy Sector Management Assistance Programme (ESMAP)
GDP	Gross Domestic Product
GHG	Green House Gas
HDI	Human Development Index
IAEA	International Atomic Energy Agency
IEA	International Environmental Agency
IESR	Institute of Energy and Social Research

LEMIGAS-KESDM	*Lembaga Penelitian Minyak dan Gas Bumi, Kementerian Energi dan Sumber Daya Mineral* (Research Centre of Oil and Natural Gas, Ministry of Energy and Mineral Resources)
LPG	Liquefied Petroleum Gas
Mboe	Million barrels of oil equivalent
MDG	Millennium Development Goal
MDN-RI	*Menteri Dalam Negeri Republik Indonesia* (Ministry of Home Affair, Republic of Indonesia)
KESDM-RI	*Kementerian Energi, Sumber Daya Mineral Republik Indonesia* (Ministry of Energy and Mineral Resources, Republic of Indonesia)
Kgoe	Kilogram of oil equivalent
MPR	*Majelis Permusyawaratan Rakyat* (People's Consultative Council)
MPPRI	*Menteri Perindustrian dan Perdagangan Republik Indonesia* (Ministry of Industry and Trade of the Republik of Indonesia)
PDIESDM-KESDM	*Pusat Data dan Informasi Energi dan Sumber Daya Mineral, Kementerian Energi dan Sumber Daya Mineral* (Data Centre and Information of Energy and Mineral Resources, Ministry of Energy and Mineral Resources)
Pertamina	*Perusahaan Pertambangan Minyak dan Gas Bumi Negara* (State-owned Oil and Natural Gas Mining Company)
PLN	*Perusahaan Listrik Negara* (State-owned Electricity Company)
PPPKI	Panitia Persiapan Kemerdekaan Indonesia
RUEN	*Rencana Umum Energy Nasional* (National Energy Planning)
RUED	*Rencana Umum Energy Daerah* (Local Government Energy Planning)
RUED-P	*Rencana Umum Energy Daerah Provinsi* (Province Energy Planning)
SUSENAS	*Survey Sosial Ekonomi Nasional* (National Survey of Socio and Economy)
UN	United Nations
UNCED	United Nations Conference on Environment Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nation Developing Programme
WHO	World Health Organisation

Chapter 1
Introduction

1.1 Rationale

The chronic problem of access to modern fuel in Indonesia has been occurring for a long time. Indonesia is one of the countries in the Asian developing world where households, in the majority, relied upon traditional fuel for cooking (Sovacool, 2012; WHO, 2012). In the 1980s, 73% of people in rural Indonesia depended on wood fuel for their cooking (Bee, 1986). Meanwhile, nearly a quarter of households used kerosene and the rest used charcoal, electricity, gas and other fuels. According to Badan Pusat Statistik (BPS) (2007b), at least 47.7% of households in 2004 used firewood for their main cooking fuel. However, this increased to 51.9% in 2006 (BPS, 2007b), although no studies are able to explain the reason for this increase. This situation reveals that Indonesia is one of the biggest countries in the world which have a high percentage of households using firewood in a traditional way, in addition to China, India and Pakistan (Bonjour et al., 2013).[1]

In addition to firewood, kerosene is one of the fuels for cooking which is used by households in Indonesia. The government of Indonesia intensively and extensively promoted kerosene starting in the 1960s (Sosiawan et al., 2011). At the point of its introduction, people had not been much using kerosene, but it is being subsidised. It attracted people to use it for cooking. A few years later, kerosene was the most used non-traditional fuel for cooking, outstripping for

[1] Data from 1980 to 2010

instance electricity, LPG, gas and biogas. By the 1970s, the use of kerosene in Indonesia was almost ten times what it had been in 1955 (Bee, 1984). In 2004 and 2006, kerosene user were 88.9% and 85.% of households respectively (BPS, 2007b).

At the end of 2007, the government of Indonesia implemented an energy substitution policy entitled *Energy Conversion Programme: From Kerosene to LPG* (ECPKL). This programme aimed to encourage the public to switch from kerosene to Liquefied Petroleum Gas (LPG) which is more modern, easier to use and cleaner than kerosene. The main target of this programme was households who did not use LPG or electricity for cooking, e.g. those who used kerosene. However, resistance from the public was inevitable because kerosene was subsidised by government, whilst LPG was not. This led the government to transfer the kerosene subsidy to LPG.

A study by Latifah et al. (2010) reported that after the implementation of ECPKL, there were considerable changes in cooking fuel consumption in the region of Bogor, a city near Jakarta, the capital city of Indonesia. Latifah et al.'s (2010) study shows that before policy implementation, 55% of households used firewood, whilst during policy implementation, in 2010, firewood usage dropped significantly to 8.3% of households, and households who used kerosene to 10% and the percentage of LPG users was 81%. However, a recent study by the Institute for Essential Service Reform (IESR) found that some of the kerosene users shifted to wood instead of LPG, even though LPG is subsidised (Tumiwa & Imelda, 2011). This is an indicator that firewood use may not be straightforward to eliminate by the policy implementation. Meanwhile, Andadari et al. (2014)

study in an area in *Kabupaten* Semarang found that there was a 79% reduction of kerosene use and 85% increase of LPG, but firewood user reduction was only about 1%. This indicates that the programme has a big influence on the reduction of kerosene use but does not strongly attract firewood users to move to LPG as well. In the case that kerosene is classified as a transitional fuel, rather than a modern fuel (Sesan, 2012; Van Der Kroon et al., 2013), or not classified as clean energy (as per the government of Indonesia view) (Sosiawan et al., 2011), this can be an indication that access to modern fuel remains far from the ideal.

In general, people who live under $2 per day have a tendency to suffer from low electrification and rely more on traditional fuels such as biomass, animal dung or charcoal (IEA, 2010). In this matter, the GDP per capita of Indonesia in 2006 was US$ 1,590.2 (World Bank, 2015), whilst the percentage of poverty was 17.75%. This implies that at least 17.75% of population might be expected to suffer from lack of modern fuel. Poor people do not have the freedom to make a choice of fuel because they have more constraints preventing access to facilities including modern fuels which are commonly more expensive than traditional fuels. Traditional fuel is unprocessed energy such as firewood which is burnt for cooking or heating. Firewood is easier to find and cheaper than modern fuels such as oil. Firewood could be collected from fallen branches of trees along the village road, yard or in the forest. In Indonesia, 67% of fuel wood users in Andadari et al. (2014) study did not buy firewood as there is abundant firewood for free, mainly in rural areas. Therefore, traditional fuel are more often consumed by poor households who have less financial resources (Khandker et al., 2010). This is formulated in the energy ladder theory where consumption on energy technology is related to a household's income (Hosier & Dowd, 1987; Masera et al., 2000). A household will use any kind of energy carrier as long as they are readily accessed and affordable. However, the energy carriers they used were not always clean. It might reduce quality of human health as well as be harmful to the environment.

In addition to low income, lack of infrastructure led people to suffer from lack of modern fuel (Kaygusuz, 2011). A report of the International Energy Agency (IEA), found that about 84% of solid fuel users in 2011 were living in rural areas (Tumiwa & Imelda, 2011). In most cases, people in rural and remote areas have problems with the transportation infrastructure. Economic opportunity in rural and remote areas also tends to be low. The lack of infrastructure might be caused by unjust policy as well.

Households without access to modern fuel services suffer from increased risks related to deforestation and the effect of combustion from polluting energy. In rural areas of developing countries, forests sustain the daily life of the local population. Wood as a biomass fuel in rural areas is generally collected from the forest. Daily use of firewood due to the absence of modern fuel, threatens forests as the firewood resource. Massive exploitation of wood from forests without good management increases deforestation (Barnes et al., 2010; Birol, 2007). Forest degradation can contribute to natural hazards, e.g. floods and landslides, even increasing global warming.

Meanwhile the burning of traditional fuel in traditional stoves jeopardizes the environment and health (DeFries & Pandey, 2010). Firewood and charcoal, which are types of biomass, generally are used by poor households in developing countries. Those fuel types when burned in traditional cook stoves creates indoor air pollution that has a contribution to environmental damage (Birol, 2007) and affects human health (IEA, 2010). Combustions of biomass in cook-stoves produce Greenhouse Gasses (GHGs) such as CO_2, CH_4 and N_2O (Sagar, 2005) and also PM_{10} (Ezzati & Kammen, 2001b). The use of biomass instead of gas and kerosene, produces more CO and PM_{10} (Huboyo et al., 2009; Smith et al., 2000). Moreover, indoor air pollution from biomass combustion is commonly higher than outdoor air pollution in polluted cities (IEA, 2010). Those gases induce poor households who use biomass for cooking to suffer from acute respiratory infection (Ezzati & Kammen, 2001a; Mestl & Edwards, 2011) and chronic bronchitis (Albalak et al., 1999). Smoke from fuel might harm eyes and lungs as well (Arnold et al., 2003). WHO (2012) states that pneumonia and other acute lower respiratory chronic pulmonary diseases and lung cancer led to increased mortality of children and adults. Women and children are more affected by indoor air pollution because they spend longer periods inside the home than men. In 2002, such air pollution led to 396,000 deaths in South East Asia (WHO, 2006). Later on, in 2008, the number of deaths caused by indoor air pollution was higher than deaths due to malaria or tuberculosis (IEA, 2010). This is the major reason why clean energy is a prerequisite for good health (WHO, 2006).

Modern fuel access is also one of the fundamentals of development (Pereira et al., 2011). Modern fuel has a considerable role in achieving social and economic, in addition to environmental goals of sustainable human development (AGECC, 2010; Anderson et al., 2000; Budiarto, 2011). In developing countries, even in rural and remote areas, where access to modern fuel is limited, people are commonly poorly educated, with low income and poor healthcare services (Bhutto

& Karim, 2007). Moreover, the use of modern kitchen appliances helps people to cook faster because modern fuel such as kerosene, LPG, gas and biogas have high efficiency (Reddy et al., 2000). This reflects in people's activities: women and young girls, especially, may have more time to improve their education and increase their income instead of spending their time in the kitchen for cooking, and collecting wood. For these reasons, providing modern energy services to the poor has a large role in poverty eradication as the first of the Millennium Development Goals (MDGs) (Urban et al., 2007). The United Nations Secretary General emphasised that providing access to adequate energy was part of energy poverty alleviation:

> *"Universal energy access is a key priority on the global development agenda. It is a foundation for all the MDGs. Without energy services, the poor are cut off from basic amenities. They are forced to live and work in unhealthy, polluted conditions. Furthermore, energy poverty directly affects the viability of forests, soils and rangelands. In short, it is an obstacle to the MDGs."* (The United Nations Secretary General, Ban Ki Moon statement cited in Foreword the CEO of Practical Action (2010))

Providing access to modern fuels should lead households to use more modern energy services. For example, access to LPG leads people to use appliances which are fuelled by LPG; similarly, the availability of electricity leads people to use appliances which are powered by electricity, as, in general, energy service appliance is determined by energy carrier. Therefore, poverty eradication could be significantly helped through providing modern fuel access for the poor (United Nations, 2005).

Due to all of the abovementioned points, a study on the access to modern fuel in Indonesia is needed as this issue has never been raised. This is because it is necessary to identify the level of access to modern fuel in a country in order to make plans to reduce the traditional fuel user (Tennakoon, 2008) and ultimately to improve development and reduce poverty.

1.2 Aim and Objectives

The main aim of this research is make an evaluation of the access to adequate and modern energy services, focusing on cooking as the main energy consuming activity, and the distribution of this access throughout Indonesia; and in addition to evaluate the contribution of the ECPKL government intervention to reducing the use of non-modern fuels. Hence, the research questions are:

1. What was the dynamic of modern and traditional fuel use in Indonesia before and after the implementation of the Energy Conversion Programme from Kerosene to LPG (ECPKL) policy?
2. How do time, household income, and location – rural and urban – affect the choice of fuel for cooking in Indonesia?
3. How effective was the governance of ECPKL and what is its relation to modern fuel improvement and energy poverty alleviation?
4. What is the level of social acceptance of LPG and what are the reasons behind LPG adoption, and persistence of firewood use, where it does persist?

1.3 Contribution of the Thesis

Various studies related to energy poverty and the problems of access to modern energy have been conducted by researchers. The impact of energy poverty and lack of access to modern energy on humans and environment, its relation to economy and development, measurement of energy poverty, strategy and policy to improve access to modern energy, as well as the influence of culture and social norms on adoption or non-adoption of modern energy are the various kinds of issues which are covered in scholarly research related to energy poverty and access to modern energy.

Studies related to human and environmental health are the background of the activities related to energy poverty alleviation and improvement of access to modern energy. Research studies on the identification of pollutants as a result of cooking activities using traditional fuels and cook-stove have been published (Clark et al., 2010; Dutta et al., 2007; Jetter & Kariher, 2009; Johnson et al., 2008; Naeher et al., 2001; Zhang et al., 2009). Negative impacts on human health of pollutants resulting from traditional fuel use have been discussed as well (Bennett et al., 2007; Ellegård, 1996; Mustapha et al., 2016; Smith et al., 2000; Tecer et al.2008; Tielsch et al., 2014). Chronic bronchitis (Albalak et al., 1999), acute respiratory infection (ARI) (Mestl & Edwards, 2011), pneumonia (Fullerton et al., 2008; Shen et al., 2009; Smith et al., 2011; WHO, 2012) and harm to eyes (Arnold et al., 2003) have been identified by researchers as the negative effects of cooking with unclean fuels. Traditional energy use related to gender has also been a concern of researchers as women have a higher probability of being affected by the exposure to cooking stove combustion (Clancy et al., 2003; Pachauri & Rao, 2013; Wickramasinghe, 2003). Also, impacts of cook stove combustion on children have been identified (Chan et al., 2013; Rivas et al., 2014; Schilmann et al., 2015; Smith et al., 2000).

Further studies have been concerned with access to modern energy in association with economic development, or the connection between poor access to modern energy and general household poverty (Cecelski, 2000; Cook, 2011; Groh, 2014; Kanagawa & Nakata, 2007; Kozulj et al., 2010; Pereira et al., 2011; Sovacool & Drupady, 2012; Welle-Strand et al., 2012). Households who live under $2 tend to be the energy poor (IEA, 2010). Thus, the energy ladder theory is formulated (Hosier & Dowd, 1987). But, there are also critiques of the energy ladder in terms of the model's inability to account for multiple fuel use in the home (Masera et al., 2000). Most often, people in rural areas in developing countries are poor. This leads to the argument that rural households tend to be energy poor (Jan et al., 2012; Kaygusuz, 2010; Oda & Tsujita, 2011; Suliman, 2013), whilst households in the city use modern energy (Leach, 1988). Yet, the main problem is that they do not have access to sufficient energy infrastructures (Mirza & Szirmai, 2010).

Progress in development needs strategy and policy intervention by the government. Policy and strategy to deal with energy poverty and access to modern energy need to be developed. Interventions of governments to alleviate energy poverty also attract the attention of scholars, such as Khennas (2012), Vahlne & Ahlgren (2014), Bazilian et al. (2012a) and Wishanti (2015). Market intervention is also needed to attract people to use modern energy as the energy market left alone may be unable to change energy use behaviour (Ailawadi & Bhattacharyya, 2006). Reducing price through subsidy and formulating incentives is even proposed to improve cleaner energy consumption (Park & Kwon, 2011).

The relation of economic development to access to energy and modern energy use attracts researchers to pay more attention to developing and least developed countries. Developing countries of Africa and South Asia are two areas where researchers had paid most attention: Nigeria (Chidebell-Emordi, 2015; Cline-Cole & Maconachie, 2016; Ezeh et al., 2014; Ifegbesan et al., 2016; Iyke, 2015; Maconachie et al., 2009; Maji, 2015; Oseni, 2012), South Africa (Bekker et al., 2008; Biermann et al., 1999; Guo et al., 2013; Liu et al., 2007; Madubansi & Shackleton, 2006; Streeter & De Jongh, 2013), Ghana (Kemausuor et al., 2011; Obeng et al., 2008), Rwanda (van Gevelt et al., 2016), Kenya (Sesan, 2012; Treiber et al., 2015; Treiber, 2012) in Africa, and meanwhile, India (Behera & Jindal, 1991; Dhingra et al. & Agarwal, 2008; Farsi et al., 2007; Pachauri et al., 2004; Pohekar & Ramachandran, 2004; Singh & Gundimeda, 2014; Srivastava et al., 2012; Strategies & Case, 1999; Urpelainen, 2016), Pakistan (Bhutto & Karim, 2007; Colbeck et al., 2010; Jan et al., 2012; Mirza et al., 2008), Bangladesh (Barnes et al., 2011; Miah et al., 2011; Mozumder & Marathe, 2007; Munim, H. & Abdullah-Al-Mamun, 2010), and Sri Lanka (Tennakoon, 2015; Wickramasinghe, 2003; Wijayatunga & Attalage, 2002; Wijayatunga et al., 2006) in South Asia have been the sites for research on energy poverty.. Additionally, research on energy poverty and access to modern energy has also been conducted in China (Duan et al., 2014; Pachauri & Jiang, 2008; Sun et al., 2015; Xu et al., 2014). Brazil (Pereira et al., 2011), Peru (Groh, 2014), Honduras (Clark et al., 2010) and Argentina (Bravo et al., 2008) have been investigated with regard to energy poverty in South America. The most research reflects where numbers of people in energy poverty are higher (Kaygusuz, 2011). A report from the IEA (2010) shows that, by 2009, number of people without electricity in Africa was 587 million people, whilst in India it was 404 million people. Meanwhile, people in Africa without electricity was about 657 million people, while in India was 855 million people. At the same time, the number of people without electricity in other Asian countries (not China and India) in total was 387 million, whilst people who relied upon traditional fuels for cooking were 659 million people. These figures reveal that India (South Asia) had the bigger problem in terms of numbers regarding lack access to modern fuel for cooking.

While studies paid attention to African and South Asian countries, Ardiansyah et al. (2012) states that Indonesia also suffered from energy poverty as more Indonesians lack access to electricity. Frequent blackout is one of problems of electricity in Indonesia in addition to lack of electricity infrastructure. Moreover, Bonjour (2013)'s study in 2006-2010 shows that Indonesia has a large number of people who rely on firewood. In 2007 Indonesia introduced LPG for general public use and replaced kerosene through a major project called Energy Conversion Programme from kerosene to LPG. Various studies related to this policy have been conducted recently. Latifah and Juanda (2010) studied the coping strategy of women during the transition from kerosene to LPG. Meanwhile, Latifah et al. (2010) studied the coping strategy of poor households during the implementation of the policy. Budya and Arofat (2011) reported the implementation of policy that able to provide cleaner fuel for cooking. However, Tumiwa and Imelda's (2011) work in Western of Java found that the impact of the policy was not merely the increase of LPG use, but it attracts households who used kerosene to use firewood instead of LPG. Apart from that result, Andadari et al.'s (2014) study in Semarang, Central Java Province, concluded that the reduction of traditional fuel use was only one percent even though there was significant reduction of kerosene use and also considerable increase of LPG.

Indonesia is different to Africa and South Asian countries in terms of society and culture, geography, government systems, energy resources and technology, as well as energy policy. Indonesia is an archipelago country that has more than 13,000 islands. The large number of islands of Indonesia might create different cultures which influence people's behaviour and life style which could affect people's habit and choice regarding energy and fuel use (Liu et al., 2008). In relation to the policy of energy transition from kerosene to LPG, there are some questions in terms of national access to fuel for cooking in relation to habit and life style. Therefore, a study on modern fuel use for cooking in Indonesia will enrich the theoretical insights on the development of access to modern fuels.

Research work on access to adequate and modern energy in Africa and South Asia has tended to frame the problem as lack of access to electricity by households (e.g. Bhattacharyya, 2006; Chaurey et al., 2004), low access to modern fuel for cooking (Farsi et al., 2007), or both (Dhingra et al., 2008). However electrification does not necessarily result in the use of modern fuel for cooking and so problems from cooking with traditional fuels can still remain. Electricity is mainly for lighting and does not always attract people to use electricity for cooking for various reasons. Providing modern cooking with electric appliances is expensive. Additionally, electrical cook stoves need high voltage which in turn affects the cost of energy.

In terms of Indonesia, the study of access to modern fuel for cooking will augment the attempt to develop the access to modern fuel and reduce traditional fuel in order to improve community health and environment in South East Asia, especially Indonesia. Being an archipelago country with diverse cultures is a specific challenge for introducing modern fuel to society. This is different from other Asian countries.

Thematic maps based on regions that identify the level of dependency of households on different types of fuel for cooking will be produced in this study. Through exploring spatial clusters of access to modern fuel in Indonesia, this study provides an empirical study on spatial convergence and concentration. Research on this matter was not developed as fast as it is needed (Arbia, 2001). Thus, this research contributes to spatial cluster studies which focus on the energy sector. This can help the government to improve the development of the access of modern fuel to alleviate energy poverty and lack of development.

Indonesia is one of the developing countries where the government has a policy on reducing kerosene in the household sector, kerosene being seen as less clean than LPG. One of the research aims of this study is to investigate the impact of this policy on development of modern fuel access in Indonesia. The results of this research can be used for evaluation of the access to modern fuel for cooking and barriers in relation to traditional fuel users. As this study will provide spatial information on fuel consumption for cooking in Indonesia, this information might be useful for developing a models, forecasting and scenario analysis. Additionally, this research will examine public decisions in adopting energy carriers for cooking related to their income conditions and location, as well any effect of the government implementing the policy. It explores the factors leading households to accept or reject the modern fuel introduced by the government, as this has been given little research attention (Pachauri & Jiang, 2008). Hence, this research will provide insights in the development of modern fuel access and its relation to traditional fuel use in developing regions in the South East Asian context as well examining social acceptance of modern fuel in the same context.

This research will be conducted to bring about some contribution to developing adequate fuel access at the domestic sector in Indonesia. The contributions may help academics, government and policy makers that have an interest in the issue of access to modern energy.

1.4 Research Scope

This study is conducted in Indonesia. Fuel and energy access will be examined from 2007 to 2013: secondary data from *Survei Sosial dan Ekonomi Nasional* (SUSENAS) or the National Survey on Social and Economy from 2007 to 2011, while interviews with government representatives and members of society were conducted during 2012 to 2013 in six regions: Banda Aceh, Muaro Jambi, Bogor, Klaten, Surakarta and Jember to evaluate the conditions in 2007 - 2011. Hence, any policy and development of energy access after 2011 will not be covered in this study.

1.5 Structure of the Thesis

The thesis is divided into nine chapters in total. After this introduction, the following 8 chapters are as follows:

Chapter 2: The Access to adequate energy: A review. The theories related to energy access will be explored and elaborated in this chapter. First, the section describes the access to adequate energy in terms of quantity, expenditure and source of energy based approaches. Other issues will be discussed such as contributing factors to modern fuel consumption, energy ladder theory, modern fuel access in rural and urban areas; and the institutional role and social acceptance of modern fuel are also elaborated on this chapter.

Chapter 3: Government, society and domestic energy in Indonesia: A brief narrative. This chapter is a brief discussion of the Indonesian context. It describes the governmental system, geography and socio-cultural aspects of Indonesia. This chapter also provides a short description of energy policy in Indonesia and domestic consumption of energy and fuel for cooking in Indonesia before ECPKL policy was implemented.

Chapter 4: Research Methodology. This chapter explains the methodology that was used to conduct this research. Sources of data and methods for gathering data and data analysis are described in this chapter. Equations, software and steps for data analysis are also provided in more detail.

Chapter 5: The Dynamic of Energy Access in the Domestic Sector in Indonesia. This chapter provides an analysis of the access to energy for cooking and energy adequacy in quantity, source of energy and expenditure based approaches. The dynamic pattern of energy access throughout Indonesia is also explored in order to investigate the transition of energy for cooking.

Chapter 6: Factors related to Domestic Fuel Use. This chapter aims to investigate the relation of energy access to time, place and household income. Year and regions are the proxies of time and place of household.

Chapter 7: The Government Intervention into Energy Access. The evaluation of the implementation of Energy Conversion Programme from Kerosene to LPG is investigated in this chapter. Rationales and its relation to the attempt to reduce the vulnerable households who used traditional fuels are also investigated in this chapter, drawing on interviews with different levels of government. Furthermore, the achievements of the government intervention will be examined.

Chapter 8: Social Acceptance of LPG in Indonesia. The social responses to the policy will be examined in this chapter. This includes acceptance and the barriers to acceptance from the public, including traditional fuel users. Moreover, government attempts to deal with the barriers to acceptance will be explored in more detail.

Chapter 9: Concluding Remarks. In the last chapter, all results of the research study will be summarised and synthesised and the implications of the research will be drawn out. In addition, some limitations of the research will be discussed in this chapter.

Chapter 2
Access to Adequate Energy: A Review

Energy is important for human life (e.g. Bazilian et al., 2012b; Kauffmann, 2005). It is needed for any sector from households to industries. It is also useful for all kinds of service from basic to luxurious needs. Yet, each fuel for energy service can have negative impacts for the environment which in turns influences the quality of life for humanity. The United Nations Conference on Environment and Development (UNCED) through the Commission on Sustainable Development (CSD) endorses more countries and organisations creating activities to improve access to modern fuel services for public, to reduce the negative impact of energy on the environment (UNDP, 2001).

This chapter explores various issues around the use of modern fuel in society today which have already been briefly introduced in Section 1.3. Health impacts and dangerous emissions created from cooking activities due to the choice of fuel and cook stove will be explored in the first section in this Chapter. Definitions of energy poverty and energy access will be discussed in detail in Section 2.2. This section contains three approaches to measuring energy poverty which have been used by experts. The next section examines the relationship of energy poverty issues with economic development and discusses the energy ladder theory. The influence of location: rural-urban on access to modern fuel will be discussed in Section 2.5. The following section explores and discusses on the important role of institutions and policy intervention in changing the fuel use.

Social acceptance of modern fuel is explored in detail in this section as well. The last section of this chapter is a summary of the theoretical framework that forms the basis of this thesis.

2.1 Carbon Emissions and Health Impacts of Cooking Fuel

In general, cooked food is preferred to raw food and is viewed as healthier. Some raw food such as meat might contain infectious bacteria which can be killed through cooking at a specific temperature. Furthermore, cooked food is good for digestion and meat and some vegetables are cooked to make them easier to digest. Hence, cooking is important in order to prevent people from suffering from diseases caused by food.

Energy carriers are generally classified as either traditional fuel or modern fuel. Traditional fuel is unprocessed, whilst modern fuel is manufactured through high technological processes (Smith et al., 2000). Most traditional fuel is solid and biomass such as firewood, crop residues and animal dung. The type of traditional fuels used in the domestic sector depends on interest, culture, geographical and environmental context. In Indonesia, firewood and crop residues are common traditional fuel used by society. In contrast, modern fuel is processed. LPG, kerosene and bioenergy are the examples of liquid energy. Some modern fuel is gas, such as natural gas or *Dimethyl Ether* (DME), some others are electricity and nuclear and are processed through high technological processes and listed as high quality energy (Barnes et al., 2004). In comparison to traditional fuels, scholars argue that modern fuel is more sustainable, more safe and more efficient (Birol, 2007; Goldemberg & Coelho, 2004). A short list of fuel types along with their category is presented in Table 2.1.

Energy produced from different techniques and processes may result in different performances and impacts. Efficiency is one of the indicators of fuel performance: more efficient fuel allows more heat to be transferred in cooking and this reduces cooking time. Meanwhile, one of the side effects of fuel usage is pollution which, unfortunately, influences the environment.

Table 2.1: List of fuels and their categories summarised from various authors

Traditional fuel	Transitional fuel	Modern fuel
Animal dung[2]	Kerosene[4]	Kerosene[5]
Crop residues[2]		LPG
Firewood[2]		Electricity
Charcoal[3]		Natural gas3
Coal[3]		Ethanol3
		Bioenergy[3]
		Dimethyl Ether (DME)[6]
		Nuclear
		Renewable Energy[7]

[2] Anderson et al. (2000)
[3] Legros et al. (2009)
[4] Barnes et al. (2004)[5] Sesan (2012)
[6] Arcoumanis et al. (2008), Semelsberger et al. (2006)
[7] Goldemberg and Coelho (2004). Renewable energy is processed energy and can be produced from firewood, crop residues and animal's dung as well as solar, wind and water power. Hence, renewable in this term is modern fuel rather than of traditional fuel.

The efficiency performance of various fuels is presented in Table 2.2. From the table it appears that liquid fuel is more efficient than solid energy. Biogas is produced from biomasses, i.e. dung or crop residues, processed through a biogas plant. Meanwhile, dung and crop residue are also utilized as a biomass without any processing. Biogas is a fluid fuel, whilst biomass is a solid fuel. Among other solid fuels, charcoal efficiency is similar to kerosene efficiency (Barnes & Floor, 1996), and even higher than the efficiency of coal (Barnes et al., 2004). Charcoal is a solid fuel, similar to biomass and is produced from wood or other substances by burning them at a high temperature until a light, black residue and ash remain which consists of carbon. Therefore, charcoal efficiency is much higher than firewood because of the lower water content.

Table 2.2: Energy efficiency of cooking fuels

Energy	Calorific power						
	in MJ/kg					in %	
	A	B	C	D	E	F	G
Electricity							55-85
LPG	45	45.7	25-30	45	45.8	55	
Biogas	-	-	15	-	17.7	55	
Kerosene	43	43.5	12	35	43.1	45	20-55
Briquette/Coal	30	-	-	23	-	-	
Charcoal	-	31	10	30	-	19–27	15-35
Firewood	15	19	5	16	15.1	11–24	3-30
Dung	-	-	-	14.5	11.8	10.6– 9	
Crop residues	-	-	-	13.5	15.36	10.2–21	

A: Goldemberg and Lucon (2010)
B: Floor & Pras (1991)
C: Barnes & Floor (1996),
D: Barnes et al.(2004)
E: Smith et al. (2000),
F: Bhattacharya & Salam (2002)
G: Ramani & Heijndermans (2003)
Note: Result from different references are not comparable since the experiments, methods and stoves are not the same. But, the result is comparable for each energy carrier for the same reference.

In addition to performance, the impact of energy should be considered and one of the problems of energy use is caused by its combustion. In some conditions combustion of fuel for cooking results in *products of incomplete combustion* (PIC) such as CO and CH_4, PM_{10} and NO_x which creates indoor pollution. The various gases emitted from the combustion of fuel are summarised in Table 2.3.

Table 2.3: Emissions of fuels from experiments with different stoves (in g/MJ)

References	Gas	Fuel							
		LPG	Biogas	Kerosene	Coal	Charcoal	Firewood	Dung	Crop residues
Smith et al. (2000), sample was taken in India	CO_2	125.6	142.0	140.4[a]; 145.2[b]	-	-	308.2 – 566.1[c]	694.9 – 1010[d]	376.9 – 862.2[e]
	CO	0.608	0.192	0.818[a] ; 3.064[b]	-	-	16.39 – 41.26[c]	21.01 – 63.66[d]	15.6 – 71.11[e]
	CH_4	0.0023	0.0989	0.013[a]; 0.053[b]	-	-	0.781 – 3.396[c]	2.378 – 18.21[d]	1.071 – 11.17[e]
	N_20	0.00598	0.0989	0.013[a] ; 0.053[b]	-	-	0.0268 – 0.0713[c]	0.209 – 0.303[d]	0.024 – 0.172[e]
Bhattacharya & Salam (2002)	CH_4	0.0211	0.0578	0.028	-	0.2[g]– 0.253[f]	0.408[g]– 0.519[f]	0.3[f,g]	0.131[g] – 0.3[f]
	N_2O	0.0018	0.00148	0.00418	-	0.001[f,g]	0.00374[f] – 0.0048[g]	0.004[f,g]	0.004[f,g]
Zhang et al. (2000) sample was taken in China	CO_2	140[h]; 153[j]	-	158[b]; 162[a]	92.5-144[k]	-	388-750[l]	-	348 – 666[m]
	CO	0.0996[h];1.03[j]	-	0.378[b]; 0.446[a]	18.1-60.4[k]	-	11.1-18.1[l]	-	24.6 – 28.9[m]
	CH_4	0.0231[h]; 0.0158[j]	-	0.00052[b]; 0.0022[a]	0.00397-3.89[k]	-	0.294-0.831[l]	-	0.983-2.02[m]
	NO_x	0.148[h]; 0.00405[j]	-	0.0777[b]; 0.0324[a]	0.000029-0.116[k]	-	0.136-0.266[l]	-	0.202 – 0.703[m]
	SO_2	0.00001[j]	-	0.000583[b]; 0.00174[a]	0.0834-1.43[k]	-	0.00054-0.00749[l]	-	0.00796-0.0649[m]

a. Kerosene tested in wick stove; b. Kerosene tested in pressure stove;
c. Two kinds of wood, i.e. Eucalyptus and Acacia were tested in five stoves, i.e. traditional mud (tm), improved metal (imet), improved vented mud (ivm), improved vented ceramic (ivc), 3-rock (3-R).
d. Minimum and maximum emissions from dung from cow, buffalo, and camel were tested in four types of stoves, i.e. tm, ivm, ivc and 3-R
e. Minimum and maximum emissions from two type of crop residues, i.e. mustard stalk and rice straw tested in two stoves, i.e. tm and ivm
f. Traditional stoves; g. Improved stoves, h. LPG stove; j. LPG stove with infra-red
k. Coal is burned in brick stove with a flue and metal coal stove with a flue and without a flue
l. Wood is burned in brick stove, improved brick stove and metal stove
m. Residue from maize is burned in improved brick stove and metal stove
Note: This table is summarised from many resources

Solid energy, e.g. *charcoal* briquettes, firewood, animal dung and crop residue, produce more dangerous gases than liquid energy, e.g. kerosene and LPG (Fischer, 2001). Biomass contributes the largest portion of CO_2 emissions among all types of cooking fuel (Adria & Bethge, 2013; Grupp, 2004), while the emissions from animal dung and crop residue are higher than from firewood (Bhattacharya & Abdul Salam, 2002; Smith et al., 2000; Zhang et al., 2000). Use of more modern fuel reduces the combustion emissions and vice versa. This could be summarised in an emission ladder where the order of energy from highest to lowest emissions is animal dung, crop residues, firewood, kerosene, gas and electricity (Smith et al., 2000).

The kind of stove used for cooking also contributes to the production of combustion emissions (Warwick & Doig, 2004). Stove design and time spent to cook food contribute to the quality of combustion and the gases and residues emitted from the stove. The better stove design produces more efficient burning and less emissions (Ballard-Tremeer & Jawurek, 1996; Bhattacharya et al., 2002; Jetter & Kariher, 2009; MacCarty et al., 2008; Yuntenwi et al., 2008). For example firewood can be burnt in a three rock stove, a traditional stove, an improved stove with metal, or a stove which uses a chimney. These stoves result in different combustion qualities. Commonly, the simple stove produces *products of incomplete combustion* (PIC) such as CO and CH_4 that have a greater impact on global warming (Smith et al., 2000) and have been associated with some diseases as revealed in Figure 2.1. Meanwhile, an improved stove for firewood, such as a stove with a chimney, produces lower emissions (Smith et al., 2011). A well designed stove might even improve performance of firewood combustion so that it is nearly equal to LPG performance (Berrueta et al., 2008). Several studies have also demonstrated that the length of stove use contributes to the quality of combustion (Shen et al., 2013). This is supported by the results of Roden et al. (2009) study that after one year, the PM_{10} factor emitted from stoves increased by 50%. Therefore, an improvement in heat power and a reduction in pollution emitted by stoves could be achieved through improving the quality of fuel used, and improving the design or refurbishing the stove.

Generally, more efficient cooking fuels and stoves produce less emission. Efficient cooking fuel will provide further benefits because people can spend their time in more productive activities instead of spending time cooking. However, combustion of fuel during cooking activities results in emissions which contain harmful pollutants and creates indoor air pollution. High pollution is a hazard to health. Lung cancer, low birth weight and infant mortality can be caused by combustion emissions from cooking activities (Bruce et al., 2000) as well as respiratory diseases such as bronchitis. Acute Respiratory Infection (ARI) is associated with PM_{10} and SO_2 exposures (Ezzati & Kammen, 2001a), while chronic bronchitis has been associated with PM_{10} exposure (Albalak et al., 1999) from cooking activity. Some empirical studies found that respiratory diseases attributed to indoor air pollutions have an association with the use of solid fuel for cooking (Emmelin & Wall, 2007; Kirkwood et al., 1995; Smithet et al., 2000; Zhang & Smith, 2007). Coal combustion produces hazardous particles that contribute to lung cancer and cardiovascular disease (Smith & Mehta, 2003; Zhang & Smith, 2007). These relations are explained in Figure 2.1.

Women and children suffer from these diseases because they are more frequently involved in, or in the vicinity of, cooking activities (Smith et al., et al., 2000; WHO, 2006). Empirical data from the World Health Organisation (WHO) confirmed that in 2012, respiratory disease infection, e.g. pneumonia, was one of top three causes of premature mortality in addition to heart disease and stroke (WHO, 2014). It appears that indoor air pollution from cooking activities must be reduced because the pollutants are harmful to human health.

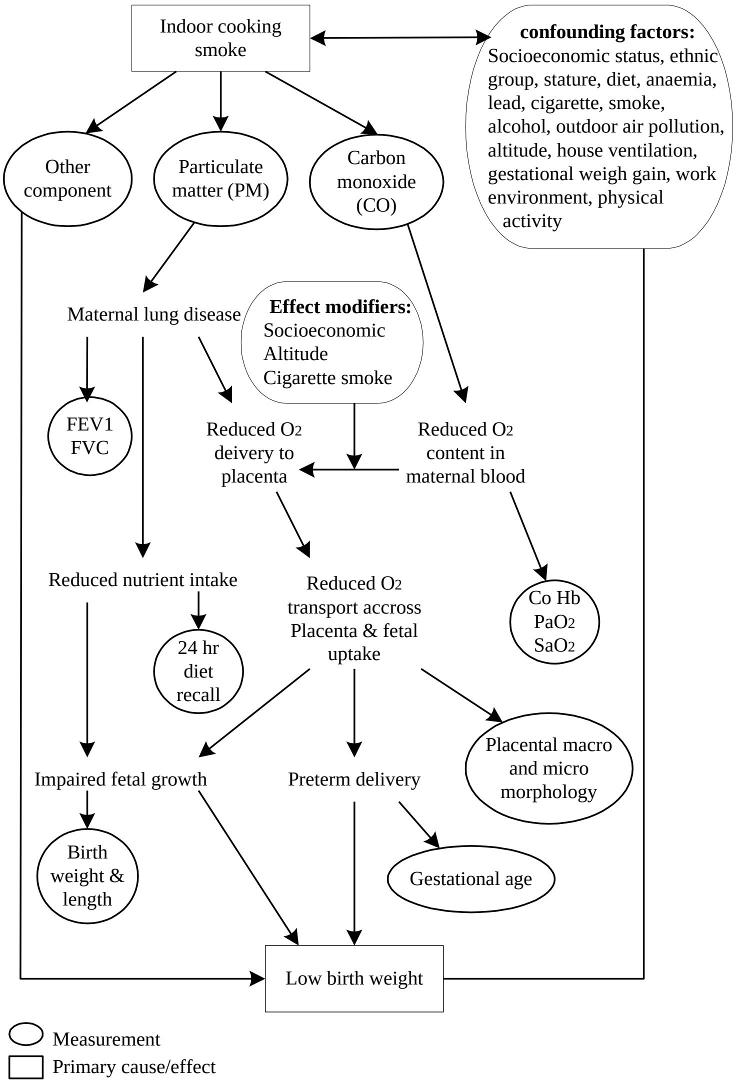

Figure 2.1: The relation of fuel combustion exposure to low birth weight (Fullerton et al., 2008)

Low quality fuel, which is more harmful, needs to be switched to high quality energy through two alternatives: switching dirty energy to clean energy or improving the stove (Arcenas et al., 2010). Traditional fuel such as biomass is low quality, whilst modern fuel such as LPG and electricity is high quality. Kerosene and coal have been considered as transitional fuels (see Table 2.1). Improving the stove to provide less harmful emissions is the other alternative to switching dirty fuel to clean fuel. Improving a cook stove does not have to mean replacing the stove with a new one, but the quality of stove can be improved through adding appliances to reduce harmful emissions such as a hood and/or chimney. In order to achieve clean indoor air quality through switching energy and stoves, government intervention through policy is required. This issue will be discussed in Section 2.6.1.

2.2 Energy Access and Energy Poverty

Lack of access to safe and clean energy services and high dependence upon traditional fuel are forms of energy poverty (Kaygusuz, 2011; Sagar, 2005; Scott et al., 2012). This argument was confirmed in the World Energy Challenge 2000 by the United Nations Development Programme (UNDP) statement that defines energy poverty as

> *... an absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development*.
>
> (Cecelski, 2000, p. 8).

The adequacy in this term means the adequacy of energy service. It is measured in units of energy such as Kilowatt hour (kWh), kilogram oil equivalent (kgoe) etc for specific energy service. For example, households have to use at least 10 kgoe for electricity and 40 kgoe of energy for cooking (Modi et al., 2005). Meanwhile, the term of affordability has a relation to income. Most commonly, income determines the use of energy service. People with high income tend to use more technological energy services, and vice versa. When a household has a low income this constraint prevents their energy consumption which affects their energy bills even though to some extent it affects human health. For example, in cold weather, every person should have sufficient warmth. However, poor people may be forced to live in a cold home which does not provide sufficient warmth. They sacrifice warmth to live in cold accommodation in order to avoid a high cost for energy during the winter. In some areas, homes are built for summer, not winter. So, they live with a colder house during winter to avoid energy cost. Another example of income constraint which influences health is poor households using firewood. Firewood may be the only fuel they have for cooking which produces worse combustion emissions than LPG. In these examples, health is affected, for example living in a cold room affects especially the elderly and children. Similarly, living in a household that cooks with firewood creates indoor air pollution which influences dwellers' health and environment. Hence, reliable, high-quality, safe and environmentally friendly energy should be provided for society to support a higher quality of daily life.

Pereira et al. (2011) view the full absence of any modern energy, for example electricity and clean fuel for cooking, as energy poverty. In this case, the using of traditional fuel is the hallmark of energy poverty (Birol, 2007). This definition is not merely applied for domestic usage, but also in industries and community services such as in education and health care centres (Practical Action, 2013). The energy at a domestic level would be used for lighting, cooking, heating and cooling (Modi et al., 2005). Meanwhile, energy services in community services and industries include mechanical power and transport in addition to energy services used in a domestic context. Nevertheless, in fact, the household might use different energy carriers for different energy services. For example, a household may use traditional fuel source for boiling water, but use electricity for cooking some food. This is not categorised as full absence of modern fuel because modern fuel is still used in some circumstances.

In most studies of energy poverty, the term energy poverty is used in connection with modern fuel access. As in the above-mentioned explanation, energy poverty refers to the lack of access to modern energy services. Meanwhile, energy access is referred to as the presence of necessary infrastructure. When infrastructure for any specific energy carrier is not available, it will be impossible to access the specific energy carrier. However, some people are unable to use a specific energy carrier even when it is available. In this case, people have access to energy but they can't afford to consume it. For this reason, Balachandra's (2011) definition of energy access may be useful. His definition of modern fuel access refers to a situation where:

> *modern fuel services should be physically accessible and available to the people, should be of acceptable quality, reliability and preference, should be affordable both in terms of low capital and operating cost and in the context of income levels, and finally it should be adequate in terms of abundance.*
>
> (Balachandra, 2011, p. 5558)

This definition is similar to the above-mentioned definition of energy poverty from the UNDP. The access to modern energy carriers is not merely about physical access but it has a relation to energy supply in terms of availability and also affordability. This is in line with the IEA definition of energy access (Birol, 2007). Affordability is determinant of the choice of energy carrier. For this reason, some households have a lack of access to specific energy carrier even though the energy infrastructure is available. However, in most studies on energy access and energy poverty, energy consumption and energy use is commonly applied as the proxy of energy access (Bazilian et al., 2012b; Bhattacharyya, 2006; Brew-Hammond, 2010). In this definition, people who do not use modern energy even though they have access to modern energy infrastructures will not be recognised as having access to modern energy. Referring to the definition of energy access stated by Cecelski (2000) and Balachandra (2011) that affordability should be considered in determining the access to energy. Thus, people are grouped as energy poor when people have access to modern energy infrastructure, but they are unable to buy modern energy because they are income poor.

2.3 The Assessment of Adequate Energy Access

There is no exact consensus among international institutions and researchers to estimate modern fuel access. Yet, the identification of the degree of access to energy is necessary (Practical Action, 2010, 2013; Tennakoon, 2008). Some scholars undertook studies to determine an assessment and measurement for energy access or energy poverty (e.g. Chakravarty & Tavoni, 2013; Sovacool, 2012). One of the benefits of the assessment is providing information on the performance of modern fuel access in a specific area (Nussbaumer et al., 2012). This information can be used for designing policies and actions to tackle the problems of modern fuel access and energy poverty.

In relation to energy need, Bravo et al. (1983) argue that there are four energy service needs that should be put as the first priority: energy for cooking and clean water, space heating and cooling, lighting, as well as leisure time and communication. Goldemberg et al. (1985) adds that the energy for health and education should be a basic energy need as well. Above all, lighting, cooking, space heating and cooling are the most important basic needs among others. This is because the shortage of those energy services influences health and development.

From the various literatures abovementioned, it can be summarised that there are three approaches applied to assess access to energy: a quantity-based approach, a share of expenditure-based approach and a source of energy-based approach. The following sections discuss the approaches in more detail.

A. Quantity-Based Approach

Energy access can be identified through the proportion or number of households who meet the minimum amount of energy consumed, in Kilowatt hour (kWh), Joule (J), barrel of oil equivalent (BOE), or kilogram of oil equivalent (kgoe). Conceptually, the quantity-based approach is derived from the notion that a person should have access to sufficient energy. This refers to the ideal that usage for every person should meet a specific minimum amount of energy. For example, the minimum requirement for domestic energy is 50 kgoe, 40 kgoe for cooking and 10 kgoe for electricity according to Modi et al. (2005). Meanwhile, based on a study in Sri Lanka, Tennakoon (2008) argues that the minimum electricity required is 120 kWh and 35 kg of LPG per person per annum. These standards are equal to 107.39 kgoe[8] for electricity and 42.14 kgoe for cooking, which are clearly

[8] See Table 4.2 for converting kWh and kg to boe. Later on, boe is equal to 146 kgoe.

higher than the levels advocated by Modi et al. (2005). Nowadays, there are various standards available and some of them are summarised in Table 2.4.

Table 2.4: Quantity threshold of basic energy need

Proposed by	Minimum level of energy received by people		
	Lighting	Cooking	heating
Modi et al. (2005) and Barnes et al. (2010)	10 kgoe per person per annum	40 kgoe per person per annum	
Tennakoon (2008)	120 kWh per person per annum	35 kg per person per annum of LPG or equivalent	
AGECC (2010)	100 kWh per person per annum	100 kgoe per person per annum of modern fuel	
Barnes et al. (2011) and Khandker et al. (2012) (study based on Bangladesh & India)	Every person needs minimum 27.4 kgoe per month		
Goldemberg 1900 cited in (Khandker et al., 2010) (study in India)	Every person needs 32.1 kgoe per month		
Pachauri (2011) (study in India)	1.5 W per person	30W per person	1.5 W per person
IEA (2012a)	250 kWh per annum for rural household whilst 500 kWh for urban household		
Practical Action (2010)	1 kg firewood or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or ethanol per person per day		

From the table, various thresholds are applied to identify the sufficiency of access to energy. But, there is no single consensus about the minimum standard that should be used. The reason is because the basic needs of energy for every person vary according to climate, region, time, age and sex (Pachauri, 2011). But, even though the needs are different, these standards can be applied as a benchmark in initiatives concerned with energy poverty and access to modern energy.

The quantity-based approach has been implemented by some scholars (see Pachauri et al. (2004), Bravo et al. (2008),[9] Practical Action (2010) and IEA

[9] Bravo et al. (2008), calculated the energy access based on type of services and type of fuel.

(2012b)). This approach has the strength of describing the amount of energy usage in some detail. However, technically, there are some limitations such as data availability. Commonly, households are unaware of the amount of energy they use. Hence, in order to assess the amount of energy usage, Andadari et al. (2014) converted the household expenditure on energy for cooking to energy used to assess it, instead of measuring it directly.

B. Share of Expenditure-Based Approach

Because it is difficult to measure energy access from the amount of energy used by people, expenditure is an alternative parameter to measure energy access. In the context of Europe the term of fuel poverty tends to be used rather than energy poverty. The expenditure measurement was adopted by some scholars, for example Barnes et al. (2010) use 10% of income as the threshold for energy poverty, in which a fuel poor household is one that spend more than 10% of their income on all energy use. This threshold is related to the previous official definition of energy poverty applied by the government of United Kingdom. Meanwhile, Fankhauser & Tepic (2007) recommend the threshold of affordability is when the energy expenditure is more than 25% of income, instead of 10%. The distribution of the percentage for this threshold for heating, water and electricity are 10%, 5% and 10%, respectively and for regions in which households do not need heating, the threshold is 15%. This threshold implies that a household is considered as having sufficient access to energy when energy expenditure is less than 10% of income. In contrast, a household is experiencing energy poverty (or fuel poverty) when energy expenditure as a proportion of income exceeds the threshold. The underlying reason for this approach is the need for affordable energy service. With reference to the term ‘sufficient’, achieving the standard minimum level for energy service is also the criteria of access to energy services. This means people who have lower income have to spend a higher share of their income on energy expenditure than the rich (Barnes et al., 2010; WHO, 2006). This approach is appropriate if it is assumed that every household will always be able to achieve the minimum standard of energy services in physical access terms. However, this is not possible in all contexts. For example, in a developing country, meeting the minimum standard of energy service is impossible because basically the energy infrastructure is not available. Meanwhile, Saghir (2005) argues that the poor households spend a small amount of their income on energy expenditure for non-commercial energy e.g. firewood, but while this means their energy expenditure may be low, it is not an ideal situation and their access to modern energy is also low. In this case, households who experience energy poverty are not those who spend more than 10% of their total income for energy, but households who pay less for energy.

Apart from the above, however, the determination of 10% of income on energy consumption as a threshold of adequate access is lacking in scientific rationale (Bazilian et al., 2010). First of all, every household may consume energy for different services. For example, household A uses energy for lighting, cooking and information and technology (television and radio), whilst household B uses energy for a refrigerator and vacuum cleaner in addition to lighting and cooking. In this matter, rural-urban location, preference and culture may influence the use of those services. Additionally, the variation of energy service used by a household influences the amount of units of energy consumed by each household.

Not all of the energy they consume is for basic energy needs. For example, electricity is not merely used for cooking and lighting, but also for entertainment. Hence, measuring energy poverty through energy expenditure does not differentiate between different energy needs, except if there is a tool which is able to measure the use of energy separately or what energy carrier is applied for one service. Thirdly, this approach (where spending more than 10% is considered energy poverty) ignores the fact that there are households who save their money through depriving themselves of ‘essential services. Based on this approach, they would not be registered as energy poor. Fourthly, as mentioned above, some households do not consume commercial energy since energy capacities are insufficient or not available yet. In this case, this expenditure based approach where more than 10% is classed as energy poverty is not appropriate for the region where they do not have any energy infrastructures that affect the price of energy.

C. Source of Energy-Based Approach

Access to adequate fuel can be approached by measurement of quality in addition to the quantity-based approach (Bravo et al., 1983; Practical Action, 2010). The quantity measurement for energy access is conceived as the minimum quantity of basic need energy that has to be received by a household. This has already been discussed in part A of this section. Meanwhile, the quality of energy refers to reliable and safe energy for humans and environment (Modi et al., 2005). This issue will be discussed in this section.

The source of energy-based approach classifies whether a household has energy adequate access through identifying the energy carrier they employ for cooking. A household that uses traditional fuel is registered as having less access to modern fuel, and therefore inadequate energy access (see Table 2.1). For example, a household that uses firewood for cooking is registered as not having access to modern fuel. In contrast, a household that uses LPG for cooking is registered as having an access to modern fuel. This approach is employed by international organisations such as WHO (Rehfuess et al., 2006) and IEA (OECD/EIA, 2010). It has been implemented by many scholars as well (Balachandra, 2011; Jannuzzi & Goldemberg, 2014; Palit et al., 2014). On the other hand, measuring energy access through a source of energy-based approach disregards the amount of energy consumed by households. Therefore, the quantity-based approach would need to be used to measure the amount of energy consumed by a household.

Discussion of the Approaches

These measurements of energy access have strengths and weaknesses which are summarised in Table 2.5. The quantity-based approach which provides specific and detailed information about energy access is the most comprehensive and offers the best measurement, describing the quantity of energy consumption in used energy in detail. But it doesn’t take account of the type of fuel and the possible health effects. In addition, data availability is one of the challenges in measuring energy access using this method (Mirza & Szirmai, 2010). In an effort to alleviate this problem energy expenditure has sometimes been used to assess quantity of energy used (Andadari et al., 2014). Energy expenditure approaches can be used in this way, where low expenditure is taken to indicate low energy access (Mirza & Szirmai, 2010), but it is hard to determine a threshold where access is considered adequate especially if it is proportion of income and not an actual amount. Expenditure approaches are also used to assess energy access in terms of affordability and here high expenditure not low expenditure is considered to be a problem. This might be more appropriate where access to energy infrastructure is not limited and only price and income determine energy access. Meanwhile, a universal assessment of energy access which is easy to compute, flexible for various contexts and able to deal with availability, reliability and comprehensiveness of data is needed (Bazilian et al., 2010). This can be met by the source of energy-based approach which is useful for giving information to design policies. Hence, although the source of energy approach neglects the quantity of energy consumed by households, this measurement is easier and more feasible for gathering valid data than the other two approaches.

Moreover, Pachauri (2011) introduces a multi-dimensional approach in modern fuel access metrics. These are the source of energy availability of energy carrier and adequacy of quantity – that means no less than the minimum threshold, affordability of energy, quality and reliability, the impact on human health or safety. In addition to these dimensions, another factor such as the ease of use and access should be considered (IEA, 2012a). Access to source of modern fuel is the prerequisite of the access to modern fuel services for households. Yet even though households have access to modern fuel, for economic reasons, adequacy may not be met. Therefore, it should be noted that affordability is one of the important dimensions to influence the willingness of people to buy energy, since a high cost for energy is a constraint (Ouedraogo, 2006). Meanwhile, quality and reliability which are characteristics of high efficiency energy that produces high calories are important dimensions related to energy impacting on human health and environment. It should be noticed that these dimensions have a strong relationship with the quality of life for humans. Last but not least, ease of access and ease of use of energy have to be considered, as these might inhibit the transition to modern fuel. All of these dimensions of access to modern fuel are presented in Figure 2.2.

Table 2.5: Potential indicators for measuring access to modern fuel

Indicators and approaches		Strengths	Weaknesses
Number of households with an efficient stove that meets minimum requirements for indoor air quality	Source of energy & quantity approach	Directly measure the main issue relating to clean cooking facilities – indoor air quality	Data improving but still not sufficient. Requires regular surveys adopting common standards for minimum acceptable air quality
Number of households who cook with modern fuel	Source of energy approach	Close to direct measurement. Does not require an inventory of stove types	Data improving but not still not sufficient. Does not reflect use of improved cook stove with traditional fuel.
Average energy consumption of household in kWh & kgoe	Quantity-based approach	This approach is able to capture detail on quantity of energy	Requires extensive data collection and difficult to implement
Average expenditure on energy as percentage of income	Share of expenditure-based approach	Captures affordability and is an indication of how price changes will affect access	Does not capture energy from gathered wood and other non-commercial energy. Requires regular expenditure surveying.

Source: Andadari et al. (2014); IEA (2012a)

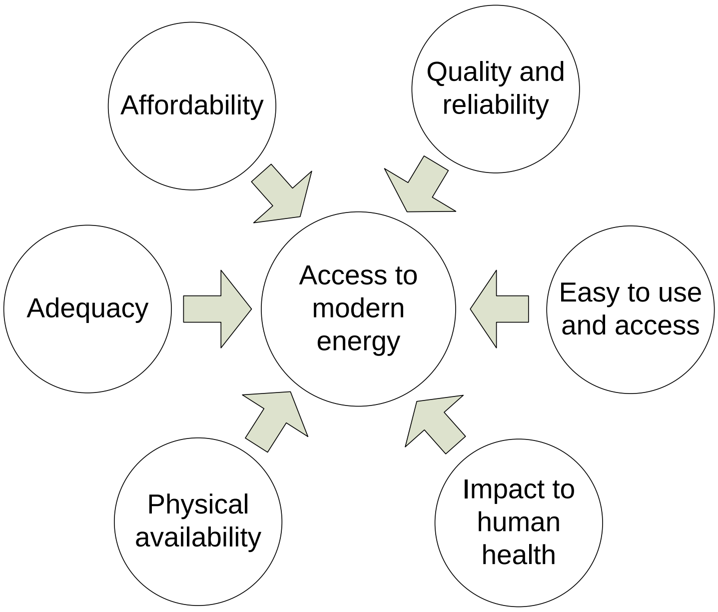

Figure 2.2: Dimension of modern fuel access – summary from many sources (Author's summary)

2.4 Economy and Modern Fuel

2.4.1. Economics and Infrastructure

The consumption of energy in a state is affected by economic growth rate (Azam et al., 2015). Moreover, a country with a per capita income of less than US$ 300 has more likelihood of having a high portion of the population who use firewood and animal dung as fuel, and they will close to entirely use modern fuel if a country has a per capita income of more than US $1000 (IEA, 2010). Generally, low income countries lack modern fuel investment (Goldemberg et al., 1985). This, unfortunately, drives the modern fuel market which in turn affects the price and affordability of modern fuel for households to use it.

Modern fuel such as oil, gas and electricity are commercial energy carriers (Barnes et al., 2010). These kinds of energy carriers are generally more expensive than traditional biomass. Cost is usually viewed as a burden for poor households either in urban or in rural areas in developing or in developed countries. Income constraints of poor households prevent them from having more freedom to buy what they want to buy (O'Brien et al., 2007; Practical Action, 2010). But, energy is needed to power their activities, for instance energy for cooking of food, water, heating and cooling. Poor households, instead of buying commercial energy carriers such as oil and gas, will choose cheaper energy carriers such as traditional fuel which can be gathered easily from the surroundings. Most traditional fuel such as wood and animal dung is freely gathered from nature (Hosier & Dowd, 1987). In rural areas, wood is freely gathered from forests and can also be found easily from gardens. Otherwise, wood is sold at cheaper prices relative to modern fuel such as oil and electricity. Thus, traditional fuel is customary used by the poor (Arnold et al., 2006). On the other hand, the affluent are able to buy any kind of fuel although the energy carriers are more expensive. They do not have a lot of constraints to buy a specific kind of energy carrier as they have more money. But when the economy of a household increases, it increases the reliance of society on modern fuel and reduces their reliance upon traditional fuel (Arnold et al., 2006; Hosier & Dowd, 1987). The increasing price of modern fuel, which is commonly commercially sold, affects the consumption of modern fuel (Aweto, 1995). Clearly, financial income is one of factors that affect the capability of a household to afford energy (Karekezi, 2002; Nkomo, 2005; Suliman, 2013).

The economics of a country influences the availability of its energy infrastructure and technology. Meanwhile, energy infrastructures influence energy consumption. The infrastructure includes energy technology, transportation of energy, regulation and laws provided by governments and institutions (Rogner &

Popescu, 2000). In general, energy infrastructures and technology in industrial countries are well developed. This also has a relation to investment and policy; most of the industrial countries have strong policies to build energy capacity, such as infrastructures for modern fuel and its technology. Strong commitment from governments through policy and regulations attract investment. Hence, it is easy for both poor and affluent citizens in developed countries to access modern fuel. In contrast countries in the global South have less modern fuel infrastructures and technology, and there may be little access to any kind of energy except traditional fuel. Low investment is the main reason behind the limited number of modern fuel infrastructures.

In the developing world, low income and poor modern infrastructures are the two main causes of low access to modern fuel (Khandker et al., 2010). In other words, financial constraints and the absence of energy infrastructures in developing countries leads poor households to be more vulnerable to be energy poverty (Fankhauser & Tepic, 2007).

Developing countries may have high numbers of people who could not access modern fuel although they are oil producing countries; the reasons are large populations, economic constraints and politics. Oil exporting, developing countries such as China, India, Nigeria and Indonesia, have very high population and will face energy security problems. Providing more energy to meet the demands of their population, however, needs political intervention as it needs high investment for the development of energy infrastructure. Furthermore, political situations in developing countries are sometimes unstable, which in turn will prevent foreign investment due to security concerns. Most often, developing and least developed countries have little development of energy policies and energy security measures. Hence, society encounters the problem of lack of modern fuel access by themselves and their community without assistance from the government. This is more severe in least developed countries which do not have energy resources (UNDP, 2010) and where a lack of energy governance leads to scarcity of energy supply and therefore high rates of energy poverty.

2.4.2. Energy Ladder Theory

The energy ladder model illustrates the transition of energy in households as the income increases (van der Horst & Hovorka, 2008; Hosier & Dowd, 1987; Treiber, 2013) as depicted in Figure 2.3. In this theory, traditional fuel and less efficient energy such as biomass are at the lowest level of the ladder, while modern fuel and more efficient energy, such as oil and electricity, are at the highest level of the ladder. The order of energy for cooking from below to the top quality are dung, crop reside, wood, kerosene and gas (Smith et al., 2000).[10] Traditional fuel is less expensive, even freely collected from nature; meanwhile, modern fuel is commercial energy. Consequently, low income households tend to use wood, dung and other biomass instead of LPG and electricity (Reddy et al., 2000) as this has a relation to affordability, as discussed in the previous section.

[10] In this theory, renewable energy is not mentioned clearly

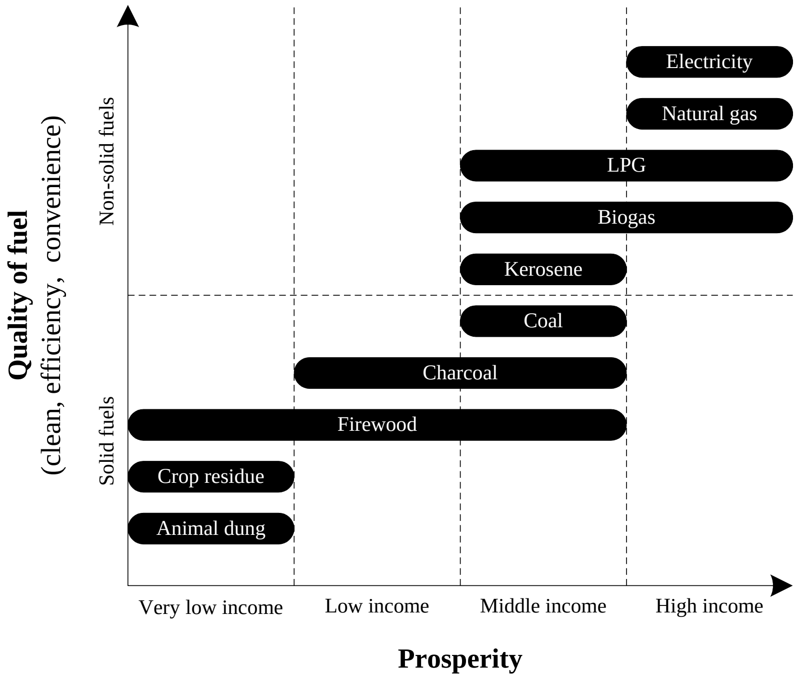

Figure 2.3: Energy ladder based on quality of fuel for cooking and household income (WHO, 2006)

The energy ladder is more focused on the quality of energy, where traditional fuel means dirty energy and modern fuel refers to clean energy. However, as previously discussed in Section 2.1, there is evidence that cleaner energy is not purely influenced by the energy carrier, but is also influenced by the quality of stove (Kshirsagar & Kalamkar, 2014). A more technologically advanced stove produces less pollutant although the energy carrier is a traditional one. In this case, the stove should be considered in the energy ladder instead of the energy itself, as proposed by IEA (2010) which shown in Figure 2.4.

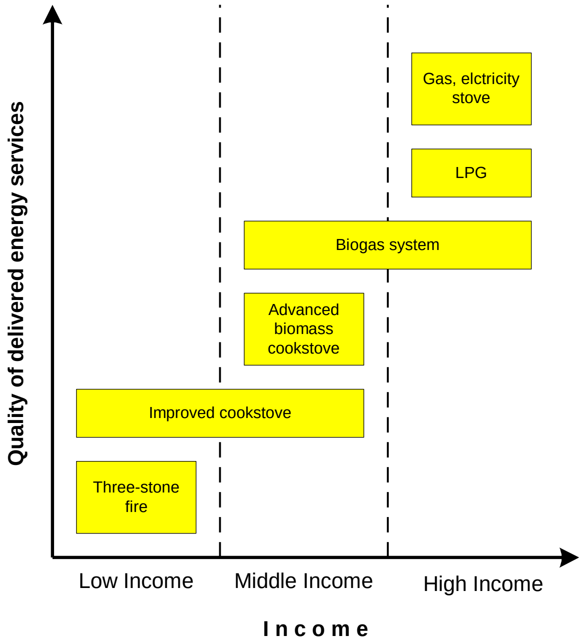

Figure 2.4: Energy ladder with stove as the main feature (IEA, 2010)

A three-stone fire is generally used for biomass. The improved cook stove may also be applied for kerosene, but with a different design to biomass improved stoves. Meanwhile an advanced biomass cook stove is the highest technological biomass stove. Biomass can be processed through a technologically improved process to produce modern biomass energy which is called biogas. The quality in terms of impact on the environment, efficiency and convenience of this energy is as high as kerosene and LPG. Therefore, biogas in the ladder system is placed in the higher part of the ladder.

It comes to mind that, normally, households select the most sophisticated and affordable energy they can get (Ramani & Heijndermans, 2003). In this context, energy which is most sophisticated has qualities of high technology, high efficiency, less pollutants and is generally more expensive. In the meantime, income and price are determinants of affordability that influence how households adopt energy (Arnold et al., 2003; der Horst & Hovorka, 2009; Ouedraogo, 2006; Ramani & Heijndermans, 2003; Reddy et al., 2000). In relation to poor households in developed and developing countries where people have different opportunities to access energy, Barnes and Floor (1996) and Sovacool (2012) divide the energy access into a different ladder as presented in Table 2.6.

According to the energy ladder, poor households are able to move up the energy ladder if their income increases. Therefore, due to the connection of low income with traditional fuel consumption, investment in lifting the income of households is one of the solutions to move up to more modern fuel (Barnes & Floor, 1996).

Table 2.6: Energy ladder, developing countries vs developed countries

Energy service	Developing countries			Developed countries
	Low income households	Middle income households	High income households	
Cooking	Animal dung, crop residues, firewood, charcoal	Animal dung, crop residues, firewood, coal, kerosene, biogas	Firewood, kerosene, biogas, coal, LPG, natural gas, electricity	Electricity, natural gas

Source: Combination of Barnes and Floor (1996) and Sovacool (2012)

The energy ladder graph depicted in Figure 2.3 and Figure 2.4 reveal that poor households tend to use traditional fuel and the rich tend to use modern fuel. There is no place for the wealthy who still use traditional fuel nor the poor who are able to access modern fuel. However, there is another possibility that traditional fuel is used by wealthier people, whilst poor people may be able to use modern fuel where there is access to modern energy infrastructure. Wealthier households in some areas use traditional fuel as they have plentiful supply and it is also cheap. Meanwhile, poorer people in rich infrastructure areas are able to access modern fuel. This issue will be discussed in Chapter 6 of this study.

Apart from that, providing infrastructure and its technology is believed to help movement up the energy ladder. Hence, political action to provide modern fuel for society is needed to make this happen.

However, in many cases households are still consuming less efficient and less convenient energy instead of using more efficient and convenient energy services (Mirza & Szirmai, 2010; Treiber, 2013). Households do not merely use one type of energy service and fuel (van der Horst & Hovorka, 2008; Hosier & Dowd, 1987; Masera et al., 2000; Mirza & Szirmai, 2010; Sovacool & Drupady, 2012). They apply multiple energy services for single fuels. For example, electricity is used for cooking and also used for lighting. Moreover some people use multiple fuels for one service but for different purpose of service. In developing countries some people cook rice by using a firewood stove, whilst fish and vegetables are cooked on a kerosene stove and water is boiled on a LPG or electricity stove. Although there is a mix of fuel, poor and rural households are more likely to use traditional fuel, whilst rich people tend to use electricity rather than traditional fuel.

2.5 Rural-Urban Location and Access to Modern Fuel

Rural and remote areas are commonly under developed. Studies in developed countries indicate that rural households tend to experience energy poverty (Roberts et al., 2015). But, rural areas in developing countries suffer from a lack of more basic amenities than rural area in developed countries (Reddy et al., 2000). One characteristic of the developing world is they do not have adequate modern fuel supply infrastructures (Khandker et al., 2010; Laufer & Schäfer, 2011; Saghir, 2005). Additionally, there is some evidence that rural households are more vulnerable to be energy poor compared to urban households (Sovacool, 2011; Suliman, 2013). This is a common situation. The study of Krey et al. (2012) shows evidence in India and China that rural households consumed more solid energy and had less consumption of electricity in comparison with urban households. The lack of infrastructure aggravates the situation: modern fuel infrastructures are not well developed. Consequently, more rural dwellers are living without modern electricity and more of them rely upon biomass, i.e. animal dung, crop residues, firewood and charcoal for lighting and for cooking (Goldemberg et al., 1985; IEA, 2010; Pereira et al., 2011). Rural households in developing countries such as Nicaragua (Alberts et al., 1997), Bolivia, Ghana (Akpalu et al., 2011), India (Pachauri & Jiang, 2008; Smith et al., 2000), Kenya (Ezzati & Kammen, 2001a, 2001b), Pakistan (Wickramasinghe, 2011) and China (Mestl & Edwards, 2011; Pachauri & Jiang, 2008) have high dependence upon burning biomass in traditional cook stoves. In contrast, more urban dwellers use modern fuel (Leach, 1988). It appears there is a significant difference in the use of modern fuel between rural and urban areas (Barnes et al., 2011; Pachauri & Cherp, 2011; Sovacool, 2011).

The disparity of energy use between rural and urban areas can be influenced by many factors, such as availability of biomass, cost of traditional fuel, distance to resources, cost for providing energy infrastructure and the feasibility of the market. Those factors will be discussed in more detail in the following paragraphs.

a. The Abundance of Resources and Low Price of Traditional Fuel

Rural areas have more vegetation than urban areas and this enables rural people to collect branches which have fallen from trees in the forest or around the rural areas. In other cases, firewood can be bought at a relatively low price. So, the accessibility and low price of firewood is a major reason for people to use firewood (Wickramasinghe, 2011).

Nevertheless, in the longer term, the supply of firewood may decrease because of deforestation; while the demand remains constant or even higher, the increase in firewood price will be inevitable. Sometimes this leads households to use other biomass such as animal dung. However, a rural household's choice of wood for energy will not drop as firewood price is relatively low (Arnold et al., 2003). Moreover, they will not move up to more sophisticated energy as long as firewood is still available (Hosier & Dowd, 1987). In this situation, the rural area needs intervention from the community or government to change its consumption to cleaner energy.

b. Physical Access and Distance From Modern Fuel Resources

The energy infrastructures in rural areas are fewer than in urban areas (Mirza & Szirmai, 2010). Lack of physical access to modern fuel due to long distances from energy resources and infrastructure increases deprivation Barnes et al. (2010). The cost for transporting energy from the energy manufacturer to rural areas is commonly higher because of the poor transportation infrastructure and the distance from urban areas where manufacturing is favourably located. Additionally, the cost of providing the energy infrastructure in rural areas is higher than in urban areas. The distance of rural areas from urban centres may increase the cost of transportation in providing energy infrastructure. Moreover, transportation to rural areas and remote area s is often not well developed and that can be the challenge to building energy infrastructure in rural areas. Hence, most of the rural areas are not well developed and lack energy infrastructures. The high cost of transportation and for building energy infrastructures elevates the cost of modern fuel facilities in rural areas (Bhutto & Karim, 2007). Availability of energy sources which in turn influences price of energy also affects affordability.

c. Economically Unfeasible Modern Fuel Infrastructure

The cost of provision and maintenance of a modern fuel infrastructure in a rural area is higher than in an urban area. Distance from maintenance centres, transport cost and low population density in rural areas increase the cost of energy per household (IEA, 2010). As a result, poor physical access in rural areas makes development economically unfeasible. In contrast, urban areas where there is a large population and less transport costs for energy provide attractive conditions for investment for energy. This leads to a greater energy supply in urban than rural areas.

d. Affordability of Modern Fuel

Economically unfeasible conditions for the provision of the modern fuel market in rural regions leads to rural inhabitants being unable to access modern fuel. This affects energy prices in rural areas and influences energy consumption for both poor and rich households (Pereira et al., 2008). Since an enormous portion of rural households are the poor, traditional fuel usage such as biomass is potentially higher than in urban households since energy consumption is controlled by the income of each household (Khandker et al., 2010; Karekezi &

Kithyoma, 2002). Therefore improving energy access in rural areas through increasing the income of households is one of the strategic options that can be taken.

In order to move up the energy ladder, urbanisation is an alternative solution besides improving the income of households (Leach, 1988). Urbanisation (or migration to urban areas) can improve family income as there are more jobs offered in the city than in villages. Moreover, the life style also leads to a change in energy consumption (Goldemberg & Lucon, 2010). By living in an urban environment people will eventually adopt urban society's values, which in turn will change their preference and lifestyle. Rural household who previously used firewood when they were in a village, will adopt the urban lifestyle in cooking with modern fuel such as LPG and electricity. However, urbanisation is not a feasible solution to solve all rural energy poverty.

2.6 The Relation between Institution, Policy and Society

2.6.1. Government and Policy Intervention

As shown in Figure 2.5, the history of energy policies are purposed to achieve five goals: access to modern fuel, supply security, cost efficiency, natural resources efficiency and social acceptability (Frei, 2004). The lower order in the pyramid is the basic need. This pyramid illustrates the argument of Sagar (2005) that access to modern fuel should be put as the first priority because its availability is the window for development. Security of supply is the next policy target once access to modern fuel has been achieved. Later on, cost efficiency, energy efficiency and social acceptance of specific energy carriers feature as the next targets of the energy policy. This pyramid is the guidance for a country to formulate energy policy and is not impossible if all of the targets can be fulfilled together.

Several studies on energy poverty found that the root cause of lack of access to modern fuel is due to failure from institutions and policy interventions (Akpalu et al., 2011; Balachandra, 2011). Energy poverty mostly occurs in least developed and developing countries, such as Ethiopia (Kebede, 2006), Nigeria (Alabe, 1996), South Africa (Davidson & Mwakasonda, 2004), Pakistan (Bhutto & Karim, 2007), India (Bhattacharyya, 2006; Palit et al., 2014) and China (Duan et al., 2014; Xu et al., 2014), where the main cause is the inability of governments to provide access to modern fuel. The evidence from several studies in developing countries show that institutional intervention such as government policy is able to alleviate energy poverty (Brew-Hammond, 2014; Jannuzzi & Goldemberg, 2014; Kees & Feldmann, 2011).

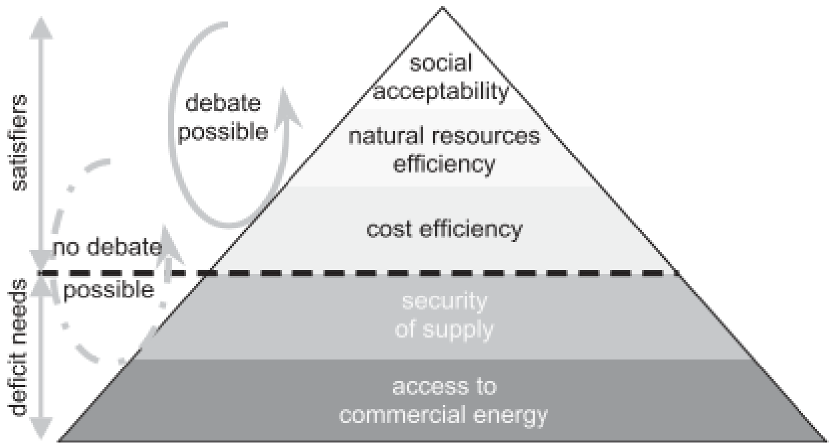

Figure 2.5: Energy policy pyramid (Frei, 2004)

The government as the political sovereign has power to change the use of energy. Providing regulations related to energy and its infrastructure are the main task of the government (IEA, 2010). Regulation is powerful in directing the energy market and society to move to specific energy. Nevertheless, establishing the regulation needs a political will and commitment from the government (Bazilian et al., 2011b; Birol et al., 1995; Zuzhang, 2014). The political institutional approach is appropriate to change energy technology since politics has a central role for collective action (Foxon, 2002). Furthermore, the government should undertake thorough preparations to carry out good and clear planning, establish targets, systematic monitoring and decide the indicator of energy poverty in order to meet the goal (IEA, 2010). Some studies have proven that poorly planned institutional and regulatory framework might create an obstacle to achieving modern fuel access (Nussbaumer et al., 2012; Saghir, 2005).

Bazilian et al. (2012a) argue that policy driven by government initiative would have a strong effect instead of policy driven by society. This is because government has an authority that led them to create and manage the energy supply from top to bottom line energy system (Anderson et al., 2000; O'Brien et al., 2007). The energy system along with the system of provision the modern energy infrastructure, both of large and small scale infrastructure, that are prepared by the government is the key factor to alleviate energy deprivation (Bouzarovski & Petrova, 2015). However, in some countries wherein decentralised policy is implemented, the local government commitment to deal with the problem of access to modern energy should also be determined. The local government are closer to the public and may have more direct influence on society. Hence, in order to achieve the goal, local government, non-governmental organisations and financial institutions might be good collaborators (Foell et al., 2011; Wong & Mathur, 2011).

There are several potential interventions from governments in developing countries for providing energy for society. Some of them will be elaborated in the next paragraphs.

a. Financial Support from Institutions

Adequate and sustainable financial support for an energy poverty alleviation programme may accelerate the success of achieving the goal and target (Bazilian et al., 2010; IEA, 2010; Practical Action, 2009, 2010). Financial support is essential in policy as this affects the implementation. Some evidence provided by scholars show that lack of investment failed to optimise the enhancement of energy development (e.g. Nygaard, 2010). Support from the Ministry of Finance plays central roles (Bazilian et al., 2014). On the other hand, especially in developing countries, ability to invest may be limited and loans from banks or international institutions may be required for energy investment, in addition to financial investment from the government.

Nevertheless, international institutions do not have authority to implement their support unless they collaborate with the government. The government has more authority to manage energy resources and infrastructures as well as control local energy markets than international institutions. Hence, cooperation between national governments and international institutions is assumed to able to increase the success of energy policy (Rondinelli & Ruddle, 1978). *Desarrollo Social y Económico del Área Rural* (DESEAR) Foundation in Nicaragua is such a programme funded by an institution from the Netherlands Development Agency (Alberts et al., 1997). This project was successful in distributing kerosene to society in rural Nicaragua through a credit scheme. The high acceptance by society of this project attracts the funding to continue financing the project.

b. Subsidy and Incentive

One of the examples of interventions by the government for improving modern fuel is the provision of energy subsidy. Subsidies and incentives are some of the financial endorsements from the government (Kraft & Furlong, 2007). The subsidies can be delivered directly to society or embedded in energy price. However, there are pros and cons on the implementation of subsidies.

Providing energy subsidies may improve affordability for vulnerable households. Subsidy was shown to improve the usage of electricity in Zimbabwe (Campbell et al., 2003) and attract public to move to cleaner energy in South Korea (Park & Kwon, 2011). There is also some evidence that the phasing out of energy subsidy increases poverty (Dartanto, 2013), because it increases price as subsidy removal reduces purchasing power. Therefore subsidy maintenance importance because its removal will generate negative impacts to the micro economy of the nation (Lin & Li, 2012; Nwachukwu & Chike, 2011).

On the other hand, studies show evidence that subsidy is not purely consumed by the poor. A study by Pitt (1985) shows that subsidy given to kerosene in Indonesia did not reduce deforestation because poor people use firewood, whilst kerosene was consumed by the wealthier people. This is known as subsidy leakage, when subsidy is consumed by non-eligible receivers (Rao, 2012). This is the reason why subsidy is potentially a costly policy to alleviate poverty (Granado et al., 2012; Rao, 2012).

Furthermore, subsidies could be a barrier to make a transition and this can be counterproductive in alleviating energy poverty (Urge-Vorsatz & Tirado Herrero, 2012). Subsidies for fossil energy are argued to be a barrier for energy diversification of renewable energy (Kaminker & Stewart, 2012). Hence, some experts disagree with subsidy provision and suggest other strategies through innovation and green technology initiatives (Jupesta et al., 2011). Therefore, it is argued that subsidies for fossil energy should be reallocated to renewable energy (Barton, 2007; Lin & Jiang, 2011).

To sum up, subsidy and incentive may improve affordability of energy for vulnerable households, on the one hand. On the other hand, in some cases, subsidy and incentive can be counterproductive (Carrico et al., 2011). Subsidy may be an obstacle in energy diversification and the introduction of new energy. Similarly, incentives may result in negative impacts. For example, an incentive for adopting a fuel by the government led people to act personally to enrich themselves while the country budget increased considerably due to high demand by members of public who wished to adopt the fuel.

c. Lock-in in the Energy Market

The success of energy transition policy will be affected by the economic market, scarcity of resources or energy supply and the energy market. A well designed new energy market by the government should be made as a priority. The market is associated with three components: energy manufacturers, business players and the public. The manufacturers and business players that have associations with energy are able to support the supply of energy that is demanded by public and industries. Moreover, current market policy might discourage government policy to introduce new energy and technology. Hence, poorly planned institutional and regulatory frameworks might create obstacles in energy transition (Saghir, 2005) and would lead to policy inefficiency. This, unfortunately, is the obstacle to achieve universal access to modern fuel (Nussbaumer et al., 2012).

The understanding of the energy market is the initial assessment to determine the strategy and policy. The *Energy Ladder* theory in the aforementioned discussion is driven by utilitarian theory of which the motive of energy usage is attracted by rational utility – maximiser – economic rationale. In addition to that motive, the social psychological motive and infrastructure of provision are two motives of the consumer (Seyfang, 2011). Social psychological motives include attitudes, perceptions, personality and lifestyle aspirations. Meanwhile, infrastructure provision is caused by the system of provision. Utilitarian motive and social psychological motive are individual motivations. Utilitarian motives have been discussed in Section 2.4.2. Meanwhile, infrastructure of provision which is driven by institutions or government could be alternatives for changing society's consumption pattern. Lack of system provision leads to energy poverty (Bouzarovski & Petrova, 2015).

However, new energy technology is able to win the competition when dominant energy is withdrawn from the market (Cowan, 1990). This argument arises from the fact that people buy something as they are locked-in by the market instead of eagerness. People that are locked-in to a specific product are unable to buy other products as they have no choice. Therefore, in order to compete with dominant product and replace with the new one, the dominant product is removed to unlock (Araújo, 2014). Thus, the new market will lead and then the new market is locked where people have only one choice in the market, buy or not buy. But, the creation of this system needs government intervention (Cowan, 1990) as this system needs regulations that can only be conducted by the government.

2.6.2. Social Acceptance of Modern fuel

In introducing modern fuel, trade-off between society, economy and environment may arise. The energy that is better from an economic point of view is not necessarily better for the environment and accepted by society. The high technology of modern fuel will not guarantee increased social acceptance. The modern fuel may be accepted in one sector but not in another sector. Olsen (1983) defines social acceptance as the intention to use. Mallett (2007) uses a definition of acceptance defined by Rogers (1962), where acceptance is an adoption of something. People who accept the modern fuel show they have a willingness to use or adopt it; meanwhile, adoption is part of the decision process to use (Renaud & Biljon, 2008). Acceptance, selection and use are parts of the process of adoption. But, people accepting something does not automatically lead to adoption as during acceptance process there is selection process before decision to use it. The acceptance is influenced by many factors. This will be explored in the next paragraphs.

Section 2.4.2 above discusses the energy ladder theory. The energy ladder follows the rational utility-maximiser. This means energy choice is determined by economic rationale (Johansson & Goldemberg, 2002). Under the energy ladder theory, household income is the determinant of energy choice. Income influences affordability. Lower household income led to lower affordability and vice versa.

Furthermore, energy price influences affordability for people with less income. High prices reduce purchasing power. Therefore, studies suggest that subsidy (Bazilian et al., 2012b; Park & Kwon, 2011) and incentive (Kshirsagar & Kalamkar, 2014) for energy are indispensable to allow people with low incomes to have access to modern energy.

Meanwhile, affordability is not solely influenced by the financial situation of a household. Preference and willingness to use energy carriers and energy services have a contribution to adoption of energy as well. A common belief is that low income households tend to be energy poor. However, not all low income households are energy poor (Barnes et al., 2011). Conversely, not all energy poor are income poor. Some people would not buy sufficient energy despite having money because they have less willingness to buy. They are satisfied with their current energy services. In this case, preference has a contribution to people's choice of energy. Preferences can be based upon physical preferences such as cleanliness, ease of use, speed of cooking and efficiency (Treiber, 2013). Availability of energy may have persuaded people's choice of energy (Meikle & Bannister, 2003; Sathaye & Tyler, 1991). Those factors are previously mentioned in Section 2.3 and revealed in Figure 2.3.

However, the rational choice of energy based merely on economic reasons may provide insufficient information to energy policy makers (Stern, 1986). A study shows that income has less influence on energy adoption in comparison to other non-financial factors such as social norms (Carrico et al., 2011). There are two kinds of social norms: descriptive norms and injunctive norms. Descriptive norms are sets of beliefs about what other people are doing (Cialdini et al., 1990).

People act as others do; their action is based on their perception of how the people around them behave. Meanwhile, an injunction norm is the contrary of a descriptive norm, and involve perceptions of behaviour that will be approved or disapproved of by other people (Schultz, 1999). People who believe what other people do may create trust among them. Trust is a moral norm where there is a moral guidance for individual to follow that led people easy to make a compromise that in turn creates cooperation to harmonize (Rothsen, 2005). Social norms motivate and steer people's behaviour (Ayres et al., 2009; Goldstein et al., 2008; Schultz, 1999). Human behaviour is obviously formed by culture and this influences the selection of energy for cooking (Alberts et al., 1997; Liu et al., 2008). The norm which influences behaviour can be changed through education; moreover, education, culture and age influence people's lifestyle (Pachauri et al., 2004; Suliman, 2013). These factors determine people's decisions to use energy carriers and its technology (Practical Action, 2010).

A campaign as a form of communication with the public provides an alternative to enrich people's knowledge in addition to formal education. Communication with society and community engagement are crucial issues in implementing the take up of clean energy by society (Streeter & de Jongh, 2013). These are able to improve awareness and concerns of people about some issues (Kollmuss & Agyeman, 2002; Maibach, 1993). In addition to the above-mentioned factors, culture and tradition influence the adoption of energy (Treiber et al., 2015). Tradition influences foods that are eaten and how to cook food. Who does the cooking affects the type of fuel. Cultures and traditions influence type of building. Households who have a modern life style are more likely to live in a modern house. On the other hand traditional households tend to have traditional houses. This has implications for the energy type and quantity that will be used in the home. Modern houses will have more modern appliances that need more energy. But, even though not all traditional houses have traditional appliances, more traditional houses have traditional appliance that influence their habits in using energy. Meanwhile, the interior designs of kitchen in modern houses are different to traditional houses, and kitchen design will influence the type of energy carrier that it is possible or easy to use.

2.7 Summary and Reflection

The three assessments of sufficiency of energy access generally applied are quantity-based, share of expenditure-based and source of energy-based approaches. The quantity-based approach and share of expenditure-based approach disregard the type of energy carrier that may have negative impacts on health and environment. Therefore, in order to acknowledge type of fuel type, traditional fuel should be excluded in the calculation of the quantity-based and share of expenditure-based approaches. Meanwhile the quantity-based approach is able to identify the sufficiency of energy used but it requires extensive data collection which is difficult. Expenditure based approaches have thresholds which are difficult to establish and different from one context to another. Source of energy based approaches can identify access to modern and clean energy but not the sufficiency of amount, without further information.

Modern fuel access is prominent because it is the primary key driver for socio-economic development (IEA, 2010). However, improving the access of modern fuel does not mean improving the economic situation automatically, but lack of access to modern fuel impedes development (Anderson et al., 2000). From the above discussion, to deal with the problem of access to modern energy, the government must have a dominant role in creating systems of provision and sustainable energy markets using instruments such as regulation and subsidy. However, a political institution has limitations in terms of stability of political concern. Nevertheless, when the access to modern energy has been provided, not all people may prefer to adopt it. Many factors determine the choice of energy or fuel, such as household income, education, norms, culture, lifestyle and building design. These factors are interrelated. This is a cyclic process that has a correlation to one another. An institutional approach can break the cycle of the factors that affect modern energy access. For example, income may influence people to adopt a fuel. Government may increase affordability of specific fuels through providing financial support to use the fuel such incentive and subsidy. In the case of developing countries that have more fuel resources, subsidy for fuel is generally given to society, but education and health are not subsidised. Fuel subsidy is given to society instead of public funds such as health and education in order to reduce social conflict in relation to the right for accessing cheaper fuel. This research study examines the institutional and non-institutional factors of the access to modern energy for cooking in Indonesia.

Chapter 3
Government, Society and Domestic Energy in Indonesia: A Brief Narrative

In order to understand the background to energy usage, consumption and the energy system in Indonesia, it is important to provide a short explanation about the government of Indonesia and its energy policy. Therefore, this chapter presents a brief description of Indonesia's governmental system, its energy system and management policies, and the current and previous energy market.

3.1 Government System and Energy

3.1.1. Government System

Since independence day, 17 August 1945, according to *Undang-undang* (law) of the Republic of Indonesia No 32, 2004, the Indonesian government is a Republic, led by the President[5] (Presiden Republik Indonesia, 2004b). The state is controlled and managed under Pancasila,[6] as the national principles, and the 1945 Constitution. In managing the state, the President has a team, a so- called cabinet which consists of ministries (Presiden Republik Indonesia, 2008). Ministries assist the President in specific areas such as education, health, national security, energy, religion, human rights and so on. Additionally, there are non-ministries and non-structural institutions which work under presidential responsibility. In some cases, a ministry works alone but in other cases a ministry has to coordinate and collaborate with other ministries, non-ministries and non-structural institutions.

[5] According to article 1, the Act No. 32, 2004 (Presiden Republik Indonesia, 2004b)
[6] Pancasila or five principles is the philosophical foundation of the Indonesia which comprises: (1) Belief in God, (2) Nationality, (3) Humanity, (4) Democracy and (5) Social Justice.

Indonesia is an archipelago country with a structure of local governments, i.e. provinces and *kabupaten* or *kotamadya* (see Figure 3.1). A province is an administrative area which consists of at least five regions, i.e. *kabupaten* or *kotamadya*. *Kabupaten* and *Kotamadya* are different in terms of administrative area. The administrative area of *kabupaten* is wider than *kotamadya*, and includes at least five *kecamatan* (sub-regions) and has some villages and remote areas. Meanwhile, *kotamadya* consists of at least four *kecamatan* and it has villages, but all of them are urban. Since *kabupaten* and *kotamadya* are different, a village in *kotamadya* is called a *kelurahan* and in *kabupaten* is called *a desa*. A *desa* is a rural village, whilst a *kelurahan* is a small urban area. The village head of *kelurahan* and *desa* is called *Lurah* and *Kepala Desa* respectively. The population of a *desa* or a *kelurahan* (village) varies. According to the Regulation of Villages, an area is considered viable as a new village when the area has at least 6000 people in Java Island and 500 people in Papua Island (Presiden Republik Indonesia, 2014b).[7] A village consists of 4-5 smaller administrative areas called *hamlets* or *Rukun Warga* (RW) (BKKBN, 2013). Each hamlet or RW consists of a number of community organisations, so called a *Rukun Tetangga* (RT). On average, the number of households in a RT is 46 to 50 (BKKBN, 2013). The leaders of a hamlet or RW and RT are community leaders who assist the head of the village to strengthen rural community empowerment (Presiden Republik Indonesia, 2014b).

Following the Presidential Decree No. 32, 2004 relating to local government, Indonesia's government devolved autonomy to the local government

[7] The different number is caused by the difference in population in Java and Papua which is very high. Meanwhile, the formation of village in other islands needs population in between 500-6000 people.

(Presiden Republik Indonesia, 2004b). As a consequence, local governments have a responsibility to manage all resources they have and may apply their own regulations in accordance with the constitution (MDN-RI, 2011). Therefore, it is possible for local governments to have different regulations to one another. Also, it is possible that a local government could implement a regulation which is not implemented by the national government. Yet, in reality, most often local government implement national regulations although they have the authority to reject them.

According to the Regulation of Ministry of Home Affairs No. 24, 2011, in Article 2, the responsibilities of the provincial government are to control and monitor *kabupaten/kotamadya* government (MDN-RI, 2011). The national government is unable to implement national policy without permission from the local government. Also the national government has to coordinate with the Minister of Home Affairs who has responsibility for managing the local government.

In most national policies, the government uses the hierarchy in Figure 3.1 as the path for implementing top-down national programmes in addition to involving non-governmental institutions.

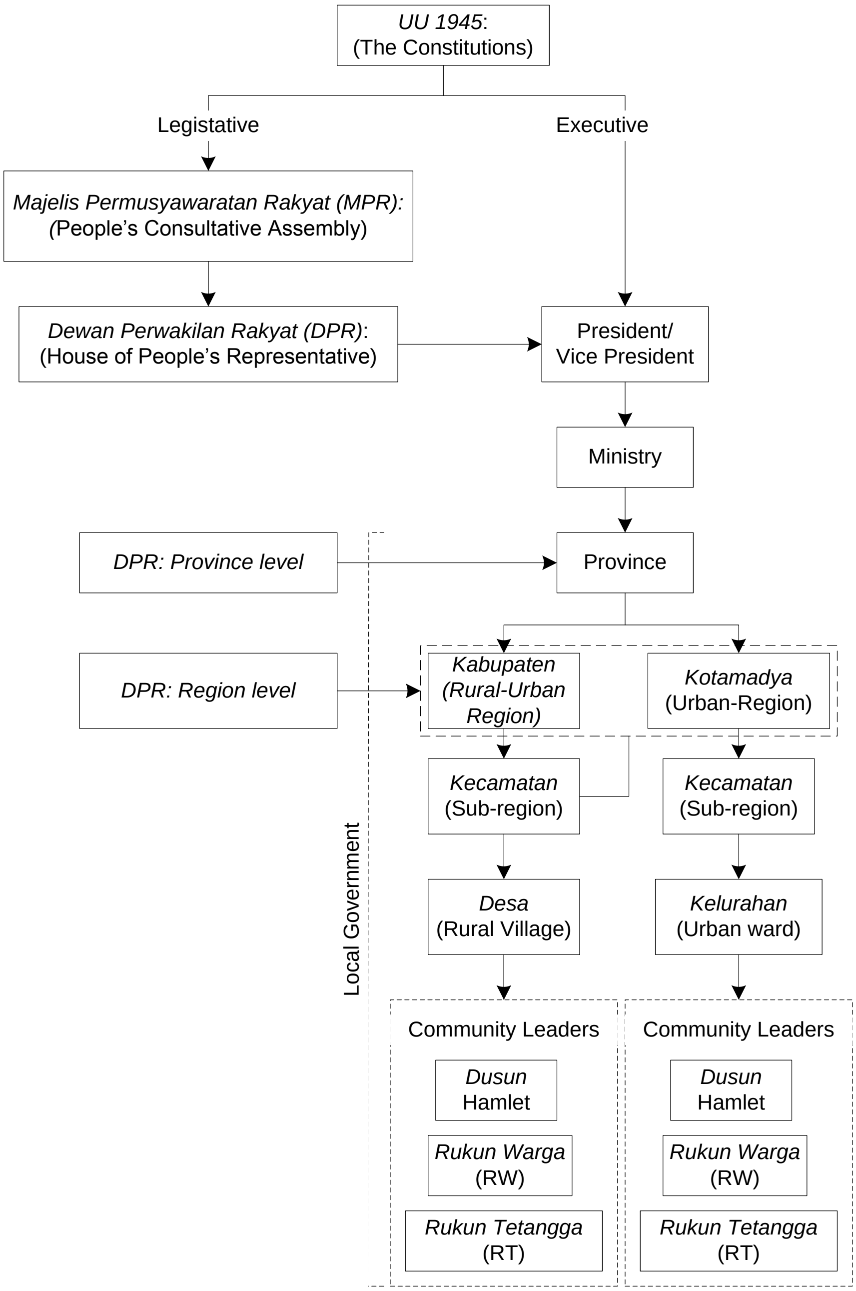

Figure 3.1: The hierarchy of the government of Indonesia (Presiden Republik Indonesia, 2004b, 2014b)

When the national government introduces a national programme, instructions for implementing the programme are conveyed down the hierarchy. Since the lowest tier has the closest relationship with communities, in many policies they are the key means of success of policy implementation because they have capabilities to persuade communities to follow governmental policy.

3.2 Geography, Society and Economy of Indonesia

Indonesia is located in South East Asia (see Figure 3.2). The north boundaries are formed by Malaysia, Singapore, the Philippines and the South China Sea; the south boundaries are Australia and the Indian Ocean; the west boundaries are the Indian Ocean; and the east boundaries are Papua New Guinea, Timor Leste and the Pacific Ocean. The area of Indonesia is 1,910,931.32 km^2 spread between 6^o 08' north latitude and 11^o 5' south latitude, and between 95^o 45' and 141^o 05' east longitude. Some of Indonesia straddles the equator. Hence, the temperatures in most areas are quite high with an average of 26^o C and ranging between 14°C–38°C night and day. As an archipelago, Indonesia consists of more than 13,000 islands.[8] Five of them are large islands: Papua, Sulawesi, Kalimantan, Java and Sumatra which are divided into 33 provinces. In 2007, there were 455 regions (*kabupaten/kotamadya*) in total. By 2011 Badan Pusat Statistik (BPS) (2014c) recorded 497 regions (*kabupaten/kotamadya*), 6,773 *kecamatan* and 78,448 villages in total. The areas of the *kabupaten* and *kotamadya* are different (see section 3.1.1). Moreover, as a consequence of being an archipelago, Indonesia has more than 300 ethnic groups and about 700 traditional languages. This creates vastly different behaviours and cultures among the regions. As a consequence, this diversity can be very challenging when implementing national public energy schemes.

[8] According BPS (2014c) reports, Indonesia has 17,504 islands. However, Badan Informasi Geospasial (BIG) the Geospatial Information Agency in Indonesia did a survey during 2007 to 2010 and confirmed that Indonesia has 13,446 islands (PPKKP3K-KKP, 2014; United Nations, 2012).

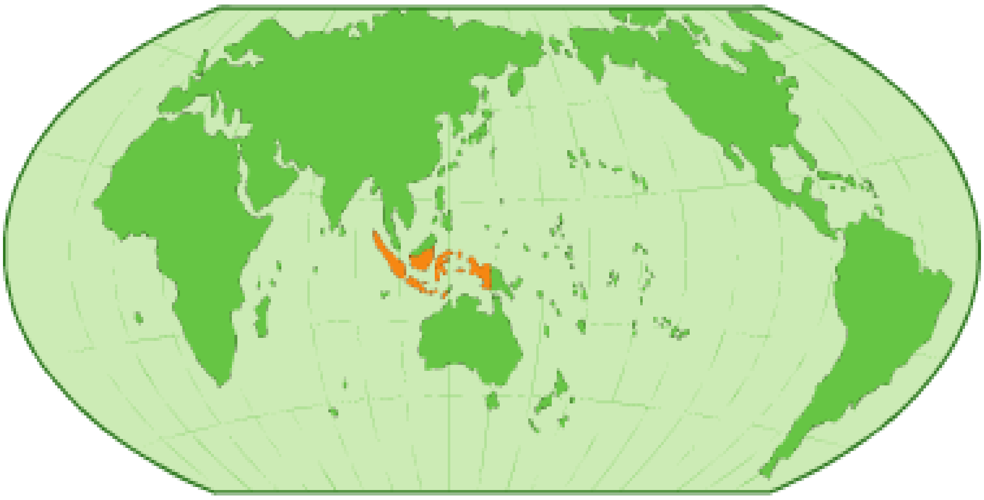

Figure 3.2: Location of Indonesia (BPS, 2013)

Table 3.1: Socio-Economic indicators of Indonesia

Description	Year				
	2007	2008	2009	2010	2011
Social					
Population (million people)[9,10]	225.6	228.5	231.4	238.5	241.0
Population Growth (%)[12]	1.28	1.25	1.22	1.32	1.32
Average number of household member[11]	4.33	4.22	4.38	4.31	4.28
Life Expectancy Rate (year) [12]	70.4	70.5	70.7	70.2	70.3
Literacy rate 15+ (%)[12]	91.9	92.2	92.6	92.9	92.8
Poor people[12,12] (million)	37.2	35.0	32.5	31.0	30.0
Percentage of poor people[12]	16.58	15.42	14.15	13.3	12.5
Human development Index[12]	70.6	71.2	71.8	72.3	72.8
Economy					
Economic growth (%)[12]	6.3	6.0	4.6	6.2	6.5
Per Capita of GDP at current price[13,12]	17.4	21.4	23.9	27.0	30.8

[9] Before 2010 was estimated from 2000's population census, but since 2010 the estimation is based on 2010's population census

[10] BPS (2012)

[11] The source of data in 2007 is from BPS (2008), data in 2008 is from BPS (2009), data in 2009 is from BPS (2010b), data in 2010 and 2011 are from BPS (2012c).

[12] Poverty is measured through the expenditure for basic needs approach. In this approach, poverty is the inability to fulfil needs for food and non-food which is assessed through expenditure for food and non-food. The poverty line (PL) is divided into two: the Food Poverty Line (FPL) and Non-food Poverty Line (NPL). FPL is minimum expenditure for consuming foods which is equal to 2,100 kcal per day, whereas NPL is minimum expenditure for housing, clothing, education, health and other basic needs. Poor households are households which have expenditure less than PL (BPS, 2014c).

[13] The estimations in 2007 and 2008 are based on 2000's population census, whilst the estimations in 2009 until 2011 are based on 2010's population census.

The latest population census of BPS (2014a) reported that in 2010 Indonesia's population was 237 million people with an annual growth rate of 1.42%. From the same census, about 61 million households in total had an average family size of four family members/household (BPS, 2014c). With this enormous population, Indonesia is the fourth most populous country in the world, creating a particular challenge for the implementation of equitable and modern energy policies. The dynamic of annual population and growth during 2007 to 2011 is presented in Table 3.1.

The details of population with areas for every province are presented in Table 3.2. The average density in Indonesia in 2010 was about 124 people per km^2 and it was predicted to increase to 130 people per km^2 in 2013.[14] The distribution of the population, however, is uneven. This, in turn, affects the nature of the Indonesian economy and has bearing on the government's energy policies. Among the five islands, the highest density was in Java Island, whilst the lowest density was in Papua Island. Almost 68% of the population were located in Java which only covers 6.7% of the total area in Indonesia. The province with the highest density of 14,469 people per km^2 was DKI Jakarta. Meanwhile, the province with lowest density was Papua Barat with only eight people per km^2.

[14] Population in 2013 is prediction, because census is only conducted every ten years in the year ended with 0.

Table 3.2: Provinces in Indonesia

Province	Capital City	Area (km2) (BPS, 2014c)	Population in 2010 (BPS, 2014c)
Nanggroe Aceh Darussalam	Banda Aceh	57,956.00	4,494,410
North Sumatera	Medan	72,981.23	12,982,204
West Sumatera	Padang	42,012.89	4,846,909
Riau	Pekanbaru	87,023.66	5,538,367
Jambi	Jambi	50,058.16	3,092,265
South Sumatera	Palembang	91,592.43	7,450,394
Bengkulu	Bengkulu	19,919.33	1,715,518
Lampung	Bandar Lampung	34,623.80	7,608,405
Bangka Belitung Islands	Pangkal Pinang	16,424.06	1,223,296
Riau Islands	Tanjung Pinang	8,201,72	1,679,163
DKI Jakarta	Jakarta	664,01	9,607,787
West Java	Bandung	35,377.76	43,053,732
Central Java	Semarang	32,800.69	32,382,657
DI Yogyakarta	Yogyakarta	3,133.15	3,457,491
East Java	Surabaya	47.718,10	37,476,757
Banten	Serang	9,662.92	10,632,166
Bali	Denpasar	5,780.06	3,890,757
West Nusa Tenggara	Mataram	18,572.32	4,500,212
East Nusa Tenggara	Kupang	48,718.10	4,683,827
West Kalimantan	Pontianak	147,307.00	4,395,983
Central Kalimantan	Palangkaraya	153,564.50	2,212,089
South Kalimantan	Banjarmasin	38,744.23	3,626,616
East Kalimantan	Samarinda	129,066.64	3,553,143
North Sulawesi	Manado	13,851.64	2,270,596
Central Sulawesi	Palu	61,841.29	2,635,009
South Sulawesi	Makasar	46,717.48	8,034,776
South East Sulawesi	Kendari	38,067.70	2,232,586
Gorontalo	Gorontalo	11,257.07	1,040,164
West Sulawesi	Mamuju	16,787.18	1,158,651
Maluku	Ambon	46,914.03	1,533,506
North Maluku	Ternate	31,982.50	1,038,087
West Papua	Manokwari	97,024.27	760,422
Papua	Jayapura	319,036.05	2,833,381
Total		1,910,931,32	237,641,326

The uneven spread of population is influenced by uneven economic development. Jakarta, which is located in Java, is the capital city of Indonesia. The second largest city in Indonesia, Surabaya, is also located in Java. In the early 1990s, 60% of the economy was concentrated in Jakarta (Petrich, 1993). In 2011 the Gross National Product Regional (GNPR) in Jakarta was 17% of total GNP (BPS, 2012b). This was the highest among the provinces. In contrast, Maluku Utara (North Maluku), which is located in eastern Indonesia, had the lowest GNPR. The GNPR of Maluku only contributed 0.14% to total GNP. The level of development in eastern Indonesia was not as high as in western Indonesia due to the lack of infrastructure which in turn failed to attract investment.

Meanwhile, from 1970 to 2011, the percentage of the population affected by poverty has reduced significantly. Statistics of Indonesia recorded that in 1970 poverty in Indonesia was 40.1%, and reduced to 11.6% in 1996 (BPS, 2012b). Although the global economic crisis during 1998-1999 increased poverty in Indonesia to 23.4%, fortunately, after 1999 BPS (2014b) estimated that poverty in Indonesia decreased gradually to 12.4% in March 2011. In 2013 the percentage of people living under the poverty line was 11.4%. Similar to economic development, there was also a big gap in the extent of poverty between western and eastern Indonesia. In 2013, poverty in the Province of Papua was the highest with 31% of its population living in poverty; Jakarta was the lowest with 3.75% of its population in poverty; and poverty in the Sumatera islands varied from 5% to 17% (BPS, 2014b)[15].

[15] BPS measures poverty as inability to meet basic needs, estimated through expenditure. The indicator of poverty is people who are below the poverty line. The poverty line is the addition of poverty line for food and non-food. The poverty line for food is determined from the cost of food

Most of the people who were below the poverty line were living in rural areas. In 2011, the Statistics of Indonesia (BPS) counted that 15.7% overall of the rural population were living in poverty, whilst it was only 9.2% for urban populations (BPS, 2013). Meanwhile, 80.3% of the population have their own house and the rest are living in rented housing and others types of housing. Among households who have their own houses, almost a half of the population are living in 55-99 m^2 housing (BPS, 2013).

In terms of education, almost all residents are literate although the number of literate people in rural areas is less than in urban areas. Older people are more illiterate than the young as they tend to have had less formal education. Even though young people have more opportunity to attend school, not all of them were able to finish their education until the end of senior high school and continue to on universities. More than 90% of Indonesians went to primary school, but only 68% and almost 48% of Indonesians went to junior high school and senior high school, respectively (BPS, 2012a). The reason is because free school was not yet available in Indonesia even though the government provides state school. School tuition is the barrier to enter the school. This means that poorer people with large families especially would not be able to afford the costs of education.

3.3 Energy Management

The 1945 Constitution, Article 33, states that all natural resources must be controlled by the government and utilised for greater social prosperity and welfare (MPR, 1945). Activities related to natural resources in Indonesia such as oil and

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which is equal to 2100 kilocalorie per capita per day. Meanwhile, the poverty line for non-food is the minimum requirement for housing, clothes, education and health.

gas mining, production and distribution are conducted and managed by state owned companies. Pertamina, which stands for *Perusahaan Pertambangan Minyak dan Gas Bumi Negara*, is a state-owned company that has responsibility for mining, producing and distributing oil and gas in Indonesia. Meanwhile, *Perusahaan Listrik Negara* (PLN) is the state-owned company responsible for providing electricity in Indonesia and it is required to meet the provisions of Act No 30, 2007 about energy, Article 2 of which elaborates the 1945 Constitution:

> *"Energy shall be managed under the principles of beneficial use, rationality, fair efficiency, value added enhancement, sustainability, people's welfare, environmental functions preservation, national resilience, and integratedness by prioritizing the nation's capability"*
> (Presiden Republik Indonesia, 2007c).

This implies that energy policies should be made to ensure energy resilience to meet demand, set affordable prices for society, improves energy technology, develop energy infrastructures and provide laws and regulations.

Since 2000, energy in Indonesia has been managed and controlled under the *Kementerian Energi dan Sumber Daya Mineral – Republik Indonesia* (KESEDM-RI),[16] the main tasks of which are planning, conducting and evaluating the energy policy. The government of Indonesia started to draw up energy policy in 1981(KESDM-RI, 2005), after which four revisions of energy policies have been made in 1987, 1991, 1998 and 2003. In addition to national government, the local government has authority in energy management by considering the social and economic situation in local government (Budiarto, 2011). This implies that energy can be managed by local government. However, when being established,

[16] *Kementerian Energi dan Sumber Daya Mineral-Republik Indonesia* (KESDM-RI) is Ministry of Energy and Mineral Resources of Republic of Indonesia

energy policy is processed through three levels of government, from municipality to national levels (Presiden Republik Indonesia, 2014a). These are:

- *Rencana Umum Energy Nasional* (RUEN) or the National Energy Master Plan which elaborates National Energy Policy.
- *Rencana Umum Energy Daerah Provinsi* (RUED-P) or the Provincial Energy Master Plan. Each of these elaborates the National Energy Master Plan (RUEN) and conducts energy policy in provinces to achieve RUEN.
- *Rencana Umum Energy Nasional Kotamadya/Kabupaten* (RUED-*Kotamadya/Kabupaten*) or Energy Master Plan of Region. Each of these elaborates the Provincial Energy Master Plan (RUED-P) and conducts energy policy in a municipality to achieve RUED-P.

In accordance with Presidential Decree No. 1 2014, the National Energy Master Plan is formulated and elaborated by considering the needs and demands of society (Presiden Republik Indonesia, 2014a). In this context the term society refers to people, professionals, and members of public who have an expertise in the energy sector. Subsequently, the National Energy Master Plan Policy from RUEN is then proposed to the ministry as the assistant of the President. The KESDM-RI proposes the master plan to the National Energy Council. With the approval from the House of People's Representatives, the energy policy is established (Presiden Republik Indonesia, 2007c). The scope of national energy policy in Indonesia is outlined in Figure 3.3.

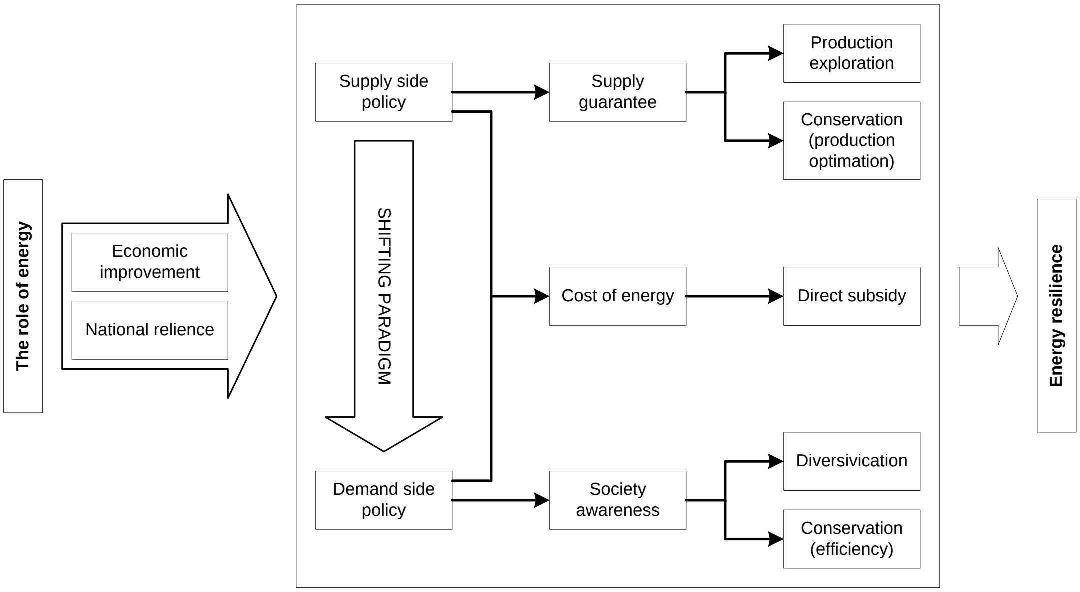


Figure 3.3: National energy policy in Indonesia (Bappenas, 2012)

3.4 Cooking Fuels in Indonesia: A Brief Review

Indonesia has suffered from lack of access to modern fuel over many years (Ardiansyah et al., 2012). By 2007, electrification had been provided to more than 88.37% of households (BPS, 2008). But in terms of energy for cooking, in 2007, only 1.86% of total households used electricity as the main fuel for cooking, whilst 49.38% of households used firewood as the principal fuel used for cooking (BPS, 2008). Even though most of the households had access to electricity, they did not use electricity for cooking.

Biomass is a traditional fuel which was used by most households (PDIESDM-KESDM, 2012). Firewood and agricultural wastes are types of biomass which are generally used by households in Indonesia. According to Arnold et al. (2003) study in 2001, in Indonesia firewood gathered from the forest and non-forest and unknown sources amounted to 6%, 65% and 29% of total firewood used, respectively. It was very rare that firewood which was used in the village was bought from the market. This is because firewood could be easily collected from the forest, non- forest or elsewhere. Farms, plantations and lands, waste from wood industries or waste from constructions are the sources of firewood which is gathered from non-forest places. Currently, agricultural wastes are from rice straws, rice hulls, palm fronds and coconut shells. Generally, this kind of biomass is accessed freely.

In addition to firewood and biomass, households also burn charcoal and briquettes. Briquette is made from coal, whilst charcoal is made from the waste of the burning process in limestone industries which are usually processed traditionally by using firewood and stoves. Differently from firewood, however, charcoal was intended for commercial use like fossil fuel; but charcoal is cheaper than kerosene, LPG and electricity. These fuels were distributed in the free market, produced and distributed by private companies. Information on coal consumption can be collected from coal industries that are listed in KESDM-RI. Getting comprehensive information of charcoal and biomass consumption is not easy because those fuels are produced by small industries which are not required to register with KESDM-RI. Therefore, in order to obtain data on the using of those fuels in society, a survey which covers type and quantity of fuels consumed by households is needed.

In Indonesia, kerosene has been one of most used energy sources for cooking in addition to biomass. Kerosene is a type of fossil fuel, and a product of oil distillation. It contains carbon and hydrogen. Indonesia's households first started using kerosene in 1885, when Indonesia started crude oil mining in Pangkalan Brandan, Langkat, West Sumatera under Dutch colonialism (Sosiawan et al., 2011). Later on, urban and wealthy households used this fuel for cooking. In rural and remote areas, where electricity is limited, kerosene was utilised as fuel for lighting in addition to cooking energy. Kerosene replaced firewood and coal as the main fuel at the domestic level after World War II (Bee, 1984). The government of Indonesia introduced kerosene as the main energy carrier for cooking during the 1960s (Sosiawan et al., 2011), and its use was encouraged by the oversupply of kerosene from Pertamina, the state-owned oil company. However the consumption of kerosene was below the government's expectation and it was therefore subsidised during the 1980s (Pitt, 1985). Since 1998 kerosene has been defined as one of *nine basic need commodities*[17] along with rice, sugar, cooking oil and butter, chicken meat and beef, chicken eggs, milk, corn and salt (MPPRI, 1998). As a consequence, its price is under government control and according to the constitution, this means it should be subsidised by government. Since kerosene was subsidised, its price was lower than the market price and it was more affordable, which inevitably increased the number of consumers. From 1955 to the end of the 1970s, the number of households who used kerosene increased by almost ten times (Bee, 1984). In 2004, 89% of households consumed kerosene (BPS, 2007b).

Indonesia's rising population contributed to increasing kerosene consumption. However, kerosene was not merely used by households but also by industries and fisheries. Kerosene is a resource for mosquito repellent industries and paint industries and a cleaner oil for industrial machines (Sosiawan et al., 2011). In Indonesia, kerosene as a subsidised fuel was intended for domestic

[17] The term of nine basic need commodities is translated from Sembilan Bahan Pokok. This is then abbreviated into Sembako.

consumption, especially for the poor (Olivia & Gibson, 2008). Yet, even though the subsidy was intended for poor households, industries were able to consume subsidised kerosene as the distribution of kerosene at that time was not well managed. Industrial use of kerosene was not intended by the government because it increased the government expenditure, given that it was subsidised.

The increasing demand for kerosene, therefore, influenced kerosene supply. Yet, the supply of kerosene in Indonesia was determined by the government with approval from the *Dewan Rakyat Indonesia* (DPR).[18] The factors which are considered in determining the estimated volume of the kerosene supply are the previous demand for kerosene, cost of production and the government budget. The expected capacity of the subsidised kerosene is proposed to the government before the beginning of the year. The volume, however, might be increased if the demand is higher than the expected capacity.

The annual production of kerosene in Indonesia between 2000 and 2011 is shown in Figure 3.4. Kerosene production between 2000 and 2008 fluctuated from about 53 Million Barrels of Oil Equivalent (mboe) to 63 mboe with the least production in 2002 and the highest production in 2003 (BPS, 2010a). After that, its production declined considerably to 14 mboe in 2011. This is a result of the kerosene reduction commitment of the government in the Kerosene-LPG Conversion Programme. In the meantime, demand during 2000-2002 which outstripped kerosene production meant that the government of Indonesia had to import oil as the raw material for kerosene. Conversely in 2003, kerosene production was above its demand. In 2004 and 2005 kerosene production was less

[18] DPR is House of People's Representatives of Republik Indonesia

than its demand and again, in 2004 and 2005 the government imported oil. Unfortunately, the rising price of global energy during 2004 contributed to an increase in the subsidy cost for kerosene. This in turn increased the expenditure for providing subsidies, which became a financial burden for the government. Therefore, in 2005 the government of Indonesia increased the kerosene price (World Bank, 2008).

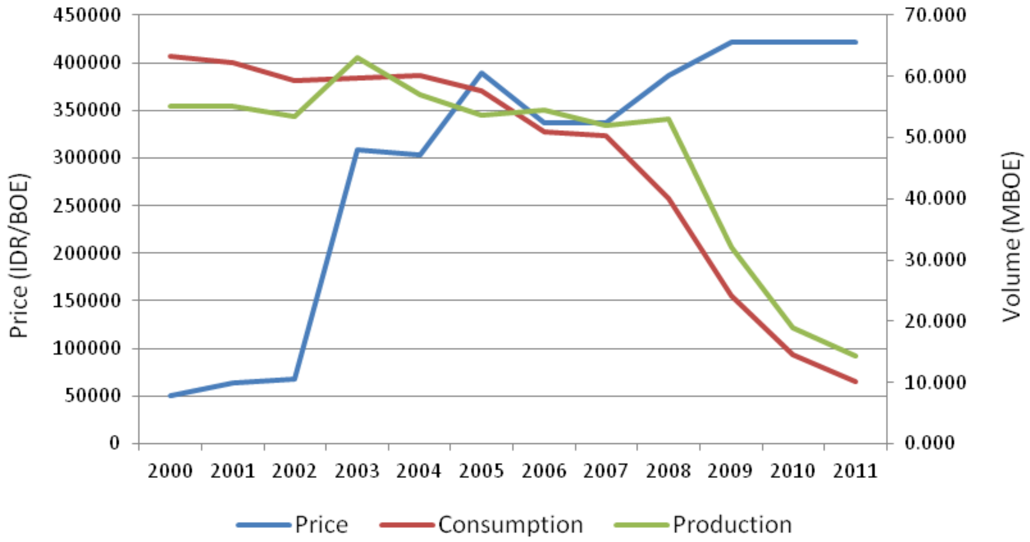


Figure 3.4: Kerosene production (BPS, 2010a), consumption and price during 2000-2011 (PDIESDM-KESDM, 2012)

LPG is a gaseous product of petroleum which contains propane, butane, and hydrocarbons and is commonly provided in canister packaging (Zhang et al., 2000). However, LPG might be produced from natural gas in addition to crude oil. Meanwhile, natural gas is distributed through gas pipes that are only provided in a few areas in Indonesia such as Jakarta, Bogor and Surabaya. LPG in Indonesia is packaged into three sizes: 3 kg, 12 kg and 50 kg canisters to make it convenient for mobility. The two lightest cylinders are for household use, while the heaviest is for industrial use. In this study, gas and LPG are put in one category because

LPG might be produced from natural gas in addition to crude oil. The distribution of oil and gas as well as the production and mining are conducted by Pertamina as the state-owned company of oil and natural gas.

Similar to LPG, natural gas is under Pertamina management which dominates the LPG and natural gas market in Indonesia. In 2000, natural gas consumption was 0.081 MBOE and then increased to 0.114 MBOE in 2011 (PDIESDM-KESDM, 2012). In Indonesia, both LPG and natural gas are used as fuel for cooking as well as fuel for industrial purposes.

In addition, electricity is produced and distributed by PLN as the state owned company for electricity. In remote and rural areas, where electricity grids are not available, electricity might be produced by a community or non-governmental organisation (NGO). In this case, electricity might be produced from hydropower or diesel which is powered by gasoline. However, electricity from PLN dominates the electricity market in Indonesia. At the domestic level this fuel is mostly used for lighting, cooking, information, and entertainment. PLN does not have detailed information on the use of electricity per energy services. Hence, the energy consumption data released by KESDM-RI above, is the total electricity consumed by households.

KESDM-RI has some records of the quantity of domestic fuel consumption. Data from PDIESDM-KESDM (2012) shows that kerosene, LPG, gas and electricity are the kinds of commercial energy consumed by households, whilst biomass is consumed as well. Moreover in general, domestic energy in Indonesia is for cooking, lighting and entertainment such as TV and radio and home business (Meikle & Bannister, 2003).

3.5 Summary and Reflection

All energy regulations and policies in Indonesia should refer to the 1945 Constitution which specifies that energy should be controlled by the government and used for the social welfare of Indonesian society. The term social welfare is commonly translated as supplying cheaper energy for society through subsidies. Hence, any reduction of subsidies has wider political ramifications.

Apart from that, in developing energy to meet societal needs, as an archipelago country, energy policy in Indonesia should consider the geographical context. Temperatures in most parts of Indonesia are high, ranging between 14°C–38°C. This ensures that cooling is needed in most areas instead, while heating is needed only in specific areas. Moreover, the diversity and complexity of ethnic groups within Indonesia ensures a wide variety of cultural values, and practices relating to energy use. This has implications for the acceptance of a national policy instrument which meets with great diversity at the local level. The large and growing population of Indonesia ensures that energy security will remain one of the country's greatest challenges into the future, with constant improvement and investment in energy infrastructure required. However, the uneven distribution of population across the country affects the affordability of different investments in energy infrastructure and will continue to ensure that a range of energy options are needed to meet the needs of Indonesia's large yet diverse and dispersed population.

Chapter 4
Research Methodology

This chapter describes the research design and all methodologies applied in this study. Hence, the three sections provided in this chapter concern the research design, methods for data collection and data analysis.

4.1 Research Design

Qualitative and quantitative paradigms could be applied in the area of research which investigates human activities and decisions about energy use (Hammersley, 1992). The two paradigms have different approaches for the creation of knowledge and the research process regarding epistemology, theoretical relation to the area of study and methodological concern (Brannen, 1992). In the qualitative paradigm, the understanding of the domain of enquiry is through interpreting information from narratives within the study. For this reason qualitative research is associated with *interpretivism* that looks at how to interpret and understand phenomena (Mason, 1995). Meanwhile, in most cases the quantitative paradigm tends to be positivist where the research is conducted to test theories. Additionally, these two paradigms are different on how to deal with data, its collection and analysis (Brannen, 1992).

Most often, qualitative and quantitative paradigms are distinguished in their application. However these approaches can be complementary to support each other (Brannen, 1992) because both qualitative and quantitative methods have strengths and weaknesses. The quantitative approach has difficulty in explaining the relationships between variables (Bryman, 2012). Hence, detailed information about the relationship of variable in deeper context can be clarified from a qualitative approach. This study applies a mixed method which combines the use of both paradigms, employing a type of mixed method research where qualitative results are used to explain the findings of quantitative outputs (Bullock et al., 1992).

The main aim of this study is to conduct a summative[19] evaluation of the access of society to modern fuel. This means the evaluation will be conducted to review whether the policy that has been enacted has achieved the aims and objectives or has unintended consequences (Kraft & Furlong, 2007; Spicker, 2006). Meanwhile, identifying the effectiveness of the policy is one of the challenges of policy evaluation because there are different stakeholders who have differing interests in the policy outcome (O'Faircheallaigh, 2002). In this study, the objective will be evaluated based on the main aims of the government and the aim of the study, to examine modern fuel access in Indonesia. In this study, the goals of the policy that are issued by the government will be identified in Chapter 7. In that Chapter the achievements of the programme will be evaluated whether all goals determined by the government have been achieved. Additionally, the side effects of the programme, especially in the relation to the attempt of reducing the presence of traditional fuel users will also be evaluated. Meanwhile, this study emphasises the need for clean energy for society and the importance of reducing reliance on traditional energy.

[19] Two types of evaluation are formative and summative evaluation. Formative evaluation is performed in order to identify the contribution of the policy, while summative evaluation is carried out in this research in order to identify whether the policy met the aims in addition to unintended consequences (Spicker, 2006). This is called goal free evaluation as the unexpected effects might arise as the consequences of the policy implementation (Scriven, 1991).

In order to address research questions stated in Chapter 1, the study used statistical analysis in combination with Geographical Information Systems (GIS) regarding modern fuel access and energy poverty. There are two types of datasets that will be used for statistical analyses: the use of domestic fuels and the main fuel for cooking, whilst the thematic map using GIS is applied for also analysing the main fuel for cooking. The analyses were applied for two purposes. First, to assess the broader pattern of modern fuels use in Indonesia before and after the implementation of governmental policy, that is Energy Conversion Programme from Kerosene to LPG (ECPKL). Second, to investigate the relationship between household income, location and modern fuel use. The statistical analyses for these purposes are explained in Section 4.3.1. Meanwhile the GIS method is explained in Section 4.3.2. In addition, qualitative methods were implemented as well. The qualitative approach allowed deeper exploration of the actors and institutions involved in the government intervention, and their actions and motivations, and also public responses to the government intervention. Qualitative data collection was through in depth, semi structured interviews with key persons in national and local government as well as members of the public. More detail on data collection is presented in section 4.2 below. Analysis was by means of qualitative content analysis, described in Section 4.3.3.

4.2 Data Collection

4.2.1. National Surveys Conducted by the Government

Information about the usage of domestic energy can be obtained through household surveys (IAEA, 2005). *Badan Pusat Statistik* (BPS)[20] as a national statistics agency in Indonesia conducts surveys of Indonesian society annually. The survey used in this research is entitled *The National Socioeconomic Survey*, or in the Indonesian language *Survei Sosial dan Ekonomi Nasional* abbreviated to SUSENAS. Five annual SUSENAS datasets, from 2007 to 2011, are used in this study. These years are used for two reasons. First, the ECPKL[21] began on 8 May 2007 (Sosiawan et al., 2011). This is the milestone of development of LPG in Indonesia, even though formally it was started in December 2007. Second, in 2007 a survey of the main fuel for cooking at the domestic level started to be included in SUSENAS. Survey data on socio-economy of household including cooking fuel was gathered during July using the Module K questionnaire.[22] In addition this study makes a comparison of the average quantity of fuel which was consumed in the five years of policy implementation from 2007 to 2011. This kind of data was gathered every March using the Module M questionnaire.[23] However, due to a limited research budget for obtaining annual data, this module M data could be obtained for two periods only, i.e. data from 2007 and 2011. Original data sets are not provided by BPS for free. For obtaining the two modules M datasets the cost was 8,662,502 IDR or £430, meanwhile the cost of

[20] BPS as abbreviation of *Badan Pusat Statistik* or Statistics of Indonesia is a non-department institution that is responsible to provide all data through surveys to society, industries, and government.
[21] ECPKL stands for Energy Conversion Programme from Kerosene to LPG.
[22] See next paragraph for the explanation
[23] See next paragraph for the explanation

five annual data sets regarding the main fuel for cooking was around £520. Additionally, the researcher was unable to obtain primary survey data in Indonesia because it is very time consuming and very expensive. As previously explained in Section 3.2, the area of Indonesia is 1,910,931.32 km^2, almost 8 times of the area of United Kingdom. The area is spreading between 6^o 08' north latitude and 11^o 5' south latitude, and between 95^o 45' and 141^o 05' east longitude. From Sabang-Sumatera, the west end, to Merauke-Papua, east end, is almost similar from London to the middle of North Kazakhstan. Moreover, the transportation infrastructures are not well developed. This can be a barrier for the researcher to collect primary data. Moreover, the complexity of beaurocracy is the other barrier for getting permission from national and local government. This is the reason that secondary data from the government which is more comprehensive was chosen instead of collecting primary survey data from all regions in Indonesia.

The number of respondents sampled by SUSENAS for Module K from 2007 until 2011 and Module M for 2007 and 2011 for every province is shown in Appendix 4.1. The two surveys were conducted at separate times. The questionnaire Module K contains questions about what kind of energy is used for cooking in a household. In addition, this survey contains the number of households, number of household members, access to electricity, and income of households. Meanwhile, Module M questionnaire contains data on the total energy used in households. The consumed energy types are measured in terms of quantity of energy used – such as litre, kilogram – and its prices in Indonesia Rupiah. The quantity of energy used, then, is converted to Barrels of Oil

Equivalent (BOE) and the multiplier factors for each type of fuel in this research use KESDM-RI standards as presented in Table 4.1.

Table 4.1: Conversion factor of each fuel

Energy	Original unit	Multiplier Factor to BOE
Briquette[24]	Ton	3.5638
Charcoal[3]	Ton	4.9713
Firewood[3]	Ton	2.2979
Kerosene[3]	Kilolitre	5.9274
Natural Gas[25]	m^3	0.0071
LPG[3]	Ton	8.5246
Electric power[3]	MWh	0.6130

Both surveys were taken from 33 provinces and all regions in Indonesia. The total number of regions in Indonesia is presented in Table 4.2.[26] However the samples that were taken every year were drawn from different villages. The sampling method used by SUSENAS is multistage random sampling. There are six levels of stages: Province, *Kabupaten* or *Kotamadya* (Region), *Kecamatan* (Sub-Region), *Desa* (Village), *Dusun* (Hamlet), RW and RT (community organisation).[27] The surveys which were conducted annually collected data for all spatial units in Indonesia which are contains Province, Region and Sub-Region until community organisations (see Figure 3.1), but, villages which were taken as the sample were selected randomly. Hence, the list of villages which were taken as a sample in one year was not the same as the list of villages which were taken in another year .

[24] PDIESDM-KESDM (2012)

[25] IGU (2012)

[26] At Table 4.2, the number of region in Indonesia is different from year to year because the government have a regulation to develop region that enable them to break up to be two or more regions.

[27] See the explanation of hamlet, RT and RW in Chapter 3, Sub-Section 3.1.1.

Table 4.2: The number of regions during 2007 to 2011

Year	Number of regions
2007	456
2008	456
2009	470
2010	497
2011	497

In particular cases, however, taking a big sample from a population is not possible. In Indonesia, because of the very large area covered by the country, and the number of islands, coupled with the lack of developed transport infrastructure in most of the islands, gathering survey data is very time consuming and expensive. For this reason, the SUSENAS samples as presented in Table 4.1.A in Appendix 4.1 are relatively small and it is possible they do not represent the population well. Commonly, the estimation method for reliability uses *standard error* (Shaw & Wheeler, 1985). The datasets which are applied in this study, which were gathered by BPS, have standard errors equal to 5%. Meanwhile, the lower standard error means higher precision, and vice versa.

4.2.2. Semi-Structured Interviews

In addition to the secondary data from the SUSENAS surveys, interviews with government representatives as well as members of the public were conducted in this research. Because the interview phase of this research includes humans as the object of the research, an Ethical Review was needed. The approval following the Ethical Review is presented in Appendix 4.2.A. Before the interviews were conducted a participation letter was sent to respondents to obtain the consent of the participants for taking part in the interview process. The consent form and the interview schedule are presented in Appendix 4.2.B and Appendix 4.2.C.

The main aim of the interviews in this research was to obtain in depth information about the policy implementation from the government and the public. Moreover, the interviews also aimed to investigate the underlying reasons of the public for decisions to choose specific fuel for cooking. The interviews that were conducted with the national government focused on the key informant in Pertamina and the KESDM-RI. Meanwhile, interviews with local government were conducted in the regions, from central government down to village level. Six regions were selected by purposive sampling as regions where interview permission could be obtained. At each level, permissions to interview government members were needed and these permissions are not easy to obtain, because of bureaucratic barriers. Any research from outside Indonesia needs clearance from the Ministry of Home Affairs. After this approval, it needs permission in every ministry, department and level of local government that would be interviewed. The length of time needed for each permission to conduct interviews was one week to one month. Moreover, the permission is hierarchical. The permission obtained from national government was used to get permission from the province government, taking one to two weeks. Later on, the permission from province government was used for getting permission from Region Government and so on until village government. Therefore, the permissions had to be obtained serially and not in parallel and this was a long process.

The regions of the sample for the qualitative phase are:

- ***Kabupaten* Jember**. This region is one of the southern regions in the Province of East Java, the east-end of the Province of Java. This region contains urban and rural area.
- ***Kotamadya* Surakarta**. This region is a municipality located in central Java which is located in the Province of Central Java area. This region is only urban.
- ***Kabupaten* Klaten**. This region is near Surakarta which is located in the Province of Central Java area. This region contains urban and rural area. But the respondents in this study are only rural households.
- ***Kabupaten* Bogor**. This region is located in the Province of West Java and is one of the areas close to Jakarta, the capital city of Indonesia. This region contains urban and rural areas.
- ***Kabupaten* Muaro Jambi**. This region is a city in the Province of Jambi which is located on Sumatera Island. This region contains urban and rural area.
- ***Kotamadya* Banda Aceh**. This region is located in a province on the west tip of Sumatera Island as well as the western-most province of Indonesia. This region is a municipality which is more urban than rural.

The respondents from the government were selected by purposive sampling and snowball sampling. The first key person to be interviewed was selected through purposive sampling. The participants selected in purposive sampling were in accordance with their relevance to the research questions (Bryman, 2012). Later on, for seeking the next key person, the snowball sampling approach was applied. This sampling is a type of purposive sampling. The snowball sampling is more practical for obtaining the next respondents because this approach allows the person who had been interviewed to suggest another person to target – in this study those who are involved in the policy implementation – to be interviewed. Different sampling methods were used to select respondents from the public. Purposive sampling was applied to select respondents from purposive areas who were the recipient of a LPG package and who were either using or not using LPG.

The interviews were conducted during two periods of time. The first tranche of interviews was conducted from November to December 2012 and a second tranche of interviews from June to October 2013. All respondents and the time of interviewing are listed in Table 4.3. During the first tranche of interviews in October to December 2012, seeking official permission from the government for interviews was time consuming due to the complexity of the bureaucracy as mentioned above. Making an appointment for a face to face interview with government staff at national level, provinces and regions was difficult and even when an appointment was arranged, it did not mean they were ready to be interviewed. One common reason was they had a meeting with other people. Thus, a second and even third attempt for rescheduling the interview was often needed. Moreover, energy is a sensitive issue for the government. Some of the targeted people who represent government staff refused to be interviewed. The second tranche of interviews was conducted through Skype, i.e. video Skype and telephone Skype, from the United Kingdom between June 2013 and October 2013. Conducting face to face interviews with respondent who were located in Java and Sumatera islands was not feasible. Furthermore, accessing respondents who live in remote areas is not easy even if the researcher lives in Indonesia and face to face interviews would never have been feasible for these participants.

Table 4.3: List of interviewees

No	ID	Institution of narratives[28]	Location of narratives	Time of interviewing	Methods for interviewing
1	IDCG01	LEMIGAS-KESDM	Jakarta	19 Nov 2012	Face to face
2	IDCG02	KESDM	Jakarta	21 Nov 2012	Face to face
3	IDCG03	KESDM	Jakarta	22 Nov 2012	Face to face
4	IDCG04	LEMIGAS-KESDM	Jakarta	23 Nov 2012	Face to face
5	IDCG05	Pertamina	Jakarta	26 Nov 2012	Face to face
6	IDCG06	Pertamina	Jakarta	27 Oct 2013	Skype
7	IDGA01	DESDM of province	Banda Aceh	24 Jul 2013	Skype
8	IDGA02	DPPKSME	Banda Aceh	28 Jul 2013	Skype
9	IDGA03	*Kabupaten* Jayabaru	Banda Aceh	19 Jul 2013	Telephone
10	IDGA04	*Kabupaten* Syah Kuala	Banda Aceh	22 Jul 2013	Telephone
11	IDGA05	Village Lamtemen, Jayabaru	Banda Aceh	25 Jul 2013	Telephone
12	IDGA06	Village Pineung, Syah Kuala	Banda Aceh	23 Jul 2013	Telephone
13	IDGA07	Community Leader, Pineung, Syah Kuala	Banda Aceh	11 Jul 2013	Telephone
14	IDGM01	DESDM of *Kabupaten/Kotamadya*	Muaro Jambi	22 Jul 2013	Telephone
15	IDGM02	*Kabupaten* Sekernan	Muaro Jambi	01 Aug 2013	Telephone
16	IDGM03	*Kabupaten* Sungai Gelom	Muaro Jambi	03 Aug 2013	Telephone
17	IDGM04	Village Rantau Majo, Sekernan	Muaro Jambi	04 Aug 2013	Telephone
18	IDGB01	DESDM *Kabupaten/Kotamadya*	Bogor	30 May 2013	Skype
19	IDGB02	DESDM *Kabupaten/Kotamadya*	Bogor	31 May 2013	Skype
20	IDGB03	*Kabupaten* Citeureup, Bogor	Bogor	04 Jun 2013	Skype
21	IDGS01	Pertamina	Jogjakarta	10 Dec 2012	Face to face
22	IDGS02	*Kotamadya* Surakarta	Surakarta	17 Dec 2012	Face to face
23	IDGS03	DPP *Kabupaten/Kotamadya*	Surakarta	18 Dec 2012	Face to face
24	IDGS04	Independent agent	Surakarta	19 Dec 2012	Face to face
25	IDGS05	*Kabupaten* Pasar Kliwon, Surakarta	Surakarta	03 Jun 2013	Skype
26	IDGS06	Village of Sondakan, Pasar Kliwon	Surakarta	28 Oct 2013	Skype
27	IDGJ01	DPP of *Kabupaten/Kotamadya*	Jember	13 Jul 2013	Skype
28	IDGJ02	Village Karang Rejo, Sumber Sari	Jember	9 Jul 2013	Telephone
29	IDGJ03	Village Dukuh Depok, Wuluhan	Jember	10 Jul 2013	Telephone
30	IDGJ04	Village Sukorambi, Sukorambi	Jember	11 Jul 2013	Telephone
31	IDGJ05	Comm. Leader, Gebang Tanggul, Patrang	Jember	15 Jul 2013	Telephone
32	IDCA01	Public member (urban[29])	Banda Aceh	9 Aug 2013	Telephone
33	IDCA02	Public member (urban)	Banda Aceh	9 Aug 2013	Telephone
34	IDCA03	Public member (suburb)	Banda Aceh	10 Aug 2013	Telephone
35	IDCA04	Public member (suburb)	Banda Aceh	10 Aug 2013	Telephone
36	IDCB01	Public member (suburb)	Bogor	8 Jun 2013	Telephone
37	IDCK01	Public member (rural)	Klaten	03 Aug 2013	Telephone
38	IDCK02	Public member (rural)	Klaten	05 Aug 2013	Telephone
39	IDCK03	Public member (rural)	Klaten	05 Aug 2013	Telephone
40	IDCS01	Public member (urban)	Surakarta	20 Jun 2013	Telephone
41	IDCS02	Public member (urban)	Surakarta	21 Jun 2013	Telephone
42	IDCS03	Public member (urban)	Surakarta	21 Jun 2013	Telephone
43	IDCJ01	Public member (suburb)	Jember	16 Jul 2013	Telephone
44	IDCJ02	Public member (suburb)	Jember	17 Jul 2013	Telephone

[28] The abbreviation and acronym of all institutions in this column are listed in the List of Abbreviation and Acronym which is located before Chapter 1.

[29] Definition of urban and suburb in this research study is based on information of respondent from local government staff

In the first tranche of interview, the respondents were from the national government and they were selected through purposive sampling. In order to get permission for the interview, letters were sent to Pertamina. After contact with the first respondent, they introduced the researcher to other key informants who were involved in the policy, for example in Pertamina and KESDM-RI. Other than interviews with decision makers who are key informants, representatives from local governments in the province, regions (*kabupaten/kotamadya*), *kecamatan* and villages were also interviewed. For this purpose, letters to local governments were sent and local government officials gave introductions to the key informants. Then, snowball sampling took place from there, where the key informant provided an introduction to the next respondent. Respondents were from all levels of province, *kabupaten/kotamadya*, *kecamatan*, village, hamlet and community leader (RW and RT, see Chapter 3).

There are many ways to conduct an interview. Three of the methods are a face to face interview, an interview using a telephone and an interview using the internet. A face to face interview is a direct interview with the respondent. This interview method enables researchers to observe and understand the eye contact and body language of the respondent. However, especially when the respondents are located in a distant geographical area, the researcher is sometimes unable to conduct a face to face interview. In this case, an interview by telephone is an alternative. A telephone interview is more time efficient (Sturges & Hanrahan, 2004), as time is not lost in travelling. However, the telephone interview has limitations. On one hand, an interview using the telephone may provide less detailed about responses to questions (Irvine et al., 2012). On the other hand, telephone interviews may result in more honest answers in comparison to face to face interview, especially on sensitive issues (Trier-Bieniek, 2012). This is because people may feel secure when they talk behind the telephone. They feel that their location can't be detected, so they feel more comfortable and answer questions more freely. Apart from that, nowadays, an interview by using the internet, such as Skype, is an alternative to the telephone interview. The benefits of interviews using Skype is that the researcher is able to interact in audio and visual terms (Hanna, 2012).

In this study, all three of the above approaches were conducted. For the first tranche of interviews, interviews with government officials were conducted face to face for central government and one region in Java Island, Indonesia from November 2012. Later, interviews with respondents in six regions which are located in five provinces were continued from June 2013 until October 2013. The respondents which were interviewed in the second tranche were government officials of the region (*kabupaten*/*kotamadya*), *kecamatan* and villages. The leaders of community organisations and members of public were also interviewed in this stage. The interviews were conducted through Skype and combined with telephone interviews because the researcher was in the United Kingdom, while the respondents were spread over some area in Java Island and Sumatera Island in Indonesia. So, all interviewees representing members of the public had access to the internet through their smart phone. Some 'elite' respondents were also interviewed by telephone at this stage due to the difficulty of making appointments earlier.

As the interviews were conducted in three ways, the informed consents to interviewees were given in two ways. First, for face to face interview, the informed consent was read to interviewees and the interviewees signed it if they agreed to be interviewed. Second, for interviews using Skype with video and Skype without video, the consent form was read and the interviewee gave an agreement to be interviewed without signature signed. Almost all interviewee agree to be recorded except one government representative who did not want to be recorded. For this, notes were taken. One further government representative interviewee withdrew the conversation few months after the interview as he felt he may have given wrong information.

Semi-structured interviews were conducted. This method was applied instead of an unstructured interview because such a method might produce large and irrelevant data (Arksey & Knight, 1999). Apart from, as I needed more focus on the objective of the study, the more structured interview would reduce material that didn't need to be analysed. In structured interviews a list of questions is determined in advance to keep the respondent more focused on the objective of the study. However, interactive communication has to be maintained during the interview to capture relevant data and hence, additional questions could be added in a semi-structured interview according to the interviewee's answers. It is also possible in a semi-structured interview for the interviewer to reorder the questions to make the conversation easier.

Kvale (in Bryman, 2012) suggests various approaches can be applied during the interview process to gather more information from narratives, such as introducing questions, follow-up questions, probing questions, specifying questions, and interpreting questions. During the interviews conducted for this research, such kinds of question were attempted to gather more information. Variations of approaches were also applied if respondents did not respond well to initial questions, and to keep them interested if they appeared bored..

4.2.3. Documents

Documents formed another secondary source of data and consisted of two types: documents which are related to regulations, and reports of the preparation and implementation of the policy. The document sources were from national and local government and they were collected alongside interviews. The documents are listed in Appendix 4.3.

4.3 Data Analysis

The three sources of data applied in this research are secondary data on household energy use, government documents and primary data obtained through interviews. Analysis methods for secondary numerical data were statistical analysis and GIS. The government documents and interview results were processed through qualitative analysis which employs an ontological approach where "*people's knowledge, views, understandings, interpretations, experiences, and interactions are meaningful properties of social reality*" (Mason, 1995, p. 63).

4.3.1. Statistical Analysis

As mentioned previously, the secondary data applied in this research was gathered from the SUSENAS which is collected by Statistics Indonesia as an official statistical data collector of the Government of Indonesia (see Section

4.2.1). Before statistical analysis, cleaning of the dataset was needed as there were some data missing. For example, an empty column on the quantity of electricity used by household, but the household was recorded as using electricity, and vice versa. In this case, the data was removed. Following cleaning, statistical analyses were applied. In order to identify whether there was a significant improvement in energy poverty each year, comparisons of energy use patterns from 2007 to 2011 were made.

In this study, bivariate analysis is applied. Bivariate analysis has limitations in terms of its simplicity and in most cases bivariate analysis is unable to fully account for the complex situation. It can hide relationships that are due to, and even sometimes better explained by, other factors that are not included in the simple model. However, bivariate analysis is applied in this study because of difficulties in accessing multivariate data in one survey. For example, data which consists of numbers of households who used specific fuels for cooking does not contain the gender or person in the family who decided to choose the fuel. Thus, this study is unable to make multivariate analysis including the gender of the fuel related decision-maker, or income of the household as well as the type of fuel used in the household due to unavailability of data.

4.3.1.1 Estimating the SUSENAS Data Sets

SUSENAS is a survey not a census. Therefore, in order to estimate the specific characteristic (Y) of a sample in one specific area, the weighting variable is commonly applied. The weighted variable is the ratio of the prediction of household population over the total household which is taken as a sample. This variable is determined by BPS to get the accurate estimation of household characteristics. All equations related to this matter are based on BPS (2007a) guidance and presented below.

The Estimation for City Level

The estimation of the average of Y is taken from the formula:

$$\bar{y}_{kh} = \frac{1}{16b_h} \sum_{i=1}^{b_h} \sum_{j=1}^{16} \frac{1}{a_{ij}} \sum_{h=1}^{a_{ij}} y_{hijl} \qquad 4.1$$

The estimation of total of Y is:

$$\hat{Y}_{kh} = \tilde{Q}_{kh} \times \bar{y}_{kh} \qquad 4.2$$

Where:

$\bar{y}_{kh}$ = the estimation of average of y in city k area h (rural/urban)

$\hat{Y}_{kh}$ = the estimation of total y in city k area h

y_{hijl} = the value of of l^{th} member of household, j^{th} household in i^{th} block census

b_h = number of census block in city k area h

a_{ij} = number of household members in j^{th} household in i^{th}

$\tilde{Q}_{kh}$ = the estimation of number of household in city k area h

The estimation of average of Y in city k in urban area (1) and rural area (2) is:

$$\bar{y}_k = \frac{\hat{Y}_{k1} + \hat{Y}_{k2}}{\tilde{P}_{k1} + \tilde{P}_{k2}} \qquad 4.3$$

The estimation of total of Y in city k in urban area $(\hat{Y}_{k1})$ and rural area $(\hat{Y}_{k2})$ is gathered from this formula:

$$\hat{Y}_k = \hat{Y}_{k1} + \hat{Y}_{k2} \qquad 4.4$$

The Estimation for Province Level

The estimation of the total of Y in a province for urban area $(\hat{Y}_{p1})$ or rural area $(\hat{Y}_{p2})$ is calculated from the formula:

$$\hat{Y}_{ph} = \sum_{k=1}^{T} \hat{Y}_{kh} \tag{4.5}$$

where T = number of city in p province. The estimation of total Y in province for urban $(\hat{Y}_{p1})$ or rural $(\hat{Y}_{p2})$ is calculated from:

$$\hat{Y}_p = \hat{Y}_{p1} \times \hat{Y}_{p2} \tag{4.6}$$

The estimation of average of Y in province k in urban (1) and rural (2) is:

$$\bar{y}_p = \frac{\hat{Y}_{p1} + \hat{Y}_{p2}}{\tilde{Q}_{p1} + \tilde{Q}_{p2}} \tag{4.7}$$

The Estimation for National Level

The estimation of total of the characteristic Y at national level is taken from the formula:

$$\hat{Y}_n = \sum_{p=1}^{L} (\hat{Y}_{p1} + \hat{Y}_{p2}) \tag{4.8}$$

where L = number of province in Indonesia. The estimation of average of Y at national level is calculated using this formula:

$$\bar{y}_n = \frac{\hat{Y}_n}{\tilde{Q}_n} \tag{4.9}$$

where $\tilde{Q}_n$ is the estimation of population in Indonesia both in urban and rural areas.

4.3.1.2 Hypothesis Testing for Identifying Similarity

The most common method for comparing two normally distributed variables is the *t-test*. However, in cases where more than two variables are compared the *t-test* is inappropriate, and *Analysis of Variance* (ANOVA) is more suitable. One of the assumptions of these tests is that the residuals are normally distributed. In order to check the normality of the data, a test such as the

Kolmogorov-Smirnov normality test was applied. Ryan-Jeiner test was applied in this research because this test it is more powerful than Kolmogorov-Smirnov (K-S) and Anderson Darling (A-D) tests (Krishnaiah, 1984). When the data did not meet those assumptions of normality, non-parametric analysis was applied, e.g. to check the difference in energy share from year to year. There are some non-parametric analyses that could be applied for testing repeated measures. Wilcoxon test is an alternative of *t*-test when the data does not meet the normal distribution assumption (Perolat et al., 2015). Meanwhile Friedman test is alternative analysis of ANOVA for non-normal distributed data. The Wilcoxon-rank test compares between two populations (Higgins, 2004), while Friedman test could be applied for more than two populations. However, if it has been found that there is a significant difference between populations, the one to one comparison is needed that identifies which pair of populations has the significant difference. In this case, the Wilcoxon test is best. The Wilcoxon test has been applied in energy studies such as by Röllin et al. (2004) who compared indoor air quality in electrified and un-electrified home, whilst Baerwald et al. (2009) applied the Wilcoxon-rank test for comparing the effectiveness of mitigation of the problems that may be caused by wind energy facilities. Meanwhile, Matsika et al. (2013) applied the Wilcoxon-rank test to compare firewood use in two villages in South Africa. Friedman and Wilcoxon test are applied in this study because these methods are appropriate for comparing dependent variables. Salov (2014) justifies that the Wilcoxon test is more powerful in comparison to Mann-Whitney. All formulas related to the Friedman test and Wilcoxon test are revealed in equations 4.10 to 4.14.

The formula of the Friedman test is summarised from studies (Schucany & Frawley, 1973; Xu et al., 2015). Suppose that n is number of observation for k treatments, where k is more than two treatments. Let x_{ij} is random variables for observation i and treatment j, where, $1 \leq i \leq n$ and $1 \leq j \leq k$. Let r_{ij} denote the rank of x_{ij} in the joint ranking of observation, x_{i1}, x_{i2}, ..., x_{ik} from the i-th observation. The S statistic for Friedman test is :

$$S = \left[\frac{12}{nk(k+1)} \sum_{j=1}^{k} \left(\sum_{i=1}^{n} r_{ij}\right)^2\right] - 3n(k+1) \qquad 4.10$$

where S is Chi-square distribution with df = $k - 1$.

Meanwhile the formulas for Wilcoxon rank test summarised from studies (Arrenberg, 1994; Sugiura et al., 2006) is as follows. Let two random observations x and y be x_1, x_2, ... x_m and y_1, y_2, ... y_n respectively. The Wilcoxon statistic (U) is defined as:

$$U = \text{number of pairs } (x_i, x_j) \text{ for which } x_i < y_j \qquad 4.11$$

A large value of U indicates that the large observations tend to occur with y and vice versa if U is small. Let $R(y_j)$ denote the rank of y. Then:

$$R(y_j) = (\text{number of } y\text{' s} \leq y_j) + (\text{number of } x\text{' s} \leq y_j) \qquad 4.12$$

In this case, observation y is ordered from smallest to largest, so $y_1 < y_2 < ... < y_n$. Then, let W be the sum of ranks of the observation y. Since the number of y's $\leq y_j$ $= j$, then:

$$W = \sum_{1}^{n} R(y_j) = 1 + 2 + \cdots + n + U \qquad 4.13$$

Since $1 + 2 + ... + n = n(n + 1)/2$, we have:

$$W = \frac{n(n+1)}{2} + U \qquad 4.14$$

4.3.1.3 Chi-Square Test for Categorical Data Analysis

The Chi-square test is a non-parametric analysis rather than parametric. It is a goodness of fit test for comparing one or more samples to an estimating distribution and determining how good is the association or 'fit' among those samples (Norcliffe, 1982). One of the assumptions in using this tool is that data are gathered as random (Daniel, 1978) which are measured at nominal scale or higher, i.e. ordinal, interval and ratio scale. In other words this test is appropriate for categorical data. Another assumption is that the categories in each variable are mutually exclusive. It should be noted that for variables with two categories the estimated frequency must be not less than 5, whilst for variables with more than two categories the estimated frequency must be not less than 1 (Norcliffe, 1982). The Chi-square test is common for measuring the association or independence of two or more variables and homogeneity of two or more populations (Daniel, 1978; Rees, 2000). Those variables, then, are structured into a contingency table or cross-tabulation table (Agresti, 1984).

The cross-tabulation table is depicted in Table 4.4. The first variable has i categories, whilst the second variable has j categories. Meanwhile n is the observed number or mathematically it can be written as $n = \sum_i \sum_j n_{ij}$. In a contingency table, cell n_{ij} is an observed cell frequencies or O_{ij}. Observed cell frequencies are gathered from observation.

The observed frequencies have a joint distribution and are gathered from $p_{ij} = n_{ij}/n$ and the total of all n_{ij} cells will have 1.0 or $\sum_i \sum_j p_{ij}$ = 1.0. Additionally, the cells have marginal distribution which is denoted by column variable where $p_{+j} = \sum_i p_{ij}$. Joint and marginal distribution of a contingency table is revealed in Table 4.5.

Table 4.4: A simple contingency table of Chi-square Test

Variables		Second variable				Total
		1	2	...	j	
First variable	1	n_{11}	n_{12}	...	n_{1j}	n_1
	2	n_{12}	n_{22}	...	n_{2j}	n_2
	...	...	...	...	...	...
	I	n_{i1}	n_{i2}	...	n_{ij}	n_i
Total		n_1	n_2	...	n_j	n

Table 4.5: Notation of joint and marginal distribution of Chi-square test

Variables		Second variable				Total
		1	2	...	J	
First variable	1	π_{11}	π_{12}	...	π_{1j}	π_{1+}
	2	π_{12}	π_{22}	...	π_{2j}	π_{2+}
	...	...	...	...	...	...
	I	π_{i1}	π_{i2}	...	π_{ij}	π_{i+}
Total		π_{+1}	π_{+2}	...	π_j	1.0

Agresti (1984) argues that "*two variable are independent if all of joint probabilities equal to product of the corresponding marginal probabilities*". This can be denoted in mathematic formula as follows:

$$\pi_{ij} = \pi_{i+}\pi_{+j} \qquad \text{for } i = 1, 2, \ldots r \text{ and } j = 1, 2, \ldots c \qquad 4.15$$

The two variables are independent, which means that probability conditional distributions within the *r* rows are the same.

In order to analyse the contingency table, the Chi-square test was used to make inferences. Generally, a Chi-square test compares observed cell frequencies and estimated cell frequencies and the null hypothesis is $H_0 : \pi_{ij} = \pi_{i+}\pi_{+j}$ for all *i* and *j* (Agresti, 2013). This null hypothesis is for *i*, whilst expected frequencies or E_{ij} are gathered from this equation:

$$E_{ij} = n\left(\frac{n_{i.}}{n}\right)\left(\frac{n_{.j}}{n}\right) = \frac{n_{i.}n_{.j}}{n} \qquad 4.16$$

In order to identify the magnitude of the discrepancy, the statistical test is:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\left[\frac{(O_{ij}-E_{ij})^2}{E_{ij}}\right] \qquad 4.17$$

If H_0 is true then the X^2 is close to χ^2 distribution with (r-1)(c-1) degree of freedom, where *r* is number of row and *k* is number of column. Null hypothesis (H_0) will be rejected at *α* level of significance if χ^2 more than ${\chi^2}_{1-\alpha}$ with (r-1)(c-1) degree of freedom. Alternatively, the likelihood-ratio Chi-square statistic of Fisher, Wilks, Neyman and Pearson can be applied (Haberman, 1978). The equation is presented below:

$$L^2 = 2\sum_{i=1}^{r} n_i \log\left(\frac{o_i}{x_i}\right) \qquad 4.18$$

4.3.1.4 Effect Size for Identifying the Magnitude of Difference

Both the statistics of Friedman test and Wilcoxon test are measuring statistically significant differences among cases. However, Grissom and Kim (2012, p. 3) argue that:

> *There are possible substitutes for the phrase 'statistically significant', such as 'result of difference not likely attributable to chance', 'difference beyond a reasonable doubt', 'apparently truly (or really or convincingly) different', and 'apparently real difference of as yet unknown magnitude'.*

This confirms that statistically significant, which is noted using *p value,* does not explain the magnitude of the effect. Moreover, statistically significant does not mean practically significant, because the judgment of practical significance is the domain of the expertise of area of the research. Therefore Effect Size (ES) is the solution for this case.

The effect size is depends on the statistical analysis that is used. Durlak (2009) explains how to select and calculate ES. One of the most used ES is *Cohen's d*. However, Thompson (2006) suggests that if the sample number is very high and it is believed that intervention influences dispersion in addition to central tendency, the proper ES is Δ, where the formula is:

$$\Delta = \frac{\mu_1 - \mu_2}{\sigma_2} \qquad 4.19$$

where μ_1 is mean of sample 1, μ_2 is mean of sample 2, σ_1 is standard deviation of sample 1, σ_2 is standard deviation of sample 2. The value of Δ is interpreted as 0.2 is small, 0.5 is medium and 0.8 is large.

The effect size above-mentioned is to identify the magnitude effect for testing two dependant samples. Meanwhile, the effect size for two independent categorical samples for chi-square or 2 x 2 table is calculated differently. There are at least two different *ES*s for categorical data which are mentioned by Grissom and Kim (2012): the *phi* coefficient and *contingency coefficient* (*CC*). The equation of *phi* coefficient is:

$$phi = \sqrt{\frac{\chi^2}{N}} \qquad 4.20$$

Meanwhile, the Effect Size for greater table, *r* x *c* table is *Pearson's Contingency Coefficient* (*CC*) which is calculated from this formula:

$$CC = \sqrt{\frac{\chi^2}{\chi^2 + N}} \qquad 4.21$$

4.3.2. Spatial Data Analysis and GIS

Spatial data according to Haining (2009) consists of three elements, attributes (x) which are measured at a set location (i) at time (t). A location element in is called a spatial reference (Albrecht, 2007; Kitchin & Tate, 2013). In this study, attribute (x) is average of the percentage of households in a spatial unit who used the specific fuel for cooking and as main cooking fuel which is taken from SUSENAS Module M. The spatial unit is in *kecamatan* (subregion) and the average of them was made in *kabupaten*/*kotamadya* (region) spatial unit. For example, 50% of household who used electricity as main cooking fuel in region X is the average of percentage of household who used electricity as main cooking fuel in all subregion (*kecamatan*) in the region X. Meanwhile, the definition of GIS according to the Chorley Committee – GIS is a system which is able to capture, store, check, manipulate, analyse and display the data which are spatially referenced to the earth (Kitchin & Tate, 2013). In GIS this is a point of reference or given name of a location. The area or polygon is a feature that is determined by a boundary of lines (Walford, 2002). In this study, the spatial entity is a region area. Meanwhile, the attribute element – that is a variable that will be assigned to a spatial location – is the attribute which is mentioned above in spatial data, i.e. the percentage of energy carrier users in each region. Therefore, the three layers that will be used in this study are a map of Indonesia, regions as the spatial reference and the level of access of energy carriers. Meanwhile, the time frames of the spatial data are from 2007 to 2011. These are analysed to produce a thematic map (Sedighi, 2008).

Table 4.6: The detail of the development of regions in 2008, 2009 and 2010

2008 (2 new regions)	2009 (15 new regions)	2010 (25 new regions)
1. Paniai from Puncak Jaya	1. Padang Lawas Utara from Tapanuli Selatan	1. Labuhan Batu Selatan from Labuhan
2. Pegunungan Bintang from Jayawijaya	2. Padang Lawas from Tapanuli Selatan	2. Labuhan Batu Utara from Labuhan
	3. Pesawaran Lampung Utara	3. Nias Utara from Nias
	4. Serang (Municipality) from Serang	4. Nias Barat from Nias
	5. Manggarai Timur from Manggarai	5. Gunung Sitoli (Municipality) from Nias
	6. Kubu Raya from Pontinanak	6. Meranti Island from Bengkalis
	7. Tana Tidung from Bulungan	7. Sungai Penuh from Kerinci
	8. Kota Tual from Maluku Tenggara	8. Bengkulu Tengah from Bengkulu Utara
	9. Memberano Raya from Sarmi	9. Pringsewu from Tenggamus
	10. Nduga from Jayawijaya	10. Mesuji from Tulang Bawang
	11. Lanny Jaya from Jayawijaya	11. Tulang Bawang Barat from Tulang Bawang
	12. Memberamo Tengah from Jayawijaya	12. Kep. Anabas from Kep. Riau
	13. Yalimo from Jayawijaya	13. Tangerang Selatan from Tangerang
	14. Puncak from Jayawijaya	14. Lombok Utara from Lombok Barat
	15. Dogiyai from Nabire	15. Sabu Raijua from Kupang
		16. Bolaang Mongondow Selatan from Bolaang Mongondow
		17. Bolaang Mongondow Timur from Bolaang Mongondow
		18. Sii from Donggala
		19. Toraja Utara from Tanatoraja
		20. Maluku Barat Daya from Maluku Tenggara
		21. Buru Selatan from Baru
		22. Morotai Island from Halmahera Utara
		23. Tambraw from Sorong
		24. Maybrat from Sorong
		25. Intan Jaya from Paniai
		26. Deiyai from Paniai

As discussed previously in Section 4.2.1, the number of administrative regions in Indonesia during 2007 to 2011 increased. The development of regions from 2007 to 2011 is shown in Table 4.2 and explained in more detail in Table 4.6. In order to examine the change of fuel use, the number of regions designated for in 2008 to 2011 is based on the regions in 2007. Similarly, the share of fuel users per region is calculated based on regions in 2007. Hence, the names and numbers of regions in 2008 to 2011 were based on the names and numbers of regions in 2007. For example, in 2007 there was the *Kabupaten* Paniai. In 2008 Paniai divided into two: the *Kabupaten* Paniai and *Kabupaten* Puncak Jaya. The calculation of the share of fuel use in the *Kabupaten* Paniai in 2008 is the sum of fuel use in Paniai and Puncak Jaya then divided by total fuel use in 2008. This formulation applies for all divided regions.

The data which were taken from the sample may not be representative of the population. Therefore it is possible that errors may be produced in making conclusions based on those data. In this case, then, a statistical estimation by considering the standard error which is provided in equation 4.22 is needed (Theakstone & Harrison, 1970).

$$\sigma_{\hat{x}} = \frac{s}{\sqrt{n}} \qquad 4.22$$

where $\sigma_{\hat{x}}$ is the standard error of sample means, *s* is standard deviation of sample and *n* is sample size. The standard deviation of the sample is estimated from:

$$s = \sqrt{\left(\frac{\Sigma(x_i - \hat{x})}{n-1}\right)} \qquad 4.23$$

Thus, estimating the mean of the sample would be under confidence limits as above-mentioned in equation 4.24.

$$\bar{x} \pm z_{\alpha} \frac{s}{\sqrt{n}} \qquad 4.24$$

This equation is applied for the sample with replacement. But, if the sample is without replacement, the equation is expressed below:

$$\bar{x} \pm z_{\alpha} \frac{s}{\sqrt{n}} \sqrt{\frac{N-n}{N-1}} \qquad 4.25$$

At the significance level (α) of 5%, the value of z_α, which has the meaning that confidence interval is 95%, is 1.96. All the statistics are the input for spatial analysis through GIS.

Spatial data analysis which is implemented by GIS has been applied by scholars for energy studies (e.g. Aydin et al., 2010; Horner et al., 2011; Hossain et al., 2011). As before, the spatial data was be analysed in order to examine the distribution and spatial pattern of energy access in Indonesia. This approach can be employed to make a decision about various issues (Demers, 2000). Therefore, this study provides more useful information for the government to make a decision in relation to improving modern fuel access.

4.3.3. Thematic Analysis of Interview Data

As mentioned above, during the interviews a series of questions were asked to collect more information from respondents. The interview method used was a semi-structured interview process and interview results were analysed by a thematic analysis method. Bryman (2012, p. 717) provides the following definition:

> *A thematic analysis is the analysis of qualitative data to refer the extraction of key themes on one's data. It is rather diffuse approach with few generally agreed principles for defining core themes in data.*

A thematic analysis is interpretive and reductive (Carroll et al., 2011). Some scholars called this analysis qualitative content analysis (Beck et al., 2010). In thematic analysis, texts and transcripts are screened for occurrence of elements that relate to themes of interest. A theme is identified through identifying data that have a relation to the focus of study – i.e. to the research questions (Bryman, 2012). Prior to applying themes to the interview data, interviews were transcribed to transfer audio to text. Next, interviews were coded. Coding is useful for categorising elements of text according to themes. Coding is useful for categorising elements of text according to themes. After coding, the text relating to each theme was analysed using an interpretivism approach.

The translation of text in to English in this study was not conducted before coding, so transcripts and coding were in the Indonesian language. This was better for understanding the meaning of respondent's narratives because original language helps to interpret the context of sentences. Sometimes meanings can be misunderstood in translation. After analysis and interpretation of the themes, sentences to be used as evidence in the thesis were translated into English.

Interviews were conducted in the Indonesian language, but not all respondents answered the question in Indonesian language. As previously mentioned, interviews were conducted with government staff at various levels and with members of the public. Some respondents even though Indonesian, did not always have good understanding of Indonesian. They spoke traditional language e.g, Javanese, Malay and Aceh language. In most cases, respondents answered the questions in Indonesia language mixed with traditional language. I, as the researcher, understand Indonesian, Javanese and partly Malay language. The respondents who had similar culture and language to the researcher, as interviewer, generally had good responses to interview questions. But, some of them who didn't speak Indonesian language well needed an interpreter, a native speaker who had also a good understanding of Indonesia. This was the case for community respondents in Banda Aceh to help the communication between interviewee and interviewer. The transcription of these interviews was in Indonesia language, spoken by the interpreter.

In accordance with thematic analysis, there are some themes related to the research questions of this study, such as laws underlying the Energy Conversion Programme from Kerosene to LPG (ECPKL), actors who are involved in the regulation, what the government does during policy implementation, what makes people want to change energy carrier or not, etc. In depth analysis of interviews with government representatives and members of public in some regions in this study help reveal the reasons behind the energy access pattern. In other words, statistical and GIS analysis in this study provide primary information about the pattern of energy access at the domestic level throughout Indonesia, and the analysis of qualitative data provides context for these patterns and helps to explain them.

4.4 Summary

In this research study, mixed quantitative and qualitative methods were applied. Quantitative analysis of secondary data revealed the general energy use in domestic setting in Indonesia and the pattern of energy carrier use for cooking as main cooking fuel. The fuels used by households and the main fuel for cooking are indicators of the use of modern or traditional fuel services. This indicator is also a common measurement for assessing energy access and energy poverty. Data for this analysis is gathered from National Survey of Socio-Economic (SUSENAS) that was conducted by the government of Indonesia. However, in order to have better result, cleaning data is needed in this research study as there are some data are missing.

Based on the quantitative analysis of secondary data from the government, interviews were conducted with government officials at different levels of government and with some members of the pubic in different regions of Indonesia, Qualitative analysis of the interviews gives more explanation of the pattern of energy use in Indonesia. Moreover, interviews with public help explain in more depth the reason for any changes and what factors underlie changes in energy use.

However, energy is a sensitive issue especially when it is in relation to policy. Moreover, I as the researcher am an academician who does not have a connection to the government. Furthermore, study from abroad needs strict evaluation by the Ministry of Home Affairs. This is to ensure that no activities in the study will threaten the state. Later, research in every ministry, department and local government needed permission as well. Consequently, negotiation of access and permission to interview took time. In addition to these barriers, access to interviewees who live in remote areas was another challenge during gathering data in this study, which was addressed by carrying out interviews by phone and skype. Interpreters were also sometimes needed where respondents spoke traditional languages. Despite several challenges the reseach managed to gain access to a unique set of data on differen hierarchies of government and members of the public in different regions of Indonesia.

Chapter 5
The Dynamics of Energy in the Domestic Sector in Indonesia

This chapter examines the use of domestic energy in Indonesia in 2007 and 2011 and the main energy carrier used for cooking over the five year period 2007-2011. The aim of the chapter is assessing access to energy in Indonesia to answer the research question: "*What is the dynamic of modern and traditional fuel used in Indonesia before and after the implementation of the Energy Conversion Programme from Kerosene to LPG (ECPKL)?"* In order to answer the question, two sections will be provided in this chapter. The first section investigates the access to energy in terms of quantity, expenditure and source of energy-based approaches. The second section portrays broader patterns of the use of energy carriers for cooking in Indonesia over the period 2007–2011.

5.1 The Access to Energy in Indonesia

Section 2.2 explores the definitions of energy access and energy poverty stated by many references. In most studies on energy access, energy or fuel use are commonly applied as the proxies of energy access (Bazilian et al., 2012a; Bhattacharyya, 2006; Brew-Hammond, 2010; Kojima, 2011). For this reasons, and due to the constraints of data availability, in this study access to energy is represented by fuel consumed for commercial and non commercial purposes; both of which are gathered from the national survey of the government of Indonesia. Types of modern fuels are listed in Table 2.1.

Electricity and LPG are types of modern fuels used for cooking (Jannuzzi & Goldemberg, 2014). The study of Barnes et al. (2004) proposes that kerosene is one kind of modern fuel. Other studies, however, categorise kerosene as a transitional fuel (Sesan, 2012; Van Der Kroon et al., 2013) where this fuel is neither modern fuel nor traditional fuel. For this reason, this study uses two scenarios: one where kerosene is included as modern fuel one where and kerosene is excluded from modern fuel. Thus, the first scenario classifies as modern fuel users household who used electricity, natural gas, LPG and kerosene, whilst the second scenario classifies as modern fuel users households who used electricity, natural gas and LPG. Meanwhile, traditional fuels are briquette, charcoal and firewood.

According to the legal rule from the 1945 Constitution, as translated in Chapter 3, the government of Indonesia has a responsibility to manage energy under principles of beneficial use, people's welfare, preservation of environmental functions and national resilience. Therefore, Pertamina and *Perusahaan Listrik Negara* (PLN) as two state-owned energy companies are assigned to manage oil and electricity distribution in Indonesia. Meanwhile, briquettes are produced by private companies. Charcoal is produced by small industries and some is collected freely from waste of burning processes of wood in industries. Biomasses, i.e. firewood and crop residues, are commonly known as non-commercial energy. Therefore, data on charcoal and biomass are more difficult to collect from the government, unless the government conducts a survey of society to collect information about domestic energy use.

In this section, data from *Survey Sosial dan Ekonomi Nasional* (SUSENAS) module M will be applied. Two annual datasets used in this study are data from surveys conducted in 2007 and 2011. A detailed description of SUSENAS used in this study is explained in Section 4.2.1. The surveys cover the use of domestic energy over type of fuel, cost and quantity of energy consumed. Calculation of energy access in terms of quantity, expenditure and source of energy-based approaches, as mentioned in Section 2.3, will be examined in the following sections. Meanwhile, the six fuel types that will be assessed in terms of access are electricity, gas, LPG, kerosene, briquette and charcoal, and firewood.

5.1.1. Quantity-Based Approach for Assessing the Access to Modern Energy

As previously mentioned, in this section data are taken from SUSENAS Module M which was collected in March 2007 and 2011. In this sub-section, the measurement merely focuses on modern fuel used in 2007 and 2011, and not traditional fuel. The first reason for this is the survey did not measure the quantity of firewood used by households. Moreover, the quantity of briquettes and charcoal are calculated in the same column in this survey. From Table 4.2 it is shown that the multiplier factor to convert 1 ton of briquettes and charcoal to BOE of briquettes and charcoal are different: they are 3.56 and 4.97 for briquettes and charcoal, respectively. Therefore, it is impossible to provide a measure in barrel of oil equivalents (BOE) or kilogram of oil equivalents (kgoe) for briquettes and charcoal because in the survey these fuels are not measured separately. The second reason is that this study will focus on access to modern fuel. Referring to Table 2.4, the use of modern fuel as a base for the thresholds of minimum energy required by people or households is only found in the work of Tennakoon (2008) and AGECC (2010). Therefore, in order to identify whether people or households have sufficient access to modern fuel, this subsection will use modern fuel, i.e. electricity, natural gas, LPG and kerosene.

Table 5.1 reveals the estimation of quantity based approach to energy use for national level. The equation for calculating the estimation of average is presented in Equation 4.1 to 4.9. Average quantities of energy use are revealed in Table 5.1. The average quantity is measured from the household who used the fuel, with non-users excluded. In general, the use of fuel in every type in 2007 and 2011 are statistically significant differences in average quantity of energy usage. The first reason is that the people who used the fuel over 2007-2011 might be different. The new users of the fuel in 2011 might start to use that specific fuel or the old users might stop using it. Another potential reason is that there are households who use new appliances, such as: TV, refrigerator, rice cooker, water heater and air conditioner that consume energy which in turn increases energy usage. This influences the average quantity of energy use in the domestic area.

Average natural gas use among natural gas users over the five years multiplied almost four times, from 10 m^3 to 39 m^3 per person per annum. Since 2010 the government of Indonesia has implemented a national programme which is called *Jaringan Gas* (Gas Network) to introduce natural gas for households. Albeit this policy has been implemented in some feasible regions in Java, this policy is presumed to be the cause of the increasing average use of natural gas by users in 2011. From the interviews with the government, most of areas that are connected to the natural gas network are elite housing areas in big cities. This implies the users of this fuel in 2011 were affluent households that previously did not have access to natural gas. This case supports the

Table 5.1: Statistics of amount fuel used from Module M of SUSENAS

Fuel	In 2007[30]			In 2011[29]			*t*-statistics[31]		
	Estimated average energy used per person/year	Estimated average energy use in BOE per person/ Year	Estimated average energy use in kgoe per person/ Year	Estimated average energy used per person/year	Estimated average energy use in BOE per person/ Year	Estimated average energy use in kgoe per person/ Year	Different	*t*-statistic (significant value)	
								Equal variances assumed	Equal variances not assumed
Electricity	263.68 kWh (206,511,724 people)	0.161	23.60	382.16 kWh (224,215,163 people)	0.234	34.20	118.48	-875.26 (0.000)	-908.18 (0.000)
LPG	24.90 kg (31,662,023 people)	0.215	31.09	20.79 kg (130,925,068 people)	0.177	25.91	-4.18	277.09 (0.000)	534.14 (0.000)
Natural gas	10.27 m^3 (36,774 people)	0.044	9.43	39.52 m^3 (936,222 people)	0.280	40.96	29.26	-13.40 (0.000)	-65.17 (0.000)
Kerosene	32.79 *litre* (193,684,982 people)	0.189	28.38	26.73 *litre* (66,291,913 people)	0.158	23.13	-6.06	238.51 (0.000)	142.18 (0.000)
Briquettes, and charcoal	39.81 kg (30,080,971 people)	-	-	79.00 kg (1,511,724 people)	-	-	39.19	-306.83 (0.000)	-262.59 (0.000)

[30] The calculation is using Equations 4.1. to 4.9 provided in Chapter 4. In this calculation, non-users of the fuel type are excluded. In this table, only users of specific fuel which are included in the calculation presented under column: "Estimated average energy used per person/year". Equation 4.1 is $\bar{y}_{kh} = \frac{1}{16b_h}\sum_{i=1}^{b_h}\sum_{j=1}^{16}\frac{1}{a_{ij}}\sum_{h=1}^{a_{ij}} y_{hijl}$ that calculate the average. But, based on BPS survey, there is a weight ($\tilde{Q}_{kh}$) of every area, so the average in a city is $\hat{Y}_{kh} = \tilde{Q}_{kh} \times \bar{y}_{kh}$ (Equation 4.2). The calculation of average in national level follows equation $\bar{y}_n = \frac{\hat{Y}_n}{\tilde{Q}_n}$ (equation 4.9) where $\hat{Y}_n = \sum_{p=1}^{L}(\hat{Y}_{p1} + \hat{Y}_{p2})$ (equation 4.8) and $\hat{Y}_{ph} = \sum_{k=1}^{T}\hat{Y}_{kh}$ (equation 4.5).

[31] SPSS version 22 is applied to calculate this statistics.

arguments of Sathaye & Tyler (1991) that the availability of energy infrastructure attracts people to have high intentions to use that energy.

In addition to natural gas, the average quantity of energy used by electricity users in 2007 was 263.68 kWh per person per year, while in 2011 it was 382.16 kWh per person per year. Clearly, the average quantity of electricity use among the users over 2007-2011 increased by about 118.48 kWh per person per year. Scholars argue that income and electricity consumption has a positive relationship (Kanagawa & Nakata, 2007; Winkler et al., 2011) and this assumption has been applied to Indonesia as well (Yoo & Kim, 2006). In this study, estimated household income increased as well (see Table 5.3). The increasing household income can be translated to households having extra money that increases the affordability of additional domestic appliances (Mahadevan & Asafu-Adjaye, 2007). For example, previously a household did not have a TV and refrigerator to keep food longer, but because the income increased the family decided to buy a TV and refrigerator. Unavoidably, additional electrical appliances in a household increase the electricity use.

By contrast, in 2011 the average amount of kerosene use was the least, whilst the average amount of kerosene use in 2007 was the second highest among non-traditional fuel types. The reduction of kerosene in domestic use is the effect of kerosene reduction during the implementation of ECPKL. This is an indication that in 2011, kerosene was not the favourite fuel in households. It is assumed that other fuel was used to substitute kerosene.

Similar to kerosene, the average quantity use of LPG among its users in 2007 and 2011 reduced from 24.9 to 20.79 kg per person annually. There are two reasons for the reduction of average household energy from LPG. First, in 2011 households were more likely to use LPG in 3 kg sized canisters rather than 12 kg. At the end of 2007, the 3 kg LPG canister began to be introduced to the public on a large scale. Previously, before the end of 2007, the 12 kg LPG canister was the only LPG canister that could be bought by households. After the end of 2007, both 3 kg and 12 kg LPG were available to households. The use of smaller sized canisters may also affect the efficiency of LPG use. Secondly, as 3 kg LPG is subsidised, LPG became more affordable. This attracts lower income households to adopt LPG but they use a smaller amount per household. This affects the calculation of average energy usage. Previously, when there were only 12 kg LPG for household, LPG was used by affluent households. But after ECPKL, more low income households use 3 kg LPG. The evidence in Figure 5.2 shows that in 2011 the percentage of low income decile households who used LPG was higher than in 2007.

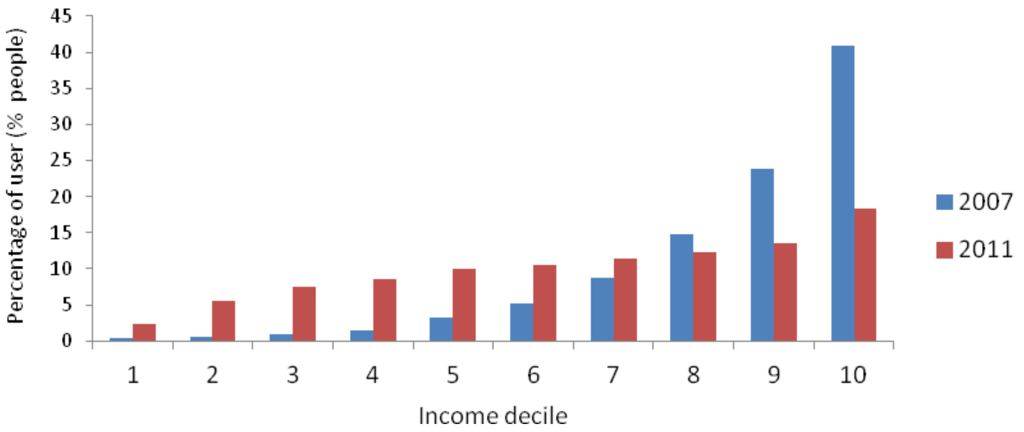


Figure 5.1: Percentage of LPG user over income decile.[32]

According to PDIESDM-KESDM (2012) total energy consumption throughout Indonesia from 2000 to 2009 was dominated by kerosene (see Figure 5.3). But in 2009 LPG took over from kerosene, as kerosene consumption in total in Indonesia plummeted to 24 MBOE per year and finally fell to 10 MBOE per

[32] The bar chart is calculated from SUSENAS 2007 and 2011

year in 2011. Consumption of LPG for domestic use fluctuated between 5.9 and 6.7 mboe in total during 2000–2006. The introduction of 3 kg LPG in the middle of 2007 increased the consumption to 8 MBOE across Indonesia in 2008. LPG consumption in total increased more than 60% annually and reached 35 MBOE per year in 2011. As discussed above, the average amount of energy from LPG consumed by household users of LPG reduced from 2007 to 2011, while data from PDIESDM-KESDM (2012) shows the increase in total consumption of LPG. This indicates the significant increase in the numbers of LPG users, despite their lower average consumption of LPG per household. From a similar table, it can be seen that from 2000 to 2007 biomass was the fuel most consumed in the domestic sphere. In 2000, total biomass consumption was 208 MBOE and then increased to 234 MBOE in total in 2011. This data is collected by PDIESDM-KESDM (2012)

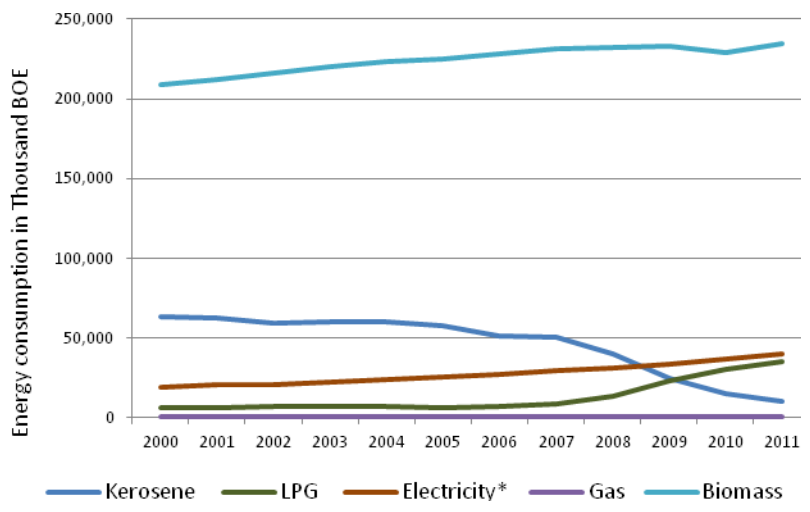


Figure 5.2: Energy consumption in barrel of oil equivalent (BOE) during 2000 till 2011 (PDIESDM-KESDM, 2012)

Nevertheless, although by 2011 the use of some fuels increased considerably, the sufficiency to meet specific requirements needs to be assessed, as the insufficiency of modern energy is a signal of energy poverty (Cecelski, 2000; Reddy et al., 2000). The standards of energy requirements that have to be met by person or household are presented in Table 2.5 in Chapter 2. Those standards are the requirement for minimum energy need. But this study concentrates on modern fuel. So, the thresholds from Table 2.4 are adopted to be applied for assessing modern energy sufficiency to meet the minimum thresholds. The results are presented in Table 5.2.

As mentioned above, the calculation of amount of energy used will solely focus on commercially produced energy, i.e. electricity, natural gas, LPG and kerosene. The data is gathered from SUSENAS 2007 and 2011. In this study, commercial fuels for cooking which are used most are natural gas, LPG and kerosene. Electricity is used for cooking as well. But electricity data in this study does not separate the use of electricity based on service. Thus, electricity is excluded in calculation of energy for cooking. Moreover, in terms of modern fuels, this study applies two scenarios, kerosene included as modern fuel and kerosene excluded as modern fuel. All the calculations of average amount of energy used by people/household are presented in Table 5.2 and Table 5.3.

Table 5.2 and Table 5.3 show average quantity usage of electricity and cooking fuel based on the SUSENAS survey. From the table, under the column "Average energy received by person or household based on SUSENAS" it is shown that average electricity used and cooking energy used varied. It is also shown that in that column the quantity of fuel used for cooking from 2007 to 2011 was reduced. There are some possible reasons for this reduction. First, SUSENAS survey does not separate the service of energy use. Therefore, this table is unable to detect the households who use electricity for cooking as there is no detailed

Table 5.2: Average energy received by person or household and percentage of energy poor in Indonesia (kerosene included)

Source	Minimum level energy have to be received based on expert argument		Year	Estimated average energy received by person or household based on SUSENAS[33]		Estimated percentage of person who below minimum level in % of total energy user[33]	
	Electricity	Modern energy for cooking (without kerosene)		Electricity	Modern energy for cooking (kerosene included)	Electricity	Modern energy for cooking (kerosene included)
A. UNDP Modi et al. (2005); Barnes et al. (2010)	10 kgoe/cap/year	40 kgoe/cap/ year	2007	23.60 kgoe/cap/year	31.14 kgoe/cap/year	57.7	29.1
			2011	41.90 kgoe/cap/year	26.28 kgoe/cap/year	28.0	12.2
B. Tennakoon (2008)	120 kWh/ cap/year	35 kg/cap/year of LPG or equivalent to 47.89 kgoe/cap/year	2007	263.68 kWh/cap/year	31.34 kgoe/cap/year	35.3	72.9
			2011	382.16 kWh/cap/year	26.28 kg/cap/year	31.0	72.2
C. AGECC (2010)	100 kWh/capita/year	100 kgoe/capita/year	2007	263.68 kWh/cap/year	31.34 kgoe/capita/year	29.3	91.0
			2011	382.16 kWh/cap/year	26.28 kgoe/capita/year	24.8	77.7
D. Barnes et al. (2011) and Khandker (2012)	Every person need minimum 27.4 kgoe per month		2007	4.23 kgoe/capita/month		99.4	
			2011	4.75 kgoe/capita/month		97.1	
E. Goldemberg 1990 cited in (Barnes et al., 2011; Khandker et al., 2010)	Every people need 32.1 kgoe per month		2007	4.23 kgoe/capita/month		99.5	
			2011	4.75 kgoe/capita/month		97.3	
F. IEA (2012b)	250 kWh per annum for rural household whilst 500 kWh for urban household		2007	Rural : 365.4 kWh/capita/year Urban : 828.3 kWh/capita/year	Both rural and urban: 589.0 kWh/cap/year	Rural : 52.3 Urban : 28.7	
			2011	Rural : 531.46 kWh/household/year Urban : 793.79 kWh/ household /year	Both rural and urban: 662.94 kWh/ hsld /year	Rural : 47.8 Urban : 45.0	
G. Practical Action (2010)	1 kg firewood or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or ethanol per person per day		2007	LPG : 0.068 kg/capita/day Kerosene :0.089 litres/capita/day		In total : 80.0 < 0.04 LPG : 2.9 < 0.2 Kerosene : 77.1	
			2011	LPG : 0.057 kg/capita/day Kerosene : 0.073 litres/capita/day		in total: 47.7 < 0.04 kg/cap/y of LPG :21.4 < 0.2 l/cap/y of Kero : 26.5	

[33] The data is gathered from SUSENAS 2007 and 2011. The average and percentage are calculated using SPSS which is presented in Appendix 5.3

Table 5.3: Average energy received by person or household and percentage of energy poor in Indonesia (kerosene excluded)

Source	Minimum level energy have to be received based on expert argument		Year	Estimated average average energy received by person or household based on SUSENAS[34]		Estimated percentage of person who below minimum level in % of total energy user[34]	
	Electricity	Modern energy for cooking (without kerosene)		Electricity	Modern energy for cooking (kerosene excluded)	Electricity	Modern energy for cooking (kerosene excluded)
H. UNDP Modi et al. (2005); Barnes et al. (2010)	10 kgoe/cap/year	40 kgoe/cap/ year	2007	23.60 kgoe/cap/year	31.07 kgoe/cap/year	57.7	79.43
			2011	41.90 kgoe/cap/year	25.92 kgoe/cap/year	28.0	84.88
I. Tennakoon (2008)	120 kWh/ cap/year	35 kg/cap/year of LPG or equivalent to 47.89 kgoe/cap/year	2007	263.68 kWh/cap/year	31.07 kgoe/cap/year	35.3	86.88
			2011	382.16 kWh/cap/year	25.92 kgoe/cap/year	31.0	94.07
J. AGECC (2010)	100 kWh/capita/year	100 kgoe/capita/year	2007	263.68 kWh/cap/year	31.07 kgoe/capita/year	29.3	99.61
			2011	382.16 kWh/cap/year	25.92 kgoe/capita/year	24.8	99.66
K. Barnes et al. (2011) and Khandker (2012)	Every person need minimum 27.4 kgoe per month		2007	0.24 kgoe/capita/month		100	
			2011	4.47 kgoe/capita/month		99.19	
L. Goldemberg 1990 cited in (Barnes et al., 2011; Khandker et al., 2010)	Every people need 32.1 kgoe per month		2007	0.24 kgoe/capita/month		100	
			2011	4.47 kgoe/capita/month		99.37	
M. IEA (2012b)	250 kWh per annum for rural household whilst 500 kWh for urban household		2007	Rural : 365.34 kWh/household/year Urban : 824.54 kWh/ household/year	Both rural and urban: 621.47 kWh/cap/year	Rural : 29.37 Urban : 15.21	
			2011	Rural : 683.68 kWh/household/year Urban : 722.46 kWh/household/year	Both rural and urban: 656.16 kWh/cap/year	Rural : 33.59 Urban : 60.33	
N. Practical Action (2010)	1 kg firewood or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or ethanol per person per day		2007	LPG : 0.068 kg/capita/day		< 0.04 kg/cap/y of LPG : 2.9	
			2011	LPG : 0.057 kg/capita/day		< 0.04 kg/cap/y of LPG :21.4	

[34] The data is gathered from SUSENAS 2007 and 2011. The average and percentage are calculated using SPSS which is presented in Appendix 5.3

information on what services are with what fuels. This is the reason to exclude the use of electricity for cooking in Table 5.2 and Table 5.3, as generally cooking with electricity is not common. Moreover, SUSENAS survey does not give any information about the share of fuel for cooking. The reduction of the average quantity of energy used for cooking per person among of modern fuels in 2011 may be caused by changing patterns of energy use where people adopt other fuels for cooking, such as electricity and firewood. Therefore, an increase in the quantities of electricity and firewood used for cooking would not be recognised and result in apparent lower levels of energy use for cooking. Second, the reduction in the amount of energy for cooking in 2011 might be caused by the use of 3 kg of LPG, whereas in 2007 the canister of LPG was only 12 kg. The widespread introduction of 3 kg LPG to the public may reduce the average quantity of LPG used. The number of low income households who used LPG in 2011 was higher than in 2007. They have different cooking habits than the high income household because their needs are lower than high income households. This can be seen from Figure 5.2 that explains the reduction in the amount of LPG used per person per year in Table 5.1.

Even though there was a reduction in the average amount of energy for cooking per person per year, based on these seven standards, the estimated number and percentage of people who suffered from lack of sufficient modern fuel in 2011 were lower than in 2007.

From Table 5.2 it is seen that by using standard A, among electricity user, the percentage of people who suffered from shortage of electricity in 2011 reduced by about 29.7% in comparison to 2007. In the meantime, the reduction in numbers of people who had insufficient energy (from modern fuels) for cooking was about 16.9%. Meanwhile, by using standards B and C, the reductions in people who lack electricity over the five years were 4.3% and 4.5%, respectively. The reduction in numbers of people who lack modern fuel for cooking between 2007 and 2011 according to standards B were 0.7%, whilst in standard C was 13.3%. The possible cause was due to the reduction of quantity of LPG and kerosene as presented in Table 5.1.

Different to the first three standards, the assessment based on thresholds D and E result in more than 95% of household unable to access modern fuels. The reason for this large figure is that the standards which are applied in this study are the minimum requirement for energy in general. However, the study in this thesis is only concerned with modern fuels. This in turn underestimates the total energy used and, therefore, lack of energy using this measurement is inevitable. However, including the traditional energy will hide that people have suffered from lack of modern fuel. Moreover, below the standards energy use in Indonesia can be caused by the difference in cooking habits in Indonesia and the place where the standard was determined. For example, India is the location of the studies of Barnes et al. (2011) and Khandker et al. (2012) whilst habit and culture in India and Indonesia are different.

IEA (2012b) distinguishes the standard use in urban and rural locations. The energy use in rural and urban areas in Indonesia in 2007 and 2011 were different. Clearly, both in 2007 and 2011 urban people used more energy than rural people. However, in 2011 there was a reduction in the energy consumption of urban people, from 828 kWh per household per year in 2007 to 793 kWh per household per year in 2011. In this case, kerosene is excluded from the calculation of modern energy, so, the possible reason for this reduction is reduction in kerosene use in urban area or a change of population who used kerosene. This can be seen from Table 6.5 and 6.6 in Chapter 6 that in 2007 percentage of urban household who used kerosene in 2007 and 2011 were 40.79% and 9.20%, respectively. Another possible reason is the increasing number of LPG users who used 3 kg LPG canister instead of 12 kg LPG canister. The reduction of amount energy used for cooking affected the increasing number of apparent energy poor in urban areas. Meanwhile, there was a reduction in the apparent energy poor in rural areas.

Different to F, the standard G from Practical Action (2010), determines the sufficiency of energy with several scenarios of energy use. In this study, firewood and charcoal is discarded from the calculation because they are not clean energy. Kerosene is included as modern fuel in this calculation to identify the minimum number of energy poor. By using this measure, there was reduction in the amount of energy used in 2007 and 2011 in urban areas. On the contrary, there was an increase in amount of modern energy used over 2007 and 2011. This implies, the percentage of household in urban areas who experienced insufficiency of modern energy in 2011 was higher than in 2007, whilst the percentage of people who suffered from insufficiency of modern energy in rural areas in 2007-2011 was reduced.

All above mentioned are when kerosene is recognised as modern fuel. However, there are different results when kerosene is excluded from modern fuel as presented in Table 5.3. In comparison to Table 5.2, the percentage of people/household who suffered from insufficiency of modern fuels were smaller than in Table 5.3. This is because excluded kerosene users Table 5.3 will reduce the quantity of the use of electricity and energy for cooking that in turn increase the number people who suffered from insufficiency of modern energy.

Using this measure of assessment some matters should be noted. First, some thresholds include traditional fuels and some others disregard traditional fuels. For example, standard A (Barnes et al., 2010; Modi et al., 2005) disregards the presence of traditional fuel use in cooking. Meanwhile, standard G, Practical Action (2010) sets a minimum level for firewood and charcoal which are widely recognised as unclean energy. Therefore, this measurement is not appropriate to be used for the attempt to reduce traditional fuel, unless the traditional fuel option is discarded from the measurement. Second, measuring the quantity of traditional fuel used by a highly populated society is not easy, which has led to failure to measure the quantity of firewood, briquettes and charcoal in SUSENAS in detail. Third, from the literature, kerosene is a transitional fuel which means that this fuel neither modern fuel nor traditional fuel, but some literatures argue that kerosene is a modern fuel. In this study modern fuel is separated into two options: kerosene is excluded as modern fuel or kerosene is included as modern fuel. In this study, when kerosene is included in calculation of energy from modern fuel, the problem of lack of modern fuel is apparent, even at very high percentage against some standards as presented in Table 5.3. Therefore, if kerosene was excluded from the calculation, there is a high probability that results would indicate an even higher level of people/households who suffered from lack of access to energy. Fourth, if traditional fuel was to be included in the calculation, it is possible that the minimum basic need requirement for energy would be seen to be met more often, even though the fuel use would result in indoor air pollution with harmful effects on human health.

5.1.2. Share of Expenditure-Based Approach for Energy Access in Indonesia

This Sub Section examines the access to modern energy in terms of expenditure in Indonesia in 2007 and 2011. The short summary of analysis is given in Table 5.4. In this section, non user of fuel is excluded from the calculation, similar to previous sub-section. This sub-section shows the annual usage per person, not the number of users. So, non-users which are identified as having zero fuel usage, are excluded to get the average quantity usage of fuel.

Table 5.4: Statistics of total expenditure for domestic energy/fuel among the users of those fuels[35]

Type of energy	2007		2011		The increase of energy expenditure[36]
	The average expenditure in IDR per person/year[3]	Standard Deviation of expenditure	The average expenditure in IDR per person/year[3]	Standard Deviation of expenditure	
Electricity	126,529.77	177262.07	186,223.50	261390.85	0.472
LPG	118,937.17	93421.06	126,249.92	119861.97	0.061
Natural gas	92,184.43	51540.55	112,538.84	120794.17	0.221
Kerosene	87,289.69	92901.08	111,145.26	144602.43	0.273
Briquettes & charcoal	62,667.46	160374.19	103,790.02	114011.87	0.656
Firewood	69,358.64	71674.03	118,178.77	117525.25	0.704
Total energy expenditure[37]	247,940.79	219533.70	331,546.16	309883.69	0.337
Total expenditure	4,241,050.66	4013701.05	6,979,624.96	8326320.78	0.646

In 2007 and 2011, electricity, gas, firewood and briquette & charcoal use were the first, third, fifth and sixth highest average expeditures. Kerosene and LPG changed position: in 2007, LPG was the second highest average of fuel

[35] The analysis is gathered from SUSENAS, raw data of Module M. Descriptive analysis that calculates the average of data is processed by using SPSS 22. See Appendix 5.1. In this study only the user of energy which are included in the calculation of the statistics.

[36] The increase of energy expenditure is calculated from the subtraction of expenditure in 2011 and 2007 divided by the expenditure in 2007.

expenditure, but in 2011 the second highest fuel expenditure was kerosene. This in line with the ECPKL policy wherein kerosene price was increased by the government, while the 3 kg LPG which is subsidised was beginning to be introduced to the public. In the meantime, households spent the least on briquettes and charcoal. In general, the highest increase of energy expenditure in five years was on firewood, briquettes and charcoal, and electricity, while the increase in LPG expenditure is the lowest.

The expenditure could be affected by the price of fuel. In order to test this assumption, there is an price index for estimating the price of energy which was calculated from energy expenditure over quantity of energy used. The index revealed in Table 5.5 is calculated from expenditure for specific fuel per person divided by energy use per person in barrel of oil equivalent (BOE). In the table, the calculation of the price index of briquette and charcoal is not presented in BOE because the quantity of briquette and charcoal in the survey is not separated. Additionally, firewood use is not measured as well, as the survey did not identify the quantity of firewood.

Table 5.5: 'Price Index' of fuels

Fuel	Price Index (expenditure (IDR)/quantity of energy used)[38]			
	Average energy use		Average energy use in BOE[39]	
	2007	2011	2007	2011
Electricity	479.86 IDR/kWh	487.29 IDR/kWh	5,361.43 IDR/BOE	5,445.13 IDR/BOE
LPG	4,776.59 IDR/kg	6,072.63 IDR/kg	3,825.58 IDR/BOE	4,872.62 IDR/BOE
Natural gas	8,976.09 IDR/m^3	2,847.64 IDR/m^3	9,775.66 IDR/BOE	2,747.53 IDR/BOE
Kerosene	2,662.08 IDR/litre	4,158.07 IDR/litre	3,075.75 IDR/BOE	4,805.24 IDR/BOE
Briquette and charcoal[40]	1,574.16 IDR/kg	1,313.80 IDR/kg	-	-

[38] The index is calculated from expenditure in Table 5.5 divided by the amount of energy used per capita which is presented in Table 5.2.
[39] The IDR/boe is applied in order to make fair comparison in spite of using IDR/kWh, IDR.kg, IDR/litre etc.
[40] For briquette and charcoal the IDR/kg is applied because in this study briquette and charcoal are not separated due to the limitation of the survey.

In 2007, among four modern fuels, the three fuels which have the highest price were natural gas, electricity and LPG. In 2011 energy expenditure increased and the rank order of price index changed as well. At that time, the highest to lowest price index were electricity, LPG, kerosene and natural gas. Based on this study, both in 2007 and 2011, the price of LPG was more expensive than kerosene. However, apparently, the increase of LPG price during those five years was lower than the increase of kerosene price. The reason for this result is that LPG was subsidised while kerosene was not subsidised anymore. Therefore, the high increase in the price index of kerosene is unavoidable.

Furthermore, for fuels which are under government control such as kerosene and LPG, the result from the survey in this study is different to government regulations. For example, the government set kerosene price in 2007 was 2,000 IDR/litre (KESDM-RI, 2007b), while 2,500 IDR/litre in 2011(Presiden Republik Indonesia, 2012). The gap of energy price between the survey of the public and that set by government regulation is possible. This is because when kerosene is sold to the public, adding a transport cost is permissible as long as it is under the range of local government regulations. As discussed in Chapter 3, Indonesia implements local government autonomy which is stated in Presidential Decree No. 32, 2004 (Presiden Republik Indonesia, 2004b). This allows them to have authority to manage some sectors such as energy, as mentioned in Government Regulation No. 38, 2007 (Presiden Republik Indonesia, 2007a). This regulation is supported by Ministerial Decree No 26, 2009 (KESDM-RI, 2009) which allows local government to determine the cost of LPG. Apart from that, the price index of electricity, LPG and kerosene increased, whilst the price index of natural gas, briquettes and charcoal decreased (see Table 5.5). The reduction of expenditure for these types of energy is caused by government intervention. Previously this energy was consumed by more affluent, but after the gas network was developed the lower income households were able to access it. This is similar to the use of briquettes, which were one of the energy alternatives to substitute for kerosene.

Annual expenditure per person for all those types of fuel between 2007 and 2011 increased (see Table 5.4). This means the increase in expenditure could be influenced by many factors such as inflation. Inflation, undeniably, led to price changes over the time (Parks, 1978). Inflation in Indonesia changed during 2007 to 2011: 6.59% (2007), 11.06% (2008), 2.78% (2009), 6.96% (2010) and 3.79% (2011) (BPS, 2014d). Clearly, from 2007 to 2011 the inflation decreased. However, the inflation decrease will not reduce the price. For example: inflation in 2008 increased the price in 2008. The price in 2009 will increase again but not by as much as in 2008, because inflation in 2009 was less.

During the five years under study, there are different changes in expenditure on each fuel because the increasing prices of energy are different. For example, formerly, in 2005, the price of kerosene was 2000 IDR (Presiden Republik Indonesia, 2005b). Later on, from 2008 until 2012 the price increased to IDR 2500 (KESDM-RI, 2008c; MESDM-RI, 2009; Presiden Republik Indonesia, 2012). However, since 2007, when the ECPKL was implemented in specific regions, the price of kerosene in those regions could not be controlled by the government anymore because the subsidy was removed: then price follows the free market. As a result, the price of kerosene in the area of implementation was more expensive (Sosiawan et al., 2011).

Regarding the classic standard for fuel poverty on the UK definition, a household is categorised as experiencing fuel poverty if their required energy expenditure is more than 10% of their income (DEFRA, 2004; DTI, 2001). As previously discussed in Section 2.5, it can be argued that this definition is not appropriate because, there are difficulties caused by lack of scientific agreement about the determination of 10% as a threshold. However, when affordability should be considered in access to energy (Arnold et al., 2003; van der Horst & Hovorka, 2008; Ouedraogo, 2006; Reddy et al., 2000), expenditure for energy should be measured. In the study by Mirza & Szirmai (2010) people who lack access to energy are those who pay less than 10% instead of those who pay more than 10% (Fankhauser & Tepic, 2007). The 'less than' is applied by Mirza & Szirmai (2010) to identify the people who experienced insufficient energy. Insufficient energy means people spent 'less' than minimum standard of adequate fuel should be used. In addition, Mirza & Szirmai (2010) approach is unusual as more references are concerned with affordability which can be predicted from the high burden of expenditure. However, in the case of Indonesia, the problem of access to energy is not so much about affordability, but it is more about the lack of energy infrastructures that causes more people to have insufficient access to minimum energy required. This implies, people who suffered from modern energy insufficiency are those who spent less money. With reference to this definition and referring to Table 5.6, the estimated number of households who spent less than 10% on modern energy in 2007 was 195,802,830 person or 87.3% of total population, while in 2011 it was 223,388,316 person or 92.8% of the population. It appears, proportion of the expenditure over total expenditure in 2011 was increased in comparison to 2007. On the other hand, when the definition of energy poverty is for those who pay more than 10%, there were 28,388,876 people (12.7%) who lack of access to energy in 2007, whilst about 17,435,822 (7.2%) person suffered from lack of access to energy in 2011.

Table 5.6: Comparison of energy poverty in terms of expenditure based approach in 2007 and 2011[41]

Note	Year	
	2007	2011
Average expenditure spent for domestic[42] energy per person/year	247,940.79 IDR	331,546.16 IDR
Average total expenditure per person/year	4,241,050.66 IDR	6,979,624.96 IDR
Estimated average share of energy expenditure over total expenditure	5.84 %	4.75 %
Estimated number of people who spent energy **more** than 10% (percentage)	28,388,876 person (12.7%)	17,435,822 person (7.2%)
Estimated number of people who spent energy **less** than 10% (Percentage)	195,802,830 person (87.3%)	223,388,316 person (92.8%)

Apart from what standard will be applied, this research study found there are weaknesses of the share of expenditure-based approach in assessing the access to modern energy. The expenditure of energy in domestic sphere and total expenditure in 2011 and 2007 seems increased. But there was reduction in percentage of people who spent less than 10% over that period because the share of expenditure was reduced. This occurred for various reasons. First, inflation is unavoidable for every country. This leads the price of commodities, including energy, to increase over the time. But the increased price for other commodities during the five year period under study was higher than the increase in energy price, because in Indonesia energy prices are under government control. As aforementioned, in Indonesia electricity, LPG, gas and kerosene as commercial

[41] The analysis is using SPSS 22 which are presented in Appendix 5.4

[42] The consumption of domestic energy is expected from the consumption of household to electricity, LPG, gas, kerosene, charcoal, coal, briquette and firewood.

energy are controlled and managed by state-owned companies, i.e. PLN and Pertamina (see Section 3.3). This means that the energy which is under the control of government is subsidised (see Section 3.3). The subsidy leads to cheaper prices for these fuels than the actual price on the international market. Subsidised energy prices are more stable in comparison to other commodities. Hence, when the price of other commodities increased, the increasing price of energy would not be as high as the increase of other commodities. This is also the reason of the higher percentage of people in 2011 in comparison to 2007 who spent less than 10%. Moreover, while expenditure increases, income increases as well. This argument is proponent to Palmer et al. (2008) in that the increase of energy expenditure is not always linear with the total expenditure.

Secondly, share of expenditure-based approach is unfair. On the affordability measurement (energy poverty is spending more than 10%) that applies the share of expenditure as well, Moore (2012)argues that this approach is unfair, as it may miscategorise people. The share of expenditure-based approach in this study which adopts Mirza & Szirmai (2010) point of view, is also found to be unfair. Similar to affordability, the minimum share of energy expenditure applied in this study also has a problem with miscategorised people. People who spend similar amounts of money for energy might have different household income which will result different percentages of expenditure over income, because of the discrepancy of income. As an example, this section presents 28 households selected randomly from the samples in the SUSENAS survey and revealed in Table 5.6. Data number 1, 6 and 9 are in the same income group, that

Table 5.7: The illustration sample of 10% threshold misuse to define energy poor

No.	Sample No.	Area	Expected income in IDR/month (decile group)	Energy expenditure (in IDR)	Type of energy consumed	Percentage of energy expenditure over income (%)
2007						
1	2962	Urban	363,438 (7th)	8,939	Electricity, LPG, kerosene	2.46 (EP)
2	3120	Urban	490,019 (8th)	16,904	Electricity, kerosene	3.45 (EP)
3	13762	Rural	271,367 (5th)	13,501	Kerosene, firewood	4.98 (EP)
4	20782	Rural	158,788 (2nd)	11,195	Electricity, kerosene, firewood	7.05 (EP)
5	26724	Rural	129,781 (1st)	22,667	Electricity, kerosene, firewood	17.47 (non EP)
6	28164	Rural	366,621 (7th)	9,146	Electricity, kerosene, firewood	2.49 (EP)
7	31091	Rural	248,332 (5th)	13,973	Electricity, firewood	5.63 (EP)
8	36784	Rural	166,551 (3rd)	4,186	Electricity, firewood	2.51 (EP)
9	47112	Urban	335,045 (7th)	39,847	Electricity, kerosene, firewood	11.89 (non EP)
10	47369	Rural	229,732 (4th)	18,930	Electricity, kerosene, firewood	8.24 (EP)
11	49336	Rural	238,084 (5th)	6,446	Kerosene, firewood	2.71 (EP)
12	50210	Rural	215,362 (4th)	11,617	Kerosene, firewood	5.39 (non EP)
13	55428	Rural	203,345 (4th)	20,944	Eletricity, kerosene	10.30 (EP)
14	15939	Urban	704,065 (10th)	21,624	Electricity, kerosene	3.07 (EP)
2011						
15	13697	Rural	1,278,393 (4th)	127,000	Electricity, firewood	9.93 (EP)
16	18406	Urban	1,592,460 (5th)	131,833	Electricity, LPG	8.28 (EP)
17	41406	Rural	3,127,167 (9th)	125,000	Electricity, kerosene, firewood	3.99 (EP)
18	65704	Rural	3,099,194 (9th)	46,000	Electricity, LPG, kerosene	1.48 (EP)
19	102826	Urban	4,999,440 (10th)	139,333	Electricity, LPG	2.79 (EP)
20	111043	Rural	2,715,142 (8th)	86,333	Electricity, LPG	3.18 (EP)
21	118267	Rural	1,781,137 (6th)	66,766	Electricity, LPG	3.75 (EP)
22	151465	Urban	1,714,995 (6th)	36,333	Electricity, firewood	2.12 (EP)
23	155251	Urban	1,504,677 (5th)	91,200	Electricity, LPG	6.06 (EP)
24	159321	Urban	2,091,875 (7th)	63,733	Electricity, LPG, firewood	3.05 (EP)
25	216943	Urban	1,123,286 (3rd)	60,333	Electricity, kerosene	5.37 (EP)
26	241417	Urban	723,970 (1st)	46,333	Electricity, LPG	6.40 (EP)
27	271158	Rural	1,747,857 (6th)	82,000	Kerosene	4.69 (EP)
28	279362	Rural	404,905 (1st)	44,333	Firewood	10.94 (non EP)

is the 7th decile. Clearly, the energy expenditure of these samples are different, i.e. 8,939 IDR; 9,146 IDR and 39,847 IDR for data 1, 6 and 9, respectively. By using Mirza & Szirmai (2010) definition, where energy poverty is viewed as not meeting the minimum expenditure for meeting energy sufficiency, the example numbers 1 and 6 are energy poor, while example number 9 is not energy poor.

Table 5.8: Number and percentage of people above and below 10% income expenditure threshold by fuel type[43]

Year	Energy expenditure	Type of fuels	
		Traditional fuel	Modern fuels
2007	Less than 10% of total expenditure	106,018,746 (47.29%)	195,232,884 (87.08%)
	More than 10% of total expenditure	17,103,665 (7.63%)	28,342,067 (12.64%)
2011	Less than 10% of total expenditure	96,938,394 (40.20%)	218,964,010 (90.81%)
	More than 10% of total expenditure	8,833,541 (3.66%)	17,167,132 (7.12%)

Note: This table is the calculation of the author from SUSENAS data in 2007 and 2011

Furthermore, there are some households who have almost similar energy expenditure, but they are in different categories of energy poverty. For example, the energy expenditure of the example numbers 26 and 28 are 46,333 IDR and 44,333 IDR respectively. The energy expenditures of them are almost similar. Even though their estimated income is different, 723,970 IDR/month and 404,905% IDR/month, both of the examples are in the same income decile group. Furthermore, the example number 28

[43] The percentage is calculated from number of users divided by total estimation of population at that time. In this case, estimation of total population in 2007 was 224,203,917 people while in 2011 was 241,133,778 people.

is categorised as not in energy poverty, whilst example number 26 is in energy poverty because it is recognised that the household has energy expenditure of less than 10% of its total income. The other examples are numbers 17, 18 and 19 which are high income decile households. In the example in Table 5.7, they are identified as energy poor.

Table 5.8 shows the potential of misclassification of energy poverty based on the threshold of 10% of energy expenditure (as the minimum that should be spent). From SUSENAS 2007, there were about 98% of people who spent less than 10% of their income on energy but used modern fuels. In the meantime, there were 7.63% of people who used traditional fuels and spent more than 10% of their income on energy. The percentage in 2011 was different to 2007. There were 90.8% of people who spent less than 10% for energy but used modern fuel, whilst about 3.66% of people who spent more than 10% for energy but still relied upon traditional energy.

In this case, the category of energy poverty is unfair as higher level income households can be categorised as energy poor, while a lower income household is categorised as non-energy poor. Thus, energy poverty as the share of expenditure less than 10% is not a good definition of energy poverty when households vary a lot in income as it can be misleading.

In this research discussion, lack of access to energy in terms of the share of expenditure-based approach refers to lower amount of money spent for energy, 10% of income is adopted as the general threshold to identify the energy poverty (below this). In Indonesia, some families who spend less money for energy may not need to pay for fuel as they are able to access energy without spending money. For example, households who live in rural areas have more sources of firewood which is cheap or even free. From Table 5.7, some households who used firewood spent less money for energy and they are energy poor, as in example numbers 6, 8, 11, 12, 22 and 24. The exceptions are examples 5, 9 and 28 who are firewood users but not energy poverty because they are identified as having spent more than 10%. In terms of modern energy access, those three examples are inconsistent as they use traditional energy even though the share of energy expenditure is more than 10%. This is because estimated income of sample 28 is in 1st decile which means that they are income poor. Those three samples indicate that the share of expenditure-based approach is unable to recognise households who rely upon traditional fuel through the share of energy expenditure.

5.1.3. Source of Energy-Based Approach for Assessing the Access to Modern Energy

Like the previous sections, this section will analyse the two annual SUSENAS module M datasets for 2007 and 2011. As previously mentioned, in the source of energy-based approach, households who used a specific energy carrier are identified to determine the households/people who have access to modern energy, and energy poverty. The percentage of households who used a specific energy carrier is calculated as the level of access. The average percentage of households who used fuel in the regions of Indonesia in 2007 and 2011 are presented in Table 5.9.

In this section, energy carriers are grouped into six categories: electricity, gas, LPG, kerosene, briquettes and charcoal, and firewood. Among those six energy carrier types, in 2007 the use of electricity was the highest and 92% of people had access to electricity; 86% of people used kerosene and 54% of people used firewood. In 2011, patterns of fuel use changed. Electricity users increased slightly to 93%, and LPG users increased considerably to 55% of people, while the use of kerosene, briquettes, charcoal and firewood in 2011 reduced. The highest reduction was in kerosene, which fell from 86% to 28% of people using it. However, the users of firewood in 2011 reduced by 9%, from 54% to 45% of the population.

Table 5.9: The statistics of access in terms of source of energy-based approach[44]

Energy	Year	
	2007	2011
Electricity	206,511,724 people (92.10%)	225,970,586 people (93.7%)
Natural gas	36,774 people (0.00%)	1,007,877 people (0.4%)
LPG	31,662,023 people (14.10%)	133,041,498 people (55.2%)
Kerosene	193,684,982 people (86.40%)	68,059,941 people (28.2%)
Briquettes and charcoal	3,080,971 people (1.40%)	1,901,069 people (0.8%)
Firewood	121,372,615 people (54.10%)	110,779,056 people (45.9%)

From Table 5.9 it can't be estimated who had access to modern fuels and who didn't have the access to modern fuels. The reason is because there were users of multiple fuels. Table 5.10 and Table 5.11 show the percentage of multiple users. Those tables can be used to estimate the percentage of people who used modern fuel and who used traditional fuels and the result is shown in Table 5.12 and Table 5.13.

[44] Calculated from SUSENAS, module K questionnaires analysed with SPSS Version 22

Table 5.10: Energy used by households in 2007

Number of fuel consumed	Type of fuel[45]							
	E	L	N	K	B&C	F	Number	Percentage
1 fuel	Y						115,939	0.05%
		Y					7,054	0.00%
				Y			811,095	0.36%
						Y	616,795	0.28%
2 fuel	Y	Y					13,659,460	6.09%
	Y		Y				10,308	0.00%
	Y			Y			70,868,863	31.61%
	Y				Y		105,389	0.05%
	Y					Y	14,079,826	6.28%
		Y		Y			10,983	0.00%
				Y	Y		180,114	0.08%
				Y		Y	15,687,137	7.00%
3 fuel	Y	Y	Y				8,183	0.00%
	Y	Y		Y			14,522,680	6.48%
	Y	Y			Y		56,117	0.03%
	Y	Y				Y	734,788	0.33%
	Y		Y	Y			14,730	0.01%
	Y		Y			Y	3,553	0.00%
	Y			Y	Y		1,223,122	0.55%
	Y			Y		Y	86,510,050	38.59%
	Y				Y	Y	56,737	0.03%
		Y		Y		Y	30,779	0.01%
				Y	Y	Y	336,025	0.15%
4 fuel	Y	Y		Y	Y		185,054	0.08%
	Y	Y		Y		Y	2,378,512	1.06%
	Y	Y			Y	Y	12,575	0.01%
	Y			Y	Y	Y	870,000	0.39%
5 fuel	Y	Y		Y	Y	Y	0	0.00%

[45] E = Electricity, L = LPG, N = natural gas, K = kerosene, BC = Briquette/charcoal, F = firewood.

Table 5.11: Energy used by households in 2011[46]

Number of fuel consumed	Type of fuel							
	E	L	N	K	B&C	F	Number	Percentage
1 fuel	Y						2,917,631	1.21%
		Y					293,967	0.12%
			Y				4,935	0.00%
				Y			921,142	0.38%
					Y		22,784	0.01%
						Y	3,155,179	1.31%
2 fuel	Y	Y					99,097,921	41.10%
	Y		Y				386,620	0.16%
	Y			Y			19,260,978	7.99%
	Y				Y		215,721	0.09%
	Y					Y	42,724,096	17.72%
		Y	Y				2,157	0.00%
		Y		Y			209,262	0.09%
		Y			Y		2,895	0.00%
		Y				Y	169,780	0.07%
			Y			Y	23,066	0.01%
			Y		Y		328	0.00%
				Y	Y		1,143,881	0.47%
				Y		Y	9,412,418	3.90%
					Y	Y	19,600	0.01%
3 fuel	Y	Y	Y				277,387	0.12%
	Y	Y		Y			5,245,896	2.18%
	Y	Y			Y		217,270	0.09%
	Y	Y				Y	22,837,351	9.47%
	Y		Y	Y			28,818	0.01%
	Y		Y			Y	142,130	0.06%
	Y			Y		Y	27,321,361	11.33%
	Y				Y	Y	100,568	0.04%
		Y	Y			Y	3,854	0.00%
		Y		Y	Y		33,173	0.01%
		Y		Y		Y	342,910	0.14%
		Y			Y	Y	1,482	0.00%
			Y	Y		Y	2,852	0.00%
				Y	Y	Y	83,833	0.03%
4 fuel	Y	Y	Y	Y			11,220	0.00%
	Y	Y	Y		Y		1,026	0.00%
	Y	Y	Y			Y	82,197	0.03%
	Y	Y		Y	Y		87,959	0.04%
	Y	Y		Y		Y	4,011,455	1.66%
	Y	Y			Y	Y	63,729	0.03%
	Y		Y	Y	Y		2,582	0.00%
	Y		Y	Y		Y	30,077	0.01%
	Y		Y		Y	Y	202,934	0.08%
	Y			Y	Y	Y	4,804	0.00%
5 fuel	Y	Y	Y	Y	Y		686	0.00%

[46] E = Electricity, L = LPG, N = natural gas, K = kerosene, BC = Briquette/charcoal, F = firewood.

Table 5.12: Estimated people who have access to modern fuels and traditional fuels 2007

Estimated number and percentage (in parenthesis) of people							
Have access to modern fuels only				Have access to traditional fuels and modern fuels		Have access to traditional fuels only	
(kerosene excluded)		(kerosene included)					
E	115,939 (0.05%)	E	115,939 (0.05%)	E-BC	105,389 (0.05%)	F	616,795 (0.28%)
L	7,054 (0.00%)	L	7,054 (0.00%)	E-F	14,079,826 (6.28%)		
E-L	13,659,460 (6.09%)	K	811,095 (0.36%)	K-BC	180,114 (0.08%)		
E-N	10,308 (0.00%)	E-L	13,659,460 (6.09%)	K-F	15,687,137 (7.00%)		
E-L-N	8,183 (0.00%)	E-N	10,308 (0.00%)	E-L-BC	56,117 (0.03%)		
		E-K	70,868,863 (31.61%)	E-L-F	734,788 (0.33%)		
		L-K	10,983 (0.00%)	E-NG-F	3,553 (0.00%)		
		E-L-N	8,183 (0.00%)	E-K-BC	1,223,122 (0.55%)		
		E-L-K	14,522,680 (6,48%)	E-K-F	86,510,050 (38.59%)		
		E-N-K	14,730 (0.01%)	E-BC-F	56,737 (0.03%)		
				NG-K-F	30,779 (0.01%)		
				K-BC-F	336,025 (0.15%)		
				E-L-K-BC	185,054 (0.08%)		
				E-L-K-F	2,378,512 (1.06%)		
				E-L-BC-F	12,575 (0.01%)		
				E-K-BC-F	870,000 (0.39%)		
Total	13,800,944 (6,19%)		100,029,295 (44.84%)		122,449,778 (54.89%)		616,795 (0.28%)

Table 5.13: Estimated people who have access to modern fuels and traditional fuels 2011

Estimated number and percentage (in parenthesis) of people							
Have access to modern fuels only				Have access to traditional fuels and modern fuels		Have access to traditional fuels only	
(kerosene excluded)		(kerosene included)					
E	2,917,631 (1.21%)	E	2,917,631 (1.21%)	E-BC	215,721 (0.09%)	BC	22,784 (0.01%)
L	293,967 (0.12%)	L	293,967 (0.12%)	E-F	42,724,096 (17.72%)	F	3,155,179 (1.31%)
N	4,935 (0.00%)	N	4,935 (0.00%)	L-BC	2,895 (0.00%)	BC-F	19,600 (0.01%)
E-L	99,097,921 (41.10%)	K	921,142 (0.38%)	L-F	169,780 (0.07%)		
E-N	386,620 (0.16%)	E-L	99,097,921 (41.10%)	N-BC	328 (0.00%)		
L-N	2,157 (0.00%)	E-N	386,620 (0.16%)	N-F	23,066 (0.01%)		
E-L-N	277,387 (0.12%)	E-K	19,260,978 (7.99%)	K-BC	1,143,881 (0.47%)		
		L-N	2,157 (0.00%)	K-F	9,412,418 (3.90%)		
		L-K	209,262 (0.09%)	E-L-BC	217,270 (0.09%)		
		E-L-N	277,387 (0.12%)	E-L-F	22,837,351 (9.47%)		
		E-L-K	5,245,896 (2.18%)	E- N-F	142,130 (0.06%)		
		E-L-N-K	11,220 (0.00%)	E-K-F	27,321,361 (11.33%)		
				E-BC-F	100,568 (0.04%)		
				L-N-F	3,854 (0.00%)		
				L-K-BC	33,173 (0.01%)		
				L-K-F	342,910 (0.14%)		
				L-BC-F	1,482(0.00%)		
				N-K-F	2,852 (0.00%)		
				K-BC-F	83,833 (0.03%)		
				E-L-N-BC	1,026(0.00%)		
				E-L-N-F	82,197 (0.03%)		
				E-L-K-BC	87,959 (0.04%)		
				E-L-K-F	4,011,455 (1.66%)		
				E-N-K-BC	2,582 (0.00%)		
				E-N-K-F	30,077 (0.01%)		
				E-N-BC-F	202,934 (0.08%)		
				E-N-K-BC-F	4,804 (0.00%)		
				E-L-N-K-BC-F	686 (0.00%)		
Total	102,980,618 (42.71%)		128,629,116 (53.35%)		109,202,689(45.29%)		3,197,563 (1.33%)

Table 5.12 and Table 5.13 estimated the access to modern energy in to two scenarios; when kerosene is excluded as modern fuel and when it is included as modern fuel. Table 5.12 shown that estimated people who have access to modern fuel in 2007 if kerosene is excluded was 6.19% of population, and when kerosene is considered as modern fuel, there were 44.8% of population who used modern fuels. Additionally, there were only 0.28% of population who had high dependency on traditional fuels. But there were 54% of population who use modern and traditional fuels. They can be viewed as having access to modern fuels but also suffering from energy poverty because they used traditional fuels.

Different to 2007, in 2011 there were about 42.7% of population who have access to modern fuels (see Table 5.13). This is much higher than 2007. Moreover, there was resulted a higher percentage when kerosene is included as modern fuels, that was 53.4% of population. While there was an increase in modern fuel users by 2011, the users of traditional fuels also slightly increased to 1.3% of population. But people who have access to traditional fuels and also used modern fuels in 2011 reduced to 45%.

The source of energy-based approach has been applied by scholars to identify the energy poverty or identify the accessibility of modern energy (see Section 2.3 Part C and Bravo et al., 1983; Practical Action, 2010). It was compiled by WHO and the data have been applied by Bonjour et al. (2013) to identify solid fuels users in the world. Inevitably, data collection is one of the challenges in measuring energy access; data availability is one of the challenges in measuring energy poverty (Mirza & Szirmai, 2010).

Compared to the quantity and share of expenditure-based approach, the source of energy-based approach is easier. However, this approach is unable to record sufficiency of energy that people have access to. Similarly, the quantity-based approach is unable to identify the type of fuels. By referring to the definition of the access to modern energy and energy poverty which is provided in Section 2.2 by UNDP that the energy poverty is not merely about the availability of access to clean and modern energy services but they should also be sufficient and affordable for people to be not in energy poverty, the source of energy-based approach is not sufficient. However, as discussed above the affordability approach by using share of expenditure may misplace people in the wrong category. Therefore, this study is unable to combine these approaches together.

5.2 The Broader Pattern of Energy for Cooking in Indonesia

The previous section examined the access to modern energy in domestic area. Attention will now focus on the access to energy for cooking as this section will be used to identify the effect of ECPKL on the transition of energy use. In terms of energy for cooking, the government of Indonesia has carried out an annual survey, that is SUSENAS Module K (referred to in Chapter 4 in more detail).

In this section, the dynamics of the distribution of energy for cooking use in Indonesia will be explored in more detail by using thematic maps in GIS that reveal the spatial distribution of specific energy carrier use in Indonesia. Spatial in this term relates to the 456 regions (*kabupaten*/*kotamadya*) within 33 Provinces around Indonesia. As described in Section 4.2.1 (Chapter 4), during 2007 to 2011, the number of administrative regions in Indonesia was developed. Hence, the number of regions in 2011 was higher than in 2007. Population growth enables one area to break into new regions. Therefore, in order to make fair comparison from 2007 to 2011, this study applies for all years the same number of regions as 2007, i.e. 456 regions. The regions which developed during 2008 to 2011 are merged to form the original regions in 2007. Hence, 456 regions will be analysed annually. Meanwhile, the percentage of households who used a specific fuel in one region is identified as having access to that fuel. The results are shown in Table 5.14 and Figure 5.5.

Table 5.14: The number and percentage of household who used main fuel for cooking in 2007-2011[47]

Fuels	The estimated number and percentage of household who use fuel				
	2007	2008	2009	2010	2011
Electricity					
Estimated number	1,059,922	611,681	833,592	942,301	745,104
Estimated percentage (in %)	1.86	1.06	1.43	1.53	1.19
Gas and LPG					
Estimated number	6,014,074	10,747,944	20,703,377	25,638,488	29,685,115
Estimated percentage (in %)	10.57	18.68	35.54	41.51	47.40
Kerosene					
Estimated number	20,799,385	17,777,081	10,565,838	7,478,589	5,980,023
Estimated percentage (in %)	36.57	30.89	18.14	12.11	9.55
Briquette and Charcoal					
Estimated number	449,835	466,258	350,795	431,884	11,704
Estimated percentage (in %)	0.79	0.81	0.60	0.70	0.02
Firewood					
Estimated number	28,086,821	27,332,001	25,189,967	26,225,958	24,983,013
Estimated percentage (in %)	49.38	47.49	43.24	42.46	39.89
Total	56,878,513	57,548,673	58,255,544	61,768,939	62,630,218

[47] Calculated from SUSENAS, module K questionnaires analysed with SPSS Version 22

The results are different from the calculation in Table 5.9, because Table 5.14 merely focuses on the main fuel for cooking. In Table 5.14 electricity use is very low, no more than 1.9% of household. With the information of average household member number from Table 3.1, it can be estimated that the people who used electricity in 2007 to 2011 were 4.6 million people, 2.6 million people, 3.6 million people, 4.1 million people and 3.2 million people, respectively. These numbers are much smaller in comparison to number which are presented in Table 5.9. This informs us that, even though electricity is the energy most used by people for domestic use, about 92% of population (see Table 5.9), it does not mean people use electricity as their main fuel for cooking. The reason is that electric stoves are expensive and most people in Indonesia are unable to afford them. Moreover, presumably electricity is used as a secondary fuel for cooking, for example just for boiling water in electric kettle or for cooking rice in an electric rice cooker. This is similar to kerosene user wherein from Table 5.9, the kerosene user in 2007 was 86%, but Table 5.9 shows that at the same time the kerosene used for main cooking fuel was only 36.6%. Kerosene in domestic use is not solely for cooking but also for lighting. Alternatively, kerosene is used as secondary or tertiary cooking fuels combined with other fuels, such as kerosene-LPG and kerosene-firewood. Nevertheless, the gaps between briquette, charcoal and firewood user (see Table 5.9) and the users of these fuels for main cooking are not high (Table 5.13). This indicates that the use of briquette, charcoal and firewood in the domestic context is predominantly for cooking.

The detailed and clear picture of the dynamic of main energy carrier used for cooking is revealed in Figure 5.3. From this picture, it appears that from 2007 to 2010 firewood dominated as the main fuel used for cooking. The gradual reduction of firewood use since 2007, however, is apparent. In the meantime, interestingly, people who used LPG and natural gas as the main cooking fuels increased, from 10% in 2007 to 47% in 2011. The sharp increase in use of these fuels for cooking occurred in 2007-2009. During 2008, people who used gas and LPG as their main cooking fuel overtook people who used kerosene as their main cooking fuel. Later on, in 2010 the percentage of people who used firewood was overtaken by people who used LPG and natural gas as main cooking fuels. Hence LPG and natural gas use were the leading modern fuel for cooking and reached 47% of people by 2011.

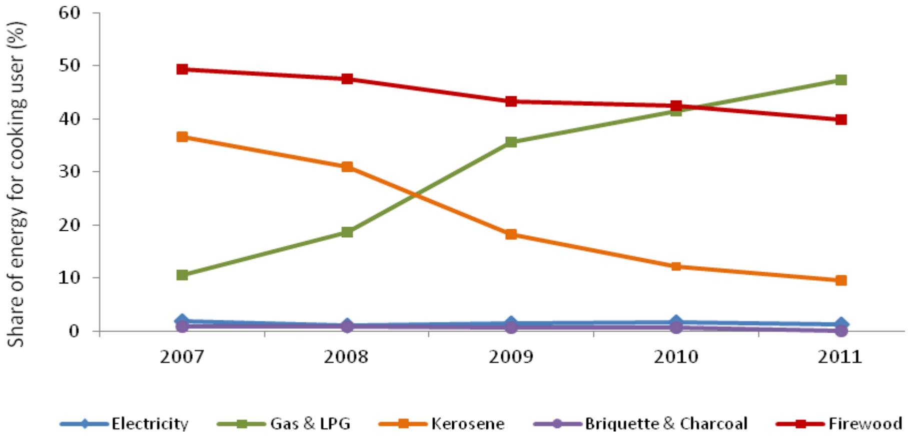


Figure 5.3: The percentage of energy users for cooking energy by energy type in Indonesia[48]

Figure 5.4 shows the estimated percentage of people who had access to modern fuels and had dependency on traditional fuels from 2007 to 2011. In the figure, there are three categories of fuel: traditional fuel, modern fuel without kerosene and modern fuel with kerosene. These three categories are applied in which kerosene is considered as a

[48] ibid

transitional fuel (Barnes et al., 2004) and kerosene as modern fuel (Sesan, 2012). Transitional fuel means neither categorised as modern fuel nor traditional fuel.

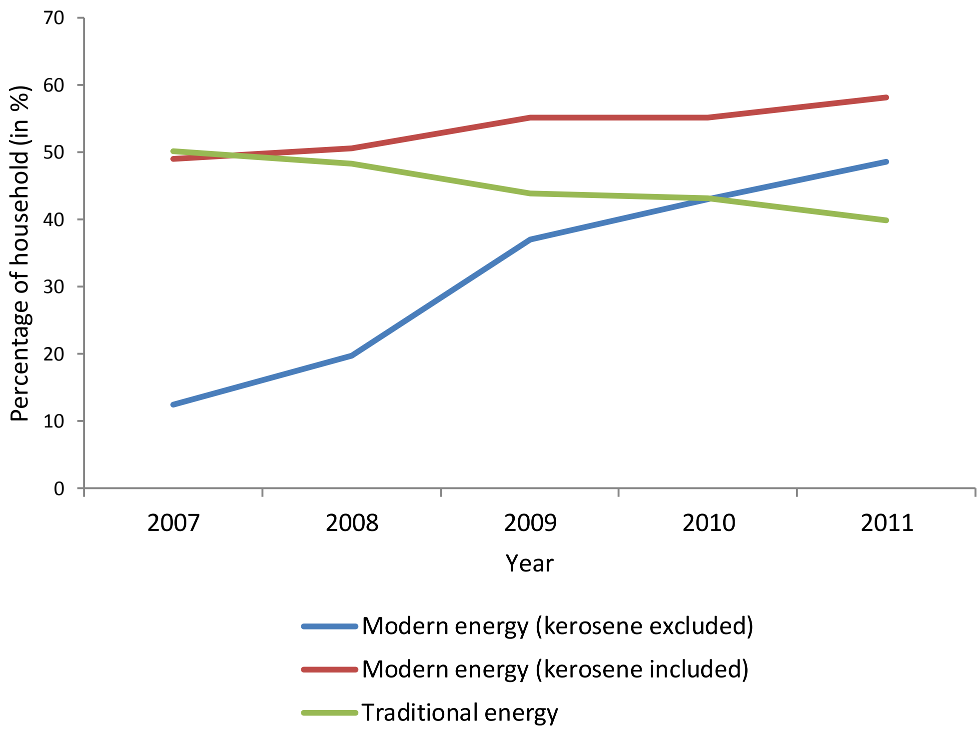


Figure 5.4: The access to fuel in Indonesia in term of the group of the source of fuels

From the table, two scenarios will be made for analysis: access to modern fuel without kerosene (with energy poverty as the inverse) and access to modern fuel with kerosene (with energy poverty as the inverse). From these scenarios, the first scenario results in apparent significant improvements on the access to modern fuel, while the second scenario produces less apparent significant improvements in the access to modern fuel. This is because in the second scenario, LPG just replaces kerosene, both of which count as modern fuel. When kerosene is not recognised as a modern fuel, the affect of ECPKL on access to modern energy will be apparent. However, when kerosene is recognised as modern fuel, whereas LPG is also modern fuel, the transition to modern fuel is not apparent, since LPG replaces other modern fuel, not transitional fuel. The following paragraphs will examine the distribution of main energy for cooking in Indonesia.

5.2.1. The Pattern of Modern Fuel (Kerosene Excluded) in Indonesia

Figure 5.5 to Figure 5.6 show the histograms of the percentage of the population that uses electricity and LPG/natural gas as the main cooking fuels in the regions in Indonesia. The *x*-axis is the percentage from 0% to 100%, whereas the *y*-axis is the frequency in regions. From Figure 5.5 it appears, the skewness of the percentage of users of electricity for main cooking fuel in 2007-2011 tends to 1% or less. This means most of the regions in Indonesia have a percentage of electricity users for main cooking at around 1% or less. The histograms are different from Figure 5.6 that represents the percentage of LPG and natural gas users in regions in Indonesia. In 2007–2008, most regions had a percentage of around 10% for users of LPG and natural gas for main cooking. Later on, in 2009–2011, the percentage of users of LPG and natural gas for main cooking fuel increased gradually in the regions. As a result, the distribution of LPG and natural user in 2010 and 2011 tends to homogeny.

Figure 5.7 to Figure 5.11 reveal the GIS maps for the percentage of users of modern fuel as main cooking fuel, but in these maps kerosene is excluded from the calculation of percentage user. From these maps there were some changes in the percentages of electricity, gas and LPG users during 2007 and 2011. The most improvements are in the regions in Java Island. In 2011 (see Figure 5.11), some regions have a percentage of modern fuel use (except kerosene) of more than 80%. This is a high improvement during five years, as in 2007 most of those regions had a percentage

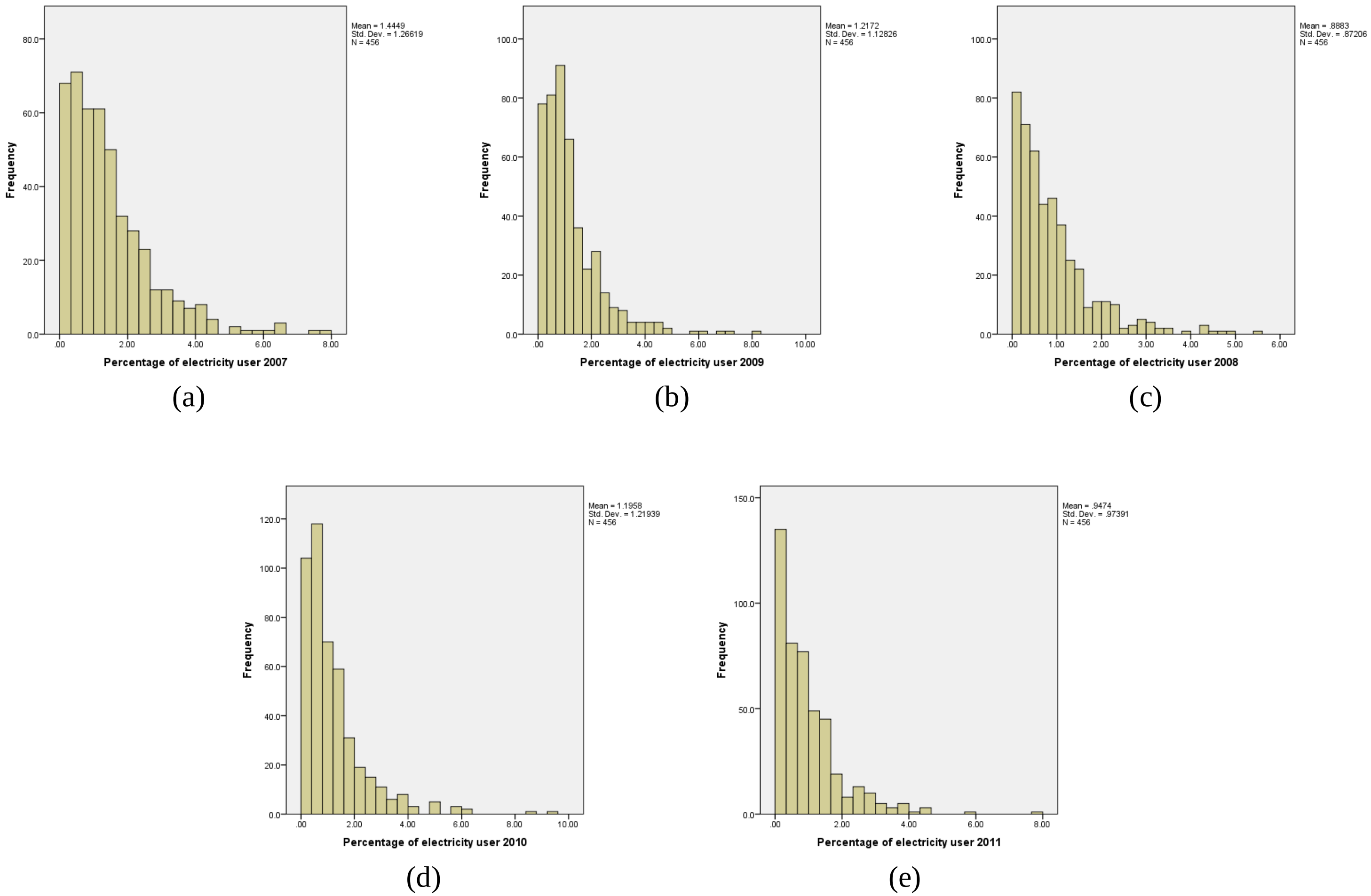


Figure 5.5: Annual distribution data of the percentage of electricity users in regions in Indonesia

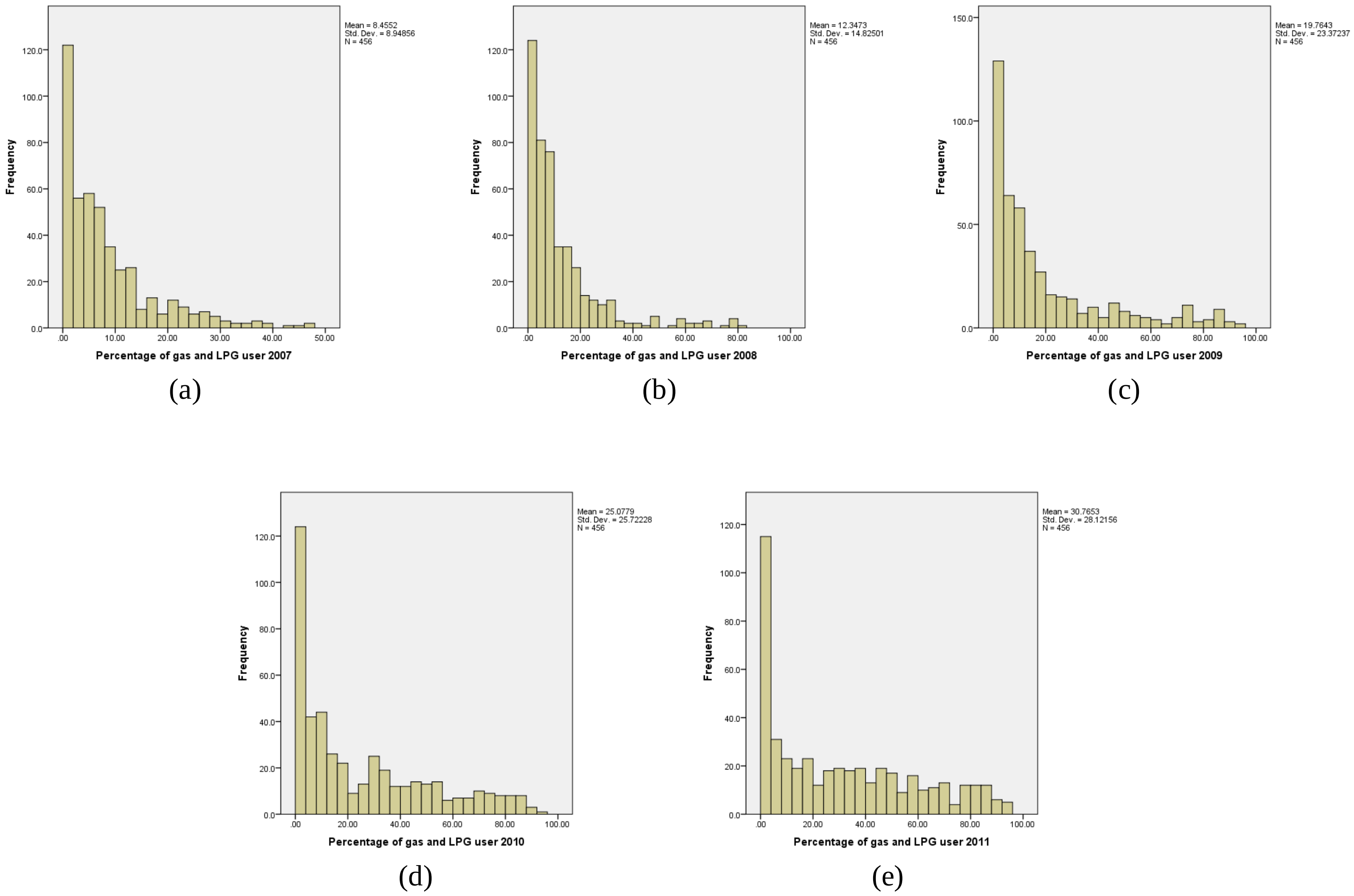


Figure 5.6: Annual distribution data of the percentage of gas & LPG users in regions in Indonesia

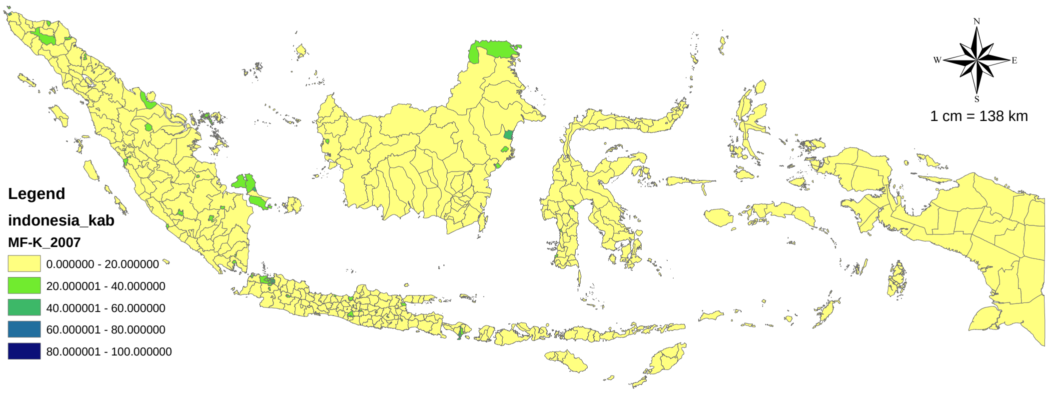


Figure 5.7: The map of access to modern fuel (without kerosene) for cooking in 2007

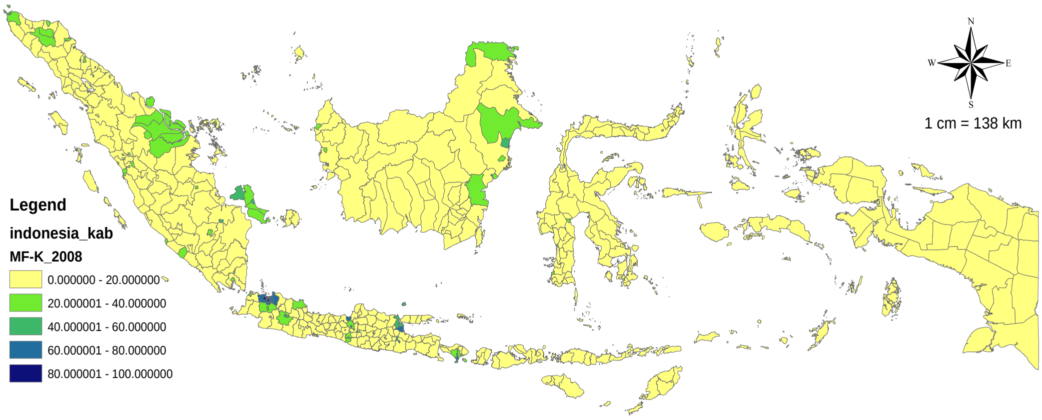


Figure 5.8: The map of access to modern fuel (without kerosene) for cooking in 2008

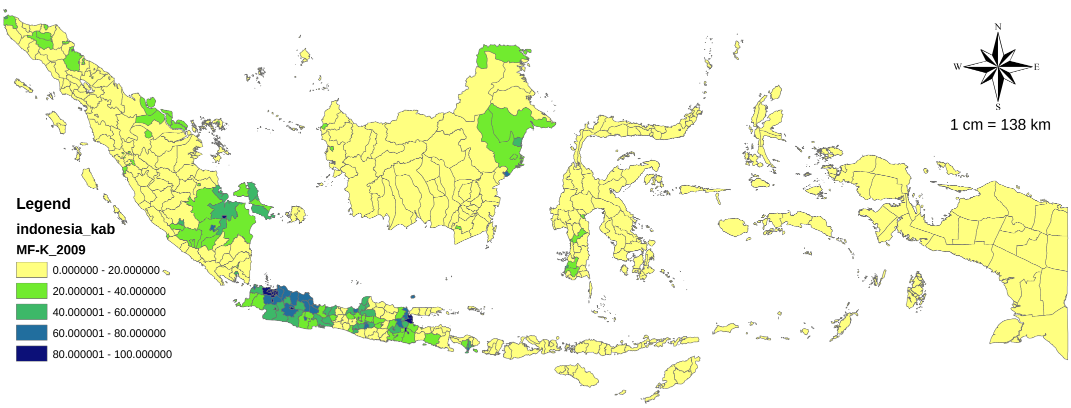


Figure 5.9: The map of access to modern fuel (without kerosene) for cooking in 2009

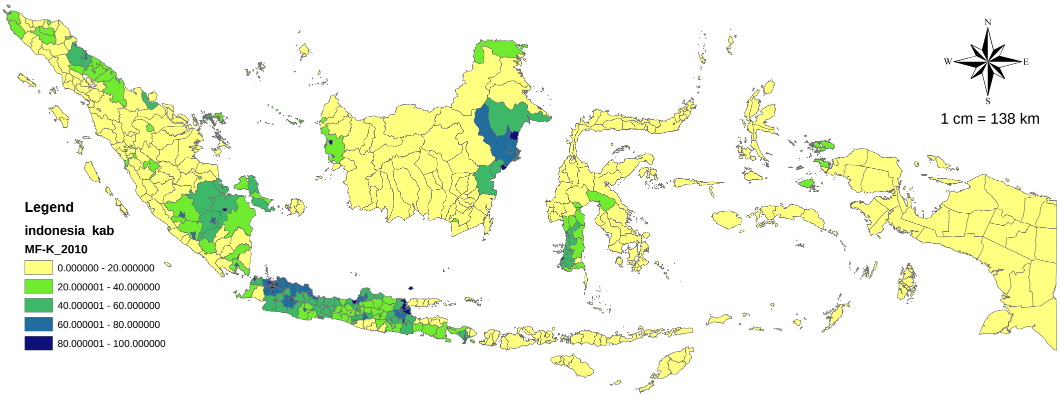


Figure 5.10: The map of access to modern fuel (without kerosene) for cooking in 2010

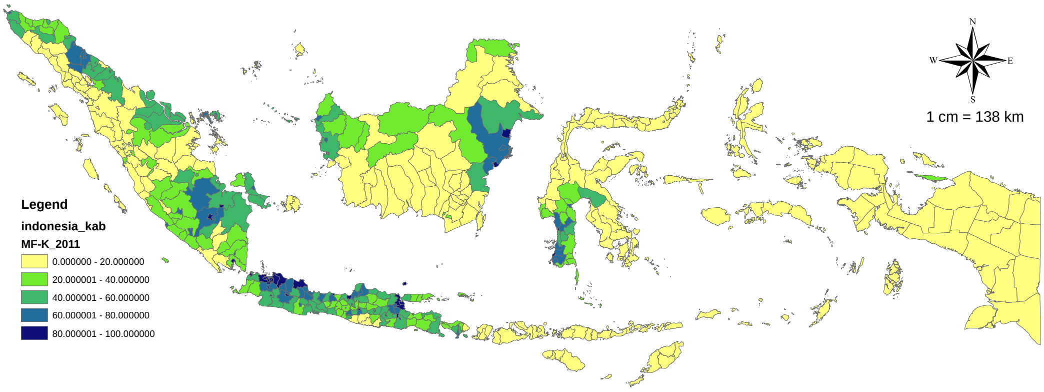


Figure 5.11: The map of access to modern fuel (without kerosene) for cooking in 2011

of modern fuel (kerosene excluded) of less than 20%. Meanwhile, Eastern Indonesia, a small part of Sumatera, and half of Kalimantan and Sulawesi remained under 20%.

Figure 5.12 reveals the summary of transition of the percentage of modern fuel users (kerosene excluded) in regions in Indonesia from 2007 to 2011. The details of the data are presented in Appendix 5.5 in Table 5.5.1. The table reveals the percentage of households who used modern fuels (kerosene excluded) as their main energy for cooking in regions in Indonesia that moved to a higher percentage group. In 2007 the regions that had less than 20% of modern fuel users (kerosene excluded) were dominant, that was 392 regions. Five years later, the regions that had less than 20% modern fuel users (kerosene excluded) had reduced to 201 regions. But, overall, the number of regions that had percentages of modern fuel (without kerosene) users in five years increased.

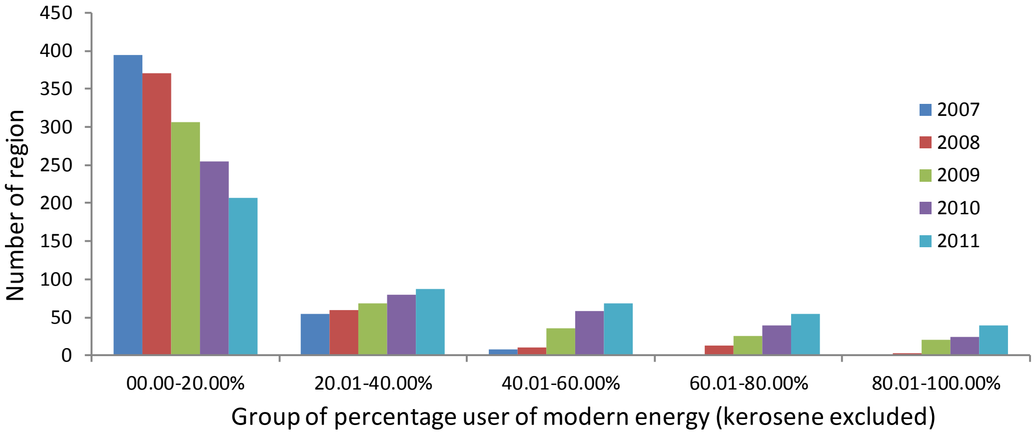
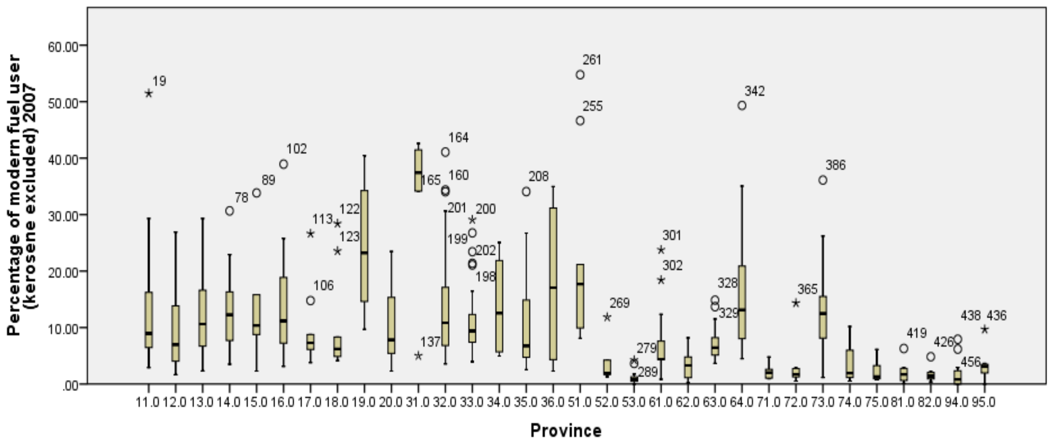


Figure 5.12: Histogram of distribution of percentage of users of modern fuel (kerosene excluded) for main cooking in regions in Indonesia during 2007–2011

The comparisons of distributions of percentage of modern fuels (kerosene excluded) for all provinces in five years are depicted in the boxplot which is presented in Figure 5.13. In the figure, the *x*-axis is 33 Provinces in Indonesia, whilst the *y*-axis is the percentage of modern fuel users in each region. The regions in a province are calculated in the boxplot. The left side to right side of the *x*-axis represents provinces from the west end to east end of Indonesia.[49] From the boxplots, in 2007 the distributions of percentage of modern fuels in regions are more homogenous in comparison to 2008 to 2011. It also appears that distributions of modern fuel users in provinces in eastern Indonesia are lower than provinces in central and western Indonesia. From Figure 5.11 it is clearly seen that

[49] List of provinces with all codes is provided in Appendix 4.1.

the increase in percentage of users of modern fuels (without kerosene) in central Indonesia in 2008-2011 is significant. By combining maps in Figure 5.5 to Figure 5.9 and boxplots in Figure 5.13 it can be summarised that the improvement in access to modern fuel (kerosene excluded) for main cooking fuel mostly happened in central Indonesia then continued to western Indonesia. Meanwhile, households who had access to electricity, natural gas and LPG in eastern Indonesia were low.



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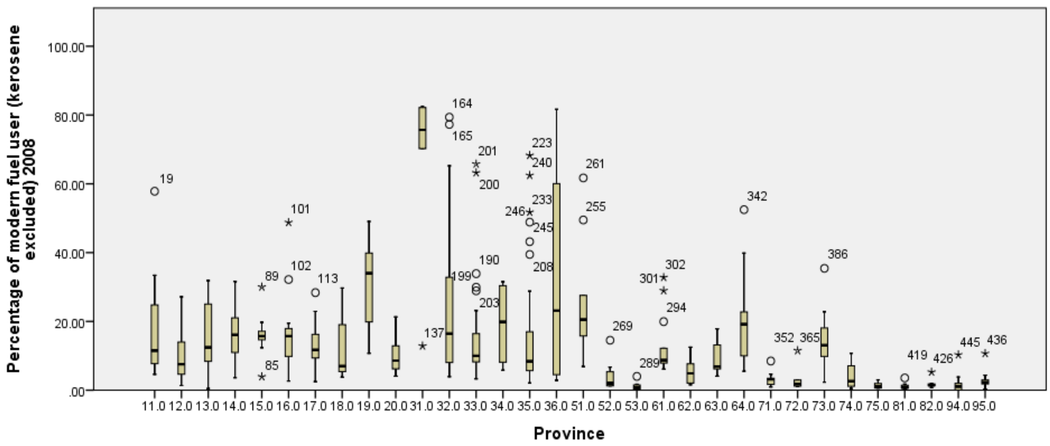

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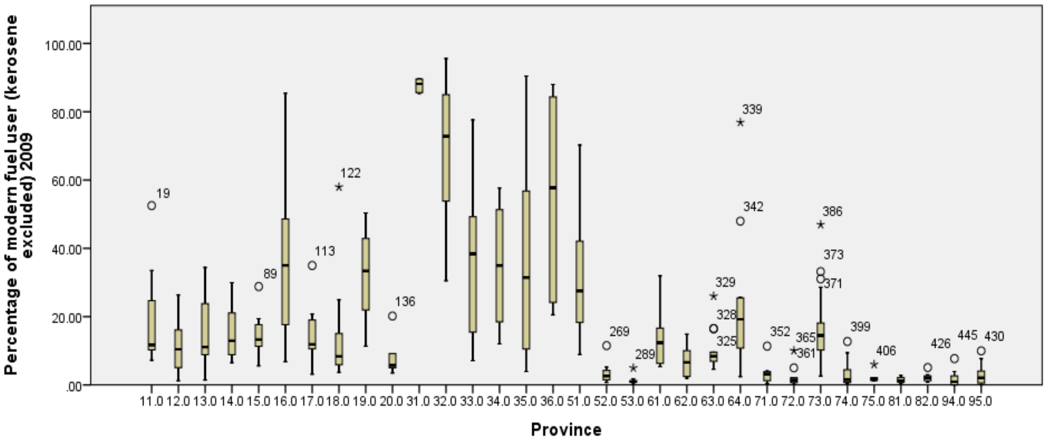

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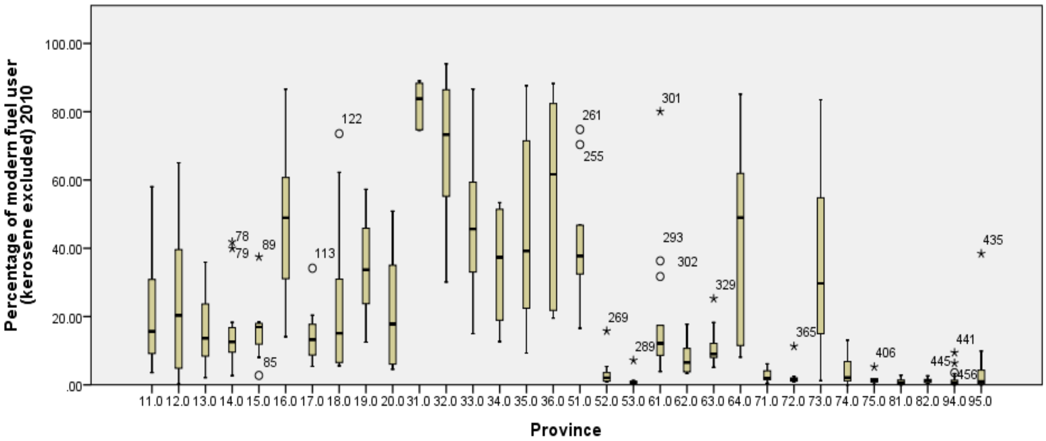

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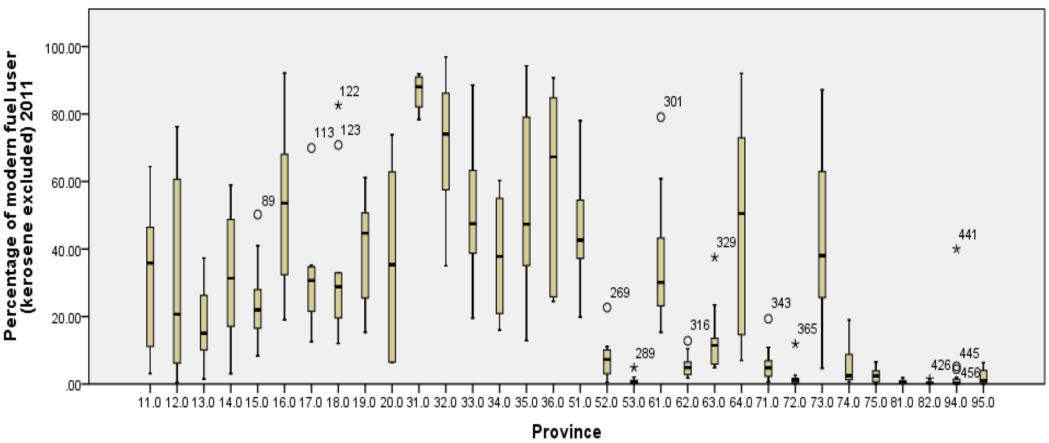

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Figure 5.13: Boxplot of distribution data of percentage of modern fuel users (kerosene excluded) in regions in 33 provinces in 2007 to 2011

5.2.2. The Pattern of Modern Fuels (Kerosene Included) in Indonesia

This section identifies the distribution of modern fuel when kerosene is included as modern fuel. The histogram of kerosene to reveal the distribution of the percentage of kerosene users (as main cooking fuel) in regions in Indonesia is presented in Figure 5.14. Similar to the previous histogram in Figure 5.5 and Figure 5.6, the trend of distribution of kerosene users for main cooking fuel in 2007–2011 changed as well. From the boxplot, the distribution of percentage of kerosene users was skewed to the left. Contrary to the distribution of percentage of LPG users, the distribution of kerosene for main cooking fuel in 2007–2011 tends to move to lower percentages. It is apparent in the last histogram in Figure 5.14, at the bottom end. Maps in Figure 5.15 to Figure 5.19 reveal the clear picture of access of modern fuel (kerosene included) in Indonesia during 2007 to 2011.

In Figure 5.15 to Figure 5.19 the changes are apparent, but there are some areas that had lower percentage of users of modern fuel (with kerosene) for the main cooking fuel. For example, the regions in eastern Indonesia such as Papua, Timor Islands and Halmahera show a lack of modern fuel. This is similar to the south of Sumatera and south of Central Java. Conversely, from central to western Indonesia, regions in 2011 were greener than 2007. This indicates the positive improvements in modern fuels (kerosene included) during five years. The details of improvement are presented in Table 5.5.2 in Appendix 5.5. The data is presented in the histogram in Figure 5.20.

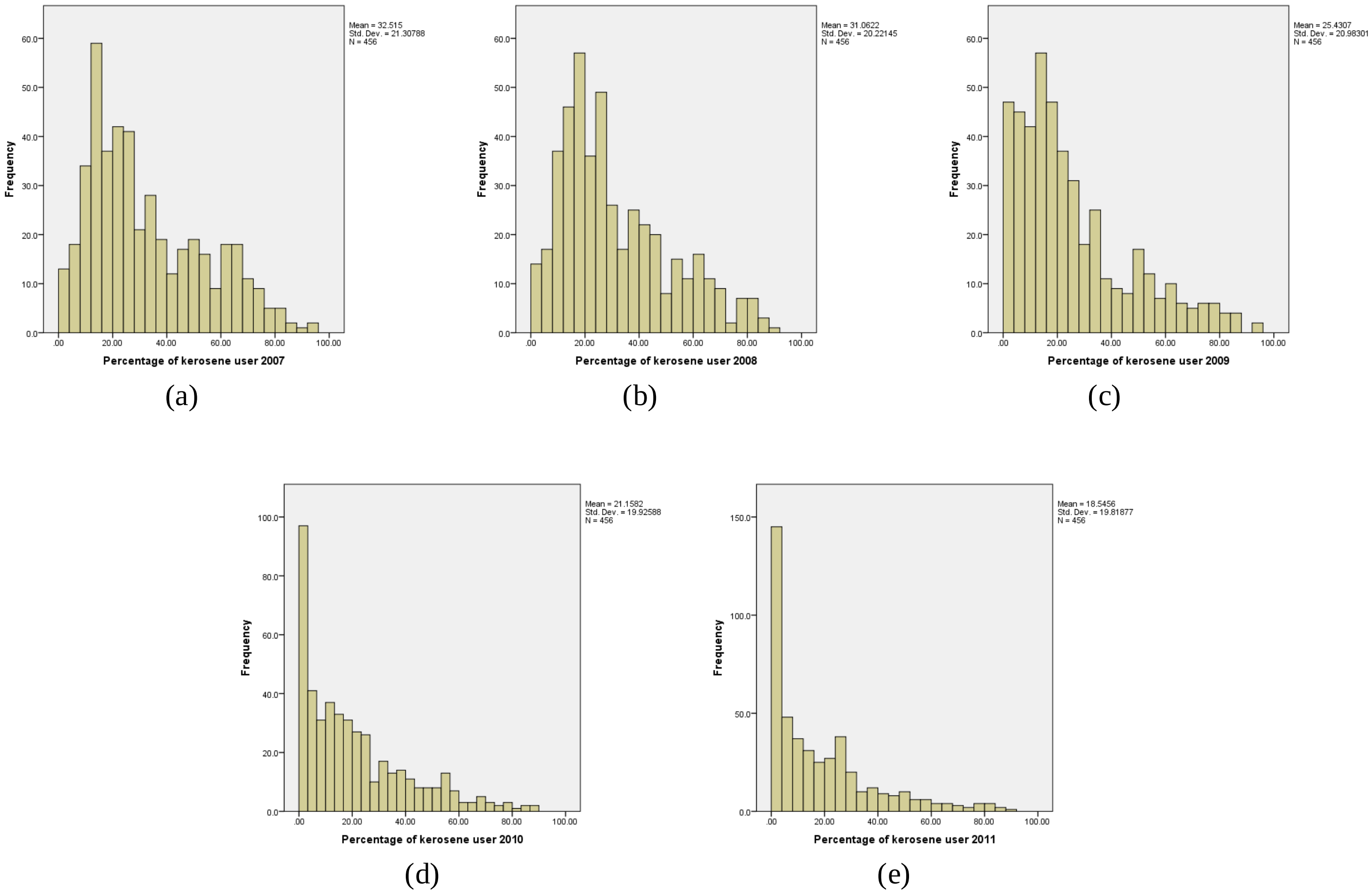


Figure 5.14: Annual distribution data of percentage of kerosene consumption in Indonesia

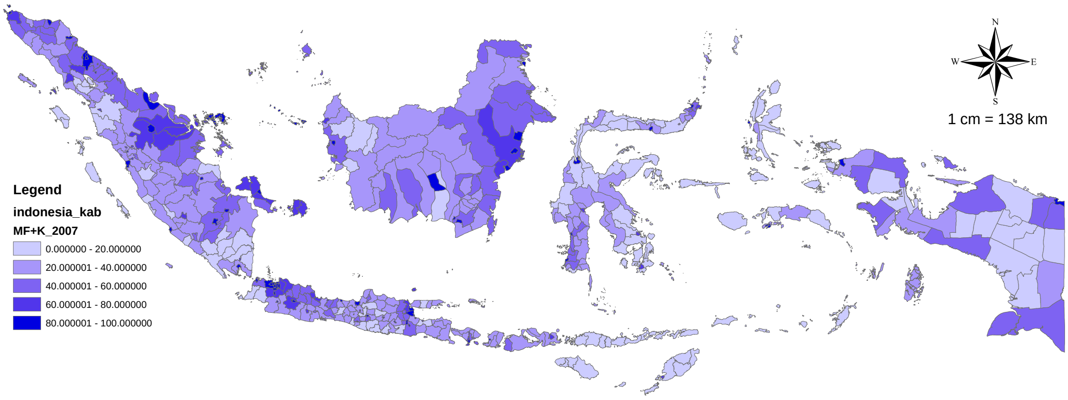


Figure 5.15: Map of the access to modern fuel (kerosene included) for cooking in 2007

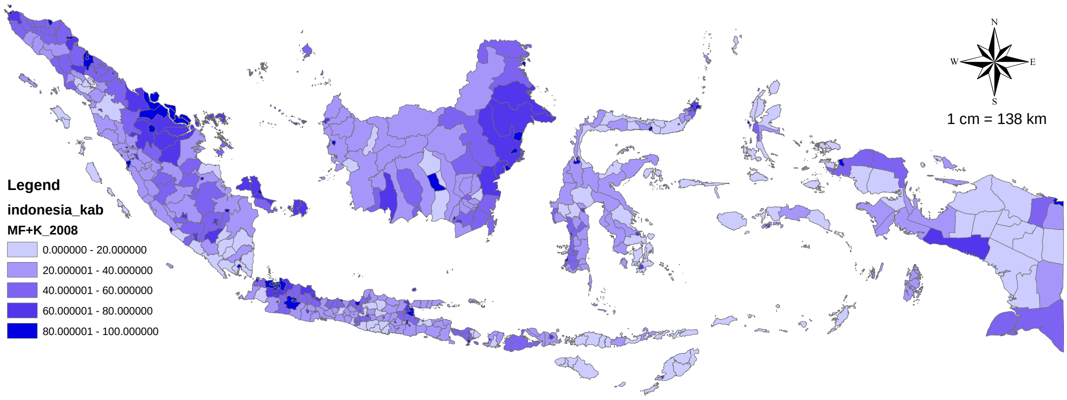


Figure 5.16: Map of the access to modern fuel (kerosene included) for cooking in 2008

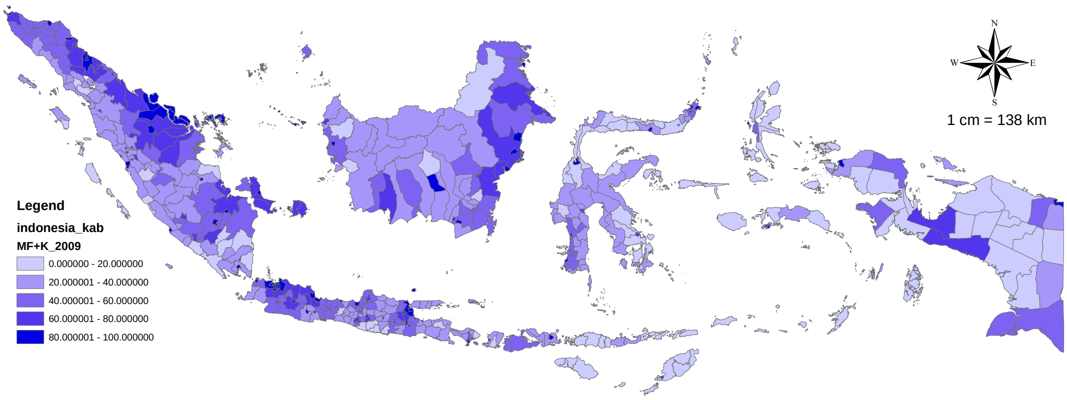


Figure 5.17: Map of the access to modern fuel (kerosene included) for cooking in 2009

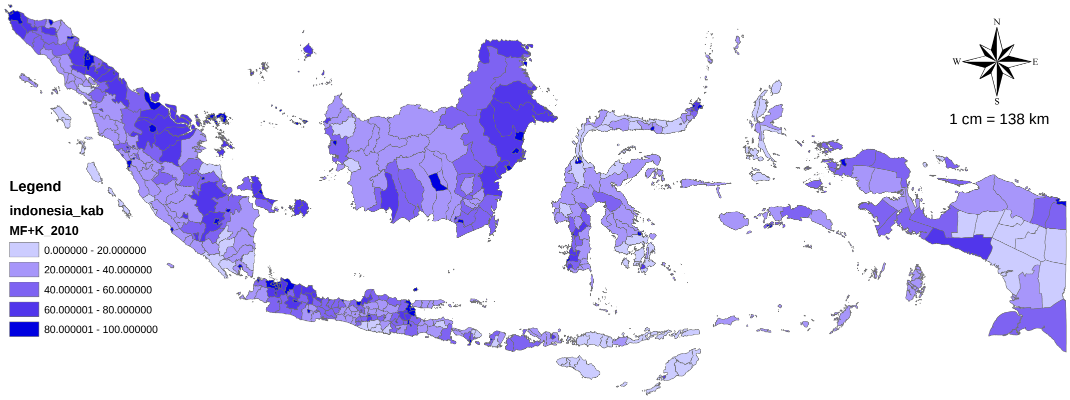


Figure 5.18: Map of the access to modern fuel (kerosene included) for cooking in 2010

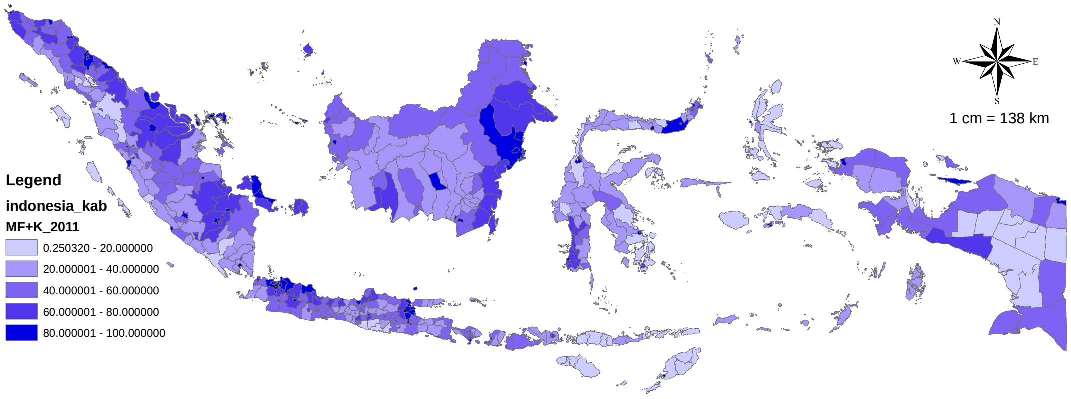


Figure 5.19: Map of the access to modern fuel (kerosene included) for cooking in 2011

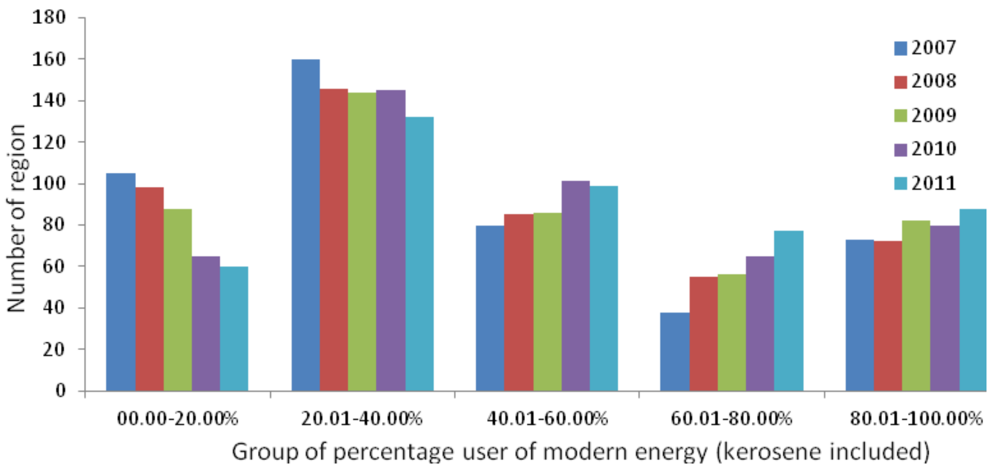
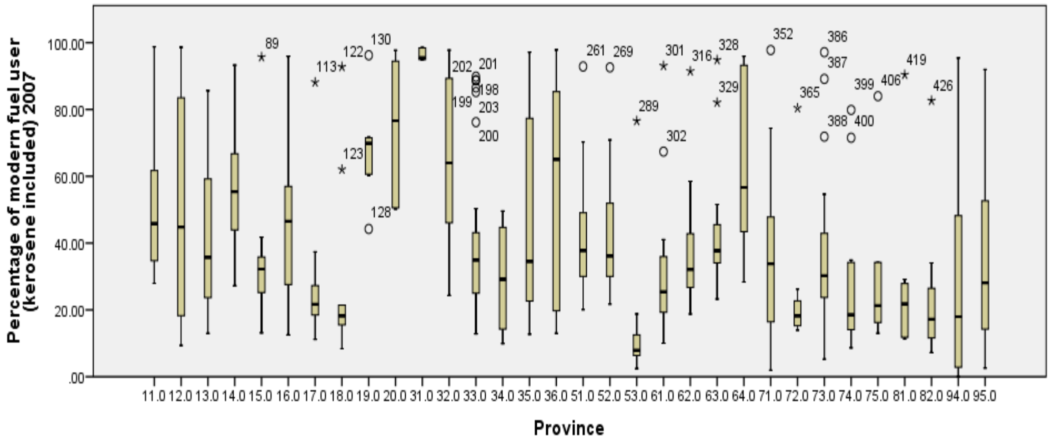


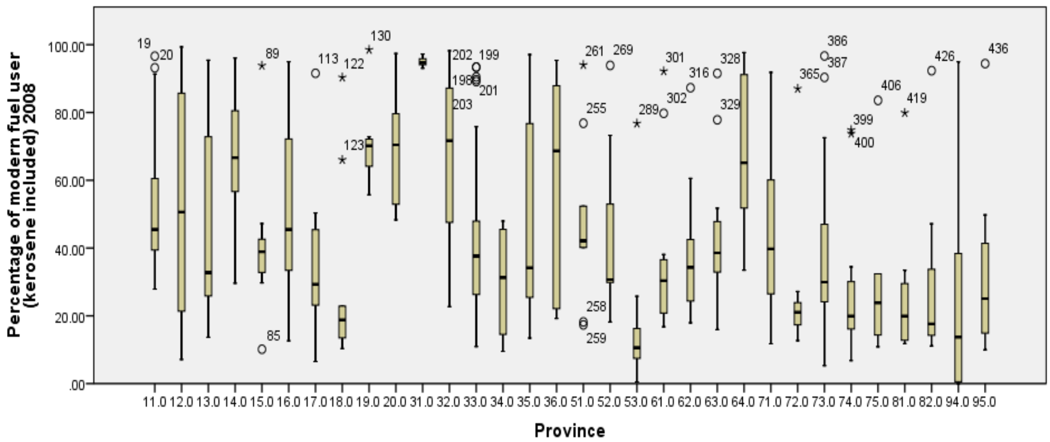
Figure 5.20: Histogram of distribution of percentage of users of modern fuel (with kerosene) for main cooking in regions in Indonesia during 2007 to 2011

From the histogram, it appears that the transition of modern fuel use when kerosene is recognised as modern fuel is different to the transition of modern fuel use when kerosene is excluded from modern fuel (see Figure 5.14). In Figure 5.20 the percentage of users of modern fuel in regions tends to increase. This can be detected from the trend of the group of percentages more than 40% that tends to increase, while the group of percentage less than 40% tends to reduce.

Boxplots of modern fuel users which include kerosene as modern fuel are revealed in Figure 5.21. Considering kerosene as modern fuel leads to the differences in the boxplot from the one in Figure 5.13. It appears that the distribution of the percentage of modern fuel users in the regions in 33 Provinces varies. But the discrepancy is not as high as when kerosene is excluded as modern fuel. There are some provinces that have average percentages of modern fuel users. For example the Province of East Nusa Tenggara (code 53) in 2007–2011 has regions that have lower percentages of users of modern fuel for cooking. On the contrary, in comparison to other provinces, the Province of DKI Jakarta has a higher percentage of modern fuel users for cooking. Overall, in 2007–2011, if kerosene is considered as a modern fuel, the distribution of modern fuels in all provinces during five years is similar. This is different to the boxplot in Figure 5.13 that shows significant increases in the percentage of modern fuel users during 2007 to 2011. The reason for this is because during 2007-2011 when the ECPKL were implemented, generally people replaced kerosene with LPG. If both kerosene and LPG are considered as modern fuel, whilst more people move from kerosene to LPG, the increase of modern fuel won't be apparent. In contrast, when kerosene excluded as a modern fuel, the changing of modern fuel will be apparent because there was significant reduction on kerosene, while LPG was also improved significantly.



(a)



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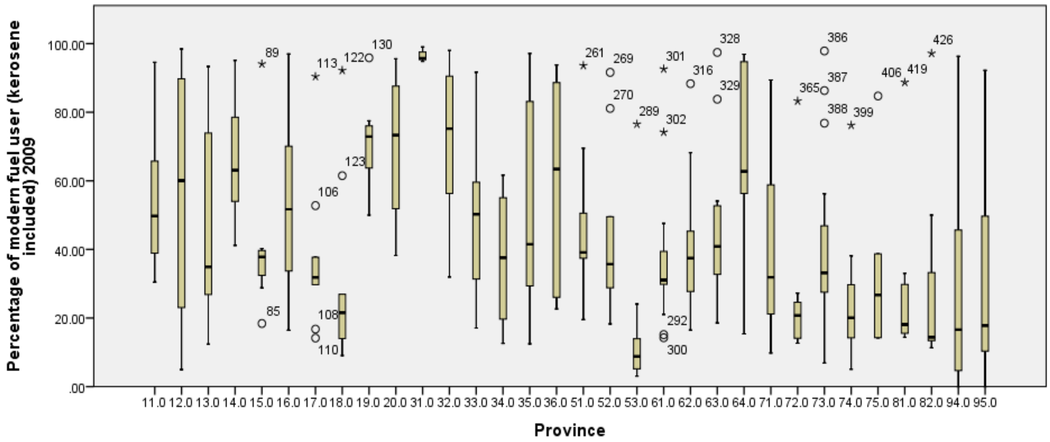

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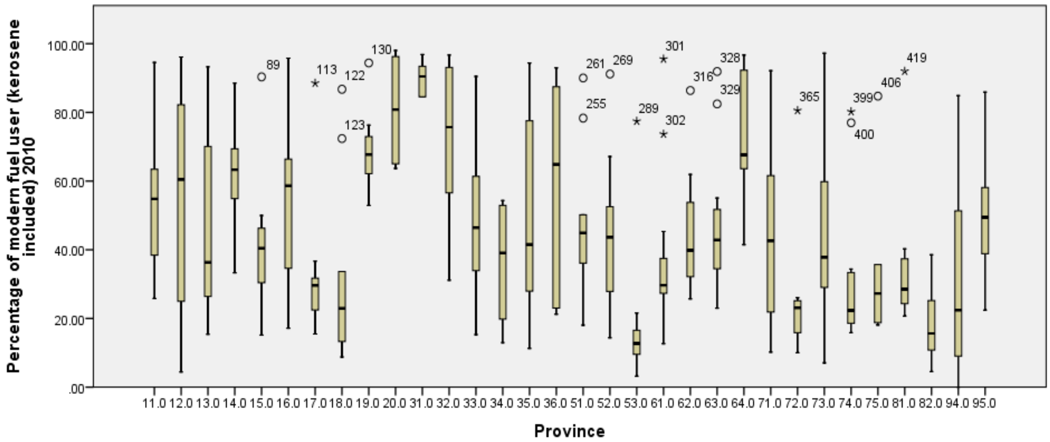

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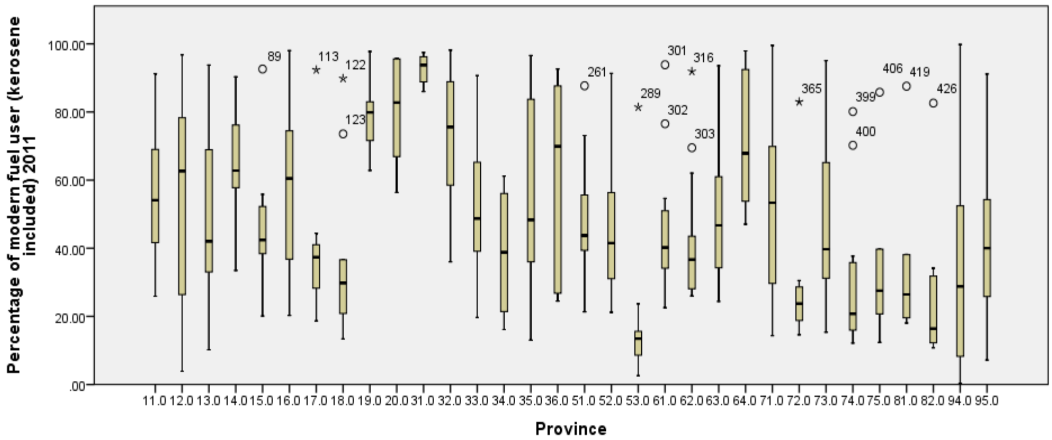

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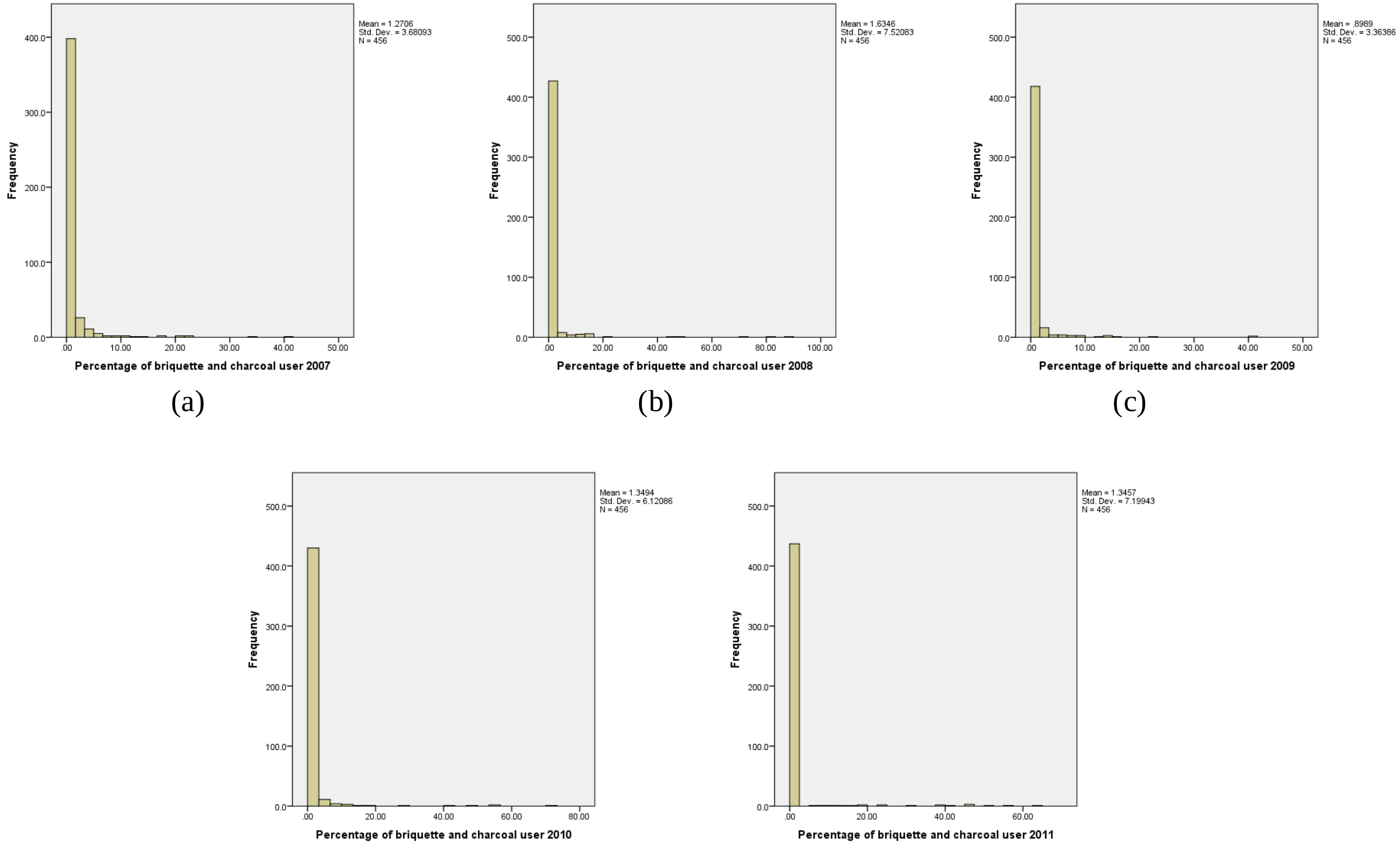
Figure 5.21: Boxplot of distribution data of percentage of modern fuel users (kerosene included) in regions in 33 provinces in 2007–2011

5.2.3. The Pattern of Traditional Fuel Use for Cooking

This sub-section provides the analysis of the use of traditional fuel as the main cooking fuel in Indonesia. Figure 5.22 and Figure 5.23 show the histogram of the distribution of the percentage of briquette/charcoal and firewood users in regions in Indonesia. The distribution data of these two kinds of fuel are considerably different. Figure 5.22 reveals that most of the regions have a percentage of briquette/charcoal users of less than 10%. This occurs over all five years, from 2007–2011. This is different to the use of firewood, where most of the regions had percentages of firewood users of around 75% in 2007. This trend is almost similar in 2008 and 2009, but changed in 2010 onwards, where most regions have reduced percentages of firewood users at around 60 to 65%.

Meanwhile, Figure 5.24 and Figure 5.28 are thematic maps for the transition of traditional fuel users. As with the previous maps, there are some changes in traditional fuel users as well. In Figure 5.24, in 2007 more regions are coloured with orange (60.0001%–80%) and some of them are red (more than 80%). In 2011, regions that are coloured with lighter orange (20%-40%) and yellow (less than 20%) are more apparent. This indicates an obvious reduction in the users of firewood by 2011. However, although this shows that less households depended upon traditional fuel, the large variation of the percentage of firewood users in regions in Indonesia is still apparent. In 2011, regions in Eastern Indonesia are coloured with dark brown (more than 80% firewood users). Previously, on the other hand, in 2009 and 2010 there was only one region in Papua – i.e. the *Kabupaten* Mimika – that has a percentage of firewood users of less than 20%. However, this study is unable to identify the changing to high



(a) (b) (c)

(d) (e)

Figure 5.22: Annual distribution data of percentage of briquette and charcoal users in regions in Indonesia

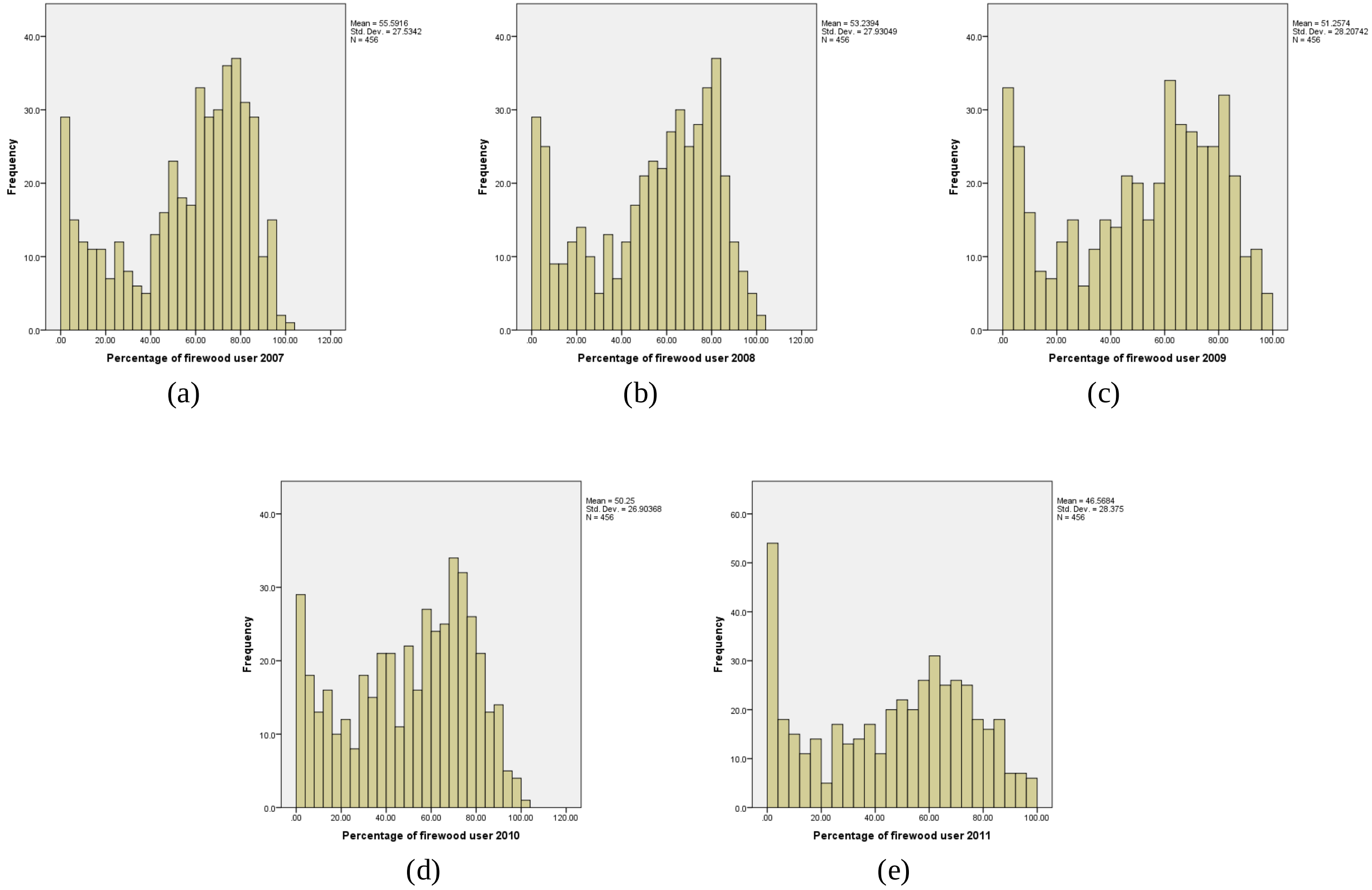


Figure 5.23: Annual distribution data of percentage of firewood users in regions in Indonesia

percentage in 2011. In the meantime, in 2011, in general, regions in Java, Sumatera, Kalimantan dan Sulawesi have lower percentages of firewood users for main cooking fuel.

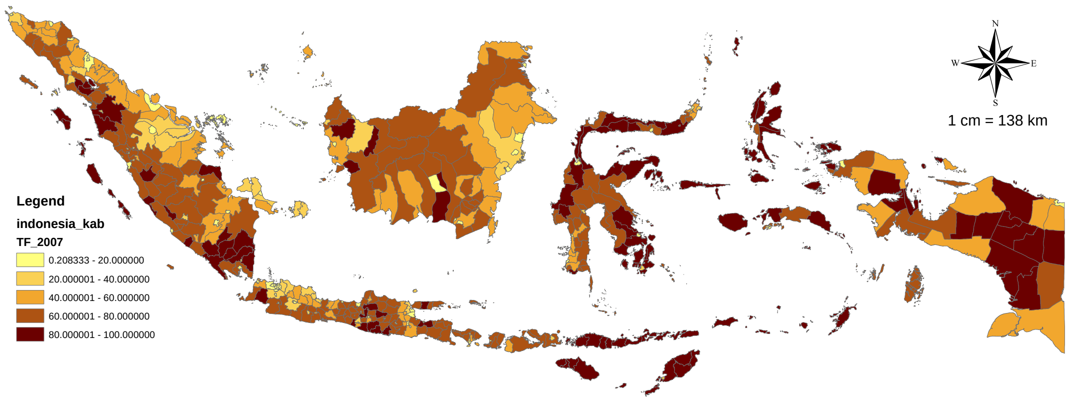


Figure 5.24: Map of use of traditional fuel for cooking in 2007

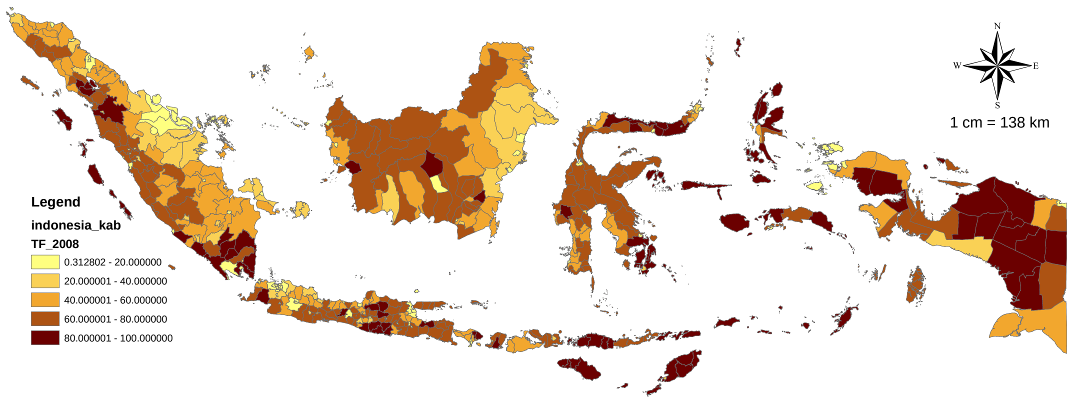


Figure 5.25: Map of use of traditional fuel for cooking in 2008

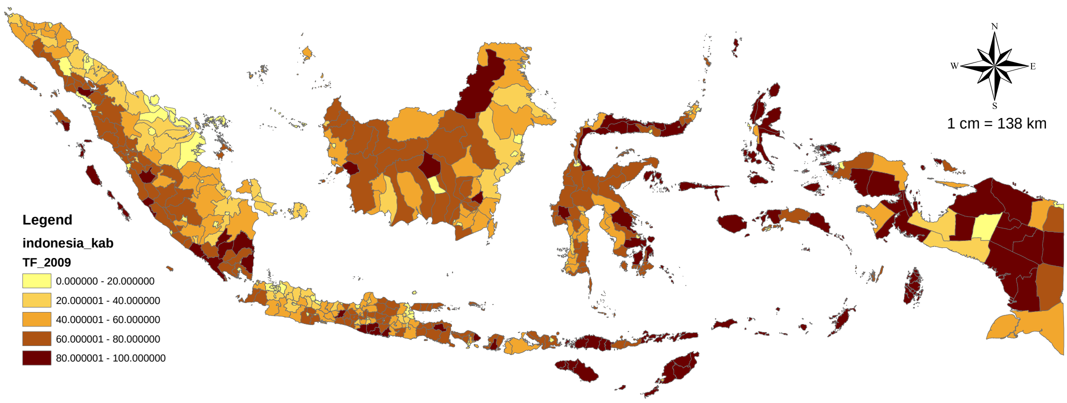


Figure 5.26: Map of use of traditional fuel for cooking in 2009

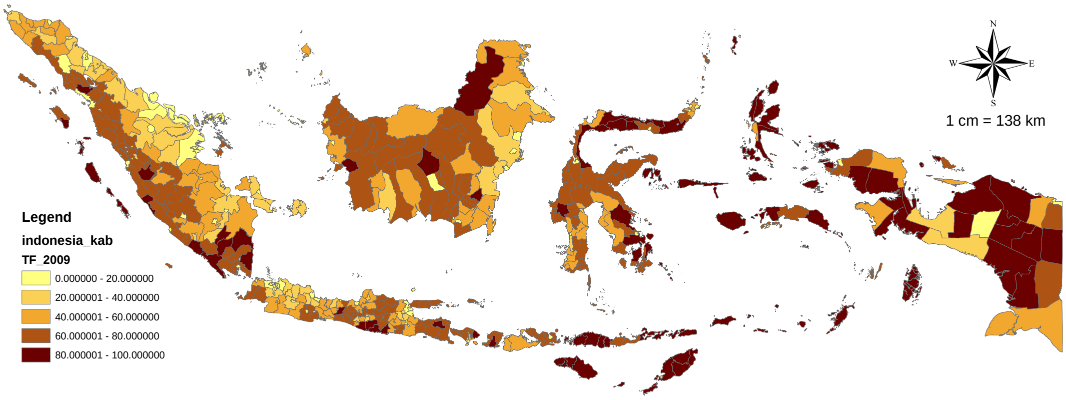


Figure 5.27: Map of use of traditional fuel for cooking in 2010

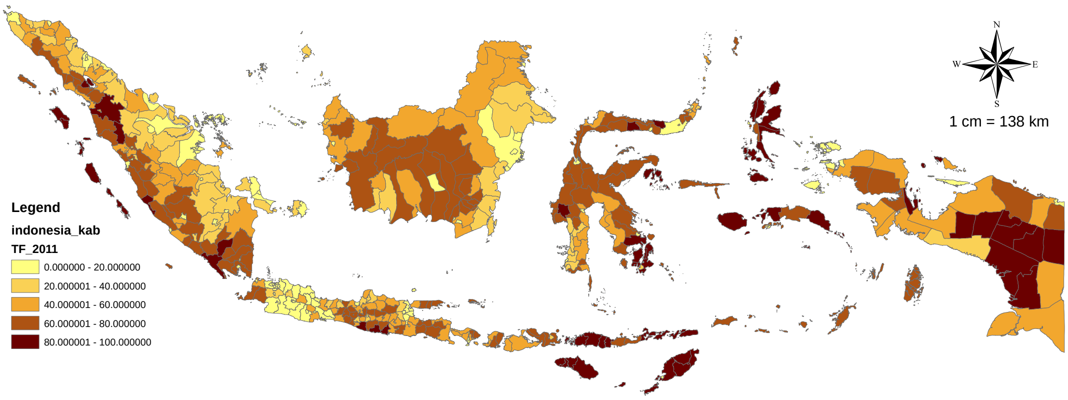


Figure 5.28: Map of access to traditional fuel for cooking in 2011

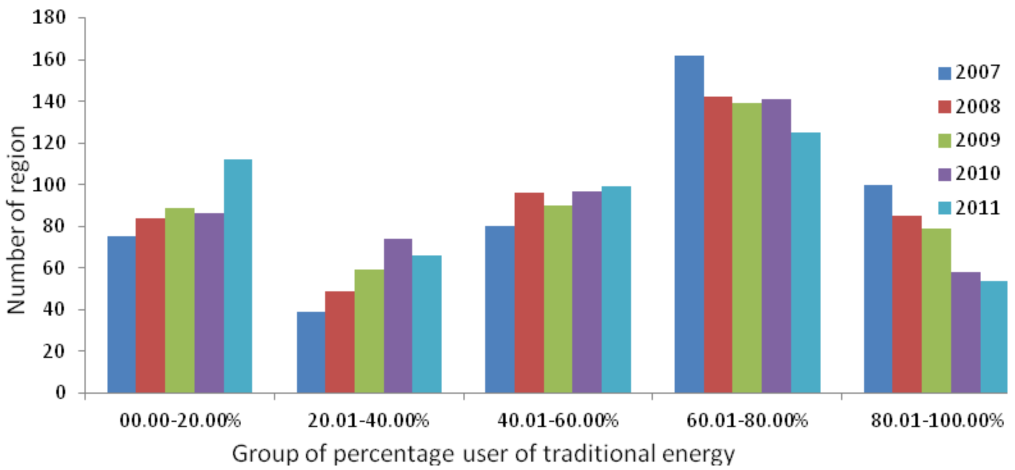
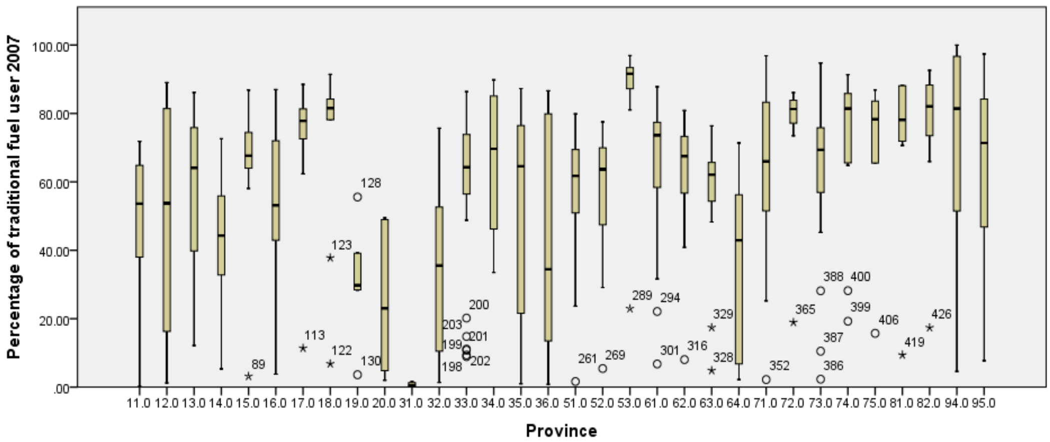


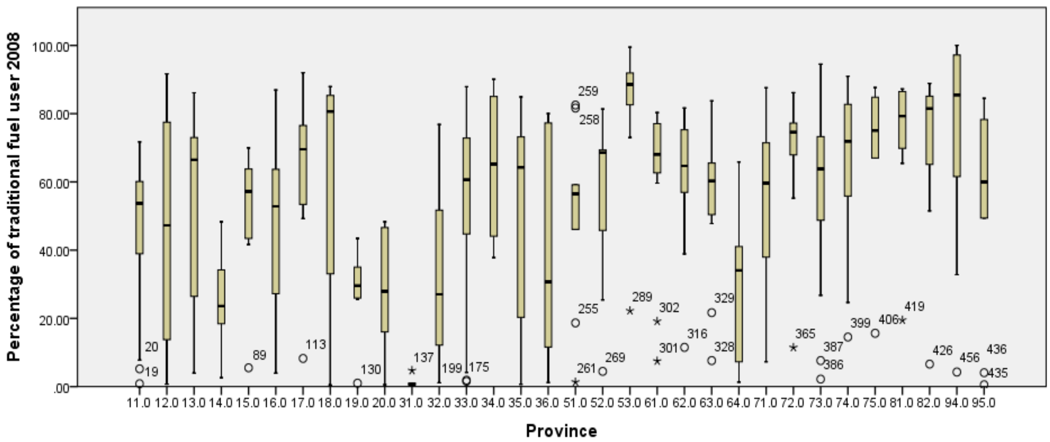
Figure 5.29: Histogram of distribution of percentage of users of traditional fuel – briquettes, charcoal and firewood – for main cooking in regions in Indonesia during 2007 to 2011

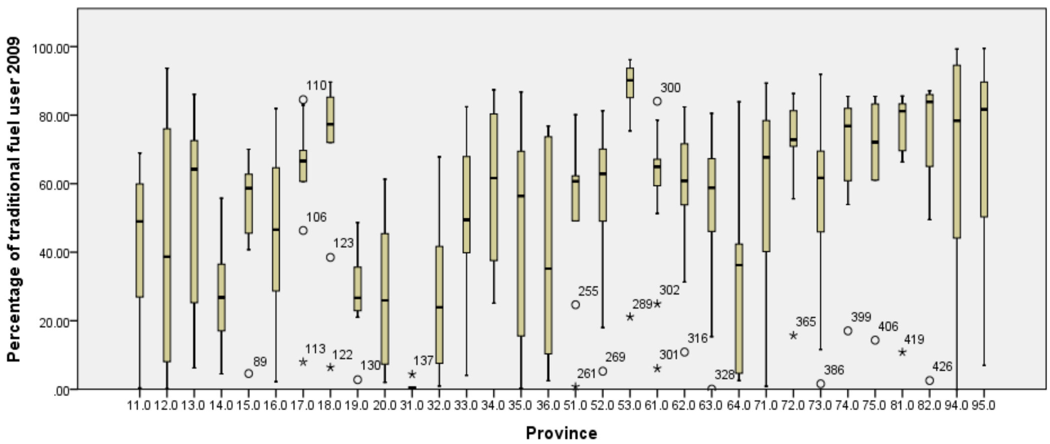
Figure 5.30 presents the number of regions that have specific percentages of traditional fuel users from 2007 to 2011. Detailed data is presented in Appendix 5.5, Table 5.5.3. Overall, the percentage of households who rely upon traditional fuels changed. Previously, in 2007, the number of regions with the percentage of traditional fuel user between 60–80% was highest. Fortunately, in 2008, the number of regions that have traditional fuel users between 60–80% reduced. The reduction occurred for the percentage group of more than 80% of traditional fuel users. By contrast, the increase in frequency of regions that have the percentage of traditional fuel less than 60% in 2007–2011 was apparent. More details of the distribution of traditional fuel access in each province are revealed in Figure 5.31.

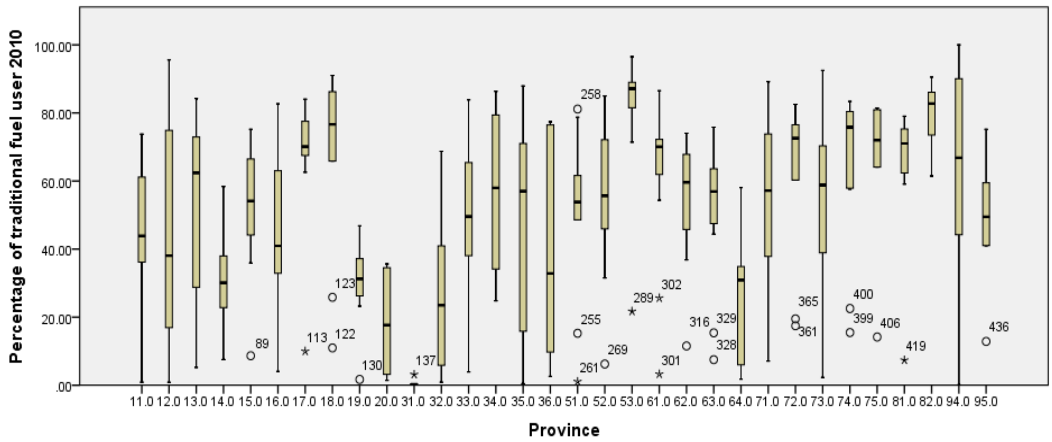
From Figure 5.30 it can be seen that most of the stars are in the bottom of the boxplots. This means there are some regions (within provinces) that have a very small percentage of traditional fuel users in 2007–2011. Moreover, there are some regions that have high variance, whereas some others have very narrow variance. This indicates even though the percentage of firewood users reduced, there is an indication that the reductions in regions are not similar. This will be identified in Section 5.3.

From this analysis, although modern fuel users in 2011 were higher than in 2007 and traditional fuel in 2011 was lower than 2007, the increase of modern fuel and the reduction of traditional fuel in Indonesia is incommensurate. This argument can be seen from the maps and boxplots in the above-mentioned discussion. The discrepancy in each region will be analysed in Section 6.1 of Chapter 6.


Percentage of traditional fuel user 2007
Province


Percentage of traditional fuel user 2008
Province


Percentage of traditional fuel user 2009
Province



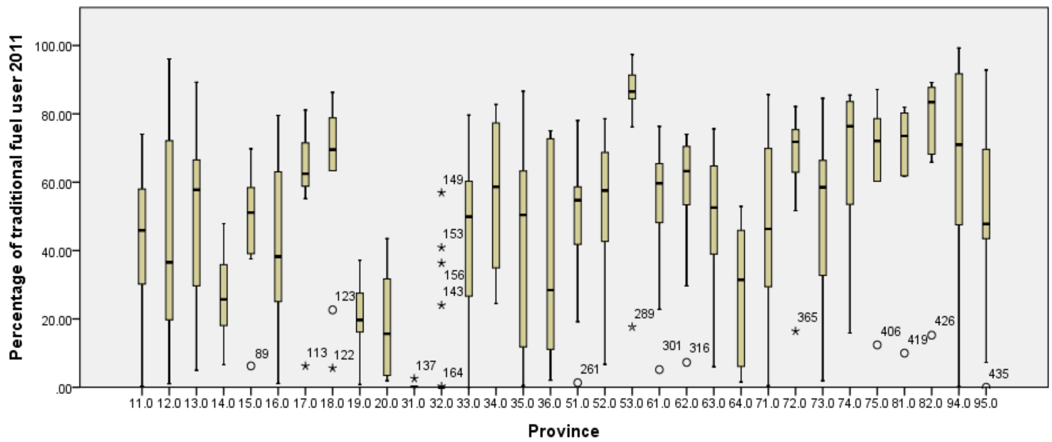


Figure 5.30: Boxplot of distribution data of percentage of users of traditional fuel in regions in 33 provinces in 2007 to 2011

For example, households who used electricity, gas and LPG predominantly lived in Java Island, Sumatera Island, northern parts of Kalimantan Island and southern parts of Sulawesi Island. The unbalance occurred for traditional fuel as well. In the Eastern Indonesia – such as Papua Island and East Nusa Tenggara Islands – there are more households who rely more upon traditional fuel in comparison to those who live in central and western parts of Indonesia. This might be caused by government policy. Figure 5.31 shows the roadmap of ECPKL implementation in Indonesia that was published by government at the early implementation of policy. This roadmap indicates the different stages in the implementation of the policy that may result in different access to some types of fuel for cooking.

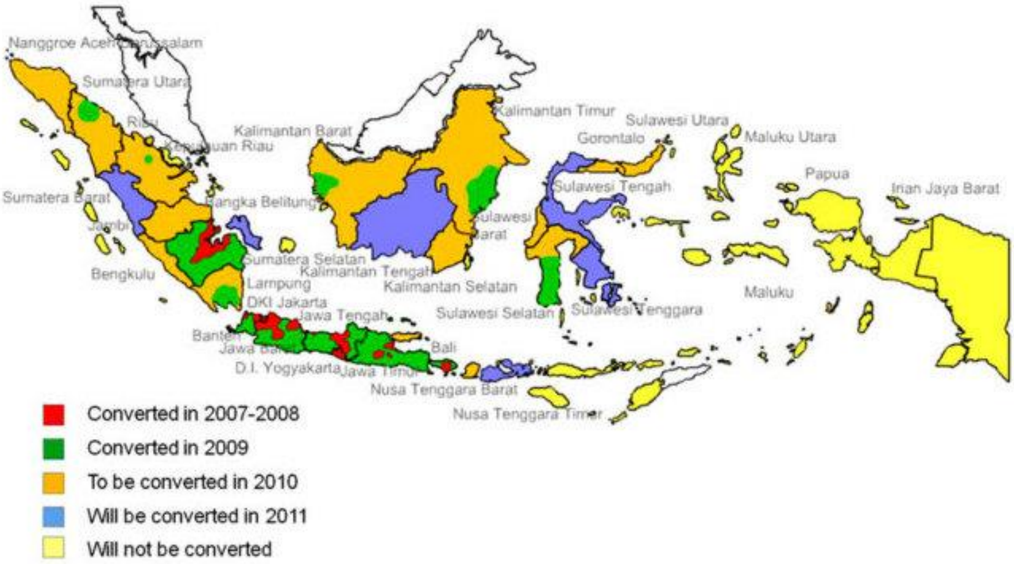


Figure 5.31: Road map plan of ECPKL that was published in 2008 (Budya & Arofat, 2011)

From the programme planning of ECPKL, the substitution of kerosene with LPG started from Java in 2007 and 2008. Initially, the policy was implemented in 32 cities in eight provinces (KESDM-RI, 2007c). Then the policy continued to introduce LPG to Sumatera, Kalimantan and Sulawesi by 2010. However, from the roadmap which was published in 2007, the policy plan in 2011 did not applied to eastern Indonesia, such as East Nusa Tenggara Islands, Halmahera Islands and Papua Island. According to the interviews with the government, the main reason why the policy had not been implemented in Eastern Indonesia was because:

> *"From an economic point of view, the government will get more benefit from the implementation of the policy in Eastern Indonesia, but not for Pertamina. This is because Pertamina (as state company)*

> *does not have enough financial support to build energy infrastructures in Eastern Indonesia such as Papua, Ambon, North Maluku. Those regions are lacking in infrastructures. Apart from that, we have to secure the energy supply in those regions. However, those regions have a lack of supply. Where are the LPG sources from? Where are the gas stations? We have to build LPG stations which need high investment, whilst the market is limited. This wouldn't give economic benefit to us. In contrast to in Java, where cost of building the infrastructures are cheaper and the population (market) is high. Hence, we could achieve the benefit faster. However, who will be the business player in those regions (Eastern Indonesia)? This needs policies from the government. If we apply this programme in eastern Indonesia, it will increase cost of subsidy. This is because regions in Eastern Indonesia is lack of supply and infrastructures. We need a heavy vehicle for transporting LPG. This means we need high quality roads to ensure LPG could be transported safely to the destination. Therefore, implementing the programme in Eastern Indonesia influences more sectors."* (IDCG05, Pertamina, Jakarta, 26/Nov/2012)

Clearly, the main consideration for implementation of the policy in an area is the financial budget to build infrastructures and availability of infrastructures as well as economic benefits of the implementation.

Based on the regulation, as the policy has not started to be implemented in Eastern Indonesia, kerosene in those regions should be subsidised. From 2007 to 2011, households who used modern fuel (with kerosene and kerosene excluded) in Eastern Indonesia remained lower in comparison to other regions. On the other hand, households who used traditional fuel remained higher in comparison to other regions. This seems like ECPKL does not influence the energy consumption in those regions.

The transition in use of energy for cooking occurred in the regions which are closer to Singapore and Malaysia, such as the Riau Islands. According to the interviews, people who live in those Islands have already used LPG since before the policy was implemented, because they get LPG from Singapore and Malaysia.

In order to make an illustration of the energy consumption in the regions, Table 5.9 shows the percentage consumption of energy in three regions, i.e. Region of Riau Islands, Region of Central Jakarta and Region of East Flores in Nusa Tenggara Islands.

During 2007 to 2011, the use of electricity for cooking in all those three regions was very small. But, the difference from 2007 to 2011 was quite small. This is similar for the use of briquettes and charcoal. The most difference in consumption is for gas and LPG, kerosene and firewood. In the Riau Islands before 2010 below 20% of households consumed gas and LPG. In contrast, in Central Jakarta more than 20% of households consumed LPG and gas during 2007 and 2011. In East Flores, gas and LPG consumption were very low with kerosene consumptions even lower. Since modern fuel use was low, householders in East Flores are more dependent upon traditional fuel.

Both the Riau Islands and East Flores Islands are far away from the capital city of Indonesia, Jakarta. However, the Riau Islands which are located in western Indonesia are very close to Singapore and Malaysia. Meanwhile, the East Flores Islands are close to Australia, but are separated by the Indian Ocean. Transport systems from the Riau Islands to Singapore or Malaysia are better than from the Flores to Australia, which is the reason why LPG from Singapore and Malaysia is able to reach the Riau Islands, whilst transportation from Australia is not so possible. Therefore, although householders in Eastern Indonesia are close to developed countries, there remained a lack of access to modern fuel because of the lack of infrastructures and market. Inevitably, they are relying more upon traditional fuel for survival.

Table 5.15: Energy for cooking consumption in the two islands vs Central Jakarta[50]

.5.5	Year	Percentage of household who use main fuel (in %)				
		Electricity	Gas and LPG	kerosene	Briquette and Charcoal	Firewood
Riau Islands	2007	0.71	6.82	72.44	0.28	16.23
	2008	1.16	10.04	66.67	0.15	17.84
	2009	0.58	6.40	79.51	0.00	11.06
	2010	0.89	16.42	54.48	0.09	39.04
	2011	1.44	37.27	42.52	0.13	13.94
Central Jakarta	2007	4.40	38.19	52.39	0.15	1.88
	2008	2.98	68.91	23.10	0.23	0.88
	2009	3.09	82.33	12.11	0.00	0.13
	2010	6.30	68.43	9.82	0.08	0.13
	2011	4.26	81.99	7.66	0.00	0.00
East Flores	2007	2.30	1.32	14.14	0.49	81.58
	2008	0.50	0.66	17.36	0.50	80.26
	2009	0.49	0.49	12.01	0.33	86.51
	2010	0.50	0.17	24.21	0.50	79.89
	2011	0.79	0.20	15.16	0.00	73.53

5.3 Discussion

The transition in use of fuels for cooking in Indonesia between 2007 and 2011 is apparent. Using the quantity-based approach, access to modern fuel (in terms of kerosene included or kerosene excluded) in 2007–2011 improved. This can be seen from Table 5.2 and 5.3. This is in line with the assessment of the share of expenditure-based and source of energy-based approaches. However, the Indonesian survey is unable to measure specific fuels, which affects the final conclusion. For example, in the quantity-based approach, SUSENAS was unable

[50] This data is calculated from SUSENAS

to provide information about the amount of briquette/charcoal and firewood use. In addition, this approach is unable to recognise the availability of traditional fuel. Therefore, in this assessment the traditional fuel is excluded from the calculation. This is similar to the share of expenditure-based approach that is unable to identify the presence of traditional fuel. The need for an alternative method in measuring energy access through the share of expenditure-based approach is obvious, because this approach can be an alternative when the quantity of fuel consumed could not be assessed due to lack of instruments to measure it. In addition to the two above-mentioned approaches, this study also measured the access of energy in terms of the source of energy-based approach. This approach is easier to be implemented in comparison to other approaches, but it does not address the sufficiency of energy..

In this study, access to modern fuel is divided into two scenarios: kerosene excluded and kerosene included. When kerosene is excluded from the modern fuel list, the improvement of modern fuel access from 2007–2011 was about 21.9%. However, if kerosene is included as modern fuel, the improvement of modern fuel access from 2007–2011 was only about 7.68%. The government of Indonesia views kerosene as not as clean as LPG. By using this argument, in this study in terms of the government of Indonesia’s point of view, kerosene is excluded as modern fuel. Therefore, it can be concluded that ECPKL has a high contribution to the improvement of modern fuel access in Indonesia. Even though, as seen in Table 5.15, the percentage of modern fuel access in 2011 was 31.9%, this percentage is inevitably not as high as the percentage of access to modern fuel when kerosene is included as modern fuel, which was 50.3% of households in 2011.

This study has also shown that during 2007 to 2011 the geographical gap of access to modern fuel was narrower. Some regions, especially in eastern regions of Indonesia, lacked modern access which led them to suffer from lack of modern fuel. The ECPKL as the national policy to improve modern fuel throughout Indonesia was unable to cure the problem of lack of access to modern fuel especially in regions in eastern Indonesia. This is due to unfavourable conditions for the implementation of ECPKL in those regions. This is in line with the argument of Leach (1987b) that when the government provides access to modern fuel it leads people to consume it. The switching to new fuel is more efficient than increasing the supply of specific energy. But this system is less effective because it needs a long process that requires cooperation between government, business and public (Anderson et al., 2000). Hence, in case of ECPKL, the government needs to make intensive improvements in infrastructure, co-operation and governance to alleviate the problem of lack access to modern fuel.

Chapter 6
Factors related to Domestic Fuel Use

Government provision of access to modern fuel is believed to have a major contribution to the reduction of households using 'unclean' energy. But, access to modern fuel is presumably influenced by other factors, such as the location and income of the households. Location, such as rural or urban, influences the fuel consumption of the household. Income also has a contribution to energy choice. This chapter aims to investigate spatio-temporal influences on the share of fuel types used within regions of Indonesia. Furthermore, this study also examines the relationship between the income of the household and the access to energy for cooking. Therefore, this chapter also address the research question: "*How do time, household income, and location – rural and urban – affect the choice of fuel for cooking in Indonesia?*"

6.1 The Change in Fuel for Cooking Over Time

The analysis in Chapter 5 attempted to identify the pattern of the percentage of households who have access to modern fuel in each region throughout Indonesia. From the analysis in Chapter 5, it was been seen that the percentage of households who access different types of fuel for cooking has changed over five years. However, in the previous chapter, the relation between ECPKL and the change of fuel use for cooking is not scientifically apparent. This section provides statistical analysis and information about the practical effects of the policy – i.e. ECPKL – on the percentage of users of different types of energy/fuel in regions in Indonesia. The association between policy and the changes to the percentages of fuel users are identified through the Friedman rank test and Wilcoxon rank test. These methods are selected because the data of the percentage of users of the various energy types in the regions in Indonesia do not follow a Normal Distribution. The evidence of this statement is provided in Appendix 6.1. Therefore, nonparametric tests such as the Friedman and Wilcoxon test are applied in this section. The equations for the Friedman rank and Wilcoxon rank test are presented in Equation 4.14 and 4.17.

In this chapter, the analysis will be conducted on the percentage of households using each energy type in 456 regions in Indonesia; the sufficiency of access to energy will be analysed in terms of the source of energy-based approach. The two other approaches – i.e. the share of expenditure and quantity-based approach – which were already measured in section 5.1.1 and 5.1.2 – will not be analysed in this section for two reasons. First, in the quantity-based approach, there is dispute about the threshold set for the amount of energy that should be consumed and this study does not have sufficient information to select one of the thresholds advocated by international organisations and scholars as shown in Table 2.5 or 5.2. Secondly, in the author’s point of view, the minimum energy requirement in every country, even regions, are different due to the different cultures and habits. Meanwhile, the study on the minimum energy that should be required by households in Indonesia has not been provided. Therefore, assessment for the quantity-based approach in the Indonesian context is still difficult. Secondly, there are scientific limitations of the implementation of the 10% of energy expenditure of energy assessment for the share of expenditure-based approach. The cost of energy is influenced by complex factors such as policy, distance between the sources to the market and so on. Furthermore, as the minimum energy required by households in the Indonesian context has not been identified, it is impossible to identify the threshold of minimum expenditure for energy that should be paid by households in Indonesia. Therefore, in this section, the source of energy-based approach is the only assessment that will be implemented.

The Friedman rank test is applied in this study for preliminary identification of the differences of percentage of households who use different types of fuel as their main cooking fuel over five years. So, the variables are the percentages of users and time. The percentage of users is calculated from the percentage of households who use each specific fuel in 456 regions in Indonesia. Meanwhile, time is the five annual datasets on the percentage of users. The results of the Friedman test are presented in Table 6.1. Access to energy in this section is separated into eight categories: five types of fuels and three types of classification of access. The five fuels are electricity, natural gas and LPG, kerosene, briquette and charcoal as well as firewood. Meanwhile, three classifications of access are: access to modern fuel in which is kerosene is categorised as transitional fuel; access to modern fuel which includes kerosene within this category; and traditional fuel.

The null hypothesis of the Friedman rank test in this study is the *average percentages of the users of the fuel for cooking in regions in Indonesia during five years are equal*. The variable that will be used in this study is the average percentage of users of each fuel type as their main energy for cooking in each region against the variable time which is set annually. The formula for calculating the Friedman test is given in

Equation 4.14 in Chapter 4. The test is conducted using SPSS version 22. The null hypothesis is rejected if p-value less than α. In this study, the α that will be used is 0.05.

The results of the Friedman test from Table 6.1 show that for all tests there are statistically significant differences between years in the average percentage of users of each fuel type for cooking in regions of Indonesia. By referring to Table 5.8, this means that the reductions of the percentage of households in each region who use electricity, kerosene and firewood for their main cooking over 2007–2011 are significant. Likewise, the increase in the percentage of households in each region who used mainly natural gas and LPG for cooking from 2007–2011 is significant as well. Similarly, the percentage of households over the same time period who used modern fuel and traditional fuel as their main cooking fuel are statistically significantly different.

Table 6.1: The results of Friedman[51] test for source of energy-based approach of access to energy

Energy type	Mean rank					$\chi 2$	p-value	Decision[52]
	2007	2008	2009	2010	2011			
Electricity	3.53	2.46	3.05	3.24	2.74	132.57	0.000	Reject H_0
Natural Gas & LPG	1.75	2.55	2.90	3.69	4.12	649.67	0.000	Reject H_0
Kerosene	3.46	3.20	2.95	3.15	2.24	156.23	0.000	Reject H_0
Briquette & charcoal	3.68	3.45	2.83	3.19	1.84	412.56	0.000	Reject H_0
Firewood	3.82	3.79	3.22	2.18	1.99	553.92	0.000	Reject H_0
Type of modern fuel and traditional fuel								
Traditional fuel	3.85	3.86	3.19	2.19	1.91	608.51	0.000	Reject H_0
Modern fuel (kerosene excluded)	4.13	3.63	3.06	2.33	1.85	629.46	0.000	Reject H_0
Modern fuel (kerosene included)	3.84	3.87	3.19	2.19	1.90	610.25	0.000	Reject H_0

[51] ANOVA Calculated by using SPSS version 22. See Appendix 6.2
[52] In this study, the significant value (α) is 5%. The null hypothesis is rejected if the p-value less than the significant value.

Table 6.2: The *Wilcoxon* test of the percentage of users per region of each fuel type for main cooking fuel[53]

Year		Main fuel for cooking														
		Firewood			Briquette & charcoal			Kerosene			Natural gas and LPG			Electricity		
x_1	x_2	Mean rank (-)	Mean rank (+)	z (*p*-value)	Mean rank (-)	Mean rank (+)	z (*p*-value)	Mean rank (-)	Mean rank (+)	z (*p*-value)	Mean rank (-)	Mean rank (+)	z (*p*-value)	Mean rank (-)	Mean rank (+)	z (*p*-value)
2007	2008	245.19	149.80	-0.853 (0.394)	163.97	243.83	-3.719 (0.000)*	249.11	196.37	-5.405 (0.000)*	230.23	182.14	-11.660 (0.000)*	227.89	223.97	-11.152 (0.000)*
	2009	226.81	191.02	-7.768 (0.000)*	110.32	253.46	-8.168 (0.000)*	267.82	164.52	-7.879 (0.000)*	213.84	176.60	-14.606 (0.000)*	238.81	196.92	-5.500 (0.000)*
	2010	250.31	189.85	-14.669 (0.000)*	75.19	246.78	-5.603 (0.000)*	268.58	170.89	-6.974 (0.000)*	226.80	189.60	-16.803 (0.000)*	250.33	127.94	-4.221 (0.000)*
	2011	243.53	180.97	-15.061 (0.000)*	56.87	252.95	-14.007 (0.000)*	270.81	136.48	-11.432 (0.000)*	205.99	187.58	-16.992 (0.000)*	252.07	116.03	-8.546 (0.000)*
2008	2009	166.09	232.42	-6.967* (0.000)*	152.53	263.73	-5.442 (0.000)*	256.74	183.12	-6.422 (0.000)*	191.38	194.71	-9.120 (0.000)*	238.69	206.13	-7.521 (0.000)*
	2010	184.08	231.85	-14.442 (0.000)*	89.05	262.39	-3.312 (0.000)*	279.22	168.25	-5.893 (0.000)*	221.58	185.75	-15.094 (0.000)*	252.01	126.99	-7.816 (0.000)*
	2011	213.43	226.50	-15.154 (0.000)*	68.24	261.15	-12.807 (0.000)*	273.22	141.38	-10.574 (0.000)*	188.33	185.60	16.067 (0.000)*	243.60	136.12	-2.022 (0.043)
2009	2010	225.13	218.50	-12.271 (0.000)*	130.74	256.68	-1.812 (0.070)	235.87	219.67	-1.184 (0.236)	216.87	192.17	-12.771 (0.000)*	252.10	153.26	-1.461 (0.144)
	2011	241.05	200.07	-13.429 (0.000)*	74.89	263.17	-9.812 (0.000)*	253.04	183.57	-7.756 (0.000)*	176.48	17.20	-15.772 (0.000)*	249.46	147.74	-4.269 (0.000)*
2010	2011	240.67	192.43	-1.552 (0.121)	115.38	268.23	-11.314 (0.000)*	237.54	187.81	-11.975 (0.000)*	188.84	180.87	-12.503 (0.000)*	222.97	231.97	-4.909 (0.000)*

* Statistically significant at $\alpha = 5\%$

[53] The Wilcoxon test is calculated by using SPSS version 22. All results of the Wilcoxon tests are presented in Appendix 6.3.

Since there is sufficient evidence to say that there is a transition from 2007 to 2011, the 'post hoc' tests – i.e. Wilcoxon test – detect the difference in percentages per region of users of each fuel type annually. The purpose of this test is to identify which year contributes significantly to the changes. The formula for the Wilcoxon test is given in equation 4.17. The results of the Wilcoxon test for all types of fuel are summarised in Table 6.2, while results of Wilcoxon tests for all measure of energy access are given in Table 6.3.

The hypothesis for the Wilcoxon test is, *the average of percentage energy users at time x is equal to average of percentage energy users at time y*. The significant value (α) that will be used in this test is 0.05. The null hypothesis is rejected when p-value less than α. In Table 6.2, by using $\alpha = 0.05$, there are some tests where the null hypothesis should not be rejected. That means, the average percentages between two years are not statistically significantly different.

Table 6.2 shows that the average percentages of households who used firewood for their main cooking fuel in 2007–2008 and 2010–2011 are not statistically significantly different. In relation to ECPKL, 2007 was the initial implementation of the policy. The effect of ECPKL on the percentage of firewood users in 2008 is not apparent. However, after 2008, the reduction of the percentage of firewood users is statistically significantly different. Nevertheless, in 2010–2011 the reduction of firewood is not statistically significant again. This can be an indication that ECPKL in 2010–2011 did not affect the percentage of firewood users.

Wilcoxon test results for average percentage of households who used briquette/charcoal, kerosene and electricity for their main cooking fuel in 2009–2010 are not statistically significant different. According to interviews with government staff, which are presented in Chapter 7.3.2, the government would reduce kerosene distribution after 80% of LPG packages were distributed to the public. However, July 2009[54] was the date of the presidential election that resulted in the election of the incumbent president, but not the re-election of the previous vice president. Meanwhile, the vice president had a strong contribution to the policy (this issue will be discussed in Chapter 7). Therefore, the political situation and the transition of government leadership are presumed to have influenced the ECPKL implementation. The attempt to reduce kerosene use in 2009 was halted by the political situation at that time. Fortunately, this did not influence the use of natural gas and LPG.

Table 6.3 identifies whether there are differences in users of modern fuel and traditional fuel within two years. The analysis of this table is similar to analysis for Table 6.2.

From the statistical analysis which is summarised in Table 6.3, results for the Wilcoxon test of traditional fuel and modern fuel when kerosene is included are similar. Test fails to reject the hypothesis that in 2007–2008 and 2010–2011 the average of traditional fuel and modern fuel are equal. This result is similar with the Wilcoxon test for firewood use (see Table 6.2). The test for traditional fuel and modern fuel (kerosene included) are similar because traditional fuel is the negation of modern fuel when kerosene is included.

[54] Vice president 2004–2009 is the top leader who got more involved in the ECPKL implementation. Unfortunately, for 2009–2014, the previous vice president was not elected.

Table 6.3: The *Wilcoxon*-test of percentage user of traditional and modern fuel for main cooking[55]

Year		Traditional fuel as main fuel			Modern fuel as main fuel					
					Kerosene excluded			Kerosene included		
x_1	x_2	Mean rank		Z (p-value)	Mean rank		z (p-value)	Mean rank		z (p-value)
		(-)	(+)		(-)	(+)		(-)	(+)	
2007	2008	231.54	221.09	-1.076 (-.282)	250.34	179.14	-8.192 (0.000)*	232.26	221.38	-1.502 (0.293)
	2009	242.29	190.18	-8.391 (0.000)*	248.55	131.42	-13.931 (0.000)*	241.34	187.51	-8.439 (0.000)*
	2010	253.20	119.10	-14.758 (0.000)*	250.74	84.75	-16.409 (0.000)*	253.73	119.17	-14.789 (0.000)*
	2011	249.21	110.41	-15.60 (0.000)*	256.52	68.20	-16.706 (0.000)*	249.75	110.39	15.690 (0.000)*
2008	2009	235.91	209.40	-7.682 (0.000)*	262.71	151.70	-10.653 (0.000)*	235.90	209.41	-7.682 (0.000)*
	2010	249.69	123.77	-14.923 (0.000)*	266.18	88.71	-15.260 (0.000)*	249.69	123.76	-14.923 (0.000)*
	2011	242.84	122.28	-16.043 (0.000)*	261.16	79.24	-16.083 (0.000)*	242.84	122.29	-16.043 (0.000)*
2009	2010	255.17	150.39	-12.159 (0.000)*	260.53	132.37	-12.926 (0.000)*	254.93	149.38	-12.161 (0.000)*
	2011	250.17	234.24	-14.322 (0.000)*	264.11	91.16	-15.397 (0.000)*	250.17	234.21	-14.323 (0.000)*
2010	2011	228.61	227.21	-2.52 (0.014)	266.19	135.10	-11.990	227.61	227.36	-2.450 (0.014)

* Statistically significant at α = 5%

Modern fuel is separated into two different classifications in order to identify whether ECPKL has made a contribution to the reduction of traditional fuel and improvement of modern fuel usage. From these analyses, there are two inferences. First, when kerosene is included as modern fuel: in 2007–2008 and 2010–2011 ECPKL did not influence the reduction of traditional fuel and did not improve modern fuel access. In other words, ECPKL had little contribution in these years to the attempt to improve modern fuel access and alleviate energy poverty. Second, when kerosene is excluded as

[55] Wilcoxon test is calculated by using SPSS version 22. All results of Wilcoxon tests are presented in Appendix 6.3.

modern fuel; in this case it can be argued that ECPKL contributed to the annually increasing use of modern fuel.

Both the Friedman test and Wilcoxon test aforementioned do not show the magnitude of the changes. Therefore, a measure of effect size (ES) is required. The ES in this section is measured in two methods, using delta (Δ). The formula of this method is presented in Equation 4.22 in Section 4.3.1.3. The delta (Δ) for all pairs, is then provided in Table 6.4. The Δ have three categories of magnitude: small, medium and large, where small is if $|d| = 0.2$, medium is if $|d| = 0.5$ and large is if $|d| = 0.8$. In most cases, the value of Δ are smaller or higher than the category. Therefore, in this study the category are divided into very small (vl) if $|d| < 0.2$, between small and medium (sm) if $0.2 < |d| < 0.5$, between medium and large (ml) if $0.5 < |d| < 0.8$ and very large (vl) if $|d| > 0.8$.

From Table 6.4, it is apparent that the highest magnitude of effect is on the percentage of users of natural gas and LPG. The difference in percentage of households per region who used natural gas and LPG for main cooking fuel between 2007 and 2011 is very large. This means that at that time, the move of households to use LPG as the main fuel for cooking was very high as this is the cumulative of the annual changes over that period. The medium and large associations between the percentage of fuel user and time or big changes occurred for the percentage of kerosene users in 2007–2011 and 2008–2011, the percentage of natural gas and LPG users in 2007–2010, 2008–2010 and the percentage of electricity users in 2007–2008 and 2010–2011. These supports the argument indicate that the ECPKL which started to be implemented at the end of 2007 affected the changes in the main source of energy for cooking in Indonesia by 2011.

When ECPKL is viewed from the point of view of dichotomy of energy: i.e. traditional and modern fuel, the association between the percentages of modern/traditional fuel users in 2007–2011 can be seen from Table 6.4.

When people use a specific fuel as the main cooking fuel it does not mean they use only one fuel for cooking; it is possible that they are users of multiple fuels for cooking. But, the main fuel choice can indicate that they prefer this fuel more and have a high dependence on it. When people used traditional fuel for cooking it does not mean they did not use modern fuel. They may use modern fuel but in a small quantity. Conversely, in cases where people used modern fuel for the main cooking fuel it does not mean they never used traditional fuel.

From the above analysis, there is significant evidence that the small to medium reduction in use of traditional fuel as the main cooking fuel happened in 2007–2011. After 2008, the reduction of firewood for main cooking was more significant after two years. This means, even though in Table 6.3 it has been demonstrated that the changes in traditional fuel in 2007–2009 and 2009–2010 are statistically significant, it does not mean the effect is a large change on this type of fuel.

Table 6.4: Effect size of change in percentage of fuel users per region in 2007–2011[56]

Year		Effect size (Δ)							
		Type of energy					Dichotomy approach of energy access		
		Firewood	Briquette & charcoal	Kerosene	Gas & LPG	Electricity	Traditional fuel	Modern fuel (Kerosene is excluded)	Modern fuel (Kerosene is included)
2007	2008	0.0046 (vs)	0.0461 (vs)	0.1266 (vs)	-0.2225 (sm)	0.6960 (ml)	0.0177 (vs)	-0.1771 (vs)	-0.0053 (vs)
	2009	0.0857 (vs)	0.0557 (vs)	0.3848 (sm)	-0.4553 (sm)	0.2583 (sm)	0.1016 (vs)	-0.4348 (sm)	-0.2924 (sm)
	2010	0.3037 (sm)	0.0783 (vs)	0.4843 (sm)	-0.6820 (ml)	0.1865 (vs)	0.3253 (sm)	-0.6722 (ml)	-0.3154 (sm)
	2011	0.2900 (sm)	0.0966 (vs)	0.7138 (ml)	-0.8061 (vl)	0.5249 (ml)	0.3189 (sm)	-0.7821 (ml)	-0.3083 (sm)
2008	2009	0.0811 (vs)	0.0097 (vs)	0.2622 (sm)	-0.3134 (sm)	-0.2892 (sm)	0.0841 (vs)	-0.3206 (sm)	-0.2735 (sm)
	2010	0.2984 (sm)	0.0273 (vs)	0.3556 (sm)	-0.5531 (ml)	-0.2977 (sm)	0.3053 (sm)	-0.5681 (ml)	-0.3093 (sm)
	2011	0.2852 (sm)	0.0473 (vs)	0.5849 (ml)	-0.6896 (ml)	-0.0905 (vs)	0.3007 (sm)	-0.6872 (ml)	-0.3027 (sm)
2009	2010	0.2053 (vs)	0.0166 (vs)	0.0804 (vs)	-0.2683 (sm)	-0.0419 (vs)	0.2095 (vs)	-0.2753 (sm)	-0.2208 (sm)
	2011	0.2011 (sm)	0.0369 (vs)	0.3091 (sm)	-0.4320 (sm)	0.2345 (sm)	0.2130 (sm)	-0.4207 (sm)	-0.2221 (sm)
2010	2011	0.0157 (vs)	0.0210 (vs)	0.2285 (sm)	-0.1894 (vs)	0.2878 (sm)	0.0216 (vs)	-0.1700 (vs)	-0.0208 (vs)

Note: vs = very small; sm = small to medium; ml = medium to large vl = very large

[56] The calculation using Microsoft Excel based on Formula 4.22.

The delta (Δ) of change in traditional fuel is different to Δ of modern fuel when kerosene is considered as modern fuel. The delta of this category is similar to Wilcoxon test in Table 6.3, where there are two small changes of percentage users in 2007–2008 and 2010–2011. In this category, kerosene is included. Meanwhile, in ECPKL, the government reduced kerosene availability. Therefore, the effect of time to modern fuel use was apparent, but the effect of time on traditional fuel use was not as high as the effect on modern fuel use. When kerosene is excluded from the list of modern fuel, the magnitudes of effect are higher than when kerosene is included as modern fuel. In the government point of view – that is kerosene is not as clean as LPG and it should be removed – ECPKL has made a significant contribution to improving modern energy access. This can be seen from the effect size in the column for modern energy when kerosene is excluded. Overall, the magnitude of effect is medium to large and small to medium. Even there, there are medium to large magnitudes, i.e. in 2007–2010, 2007–2011, 2008–2010 and 2008–2011. This is because the change relating to LPG is highest among the fuel types. However, when kerosene is viewed as a modern fuel, the ECPKL does not have as high a contribution to the improvement of use of modern fuel. From this point of view, ECPKL just substitutes one modern fuel for another modern fuel. Apart from that, fortunately, ECPKL has contributed to the reduction of traditional fuel use even though the effect is small.

Many scholars argue that energy substitution significantly reduces amount of wood consumption (Hosier & Dowd, 1987; Khandker et al., 2012). In this study, there is evidence that during the first five years of ECPKL implementation, the number of LPG users increased and meanwhile kerosene users were reduced.

There is also an indication that ECPKL was able to reduce the number of firewood users. However, the reduction in firewood users is significant after three years of ECPKL implementation. Additionally, the reduction in firewood users was not as high as the reduction for kerosene and not as high as the increase of natural gas and LPG users. The reason is because the government was merely concerned to reduce kerosene use not firewood use. Hence the government only encouraged kerosene users to replace kerosene with LPG, instead of replacing firewood with LPG. This study also noticed that the reduction for kerosene was not as high as the increase of LPG. This means the '*zero-kero*' target of ECPKL, which is discussed in Section 7.1, Chapter 7, could not be achieved. The problem is that kerosene is not merely used for cooking. It is also used as energy for lighting, farming and fishing. Meanwhile, LPG is mostly used for cooking. Therefore, kerosene production and consumption could not be totally ceased.

6.2 The Connection Between Urban-Rural Location and Energy Choice

Departing from the previous section, this section investigates the influence of location – i.e. urban or rural – on energy use. Therefore, different data will be used; data is gathered from Module M which covers all domestic energy use, and does not merely focus on energy for cooking. The main question addressed by this section is, "*does urban-rural location influence fuel choice?*" In order to answer the question the Chi-square test is applied. Hence, the first variable is location – i.e. urban and rural – and the second variable is the choice of specific fuel type which is categorised as 'yes' if the fuel is used by household or 'no' if the fuel is not used by household. The results of chi square tests are presented in Table 6.5 and Table 6.6.

Table 6.5: Chi-Square test[57] of energy choice vs location in 2007

Fuel	Use	Observed value (Estimated value)		χ^2 Pearson chi-square (p-value)	Effect size	
		Urban	Rural		Phi	CC
Electricity	No	1,088,653 (8,547,341.6)	16,603,540 (9,144,851.4)	13670909.0 (0.000)	0.247	0.240
	Yes	107,227,341 (99,768,652.4)	99,284,383 (106,743,071.6)			
Natural gas	No	108,279,220 (108,298,228.0)	115,887,923 (115,868,915.0)	39351.16 (0.003)	0.013	0.013
	Yes	36,774 (17,766.0)	0 (19,008.0)			
LPG	No	82,290,914 (93,019,635.5)	110,250,980 (99,522,258.5)	16952387.15 (0.000)	0.275	0.265
	Yes	26,025,080 (15,296,358.5)	5,636,943 (16,365,664.5)			
Kerosene	No	16,850,557 (14,744,117.0)	13,668,378 (15,774,818.0)	673956.226 (0.000)	0.055	0.055
	Yes	91,465,437 (93,571,877.0)	102,219,545 (100,113,105.0)			
Briquette/ Charcoal	No	107,395,635 (106,827,534.6)	113,727,311 (114,295,411.4)	425331.595 (0.000)	0.044	0.044
	Yes	920,359 (1,488,459.4)	2,160,612 (1,592,511.6)			
Firewood	No	80,972,567 (49,679,215.4)	21,858,735 (53,152,086.6)	70446096.55 (0.000)	0.561	0.489
	Yes	27,343,427 (58,636,778.6)	94,029,188 (62,735,836.4)			

The null hypothesis is that the proportion in each cell is equal. In other words, this null hypothesis is testing whether there is an association between the first variable and second variable. The null hypothesis will be rejected when p-value of statistics χ^2 is less than α. According to the results which are presented in Table 6.5 and Table 6.6, all p-value of Pearson's chi-square statistics (χ^2) are

[57] The analysis is using SPSS version 22 and the output is presented in Appendix 6.4.

equal to zero. By using α = 1% and 5%, the null hypothesis of all chi-square tests in Table 6.5 and Table 6.6 can be rejected. In other words, there is sufficient evidence to say that location in terms of urban or rural has an association with household's choice of domestic fuel.

Table 6.6: Chi-Square test[58] of energy choice vs location in 2011

Energy	Use	Observation value (Estimated value)		χ^2 Pearson chi-square (*p*-value)	Effect size	
		Urban	Rural		Phi	CC
Electricity	No	1,158,741 (7,550,501.0)	14,004,453 (7,612,693.0)	11500683.8 (0.000)	0.218	0.213
	Yes	118,913,642 (112,521,882.0)	107,056,944 (113,448,704.0)			
Natural gas	No	119,450,504 (119,570,510.4)	120,675,398 (120,555,391.6)	3231863.8 (0.000)	0.015	0.015
	Yes	621,878 (501,871.6)	385,999 (506,005.4)			
LPG	No	31,873,445 (53,824,469.4)	76,218,836 (54,267,811.6)	32318643.8 (0.000)	0.366	0.366
	Yes	88,198,937 (66,247,912.6)	44,842,560 (66,793,584.4)			
Kerosene	No	97,885,437 (86,181,986.3)	75,188,400 (86,891,850.7)	11215798.8 (0.000)	0.216	0.216
	Yes	22,186,946 (33,890,396.7)	45,872,996 (34,169,545.3)			
Briquette/ charcoal	No	119,543,838 (119,125,747.1)	119,688,873 (120,106,963.9)	370321.93 (0.000)	0.039	0.039
	Yes	528,545 (946,635.9)	1,372,524 (954,433.1)			
Firewood	No	95,493,415 (64,910,035.8)	34,861,308 (65444687.2)	62475804.6 (0.000)	0.509	0.509
	Yes	24,578,968 (55,162,347.2)	86,200,088 (55,616,708.8)			

From Table 6.5 and Table 6.6, the trend of energy used in rural and urban areas in 2007 and 2011 are similar. In Table 6.5, in the row of electricity and column observation value, the estimated number of urban people who used

[58] The analysis is using SPSS version 22 and the output is presented in Appendix 6.4.

electricity in 2007 was about 107,227,341 people. This is higher than rural people who used electricity, which was 99,284,383. In 2011 – see Table 6.6 – the trend that urban people who used electricity is higher than rural people is still apparent. Urban people who used natural gas and LPG in 2007 and 2011 were also more than rural people. Meanwhile, urban people who used kerosene and briquette/charcoal are fewer than the rural people who used these fuels.

This indicates that the lack of access to electricity, natural gas and LPG for urban people was less than for rural people. In contrast, urban people had a high possibility of not using kerosene, briquettes/charcoal and firewood. This is in line with previous studies. The study by Barnes and Floor (1996) shows that rural people tends to suffer from lack of access to electricity. The study of IEA (2011) indicated that about 84% of solid energy users are living in rural areas. A similar trend also occurred in India (Reddy & Balachandra, 2006), Pakistan (Bhutto et al., 2011), Malawi (Bandyopadhyay et al., 2011) and China (Fischer, 2001). This study adds to the evidence of the previous studies that have proven that domestic energy is influenced by urban-rural dichotomy (D'Sa & Murthy, 2004; Leach, 1988; Leach, 1987b).

The indication of association between location and energy choice is the initial information. The magnitude effect of location to energy choice in this study is known from the effect size. The effect size that will be implemented are *phi* and *Contingency Coefficient* (CC) that are described in Section 4.3.1.4 of Chapter 4. The formula for calculating *phi* is presented in Equation 4.23, whilst CC is presented in formula 4.24. The results are presented in Table 6.5 and Table 6.6.

From the results in Table 6.5 and Table 6.6, values of *phi* and CC for each test are similar. Additionally, in 2007 and 2011 the *phi* and *CC* values of tests of the association between energy choice and rural-urban dichotomy show a large effect size. The magnitude association of electricity use and urban-rural dichotomy in 2007 are 0.247 and 0.240, while in 2011 they are 0.218 and 0.213. Meanwhile, the magnitude association of LPG use and urban-rural dichotomy in 2007 are 0.275 and 0.265, while in 2011 is 0.366 and 0.366. At the same time, the magnitude association between firewood and urban-rural dichotomy in 2007 are 0.561 and 0.489, whilst in 2011 it is 0.509 and 0.509. From this test, it is apparent that the magnitude of association of electricity with location reduced from 2007 to 2011 reduced. However, the magnitude of association of LPG with location increased in 2007 to 2011 increased.

Differences between fuel use in rural and urban areas would be contributed to by infrastructure and industrialisation in urban areas that led households to use more modern fuel (Jones, 1991). In order to close the gap, the government would have to intervene in rural development.

6.3 Distribution of Fuel Use Based on Income

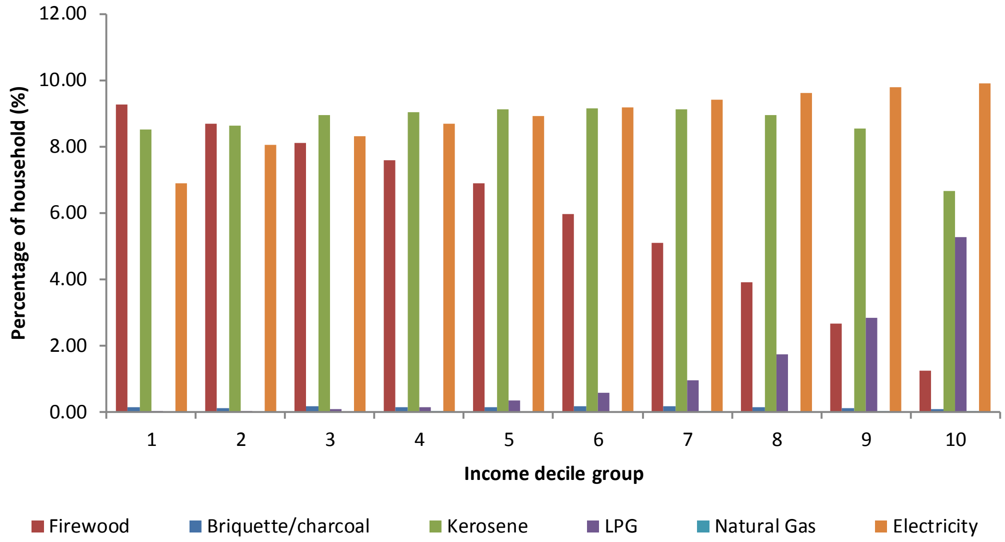
According to the energy ladder theory, income of household determines energy choices (van der Horst & Hovorka, 2008; Hosier & Dowd, 1987; Treiber, 2013). This section is going to identify the use of fuel based on household income. Two different types of analysis will be presented in this section. The first analysis intends to identify the fuel use based on income. The second analysis identifies multiple fuel use in households.

6.3.1. Domestic Fuel Choice and Household Income

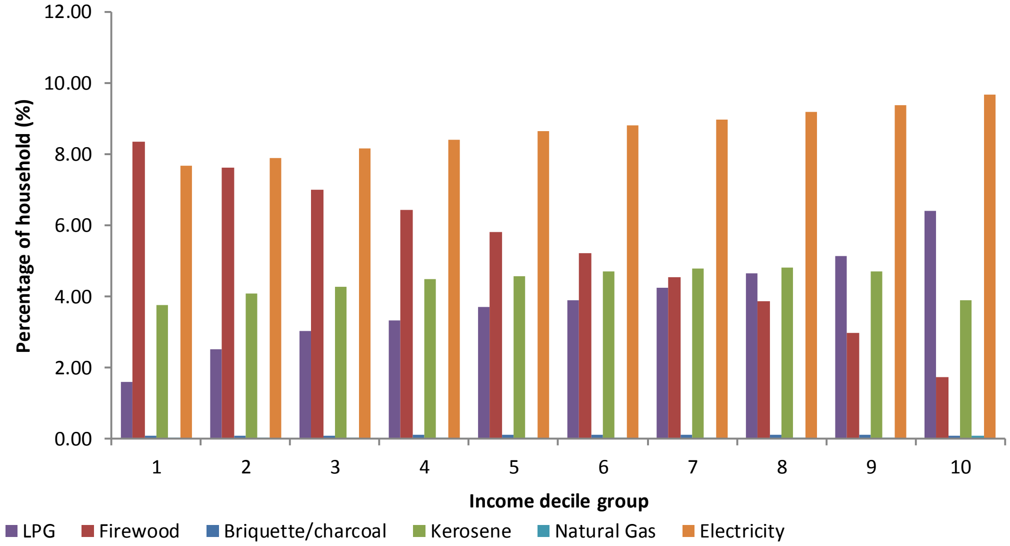
In this section, the data used is taken from SUSENAS Module M which is collected in two years, i.e. 2007 and 2011. This survey investigates the use of fuel in the domestic sector which covers all services in the domestic domain. The objective of this section is identifying the association between fuel choice and household income. Therefore, the variables are fuel choice and income of the household. Income is grouped into income deciles. The summary of number of fuel users along with percentage over total users for every income group in 2007 and 2011 are presented in Appendix 6.5 and the data is depicted in Figure 6.1.

From Figure 6.1(a) it is seen that the percentage of 1^{st} income decile people who used firewood in 2007 was about 9.26%. In 2007, this is the highest among fuel users. In 2011 the highest percentage in this income decile group are firewood users as well. It is seen in Figure 6.1(b) that 8.35% of people in 2011 used firewood. In both 2007 and 2011 when income increased the percentage of firewood users reduced. This implies that lower income households tend to use firewood. Differently to the firewood user trend, the trend of electricity users over income is the reverse of firewood users over income. In 2007, the lowest income people who used electricity was about 6.9%, whilst the highest income people who used electricity was about 9.91%. The percentages of electricity user over income of people in 2011 are almost similar. The gap of percentage of electricity users between the lowest income people and highest income people in 2007 was 3%, while in 2011 it was 2%. This is different to the firewood users, where the gap between the poorest group and the richest group was 7.99% in 2007, and

7.61% in 2011. This can be an indication that the heterogeneity of the income of firewood users is higher than for electricity users.[59]



(a)



(b)

Figure 6.1: Bar chart of income decile versus percentage of household who used specific fuel (a) in 2007) and (b) in 2011[60]

[59] Note: data in this section is gathered from Module M. This data is different to Module K which is applied in Section 6.1. Therefore, the difference of energy users in 2007 and 2011 is not tested.
[60] Total percentage of all fuels in these figures will be more than 100% because it may possible that a people use more than one fuel, while the percentage user is divided by total population.

Meanwhile, the trend of kerosene users over income of people in 2007 and 2011 is different to the trend for firewood and electricity users. Nevertheless, the trends of kerosene users in 2007 and 2011 are almost similar, even though there is a significant reduction in the users of kerosene in 2011. From Figure 6.1(a) and (b), the percentage of the lowest income people who used kerosene is smaller than the middle income people. Moreover, the percentage of kerosene users from the highest income people in 2007 is not as high as the users from the lowest income. In other word, the users of kerosene in each income level are almost similar.

Meanwhile, the trend of LPG users by income is different those above-mentioned fuels. Furthermore, the trend of LPG users by income in 2007 and 2011 is different as well. In 2007, from the 1st income decile until the 7th income decile, the percentage of people who used LPG was less than 1% of the population. In the meantime, it is estimated about 5.28% of the population who were in the 10th decile used LPG. Five years later, in 2011, the percentage of people using LPG in the 1st to 9th income deciles rose considerably. It is apparent that by 2011, there was an increase of LPG users who are grouped in lower income levels. This means, the distribution of LPG to society reached the lower income groups. Additionally, the distribution of LPG by income level in 2011 was more equal than in 2007. This can be seen from 2nd to 7th income deciles where the percentage gaps of LPG users are not significantly different.

This analysis shows that both in 2007 and 2011 a high density of the poor use firewood, but a lower of the density of affluent use firewood. In the meantime, a high density of the affluent use LPG, natural gas and electricity, whilst less poor people use these fuel types. The energy ladder theory which is depicted in Figure

2.4 and explained in Section 2.4.1 says that when income increases people tend to use a higher quality of energy. But the ladder which is depicted in Figure 2.4 may have a different interpretation. The ladder can be interpreted as the impossibility of the poor using modern fuel, while it does not make sense for the affluent to use traditional fuel. Figure 6.1 in this study shows that both low income people and high income people used modern fuel. In this study it is also apparent that affluent people used traditional fuel and the poor are able to use natural gas, LPG and electricity. This does not correspond exactly with the energy ladder theory.

This study shows that introducing modern fuel does not necessarily persuade people who use traditional fuel to modify their habits to adopt modern fuel, but it gives better opportunity to the poor who prefer to use modern fuel. This model is in line with the study of Barnes (2002) in Arnold et al. (2003) which is presented in Table 2.7. This is also shown by Arcenas et al. (2010) study.

It has been widely studied in the global context that poorer countries tend to consume less modern fuel than wealthier countries (IEA, 2010). The reason for this is that modern fuel is commercial energy and it is more expensive than traditional fuel which is commonly available for free. Some developing countries are unable to provide a cheaper commercial energy, which leads their society to have a lack of access to modern fuel.

The trends of the above graphs have shown the indication of the relationship between the income of households and energy choice. In order to identify the relationship between those variables, Chi Square analysis is applied in . The result of Chi square as well as the Pearson's Contingency Coefficient (CC) to calculate the effect size are summarised in Table 6.7.

The equation for measuring Chi-Square is given in formula 4.22 which is given in Section 4.3.1.4. By using α = 0.01 and 0.05, all *p-values* of Chi-square tests in 2007 and 2011 show that *p*-values less than α. It can be concluded that there is a relationship between the household and domestic fuel choice. However, this test is an initial indicator of the relationship because the magnitude of association can be detected through ES which is also revealed in Table 6.7 as well.

In 2007, among those six fuel types, the highest ES is the relation between LPG users and income. The *phi* and *CC* values are 0.545 and 0.479. The relation between firewood and income is the second highest effect size. The ESs are 0.523 and 0.463 of *phi* and *CC*, respectively. Meanwhile, the magnitude of the relation

Table 6.7a: Summary of Chi Square test and effect of energy over income in 2007[61]

Energy	Use	Observation value (Estimated value)										χ^2 Pearson chi-square (p-value)	Effect size	
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th		*Phi*	CC
Electricity	No	5,988,635 (1,989,467)	3,245,184 (1,904,104)	2,601,865 (1,842,278)	1,918,476 (1,792,839)	1,541,765 (1,783,655)	1,020,314 (1,747,416)	661,613 (1,707,019)	400,851 (1,665,768)	213,977 (1,656,495)	99,513 (1,603,152)	15099654.0 (0.000)	0.260	0.260
	Yes	19,222,839 (23,222,007)	20,884,533 (22,225,613)	20,744,357 (21,503,944)	20,801,239 (20,926,876)	21,061,565 (20,819,675)	21,123,772 (20,396,670)	20,970,552 (19,925,146)	20,708,552 (19,443,635)	20,777,922 (19,335,404)	20,216,393 (18,712,754)			
Natural gas	No	25,211,474 (25,207,339)	24,129,717 (24,125,759)	23,346,222 (23,342,393)	22,716,162 (22,715,989)	22,603,330 (22,599,623)	22,144,086 (22,140,454)	21621857 (21,628,617)	21,109,403 (21,105,941)	20,983,716 (20,988,456)	20,301,176 (20,312,574)	81135.4 (0.000)	0.019	0.019
	Yes	0 (4,135)	0 (3,958)	0 (3,829)	3,553 (3,726)	0 (3,707)	0 (3,632)	10,308 (3,548)	0 (3,462)	8,183 (3,443)	14,730 (3,332)			
LPG	No	25,113,347 (21,651,116)	23,951,382 (20,722,124)	23,046,141 (20,049,274)	22,279,330 (19,511,242)	21,563,791 (19,411,293)	20,481,862 (19,016,904)	18,886,595 (18,577,276)	16,427,037 (18,128,338)	13,419,691 (18,027,428)	7,372,718 (17,446,899)	66624191.4 (0.000)	0.545	0.479
	Yes	98,127 (3,560,358)	178,335 (3,407,593)	300,081 (3,296,948)	440,385 (3,208,473)	1,039,539 (3,192,037)	1,662,224 (3,127,183)	2,745,570 (3,054,889)	4,682,366 (2,981,065)	7,572,208 (2,964,471)	12,943,188 (2,869,007)			
Kerosene	No	4,134,801 (3,431,8193)	3,276,614 (3,284,569)	2,314,596 (3,177,919)	1,945,522 (3,092,638)	1,739,775 (3,076,795)	1,687,072 (3,014,282)	1,766,034 (2,944,599)	2,387,433 (2,873,440)	3,487,513 (2,857,445)	7,779,575 (2,765,428)	13605717.9 (0.000)	0.246	0.239
	Yes	21,076,673 (21,779,655)	20,853,103 (20,845,148)	21,031,626 (20,168,303)	20,774,193 (19,627,077)	20,863,555 (19,526,535)	20,457,014 (19,129,804)	19,866,131 (18,687,566)	18,721,970 (18,235,963)	17,504,386 (18,134,454)	12,536,331 (17,550,478)			
Briquette/ charcoal	No	24,859,834 (24,865,022)	23,801,209 (23,798,131)	22,962,249 23,025,402)	22,392,496 (22,407,505)	22,259,086 (22,292,719)	21,779,022 (21,839,786)	21,289,029 (21,334,899)	20,862,350 (20,819,321)	20,798,882 (20,703,432)	20,118,789 (20,036,728)	99567.7 (0.000)	0.021	0.021
	Yes	351,640 (346,452)	328,508 (331,586)	383,973 (320,820)	327,219 (312,210)	344,244 (310,611)	365,064 (304,300)	343,136 (297,266)	247,053 (290,082)	193,017 (288,467)	197,117 (279,178)			
Firewood	No	2,287,213 (11,563,262)	4,225,914 (11,067,114)	5,918,639 (10,707,763)	7,152,593 (10,420,415)	8,969,709 (10,367,035)	11,240,629 (10,156,402)	12,872,190 (9,921,609)	14,806,903 (9,681,844)	16,880,038 (9,627,951)	18,477,474 (9,317,906)	61324272.1 (0.000)	0.523	0.463
	Yes	22,924,261 (13,648,212)	19,903,803 (13,062,603)	17,427,583 (12,638,459)	15,567,122 (12,299,299)	13,633,621 (12,236,295)	10,903,457 (11,987,684)	8759,975 (11,710,556)	6,302,500 (11,427,559)	4,111,861 (11,363,948)	1838,432 (10,997,999)			

[61] Chi-Square analysis in this research is using SPSS 22 and the output is presented in Appendix 6.5.

Table 6.7b: Summary of Chi Square test and odds ratio of energy over income in 2011 (cont'd) [62]

Energy	Use	Observation value (Estimated value)										χ^2 Pearson chi-square (p-value)	Effect size	
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th		*Phi*	CC
electricity	No	1,847,093	2,279,895	2,210,138	1,991,824	1,690,663	1,492,999	1,302,591	1,050,979	823,003	474,008	4262679.6 (0.000)	0.133	0.132
		(893,367)	(1,334,703	(1,480,154)	(1,518,034)	(1,554,303)	(1,577,799)	(1,582,629)	(1,620,086)	(1,652,435)	(1,949,683)			
	Yes	12,359,746	18,945,314	21,328,121	22,148,816	23,026,752	23,598,072	23,865,276	24,712,561	25,454,957	30,530,971			
		(13,313,471)	(19,890,506)	(22,058,105)	(22,622,606)	(23,163,112)	(23,513,272)	(23,585,238)	(24,143,454)	(24,625,526)	(29,055,296)			
Natural gas	No	14,175,623	21,176,405	23,467,944	24,066,840	24,644,700	25,021,077	25,071,984	25,662,075	26,151,421	30,687,833	343861.3 (0.000)	0.038	0.038
		(14,147,459)	(21,136,493)	(23,439,875)	(24,039,737)	(24,614,103)	(24,986,197)	(25,062,673)	(25,655,855)	(26,168,125)	(30,875,386)			
	Yes	31,217	48,804	70,315	73,799	72,715	69,994	95,884	101,465	126,539	317,146			
		(59,381)	(88,716)	(98,384)	(100,902)	(103,313)	(104,874)	(105,195)	(107,685)	(109,835)	(129,593)			
LPG	No	11,133,738	13,934,321	13,630,500	12,678,565	11,470,371	11,009,362	9,988,607	9,310,270	8,369,204	6,567,344	22277776.6 (0.000)	0.304	0.291
		(6,368,456)	(9,514,558)	(10,551,421)	(10,821,449)	(11,079,998)	(11,247,496)	(11,281,921)	(11,548,941)	(11,779,539)	(13,898,505)			
	Yes	3,073,102	7,290,889	9907758	11,462,075	13,247,044	14,081,709	15,179,261	16,453,270	17,908,756	24,437,635			
		(7,838,385)	(11,710,652)	(12986837)	(13,319,191)	(13,637,417)	(13,843,576)	(13,885,947)	(14,214,599)	(14,498,422)	(17,106,475)			
Kerosene	No	10,509,887	15,668,662	17,056,488	17,280,563	17,616,274	17,436,234	17,383,916	17,776,825	18,326,710	24,018,277	889484.6 (0.000)	0.061	0.061
		(10,196,963)	(15,234,399)	(16,894,592)	(17,326,950)	(17,740,931)	(18,009,123)	(18,064,243)	(18,491,788)	(18,861,013)	(22,253,832)			
	Yes	3,696,953	5,556,547	6,481,771	6,860,076	7,101,141	7,654,837	7,783,951	7,986,715	7,951,250	6,986,702			
		(4,009,877)	(5,990,809)	(6,643,667)	(6,813,689)	(6,976,484)	(7,081,948)	(7,103,624)	(7,271,752)	(7,416,947)	(8,751,147)			
Briquette/ charcoal	No	14,121,155	21,099,441	23,377,828	23,946,649	24,529,247	24,855,354	24,936,505	25,532,681	26,047,257	30,786,592	42522.9 (0.000)	0.013	0.013
		(14,094,835)	(21,057,872)	(23,352,686)	(23,950,318)	(24,522,546)	(24,893,256)	(24,969,446)	(25,560,423)	(26,070,788)	(30,760,539)			
	Yes	85,685	125,769	160,431	193,991	188,168	235,717	231,362	230,859	230,703	218,387			
		(112,005)	(167,337)	(185,573)	(190,322)	(194,869)	(197,815)	(1,984,201)	(203,117)	(207,173)	(244,439)			
Firewood	No	2,294,955	5,193,536	7,587,590	9,459,249	11,744,267	13,799,115	15,601,349	17,730,358	19,970,829	26,973,475	44337283.8 (0.000)	0.429	0.394
		(7,680,088)	(11,474,155)	(12,724,568)	(13,050,209)	(13,362,009)	(13,564,004)	(13,605,519)	(13,927,535)	(14,205,626)	(16,761,009)			
	Yes	11,911,885	16,031,673	15,950,668	14,681,390	12,973,149	11,291,956	9,566,518	8,033,182	6,307,131	4,031,504			
		(6,526,752)	(9,751,055)	(10,813,690)	(11,090,429)	(11,355,406)	(11,527,067)	(11,562,348)	(11,836,005)	(12,072,334)	(14,243,970)			

[62] Chi-Square analysis in this research is using SPSS 22 and the output is presented in Appendix 6.5.

between electricity and income is 0.260. This magnitude is almost similar to the association between kerosene and income, where the *phi* and *CC* values are 0.246 and 0.239, respectively. Differently to 2007, in 2011 the highest ES is the magnitude association between firewood use and income with the *CC* at 0.39. In comparison in 2011, this value is reduced, where the *phi* value is 0.429 and *CC* value is 0.394. At that time, the ES association between LPG use and income in 2011 is 0.304 (*phi*) and 0.291 (*CC*). This magnitude is lower in comparison to 2007. This reduction can be an indication that the relation between LPG and income in 2011 is weaker than in 2007. In addition to LPG, the relation of electricity and income in 2011 reduced as well. This means, the determinant of income household to firewood, LPG and firewood in 2007 to 2011 are reduced.

This study shows that the relation of income-fuel choice is statistically significant. Far before this study, the study of Soussan et al. (1990) shows that in three countries income determines energy choice. Similarly, the study of Koshal et al. (1999) shows that household income in addition to price determines kerosene consumption. Income has a relation to affordability (Karekezi, 2002; Nkomo, 2005; Suliman, 2013). Affordability influences people's preference to consume a product/service.

From the analysis in this study, it can be summarised that energy use has an association with income. Nevertheless the association for each type of energy varies. The relation of income and electricity, LPG use, kerosene use and firewood use in 2007 are apparent. But, after five years, in 2011, the relation of income to kerosene reduced significantly. Therefore, income merely determines electricity, LPG and firewood use. The reduction in the strength of association with income can be influenced by the ECPKL. This implies, the intervention from the government by introducing modern fuel to society is able to reduce the income barrier in using modern energy.

6.3.2. Relationship between Number of Fuel Types and Income of Household

This sub-section investigates the users of multiple fuel types at the domestic level. The analysis will be made by using SUSENAS Module M (see Section 4.2.1). The results of analysis for 2007 and 2011 are shown in Table 5.12 and Table 5.13 respectively.

From those tables, it is apparent that there was a change in the number of types of fuel used by people from 2007 to 2011. In 2007, about 38.59% of people used electricity, kerosene and firewood. This was the highest percentage of users in 2007. Meanwhile, by 2011, people who used these fuel types dropped to 11.33%. In 2011, people who used electricity and LPG were the highest among possible combinations, at about 41.10%. In 2007, only 6.09% of people used electricity and LPG. Interestingly, the users of electricity and firewood in five years, from 2007 to 2011, increased from 6.28% to 17.72%. From this analysis, it is clear that the use of firewood combined with other fuels is apparent. This can be an indication that during the implementation of ECPKL, some households moved to firewood use in addition to the move to LPG as found by IESR (Tumiwa & Imelda, 2011). This is discussed in Section 8.1. However, in the previous Chapter 5, in Table 5.8 it is apparent that the percentage of households who used firewood for the main cooking fuel reduced. Information from Table 5.7 also shows that the percentage of people who used firewood reduced as well. From this data it can be clearly seen that the existence of households who still depend on firewood should not be overlooked, even though firewood might not be the main fuel they use.

Table 6.8: Number of people who used multiple fuel based on income

Income decile	Number of fuel used by a household									
	2007					2011				
	Single fuel	Two fuel	Three fuel	Four fuel	Five fuel	Single fuel	Two fuel	Three fuel	Four fuel	Five fuel
1st	485,193	10825099	13712436	186474	0	600220	10227819	3222790	141973	1416
	18.8%	9.6%	13.1%	4.9%	0.0%	11.0%	6.0%	5.4%	3.0%	3.6%
2nd	310,964	9538045	14064339	207517	6749	697608	14342168	5796681	377852	0
	12.1%	8.4%	13.4%	5.5%	8.7%	12.7%	8.4%	9.7%	8.1%	0.0%
3rd	285,704	9717954	13079299	256306	4218	650302	15434886	6957836	481134	2999
	11.1%	8.6%	12.5%	6.8%	5.5%	11.9%	9.0%	11.7%	10.3%	7.6%
4th	279594	9893486	12283044	260423	2531	636465	15676251	7261083	541802	3089
	10.8%	8.7%	11.7%	6.9%	3.3%	11.6%	9.2%	12.2%	11.6%	7.8%
5th	214195	10763155	11216931	391348	15883	584202	16248869	7324396	535328	4537
	8.3%	9.5%	10.7%	10.3%	20.5%	10.7%	9.5%	12.3%	11.5%	11.5%
6th	175876	11898273	9660121	405892	2561	543832	17045262	6946159	530455	5350
	6.8%	10.5%	9.2%	10.7%	3.3%	9.9%	10.0%	11.6%	11.4%	13.5%
7th	171219	12290378	8687014	467340	16214	519839	17564785	6486386	562695	6891
	6.6%	10.9%	8.3%	12.3%	21.0%	8.9%	10.9%	10.1%	11.9%	7.9%
8th	208608	12637842	7726045	521530	15378	420793	19968835	5313838	526119	4064
	8.1%	11.2%	7.4%	13.8%	19.9%	7.7%	11.7%	8.9%	11.3%	10.3%
9th	203345	12666411	7592610	523943	5590	337855	25840554	4354518	414514	8019
	7.9%	11.2%	7.3%	13.8%	7.2%	7.7%	11.7%	8.9%	11.3%	10.3%
10th	244320	12942673	6550417	569036	8183	337855	25840554	4354518	414514	8019
	9.5%	11.4%	6.3%	15.0%	10.6%	6.2%	15.1%	7.3%	8.9%	20.3%
Total	2579018	113173316	104572256	3789809	77307	5479261	170974087	59712491	4666895	39499
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
% over total	1.15%	50.48%	46.64%	1.69%	0.03%	2.27%	70.90%	24.76%	1.94%	0.02%

Note: Calculation by author from SUSENAS

Table 6.8 shows the number of people who used multiple types of fuel over income. From 2007 to 2011, people who used a single fuel in domestic use increased from 1.15% to 2.27%, respectively. Meanwhile from 2007 and in 2011, people who used two energy types increased significantly from 50.48% to 70.9%. In contrast, people who used a combination of three types of fuel in 2007 and 2011 reduced considerably from 46.6% to 24.76%. From the table, it can be summarised that from 2007 and 2011, people tended to move to smaller combinations of fuel use rather than to a higher combinations of fuels.

Graphs in Figure 6.2 and Figure 6.3 show clearer descriptions of the distribution of multiple fuel users based on the number of types of fuel they used and income decile.

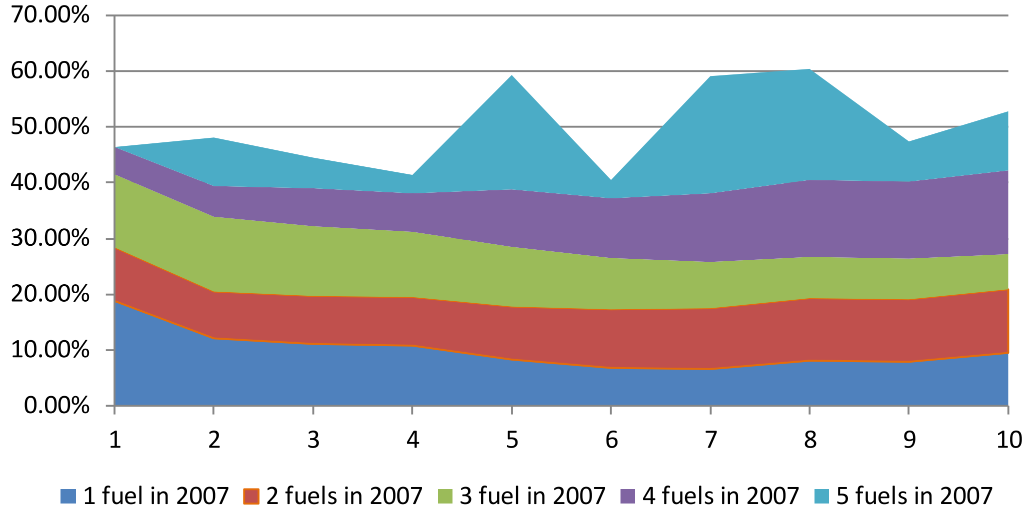


Figure 6.2: Multiple fuel use by income in 2007 (author's calculation)

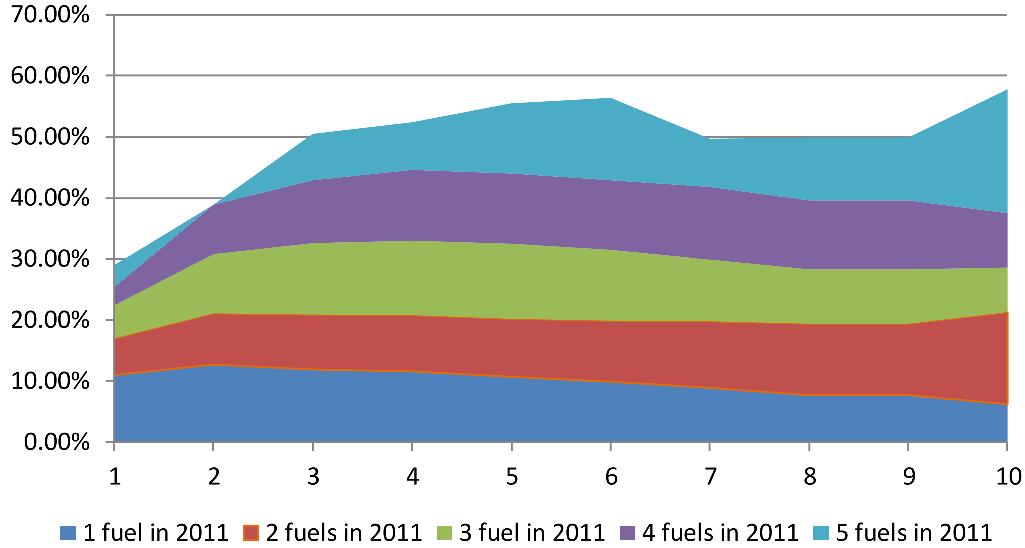


Figure 6.3: Multiple fuel use by income in 2011 (author's calculation)

Figure 6.2 and Figure 6.3 show that both in 2007 and 2011, the percentage of the poor who used one fuel was the highest among all income levels. In 2007, Table 5.12 shows that the most common highest user among single fuel user in 2007 was the kerosene user, whilst in 2011 it was the firewood user. Meanwhile, households who used two fuels in 2007 were most often electricity and kerosene users (31.61%), whilst in 2011 they were electricity and LPG users (41.10%). The trend of the dual fuel user by income is different to the single fuel user. The increase in income led to an increase in the frequency of households who used dual fuels. Having more than one fuel type means more money would be needed. For example, a household has a firewood stove that led them to depend more upon firewood for cooking. If they want to use LPG, they need a new stove, pipe and stove regulator. Providing these appliances requires money. Meanwhile, low income households have low affordability. This is different to the middle income households who have higher affordability than the poor. From those graphs, there is an indication that there is a linkage between income level and number of fuel used.

However, the linkage between the number of fuels used and income should be investigated through a statistical test. In order to prove this hypothesis, the chi-square test is implemented. Variables which are tested are income and number of fuels used. The income of households in this study is grouped into income deciles. The result from the Chi-Square test which is presented in Table 6.9 shows that *p-values* of χ^2 of the tests in 2007 and 2011 indicate that the relation between income and number of fuels used are statistically significant at α

= 1% and α = 5%. Meanwhile, the magnitude of association between these variables are 0.185% (2007) and 0.13% (2011).

Table 6.9: Chi-square test of number of fuel and income decile

Variables	χ^2		Effect size			
			Phi		Contingency Coefficient (CC)	
	2007	2011	2007	2011	2007	2011
Income decile versus number of energy used by household	7,954,047.53 (0.000)	4,601,549.24 (0.000)	0.188	0.137	0.185	0.137

The using of multiple fuel types is mostly adopted as a way to survive. In this study, from the interviews with respondents which represent members of the public, it is apparent that the use of multiple fuels by households provides different services in the household. For example, electricity is the power used for lighting, meanwhile, LPG, kerosene and firewood are mostly used for cooking. Moreover, some households have different types of fuel for cooking, for instance, electricity, LPG and firewood. Firewood is used by households as an alternative fuel if LPG is not available in the market. In rural areas, firewood stoves are mostly used for boiling water. Electricity is used for cooking with an electric rice cooker. Moreover, the use of firewood is because the households have space for a firewood stove in the kitchen. This issue will be discussed in more detail in Chapter 8.

From the above analysis there are several points. In relation to the energy ladder, there is an argument that income has a relation to energy stacking instead of the energy ladder (i. e. Jan et al., 2012). This means that households utilise more than one type of fuel in households to meet their needs for survival. In terms of Indonesia, in this study it has been shown that the energy stacking during 2007 to 2011 was apparent. This is in line with Andadari et al. (2014) study. But, five year after implementation of ECPKL, energy stacking is reduced. From Table 5.7 on the energy used by household in 2007, it is apparent that the use of electricity, kerosene and firewood had the highest percentage (38%), whilst electricity and kerosene use was the second highest percentage (31%). In 2011 (see Table 5.8), electricity and LPG use was the highest among others, i.e. 41%, while electricity and firewood use was the second highest percentage, i.e. about 17%. All of the facts give evidence on the reduction of fuel and these provide a positive signal of the development of access to modern energy, giving indication that, in 2011, the number of households in Indonesia having access to more modern energy, in this case i.e. LPG. The transition of energy after government intervention – such as providing modern fuel or substituting energy – is unavoidable. Intervention by providing more modern yet less expensive energy such as 3 kg LPG in the ECPKL, meaning that households of all income levels were able to use the 3 kg LPG. This makes the stacking is reduced or less varied.

6.4 Discussion

Analysis of SUSENAS data showed that the change from 2007-2011 in percentage of people per region who used firewood as their main fuel for cooking was not as high as the changes of kerosene and natural gas/LPG users. Also, the changes in percentage of kerosene users were not as high as the change in percentage of natural gas and LPG users. This affects the measurement of access to modern fuel. When kerosene is classified as a modern fuel, the change in access to modern fuel in Indonesia from 2007 to 2011 was not as high as a when kerosene is excluded as modern fuel. This is because when kerosene is included, the change merely substitutes one modern fuel (kerosene) with another modern fuel (LPG). This would lead to the conclusion that the – Energy Conversion Programme from Kerosene to LPG (ECPKL) – as the attempt of the government of Indonesia to improve access to modern fuel – does not have a highly significant contribution to reducing energy poverty in terms of lack of access to modern fuel. However, if kerosene is recognised as a transitional fuel, this implies that kerosene is considered neither as a clean energy nor traditional fuel. As a result, the significant improvement of LPG use can be recognised as the success of ECPKL. With this assumption, it can be concluded that ECPKL is able to improve modern fuel and alleviate of energy poverty, when energy poverty is defined as lack of access to modern fuel.

It was also found that location in terms of urban or rural is statistically significant in its relationship with household choice of domestic fuel. This study supports the argument from previous studies (Sovacool, 2011; Suliman, 2013) which shows that urban-rural location influences households in decisions on using modern fuel. This study supports previous studies which show that urban households tend to use cleaner energy than rural households (Cai & Jiang, 2008). Additionally, from this study there is sufficient evidence to say that increase in income household increases the possibility to adopt modern fuel. However, even though it has been shown that income is related to fuel choice, the relation between these variables is quite small. This may be an indication that there are another factors – e.g. household preference and willingness to use the fuel in relation to the availability and convenience in using of appliances (Sathaye & Tyler, 1991) – which influence the fuel choice.

Furthermore, income influences the propensity of households to be multiple fuel users. But nevertheless the fuel stacking reduced from 2007 and 2011. The idea of energy stacking is an alternative to the energy ladder theory which tends to assume households are single fuel users. This study found evidence that the relationship between, income and the frequency of people who choose a specific energy type tends to a pyramid, not a ladder. This implies that at least some of the poor and the rich haves opportunity to access traditional, transitional and modern fuel. Nevertheless, the frequency of the poor who use traditional fuel is higher than the more affluent, whilst the frequency of the affluent who use modern fuel is higher than the poor.

Chapter 7
Government Intervention into Energy Access

This chapter aims to examine the intervention by the Republic of Indonesia government in providing modern fuel through a policy called the Energy Conversion Programme from Kerosene to LPG (ECPKL). The research question that will be answered is: *How effective was the governance of ECPKL policy and what is its relation to modern fuel improvement and energy poverty alleviation?* In order to answer the research questions, this chapter is divided into four sections. The first section provides the underlying reasons for the policy and identifies whether the policy is effective in reducing the use of traditional fuel and kerosene as a transitional fuel. The second section investigates the roles of central government in the energy transition. The third section looks into challenges faced by the policy. The last section explores the achievements as well as the intended and unintended effects of the policy.

7.1 Rationales for the Policy

The four main aims of the ECPKL policy as set out in the government document are energy diversification in order to reduce the dependency on kerosene as a fossil fuel; reduction of kerosene subsidy leakage through kerosene reduction; and the provision of cleaner and more efficient fuels for society (KESDM-RI, 2007a). According to interviews narrative with government officials and members of the public, people perceive the four underlying reasons for the ECPKL policy to be a reduction of the kerosene subsidy; cutback of kerosene consumption; security of energy for cooking; and provision of cleaner energy for cooking. Among these stated reasons, the security of energy is the only one to differ from the aims of ECPKL as set out in MESDM-RI (2007a). However, diversification of energy can be considered as one of the solutions for energy security (Cohen et al., 2011). It is evident that there are no differences between what is stated in the government document as the aims of the ECPKL policy and the interviewees' perception of the underlying reasons for the policy. From the responses of the interviewees in Table 7.1, it can be seen that subsidy reduction is mentioned most frequently as the rationale for the ECPKL policy. It was also stated by some respondents that the subsidy of the kerosene was the initial cause leading to the implementation of the ECPKL policy. This issue will be discussed further in the next Section.

Table 7.1: Underlying reasons of the ECPKL as stated in the interviews

Respondent ID	Location of respondent	Underlying reasons			
		Reduction of kerosene subsidy	Cutback of kerosene consumption	Security of energy for cooking	Provision of cleaner energy for cooking
IDGA01	Banda Aceh	√	√	√	
IDGA02	Banda Aceh	√			
IDGA05	Banda Aceh	√	√		
IDGB01	Bogor	√	√	√	
IDGB02	Bogor			√	
IDCG01	Central gov.	√			√
IDCG02	Central gov.	√			√
IDCG05	Central gov.				√
IDCG06	Central gov.	√			
IDGJ01	Jember	√	√		
IDGJ02	Jember		√		
IDGJ03	Jember	√			
IDGJ04	Jember	√			
IDGJ05	Jember		√		
IDGM01	Muaro Jambi	√			
IDGM03	Muaro Jambi	√	√	√	
IDGS05	Surakarta	√	√		
Total		13	8	4	2

Figure 7.1 provides oil production by countries in Asia-Pacific between 1965 and 2012. As presented in Figure 7.1, Indonesia was the second highest oil producing country in Asia-Pacific from 1965 to 2012. From 1965 until 2003 oil consumption in Indonesia was below its production and, as a result, it became a net oil exporting country during this period. In order to increase oil consumption, the Indonesian government provided subsidies to gasoline, diesel oil and kerosene for society and industries. Since 2000, crude oil production in Indonesia has plummeted (see Figure 7.2). This was the result of a reduction in crude oil reserves, lack of technology and lack of investment in building infrastructure and energy exploration. In the meantime, oil consumption increased gradually. As a consequence, Indonesia was unable to meet the overconsumption of oil and in 2003 started to be a net oil importing country (Bulman et al., 2008). Importing oil means the price of oil in Indonesia will be influenced by international oil prices; however, the oil price from 1965 to 2003 was set cheaper than that of international markets.

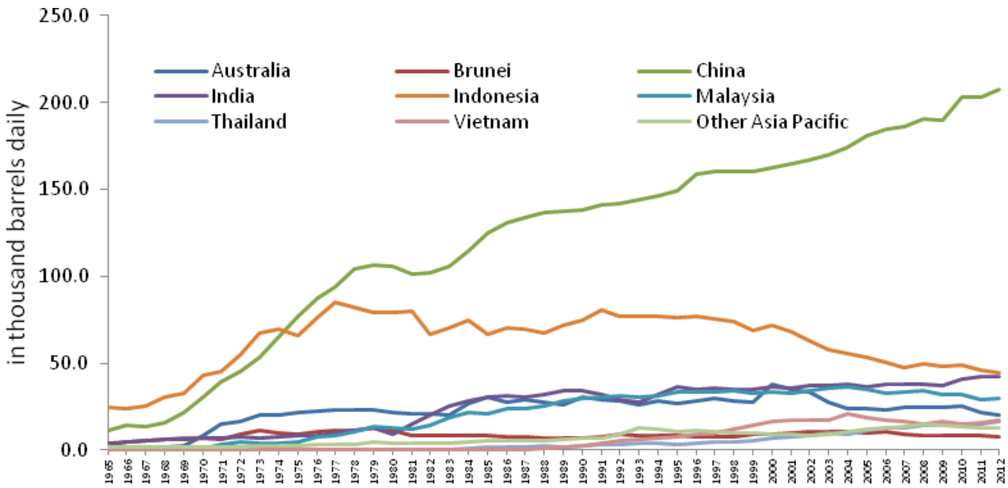


Figure 7.1: Oil production by countries in Asia Pacific 1965-2012 (British Petroleum, 2013)

As shown in Figure 7.2, the oil price in Indonesia rocketed significantly from 2004 to 2007. The global kerosene price also increased since 2002 (see Figure 3.4). This situation shook the Indonesian economy and led to an increasing subsidy for energy, including a subsidy for kerosene. As presented in Figure 7.3, the subsidy for kerosene increased from USD 1.96 billion in 2005 to USD 3.78 billion in 2006.

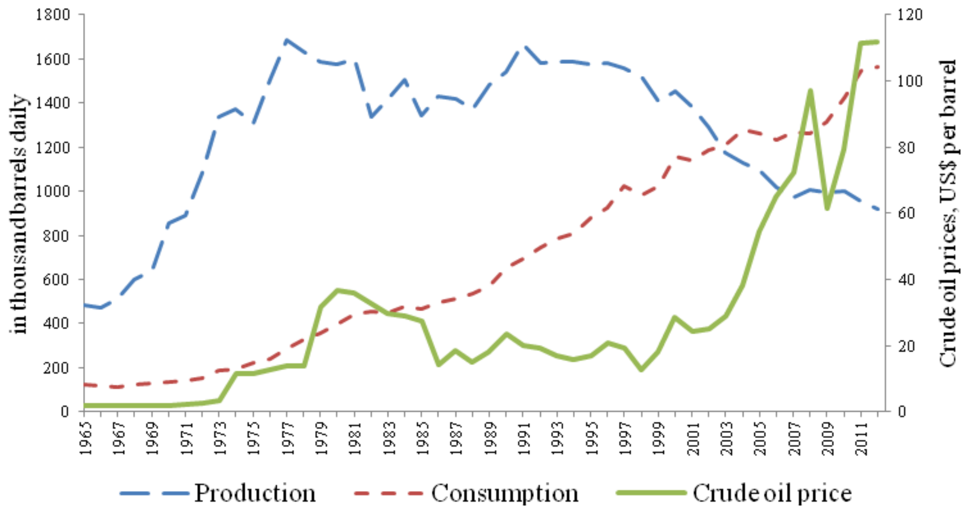


Figure 7.2: Oil production and consumption in Indonesia 1965-2012 (British Petroleum, 2013)

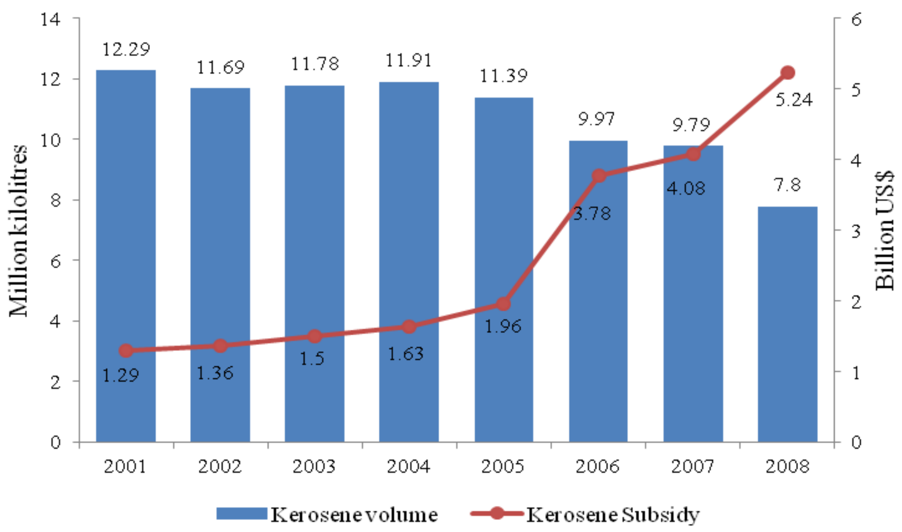


Figure 7.3: Kerosene consumption and kerosene subsidy in Indonesia (Budya & Arofat, 2011)

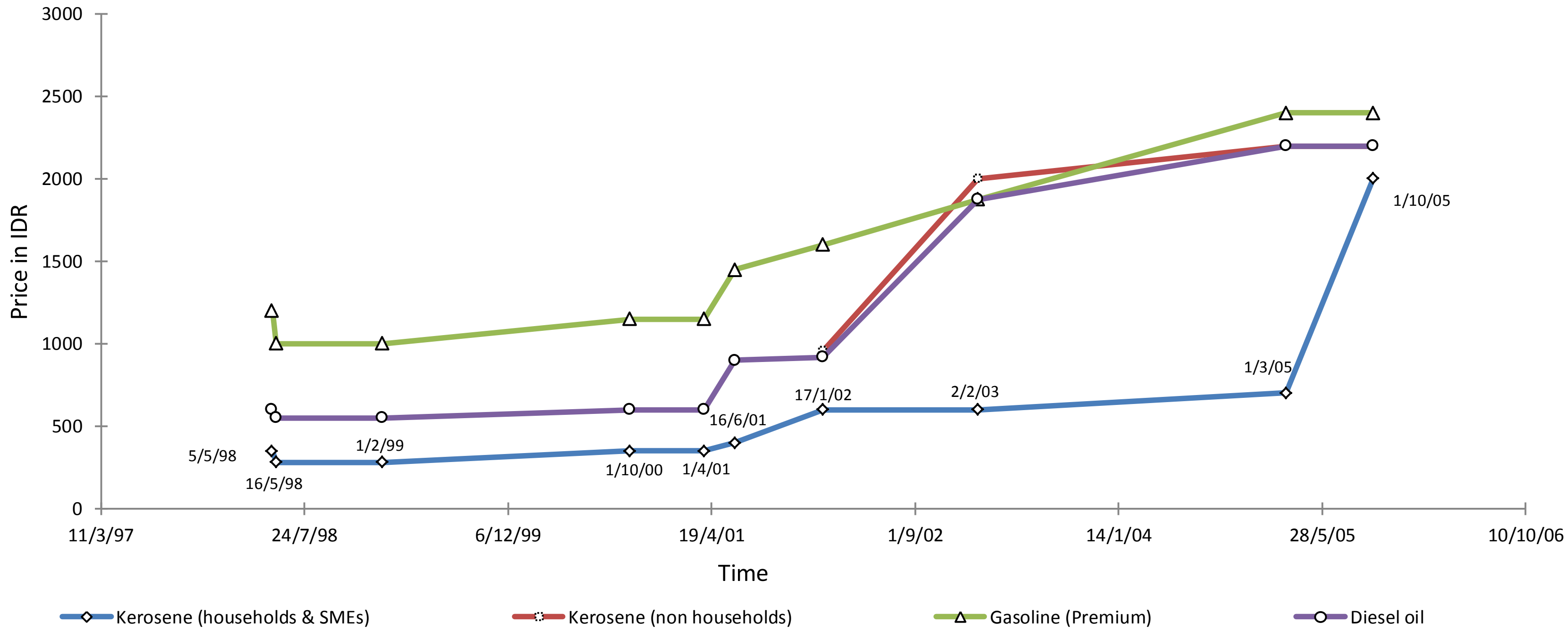


Figure 7.4: Price of fossil energy in Indonesia[63]

[63] Source: Price in 26th June 1998 based on Presidential Decree No. 69 Year 1998 (Presiden Republik Indonesia, 1998a), price in 16th May 1998 based on Presidential Decree No. 78 Year 1998 (Presiden Republik Indonesia, 1998b), price in 1st February 1999 based on Presidential Decree No. 10 Year 1999 (Presiden Republik Indonesia, 1999), price in 1st October 2000 based on Presidential Decree No. 135 Year 2000 (Presiden Republik Indonesia, 2000), price in 1st April 2001 based on Presidential Decree No. 45 Year 2001 (Presiden Republik Indonesia, 2001a), price in 16th June 2001 based on Presidential Decree No. 73 Year 2002 (Presiden Republik Indonesia, 2001b), price in 17th January 2002 based on Presidential Decree No. 9 Year 2002 (Presiden Republik Indonesia, 2002a), price in 2nd February 2003 based on Presidential Decree No. 90 Year 2002 (Presiden Republik Indonesia, 2002b), price in 1st March 2005 based on Presidential Regulation No. 22 Year 2005 (Presiden Republik Indonesia, 2005a), price in 1st October 2005 based on Presidential Regulation No. 55 Year 2005 (Presiden Republik Indonesia, 2005b). Price of global kerosene, gasoline & diesel oil in October 2005 based on IISD (2005); Presiden Republik Indonesia (1998b) reports.

This situation compelled the government to make a policy of elevating the oil price. Through the policy, the government expected to reduce kerosene consumption which in turn would reduce the budget for the kerosene subsidy. In 2005 the government decided to cut the subsidy budget for three fossil fuels, i.e. kerosene, gasoline and diesel oil. The records of prices of these energy types are provided in Figure 7.4.

From Figure 7.4, the price of kerosene can be seen to be the lowest historically in comparison to gasoline and diesel oil. This is because the government kept the kerosene price the lowest for the reason that this energy was mostly consumed for domestic use of which dominant elements are rural households (see Section 6.2) as well as middle and lower income households (see Figure 6.1 in Section 6.3.1). However, since the price of oil continued increasing, the government decided to raise the kerosene price as well those of gasoline and diesel oil on 2nd February 2002. The records also show that in 2005, the fuel prices were increased on the first of March and first of October. On first of October 2005, the price of kerosene for households was inflated three times higher than that on 1st March in the same year. This caused the price of kerosene to reach a level just under the prices of gasoline and diesel oil which are consumed more for transportation.

It is generally believed that the negative effect of energy liberalisation through subsidy phase-out will influence household deprivation (Birol et al., 1995). Subsidy phase-out increases inflation and influences affordability for households (Hope & Singh, 1995). These in turn reduce domestic consumption because their expenses increase unavoidably. On one hand, energy subsidy removal without any compensation affects welfare (Adam & Lestari, 2008). The subsidy phase-out also contributes to income loss (Mourougane, 2010) because it reduces the purchasing power of society. The subsidy removal, on the other side, gives benefits to the government through reduction of social spending. The government can reallocate funds resulting from the saved spending to increase other expenditure, such as the poverty reduction programme and infrastructure improvement, to name but two. Within the Indonesian context, subsidy phase-out increases poverty in the short term (Clements et al., 2007). This is because the increasing price of energy causes the increasing aggregate level of prices (Hope & Singh, 1995). In the long term, however, the reallocation of the energy subsidy improved human welfare (Dartanto, 2013). In most cases, subsidy phase-out in Indonesia led to social reluctance and protests such as riots and demonstrations. It in turn led to social conflicts and even created violence and crime (Beaton & Lontoh, 2010).

Moreover, kerosene in Indonesia is not merely consumed by the poor (Dartanto, 2013). This is confirmed by the interviewees in this study, who stated that rich people in urban areas used kerosene as well. Kerosene was also consumed by manufacturers, despite being in eligible to receive the kerosene subsidy. Regarding this, the government had found that there were a variety of abuses by kerosene sellers and manufacturers. For example, the kerosene quality was reduced by mixing kerosene with other fuels. It was also the case that subsidised kerosene which was provided for domestic consumption was consumed by manufacturers as the source of matches industries. Kerosene was sold by kerosene stations and small resellers. A kerosene station is a legal distributor which should be registered by KESDM-RI. They sold kerosene to small resellers and end users. It was more often that kerosene consumers bought the kerosene from small resellers due to limited numbers of kerosene stations. The abuses of mixing kerosene with other fuels mostly happened with such small resellers as they were not registered legally. The economy of Indonesia and the subsidy abuses encouraged the government to reduce kerosene production until *zero-kero* was achieved – a situation where kerosene was no longer subsidised and the government produced kerosene only for lighting and unsubsidised use (KESDM-RI, 2005).

All of the above-mentioned factors and issues were considered by the Indonesian government such that the government had to give careful deliberation to cut the subsidy of kerosene. By considering these issues, the interviewees in this study confirmed that the government decided to provide energy diversification instead of to reduce fossil fuel entirely. It was decided to replace the kerosene, as well as the subsidy embedded within it, with LPG.

The first option for kerosene substitution was briquettes.[64] Indonesia is one of the countries with the largest coal reserves in the world (British Petroleum, 2013). At that time, and on account of this abundance, the Indonesian government thought that the provision of briquettes for society might help them have access to cheaper energy for cooking. However, the government changed their decision and turned to replace kerosene with LPG instead of briquettes. The efficiency of a briquette is much lower than LPG, about 30% and 60%, respectively (Pokharel & Chandrashekar, 1995). Also, LPG is more efficient than kerosene with a range of

[64] Briquette is produced from coal.

25-60% and 12-55% for LPG and kerosene, correspondingly (see Table 2.2). Furthermore, in comparison to briquettes, the LPG supply chain and its infrastructure are well prepared.

In Indonesia, LPG is produced from crude oil and natural gas and three types of LPG have been distributed: mixed, *propane* (C3H8) and *butane* (C4H8). Before the ECPKL, LPG was available in canisters of two different sizes: 50 kg and 12 kg. These types of LPG are not subsidised. The 50 kg LPG is intended for business consumers, whilst 12 kg LPG is intended for domestic consumers. In ECPKL, in order to increase the adoption and affordability of LPG for society, the government produced a smaller unit of LPG in a 3 kg canister. This LPG is subsidised. Therefore, when the household refills the LPG in a 3 kg LPG canister, the price is lower than the 12 kg LPG and 50 kg LPG canisters. All of those LPG canisters are presented in Figure 7.5.

Figure 7.5: Types of LPG canisters in Indonesia, 3 kg LPG canister in green colour and 12 kg LPG and 50 kg LPG canisters are in blue colour

From the above-mentioned explanation, it is clear that the aim of the policy from the government's point of view is mainly to reduce economic costs of the energy subsidy spent by the government. The main target of the policy is to lessen the economic burden the government of Indonesia has to deal with, without totally removing the subsidy for cooking energy. With this aim, the Indonesian government expected that the policy would help diminish the dependency of society on kerosene and direct them to move to LPG. In comparison to kerosene, the sources of LPG supply in Indonesia are a lot more extensive. In terms of energy security, the supply of LPG is more secure than that of kerosene.

Moreover, this research study identified that the ECPKL policy tried to reduce environmental damage caused by energy through selecting cleaner energy such as LPG instead of less clean ones like briquettes. It has been presented in Table 2.3 in Chapter 2 that LPG produces lower carbon monoxide (CO) and sulphur dioxide (SO2) in comparison to coal briquettes. In addition, LPG has higher calories than coal briquettes (see Table 2.2 in Chapter 2). In comparison to kerosene, LPG is also cleaner (Jungbluth et al., 1997). In contrast to arguments by many scholars that LPG and kerosene are considered as modern fuel, Barnes et al. (2004) propose that kerosene should rather be considered a type of transitional fuel and therefore is less ‘modern’ than other types of modern fuel. It is apparent, therefore, that one motivation of the ECPKL policy is providing LPG as a cleaner energy for society.

7.2 Institutional Support

Based on the interviews with respondents who represent the government, several government-related factors leading to the success of the policy have already been identified. Further details of these factors are explored in this section.

7.2.1. Institutional Setting: From Central to Local Government

The institutional setting determines the institutions and organisations involved in the ECPKL policy. In this study, the institutions involved in the policy range from national level to local level and a list of institutions and their relationships are presented in Figure 7.6. Descriptions of the roles and responsibilities of each of the institutions are provided in Figure 7.2 and Figure 7.3.

The government of Indonesia, through its Vice President, paid close attention to the policy and gave it full support. The following are some respondents' narratives regarding this matter:

> *The Vice President spent a lot of time on this project. He and his staffs monitored us every week. He asked our progress and achievement. We worked very hard for this reason. We worked under pressure. It seemed like we built 45 temples in a month.* (IDCG06, Pertamina, Jakarta 27/11/2013)

> *In this policy, the central government had a significant role. They had high initiative to respond to all weaknesses and barriers in the early implementation of the policy, such as improving the quality of LPG canisters and dealing with the explosion caused by the 3 kg LPG canister. They actively searched for solutions for all barriers at local government level. The role of Vice President in controlling this policy had a considerable contribution to the success of implementation.* (IDGA03, Local Government, Banda Aceh, 19/07/2013)

> *According to my experience here, high attention of the President or Vice President is needed to achieve the successful implementation of public policies which have big impacts on society around Indonesia.* (IDCG02, KESDM-RI, Jakarta, 21/11/2012)

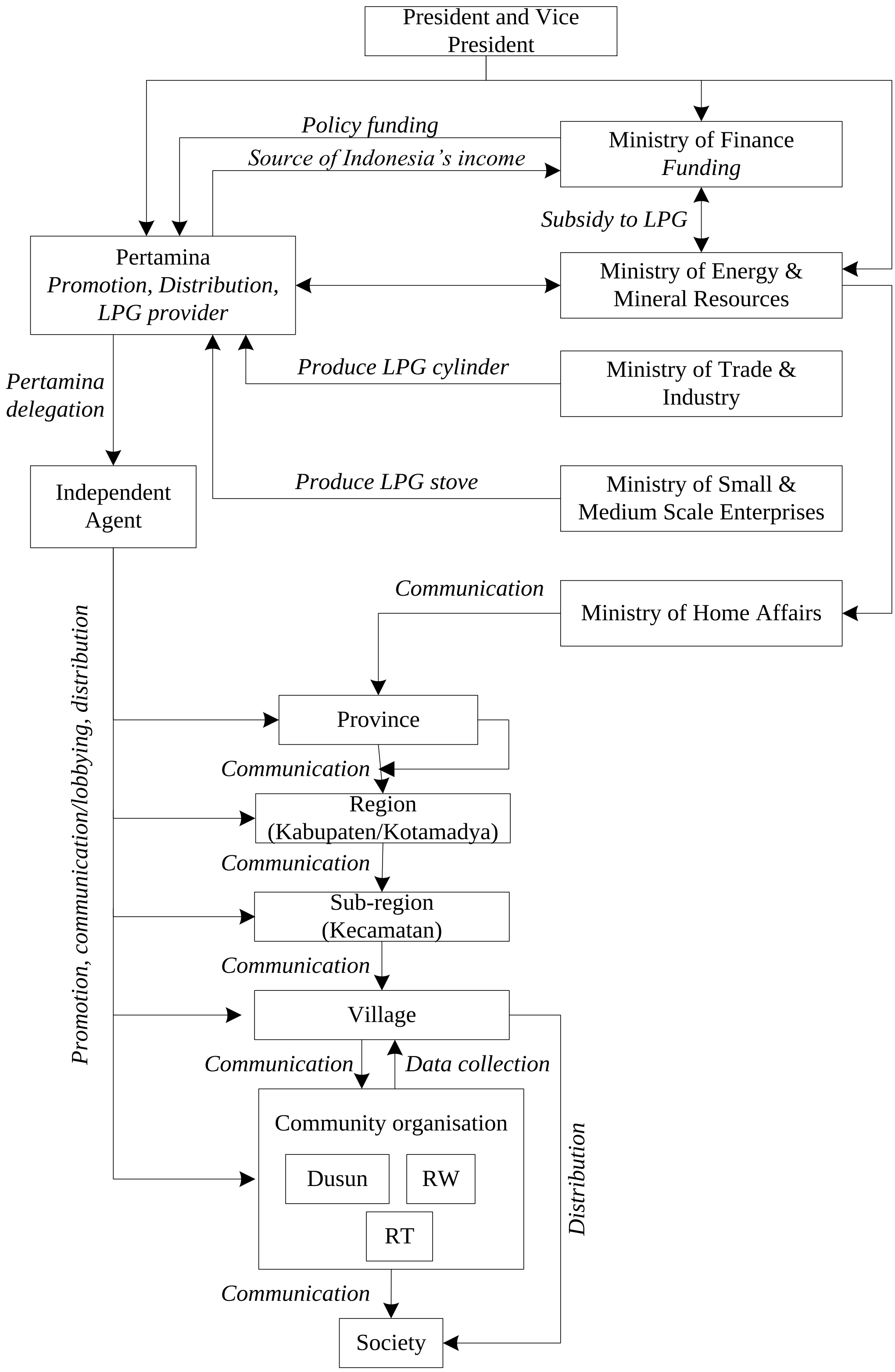


Figure 7.6: The institutional setting in the ECPKL based on the respondents from the government

Table 7.2: Central government institutions, role and responsibilities in the policy[65]

Institution	Roles and responsibilities	Related institutions
National institutions		
President/Vice President	Serving as a team leader	• Pertamina • Ministry of Energy & Mineral Resources • Ministry of Finance • Ministry of Trade • Ministry of Cooperative & SME • Ministry of Home Affairs
Pertamina	• Determining specification and standard of the LPG canisters	• Ministry of Finance
	• Selecting independent agents for assisting the project • Collecting data and verifying the recipients from village government officials and conducting controlling function • Carrying out promotions to society • Organising distribution to society • Serving as part of solution during the policy implementation • Carrying out communication to society	• Independent agent
Independent agents	Giving assistance to Pertamina	• Pertamina
Police Department	Making sure that the policy implementation runs well and safely	• Pertamina
Ministry of Energy and Mineral Resources	• Publishing regulations in relation to LPG trade, supply and distribution as well as its prices	• Ministry of Finance
	• Developing LPG infrastructures	• Pertamina • Ministry of Finance
	• Managing LPG supply and demand	
	• Contacting local governments through Ministry of Home Affairs	• MHA
Ministry of Industry	Producing LPG canisters	• National Certification Institution
Ministry of Cooperative and SME	Producing LPG stove	• Ministry of Industry
Ministry of Home Affairs	Intermediating communication from Ministry of Energy and Mineral Resources to Provinces and Regencies about the policy	• President Ministry of Energy and Mineral Resources To: Provinces

Source: Author’s summary from interviews with respondents

[65] Interview and document verification.

Table 7.3: Local government institutions, roles and responsibilities in the policy[66]

Institution	Roles and responsibilities	Related institutions
Local Government		
Province	• Producing regulations for LPG implementation • Producing regulation to determine LPG price which considers transport cost from LPG plants to LPG stations	From: • Ministry of Home Affairs Pertamina & independent agent Ministry of Energy and Mineral Resources to: • Regencies
Region	• Producing regulation for LPG implementation • Producing regulation to determine price of LPG which considers transport cost from LPG station to society in a specific area	From: • Province To: • Region • Pertamina & independent agent • Ministry of Energy and Mineral Resources
Region	• Serving as intermediate party between region and village	From: • Region • Pertamina & independent agent To: • Villages
Village government	• Communicating policy to society • Along with Pertamina & community leader verifying data of recipients proposed by community leader • Assisting Pertamina & independent agent in distributing LPG packages to society	From: • Region • Pertamina & independent agent To: • Community leader (Dusun, RW, RT)[67]
Community leader (Dusun, RW, RT)	• Collecting data of recipients • Communicating policy to society	From: • Village government • Pertamina & independent agent

Source: Author's summary from interviews with respondents

In this policy the government of Indonesia, through the Vice President, closely monitored and controlled the policy to replace kerosene with LPG. In fact, the top leaders who directed and controlled the actions of the policy which led the staff of governmental institutions, worked hard to achieve the main goals.

[66] from Interview and document verification.
[67] Dusun, RW and RT are subdivisions of village government under the community leader, previously explained in Chapter 3 and depicted in Figure 3.1.

Furthermore, KESDM-RI along with Pertamina are the keys of ECPKL. As presented in Section 3.2.2 in Chapter 3, KESDM-RI has an authority to managing and developing energy in Indonesia. Meanwhile, Pertamina is an oil and gas company in oil and gas markets in Indonesia. KESDM-RI along with Pertamina developed the LPG infrastructure to ensure the LPG supply chain. The infrastructure for LPG at the start of the ECPKL policy was limited, simply because the 12 kg and 50 kg LPG market was small. Their primary market was the rich, given that they were not subsidised. Meanwhile, the 3 kg LPG introduced in the ECPKL is subsidised. The subsidy embedded in the 3 kg LPG led to an increase in its demand. Afterwards, Pertamina recruited independent agents to ensure that the implementation of the ECPKL policy in every stage of governmental areas would be well conducted. An independent agent is a consultative agent who assisted Pertamina in implementing the ECPKL policy. These agents are from consultant firms and were recruited through an open recruitment. In order to implement the policy throughout Indonesia, Pertamina also assigned all of their branch leaders to all areas throughout Indonesia in order to implement the ECPKL policy assisted by the independent agents previously recruited.

> *During the implementation, we collaborated with independent agents. We went to provinces, kabupaten/kotamadya, kecamatan and villages to lobby until we got permission for the implementation. The leaders of these governmental units had various political affiliations. We had to deal with difficult situations at that time. In order to develop the infrastructure, we have to collaborate with government ministries. That is why we needed support from the top leader, i.e. the President.* (IDCG06, Pertamina, Jakarta, 27/10/2013)

The independent agents accompanied local governments in every step of the implementation at local governmental levels. The main responsibility of an independent agent – who represents Pertamina – is to ensure that the implementation of the policy at all stages will be well executed. The independent agent has to communicate the policy from the central government and the local government. They helped Pertamina and KESDM-RI to ask the local government to publish the regulations related to the policy implementation and the price of LPG in the market. An ability to lobby effectively and good communication skills were crucial for independent agent at this stage.

It was also the role of the independent agent to accompany the society members during the implementation of the policy, providing consultancy and assistance in installing and operating the LPG package, especially for those who previously had not used LPG yet. Pertamina along with the independent agents demonstrated the mitigation of accidents caused by LPG. This proved to be very helpful and was needed to reduce LPG accidents.

> *The independent agents, who represent Pertamina, distributed free LPG packages to society. The packages were dropped in to villages. For example a village got 100 3 kg LPG canisters and their kits. These were then delivered to society members in the village. We did not need to be guarded by police officers during the implementation.* (IDGA04, Local Government, Banda Aceh, 22/07/2013)

> *After the recipient received the LPG package, they went home. But when they installed the LPG stove, the stove did not work. They turned back to village office to ask for assistance on how to install and use the LPG canister and stove. We helped them and gave several suggestions. I thought the quality of LPG regulator from the government was not good. I knew that because we found some of the regulators were broken when we installed them.* (IDGA05, Local Government, Aceh Besar, 25/07/2013)

In the ECPKL policy, the provincial governments served as an intermediary institution between the central government at national level and local governments. The central government at national level would not able to implement the policy at lower levels if the provincial governments and the regional governments did not give permission. As aforementioned, the Republic of Indonesia implements the law of autonomy (Presiden Republik Indonesia, 2004b) which gives its regional governments authority to rule their own area. When provincial and regional (*kabupaten/kotamadya*) governments agree to implement the ECPKL policy, they have to make available regional laws and regulations about the LPG market and guidelines to determine the price of the LPG. At this stage, the independent agents have the task of communicating and lobbying the implementation of the policy in provinces and regions (*kabupaten/kotamadya*). Once permission for the policy implementation is approved by provincial and regional (*kabupaten/kotamadya*) governments, governments at *kecamatan* (sub-region) and village levels follow the instructions given by government officials at the associated *kabupaten/kotamadya*.

With respect to the ECPKL policy, government officials at *kecamatan* levels are mediators between *kabupaten/kotamadya* and village governments. Most often, the officials accepted the ECPKL policy when their *Bupati* or *Walikota* (Mayor), as a leader of the region (*kabupaten/kotamadya*), gave permission. This is because a *Camat* – the leader of a *kecamatan* – is assigned by *Bupati* or *Walikota*. This makes a *Camat* have a tendency to be obedient to *Bupati* or *Walikota* and always follow any decisions made by the Bupati/Walikota in order to maintain their career.

In comparison to other governmental institutions, village governments played the most important role during the implementation of the policy. They are closer to the society in comparison to regional and provincial governments. Targets of the ECPKL policy are households and conflicts of interest between stakeholders in the village may arise. In order to reduce this problem, the community leader was involved.

As previously mentioned in Figure 3.1 of Chapter 3, community organisations under a village government administration are *Dusun* (hamlet), *Rukun Warga* (RW) and *Rukun Tetangga* (RT). It is important to involve these three sub-organisations of village government in the ECPKL policy implementation as they generally have good relations with households living in the area of these community organisations. Along with the independent agent, the community organisations collected data in order to identify those eligible as receivers of the LPG package. Moreover, with assistance from the independent agent, the community leaders play the main role in influencing the society members to accept the policy.

> *All community leaders were involved in the implementation of the policy and they were responsible for the implementation in their area. We helped each other if we have difficulties in encountering any problems arising. We have five heads of Dusun. One of them was very old. He worked so slowly that we helped him. We recruited many more people to get involved because we want to give better satisfaction to our customers, the society members.* (IDGA05, Local Government, Banda Aceh, 25/07/2013)

In addition to Pertamina and the independent agents, the local governments have a significant contribution to the success of the policy. The role of the local governments with regard to the policy is giving permission for the implementation of the policy. With assistance from the independent agents serving Pertamina, local governments also have to guarantee the implementation in the local region is well prepared. Local government involvement improves trust in the policy by the public. The trust from the society members of the institutions getting involved in the ECPKL policy does reduce social conflict, which subsequently accelerates the policy implementation in the regions. Issues on social trust will be discussed in more detail in Sub-section 8.2.2 of Chapter 8.

7.2.2. Policy Instruments: Regulatory and Economic Instruments

A policy instrument is any instrument which supports a policy. It may consist of a regulatory instrument, such as regulations and laws, and/or an economic instrument such as subsidy or subsidy phase-out. In this study, it has been identified that the policy instruments of the ECPKL policy are regulations, laws, free LPG packages and subsidies for 3 kg LPG. All of the laws and regulations which give support to the ECPKL are listed in Appendix 7.1. From the appendix, there were at least 34 national and local government laws and regulations supporting the ECPKL policy.

The ECPKL is backed up by law No. 22, 2001 (Presiden Republik Indonesia, 2001c) which has subsequently been amended by the Constitutional Court No. 002/PPU-I/2003 in order for the law to meet the 1945 Constitution (PPPKI, 1945). Article 2 of Law No 30, 2007 on Energy says that

> *Energy shall be managed under the principles of beneficial use, rationality, fair efficiency, value added enhancement, sustainability, people's welfare, environmental function preservation, national resilience, and integratedness by prioritizing the nation's capability.*
>
> (Presiden Republik Indonesia, 2007b, p. 4).

This law gives affirmation that all products of natural resources, i.e. oil and gas, should be controlled by the government. This means all management, including the determination of price, should be decided by the government with approval from *Dewan Perwakilan Rakyat* (DPR).[68] From these laws, the government established Presidential Decree No. 104 Year 2007 (Presiden Republik Indonesia, 2007b) to support the ECKPL. In order to implement the policy at local levels of government, regulations were also established in provinces and region. Since LPG is subsidised, it is the central government which has authority to determine the LPG price. Provincial governments determine transport costs from LPG plants to LPG stations, whilst regional governments determine transport costs from LPG stations to customers. Another role of local governments is preventing the price of LPG in the market from being much higher than the regulation set by central government and local government, to ensure all society members will have similar opportunities to access LPG. All of the regulations in relation to this policy, and with the setting of the LPG price are annually reviewed.

The above-mentioned laws and regulations are enforced by the government to provide subsidies for energy. Regarding the ECPKL policy, when a certain area was ready for the policy to be implemented, the Pertamina distributed free 3 kg LPG packages containing LPG, LPG stove, LPG regulator and LPG pipe to households. The distributed packages enabled the households to refuel their LPG canister with subsidised LPG afterwards. Moreover, once the LPG packages distributed reached about 80% of the target, the government was given authority by the laws and regulations to reduce the kerosene supply to the market by around 50%. This resulted in the increase of kerosene prices because, along with the presence of the subsidised 3 kg LPG packages, the supply-demand

[68] DPR or House of People's Representatives is explained in Section 3.3.

mechanism was taking place. In this study, the timeframe of the transition was, on average, one month. The above-mentioned schematic process took place with the support of the Ministerial Decree No. 3174/12/MEM/2007 (KESDM-RI, 2007b).

Regulatory measures underpinning the ECPKL policy are needed by the local governments to ensure that the policy implementation is legal. Regulatory instruments are believed to be able to change personal choice on energy (Rogner & Popescu, 2000).

It is found in this study that 12 out of 13 respondents from the public did not want to know about laws and regulations underpinning the policy. Their narratives are:

> *We did not know about the regulations which give support to the policy. For us, we just want to cook without lacking cooking energy.* (IDC02, public member, Banda Aceh, 09/08/2013)
>
> *There is no need for the regulation to be shown to the public. It is local governments, NGOs or stakeholders who needed the regulations and laws*. (IDCJ01, public member, Jember, 16/07/2013)

The respondents from the public in this study did not want to know the laws and regulation in paper; they didn’t need to read it because they believed to the local government that the policy is national government regulation. They also believed that national government had already prepared the regulations underpinning the policy. The fact that public did not want to know the laws and regulation does not mean that the regulatory instrument in ECPKL did not work to change public to move to LPG. But it shows that in most cases, especially in Indonesia, the public did not need to read laws and regulation underpinning the policy such as regulation for legal activity for replacing kerosene with LPG and regulation on the price of subsidised LPG. From their point of view, they simply wanted the government take their needs on energy into consideration.

Regardless of the fact that the society members did not want to know the regulations, the governments at local levels encouraged the central government to make available national laws and regulations giving support to the policy. Absence of the required laws and regulations was seen to make the implementation of the policy at local levels more difficult. It is found that during the implementation of the ECPKL policy some stakeholders, such as several community organisations, NGOs and kerosene-related business parties, would not accept the policy unless the local government was able to show the regulations which underpinned the implementation of the policy.

This study shows that the central government and local governments had the regulations needed to underpin the ECPKL policy prepared well. Members of the public who were interviewed in this study, nonetheless, were found to have no concerns about the regulations, regardless of the refusal to accept the policy by some stakeholders in cases where the local governments were unable to show the regulations. Demands by society from the governments at all levels are more typically a guarantee that all of the society members have adequate access to energy.

7.2.3. Financial Donors

The ECPKL is funded by the government of Indonesia, Pertamina and private investors. The amount of investment can be seen from Figure 7.7. Pertamina is a state-owned company and income from it is counted on by the government of Indonesia in addition to tax and other incomes. In the case of the

ECPKL policy, Pertamina makes a large contribution in terms of financial support. The government, through the Ministry of Finance, also gives financial support to the ECPKL policy, especially the subsidised 3 kg LPG packages.

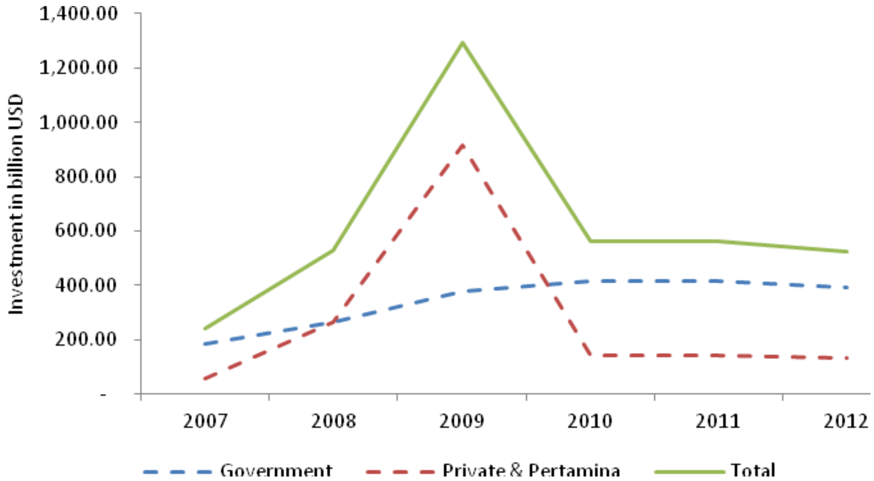


Figure 7.7: Policy investment[69] and investors (KESDM-RI, 2007a)

Presented below are two statements from the respondents gathered from two different places:

> *A financial investment would be granted to this policy. We made a financial scheme for this policy, but it is not our (Pertamina) authority to approve the scheme. The government responsible for the financial support to the policy was actually the Ministry of Finance. The proposed financial budget for the policy we made was then submitted to the DPR for approval by the government. Once the DPR approved the proposed scheme, the Ministry of Finance sent it back to us.* (IDCG05, Pertamina, Jakarta, 26/11/2012)

> *In order to deal with financial problems, before the government sent money to us, we funded this policy. We paid all of the funds for this policy, including funds for procuring LPG canisters and stoves. Local governments have contributions to financial support as well in terms of promotion. However, all funds during this policy are provided by us.* (IDCG01, Pertamina, Jogjakarta, 10/12/2012)

Private investors in the scheme consist of private companies in the LPG business. Figure 7.10 presents policy investment and investors. Generally, most funds are

[69] Average annual currency for 1 US$ are 9,136.35 IDR in 2007, 9,679.55 IDR in 2008, 10,398.35 IDR in 2009, 8,779.49 IDR in 2010, 8,779.49 IDR in 2011 and 9,378.22 IDR in 2012.

from the government, but in 2009 Pertamina provided more funds to the policy. This is because at that time, Pertamina developed more LPG infrastructure from west to east Java to increase LPG production. In total, it spent 70% of total investments in 2009.

7.2.4. Infrastructure Preparedness

The infrastructure is the most important part of energy transition policy. Before implementation, the government should have adequate infrastructure in place. Fortunately, long before the policy was implemented, Indonesia already had LPG infrastructures in a market that was dominated by Pertamina. However, the previous infrastructures were unable to meet the 3 kg LPG demand. From the calculations of the government of Indonesia, the usage of 1 litre of kerosene use is equal to 0.45 kg of LPG use. Since the government produced 10 million kilolitres of kerosene, it determined on the basis of this equivalence that it would need 4.5 million tons (MT) of LPG. With this calculation, the policy team decided to improve the infrastructure in order to meet the demand. Figure 7.8 reveals the previous and current supply chains from upstream to downstream of LPG in Indonesia, whilst Table 7.4 provides the road map of LPG infrastructure's development.

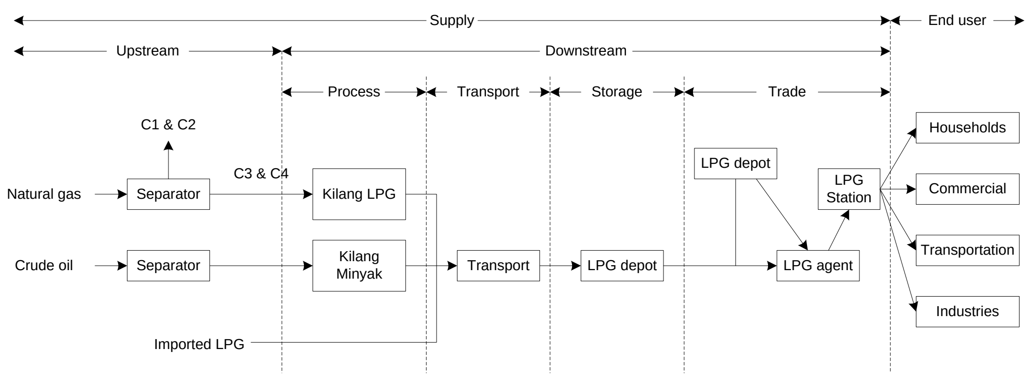


Figure 7.8: The provision system of LPG

Table 7.4: LPG infrastructure

Institution	Year			
	2007	2008	2009	2010-2012
LPG consumption (BT daily)	911	5,729	11,000	12,800 – 16,000
LPG terminal/storage	Terminal Pressurized (Q4 2007) n Eretan (10,000 BT)	Floating storage: 40,000 BT (West Java) 40,000 BT (East Java)	Terminal Pressurized (Q1 2009) 10,000 BT (Semarang) 10,000 BT (Surabaya) 10,000 BT (Tanjung Wangi) Terminal refrigerated (Q4 2009) 160,000 BT (West Java) 120,000 BT (East Java)	Terminal Pressurized: 10,000 BT (North Sumatera) 6,000 BT (Other Sumatera) 6,000 BT (North Sulawesi) 6,000 BT (South Sulawesi)
Filling station: 50 BT daily 30 BT daily	 - 30	 3 27	 10 56	 5 50
3 kg LPG canister (initial purchase with stove and accessories)	6 Million	9 Million	14 Million	13 Million
3 kg LPG canister (initial purchase) along with stove and kits	6 Million	9 Million	14 Million	13 Million
3 kg LPG rolling	6 Million	9 Million	14 Million	13 Million

In 2007 five LPG giant plants had already been prepared in Plaju, Balongan, Cilacap, and Balikpapan in addition to importing LPG from other countries. In total, the government already had responsibility for 17 of the LPG plants to date. From this number, 13 plants are owned by the Pertamina and the rest are private company's plants. These plants include storage tanks, 6 receiving/loading terminals, 57 filling plants, 3,333 LPG agents, 51,000 stations and ships for transporting LPG from one place to another.

In addition to building LPG plants, canisters, stoves and kits for the 3 kg system were also needed. A key respondent said:

> *Before we implemented this policy, we calculated all of infrastructures needed. It includes LPG stoves and canisters required for the policy. In order to produce the LPG canisters and stoves, we need manufacturers able to produce them. We, then, founded hundreds of small-scale enterprises to produce the LPG stoves and canisters. We also provided investment on LPG stations. We bought ships for transporting the LPG from one island to another island. We also bought big trucks, and we built LPG depots. All of these were prepared in less than 2 years. In relation to the supply chain, we had to calculate the need of the LPG. For example, if the government wanted to replace kerosene with LPG, we had to calculate how many LPG canisters should be produced. We did a study and found that 1 litre of kerosene equals 0.4 kg of LPG. We also calculated how many independent agents would have to be involved in this policy. There were lots of things we have to prepare with regard to this policy implementation.* (IDCG06, Pertamina, Jakarta, 27/10/2013)

As aforementioned in Table 7.3, production of LPG canisters and stoves is the responsibility of *Kementerian Industri* (Ministry of Industry) and *Kementerian Koperasi dan Usaha Kecil dan Menengah* (Ministry of Cooperative and Small and Medium Size Enterprises). In this sense, the Ministry of Industry cooperated with the National Standard Institution and invited the LPG canister manufacturers. On the other hand, the Ministry of Industry and Ministry of Cooperative and Small and Medium Size Enterprise gave assignments to Small Medium Enterprises (SMEs) to serve as stove manufacturers. The investors in the LPG canister and stove manufacturers are the government and Pertamina.

Support from the government is paramount because it determines the success of a policy implementation (Brew-Hammond et al., 2014; Jannuzzi & Goldemberg, 2014; Kees & Feldmann, 2011). In this study, full support from the Vice President represents a high commitment from the central government and such high political commitment from government is needed to improve modern fuel access (Bazilian et al., 2011b; Birol et al., 1995). Bazilian et al. (2012a) argues further that a policy driven by government initiative will have a much stronger effect in comparison to that driven by society. This study found that the ECPKL policy is driven by the government with the main purpose of reducing the subsidy budget for energy. There are some reasons for it. First, initiative from the government will be followed by government commitment, while initiative from public does not always imply the government commitment. Second, in comparison to public initiative, government have more power and capability to alter society through regulation that impact to society.

Moreover, a system and infrastructure of energy provision is needed to ensure that the supply chain of energy will not obstruct the government's work in providing modern fuel access for society (Bouzarovski & Petrova, 2015). With respect to the ECPKL policy, it is found in this study that the government of Indonesia started to develop LPG infrastructures, calculated the supply and demand of LPG and prepared the needed regulations immediately after the ECPKL was launched.

7.3 Challenges to Policy Implementation

This section aims to explore the challenges experienced during the implementation of the ECPKL policy. The challenges to the policy were unavoidable. From the interviews with five local governments official, it is found that the challenges to the policy implementation are social barriers, geographical location barriers which inhibit infrastructure provision, local government and kerosene market barriers. The social barriers will be discussed in detail in Chapter 8. This section meanwhile, will explore in more detail the remaining four challenges.

7.3.1. Lack of Infrastructure and Geographical Location

Infrastructure is a key driver in providing access to modern fuel for society. Infrastructure in Indonesia, especially in rural remote areas and in outer Java Island, are not well developed. Most of the roads in remote areas and regions outside of Java are built without asphalt paving. Transporting the LPG canisters and kits to these regions required vehicles, including heavy ones.

> *We have difficulties in transporting the 3 kg LPG packages from villages to houses of members of public. They live in farming areas far from dwelling locations. Moreover, they did not have enough time to come to the meeting at the village office because they work from the morning until afternoon. They are latex farmers that have a strict schedule regarding their job. Picking up the LPG package was not worthwhile for them as the transport cost is more expensive due to the lack of transportation. Hence, for those who live in remote areas, we gave them a visit. We brought the LPG packages to their house.* (IDGM01, Local Government, Muaro Jambi, 22/07/2013)

Additionally, some regions can be accessed only by rivers separating them from other more accessible areas. There are a limited number of bridges crossing rivers and going from one region to another by road requires detours and is longer than navigation by the river.

> *Transporting LPG here, a remote village takes one hour by boat through Batanghari River. Loading and unloading of the LPG to the boat required money. That is why the price of LPG is expensive in comparison to wood collected freely from around our house.* (IDGM04, Rural Government, Muaro Jambi, 04/08/2013)

In this study it was found that in regions wherein most of the members of its society live in remote areas, village leaders and independent agents had to be more creative in attracting society members to come to the village office for further explanations about the policy and to ultimately accept LPG. In areas where much of the public live on latex farms and are far away from dwelling areas, coming to the village office was not worthwhile. Hence, the leader or independent agent of the related village had to come to their houses instead. Moreover, village leaders had to make representations to the government to get the ECPKL packages for their members of the village. Otherwise, they would be ignored from being considered as policy recipients.

> *We sent a proposal to the government to get LPG packages from the policy because we are enlisted in Inpres Desa Tertinggal (IDT).*[70] *We live far from other villages; we are in a remote area. In addition, kerosene was difficult to be found at that time.* (IDGM04, Rural Government, Muaro Jambi, 04/08/2013)

Lack of development in rural areas is common in all countries (Mirza & Szirmai, 2010). Lack of access to modern fuel due to distance from energy resources and infrastructure increases energy deprivation (Barnes et al., 2010). However, in this study – especially in Muaro Jambi – people who live in palm farming areas have bioenergy produced from palms (Harsono et al., 2012; Mahlia et al., 2001). Abundant energy resources are available there. Otherwise, people in these areas are most likely to suffer from lack of modern fuel because they only have access to traditional fuel.

7.3.2. Local Government Policies

The most important endorsement in delivering LPG is local government support. In this study, most of the regions accept the ECPKL policy. Governors and Mayors have authority to reject the policy of the central government, but in most cases, the majority of local governments accepted the policy as the tradition of always following central government decisions has been nurtured by previous

[70] IDT, *Inpres Desa Tertinggal* is a national regulation to reduce poor households in less developed villages. Most often, those villages are in remote areas. This regulation has been started in 1983.

leaders. In the meantime, *kecamatan* and village governments are conditioned to always follow their regional governments.

However, there are a small number of region (*kabupaten/kotamadya*) and *kecamatan* which initially refused the policy. According to the interviews, one of the main reasons was lack of communication due to differences of political affiliation. This is the toughest barrier the central government had to encounter. At that time, the President was from the *Demokrat* party and the Vice President was from the *Golongan Karya* party. Leaders at *kabupaten*/*kotamadya* level might have different party affiliations. For example, the *Walikota* (Mayor) of Surakarta Municipality was from *Partai Demokrasi Indonesia Perjuangan* (PDIP) while PDIP served as opposition to the government. When the government implemented the policy, the *Walikota* of Surakarta expressed his refusal. One of the interviewees stated that this situation arose due to the difference in political affiliations of the related parties. However, the government of Surakarta stated that the refusal was caused by lack of communication, not difference of political affiliation. The *Walikota* (Mayor) of Surakarta wanted to make sure that the policy would not cause negative effects on the society in the region, such as those related to safety. In this case, the difference statements from the interviewees are possibly true. There was a fact that political affiliation of the leader of Surakarta and the leading party in Surakarta was different to national leader. In most cases, the difference of political affiliation contributed to the lack of communication between the local government and national government. In the case of the implementation of ECPKL in Surakarta, political affiliation combined with poor communication resulted refusal of ECPKL. This led the distribution of the 3 kg

LPG packages in Surakarta was postponed, while the distribution of kerosene was not good as the quota for kerosene in Surakarta was consumed by people from outside Surakarta, where the ECPKL had been implemented before Surakarta.

In Nanggroe Aceh Darussalam (NAD), the government official of the *Kabupaten* Bener Meriah refused the policy. In contrast to their government official, however, the society in the region accepted the policy. Given this situation, many households in Bener Meriah tried and succeeded to get the 3 kg LPG packages from neighbouring regions. In this case, the households in Bener Meriah had not received the free 3 kg LPG packages but they could buy it and subsequently were able to use the LPG packages. Later on, the government of the region accepted the ECPKL policy. Interestingly, neither the policy team at province level nor the team at national level did anything to persuade the leader of Bener Meriah to accept the policy. The acceptance of the policy is simply explained by the arrival of a new leader to the region with a new decision after the previous leader's tenure had ceased.

In addition to a lack of communication due to gaps in political affiliation, the lack of required regulations is another barrier to the policy implementation. Regulations related to the ECPKL implementation at all levels of governmental structure existing during its early stages were not sufficient to give support to the implementation. Required regulations became more complete as the policy implementation proceeded with time. Many governments at local levels initially refused the implementation due to this regulation inadequacy. In the meantime, refusal from community leaders, NGOs or community organisations occurred when approaches the Pertamina, KESDM-RI and independent agents did not have the support of appropriate regulations at local levels. It seems that, without official regulations and letters from the government at local levels referring to the regulations, the implementation was poorly organised.

In order to reduce the aforementioned barriers, the local governments along with the independent agents, Pertamina and KESDM-RI conducted intensive communication with the society members through local communities. Some of the local governments set a time limit for the governments at lower levels to make decisions on accepting or refusing the policy implementation.

> *Initially, this policy was neither accepted nor rejected by local government at kecamatan level. They need more explanations, about the advantages and disadvantages of the policy. We gave them between three to six months for learning about this policy and for making a decision. Once they understood, all of them accepted the policy.* (IDGM01, Local Government, Jambi, 22/07/2013)

This is important because the government in a certain province, for example, wanted to implement the policy simultaneously within the province. This method was applied to make sure that the policy implementation would cause simultaneous scarcity of kerosene. As explained by an official of Pertamina:

> *When a region refused this policy... for example the Municipality of Bogor refused the policy. Then we went to the Municipality of Depok. Depok accepted the policy. Once we implemented the policy in Depok, we reduced kerosene supply in the municipality. In the meantime, the Municipality of Bogor did not change their decision and they still had kerosene. Consumers in Depok looked for kerosene in Bogor because the kerosene supply in Depok had already been reduced. As a consequence, kerosene supply in Bogor was declining and this eventually caused kerosene prices to be increased. This was a tougher situation for Bogor, simply because they did not have 3 kg LPG packages and, at the same time, their kerosene was consumed by people from Depok. This also applied to region around Bogor and we used this method if a certain region refused the policy.* (IDC06, Pertamina, Jakarta, 27/10/2013)

Suppose there are two neighbouring areas, A and B. Implementing the ECPKL policy in area A means a replacement of kerosene with LPG and kerosene volume will eventually be reduced. This also means that kerosene price in area A will not be cheap anymore since the subsidy on it will be phased out and LPG price is artificially cheaper as it is subsidised. At the same time, kerosene users still exist in area A. Loyal kerosene consumers in area A will look for kerosene from any areas as long as they could afford the kerosene. If the policy has not been implemented in area B, the policy would not run effectively since loyal kerosene consumers in area A who live near the borderline of area B will consume kerosene from area B wherein the kerosene is still subsidised. Obviously, kerosene consumers in area B will have difficulties in accessing kerosene. As a consequence, the price of kerosene in area B will be more expensive as kerosene supply in area B is reduced due to more kerosene users competing for the same amount of kerosene in area B. This is why the policy has to be implemented simultaneously in one province.

The aforementioned situation gives advantages for the central government because it might accelerate the implementation. Energy scarcity could lead to chaos and most Mayors did not want the chaos to occur. Hence, despite an initial refusal, after six months to one year the Mayors accepted the policy.

7.3.3. Market Barriers: Kerosene Seller and SMEs

Energy substitution is not merely about changing fuel type. It also changes all infrastructures and markets which has a relation to suspending old businesses and creating new businesses. With respect to the ECPKL policy, businesses associated with kerosene will be suspended whilst businesses associated with LPG will be created. Conflicts of interest among kerosene stakeholders were inevitable. People who have a relation to kerosene-related businesses, such as kerosene sellers and kerosene stove producers, were worried about the sustainability of their businesses. Demonstrations took place at an early stage of the implementation of the ECPKL policy. Expressions of disappointment came from kerosene sellers; however, kerosene stove producers did not show their disagreement to the policy.

In order to reduce the conflict of interest from the kerosene sellers, the government through the KESDM-RI conducted discussions and negotiations with the resultant proposal that the kerosene sellers would be prioritised to be registered as LPG sellers/agents as long as they met requirements such as investments and all necessary infrastructures. Not all kerosene sellers could be converted to become LPG sellers, because not all of them met the requirements. This solution in turn reduced the strikes from the kerosene sellers.

Many of the kerosene sellers remained reluctant to accept the policy despite the aforementioned government's offer of the alternative solution. Moving to become LPG sellers would lead to a reduced income. Running an LPG business needs more workers for loading–unloading, requires vehicles for transporting LPG canisters from stations to customers and therefore demands higher investment than that for kerosene business. All of these explain why Pertamina staffs were threatened by kerosene businessmen and their collaborators. What follows is a statement from a Pertamina official who made contact with a local government:

They, the kerosene seller and his collaborators, wanted to kill me. They are kerosene mafia who sold subsidised kerosene to industries.[71] *I visited a local government guarded by a soldier from Kopassus to ensure our safety*. (IDGS01, Pertamina, Jogjakarta, 10/12/2012)

Kerosene sellers are not the only ones impacted by the implementation of the ECPKL policy. Kerosene stove producers – dominated by small-scale enterprises and home industries – were also affected by the ECPKL implementation. The 'power' of kerosene stove producers is lower than kerosene sellers and most of them are in collaboration with the kerosene sellers. This might explain why the kerosene stove producers did not conduct strikes to refuse the ECPKL policy.

Pertamina and local governments conducted free training for workers in small-scale enterprises for kerosene stove for the purpose of providing various skills, such as how to make LPG stoves, and helping them to look for other jobs. In the Municipality of Bogor, the government also provided a grant of about IDR 500 million (around US$ 50,000) for every kecamatan through the GUMBIRA[72] programme.

We invited kerosene sellers to brief them and gave more information on how to get converted to LPG sellers. We offered free education to those who wanted and were able to get converted to LPG sellers. The education was given because transport, logistics, handling and safety of kerosene is different from those of LPG. (IDGM01, Local Government, Muaro Jambi, 22/07/2013)

Kerosene supply would be reduced and kerosene sellers could not sell kerosene beyond their business area for any longer. If they did so, the maximum punishment is about 200 million rupiahs.[73] *By considering this situation, many kerosene sellers got themselves subsequently converted to LPG sellers even though their incomes are smaller than*

[71] Since 2005 subsidised kerosene was sold to households and not allowed to be sold to industries.
[72] GUMBIRA stands for *Gerakan Untuk Masyarakat Bogor Ceria* is the programme from the local government dedicated to Bogor society.
[73] With the assumption 1 US$ is equal to 10,000 IDR, 200 million IDR is equal to 20,000 US$.

those when they sold kerosene. (IDGS01, Pertamina, Jogjakarta, 10/12/2012)

Pertamina provided financial support to SMEs who were affected by the ECPKL policy. They also promised to promote the SMEs' products so that the SMEs would not have difficulties in selling their new products. This strategy was successfully accepted by most SMEs and was reduced conflicts between governments and stakeholders with relation to kerosene businesses.

7.4 Policy Achievement and Impacts

This section addresses evaluation of the ECPKL policy effectiveness through identifying attainment of the policy goals and objectives. Identification with or alignment with the aims of a policy lead to achievement of the objectives of the policy (Prasad, 2008). In relation to a certain policy, each stakeholder may have different objectives and therefore a research study concerning the policy has to determine which objectives are chosen (O'Faircheallaigh, 2002). With this background, the attainments of the ECPKL policy in this study are separated into two types: the achievement of policy based on the motivation (examined in Sub-section 7.4.1) and the side effects of the policy (explored in Sub-section 7.4.2).

7.4.1. Achievement of the Goal: Providing Cleaner Energy

In section Chapter 7 the objectives of the ECPKL were considered as follows: to reduce kerosene subsidy, to reduce kerosene consumption, to lessen dependency on kerosene in order to improve energy security and to provide cleaner energy. This study focuses on modern fuel access, and therefore attention will be focused on the goals relating to modern fuel provision. From the results in Section 7.1, the first three objectives can be put into one topic: kerosene subsidy reduction. This goal can be achieved by diminishing the kerosene supply and replacing it with LPG in order to reduce kerosene abuse.

From 2007 to 2011, PKPPIM (2013) reports that the Indonesia government had made cost saving to a total of 39 trillion IDR by replacing the kerosene subsidy. The details of this saving can be seen in Table 7.5. This is evidence that the ECPKL had met the aim of the implementation, i.e. to reduce the kerosene budget. The saving from the energy subsidy was reallocated to other public policies such as education, the health service and infrastructure improvement.

> *Saving on the energy budget was reallocated to education and health. This reallocation alleviated the poverty of those who have difficulty affording education and health.* (IDCG06, Pertamina, Jakarta, 26/10/2013)

Table 7.5: Subsidy saving made by the ECPKL

Explanation	Year					
	2007	2008	2009	2010	2011	Total
Subsidy saving	1.40	12.34	7.41	12.39	18.38	51.92
Policy cost	.94	2.02	5.08	4.71	0.00	12.75
Total saving	0.46	10.32	2.34	7.67	18.38	39.17

Source: (PKPPIM, 2013)

The central government claimed that about 53,991,513 of 3 kg LPG canisters in total have been distributed to areas in Indonesia from 2007 to 2011 (DJMGB-MESDM, 2013). In the meantime, the estimated number of households in Indonesia in 2011 was about 60,283,430 (PDIESDM-KESDM, 2012). From these data, the total number of 3 kg LPG canisters distributed between 2007 and 2011 should have covered 89.56% of the total number of households. However, by referring to the estimated percentage of LPG users in Table 5.7 of Chapter 5 this provided for 55.2% of people or about 53%[74] of households. Therefore the estimated number of LPG users in total in 2011 was about 133,041,498 people[75] or 33,543,478[76] households. But of those, only 18,675,807[77] households used LPG as a main cooking fuel. By comparing this number with that made by the government (see DJMGB-MESDM, 2013), it is found that there is a gap. The reason is that the government calculation is based on number of LPG canisters distributed to society, whilst the calculation in this study is based on the estimated number of LPG users calculated from the survey of BPS. The ratio between the government claim and the estimated number of users in this study is 1.6.[78] This gives an indication that the number of LPG canisters already distributed by the government in 2011 was roughly almost twice the number of LPG users. This is in line with the respondent statement in this study that, in general, each household or small-scale industry has more than one 3 kg LPG canister. Figure 7.9 shows a food street vendor who has more than one 3 kg LPG canister. One canister is used for cooking and the other is stored for a reserve. The reserve will be used in case the LPG in canister for cooking ran out.

> *They have two LPG canisters. When they cooked and the LPG ran out, they can change the empty LPG canister with the filled LPG canister.* (IDCB01, public member, Bogor, 08/06/2013)

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[74] The expected percentage of household is calculated from weighted factor for household that is provided by BPS in SUSENAS survey.
[75] See Table 5.7. In this table, the expected user is using weighted factor for individual that is provided by BPS in the survey.
[76] See footnote 13
[77] The expected percentage of LPG users in 2011 according to Table 5.8 was about 30.98%. Meanwhile the expected total number of households in Indonesia at the same time was 6.283 thousand households (Table 4.1.A.). Therefore, expected number of households who used LPG in 2011 is calculated from 30.98% x 6.283 = 18,675,807.
[78] Total number of 3 kg LPG distributed in 2011 was 53,991,513 3 kg LPG canisters. Meanwhile number of LPG and Natural Gas users was 33,543,478 households. The calculation of three times is gathered from 53,991,513: 33,543,478 = 1.61.

The above-mentioned LPG canister used as a reserve is also provided by LPG sellers and has been filled with LPG. Moreover, in fact, the 3 kg LPG packages are consumed not only by households but also by small-scale enterprises and food street vendors. This study implies that distributing the LPG packages to a larger number of households in particular is needed for the reason that the number of LPG users in 2011 is not more than a half of the total number of households in Indonesia.

Figure 7.9: A food street vendor who has two 3kg LPG canisters

Based on a national survey conducted by BPS which has subsequently been recalculated by the author and presented in Table 5.7, the total number of kerosene users decreased about 14.35% from 32% or 19.729 million households in 2007 to 18% or 11.080 million households in 2011. In addition, BPK-RI (2011) reported that there was a 74% reduction in kerosene volume from 9.849.769 kilolitres in 2007 to 2.349.288 kilolitres in 2010. It can be concluded that for five years, the reduction of kerosene production by the government indeed pushed society to reduce kerosene consumption.

To sum up, there is a significant increase in the number of LPG users and a considerable reduction in the number of kerosene users. In terms of providing cleaner energy, the government of Indonesia have successfully increased the number of households using LPG on one hand and, on the other hand, decreased the number of households using kerosene.

7.4.2. Energy Poverty Alleviation

It is not uncommon that a policy results in unintended effects in addition to intended effects. This section is intended to look deeper at the recipients of the ECPKL policy, to analyse the policy, and to explore the unintended effects, if any, of the policy.

Under the ECPKL policy, the recipients received free LPG and its kit consisting of an LPG stove, a 3 kg LPG canister already filled with LPG, an LPG regulator and a gas pipe as presented in Figure 7.10. Since the main goal of this policy is *zero-kero*, the recipients who are targeted in the policy are kerosene-user households, kerosene-user small-scale industries and kerosene-user food street vendors. According to BPS, about 42,020,000 households were targeted as the recipients of the free LPG packages (Sosiawan et al., 2011).

Figure 7.10: A free LPG package

During the policy implementation, however, the local governments have different interpretations about the recipients. In their view, firewood and other biomass users should also be included as the ECPKL recipients.

> *There are lot of criteria for someone to be eligible as the LPG recipient. One of them is that the recipient has to be a kerosene user. This does not always mean that this potential recipient is the poor. Therefore there is another criterion, saying that if the recipient candidate did use kerosene, then he has to be in the poor category. Therefore, those decided to be the recipients of this policy are households who used to cook with kerosene, firewood or other traditional fuels. So, the recipients targeted by this policy are adjusted and therefore are not always the poor. This is because the main goal of the policy is energy security, not poverty alleviation. This policy is not securing households who lacked income but those who suffered from lack of modern fuel.* (IDGM01, Local Government, Muaro Jambi, 22/07/2013)

In Indonesia, kerosene is well known as *modern fuel for the poor*. Not all the poor, nevertheless, use kerosene: some of them use firewood. For this reason, some of the local governments in five regions, i.e. Banda Aceh, Muaro Jambi, Bogor, Surakarta and Jember, decided that, along with kerosene users, the poor (more generally) were also eligible as policy recipients. This explains why the poor who did not use kerosene, such as households who used firewood, briquettes or charcoal, are also included as recipients of this policy. This is supported by the respondent narrative below:

> *We have some criteria. We collected data to identify who would deserve to get benefit from this policy. But for some reasons, the implementation was different from what we had planned. Everyone would be very happy if they received an LPG package and, therefore, anyone would be proposed by a village government to get benefit from LPG conversion programme as long as she has an ID card showing that she is a local inhabitant in the area.* (IDGS01, Pertamina, Jogjakarta, 10/12/2012)

It is inevitable, however, that giving free access to society causes some problems. People who did not get free access to the policy might envy those who received free access. This was one of the problems occurring during the distribution of the 3 kg LPG packages. This might arise with village leaders, local governments or members of society. In one area, the local community leader asked that free LPG packages for all households had to be granted without exception. He just wanted all members of the public to receive equal benefits from the government. As it was expressed by a *Kepala Desa* (village leader):

> *Initially, they [consultants from the Pertamina] said that the LPG canisters* and their kits *should be given to household who did not use LPG. However I insisted that this policy should be for all society members. Then they said that this policy is for poor people. Given this explanation, I then looked for more information from other villages. Most of these village leaders said that the policy target is all households. With this information at hand, I spoke to the consultants again that all of society members in my village should benefit from this policy. Soon afterwards, they [the consultants] agreed with me and we finally distributed LPG* packages *to all households.* (IDGJ02, Rural Government, Jember, 09/07/2013)

The presence of recipient targets not in accordance with central government requirements might be caused by requests from the society members.

> *The main target of the policy is low income households who had been selected by community leaders and had been confirmed by consultants from the Pertamina who audited a list of the recipients. However, it was difficult to be implemented as many other households asked for benefit from the LPG packages even though they are the rich.* (IDGJ01, Local Government, Jember, 13/07/2013)

Due to the aforementioned different interpretations, all households in some areas received the LPG package even though they had already had 12 kg LPG canisters and its kits. Moreover, poor households who mostly used firewood and charcoal also got benefits from the policy.

> *The independent agent*[79] *told me that all households should get the free 3 kg LPG and its kit. All criteria are clear. They all knew that.*

[79] An independent agent is a private consultant who selected by Pertamina. This institution is selected in every local government throughout Indonesia to assist Pertamina in promoting,

> *Who are the target of recipients, are they poor households, only kerosene users or those who did not use LPG? The criteria mean that households who used to cook in LPG stove would not get a free LPG and its kits, even though they used LPG from other than the Pertamina. However, some of the households thought that they deserve to get benefit from the policy, simply because the LPGs and their kits are free of charge.* (IDCG05, Pertamina, Jakarta, 26/11/2012)

From this explanation, the targeted recipients in some areas were different from those identified by the central government. The Audit Board of the Republic of Indonesia investigated that there were about 48.4% of the total number of regions which had distributed the LPG packages to more than 80% of those eligible for the packages (BPK-RI, 2011). Poorly targeted LPG package distribution led to an increasing demand for the 3 kg LPG packages. This ultimately affects the subsidy for the 3 kg LPGs.

Poorly targeted distribution of the packages, unintentionally, had positive impacts on poor people. The previous LPG package for households which was only available in a 12 kg canister was well known as '*energy for the rich*' because this was consumed by middle and higher income households. The 12 kg LPG packages already present before the ECPKL policy was not attractive to poor people for the reason of its higher volume of canister and unsubsidised status. The LPG packages in the ECPKL, on the other hand, have smaller volume and were subsidised and, therefore, are more affordable for the poor. This kind of LPG package is also consumed by food street vendors who had previously used kerosene (see Figure 7.6). Its easiness to handle by hand (see Figure 7.11) attracted poor households in remote areas to use the 3 kg LPG. From the interviews conducted in this study, the 3 kg LPG package is also consumed by

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persuading, delivering and controlling the implementation of the policy to local government and society.

people who used to cook with firewood and live in remote areas far from the city and which can only be accessed through the river in Muaro Jambi.

From Table 5.7 of Chapter 5, the percentage of firewood users in 2007 was about 54.10% of the total households in Indonesia and it decreased to 45.9% in 2011. From Chapter 6.1, however, it is found that, despite its statistical significance, the reduction in numbers of firewood users during 2007 to 2011 is smaller than the increase of LPG users during the same time period. From this study, the estimated number of reductions of firewood users according to source based approach from 2007 to 2011 was 10,593,559 people. In the meantime, it was expected in 2011 that the number of households with who use firewood would be 110,779,056 people.

Figure 7.11: A villager carries a 3 kg LPG canister (Source: taken by government staff)

7.5 Findings and Discussion

This study affirms that the ECPKL is an energy policy which intends to reduce energy subsidies through replacement of kerosene with LPG. The policy is beneficial for the Indonesian government because the government is able to reduce the kerosene subsidy, while society members in the country are able to consume cheaper and cleaner energy for cooking through subsidised LPG. This means that the ECPKL policy successfully removes subsidies for one type of energy and replaces it with another fuel type. Interestingly, the report of PKPPIM (2013) reveals that the government is able to improve the efficiency of the energy subsidy cost. This is because the production cost of LPG is cheaper than that of kerosene. In Chapter 5 and Chapter 6 it is evident that the ECPKL policy is able to reduce kerosene usage significantly and, at the same time, is successful in increasing LPG usage considerably. This policy also has the side effect of reducing firewood. However, some households continue using traditional fuel such as firewood, briquettes and charcoal, and their numbers have not decreased significantly.

It is provided in Chapter 2 that Frei (2004) and Scrase and Ockwell (2009) propose an energy policy pyramid where the order from bottom to top level is access, security, efficiency and environmental. According to Sagar (2005), accessibility to energy should be a priority energy policy for developing countries. In this context, the ECPKL policy has put access to modern fuel as second priority after economic benefit. This may explain why the reduction of the traditional fuel users is not as much as the increase of the LPG users.

Effectiveness of a policy can be measured through the consistency of policy implementation with the policy itself (Spicker, 2006) or can be measured from achievement of expected goals and objectives (Kraft & Furlong, 2007). With respect to this study, two results are obtained. From an economic point of view where the main aim is an economic achievement through a reduction of subsidy, the broadening of recipients of the ECPKL policy – such as people who are not eligible to receive free LPG packages – can be seen as inefficiency. The reason is that the increasing demand of the 3 kg LPG packages automatically means that the government has to provide more subsidies for the 3 kg LPG. However, in terms of providing cleaner energy for society, it is evident from this study that the ECPKL policy has made a contribution to the provision of cleaner LPG energy for cooking, in contrast to the less environmentally-friendly energy such as kerosene and biomass which were formerly used.

One of the methods of governmental intervention for shifting traditional to modern energy service is through the introduction of a policy to replace traditional fuels with modern fuels. The transition due to a policy, however, is a long term process. Hence, it needs endorsement and collaboration among stakeholders, i.e. governmental institutions, business communities and society (Anderson et al., 2000; Bazilian et al., 2012a; Practical Action, 2009).

In this study, it is proven that the Indonesian government intervention has contributed to the increasing access to modern fuel as well as to the reduction of traditional fuel use. Studies of Hosier and Dowd (1987) and Khandker (2012) also found that government policy related to energy substitution has a significant impact in reducing the amount of wood consumption. Furthermore, Bazilian et al. (2012a) argue that a policy driven by government initiative will have a stronger effect in comparison to policy driven by society. For example the policy of solar electricity which is initiatives by the government of India drives the public to use solar and it was able to reduce the lack of electricity in India. It is revealed in this study that the ECPKL policy is driven by the government with the need to reduce the budget for energy subsidy as part of the measures to deal with economic problems experienced by Indonesia. This study gives support to the argument that government policy is needed to increase access to modern fuel (Brew-Hammond et al., 2014; Jannuzzi & Goldemberg, 2014; Kees & Feldmann, 2011).

In addition to the aforementioned issues, the success of the ECPKL policy is influenced by various factors. Firstly, this policy is highly affected by the strong leadership of the Vice President as a representation of the top leader, of the leaders in the Pertamina and of leaders of KESDM-RI. The ECPKL policy is mostly supported by the government and Pertamina as a state-owned company. This study is in line with the argument of Bazilian et al. (2012a) that strong leadership leads to the success of energy policy. The second factor of the success is regulation, subsidy and incentive. These policy instruments attracted the public members to move to LPG even though most of the members did not read and know the regulations and laws associated with the policy directly. This is because policy instruments such as subsidy, incentives and regulation are able to deal with a particular issue (Kraft & Furlong, 2007). Last but not least, infrastructure preparedness makes a large contribution in accelerating the policy implementation. System and infrastructure provision in the context of modern fuel provision is needed for the reason of alleviating energy deprivation (Bouzarovski & Petrova, 2015). In spite of the requirement for some improvements during the policy implementation, the system of LPG provision as the substitute for kerosene has been prepared by the Pertamina along with KESDM-RI.

The challenges arising during the policy implementation, however, are different from those aforementioned scholars' have proposed. Despite good preparation by the Indonesian government, the challenges from stakeholders are unavoidable. Four barriers which influence the implementation of the ECPKL policy, according to this study, are social restriction, location, local government refusal and kerosene sellers and SMEs. A social barrier is a classic problem in implementing the policy. However, the government had solutions on that matter by involving community leaders in intensive communication. Meanwhile, difficulties caused by remote locations are, in general, more difficult to be solved. Yet, some local governments had directed considerable efforts in approaching communities in remote areas through direct visits; and it is also the case that some community leaders in remote areas actively came to village offices and requested LPG packages for his/her members of society. The other barrier is the local government refusal which may be caused by lack of communication and bureaucracy. The last barrier originates from stakeholders who have a relation to kerosene businesses because they did not want their business would be collapse.

Chapter 8
Social Acceptance of LPG in Indonesia

This chapter aims to investigate the social responses of society to the substitution of kerosene with LPG as advocated by the ECPKL policy. The research question that will be answered in this chapter is: "*What is the* social *acceptance of LPG and what are the reasons behind LPG adoption?*" In order to answer the research question, this chapter focuses on three topics: social responses to 3 kg LPG based on interviews with respondents in six regions, the reasons behind societal adoption of LPG, and the factors which led to the reluctance of traditional fuel users to adopt LPG.

8.1 Responses of Society to LPG

This section aims to explore the responses of society based on interview feedback from interviewees representing the government and members of the public selected from six regions. A summary of the number of respondents is presented in Table 8.1 and details are presented in Table 4.1.

It has been described in section 2.4.4 that *accept* is defined as the intention to use (Olsen, 1983). Meanwhile, acceptance, selection and decision to use in this definition are the process of adoption. With this definition which is discussed in Section 2.6.2, people who accept technology may not adopt it. Equally, people may adopt a new technology without necessarily accepting it according to their preference, e.g. because they feel they have no other choice.

Table 8.1: Interviewee locations

Regions	Island	The interviewees	
Kotamadya Banda Aceh	Sumatera	Local government (7 respondents)	Society – urban (4 respondents)
Kabupaten Muaro Jambi	Sumatera	Local government (4 respondents)	-
Kabupaten Bogor	Java	Local government (3 Respondents)	Society – peri urban (1 respondent)
Kotamadya Surakarta	Java	Local government (5 respondents)	Society – urban (3 respondents)
Kabupaten Klaten	Java	-	Society – rural (3 respondents)
Kabupaten Jember	Java	Local government (5 respondents)	Society – urban and peri urban (2 respondents)
Total		24 respondents	13 respondents

Source: Author's summary from interviews with respondents

According to interview results from this research study, interviewees tend to receive the 3 kg LPG package offered by the government. It is found in this study, nonetheless, that despite their receipt of the free LPG package, some of the recipients did not use it. They instead gave the LPG package to their family or sold the package to others. In this case, the recipients received the free LPG package given by the government but did not adopt it in terms of their usage. Meanwhile, there are interviewees who received the LPG package and decided to adopt the LPG for their cooking. However, they did not really want to adopt it. They argue that lock-in in the market of LPG led to them being trapped in using LPG (as discussed in Section 8.2.1).

Acceptance as defined by Olsen (1983) and Rogers (1962) is viewed as adoption (see Chapter 2.6.2). However, the fact that in the interviews there were some people who adopted LPG but did not really want to use it can indicate the lack of acceptance. Meanwhile, the decision to receive LPG, followed by adoption of LPG can be the indication of acceptance. Therefore, the term of '*adoption*' is applied to those who decided to use the LPG, rather than merely accepting the free 3 kg LPG package.

Based on the study in six regions, the level of adoption of those who received the 3 kg LPG package is grouped into three categories as summarised in Table 8.2. The responses of the interviewees are categorised in accordance with the final decision made by the recipient of the ECPKL.

Table 8.2: Category of level of adopter of LPG under the study

Decision	Description
Full adopter	Use the LPG
Partial adopter	Use the LPG in some circumstances.
Resistant – Non Adopter	Do not use the LPG in any circumstances.

Source: Author's summary from interviews with respondents

The first category of the response is *full adopters*, referring to those who received the free 3 kg LPG package and decided to use it afterwards. Based on the interviews, those who adopt the 3 kg LPG have wanted to use LPG even before the ECPKL was implemented. Before the government introduced the 3 kg LPG package, nevertheless, they could not afford to buy the LPG available at that moment, which was a 12 kg LPG package. They tended to use kerosene in favour of LPG because, differently from LPG, kerosene could be bought per litre. This means people who use LPG after the ECPKL implementation generally use 3 kg LPG on account of its convenience. It has to be mentioned that some households that formerly used 12 kg before the policy decided to use 3 kg LPG package for the reason that the 3 kg LPG package is more affordable.

The second category of the response is *partial adopters* which are households that use LPG for specific cooking.

> *I boil some water and rice in firewood stove, but cook other foods in LPG.* (IDCA03, urban public member, NAD, 10/08/2013)

In this case, they use LPG for frying and boiling foods on one hand and, on the other hand, boil water for drinking and bathing on a firewood stove. The partial adopters cook rice either on a firewood stove or by using an electricity-powered rice cooker. In other words, the partial adopters are users of multiple fuels, as it is identified in Sub-section 6.3.1. The economic factor is one of the main reasons why they use multiple fuels. They still have firewood stove and they also have an electricity-powered rice cooker. They also have easy access to firewood and electricity.

The last category of the response is *resistant non adopters*. This refers to people who are not influenced by any interventions of using LPG. In this study, the households that are resistant to LPG usage mostly use firewood.

> *If the government forbids us to use firewood, I'll ask my daughter or my son to cook for me. I won't cook anymore.* (IDCK03, public member, Klaten, 05/08/13)

In cooking, the resistant interviewees prefer firewood to LPG. Before the ECPKL was implemented, it was unclear whether this was due to lack of access to modern fuel or to unwillingness to use modern fuel. The presence of resistant non-adopters after the implementation of ECPKL shows that the ease of access to LPG is not the main reason why people keep using firewood.

In this study, all of the respondents who represent members of the public were target recipients of the ECPKL. In addition, from the interview with the respondent who represented the government, members of the public who are not in receipt of the free LPG package were also discussed. Some of them had used LPG before the policy was implemented. In this study, they are called *active adopters* as they decided to use LPG as they have a willingness to use it. They mainly use the 12 kg LPG. Meanwhile, the households who use 3 kg LPG in this study, in general, are *passive adopters*. This refers to those who adopt LPG because of government policy, i.e. the ECPKL.

Table 5.5 – see Chapter 5 – identified that there was a reduction of firewood users during the period of 2007 to 2011, from 54.1% to 45.9%. Over the same period, the same table also shows that the number of LPG users increased significantly and the number of kerosene users fell considerably. Table 8.3 meanwhile, shows the domestic fuel transition experienced by the interviewees under study. The table reveals that households that previously used kerosene before the ECPKL was implemented subsequently move to LPG, albeit they continued to use kerosene during a transitional period. However, it is also clear from Table 8.3 that households that previously used firewood did not always totally move to LPG. Some of them continue to use firewood. Based on statistical data from Section 5.1.3, the percentage of households who mainly depend on firewood fell about 7.79% from 2007 to 2011. Thus, even though not all firewood users totally wanted to move from kerosene to LPG as revealed in the column '*During Transition*' in Table 8.3, the ECPKL makes a contribution to increasing the usage of modern fuels.

General information on the changing use of fuel for cooking in each of the regions under study is provided in Figure 8.1.[80] From the figure it is apparent that LPG has been used in the years 2007 and 2008 although the ECPKL programme had not been implemented in these years. Apart from Banda Aceh, however, the percentage of households that use LPG as the main cooking fuel in the five regions were lower in comparison to kerosene and firewood. After 2008, the percentage of households that used LPG as the main fuel for cooking in Banda Aceh and Muaro Jambi were increased slightly. The use of LPG as the main cooking fuel in Bogor, Klaten, Surakarta and Jember, in the meantime, grew dramatically despite the refusal from the local government or the public in Bogor and Surakarta in the early stages of implementation of the ECPKL programme. Firewood users remained dominant in Muaro Jambi, Klaten and Jember. Banda Aceh, Bogor and Surakarta, meanwhile, are dominated by LPG users.

It is shown in Table 8.3 that there was a household that prior to the ECPKL used kerosene as the main fuel for cooking and during transition used firewood. This finding is in accordance with the study of Tumiwa and Imelda (2011) that there were households that moved to firewood even though they previously used kerosene. But the use of firewood was not the final decision, it occurred in the transitional phase. The trend of people moving from kerosene to firewood does not appear in data from SUSENAS which is revealed in Figure 8.1. This is because the time frame of the data presented in Figure 8.1 is one year, whilst the narrative from the respondents as presented in Table 8.3 is related to the situation within a period of time of less than six months to one year. After one

[80] The data are gathered from SUSENAS and have been discussed in Chapters 5 and 6.

year of the ECPKL programme implementation, some of these households adopted LPG. It indicates that changes from kerosene to firewood instead of from kerosene to LPG – as provided by the respondent – is a short-term effect of the ECPKL programme, whereas the tendency of the switch from kerosene to LPG (as suggested by Figure 8.1) may represent a long-term effect of the same programme.

The variety of fuel adopted in each region is due to many contributory factors from both local governments and society. Table 8.4 shows the characteristics of the cities in which interviewees live, based on several secondary sources.

The location of the interviewees led to the different levels of adoption of LPG. Banda Aceh is the capital city of Nanggroe Aceh Darussalam province. This region is entirely an urban area. Similar to Banda Aceh, Surakarta does not have rural areas either, because those regions are municipalities (see Section 3.2.1 in Chapter 3). Nevertheless, Surakarta is not as big as Banda Aceh despite its status as the centre of Javanese culture. Meanwhile, Bogor is located near Jakarta – the capital city of Indonesia. Unlike the two previous regions, Bogor has rural areas. These three regions, on the other hand, are different from Muaro Jambi, Klaten and Jember. Having urban areas as their centres, the last three regions are surrounded by rural areas. As presented in Chapter 6, in 2007 and 2011, urban and rural areas influence the level of adoption, wherein urban households tend to use electricity, natural gas and LPG, whilst rural households tend to use kerosene and firewood.

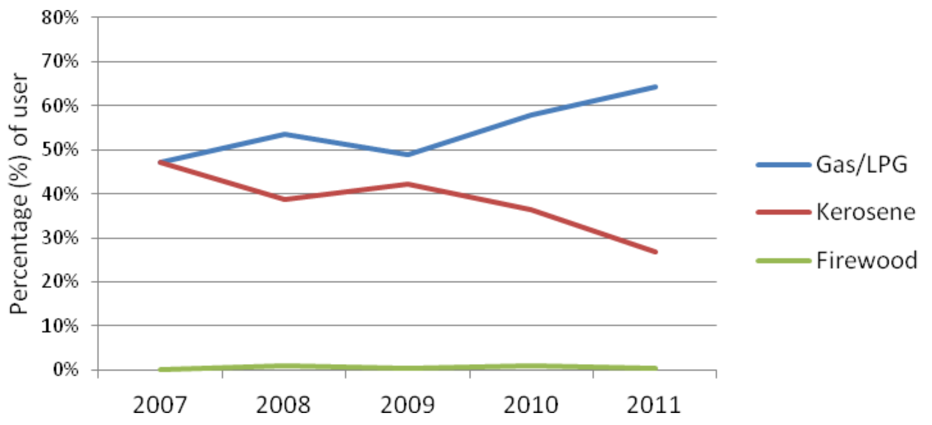
Table 8.3: The transition of the users, summary of the interviews (members of the public)

Interviewees	Gender of interviewee	Location	Time frame until the adoption	Fuel which is used for cooking		
				Pre-policy	During transition	The decision for adoption
IDCA01	Female	Urban - Banda Aceh	-	Kerosene (primary) Firewood (when kerosene limited)	Kerosene, firewood	Electricity (rice) LPG (primary) Firewood (when kerosene scarce)
IDCA02	Female	Urban - Banda Aceh	5 months	Kerosene (primary)	Kerosene	LPG (primary) Electricity (rice)
IDCA03	Female	Peri urban - Banda Aceh	6 months	Kerosene (primary) Firewood	Firewood (primary), kerosene	LPG (primary) Electricity (rice) Firewood (boiling water)
IDCA04	Female	Peri urban - Banda Aceh	1 week	Firewood (rice & water) Kerosene	Firewood, kerosene	LPG Electricity (rice) Kerosene (some occasions)
IDCB01	Male	Peri urban – Bogor	-	Kerosene, firewood	LPG	LPG Electricity (rice)
IDCK01	Female	Rural – Klaten	Could not recall	Kerosene, firewood	LPG	LPG
IDCK02	Female	Rural - Klaten	1 week	Firewood, kerosene	Firewood	Firewood LPG
IDCK03	Female	Rural - Klaten	-	Firewood	Firewood	Firewood
IDCS01	Female	Urban – Surakarta	-	Charcoal (primary), kerosene	Charcoal (primary) LPG	Charcoal (primary) LPG
IDCS02	Male	Urban – Surakarta	-	Kerosene	LPG	LPG
IDCS03	Male	Urban – Surakarta	-	Kerosene	LPG	LPG
IDCJ01	Male	Peri-urban Jember	-	Kerosene	LPG	LPG
IDCJ02	Male	Peri-urban Jember	-	Kerosene Firewood (some occasions)	LPG	LPG

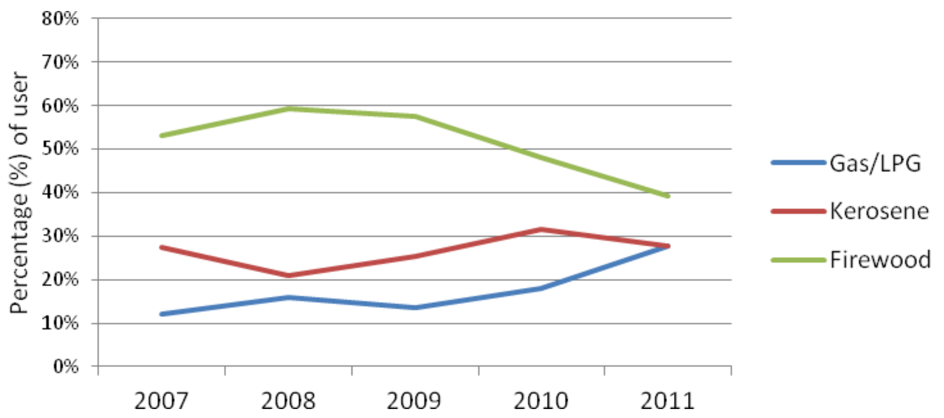
Table 8.4: Characteristics of cities under study[81]

	Regions					
	Kotamadya Banda Aceh	*Kabupaten* Muaro Jambi	*Kabupaten* Bogor	*Kotamadya* Surakarta	Kecamatan Prambanan, *Kabupaten* Klaten	*Kabupaten* Jember
Province	Nanggroe Aceh Darussalam	Jambi	West Java	Central Java	Central Java	East Java
Short description	This is urban area, the capital city of Nanggroe Aceh Darussalam Province	This region contains urban and rural areas where the capital city of region is in Muaro Jambi	This region contains urban and rural areas, where the capital city of region is in Bogor	This region is urban area	*Kabupaten* Klaten contains urban and rural areas. But this study is only conducted in rural area	This region contains urban and rural areas where the capital city of region is in Jember
Human Development Index (HDI)						
2009	76.74 (BPS, 2015d)	76.74 (BPS, 2015a)	71.35[82] (BIPDS, 2012)	77.49 (BPS, 2015b)		64.33 (BPS, 2015b)
2010	77.00 (BPS, 2015d)	77.00 (BPS, 2015a)	72.29 (Jalaluddin et al., 2012)	77.86 (BPS, 2015b)		64.95 (BPS, 2015b)
2011	77.45 (BPS, 2015d)	77.45 (BPS, 2015a)	72.73 (Jalaluddin et al., 2012)	78.18 (BPS, 2015b)		65.53 (BPS, 2015b)
ECPKL Implementation	2010	2010	2008	2010	2009	2009
Forest area in province (BPS, 2015c)	3599 ha	2108 ha	817 ha	757 ha		1361 ha

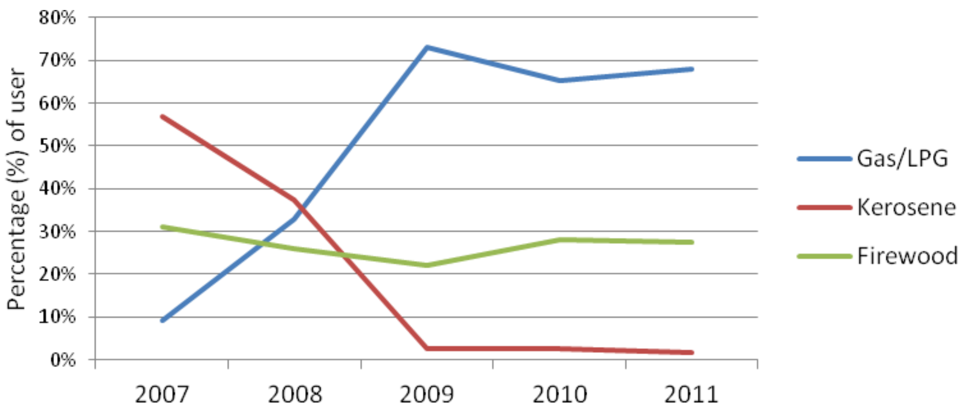
[81] Case study in Klaten was conducted in one rural area only.



(i) Fuel used for cooking in Banda Aceh (urban areas)



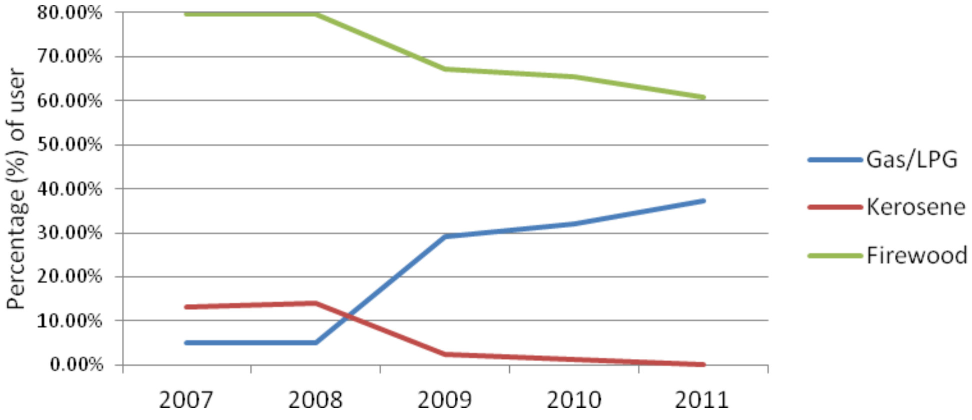
(ii) Fuel used for cooking in Muaro Jambi (urban and rural areas)



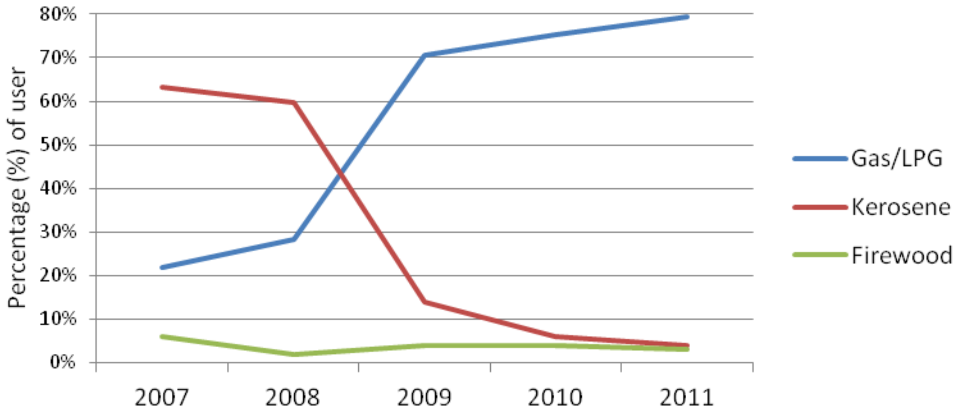
(iii) Fuel used for cooking in Bogor (urban and rural areas)

Figure 8.1: The dynamics of main fuel for cooking[83]

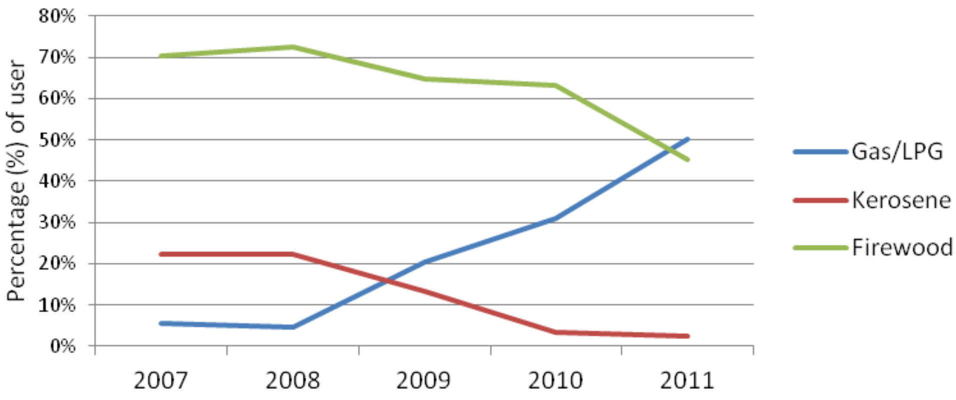
[83] The analysis is based on SUSENAS data



(iv) Fuel used for cooking in Klaten



(v) Fuel used for cooking in Surakarta (urban areas)



(vi) Fuel used for cooking in Jember (urban and rural areas)

Figure 8.1: The dynamics of main fuel for cooking (cont'd)

Referring to the study in five[84] regions – as previously discussed in Chapter 7[85] – the reluctance of local governments to take part in the ECPKL programme at its early stage of implementation is apparent. Some regions accepted the policy while others required particular approaches. The reluctance influenced the acceptance of the related members of the public within these regions to LPG which, in turn, affected the speed of the adoption of LPG. With respect to its time frame, the ECPKL policy was implemented in Java at its very early stage of implementation. Certainly, demonstrations in Java to reject the policy which were held by kerosene stakeholders and NGOs were more apparent in the early implementation of the ECPKL. In this case, ECPKL was a challenge to stakeholders that had some relation to the kerosene business. If the public preferred to use LPG, kerosene business would collapse. Different to these stakeholders, NGOs concerned with human rights issues did not agree with ECPKL because not all members of society wanted to adopt LPG. Some NGOs thought that, people have the right to use any type of energy without government intervention. Regions other than those in Java Island in the meantime, implemented the ECPKL programme two to four years after initial implementation of the same programme in Java. The interview results reveal that the local governments of other-than-Java regions and the related societies easily accepted the ECPPKL policy and adopted LPG. Referring to the interview narrative, there was increasing trust from people – probably on account of a reducing level of fear of the possibility of LPG explosion – on one hand and

[84] There were five local governments that interviewed in this study
[85] Due to administration barriers during interviewing, respondents from local governments interviewed in this research are from five local governments only.

improved preparedness of the subsequent ECPKL programme implementation on the other.

8.2 The Reasons behind LPG Adoption

This sub section explores several reasons for society adopting LPG and barriers during the adoption. All of the reasons are summarised in Table 8.5. The interviewees in this research are representatives of national government, five local governments – i.e. Banda Aceh, Muaro Jambi, Bogor, Surakarta and Jember - and communities in five different regions – i.e. Banda Aceh, Bogor, Klaten, Surakarta and Jember. According to the interviews, five factors are identified as the reasons behind the adoption of LPG after ECPKL policy implementation. These factors will be discussed in more detail in this section.

8.2.1. Energy Price, Market and Affordability

Incentive and Subsidy Attract Society to Adopt LPG

The instruments of the ECPKL mentioned in Chapter 7 are regulations and laws as well as incentives and subsidies that are designed to attract people to follow governmental policy. In the ECPKL, the incentives are given through providing free stoves and its kits, whilst subsidies apply to refilling 3 kg LPG. It is found that respondents from both government and communities in the study confirm that the incentive, i.e. the LPG package, attracted them to accept the policy.

> *They were pleased to get something without losing their money. This also happened to those who worked at stove industries. They never thought that this policy will cause them to be unemployed. They didn't know that kerosene will be replaced with LPG. They only thought about getting the free LPG package.* (IDGB03, community leader, Bogor, 04/07/2013)

Table 8.5: Reasons of for social acceptance

Province	Trust in government	Communication	Community leader	Demonstration to use LPG	Influenced by neighbour	Influenced by family	TV advert	Market locked in	Subsidy & incentive for LPG	LPG is more efficient	Easy to use	LPG is quicker	LPG is cleaner
Banda Aceh, NAD													
IDGA01, Government											√		
IDGA02, Government		√	√		√								
IDGA03, Government		√			√	√		√					
IDGA04, Government						√		√	√				
IDGA05, Government	√			√									
IDGA07, Government					√	√							
Muaro Jambi, Jambi													
IDGM01, Government									√				
IDGM02, Government		√		√			√						
IDGM03, Government													
IDGM04, Government		√											
Bogor, West Java													
IDGB01, Government		√	√	√	√								
IDGB02, Government													
IDGB03, Government	√												
Surakarta, Central Java													
IDGS05, Government								√					
Jember, East Java													
IDGJ01, Government									√				
IDGJ03, Government					√								
IDGJ04, Government								√					
IDGJ05, Government					√								

Table 8.5: Reasons of the social acceptance (cont'd)

	Trust in govern-ment	Commu-nication	Commu-nity leader	Demon-stration to use LPG	Influen-ced by neighbour	Influen-ced by family	TV advert	Market locked in	Subsidy & incentive for LPG	LPG is more efficient	Easy to use	LPG is quicker	LPG is cleaner
Banda Aceh													
IDCA01, public member								√	√				
IDCA02, public member					√			√		√	√		
IDCA03, public member					√					√			
IDCA04, public member					√			√		√	√	√	
Bogor													
IDCB01, public member				√				√					
Klaten													
IDCK01, public member								√					√
IDCK02, public member								√					
Surakarta													
IDCS01 public member									√			√	
IDCS02 public member										√	√	√	√
IDCS03 public member													
Jember													
IDCJ01, public member								√					
IDCJ02, public member	√							√		√	√		
Total Gov. Perspective	2	5	2	3	6	3	1	4	3	0	1	0	0
Total Com. Perspective	1	0	0	1	3	0	0	8	2	5	4	3	2
Total	3	5	2	3	9	3	1	12	5	5	5	3	2

Source: Author's summary from interview with respondents

It was also found from the information of village staff who were interviewed in this research that most of the people who work in small scale industries associated with kerosene stoves unconditionally accepted the free LPG package. In this case, as previously discussed in Section 7.2.5, the possible negative effects of LPG use to their job – i.e. due to the fact that kerosene and LPG are substitutive and would likely cause the kerosene stove industry to collapse – were not realised by these people. People that worked in the kerosene stove industry were not sufficiently aware that distribution of the free LPG package has a negative impact on them. They did not realise that when the government distributes LPG to the public and the public accept it, the government would remove the kerosene subsidy and thus reduce kerosene distribution and hence the market for their stoves. They just accepted the LPG package because they wanted to get benefits from the LPG package, such as money from selling it. However, they did not realise that when they gave or sold the LPG by other means that they helped the government to distribute LPG.

It was also found that during the implementation process, in some places the free 3 kg LPG packages from the government were sold by local government officials to the public. This is in contrast to the formal rule that the package should be given for free to society.

> *I paid IDR 20 thousand for the LPG package and I use the LPG forever.* (IDCK01, rural public member, Klaten, 03/08/2013)

People agreed to buy the 3 kg LPG package because the package was much cheaper than either the 3 kg LPG from the market or the new 12 kg LPG cylinder with a new branded stove. From the interview with government representatives, the total price of the 3 kg LPG cylinder, the LPG, gas pipe, regulator and the stove in the market were equal to 200 thousand to 250 thousand, while the interviewee paid only IDR 20 thousands for getting the 3 kg LPG package: the respondents felt it much cheaper than the original price in the market.

Additionally, once the LPG packages were distributed and available all over Indonesia, many people presumed that LPG was much cheaper than kerosene. When access to LPG was not as straightforward as during the time after the ECPKL policy, for example in 2005, the price of the 12 kg LPG set by the government was IDR 4,250/kg. This is more expensive in comparison to the kerosene price at IDR 2,000/litre (Presiden Republik Indonesia, 2005b).

As can be seen in Table 8.6, the price of the 3 kg LPG package, in fact, was not as cheap as before the implementation of the ECPKL. Yet, this package was conversely supposed to be as cheap as previous years. The 3 kg LPG package was also subsidised which explains why it was artificially cheaper than the 12 kg LPG. Furthermore, by producing smaller LPG canister, from 12 kg LPG cylinder volume to the 3 kg LPG, increased the affordability of LPG as families did not have to outlay a large sum of money at one time. Contrasting kerosene to the subsidised and easier-to-find LPG brought about the awareness of lower cost. Additionally, the usage of kerosene is equal to 0.39% to 0.57% kg of LPG (Pertamina/WLPGA, 2012) or 0.77% of LPG (Barnes et al., 2004). This information was provided by the government to the public during the policy campaign in local communities and was supplied by media advertisements in the early implementation of the policy. This definitely affects people’s perception and led to the supposition that LPG is better than kerosene.

Table 8.6: Price of kerosene and LPG after implementation

Location of respondent	Character of user	Kerosene			LPG		
		Price[86]/litre (IDR)	Duration[87] (day)	Daily price	Price[6]/kg (IDR)	Duration[7] (day)	Daily price
Government, Banda Aceh, NAD (IDGA04)	-	10,000	7	1,428	5,000	5	1,000
Public member, Banda Aceh, NAD (IDCA03)	- 5 family members - Multiple cooking fuel user (firewood, LPG, Electricity)	11,000	1.5	7,333	6,667	5	1,333
Government, Jambi, Jambi (IDGM01)	-	10,000 - 15,000	4	2,500 to 3,750	5,000	7	714
Government, Jember, East Java (IDGJ01)	-	10,000	3	3,333	5,000	3	1,667
Public member, Jember , East Java (IDCJ01)	- 3 family member - Multiple cooking fuel user (LPG and electricity)	9,000 – 12,000	1 – 2	4,500 to 12,000	5,000	2 – 3	1,667 to 2,500
Public member, Jember, East Java (IDCJ02)	- 6 family member - Multiple cooking fuel user (firewood and LPG)	11,000	1.5	7,333	5,000	5	1,000
Public member, home food industry, Surakarta (IDCS02)	- 4 family member - LPG	15,000	1	15,000	5,000	2	2,500

Source: Author's summary from interviews with respondents

Referring to data from the SUSENAS surveys in 2007 and 2011 which are presented in Table 5.5, in general, the average price of kerosene in Indonesia 2007 and 2011 was IDR 2,662/litre and IDR 4,158/litre, respectively. The average price of LPG in 2007 and 2011 in Indonesia was IDR 4,776/kg and IDR 6,072/kg, respectively. The data indicate that kerosene is much cheaper than LPG. In energy terms, it is clear that the price of LPG in 2007 and 2011 were IDR 3,822/BOE and

[86]According to the Central Bank of Indonesia, the average USD-IDR currency in June 2013 was 9,881 IDR; July 2013 was 10,073 IDR; and in August 2013 was 10,573 IDR. Source: http://www.bi.go.id/en/moneter/informasi-kurs/transaksi-bi/Default.aspx USD

[87] Expectation from interviewee

IDR 4,872/BOE, respectively and the price of kerosene in the same years were IDR 3,075/BOE and IDR 4,805/BOE, respectively. So for equivalent energy the price of kerosene both when kerosene was subsidised (2007) and after the subsidy for kerosene was moved to LPG (2011) was slightly lower than that of LPG. This supports the perception of the public that kerosene is cheaper than LPG,

China had successfully encouraged rural people to consume modern fuel through direct subsidies for buying modern fuel powered appliances (Han et al., 2014). In most cases, the subsidy was a successful determinant in attracting people to change energy usage and in improving societal acceptance (Akpalu et al., 2011; Bazilian et al., 2012a; Park & Kwon, 2011). In this study on the contrary, the incentive offered by the supply of free LPG appliances did not totally persuade people to adopt LPG for cooking. Many people were reluctant and did not want to adopt LPG; some others sold or gave the LPG package to others and continued to use kerosene. Only after several months did such people come to understand that the subsidised 3 kg LPG is cheaper than the no longer subsidised kerosene. To sum up, it is found in this study that incentives and subsidies affect the energy transition several months after its initiation.

Several scholars argue that subsidies can be a barrier to make a transition and be counterproductive in alleviating energy poverty (Urge-Vorsatz & Tirado Herrero, 2012). This is especially the case if the subsidy is given to fossil fuels. A subsidy can result in overconsumption of fossil fuel and worsens the environmental problems (Koplow, 2014). Therefore, those who disagree with subsidy provision suggest innovation and green technology initiatives (Jupesta et al., 2011). Indonesia, however, is a developing country and therefore, has to consider the conflicting issues in dealing with energy access. Giving more attention to access to modern fuel – which commonly is dominated by commercial energy – and energy security is more important than dealing with the trade-off of energy development (Frei, 2004; Sagar, 2005). Additionally, LPG is one of many alternatives for transforming fuel to become more sustainable (D'Sa & Murthy, 2004). For all of these reasons, this research study takes a position that providing subsidies and incentives to LPG as a fossil fuel is tolerable.

Market Lock-in Forces Society to Adopt LPG

In this research, it has been found that to some extent, incentives and subsidies did not attract those with high resistance or those who thought that the risk of adopting LPG for cooking was high. These people did not use LPG even though they received a free package of LPG. They saved, gave or sold it to family members, neighbours or someone else. They decided to use kerosene or firewood instead of LPG although they had a LPG cylinder, stove and kits. This is similar to the finding from the study by Palit et al. (2014) in India. In their study, subsidies for commercial energy merely attracted rich people even though the energy was highly subsidised. This is in line with the argument put forward by Bordoff (2014) that, in general, the subsidy is utilised by rich people.

In most cases, households who previously refused to use LPG eventually changed their mind and decided to use LPG. This is because of the rising price of kerosene while its availability was reduced considerably. They do not have any choice to consume other kinds of energy except LPG, otherwise they could not cook.

This policy helped us when we suffered from lack of energy for cooking even though the quality of stove and kits is not good enough. (IDCA01, urban public member, Banda Aceh, 09/04/2013)

Without reducing kerosene availability and increasing the price of kerosene, people would not have moved to LPG. Reducing kerosene availability on one hand and uplifting its price on the other hand are considered as the most successful strategy conducted by the government and Pertamina which in turn contributes to the substitution of kerosene by LPG.

This is called '*lock in*' for the consumer (Røpke, 1999; Sanne, 2002; Seyfang, 2011). People consume specific fuels because they have difficulties in accessing other kinds of energy, not because they are keen to use the fuel. As previously mentioned above that there were some people adopt LPG because don't have best fuel choice except LPG (see Section 8.1).

A locked-in market can be created through government policy which enables control of the market. As previously discussed in Sub-section 7.2.4, the government strategy to insist that local governments follow their fuel policy is through locking the market, encouraging use of LPG and discouraging use of kerosene. In this case, the LPG market is expanded and subsidised and, at the same time, kerosene supply is reduced and its price is raised.

Despite its success in pushing the public to consume LPG, the strategy may also create social conflict. At the time of the policy implementation, the supply of kerosene was limited as a result of the diminishing amount of kerosene production. Meanwhile, the government failed to meet LPG demand due to lack of government readiness in producing adequate volumes of LPG. This led to societal anger. Demonstrations and protests took place in some areas in Indonesia because of the limited supply kerosene while LPG supply was also limited. Worse than that, staff in many places were threatened by community organisations demanding guarantee that the reduction of kerosene would not result in the public having insufficient fuel for cooking.

8.2.2. Social Trust, Norms and Awareness

Interviewees who were members of the public in Banda Aceh argued that people should trust the government more. This belief led them to accept the policy of their local government and adopt the LPG. This statement is affirmed by the interviewee from government.

It is a common thought in Indonesia that a good citizen should not disobey nor express complaint of the leaders' orders. This is especially the case in rural areas and with respect to poor people. During the implementation of the ECPKL policy, most people in Banda Aceh positively accepted the policy because they highly trusted the government. This included high levels trust in the policy of replacing kerosene with LPG.

> *In here (Banda Aceh), members of public always accepted the policy. They never complained. We did not have difficulties in convincing them to move to LPG. With their self-awareness they accepted the policy (IDGA03, Local Government, Banda Aceh, 19/07/2013).*

> *We accept the programme unconditionally because this is from the government (IDCA01, public member, Banda Aceh, 09/08/13)*

The trust derives from the public's existing level of satisfaction with the prior governmental interventions. For example, two of the public policies in Banda Aceh at that time were providing financial support for undertaking study at universities – in Indonesia and abroad – and giving health services for all Banda Aceh citizens. These led to increased trust in the government because the public were satisfied with the service they were getting. The members of the public who were satisfied in public *policies* tended to have higher trust in the government. Because of the trust, the members of public cooperated with the government by accepting the ECPKL through their own volition. Moreover, despite concerns about the safety of the use of the 3 kg LPG package, the members of public's compliance and their decision to accept the free 3 kg package, as opposed to refusing the incentive, can be translated as thankfulness to the government for providing good public policy.

> *At that time, price of kerosene increased. We were unable to afford it because my husband did not have high income. The free LPG package from government was very helpful that leaded me be able to cook. We thankful to the government that have provided us a cheaper fuel for cooking (IDCA02, public member, Banda Aceh, 09/08/13).*

This is called *trust* where the public agrees to do something due to the belief that they will get some benefit from their compromise (Rothsen, 2005). In this study, society appears more trusting because they have memories from previous experiences that cooperation with government will give them some benefits.

The absence of *trust* could be a barrier to the implementation. In the early implementation of the ECPKL, the members of public in Surakarta expressed their concerns about the policy in relation to the LPG quality and safety. This concern, as previously mentioned in Sub-section 7.2.4, was taken up by the local government that led to them not accepting the ECPKL until the national government gave a guarantee to address the public concern. This led to the ECPKL being postponed. However, noncompliance by rejecting the policy is still permitted according to Indonesian's law, since the implementation of autonomy, local governments are allowed to set regulations for themselves that are different from the national policy.

The social environment such as family, neighbours and friends influences trust which in turn affects adoption of LPG. The community leaders in this study played the main role in influencing the public to switch from kerosene and firewood to LPG because most of the community leaders are neighbours, family members or friends. Given strong descriptive norms, [88] undeniably, accepting the policy is the only choice for any member of the societies in order to maintain good relationships with others. In addition to close relationships with the community leader, members of the community tend to comply with the religious leader's instruction. Most of the areas in Indonesia have weekly or monthly local community gatherings and religious events. People in the community frequently share their experiences in these events. In the case of the ECPKL policy, community gatherings are advantageous in promoting the use of LPG.

> *People in here tend to follow what other people do. If one individual adopted LPG, the other would follow to adopt the LPG, because he already had evidence that the policy gave benefits to him.* (IDGJ04, Community Leader, Jember, 15/07/2013)

The individual tends to accept a new technology if the other people around them are able to be convincing that the technology is better than what they have previously used. In cases where individuals prefer other types of energy, they did not use the LPG package themselves, and gave or sold the package to other individuals, and yet did not openly express their refusal. In this study, descriptive norms determine the acceptance of society to LPG.

[88] Descriptive norm is is sets of beliefs about what other people are doing (Cialdini et al., 1990) in Section 2.6.

In addition to above-mentioned factors, adequate information influences people's awareness in accepting new technology. In most cases, the refusal of new technologies, according to some respondents, might come from individuals with poor education.

> *People with poor education and less information decided to sell LPG package to others when anybody else said that LPG is not safe. They tended to use kerosene in spite of its higher price. They felt comfortable using kerosene instead of LPG because most of them could not use LPG stove. There are lots of people with poor education in this area and they needed help to be well informed.* (IDCJ01, Peri-Urban Community, Jember, 16/07/15)

> *For those who never used LPG in advance, they had difficulties in getting information regarding LPG usage. They needed information to understand how to use LPG.* (IDG03, Local Government, Bogor, 04/07/2013)

People who thought that LPG is dangerous and highly risky needed special approaches, such as intensive communication including much more information about the LPG. The government cooperated with local government in the village by providing operational training for LPG. In this case, the interviewee considered that communication and additional information along with a demonstration on how to use LPG would be useful to convince more people that LPG is safe and easier to use than either kerosene or firewood. In Chapter 7, Section 7.3.3, the government in cooperation with community leaders and independent agents provide information to those who did not know much about LPG through training. This approach definitely increases LPG use whatever level the adopter's education level is.

> *Those who were still worried asked some questions to those who understand. In this case, I found a person who was graduated from a master degree programme. She was afraid in using LPG and she never used LPG before. In this situation, the information about LPG*

> *played a main role in improving the adoption of LPG.* (IDGM01, Local Government, Muaro Jambi, 22/07/2013)

However, in some places, the independent agents did not go into the communities and did not give detailed information and demonstrations to operate LPG stoves to members of the public. They just went to village offices and distributed the LPG packages without giving any information. Having no prior experience on using LPG, the members of public who used firewood for cooking could not cope with the situation. As a consequence, they decided to remain using firewood instead of moving up to LPG.

According to previous studies it has been shown that good education is one, among others, that determines people's preference for modern fuel carriers (Pandey & Chaubal, 2011; Reddy & Srinivas, 2009). Practical Action (2010) has proven that Human Development Index (HDI) is related to energy access. In general HDI is measured from the average of years of schooling, life expectancy and economy. In the case of Surakarta the HDI is high (see Table 8.4). Surprisingly, it is found in this study that social resistance to the ECPKL policy in Surakarta was still unavoidable in spite of the data that its HDI is high and its citizens are more familiar with modern technology. It might be that education enhances people's level of critical awareness which eventually led the people to be more careful in accepting and adopting new technology. This study also found cases where people with poor education are happy to accept new technology. In one of the communities in Bogor wherein kerosene stove industries are located, most of the people – who are the workers of kerosene stove industries – received the LPG package because of the incentive. They did not think that the ECPKL policy would have negative impacts to kerosene stove industries. In this case, people tended to be obedient. They believed that nothing could be done except to submissively accept governmental directives. Such people would not be influenced by changes in price. They would not reduce LPG consumption even though the price of energy had increased. They would not move to kerosene or firewood either, because most of them were trapped in using LPG.

Education improves social acceptance of LPG, which in turn leads to the adoption of the LPG (Andadari et al., 2014). Nonetheless, in spite of good education, some people in this study did not want to adopt LPG as they do not trust the government. In the meantime, uneducated people tend to be compliant instead of refusing LPG. Based on the interviews, education is not the only determinant for acceptance and adoption of LPG. People with high education but lacking information about LPG tend to show their refusal to it, whilst people with poor education but with more information about modern fuel, in addition to getting incentives and having trust, tend to adopt it. Therefore, it is imperative to communicate to society all information regarding energy in order to improve trust which in turn affects energy acceptance and adoption.

8.2.3. Tangible and Intangible Characteristics of the Appliance

Easy to Use and More Efficient

Cooking by using a LPG stove is easier than that of using firewood or kerosene. Before being burned during the cooking process, wood needs to be cut into small pieces and dried to make it burn more easily. Meanwhile, cooking by kerosene is easier than by firewood as it only needs to be put into the stove tank. When cooking using a firewood stove, matches are needed to ignite the wood. Sometimes the fire needs to be fanned in order to keep the flames sustained. Fire ignition by using matches is also needed in cooking by kerosene stove, however, differently from cooking with a firewood stove the fire or heat remains constant. In the meantime, the only thing needed to turn on an LPG stove is pressing its button. This ease of use led many people to move to LPG. The easiness of operating LPG even attracted poor people who had previously used firewood to learn how to operate it. It eventually drove some of them to move to LPG even though the firewood resource is abundant.

> *We prefer LPG to firewood even though firewood is cheaper, because using firewood is not easier than LPG. We cannot use firewood not until we cut it into smaller pieces. It takes time.* (IDCA03, Urban Community, Banda Aceh, 10/08/2013)

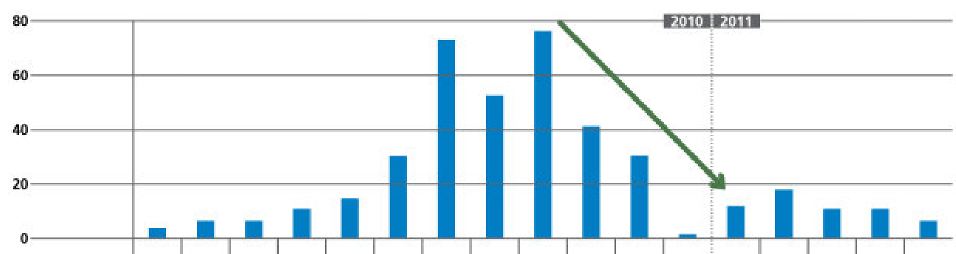
Quality and Safety of Energy

In this study, the interviewees claimed that smoke from LPG is little or even none. Kerosene and firewood meanwhile, produce a lot more smoke than LPG.

> *Firewood produces more smoke, while LPG does not. Cooking by LPG is cleaner than that by firewood. Our kitchen and kitchen appliances are cleaner.* (IDCA03, Urban Community, Banda Aceh, 10/08/2013)

In addition to the stove, smoke also makes the appliance as well as the kitchen dirtier. In this context, LPG is therefore more preferable than firewood and kerosene.

In the early implementations of the ECPKL policy which were concentrated in west Java and Jakarta, accidents related to LPG were mostly caused by the 3 kg LPG packages: details of such accidents during 2010 and 2011 (until May) are provided in Figure 8.2. The accidents also occurred in other areas even though there were not that many. In comparison to LPG, the vapour pressure (high flashpoint) of kerosene at ambient conditions is lower (Lam et al., 2012). This makes kerosene have a lower risk of explosion in comparison to LPG. Fire from LPG could not be stopped by pouring water; it needs the use of a fire extinguisher instead, equipment that is uncommon in Indonesia's housing. This explains why the explosion of a 3 kg LPG package that occurred in 2010-2011 eventually led to a house catching fire. Fires on kerosene stoves, on the other hand, can be stopped by pouring water on the stove or by covering it with wet gunny cloth. This is similar to preventing fires with firewood or charcoal stoves. People eventually were worried about the safety of the 3 kg LPG package and did not use the package soon after they received it, scared about a possible LPG explosion.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
# Accidents	4	7	7	11	15	31	74	53	77	42	31	2	12	18	11	11	7
Accumulative	4	11	18	29	44	75	149	202	279	321	352	354	12	30	41	52	59

Figure 8.2: Accidents caused by LPG in 2010 and 2011(Pertamina/WLPGA, 2012)

From the investigation, the accidents with the 3 kg LPG packages were caused by several factors. Firstly, the quality of the LPG packages, especially the LPG pipe and the regulator were not good. From 2009 to 2011 the government therefore, evaluated and improved the quality of the production of the LPG regulator and pipe. After that, explosions from the 3 kg LPG packages were reduced significantly. Secondly, communities got limited information about the LPG. As formerly mentioned, the cooking processes by LPG, and kerosene and firewood are different from one another. The habit of the society members in cooking by using a kerosene or firewood stove was also applied to cooking on a LPG stove, whereas cooking by LPG is quicker than that by kerosene or by firewood. The carelessness resulted in accidents. For example, while people cook by firewood stove, they are able to do other activities in addition to cooking because cooking by firewood needs plenty of time. But, cooking by using LPG is faster. People are unable to do other activities when they cook with an LPG stove, otherwise, there will be accidents.

8.2.4. Campaign, Communication and Familiarisation with LPG

During the policy, there were some accidents. The news on accident, spread around Indonesia through television news. But, the government evaluated the implementation to reduce the problems caused by LPG use. Additionally, the government made an improvement in the quality of stove, LPG cylinder and kits. When the receiver of 3 kg of LPG found a poor quality of stove, cylinder and kits, the government replaced them. Unfortunately, even after the government had improved the quality of the LPG cylinder, stove, pipe and regulator, some people were still worried about using LPG. This unavoidably hampered the diffusion of LPG. Rogers (1962) argues that the communication channel is one of the most important elements in innovation diffusion. Therefore Pertamina designed how the ECPKL policy was narrated and who the narratives of the policy were for. Independent agents were recruited in every region to assist Pertamina in implementing the policy. Moreover, village government officials involved community leaders as data collectors. The community leaders along with the independent agents are the narrators to the communities.

In this research, local governments and the independent agents are the key actors who play the main roles in conveying the governmental policy to societies. They provided information in relation to the LPG. The communication was conducted in several ways, some of which were one-to-one approaches through local governments and communities, invitations to members of public to come to the village office and advertisements on TV and leaflets. Figure 8.3 presents one of the leaflets distributed to one of the communities.

> *We promoted the policy in many ways. We came to the society directly and invited members of public in every village. We gave them the information through leaflets. We also came to remote areas. Additionally, we promoted the policy to housewife communities and religious communities.* (IDGM01, Local Government, Muaro Jambi, 22/Jul/2013)

Figure 8.3: Leaflet of the ECPKL policy distributed by the Kotamadya Surakarta

In the first approach, the local government officials, community leaders along with the Pertamina officials, came directly to the houses of citizens with high resistance to ECPKL and who have potential influence with members of public and gave more explanations. In the second approach, the government invited the members of public to come to the village office and supplied the people with more information and familiarisation on using the LPG. Pertamina –

most often represented by an independent agent – and village government officials demonstrated the LPG use in front of the public members and showed them how to deal with problems arising during cooking by LPG. During the demonstration in the village office, the people were given an opportunity to practise in front of the independent agent. This increased people's knowledge of LPG which in turn affected their confidence in using the LPG at home. Meanwhile, for those who could not attend the meeting in the village office, information was obtained by word of mouth. This also significantly reduced people's worries about LPG. The last approach in communicating the benefit of the LPG was through mass media such as TV advertisements and leaflets. This also contributed to social acceptance because people knew how to use LPG from the advertisements and leaflets. Communication changes the mind-set of the people who initially were of the impression that LPG is dangerous.

However, to some extent the media is able to shape contrasting *images* which are different from the factual. In the early implementation of the ECPKL policy, the media repeatedly provided news about accidents caused by the 3 kg LPG packages. Unfortunately, this news shaped public opinion, even though the accidents were limited to small regions and never happened in other regions. In this case, the government suppressed the bad news. But, people with limited education or people who were cautious about the safety of the package became highly worried, and were reluctant to adopt the LPG. Some of them even sold the 3 kg LPG.

> *Actually, I got LPG kits from the government. But I gave it to my sister. This new stove*[89] *was bought by my son. He bought it for me*

[89] Her son bought 3 kg LPG canister and stove in the market after she sold the LPG package given by the government.

> *and he used it when he visited me and wanted to make tea or coffee here. I've never used it.* (IDCK03, Rural Community, Klaten, 05/08/2013)

Moreover, there were provocateurs that persuaded the LPG package recipients to sell the package they received. These people were not the targeted receivers, but they wanted to get the benefit from the 3 kg LPG package. They expected to buy the LPG packages at a cheaper price and sold the packages to the market at a high price. This in the end led to leakage of the incentive and subsidy, in the sense that the incentive and subsidy were received by non-targeted households.

8.2.5. Modern Kitchen Architecture

In this study, it is evident that house architecture affects the adoption of LPG. In urban areas, houses are small, of terrace type and without backyards as already mentioned in relation to the case study in Banda Aceh. Moreover, traditional houses which are generally big and have wide back and front yards are limited. In a small house, the kitchen tends to be of small size and vice versa. On the contrary, houses in rural areas are generally traditional houses which are wider than houses in urban areas. The houses often have a backyard in spite of the owner's poverty.

> *There are some traditional houses in Aceh. Generally their kitchen is in size of 2 meter x 1 meter and is mostly placed outside of the house. However, now we live in modern houses. So, we do not have enough space to cook by firewood.* (IDGA03, Local Government, Banda Aceh, 19/07/2013)

> *Most households have a small kitchen as they live in a modern house. There is no space for cooking by firewood.* (IDGS05, Local Government, Surakarta, 03/06/2013)

> *We generally live in traditional houses, i.e Minang houses. When LPG price increased whilst kerosene price was also high, we cooked by firewood because our house enables us to cook by firewood outside the house*. (IDGM04, Rural Government, Muaro Jambi, 04/08/2013)

Kitchens in urban and peri-urban houses in Indonesia are of small size. These kitchens are suitable for modern appliances but not for firewood stoves. In contrast, houses in rural areas are mostly detached and have a wide space for the kitchen. In addition, some households have a kitchen outside the house, an example of which is presented in Figure 8.4.

Figure 8.4: Cooking outside a house (Source: Field researcher documentation)

8.3 Resistance from Traditional Fuel Users

Table 8.3 shows that some people who formerly used firewood did not want to move to LPG. This section aims to investigate the reasons for partial LPG adoption and resistant adopters who continued to solely use firewood.

8.3.1. Behaviour and Lifestyle

The stoves for cooking by firewood, kerosene or LPG are different. More modern fuel has a more modern stove which is easier to use than a traditional stove (but contingent upon perspective and experience). Firewood is needed in order to cook using a firewood stove. In many occasions the wood needs to be cut into smaller pieces. When somebody cooks with a firewood stove, matches are needed to set fire to the wood. Some people put kerosene on the wood to produce a bigger flame for the stove. Meanwhile, cooking with a LPG stove is easier to do: the cook just needs to turn the stove on or press the button. Despite its ease of use, it is found that not all people adopt LPG.

The cooking process of Indonesia's traditional foods needs specific techniques and conditions in order to get a good result. Sometimes it requires a small flame and a long cooking time. Many Indonesian people prefer this type of cooking process and refuse to use a more efficient stove with a higher flame production. These types of people are unenthusiastic about learning how to use the LPG stove and, as a result, producing a smaller flame with the LPG stove is not easy for them. Cooking by using an inefficient stove does not matter for these people even though they are workers and should go to work every day from morning until the afternoon.

> *Cooking by firewood stove needs longer time. While the society members cooked, they did other activities such as cleaning the house or cleaning the garden. This is similar to when they cook by kerosene stove. However, cooking by LPG stove is different in the sense that it is quicker than cooking by kerosene or by firewood. The consequence is that they cannot do other activities because they have to be more careful and stay in the kitchen until their cooking activities are completed.* (IDCB01, Peri-urban Community, Bogor, 08/07/2013)

One of the interviewee is a young female worker. She wakes up early in the morning, at about 4.00 a.m., then she boiled water and cooked rice for her family. While cooking, she did other activities such as prayers and cleaned the house. At around 8.00 a.m. she went to work and was back home at about 4.00 p.m. Her activities as a female worker were not interfered with by her cooking activities. This is similar to an interviewee who is an elderly woman and a worker. In Indonesia, early morning activities are common, as the people in the country are mostly Muslims whose routines for prayer makes them wake up at about 4.00 a.m. every day. Domestic activities in the early mornings, hence, are by no means a burden for them.

A study by Alberts et al. (1997) has proved that the behaviour of a society in preparing food has a relation to fuel they used and it determines social acceptance. Rice is the main food for most of Indonesian society members. Before the ECPKL policy was implemented, people cooked rice by firewood or charcoal stoves, kerosene stoves or electricity stoves. Households who cooked rice by firewood tend to be reluctant to move on to kerosene or LPG because, according to them, kerosene influences the taste of rice.

> *Food which is cooked by LPG is not as tasty as food cooked by firewood. I have never bought ready-to-eat food from food store because I do not like food cooked by other people.* (IDCK03, Rural Community, Klaten, 05/08/2013)

> *Previously my family cooked by firewood. For me, water boiled by firewood stove is tastier than that cooked by kerosene or LPG.* (IDGA05, Local Government, Banda Aceh, 25/July/2013)

Akpalu et al. (2011) argue that the taste of food determines people's choice of energy for cooking. Their study provides evidence that the taste prevents people from using modern fuel because, in some cases, tastes of foods are better when the foods are cooked by firewood.

More generally, Pachauri (2004) has obtained evidence from an Indian case study that lifestyle influences people's choice of energy. In this study, the interviewees trapped in specific behaviours, such as seeing the taste of food as an important factor, were unable to move on to modern fuel. They already have routine activities that can be a habit, meaning they do not want to change their behaviour.

8.3.2. Elderly People

One of the determining factors that meant people kept using firewood is age. In this study, the interviewees provided information that most of the elderly people have difficulties in using LPG.

> *In here, people who carry on using firewood are elderly people whose ages are more than 50 year olds. They have higher resistance on using LPG.* (IDCB01, Peri Urban Community, Bogor, 08/06/ 2013)

This also relates to behaviour. They have a long experience with cooking by firewood or kerosene. Habitually they are stuck in routines which could not be changed by anyone or by any situation without difficulty. In this situation, their perception is easily influenced by negative information about any new technology mainly because, inherently, they merely do not want to use the technology.

> *Elderly people prefer using firewood and charcoal. My Mom uses charcoal because she thought that LPG is dangerous. She watched from TV that LPG is easy to explode.* (IDGS04, Local Government, Surakarta, 19/12/ 2012)

Communication by key informants around them, as above mentioned, is imperative in this situation in convincing the elderly people to move onto modern fuel. Yet, this way was not always effective, especially for those who live alone. They are the only individual responsible for cooking in their house.

> *Some of the elderly people use LPG even though, generally, they have high resistance to it. This is because they follow people in their surroundings*. (IDGJ03, Local Government, Jember, 10/07/2013)

> *I cook by firewood stove because I am scared of using LPG. But, my Mom cooks by LPG as well as by firewood because when she was young, she worked for a household in a city and, so, she is familiar with a modern stove.* (IDCK02, Rural Community, Klaten, 05/08/2013)

> *Elderly people use LPG because they have children and grandchildren who teach them on how to use LPG. They are more modern, now.* (IDGB03, Bogor, 4/06/2013)

However, it has been found in this study that some elderly people who previously used firewood (as well as kerosene) subsequently move to LPG. The elderly people use LPG because they had the willingness to learn about LPG usage and were not scared about the possibility of LPG explosions anymore or have experience in using LPG when they lived in a certain city. From this study, it is apparent that the *communication channel*,[90] that family members who live with the elderly, have a significant role in changing elderly people's behaviour in cooking.

8.3.3. Location and Resource Availability

Lower numbers of urban households use firewood in comparison with those who live in rural areas that have a lot of resources of firewood. In urban areas such as Banda Aceh, the capital city of the Aceh province, and Surakarta, firewood availability is limited. Additionally, firewood in the city is commercially

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[90] Communication channel is the agency, people or anything who are able to transfer information about new technology from one to another in order to improve the technology adoption (Rogers, 1962).

traded. But small numbers of households in the city collect free firewood from the branches of trees and waste from building construction. In the city of Surakarta people who still used firewood are, generally, those who sell traditional food.

Meanwhile, in rural areas, firewood utilisation by people is a common practice. The most logical reason is that the people in these areas have lots of resources of firewood which can be collected for free. Farmers in rural areas use firewood stoves because they have free resources from the waste of farms. Most goatherds and farmhands also use firewood.

In many studies, low price or even free access to firewood is the main reason for people to use firewood (Sathaye & Tyler, 1991). In the areas where forest exists and therefore is able to provide free firewood such as in rural areas, many households prefer to use firewood. This is why many scholars argue that location determines the choice of energy use (Suliman, 2013). However, this study found that in some regions firewood is not cheap and is even sold at a price higher than that of LPG or kerosene. In this case, free firewood is not an actual price. For this reason, firewood for free in this study is called perceived cost which, unfortunately, has a strong influence on the decision to use firewood, which is in line with the arguments of Wickramasinghe (2011), Reddy and Srinivas (2009) and Leach (1987b). From this study it is also found that rural households able to get free firewood tend not to want to move to modern fuel. This is similar to the findings of Arnold et al. (2003) and Hosier and Dowd (1987).

8.3.4. Economic Rational Adopter

In this study, the people who still carry on using firewood for cooking are households who totally use firewood and households who use firewood on some occasions. All of them are rural households. Meanwhile, urban households who previously used firewood before the ECPKL policy implementation, have recently moved to becoming LPG users. Two households recently use multiple fuels, i.e. firewood and LPG (see Table 8.3), whilst one household remains using firewood. The decision made by the two households to use LPG is based on their desire to reduce the cost of fuels.

> *I have a lot of accesses to get free firewood. As a result, I can save money for buying LPG more. I can use the money for paying school fees of my son and my daughter.* (IDCK02, Rural Community, Klaten, 05/08/2013)

> *People who sold an LPG package are commonly poor people who need money. They did not want to move on to use LPG because they cannot afford LPG even in small size of cylinder. Moreover, they can get free access to firewood.* (IDGM02, Local Government, Muaro Jambi, 01/08/2013)

> *Some people use firewood to reduce cost of cooking. Firewood is mainly for boiling water and cooking rice because it needs a longer time to use and might consume more energy. In some occasions firewood is used to do cooking in the event of a big party preparation in order to reduce cost, and it is the case that modern stove is unable to handle a big appliance for cooking at a big quantity.* (IDGA05, Local Government, Banda Aceh, 25/07/2013)

> *Buying kerosene is more expensive. When I received LPG, the kerosene price was IDR 15 thousands and is even more expensive today. Now, LPG price is IDR 20 thousands. It can be used for two weeks or even more if I use multiple fuels, another fuel combined with firewood for cooking. If we use the 3 kg LPG for cooking water and food, it will be lasting for 10 days. I cook by firewood for efficiency reason*. (IDCK01, Rural Community, Klaten, 03/08/2013)

In this study, poor people in rural areas use firewood for cooking because they have access to free firewood (see Section 6.2). When they do not have access to free energy, they will not use firewood. When access to modern fuel was provided in rural areas, more energy options were available. This persuaded many of the people to choose modern fuel on the one hand and, on the other hand, did not affect the choice of some of them in favour of firewood due to free resources. In these cases both affluent and poor households in the areas are able to adopt LPG, a finding similar to that of Pereira et al. (2008). Therefore, there are people who do not take the price of energy into their consideration in choosing energy alongside those who are fully aware of energy prices. In this case the income of households is not the only determining factor in energy selection (Arthur et al., 2010).

8.4 Discussion

This study found that the government intervention to introduce modern fuel does not always bring about positive acceptance from society. In the early stages of the modern fuel introduction, resistance from society is unavoidable. However, once the government communicated and promoted the ECPKL to society more intensively, the social acceptance started to progress.

In the case of the ECPKL policy, at least three levels of adoption on the LPG are identified: full adopter of the LPG for the purpose of cooking, partial adopter of the LPG - because the household uses multiple fuels - and non-adopter of the LPG who did not intend to use LPG regardless of the situation. The adoption of the LPG mostly came from those who previously used kerosene, whilst not all traditional fuel users have the willingness to adopt the LPG. This adoption is a signal of acceptance, even though there are people who 'just accept' the ECPKL package as a result of the lock-in to the kerosene and LPG market.

The variety of the adoption of LPG in this study is caused by several factors which relate to one another. All of the factors are revealed in Figure 8.5.

Figure 8.5: Influencing factors of LPG adoption from this study (source: Author's construct)

The first factor is price and market of kerosene and LPG. The cheap price of the 3-kg LPG package is created from incentive through giving free stove and free 3-kg LPG canister and its kits and subsidy to the 3-kg LPG package. The incentive reduces the initial cost for LPG stove and LPG canister and its kits, whilst the subsidy reduces the price of the 3-kg LPG package. This makes LPG appliances more affordable for households and attracts the households to adopt LPG. Although to some extent subsidies and incentives do not succeed in attracting people to adopt modern fuel (Stern et al., 1986), in most cases incentives and subsidies have been proven to subsequently affect the decision to use a different energy type (Reddy & Srinivas, 2009). This study also proves that subsidy and incentive attract people to adopt LPG. Another influential factor of the transition to LPG is the locked-in market where people use LPG due to lack of kerosene supply. This refers to the argument that availability of energy influences people's choice on energy use (Sathaye & Tyler, 1991). This study adds to the evidence of success of the lock-in theory in changing energy use (Arthur, 1989; Foxon, 2002; Seyfang, 2011), where the supply of kerosene - the most dominant non-traditional fuel for cooking in Indonesia at the time of the study - was reduced gradually along with an increasing supply of LPG by the government. Despite its success in creating a strong market for LPG, the lock-in market approach did not satisfy the public because, in the early stages of its implementation, the approach made the kerosene supply scarce accompanied by a situation where large numbers of people did not want to move to LPG. However, the subsidy to LPG – which is a kind of fossil fuel – and its lock-in – which traps the public into using a particular type of fuel - will be a barrier for encouraging the public to move to any types of renewable energy.

The second factor, trust – which is created by culture, norms and government service – is also found as a determinant of social acceptance to LPG. This is influenced by other various factors. Trust of each of individuals to other people surrounding him/ her, such as families and friends, is seen in this research study as a contributing factor to the willingness of individuals to adopt LPG. Social norms, values and cultures lead people to follow the crowd (Carrico et al., 2011; Masera et al., 2000; Sovacool, 2011). Social norms influence behaviour and behaviour, in turn, affects lifestyle (Alberts et al., 1997; Ayres et al., 2009; G. Liu et al., 2008; Schultz, 1999). Conversely, the absence of trust increases the likelihood of LPG rejection. In this study, the fear of a possible LPG accidence obviously hampers the implementation of the ECPKL policy. However, after a series of improvements along with an intensive campaign about the policy from the government to the public, households tend to use LPG instead of using firewood or kerosene. Meanwhile, training during the campaign may persuade society to be more interested in adopting the technology (Byrne et al., 2007). These all are elements that apparently contribute to the enhancement of trust.

The third and fourth factors affecting the willingness of households to adopt LPG are tangible and intangible characteristics of the stove and the kitchen architecture. Cleanliness, ease of use, speed of cooking and efficiency attract households to adopt particular fuel types (Hosier & Dowd, 1987). Additionally, convenience of the appliance in using energy influences households to adopt energy (Sathaye & Tyler, 1991). Convenience of appliance is a common demand from consumers of the appliance. Therefore, in some energy technology introduction, convenience in using the appliance should be considered in order to attract people to use it. Meanwhile, kitchen architecture in this study is also found as an influencing factor for people on choosing fuel for cooking. For example, urban people who have modern housing architecture will not choose firewood because they do not have space for cooking. On the contrary, rural households tend to use firewood not merely because of firewood availability, but also for the reason that they have spacious place allowing them to do cooking with firewood.

It is also found in this study that some households do not adopt LPG. They are partial users or full users of firewood for cooking. This study highlights four main factors which influence people to continue with their use of traditional fuel. The factors are: (1) behaviour and life style; (2) age, especially elderly people in rural areas; (3) location with availability of resources; and (4) economic reasons where people carry on using firewood due to limited income.

Life style and behaviour of households are affected by norms and values. In this study, it is undeniably indicative that lifestyle of firewood users is a barrier that made the firewood users difficult to change from using firewood to modern fuel. One of the reasons is age. One of the interviewees who lived alone refused to use LPG. The rest of the firewood users living with the elderly people (see Table 8.3) are multiple fuel users. The study of Palmborg (1986) finds that family members are likely to influence the elderly people in relation to their fuel usage even though the relation between younger family members in persuading the elderly is not clear. The presence of elderly and multiple fuel users in Table 8.3 can be an indication of the relation among family members in choosing types of energy for cooking. Taste is another reason for the continuing use of firewood. This is supportive of the finding of Leach (1987a) that taste influences the fuel preferences.

Furthermore, location – availability of resource - determines people's use of traditional fuel. From Table 6.6 in Section 6.2 of Chapter 6, it is obvious that rural-urban areas affect the choice of the usage of firewood. Evidence presented in section 8.3.3 show that the source of firewood is not from forest but waste of farms and fallen branches of trees in villages in rural areas. This strengthens the findings of Lee et al. (2015) that firewood used by households in east Indonesia do not come from forest. Free collection of firewood by households is the indication that price of fuels determines the energy choice. This presumption is supported by the interviews in this study. This also enriches the findings of other previous studies (e.g. Karekezi, 2002; Nkomo, 2005; Suliman, 2013). These findings endorse the findings from Chapter 6 where incomes and urban-rural areas have a relation to energy use.

Chapter 9
Conclusion

The important issue of access to adequate modern fuel, especially for cooking, has been paid little attention with respect to Indonesia by researchers or government. Meanwhile, the negative effects of indoor air pollution caused by the use of traditional fuel are apparent. This study has addressed the usage of different types of fuel in the domestic sector. Particular attention is focused on the main cooking fuel, the changes in fuel use and the factor of fuel choice in relation to the implementation of government policy through the *Energy Conversion Programme from Kerosene to LPG*. Section 9.1 summarises the conclusions drawn from the results discussed in Chapter 5 to Chapter 8. Conclusions are presented for each research question set out in Chapter 1. Section 9.2 contains reflection on the research and its limitations and Section 9.3 comments on the policy implications and directions for future work.

9.1 Concluding Remarks

This study investigates the impact of Energy Conversion Programme from Kerosene to LPG (ECPKL) that was conducted by the government of Indonesia starting in 2007. The evaluation was made from 2007 to 2011. There are four research questions that support the main aim of this research. The first question requires the identification of energy poverty and the development of access to modern fuel for cooking from 2007 and 2011. This is a big picture of the real situation of access to energy for cooking before the implementation of ECPKL and after the implementation of ECPKL. The second question requires investigation of the changes in access to energy for cooking from 2007 to 2011 in terms of time, household income and rural-urban location. This provides empirical studies on the determinant of access to energy. Addressing the third question identifies and investigates the role of government in intervening in the access to energy for cooking. This part provides a descriptive and critical analysis on the implementation of ECPKL. Finally, the last question involves investigating the perspective of the public in accepting the intervention of government.

The first part of this section will summarise the conclusions of the thesis where the research questions will be answered. The second part of this section is the summary of the thesis as a whole.

Research question 1:
What was the dynamic of modern and traditional fuel use in Indonesia before and after the implementation of the Energy Conversion Programme from Kerosene to LPG (ECPKL) policy?

Energy Conversion Programme from Kerosene to LPG (ECPKL) was been implemented in Indonesia starting from the end of December 2007. During the implementation, the transition of energy for cooking in Indonesia is apparent. Based on three approaches to assess energy access, i.e. quantity-based, share of expenditure-based and source of energy-based, there are changes in access to modern fuel in Indonesia. In term of quantity of energy used by households, average electricity used per person per year during 2007-2011 increased about 118.48 BOE per person among electricity users, but quantity of kerosene fell significantly from 31.09 BOE to 25.91 BOE. LPG use during 2007-2011 was also reduced to about 6.06 BOE per person, among LPG users. The reduction of average amount of LPG consumed by LPG users is caused by the transition of

LPG user. Before 3 kg LPG was introduced to public, the LPG package available – i.e. the 12 kg LPG - was more consumed by the middle income and upper income households, who were able to use more per household. Moreover, based on share of expenditure-based approach, the percentage energy expenditure over total expenditure from 2007 to 2011 was reduced. However, this research study found that this approach is not appropriate in determining people who have sufficient access in a sense that this approach miscategorise rich households as lacking access to energy because they spent a low share of energy and vice versa. Meanwhile, according to source of energy based approach, electricity, natural gas and LPG user from 2007 to 2011 increased. Unlike these fuels, however, the user of kerosene, briquette and charcoal as well as firewood were reduced.

Additionally, this study found that when kerosene was excluded from modern fuel, the improvement of access to modern fuel from 2007 to 2011 was about 9.13% of all households. If kerosene is included as modern fuel, however, the improvement - about 36.15% of household’s population was much higher than when kerosene was excluded from the list of fuel which are categorised as modern fuel. On the other hand, the reduction of traditional fuels in the same period was 10.26%. Regarding kerosene, this study prefers to class kerosene as a transitional energy meaning that it is not recognised either as modern fuel or traditional fuel. From this point of view, this implies that the ECPKL has used of modern fuels as main cooking fuel by 9% and, at the same time, it reduces 10% of user of traditional fuel as main cooking fuel.

This study provides evidence that the distribution of percentage of access to modern fuels in regions of Indonesia between 2007 and 2011 varied. In general, some regions in eastern parts of Indonesia had lack of access which led to them suffering from energy poverty. The ECPKL that was not well implemented in eastern parts of Indonesia is presumably the cause of the present problem of lack access to modern energy.

Research question 2:
How do time, household income, and location – rural and urban - affect the choice of fuel for cooking in Indonesia?

From non-parametric statistical analysis point of view, the use of electricity, natural gas, LPG, kerosene, briquette and charcoal and firewood in 2007 and in 2011 were statistically different. The effect size shows there was small-medium to medium-large changes in modern fuel use in every year during 2007-2011, except in 2010-2011 when the change was very small. This can be an indication that there is an effect of ECPKL on the preference of traditional fuels as main cooking fuel, but the larger effects occurred after three years of its implementation. However, the change after the fourth year, 2010-2011, was not large.

Furthermore, this study found that urban people are more likely to use LPG for main cooking fuel, whilst rural people tend to use firewood for main cooking fuel. This study strengthens the argument that there is a rural-urban dichotomy in the choice of fuel (see Krey et al., 2012; Suliman, 2013).

In addition to the abovementioned factors, this research study also supports the argument that income influences energy or fuel choice. However, this does not mean this study supports the energy ladder theory (van der Horst & Hovorka, 2008; Hosier & Dowd, 1987; Treiber, 2013), as it was found that there were more affluent households who used traditional fuels and also poorer households who used modern fuels. This study found that household income had a little influence on the choice when the government intervened to change public fuel use. Moreover, the study found that there was fuel stacking, i.e. a situation where a household used more than one fuel. Over the period 2007 to 2011, however, the fuel stacking in Indonesia was reduced.

Research question 3:
How effective was the governance of ECPKL and what is its relation to modern fuel improvement and energy poverty alleviation?

This study indicates that the ECPKL policy made a contribution to the switching of energy for cooking, from the more polluting fuel such as kerosene and biomass to cleaner energy, i.e. LPG and natural gas. Meanwhile, the policy would be considered effective when its goals are met. The main goal of ECPKL was reducing the economic burden on the government caused by kerosene subsidy. This goal has been achieved. But it led to inefficient distribution of the 3 kg LPG in the sense that some of the packages were received by those who are not eligible. In term of economy, this might create another economic problem. The increase in the market for 3 kg LPG, which is subsidised by the government, will increase the government expenditure on subsidy. Non-eligible 3 kg LPG user will be the burden of the government. Apart from that, the target for replacing kerosene with LPG is also achieved and it has been shown in this study that the ECPKL has had indicative influence in the reduction of traditional fuel users in Indonesia from 2007-2011. However, literally, the ECPKL does not have a relation to the programme for reducing energy poverty in terms of traditional fuel use. The reduction of traditional fuel use for cooking is an unintentional effect of the ECPKL.

Research question 4:
What is the social acceptance of LPG and why do households adopt or not LPG?

There are three levels of acceptance of LPG identified in this study: full adoption of LPG for the purpose of cooking, partial adoption of LPG because the household uses multiple fuels and non-adoption of the LPG where the household does not intend to use LPG regardless of the situation. More of LPG adopters were those who previously used kerosene, whilst some traditional fuel users adopted LPG. There are five factors which affected the acceptance of LPG: incentive and subsidy; lock-in of the market; trust – which is created by culture, norms and government service; campaign and familiarisation of technology and kitchen architecture. Moreover, there are four main reasons of people who still carried on using traditional fuel: behaviour and life style; income constraint; being elderly people in rural areas; and location with availability of resources.

To sum up, it is apparent that energy poverty in Indonesia from 2007 to 2011 still existed even though there was reduction during that period. The availability of firewood as well as the access to modern energy for cooking such as LPG and electricity varied from the west to east of Indonesia. This study shows that from 2007 and 2011 there were injustices in access to modern fuels for cooking from west to east Indonesia. Mostly, Western Indonesian regions had more access to modern energy for cooking and relied less on firewood. In contrast, Eastern Indonesian regions had less access to modern fuel and more households who more relied upon firewood.

Fortunately, the ECPKL which was conducted by the government of Indonesia had significant impacts on the development of access to LPG in Indonesia. This is in line with the claim of the government that the policy was successful in increasing access to LPG and reducing use of kerosene. However, the policy had less impact on the reduction of firewood, especially in regions of Eastern Indonesia. But, ECPKL still contributed to spreading the LPG to rural areas. Hence, after ECPKL more rural households had high possibility to access LPG than before the implementation of the ECPKL. Additionally, ECPKL enabled more poor people to access LPG as 3 kg LPG which was provided by the government of Indonesia was more affordable in comparison to 12 kg LPG which was not subsidised and had been sold before ECPKL was implemented. Apparently, the ECPKL had a significant impact to introduction of modern fuel, i.e. LPG, to Indonesia's people.

The role of the government of Indonesia in this case is clear. Financial support from the government was crucial. Also, high commitment and high involvement of the vice president in implementing the policy was one of the most important factors. Pertamina as the state owned oil company which dominates the energy market in Indonesia had a significant influence on the success of changing the market from kerosene to LPG through a lock in market scheme. Apart from that, without societal acceptance, the ECPKL would not be as successful as the government target. Hence, social trust, and norms, and subsidy that attract people to use LPG are additional factors that were needed to influence people to change their habits in using energy in the home.

9.2 Research Reflection and Limitation

This research study was commenced in September 2011. A year later, data collection was started in Indonesia for three months. The limited time of field research in this study is due to the constraint from the scholarship funding that did not give permission to stay longer than three months in the home country. However, even though limited time was available for field research from within the country, the interviews could be continued from the United Kingdom by using Skype and telephone conference. In some cases, telephone interviewing is unable to capture the body language of the interviewee that may help in interpreting the interview. But this type of interview is able to get 'honest' answers as interviewees may feel more comfortable to talk distant people without being face to face. This is very useful for investigating the sensitive political issues such as energy issues in Indonesia.

Regarding the interview, the interview data collection was conducted in six cities. Meanwhile Indonesia has more than 300 cultures. The six cities are located on two islands, Java and Sumatera, while Indonesia has five major islands: Sumatera, Java, Kalimantan, Sulawesi and Papua, and many small islands. Moreover, interviews with users of firewood in this study were few and there is no interviewee that represents the firewood and & or briquette/charcoal user in urban area.

Apart from that, in relation to approaches that are applied in this study, the approaches have weaknesses as each of them is unable to identify the prerequisite to have access to sufficient, affordable, clean and environmentally good energy service. Theories of affordability which are commonly applied are not appropriate for the Indonesian situation because the problem is not merely about inability to afford, but the lack of modern energy infrastructure. Meanwhile, it is not easy to determine the minimum threshold of sufficiency of energy because of the high variation of culture and habit of people in Indonesia. Among the three approaches which are applied in this study, i.e. quantity-based, share of expenditure-based and source of energy-based, the share of expenditure-based approach has a scientific limitation on determining the threshold. However the need to measure the access to modern energy is important as modern energy may able to support the achievement of Millennium Development Goals.

9.3 Policy Implication and Future Work

Access to modern fuels is an important issue because dependence on traditional fuels that create pollution affects human health, even causing premature death. The government of Indonesia only gives minor attention to the issue of energy poverty despite the fact that, in 2011, about 46.7% of people or 110 million people in Indonesia were still using traditional fuels, such as briquette, charcoal and firewood. In the meantime, about 39.89% of households or 24.9 million households in Indonesia had high dependency on traditional fuels. Some of them have access to modern energy infrastructure, but they did not want to adopt it since some of them still have access to free traditional fuels. The

ECPKL has been able to improve the access to LPG, but government intervention to reduce the traditional fuel user to alleviate energy poverty (in terms of lack of use of modern fuels) is important.

In relation to reducing kerosene use and improving LPG use throughout Indonesia, the government has successfully replaced kerosene with LPG. But, in terms of reducing traditional energy use and improving modern energy use, the government has to make more effort. Regulation on the architecture of the house may reduce the number of traditional fuel users, for example stipulating that the kitchen has to be located inside the house. Moreover, the case of 'locking in' the market for the LPG and kerosene which was applied by the government is a good example to be practiced for reducing firewood user. Hence, one option to replace firewood is to lock-in the market for firewood and replace it with modern fuel such as natural gas, LPG, electricity and renewable energy. Increasing the price of firewood and reducing its market, while the government continues to distribute LPG or other cleaner energy, is a good alternative strategy.

In relation to the sufficiency of energy, the minimum standards of energy access should be met which are applied in this study are from outside Indonesia. Culture, habits and lifestyle of Indonesian people are different to people from other countries. Thus, further research to measure sufficiency of modern energy services in Indonesia is needed. Moreover, investigating the public's ability to pay for modern fuel, i.e. affordability, is one of the next agenda. Furthermore, the research which applies a combination approach to assess better the expectation of people who suffer from lack of modern energy can be a worthwhile topic of future study.

Appendices

Appendix 4.1: Sample Number of Module K of SUSENAS

Table 4.1.A: Number of sample taken from SUSENAS 2007 - 2011

Code of prov.	Province	Sample				
		2007	2008	2009	2010	2011
11	Nanggroe Aceh Darussalam	11,817	11,718	11,840	11,390	11,111
12	North Sumatera	17,341	17,149	18,749	20,959	17,899
13	West Sumatera	11,072	10,970	11,070	10,576	9,590
14	Riau	6,933	6,876	6,944	7,284	7,085
15	Jambi	6,078	6,025	6,080	6,327	5,898
16	South Sumatera	9,056	8,949	9,056	8,701	4,925
17	Bengkulu	5,472	5,424	5,472	5,844	4,902
18	Lampung	7,008	6,963	7,808	8,969	8,815
19	Bangka Belitung Islands	3,680	3,631	3,680	3,574	3,479
20	Riau Islands	3,680	3,607	3,664	3,904	3,228
31	DKI Jakarta	6,832	6,721	6,832	6,258	4,603
32	West Java	21,312	21,189	21,312	20,541	22,470
33	Central Java	25,248	25,114	25,248	24,733	26,769
34	DI Yogyakarta	3,456	3,424	3,456	3,378	3,617
34	East Java	29,952	29,646	29,952	29,571	29,200
35	Banten	4,864	4,836	5,696	6,366	6,429
51	Bali	5,728	5,693	5,728	5,663	5,619
52	West Nusa Tenggara	5,760	5,718	5,760	6,025	5,974
53	East Nusa Tenggara	10,976	10,742	11,579	11,787	10,504
61	West Kalimantan	7,710	7,649	8,352	8,066	7,657
62	Central Kalimantan	8,543	8,421	8,544	8,015	6,681
63	South Kalimantan	7,904	7,837	7,904	7,556	7,298
64	East Kalimantan	7,578	7,501	7,932	7,516	6,857
71	North Sulawesi	7,520	7,429	7,520	8,060	6,994
72	Central Sulawesi	6,208	6,143	6,208	6,428	5,799
73	South Sulawesi	14,687	14,560	14,688	14,594	13,198
74	South East Sulawesi	7,680	7,567	7,680	7,437	5,624
75	Gorontalo	3,839	3,809	3,840	3,703	2,931
76	West Sulawesi	3,134	3,121	3,136	3,017	2,572
81	Maluku	3,424	3,236	3,808	4,346	5,028
82	North Maluku	3,344	3,306	3,331	3,702	3,811
91	West Papua	2,329	2,196	2,330	2,539	3,609
92	Papua	5,021	5,217	6,554	6,882	11,131
Total		285,186	282,387	291,753	293,715	285,307
Standard error ($\sigma_{\bar{x}}$)		0.05166	0.05248	0.05225	0.04606	0.05135
Household's number (in thousands)		52,411	57,131	58,422	59,119	60,283

Table 0.1.B: Number of sample taken for Module M of SUSENA 2007 and 2011

Code of province	Province	Samples are taken	
		2007	2008
11	Nanggroe Aceh Darussalam	1,925	11,111
12	North Sumatera	2,818	17,899
13	West Sumatera	1,713	9,590
14	Riau	1,606	7,085
15	Jambi	1,114	5,898
16	South Sumatera	1,761	8,925
17	Bengkulu	996	4,902
18	Lampung	2,093	8,815
19	Bangka Belitung Islands	779	3,479
20	Riau Islands	731	3,228
31	DKI Jakarta	2,859	4,603
32	West Java	6,928	22,470
33	Central Java	7,226	26,769
34	DI Yogyakarta	2,033	3,617
34	East Java	8,810	29,200
35	Banten	1,859	6,429
51	Bali	1,819	5,619
52	West Nusa Tenggara	2,108	5,974
53	East Nusa Tenggara	1,566	10,504
61	West Kalimantan	1,838	7,657
62	Central Kalimantan	1,106	6,681
63	South Kalimantan	1,717	7,298
64	East Kalimantan	1,039	6,857
71	North Sulawesi	1,094	6,994
72	Central Sulawesi	1,078	5,799
73	South Sulawesi	1,986	13,198
74	South East Sulawesi	1,099	5,624
75	Gorontalo	770	2,931
76	West Sulawesi	557	2,572
81	Maluku	737	5,028
82	North Maluku	484	3,811
91	West Papua	421	3,609
92	Papua	993	11,131
Total		65,663	285,307
Household's number (thousand)[91]		52,411	57,131

[91] source of data from PDIESDM-KESDM (2012, p. 3).

Appendix 4.2: Interview

4.2.A. Ethical Review Approval

From: Gemma Williams (Research Support Group)
Sent: 23 October 2012 09:37
To: 'Stefan Bouzarovski'; Rosie Day
Cc: 'Septin Astuti'
Subject: Application for Ethical Review ERN_12-1025

Dear Professor Bouzarovski & Dr Day

Re: "Unpacking energy poverty in Indonesia: evaluating the government's fuel substitution programme"
Application for Ethical Review ERN_12-1025

Thank you for your application for ethical review for the above project, which was reviewed by the Science, Technology, Engineering and Mathematics Ethical Review Committee. The study was granted conditional ethical approval on 8th October 2012.

On behalf of the Committee, I can confirm the conditions of approval for the study have now been met and this study now has full ethical approval.

I would like to remind you that any substantive changes to the nature of the study as described in the Application for Ethical Review, and/or any adverse events occurring during the study should be promptly bought to the Committee's attention by the Principal Investigator and may necessitate further ethical review.

Please also ensure that the relevant requirements within the University's Code of Practice for Research and the information and guidance provided on the University's ethics webpages (available at https://intranet.birmingham.ac.uk/finance/accounting/Research-Support-Group/Research-Ethics/Links-and-Resources.aspx) are adhered to and referred to in any future applications for ethical review. It is now a requirement on the revised application form (https://intranet.birmingham.ac.uk/finance/accounting/Research-Support-Group/Research-Ethics/Ethical-Review-Forms.aspx) to confirm that this guidance has been consulted and is understood, and that it has been taken into account when completing your application for ethical review.

Please be aware that whilst Health and Safety (H&S) issues may be considered during the ethical review process, you are still required to follow the University's guidance on H&S and to ensure that H&S risk assessments have been carried out as appropriate. For further information about this, please contact your School H&S representative or the University's H&S Unit athealthandsafety@contacts.bham.ac.uk.

If you require a hard copy of this correspondence, please let me know.

Thank you,

Gemma Williams
Deputy Research Ethics Officer
Research Support Group
Finance Office

Aston Webb, B Block
Edgbaston, Birmingham
B15 2TT
[redacted]
Web: www.birmingham.ac.uk/researchsupportgroup

4.2.B. Informed Consent

Septin Puji Astuti – Septin, S.Si, M.T
PhD Student
School of Geography, Earth and Environmental Sciences
University of Birmingham
B15 2TT, United Kingdom
[redacted]

(date)

(participant name and address)

Unpacking Energy Poverty In Indonesia: Evaluating The Government's Fuel Substitution Programme

Dear Madam or Sir:

I am writing to request your participation in an interview for the purposes of "Unpacking Energy Poverty In Indonesia: Evaluating The Government's Fuel Substitution Programme" research project. This three-year initiative, funded by the Islamic Development Bank Merit Scholarship, is aimed at developing a conceptual framework and methodology to analyse energy poverty and energy governance by the government of Indonesia. It will identify the dynamic, regulations and actors of the energy conversion programme, from kerosene to LPG into government of Indonesia and its affects to energy poverty pattern. The project is co-ordinated by the Universities of Birmingham.

The interview would not take more than one and half hour; I should be able to come to your premises. With your permission, I would voice-record the interview. The questions will be open-ended and will focus on the activities of your organization in this domain.

The information you provide will be used solely for the purposes of the project. All the statements you make, as well as any information about you, will be treated as confidential: only I will have access to this information. Any quoted views will not be attributable to you the publicly available outputs of the project, unless you have given explicit consent for that to happen.

Interview data will be stored securely at the University of Birmingham for 10 years after the interview date. You will be able to withdraw from the study within 6 months of the interview. The data will be destroyed or not used in the project if you request so.

A copy of the thesis and subsequent academic papers will be sent to you upon request.

Yours,
Septin Puji Astuti

4.2.C. Interview Schedule for government official (translated from Indonesian)

1. What are underlying reasons of ECPKL? (*probe*)
2. What are the problems behind the underlying reasons? (*probe*)
3. Please explain what are the relations between the rationales of ECPKL and the government goals? (*probe*)
4. What are the aims and objectives of the ECPKL? (*probe*)
5. What are the underlying reasons of choosing this/these aim(s) and objective(s)? (*probe*)
6. What are the most important aims and objectives to the government? (*probe*)
7. Why are these aims and objectives important to the government? (*probe*)
8. To what extent the aim and objective(s) can be achieved? (*probe*)
9. What are the goals of the ECPKL? (*probe*)
10. Why should these goals be achieved? (*probe*)
11. To what extent can the goal(s) be achieved? (*probe*)
12. Who is the target of receiver of ECPKL? (*probe*)
13. To what extent can the target of ECPKL be achieved? (*probe*)
14. What is the relation of the ECPKL to other national programmes? (*probe*)
15. What is the relation of the ECPKL to local policies? (*probe*)
16. What are the (national and local) law and regulations underpinning this programme and please explain them? (*probe*)
17. To what extent do those regulation influence implementation of ECPKL? (*probe*)
18. To what extent dothe (national and local) laws and regulations encourage or discourage people to move to LPG? (*probe*)
19. What are other instruments for implementing ECPKL? (*probe*)
20. To what extent do those that instruments influence people to move to LPG? (*probe*)
21. Who are the financial donors of the ECPKL? (*probe*)
22. To what extent do the financial donors support the ECPKL? (*probe*)
23. What infrastructures are needed for implementing ECPKL? (probe)
24. Who are actors involved in this programme? (*probe*)
25. What are their roles on the programme? (probe)
26. Who are the institutions/organisations involved in this programme (in this area)? (*probe*)
27. What are their roles on the programme? (probe)
28. How did they work and make co-ordinate to each other? (*probe*)
29. How was the transfer (coordination) of the programme from national to local government? (*probe*)
30. How did the process of implementation go from national level to community level? (*probe*)
31. What are the achievements of the programme? (*probe*)
32. What were the barriers to success of the ECPKL? (*probe*)
33. What factors led to its achievements? (*probe*)
34. What are side effects of the programme? (*probe*)
35. To what extent the implementation of programme a success? (*probe*)
36. How does the programme relate the attempt to improve modern fuel? (*probe*)
37. How does the programme relate the attempt to reduce traditional fuel? (*probe*)
38. To what extent does government (province/region/village) want to improve modern fuels? (*probe*)

39. To what extent does government (province/region/village) want to reduce traditional fuels? (*probe*)
40. To what extent do the public (province/region/village) accept the programme? (*probe*)
41. As far as you know, what are the reasons of their acceptance? (*probe*)
42. To what extent do public want (or not want) to replace kerosene with LPG? (*probe*)
43. To what extent traditional fuel users want (or not want) to replace with LPG? (*probe*)
44. What factors led them keeping on using kerosene (or other fuels) or move to LPG? (*probe*)
45. What factor led them keeping on using firewood or move to LPG? (*probe*)
46. How was the response of households who use firewood or charcoal or other energy when they received LPG package? (*probe*)
47. In relation to rejection, how did the government (you) manage social rejection? (*probe*)
48. What are the strategies implemented to deal with social obstacles? (*probe*)
49. To what extent were the strategies able to handle the problem? (*probe*)

4.2.D. Interview Schedule for members of public

1. How did you receive the LPG package? (*probe*)
2. How did you feel when you receive the LPG package? (*probe*)
3. Who are the actors involved in this programme? (probe)
4. What were their roles on the programme? (probe)
5. What did they do to influence you to move to LPG? (probe)
6. To what extent did their roles influence you to accept/not accept? (probe)
7. Who were the institutions/organisation involved in this programme (in this area)? (probe)
8. What were their roles on the programme? (probe)
9. What did they do to influence you to move to LPG? (probe)
10. To what extent did their roles influence you to accept/not accept? (probe)
11. To what extent did you decide to accept the LPG package? (probe)
12. What are the main reasons you accept LPG package? (probe)
13. What factors led you accept it? (probe)
14. To what extent did you decide to use the LPG for cooking fuel? (probe)
15. What factors led you decide to adopt it? (probe)
16. What is your opinion on the importance of the laws that underpin the programme? (probe)
17. To what extent was the law is important to your decision to accept (not accept) the programme? (probe)
18. What kind of fuel do you use for cooking? (probe)
19. Why do you use that fuel? (probe)
20. Who influenced you most to change the fuel to LPG (or not)? (probe)
21. Why did they (it) influence you change/not change the fuel? (probe)
22. What were the most important factors that led you to change/not change the fuel for cooking? (probe)

23. To what extent do the public (household surrounding) accept the programme? (probe)
24. To what extent did the response of your neighbour to the LPG influence you to choose the fuel? (probe)
25. If you use firewood, to what extent you use/not use firewood? (probe)
26. If you use firewood, what factors led you keep on using firewood? (probe)
27. If you use firewood, what factors make you move to other fuels? (probe)
28. What would you do (have you done) if the government have the regulation to restrict the firewood use? (probe)

Appendix 4.3: List of Laws and Regulations

Laws and Regulations

1. 1945 Constitution. Article 33 at paragraph 2 states that all production which are important for the state and affect the livelihood should be controlled by government. In paragraph 3 also confirmed that water and natural resources should be controlled by the government for greatest prosperity (PPPKI, 1945)
2. Law No 22, 2001 about Oil and Gas. In this law, price of oil and gas previously determined by company then amendment by Constitutional Court No 002/PPU-I/2003 that price of oil and gas are determined by government (Presiden Republik Indonesia, 2001c).
3. Law No 18, 2006 about National Budget 2007 which is established in 15 November 2006. This is financial support for 2007 to subsidised energy (Presiden Republik Indonesia, 2006b),
4. Law of President of Indonesia No. 30, 2007 about Energy (Presiden Republik Indonesia, 2007c).

Regulations

5. Directorate General Oil and Gas Decree No. 25 K/36/DDJM/1990 which manage the specification of LPG which is distributed inside Indonesia.
6. Governmental Decree No. 36 No, 2004 about activities of downstream business of oil. This is established in 14 October 2014. One of the main points of this regulation is strengthening the statement that Government of Indonesia gives more warrant for poor households to access modern energy. In this kind of energy, oil and business players could not set the price without government approval (Presiden Republik Indonesia, 2004a).
7. Presidential Decree No. 5, 2006 about the Policy of National Energy which regulate the policy of energy from national to local government (Presiden Republik Indonesia, 2006a).
8. Presidential Decree No. 104, 2007 about the provision, distribution and price determination of 3 kg Liquefied Petroleum Gas (LPG) price. This is established in 28 November 2007. This regulation also manages the procedures of State-Own Enterprises who responsible to provide and distribute 3 kg LPG, annual planning of LPG volume will be sold and regulation of LPG export and import (Presiden Republik Indonesia, 2007b).
9. Ministry Law No. 021, 2007 which is established in 18 December 2007. This policy is about 3 kilogram LPG procurement and distribution (MESDM-RI, 2007)
10. Ministry Decree No. 3174/12/MEM/2007 which is established in 27 December 2007 about the standard price and economic price of 3 kg LPG in Year 2007 (KESDM-RI, 2007b).
11. Ministry Decree No. 3175/K/10/MEM/2007 which is established in 27 December 2007 about the assignment of Pertamina, ltd (Persero) and determination of special area in procurement and distribution 3 kg of LPG in year 2007 (KESDM-RI, 2007c)
12. Ministry Decree No. 1788 K/12/MEM/2007 about the Transfer of Ministry of Energy and Mineral Resources authority to General Director of Oil and Natural Gas for Provision and Distribution 3 kg LPG (KESDM-RI, 2008a).

13. Ministry of Energy and Mineral Resources Decree No 28 year 2008 about retail price 3 kg LPG for households and Small Medium Enterprises (KESDM-RI, 2008b)
14. Ministry of Energy and Mineral Resources Decree No 1661 K/12/MEM/2008 about the price of LPG (MESDM-RI, 2008)
15. Ministry Decree No. 13767/K/10/2008 about the Assignment Pertamina, ltd. and the Decision of Special Area which Provide and Distribute 3 kg LPG in 2008 .
16. Industrial Minister the Republic of Indonesia Decree No 102/M-IND/PER/12/2008 about the price of 3 kg LPG, its Stove and kits for the Conversion Programme to Replace Kerosene with LPG (MP-RI, 2008)
17. Ministry of Energy and Mineral Resources Decree No 01.K/10/DJM.S/2009 about price of kerosene for all sectors (KESDMRI, 2009a)
18. Ministry of Energy and Mineral Resources Decree No 2359 K/12/MEM/2010 about the price of 3 kg LPG in 2010 (KESDM-RI, 2010)
19. Local government regulations in each province and regency of which determine the price of energy in local area by considering the transport cost.
20. Regulation of Government of Central Java Province about Price of Kerosene in Central Java.
21. A letter from Governor of Central Java No. 540/00044 on A Guidance to distribute LPG 3 kg (GCJ, 2010)
22. Regulation of Mayor of Surakarta No. 540/60.A/1/2012 (GOSKA, 2012)
23. Blue Print of Substitution Policy from Kerosene to LPG 2007-2009 (KESDM-RI, 2007a)
24. A Guidance for implementing Substitution Policy from Kerosene to LPG in Province (ESDMRI, 2010b)
25. Coordination of Implementation Substitution Kerosene with LPG 3 kg (CMPWRI, 2010)
26. A Guidance for implementing Substitution Policy from Kerosene to LPG in Central Java (ESDMRI, 2010a)
27. A Guidance for implementing Substitution Policy from Kerosene to LPG in local government (ESDMRI, t.t.)
28. A progress and Planning Substitution kerosene with LPG by 2010 and 2011 (PERTAMINA, 2010).
29. A Guidance for SPBE Licensing (ESDMRI, 2010c)
30. Trading Regulation of Oil and Gas (ESDMRI, 2011)
31. Follow up of Substitution Policy for implementing Close Distribution 3 kg LPG (ESDMRI, 2012b).
32. A Guidance for Implementing Close Distribution of LPG 3 kg in Region 2 (ESDMRI, 2012a)
33. National Social and Economy Survey 2007 (BPS, 2007c).

Appendix 5.1: Descriptive Statistic of fuels cost and quantity consumed

5.1.A. The Estimation of Energy Used in 2007 (SUSENAS 2007)

5.1.A.1. The Estimation of quantity of energy use in 2007

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in kWh percapita per year	206511724	1.00	30000.00	263.675	440.8322
LPG used in kg percapita per year	31662023	.80	297.50	24.979	14.4570
Gas used in metre cubic percapita per year	36774	1.70	100.00	10.267	23.0595
Kerosene used in litre percapita per year	193684982	.80	6250.00	3.279	42.3001
Briquette/charcoal used in litre percapita per year	3080971	2.00	15000.00	39.817	941.8134
Valid N (listwise)	0				

5.1.A.2. The Estimation of quantity of energy use in 2007 in gi ergy equivalent (BOE)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in boe percapita per year selected	206511724	.00	18.4	.161	.2728
LPG used in boe percapita per year selected	31662023	.00	2.5	.215	.1254
Gas used in boe percapita per year selected	36774	.00	.6	.044	.1407
Kerosene used in boe percapita per year selected	193684982	.00	37.0	.189	.2550
Total energy used in boe percapita per year selected	223574911	.00	37.5	.348	.3944
Valid N (listwise)	0				

5.1.A.3. The estimation of quantity of energy use in 2007 in barrel of oil equivalent (kgoe)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in kgoe percapita per year selected	206511724	.01	268.49	2.3598	3.94531
LPG used in kgoe percapita per year selected	31662023	.10	37.03	3.1088	1.79916
Gas used in kgoe percapita per year selected	36774	.15	9.20	.9432	2.12241
Kerosene used in kgoe percapita per year selected	193684982	.07	540.88	2.8381	3.66040
Total energy used in kgoe percapita per year selected	223574911	.01	546.87	5.0788	5.73904
Valid N (listwise)	0				

5.1.A.4. The Estimation of energy expenditure 2007 in Rupiah

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity expenditure in Rupiah percapita per year	206647083	13.36	8858404.08	126529.7666	177262.07042
LPG expenditure in Rupiah percapita per year	31999177	6.71	3178959.10	118937.1746	93421.05614
Gas expenditure in Rupiah percapita per year	34369	25627.87	188428.23	92184.4293	51540.55274
Kerosene expenditure in Rupiah percapita per year	194756878	245.41	4761011.89	87289.6861	92901.08303
Briquette/charcoal expenditure in Rupiah percapita per year	3378067	53.03	4140095.22	62667.4558	160374.19458
Firewood expenditure in Rupiah percapita per year	121372615	.48	3143319.79	69358.6356	71674.03187
Valid N (listwise)	0				

5.1. B. The Estimation of Energy Consumption in 2011 (SUSENAS 2011)

5.1.B.1. The Estimation of quantity of energy used in 2011

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in kWh percapita per year	224215163	.80	97500.00	382.1589	1898.75581
LPG used in kg percapita per year	130925068	.40	20000.00	20.7959	84.63958
Gas used in metre cubic percapita per year	936222	.17	16800.00	39.5161	418.53892
Kerosene used in litre percapita per year	66291913	.40	60000.00	26.7328	346.23010
Briquette/charcoal used in litre percapita per year	1815321	.20	3840.00	79.0036	187.62039
Valid N (listwise)	686				

5.1.B.2. The estimation of quantity of energy used in 2011 in barrel of oil equivalent (BOE)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in BOE percapita per year selected	224215163	.000490	59.767500	.23426342	1.163937310
LPG used in BOE percapita per year selected	130925068	.003414	170.692000	.17748505	.722364960
Gas used in BOE percapita per year selected	936222	.001207	119.280000	.28056459	2.971626333
Kerosene used in BOE percapita per year selected	66291913	.002371	355.644000	.15845591	2.052244286
Valid N (listwise)	16640				

5.1.B.3. The estimation of quantity of energy used in 2011 in barrel of oil equivalent (kgoe)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in kgoe percapita per year	224215163	.07	8726.06	34.2025	169.93485
LPG used in kgoe percapita per year	130925068	.50	24921.03	25.9128	105.46528
Gas used in kgoe percapita per year	936222	.18	17414.88	40.9624	433.85744
Kerosene used in kgoe percapita per year	66291913	.35	51924.02	23.1346	299.62767
Valid N (listwise)	16640				

5.1.B.4. The Estimation of energy expenditure 2011 in Rupiah

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cost spent for electricity in Rupiah percapita per year	225970586	666.00	26299998.00	186223.5030	261390.85199
Cost spent for LPG in Rupiah percapita per year	133041498	570.86	19893332.00	126249.9205	119861.97427
Cost spent for gas in Rupiah percapita per year	1007006	559.20	1716000.00	112538.8366	120794.17011
Cost spent for kerosene in Rupiah percapita per year	68059941	570.86	10236000.00	111145.2565	144602.43179
Cost spent for briquette/charcoal in Rupiah percapita per year	1901069	399.60	3020004.00	103790.0214	114011.86950
Cost spent for firewood in Rupiah percapita per year	110778151	12.00	3733332.00	118178.7737	117525.24572
Total energy expenditure percapita per year	240824138	2001.00	26779998.00	331546.1577	309883.69459
Expenditure of household percapita per year	241133779	710499.00	1023899240.00	6979624.9579	8326320.78259
Valid N (listwise)	0				

Appendix 5.2: Independent t-test of energy use – Quantity-based approach

[DataSet1] S:\Septin\My Research\PhD Septin\PhD Thesis\Reading summary\Thesis\Data analysis final\Data for analysis\summary energy consumption comparison.sav

Group Statistics

	year	N	Mean	Std. Deviation	Std. Error Mean
Electricity used in kWh percapita per year	2007.00	206511724	263.6754	440.83220	.03068
	2011.00	224215163	382.1589	1898.75581	.12681
LPG used in kg percapita per year	2007.00	31662023	24.9786	14.45697	.00257
	2011.00	130925068	20.7959	84.63958	.00740
Gas used in metre cubic percapita per year	2007.00	36774	10.2594	23.05952	.12025
	2011.00	936222	39.5161	418.53892	.43256
Kerosene used in litre percapita per year	2007.00	193684982	32.7944	42.30014	.00304
	2011.00	66291913	26.7328	346.23010	.04252
Briquette/charcoal used in litre percapita per year	2007.00	3080971	39.8168	94.18134	.05366
	2011.00	1815321	79.0036	187.62039	.13925

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Electricity used in kWh percapita per year	Equal variances assumed	1312274.557	.000	-875.265	430726885	.000	-118.48351	.13537	-118.74883	-118.21820
	Equal variances not assumed			-908.178	250295959.552	.000	-118.48351	.13046	-118.73922	-118.22781
LPG used in kg percapita per year	Equal variances assumed	408.458	.000	277.088	162587089	.000	4.18262	.01509	4.15303	4.21221
	Equal variances not assumed			534.138	155086721.809	.000	4.18262	.00783	4.16727	4.19797
Gas used in metre cubic percapita per year	Equal variances assumed	180.518	.000	-13.404	972994	.000	-29.25672	2.18269	-33.53471	-24.97873
	Equal variances not assumed			-65.165	943115.195	.000	-29.25672	.44896	-30.13667	-28.37677
Kerosene used in litre percapita per year	Equal variances assumed	2260.033	.000	238.509	259976893	.000	6.06166	.02541	6.01184	6.11147
	Equal variances not assumed			142.184	66970387.433	.000	6.06166	.04263	5.97811	6.14521
Briquette/charcoal used in litre percapita per year	Equal variances assumed	58781.916	.000	-306.825	4896290	.000	-39.18685	.12772	-39.43717	-38.93653
	Equal variances not assumed			-262.590	2363672.433	.000	-39.18685	.14923	-39.47934	-38.89436

Appendix 5.3: Calculation of sufficiency of energy use

5.3.A. When kerosene recognised as a modern fuel

5.3.A.1. The Estimation of energy used in 2007

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[DataSet1] S:\Septin\My Research\PhD Septin\PhD Thesis\Reading summary\Thesis\Data analysis
final\Data for analysis\summary energy consumption 2007.sav
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Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in kgoe percapita per year selected	206511724	.10	2684.90	23.5977	39.45312
Total energy for cooking in kgoe percapita per year selected	208177020	.70	5408.80	31.1356	36.51476
Electricity used in kWh percapita per year selected	206511724	1.00	30000.00	263.6754	440.83220
Total energy for cooking in kgoe percapita per year selected	208177020	.70	5408.80	31.1356	36.51476

Frequency Table

Electricity < 10 kgoe percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	77035549	34.4	37.3	37.3
	Selected	129476175	57.7	62.7	100.0
	Total	206511724	92.1	100.0	
Missing	System	17692193	7.9		
Total		224203917	100.0		

Cooking <40 kgoe percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	142972318	63.8	68.7	68.7
	Selected	65204702	29.1	31.3	100.0
	Total	208177020	92.9	100.0	
Missing	System	16026897	7.1		
Total		224203917	100.0		

Electricity <120 kWh percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	127339593	56.8	61.7	61.7
	Selected	79172131	35.3	38.3	100.0
	Total	206511724	92.1	100.0	
Missing	System	17692193	7.9		
Total		224203917	100.0		

Cooking < 35 kg of LPG percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	44670123	19.9	21.5	21.5
	Selected	163506897	72.9	78.5	100.0
	Total	208177020	92.9	100.0	
Missing	System	16026897	7.1		
Total		224203917	100.0		

Electricity <100 kWh percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	140813671	62.8	68.2	68.2
	Selected	65698053	29.3	31.8	100.0
	Total	206511724	92.1	100.0	
Missing	System	17692193	7.9		
Total		224203917	100.0		

Cooking < 100 kgoe percapita per year (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	4210743	1.9	2.0	2.0
	Selected	203966277	91.0	98.0	100.0
	Total	208177020	92.9	100.0	
Missing	System	16026897	7.1		
Total		224203917	100.0		

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
totkgoemonth_select	223574911	.01	455.73	4.2324	4.78254
Valid N (listwise)	223574911				

Total energy <27.4 kgoe percapita permonth (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	688070	.3	.3	.3
	Selected	222886841	99.4	99.7	100.0
	Total	223574911	99.7	100.0	
Missing	System	629006	.3		
Total		224203917	100.0		

Total energy <32.1 kgoe percapita permonth (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	386883	.2	.2	.2
	Selected	223188028	99.5	99.8	100.0
	Total	223574911	99.7	100.0	
Missing	System	629006	.3		
Total		224203917	100.0		

Descriptive Statistics

Area (1) Urban (2) Rural		N	Minimum	Maximum	Mean	Std. Deviation
1	totkwhyear	108315994	.00	63600.98	828.2967	752.75617
	Valid N (listwise)	108315994				
2	totkwhyear	115887923	.00	31266.09	365.3515	477.68577
	Valid N (listwise)	115887923				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
totkwhyear	224203917	.00	63600.98	589.0067	667.24502
Valid N (listwise)	224203917				

Total energy < 500 kWh percapita per year in rural (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	77251161	71.3	71.3	71.3
	Selected	31064833	28.7	28.7	100.0
	Total	108315994	100.0	100.0	

Total energy < 250 kWh percapita per year in rural (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	55221963	47.7	47.7	47.7
	Selected	60665960	52.3	52.3	100.0
	Total	115887923	100.0	100.0	

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
lpgcapday	31662023	.00	.82	.0684	.03961
kerocapday	193684982	.00	17.12	.0898	.11589
Valid N (listwise)	17183846				

Frequency Table

LPG < 0.04 percapita per day (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	25218733	11.2	79.6	79.6
	Selected	6443290	2.9	20.4	100.0
	Total	31662023	14.1	100.0	
Missing	System	192541894	85.9		
Total		224203917	100.0		

Kerosene < 0.2 percapita per day (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	20718603	9.2	10.7	10.7
	Selected	172966379	77.1	89.3	100.0
	Total	193684982	86.4	100.0	
Missing	System	30518935	13.6		
Total		224203917	100.0		

5.3.A.2. The Estimation of energy used in 2011

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Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Electricity used in kgoe percapita per year selected	224298145	.18	81407.38	41.8964	427.85761
Total energy for cooking in kgoe percapita per year selected	188614879	.35	51924.02	26.2768	199.97625
Electricity used in kWh percapita per year selected	224215163	.80	97500.00	382.1589	1898.75581
Total energy for cooking in kgoe percapita per year selected	188614879	.35	51924.02	26.2768	199.97625

Frequency Table

Electricity <10 kgoe percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	156706835	65.0	69.9	69.9
	Selected	67616725	28.0	30.1	100.0
	Total	224323560	93.0	100.0	
Missing	System	16810220	7.0		
Total		241133779	100.0		

Cooking < 40 kgoe percapita per year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	159212411	66.0	84.4	84.4
	Selected	29402467	12.2	15.6	100.0
	Total	188614879	78.2	100.0	
Missing	System	52518901	21.8		
Total		241133779	100.0		

Electricity < 120 kWh percapita per year (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	149445088	62.0	66.7	66.7
	Selected	74770075	31.0	33.3	100.0
	Total	224215163	93.0	100.0	
Missing	System	16918616	7.0		
Total		241133779	100.0		

Cooking LPG <35 kg percapita per year (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	14569074	6.0	7.7	7.7
	Selected	174045805	72.2	92.3	100.0
	Total	188614879	78.2	100.0	
Missing	System	52518901	21.8		
Total		241133779	100.0		

Electricity < 100 kWh percapita per year (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	164396930	68.2	73.3	73.3
	Selected	59818233	24.8	26.7	100.0
	Total	224215163	93.0	100.0	
Missing	System	16918616	7.0		
Total		241133779	100.0		

Cooking < 100 kgoe percapita per year (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	1216723	.5	.6	.6
	Selected	187398155	77.7	99.4	100.0
	Total	188614879	78.2	100.0	
Missing	System	52518901	21.8		
Total		241133779	100.0		

Energy consumed <27.4 percapita per month (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	1918765	.8	.8	.8
	Selected	234164282	97.1	99.2	100.0
	Total	236083047	97.9	100.0	
Missing	System	5050732	2.1		
Total		241133779	100.0		

Energy consumed <32.1 percapita per month (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	1474676	.6	.6	.6
	Selected	234608371	97.3	99.4	100.0
	Total	236083047	97.9	100.0	
Missing	System	5050732	2.1		
Total		241133779	100.0		

Descriptive Statistics

b1r5		N	Minimum	Maximum	Mean	Std. Deviation
1	Totkwhyear	118323003	2.04	202158.10	793.7869	3228.53277
	Valid N (listwise)	118323003				
2	Totkwhyear	117760044	2.04	203722.96	531.4630	3921.16382
	Valid N (listwise)	117760044				

totkwhyear < 500 (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	64280631	53.5	54.3	54.3
	Selected	54042372	45.0	45.7	100.0
	Total	118323003	98.5	100.0	
Missing	System	1749380	1.5		
Total		120072383	100.0		

totkwhyear < 250 (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	59888143	49.5	50.9	50.9
	Selected	57871900	47.8	49.1	100.0
	Total	117760044	97.3	100.0	
Missing	System	3301352	2.7		
Total		121061396	100.0		

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
lpgcapday	130925068	.00	54.79	.0570	.23189
kerocapday	66291913	.00	164.38	.0732	.94858
Valid N (listwise)	9121163				

lpgcapday < 0.04 (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	79206405	32.8	60.5	60.5
	Selected	51718663	21.4	39.5	100.0
	Total	130925068	54.3	100.0	
Missing	System	110208711	45.7		
Total		241133779	100.0		

kerocapday < 0.2 (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	2447143	1.0	3.7	3.7
	Selected	63844770	26.5	96.3	100.0
	Total	66291913	27.5	100.0	
Missing	System	174841866	72.5		
Total		241133779	100.0		

Appendix 5.4: Calculation of fuel expenditure

5.4.A. SUSENAS 2007

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Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cost spent for electricity in Rupiah per year	206647083	13.36	8858404.08	126529.7666	177262.07042
Cost spent for LPG in Rupiah per year	31999177	6.71	3178959.10	118937.1746	93421.05614
Cost spent for gas in Rupiah per year	34369	25627.87	188428.23	92184.4293	51540.55274
Cost spent for kerosene in Rupiah per year	194756878	245.41	4761011.89	87289.6861	92901.08303
Cost spent for briquette/charcoal in Rupiah per year	3378067	53.03	4140095.22	62667.4558	160374.19458
Cost spent for firewood in Rupiah per year	121372615	.48	3143319.79	69358.6356	71674.03187
Tot_energy_expend_y_select	224191706	139.16	9159052.94	247940.7858	219533.69972
expf_y	224203917	511677.55	250265899.97	4241050.6579	4013701.05480
Valid N (listwise)	0				

EnExpTotExp > 10.00 (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	195802830	87.3	87.3	87.3
	Selected	28388876	12.7	12.7	100.0
	Total	224191706	100.0	100.0	
Missing	System	12211	.0		
Total		224203917	100.0		

5.4.A. SUSENAS 2011

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Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cost spent for electricity in Rupiah percapita per year	225970586	666.00	26299998.00	186223.5030	261390.85199
Cost spent for LPG in Rupiah percapita per year	133041498	570.86	19893332.00	126249.9205	119861.97427
Cost spent for gas in Rupiah percapita per year	1007006	559.20	1716000.00	112538.8366	120794.17011
Cost spent for kerosene in Rupiah percapita per year	68059941	570.86	10236000.00	111145.2565	144602.43179
Cost spent for briquette/charcoal in Rupiah percapita per year	1901069	399.60	3020004.00	103790.0214	114011.86950
Cost spent for firewood in Rupiah percapita per year	110778151	12.00	3733332.00	118178.7737	117525.24572
Total energy expenditure percapita per year	240824138	2001.00	26779998.00	331546.1577	309883.69459
Expenditure of household percapita per year	241133779	710499.00	1023899240.00	6979624.9579	8326320.78259
Valid N (listwise)	0				

EnExpTotExp > 10 (FILTER)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Selected	223388316	92.6	92.8	92.8
	Selected	17435822	7.2	7.2	100.0
	Total	240824138	99.9	100.0	
Missing	System	309642	.1		
Total		241133779	100.0		

Appendix 5.5: The transition of energy access in region in Indonesia

5.5.A. Modern energy (kerosene is excluded)

Table 9.5.1: The transition of modern fuels (kerosene excluded) during 2007-2011

Interval	Number of region				
	2007	2008	2009	2010	2011
00.00-20.00%	392	375	314	244	201
20.01-40.00%	55	52	63	86	93
40.01-60.00%	8	12	34	62	67
60.01-80.00%	0	12	23	41	54
80.01-100.00%	0	4	21	22	40

Table 1.5.2: The transition of modern fuels (kerosene included) during 2007-2011

Interval	Number of region				
	2007	2008	2009	2010	2011
00.00-20.00%	100	78	90	39	56
20.01-40.00%	164	156	154	154	129
40.01-60.00%	80	77	84	107	111
60.01-80.00%	39	42	48	84	71
80.01-100.00%	72	73	79	71	88

Table 1.5.3: The transition traditional consumption in regions in 2007-2011

Interval	Number of region				
	2007	2008	2009	2010	2011
00.00-20.00%	79	73	79	74	95
20.01-40.00%	37	42	46	86	65
40.01-60.00%	82	77	85	110	113
60.01-80.00%	161	156	155	148	126
80.01-100.00%	99	107	90	37	55

Appendix 6.1: Normal Distribution test: Kolmogorov-Smirnov Normality test

6.1.A. Year 2007

One-Sample Kolmogorov-Smirnov Test

		Electricity 2007	Natural Gas & LPG 2007	Kerosene 2007	CB 2007	Firewood 2007	Modern energy (without kerosene) 2007	Modern energy (with kerosene) 2007
N		455	455	455	454	455	455	455
Normal Parametersa,b	Mean	1.4543	8.5312	32.2718	2.1402	55.1296	89.5369	57.2651
	Std. Deviation	1.27302	8.92597	21.02648	8.94955	27.71279	11.67846	27.99027
Most Extreme Differences	Absolute	.131	.170	.122	.406	.128	.181	.122
	Positive	.131	.153	.122	.402	.081	.181	.079
	Negative	-.127	-.170	-.070	-.406	-.128	-.156	-.122
Test Statistic		.131	.170	.122	.406	.128	.181	.122
Asymp. Sig. (2-tailed)		.000c	.000c	.000c	.000c	.000c	.000c	.000c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

6.1.B. Year 2008

One-Sample Kolmogorov-Smirnov Test

		Electricity 2008	Natural Gas & LPG 2008	Kerosene 2008	CB 2008	Firewood 2008	Modern energy (without kerosene) 2008	Modern energy (with kerosene) 2008
N		455	455	455	455	455	455	455
Normal Parametersa,b	Mean	.8663	11.7976	29.7393	1.7757	54.9993	86.5140	56.7747
	Std. Deviation	.84487	14.68231	20.00354	7.90913	28.11360	15.67141	27.75613
Most Extreme Differences	Absolute	.153	.211	.140	.411	.123	.204	.125
	Positive	.140	.196	.140	.404	.080	.195	.077
	Negative	-.153	-.211	-.082	-.411	-.123	-.204	-.125
Test Statistic		.153	.211	.140	.411	.123	.204	.125
Asymp. Sig. (2-tailed)		.000c	.000c	.000c	.000c	.000c	.000c	.000c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

6.1.C. Year 2009

One-Sample Kolmogorov-Smirnov Test

		Electricity 2009	Natural Gas & LPG 2009	Kerosene 2009	CB 2009	Firewood 2009	Modern energy (without kerosene) 2009	Modern energy (with kerosene) 2009
N		455	455	455	455	455	455	455
Normal Parametersa,b	Mean	1.1769	19.0127	24.3239	1.6988	52.7169	78.7394	54.4155
	Std. Deviation	1.07400	23.01958	20.65296	7.93621	28.14711	24.10938	28.03900
Most Extreme Differences	Absolute	.161	.212	.159	.418	.117	.212	.120
	Positive	.161	.212	.159	.418	.080	.189	.080
	Negative	-.137	-.204	-.119	-.415	-.117	-.212	-.120
Test Statistic		.161	.212	.159	.418	.117	.212	.120
Asymp. Sig. (2-tailed)		.000c	.000c	.000c	.000c	.000c	.000c	.000c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

6.1.D. Year 2010

One-Sample Kolmogorov-Smirnov Test

		Electricity 2010	Natural Gas & LPG 2010	Kerosene 2010	CB 2010	Firewood 2010	Modern energy (without kerosene) 2010	Modern energy (with kerosene) 2010
N		455	455	455	455	455	455	455
Normal Parametersa,b	Mean	1.2278	25.8093	22.7425	1.5806	47.6862	72.0093	49.2670
	Std. Deviation	1.21451	25.33463	19.67470	7.14692	24.50586	26.62102	24.58893
Most Extreme Differences	Absolute	.158	.154	.124	.412	.087	.147	.091
	Positive	.158	.150	.091	.396	.059	.147	.061
	Negative	-.156	-.154	-.124	-.412	-.087	-.147	-.091
Test Statistic		.158	.154	.124	.412	.087	.147	.091
Asymp. Sig. (2-tailed)		.000c	.000c	.000c	.000c	.000c	.000c	.000c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

6.1.E. Year 2011

One-Sample Kolmogorov-Smirnov Test

		Electricity 2011	NatGas&LPG 2011	Kerosene 2011	CB 2011	Firewood 2011	Modern energy (without kerosene) 2011	Modern energy (with kerosene) 2011
N		455	455	455	455	455	455	455
Normal Parametersa,b	Mean	.9528	31.1151	18.2558	1.4254	47.2603	66.9413	48.6856
	Std. Deviation	.95550	28.01480	19.63447	7.40612	27.13482	29.01866	26.90319
Most Extreme Differences	Absolute	.159	.133	.176	.433	.079	.127	.080
	Positive	.130	.118	.140	.433	.071	.127	.071
	Negative	-.159	-.133	-.176	-.424	-.079	-.119	-.080
Test Statistic		.159	.133	.176	.433	.079	.127	.080
Asymp. Sig. (2-tailed)		.000c	.000c	.000c	.000c	.000c	.000c	.000c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Appendix 6.2: Friedman rank test: Percentage Energy User vs Time

6.2.A. Friedman Test: Electricity

Ranks

	Mean Rank
Electricity 2007	3.53
Electricity 2008	2.46
Electricity 2009	3.05
Electricity 2010	3.24
Electricity 2011	2.72

Test Statistics[a]

N	455
Chi-Square	132.571
df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.B. Friedman Test: Natural gas and LPG

Ranks

	Mean Rank
Natural Gas & LPG 2007	1.75
Natural Gas & LPG 2008	2.55
Natural Gas & LPG 2009	2.90
Natural Gas & LPG 2010	3.69
Natural Gas & LPG 2011	4.12

Test Statistics[a]

N	455
Chi-Square	649.669
df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.C. Friedman Test: Kerosene

Ranks

	Mean Rank
Kerosene 2007	3.46
Kerosene 2008	3.20
Kerosene 2009	2.95
Kerosene 2010	3.15
Kerosene 2011	2.24

Test Statistics[a]

N	455
Chi-Square	156.229
df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.D. Friedman Test: Coal and Briquette

Ranks

	Mean Rank
Coal & Briquette 2007	3.68
Coal & Briquette 2008	3.45
Coal & Briquette 2009	2.83
Coal & Briquette 2010	3.19
Coal & Briquette 2011	1.84

Test Statistics[a]

N	454
Chi-Square	412.557
df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.E. Friedman Test: Firewood

Ranks

	Mean Rank
Firewood 2007	3.82
Firewood 2008	3.79
Firewood 2009	3.22
Firewood 2010	2.18
Firewood 2011	1.99

Test Statistics[a]

N	455
Chi-Square	553.918
Df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.F. Friedman Test: Modern energy (kerosene excluded)

Ranks

	Mean Rank
Modern energy (without kerosene) 2007	4.13
Modern energy (without kerosene) 2008	3.63
Modern energy (without kerosene) 2009	3.06
Modern energy (without kerosene) 2010	2.33
Modern energy (without kerosene) 2011	1.85

Test Statistics[a]

N	455
Chi-Square	629.462
df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.G. Friedman Test: Modern energy (kerosene included)

Ranks

	Mean Rank
Modern energy (with kerosene) 2007	3.84
Modern energy (with kerosene) 2008	3.87
Modern energy (with kerosene) 2009	3.19
Modern energy (with kerosene) 2010	2.19
Modern energy (with kerosene) 2011	1.90

Test Statistics[a]

N	455
Chi-Square	610.245
df	4
Asymp. Sig.	.000

a. Friedman Test

6.2.H. Friedman Test: Traditional energy

Ranks

	Mean Rank
Traditional Energy 2007	3.85
Traditional Energy 2008	3.86
Traditional Energy 2009	3.19
Traditional Energy 2010	2.19
Traditional Energy 2011	1.91

Test Statistics[a]

N	454
Chi-Square	608.513
Df	4
Asymp. Sig.	.000

a. Friedman Test

Appendix 6.3: Wilcoxon rank test: Percentage Energy User vs Time

6.3.A. Wilcoxon Signed Ranks Test: Electricity

Test Statistics[a]

	Electricity 08-Electricity 07	Electricity 09 -Electricity 07	Electricity 10 -Electricity 07	Electricity 11 -Electricity 07	Electricity 09 -Electricity 08	Electricity 10 -Electricity 08	Electricity 11 -Electricity 08	Electricity 10 -Electricity 09	Electricity 11 -Electricity 09	Electricity 11 - Electricity 10
Z	-11.152[b]	-5.500[b]	-4.221[b]	-8.546[b]	-7.521[c]	-7.816[c]	-2.022[c]	-1.461[c]	-4.269[b]	-4.909[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.043	.144	.000	.000

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.
c. Based on negative ranks.

6.3.B. Wilcoxon Signed Ranks Test: Natural gas and LPG

Test Statistics[a]

	NG&LPG 08-NG&LPG 07	NG&LPG 09 - NG&LPG 07	NG&LPG 10 - NG&LPG 07	NG&LPG 11 - NG&LPG 07	NG&LPG 09 - NG&LPG 08	NG&LPG 10 - NG&LPG 08	NG&LPG 11 - NG&LPG 08	NG&LPG 10 - NG&LPG 09	NG&LPG 11 - NG&LPG 09	NG&LPG 11-NG&LPG 10
Z	-11.660[b]	-14.606[b]	-16.803[b]	-16.992[b]	-9.120[b]	-15.094[b]	-16.067[b]	-12.771[b]	-15.772[b]	-12.503[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

6.3.C. Wilcoxon Signed Ranks Test: Kerosene

Test Statistics[a]

	Kero 2008 - Kero 2007	Kero 2009 - Kero 2007	Kero 2010 - Kero 2007	Kero 2011 - Kero 2007	Kero 2009 - Kero 2008	Kero 2010 - Kero 2008	Kero 2011 - Kero 2008	Kero 2010 - Kero 2009	Kero 2011 - Kero 2009	Kero 2011 - Kero 2010
Z	-5.405[b]	-7.879[b]	-6.974[b]	-11.432[b]	-6.422[b]	-5.893[b]	-10.574[b]	-1.184[b]	-7.756[b]	-11.975[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.236	.000	.000

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

6.3.D. Wilcoxon Signed Ranks Test: Briquette and Charcoal

Test Statistics[a]

	CB 08-CB 07	CB 09-CB 07	CB 10-CB 07	CB 11-CB 07	CB 09-CB 08	CB 10-CB 08	CB 11-CB 08	CB 10-CB 09	CB 11-CB 09	CB 11-CB 10
Z	-3.719[b]	-8.168[b]	-5.603[b]	-14.007[b]	-5.442[b]	-3.312[b]	-12.807[b]	-1.812[c]	-9.462[b]	-11.314[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.001	.000	.070	.000	.000

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.
c. Based on negative ranks.

6.3.E. Wilcoxon Signed Ranks Test: Firewood

Test Statistics[a]

	Wood 2008 - Wood 2007	Wood 2009 - Wood 2007	Wood 2010 - Wood 2007	Wood 2011 - Wood 2007	Wood 2009 - Wood 2008	Wood 2010 - Wood 2008	Wood 2011 - Wood 2008	Wood 2010 - Wood 2009	Wood 2011 - Wood 2009	Wood 2011 - Wood 2010
Z	-.853[b]	-7.768[b]	-14.699[b]	-15.061[b]	-6.967[b]	-14.422[b]	-15.154[b]	-12.271[b]	-13.429[b]	-1.552[b]
Asymp. Sig. (2-tailed)	.394	.000	.000	.000	.000	.000	.000	.000	.000	.121

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

6.3.F. Wilcoxon Signed Ranks Test: Modern energy (kerosene excluded)

Test Statistics[a]

	ME-NK2008 - ME-NK2007	ME-NK2009 - ME-NK2007	ME-NK2010 - ME-NK2007	ME-NK2011 - ME-NK2007	ME-NK2009 - ME-NK2008	ME-NK2010 - ME-NK2008	ME-NK2011 - ME-NK2008	ME-NK2010 - ME-NK2009	ME-NK2011 - ME-NK2009	ME-NK2011 - ME-NK2010
Z	-8.192[b]	-13.931[b]	-16.409[b]	-16.706[b]	-10.653[b]	-15.260[b]	-16.083[b]	-12.926[b]	-15.397[b]	-11.990[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

6.3.G. Wilcoxon Signed Ranks Test: Modern energy (kerosene included)

Test Statistics[a]

	ME-K2008 - ME-K2007	ME-K2009 - ME-K2007	ME-K2010 - ME-K2007	ME-K2011 - ME-K2007	ME-K2009 - ME-K2008	ME-K2010 - ME-K2008	ME-K2011 - ME-K2008	ME-K2010 - ME-K2009	ME-K2011 - ME-K2009	ME-K2011 - ME-K2010
Z	-1.052[b]	-8.439[b]	-14.789[b]	-15.690[b]	-7.682[b]	-14.923[b]	-16.043[b]	-12.161[b]	-14.323[b]	-2.450[b]
Asymp. Sig. (2-tailed)	.293	.000	.000	.000	.000	.000	.000	.000	.000	.014

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

6.3.H. Wilcoxon Signed Ranks Test: Traditional energy

Test Statistics[a]

	Traditional Energy 2008 - Traditional Energy 2007	Traditional Energy 2009 - Traditional Energy 2007	Traditional Energy 2010 - Traditional Energy 2007	Traditional Energy 2011 - Traditional Energy 2007	Traditional Energy 2009 - Traditional Energy 2008	Traditional Energy 2010 - Traditional Energy 2008	Traditional Energy 2011 - Traditional Energy 2008	Traditional Energy 2010 - Traditional Energy 2009	Traditional Energy 2011 - Traditional Energy 2009	Traditional Energy 2011 - Traditional Energy 2010
Z	-1.076[b]	-8.391[b]	-14.758[b]	-15.660[b]	-7.682[b]	-14.923[b]	-16.043[b]	-12.159[b]	-14.322[b]	-2.452[b]
Asymp. Sig. (2-tailed)	.282	.000	.000	.000	.000	.000	.000	.000	.000	.014

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

Appendix 6.4 Chi-Square tests: Fuel versus Urban-Rural Location

6.4.A. Chi-Square test for 2007

[DataSet1] S:\Septin\My Research\PhD Septin\PhD Thesis\Reading summary\Thesis\Data analysis final\MERGE07.sav

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
ELEC07 * UR07	224203917	100.0%	0	0.0%	224203917	100.0%
LPG07 * UR07	224203917	100.0%	0	0.0%	224203917	100.0%
NG07 * UR07	224203917[a]	100.0%	0	0.0%	224203917	100.0%
KERO07 * UR07	224203917[a]	100.0%	0	0.0%	224203917	100.0%
BC07 * UR07	224203917[a]	100.0%	0	0.0%	224203917	100.0%
FW07 * UR07	224203917[a]	100.0%	0	0.0%	224203917	100.0%

a. Number of valid cases is different from the total count in the crosstabulation table because the cell counts have been rounded.

6.A.1. Chi-Square test for Electricity vs Urban-rural 2007

Crosstab

			UR07		
			1.00	2.00	Total
ELEC07	.00	Count	1088653	16603540	17692193
		Expected Count	8547341.6	9144851.4	17692193.0
	1.00	Count	107227341	99284383	206511724
		Expected Count	99768652.4	106743071.6	206511724.0
Total		Count	108315994	115887923	224203917
		Expected Count	108315994.0	115887923.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13670908.970[a]	1	.000		
Continuity Correction[b]	13670907.137	1	.000		
Likelihood Ratio	16396770.980	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	13670908.909	1	.000		
N of Valid Cases	224203917				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8547342.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.247	.000
	Cramer's V	.247	.000
	Contingency Coefficient	.240	.000
N of Valid Cases		224203917	

6.A.2. Chi-Square test for LPG vs Urban-rural 2007

Crosstab

			UR07		
			1.00	2.00	Total
LPG07	.00	Count	82290914	110250980	192541894
		Expected Count	93019635.5	99522258.5	192541894.0
	1.00	Count	26025080	5636943	31662023
		Expected Count	15296358.5	16365664.5	31662023.0
Total		Count	108315994	115887923	224203917
		Expected Count	108315994.0	115887923.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16952387.146[a]	1	.000		
Continuity Correctionb	16952385.566	1	.000		
Likelihood Ratio	18050724.514	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	16952387.071	1	.000		
N of Valid Cases	224203917				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 15296359.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.275	.000
	Cramer's V	.275	.000
	Contingency Coefficient	.265	.000
N of Valid Cases		224203917	

6.A.3. Chi-Square test for Natural Gas vs Urban-rural 2007

Crosstab

			UR07		
			1.00	2.00	Total
NG07	.00	Count	108279220	115887923	224167143
		Expected Count	108298228.0	115868915.0	224167143.0
	1.00	Count	36774	0	36774
		Expected Count	17766.0	19008.0	36774.0
Total		Count	108315994	115887923	224203917
		Expected Count	108315994.0	115887923.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	39351.175[a]	1	.000		
Continuity Correctionb	39349.104	1	.000		
Likelihood Ratio	53512.857	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	39351.174	1	.000		
N of Valid Cases	224203917				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 17766.02.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.013	.000
	Cramer's V	.013	.000
	Contingency Coefficient	.013	.000
N of Valid Cases		224203917	

6.A.4. Chi-Square test for Kerosene vs Urban-rural 2007

Crosstab

			UR07		
			1.00	2.00	Total
KERO07	.00	Count	16850557	13668378	30518935
		Expected Count	14744117.0	15774818.0	30518935.0
	1.00	Count	91465437	102219545	193684982
		Expected Count	93571877.0	100113105.0	193684982.0
Total		Count	108315994	115887923	224203917
		Expected Count	108315994.0	115887923.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	673956.226[a]	1	.000		
Continuity Correction[b]	673955.906	1	.000		
Likelihood Ratio	674049.928	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	673956.223	1	.000		
N of Valid Cases	224203917				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14744117.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.055	.000
	Cramer's V	.055	.000
	Contingency Coefficient	.055	.000
N of Valid Cases		224203917	

6.A.5. Chi-Square test for Briquette/Charcoal vs Urban-rural 2007

Crosstab

			UR07		
			1.00	2.00	Total
BC07	.00	Count	107395635	113727311	221122946
		Expected Count	106827534.6	114295411.4	221122946.0
	1.00	Count	920359	2160612	3080971
		Expected Count	1488459.4	1592511.6	3080971.0
Total		Count	108315994	115887923	224203917
		Expected Count	108315994.0	115887923.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	425331.595a	1	.000		
Continuity Correctionb	425330.846	1	.000		
Likelihood Ratio	439265.406	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	425331.593	1	.000		
N of Valid Cases	224203917				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 1488459.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.044	.000
	Cramer's V	.044	.000
	Contingency Coefficient	.044	.000
N of Valid Cases		224203917	

6.A.6. Chi-Square test for Firewood vs Urban-rural 2007

Crosstab

			UR07		
			1.00	2.00	Total
FW07	.00	Count	80972567	21858735	102831302
		Expected Count	49679215.4	53152086.6	102831302.0
	1.00	Count	27343427	94029188	121372615
		Expected Count	58636778.6	62735836.4	121372615.0
Total		Count	108315994	115887923	224203917
		Expected Count	108315994.0	115887923.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	70446096.551[a]	1	.000		
Continuity Correctionb	70446094.300	1	.000		
Likelihood Ratio	74650797.972	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	70446096.237	1	.000		
N of Valid Cases	224203917				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 49679215.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.561	.000
	Cramer's V	.561	.000
	Contingency Coefficient	.489	.000
N of Valid Cases		224203917	

6.4.B. Chi-Square test for 2011

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
ELEC11 * UR11	241133780	100.0%	0	0.0%	241133779.100	100.0%
LPG11 * UR11	241133778[a]	100.0%	1.100	0.0%	241133779.100	100.0%
NG11 * UR11	241133779[a]	100.0%	.100	0.0%	241133779.100	100.0%
KERO11 * UR11	241133779[a]	100.0%	.100	0.0%	241133779.100	100.0%
BC11 * UR11	241133780[a]	100.0%	0	0.0%	241133779.100	100.0%
FW11 * UR11	241133779[a]	100.0%	.100	0.0%	241133779.100	100.0%

a. Number of valid cases is different from the total count in the crosstabulation table because the cell counts have been rounded.

6.B.1. Chi-Square test for Electricity vs Urban-rural 2011

Crosstab

			UR11		
			1.00	2.00	Total
ELEC11	.00	Count	1158741	14004453	15163194
		Expected Count	7550501.0	7612693.0	15163194.0
	1.00	Count	118913642	107056944	225970586
		Expected Count	112521882.0	113448704.0	225970586.0
Total		Count	120072383	121061397	241133780
		Expected Count	120072383.0	121061397.0	241133780.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11500683.769[a]	1	.000		
Continuity Correctionb	11500681.970	1	.000		
Likelihood Ratio	13452923.656	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	11500683.721	1	.000		
N of Valid Cases	241133780				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7550501.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.218	.000
	Cramer's V	.218	.000
	Contingency Coefficient	.213	.000
N of Valid Cases		241133780	

6.B.2. Chi-Square test for LPG vs Urban-rural 2011

Crosstab

			UR11		
			1.00	2.00	Total
LPG11	.00	Count	31873445	76218836	108092281
		Expected Count	53824469.4	54267811.6	108092281.0
	1.00	Count	88198937	44842560	133041497
		Expected Count	66247912.6	66793584.4	133041497.0
Total		Count	120072382	121061396	241133778
		Expected Count	120072382.0	121061396.0	241133778.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	32318643.825[a]	1	.000		
Continuity Correction[b]	32318642.352	1	.000		
Likelihood Ratio	33127624.977	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	32318643.691	1	.000		
N of Valid Cases	241133778				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 53824469.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.366	.000
	Cramer's V	.366	.000
	Contingency Coefficient	.344	.000
N of Valid Cases		241133778	

6.B.3. Chi-Square test for Natural Gas vs Urban-rural 2011

Crosstab

			UR11		
			1.00	2.00	Total
NG11	.00	Count	119450504	120675398	240125902
		Expected Count	119570510.4	120555391.6	240125902.0
	1.00	Count	621878	385999	1007877
		Expected Count	501871.6	506005.4	1007877.0
Total		Count	120072382	121061397	241133779
		Expected Count	120072382.0	121061397.0	241133779.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	57396.805a	1	.000		
Continuity Correctionb	57396.327	1	.000		
Likelihood Ratio	57911.177	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	57396.805	1	.000		
N of Valid Cases	241133779				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 501871.6.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.015	.000
	Cramer's V	.015	.000
	Contingency Coefficient	.015	.000
N of Valid Cases		241133779	

6.B.4. Chi-Square test for Kerosene vs Urban-rural 2011

Crosstab

			UR11		
			1.00	2.00	Total
KERO11	.00	Count	97885437	75188400	173073837
		Expected Count	86181986.3	86891850.7	173073837.0
	1.00	Count	22186946	45872996	68059942
		Expected Count	33890396.7	34169545.3	68059942.0
Total		Count	120072383	121061396	241133779
		Expected Count	120072383.0	121061396.0	241133779.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11215798.840a	1	.000		
Continuity Correctionb	11215797.882	1	.000		
Likelihood Ratio	11399225.024	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	11215798.794	1	.000		
N of Valid Cases	241133779				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 33890397.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.216	.000
	Cramer's V	.216	.000
	Contingency Coefficient	.211	.000
N of Valid Cases		241133779	

6.B.5. Chi-Square test for Briquette/charcoal vs Urban-rural 2011

Crosstab

			UR11		
			1.00	2.00	Total
BC11	.00	Count	119543838	119688873	239232711
		Expected Count	119125747.1	120106963.9	239232711.0
	1.00	Count	528545	1372524	1901069
		Expected Count	946635.9	954433.1	1901069.0
Total		Count	120072383	121061397	241133780
		Expected Count	120072383.0	121061397.0	241133780.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	370721.926a	1	.000		
Continuity Correctionb	370721.039	1	.000		
Likelihood Ratio	384110.806	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	370721.924	1	.000		
N of Valid Cases	241133780				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 946635.9.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.039	.000
	Cramer's V	.039	.000
	Contingency Coefficient	.039	.000
N of Valid Cases		241133780	

6.B.6. Chi-Square test for Firewood vs Urban-rural 2011

Crosstab

			UR11		
			1.00	2.00	Total
FW11	.00	Count	95493415	34861308	130354723
		Expected Count	64910035.8	65444687.2	130354723.0
	1.00	Count	24578968	86200088	110779056
		Expected Count	55162347.2	55616708.8	110779056.0
Total		Count	120072383	121061396	241133779
		Expected Count	120072383.0	121061396.0	241133779.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	62475804.577a	1	.000		
Continuity Correctionb	62475802.534	1	.000		
Likelihood Ratio	65623038.398	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	62475804.318	1	.000		
N of Valid Cases	241133779				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 55162347.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.509	.000
	Cramer's V	.509	.000
	Contingency Coefficient	.454	.000
N of Valid Cases		241133779	

Appendix 6.5 Chi-Square tests: Energy versus Income Decile

6.5.A. Chi Square test for Energy vs Income in 2007

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
ELEC07 * DECILE07	224203917	100.0%	0	0.0%	224203917	100.0%
LPG07 * DECILE07	224203917	100.0%	0	0.0%	224203917	100.0%
NG07 * DECILE07	224203917[a]	100.0%	0	0.0%	224203917	100.0%
KERO07 * DECILE07	224203917[a]	100.0%	0	0.0%	224203917	100.0%
BC07 * DECILE07	224203917[a]	100.0%	0	0.0%	224203917	100.0%
FW07 * DECILE07	224203917[a]	100.0%	0	0.0%	224203917	100.0%

a. Number of valid cases is different from the total count in the crosstabulation table because the cell counts have been rounded.

6.5.A.1. Chi Square test for Electricity vs Income 2007

Crosstab

			DECILE07										Total
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	
ELEC07	.00	Count	5988635	3245184	2601865	1918476	1541765	1020314	661613	400851	213977	99513	17692193
		Expected Count	1989466.9	1904104.2	1842277.7	1792839.3	1783655.2	1747415.7	1707019.4	1665767.7	1656495.3	1603151.9	17692193.0
	1.00	Count	19222839	20884533	20744357	20801239	21061565	21123772	20970552	20708552	20777922	20216393	206511724
		Expected Count	23222007.1	22225612.8	21503944.3	20926875.7	20819674.8	20396670.3	19925145.6	19443635.3	19335403.7	18712754.1	206511724.0
Total		Count	25211474	24129717	23346222	22719715	22603330	22144086	21632165	21109403	20991899	20315906	224203917
		Expected Count	25211474.0	24129717.0	23346222.0	22719715.0	22603330.0	22144086.0	21632165.0	21109403.0	20991899.0	20315906.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15099654.008[a]		.000
Likelihood Ratio	14571367.232		.000
Linear-by-Linear Association	12805789.501		.000
N of Valid Cases	224203917		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 1603152.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.260	.000
	Cramer's V	.260	.000
	Contingency Coefficient	.251	.000
N of Valid Cases		224203917	

6.5.A.2. Chi Square test for LPG vs Income 2007

Crosstab

			DECILE07										Total
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	
LPG07	.00	Count	25113347	23951382	23046141	22279330	21563791	20481862	18886595	16427037	13419691	7372718	192541894
		Expected Count	21651115.7	20722124.2	20049274.2	19511242.3	19411293.2	19016903.5	18577275.9	18128338.2	18027428.1	17446898.7	192541894.0
	1.00	Count	98127	178335	300081	440385	1039539	1662224	2745570	4682366	7572208	12943188	31662023
		Expected Count	3560358.3	3407592.8	3296947.8	3208472.7	3192036.8	3127182.5	3054889.1	2981064.8	2964470.9	2869007.3	31662023.0
Total		Count	25211474	24129717	23346222	22719715	22603330	22144086	21632165	21109403	20991899	20315906	224203917
		Expected Count	25211474.0	24129717.0	23346222.0	22719715.0	22603330.0	22144086.0	21632165.0	21109403.0	20991899.0	20315906.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	66624191.444[a]	9	.000
Likelihood Ratio	58525357.076	9	.000
Linear-by-Linear Association	48158566.540	1	.000
N of Valid Cases	224203917		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 2869007.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.545	.000
	Cramer's V	.545	.000
	Contingency Coefficient	.479	.000
N of Valid Cases		224203917	

6.5.A.3. Chi Square test for Natural Gas vs Income 2007

Crosstab

			DECILE07										Total
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	
NG07	.00	Count	25211474	24129717	23346222	22716162	22603330	22144086	21621857	21109403	20983716	20301176	224167143
		Expected Count	25207338.8	24125759.2	23342392.7	22715988.5	22599622.6	22140453.9	21628616.9	21105940.6	20988455.9	20312573.8	224167143.0
	1.00	Count	0	0	0	3553	0	0	10308	0	8183	14730	36774
		Expected Count	4135.2	3957.8	3829.3	3726.5	3707.4	3632.1	3548.1	3462.4	3443.1	3332.2	36774.0
Total		Count	25211474	24129717	23346222	22719715	22603330	22144086	21632165	21109403	20991899	20315906	224203917
		Expected Count	25211474.0	24129717.0	23346222.0	22719715.0	22603330.0	22144086.0	21632165.0	21109403.0	20991899.0	20315906.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	81135.362a	9	.000
Likelihood Ratio	79614.241	9	.000
Linear-by-Linear Association	40984.466	1	.000
N of Valid Cases	224203917		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 3332.22.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.019	.000
	Cramer's V	.019	.000
	Contingency Coefficient	.0 19	.000
N of Valid Cases		2 24203917	

6.5.A.4. Chi Square test for Kerosene vs Income 2007

Crosstab

			DECILE07										
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	Total
KERO07	.00	Count	4134801	3276614	2314596	1945522	1739775	1687072	1766034	2387433	3487513	7779575	30518935
		Expected Count	3431819.3	3284569.1	3177918.8	3092637.8	3076795.3	3014282.4	2944599.0	2873440.0	2857445.2	2765428.1	30518935.0
	1.00	Count	21076673	20853103	21031626	20774193	20863555	20457014	19866131	18721970	17504386	12536331	193684982
		Expected Count	21779654.7	20845147.9	20168303.2	19627077.2	19526534.7	19129803.6	18687566.0	18235963.0	18134453.8	17550477.9	193684982.0
Total		Count	25211474	24129717	23346222	22719715	22603330	22144086	21632165	21109403	20991899	20315906	224203917
		Expected Count	25211474.0	24129717.0	23346222.0	22719715.0	22603330.0	22144086.0	21632165.0	21109403.0	20991899.0	20315906.0	224203917.0

Chi-Square Tests

	Value	f	Asymp. Sig. (2-sided)
Pearson Chi-Square	13605717.941a	9	.000
Likelihood Ratio	11109611.030	9	.000
Linear-by-Linear Association	2326419.361	1	.000
N of Valid Cases	224203917		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 2765428.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.246	.000
	Cramer's V	.246	.000
	Contingency Coefficient	.239	.000
N of Valid Cases		224203917	

6.5.A.5. Chi Square test for Briquette/Charcoal vs Income 2007

Crosstab

			DECILE07										
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	Total
BC07	.00	Count	24859834	23801209	22962249	22392496	22259086	21779022	21289029	20862350	20798882	20118789	221122946
		Expected Count	24865022.3	23798130.7	23025402.3	22407504.7	22292719.0	21839785.8	21334899.6	20819321.3	20703432.0	20036728.4	221122946.0
	1.00	Count	351640	328508	383973	327219	344244	365064	343136	247053	193017	197117	3080971
		Expected Count	346451.7	331586.3	320819.7	312210.3	310611.0	304300.2	297265.4	290081.7	288467.0	279177.6	3080971.0
Total		Count	25211474	24129717	23346222	22719715	22603330	22144086	21632165	21109403	20991899	20315906	224203917
		Expected Count	25211474.0	24129717.0	23346222.0	22719715.0	22603330.0	22144086.0	21632165.0	21109403.0	20991899.0	20315906.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	99567.708a	9	.000
Likelihood Ratio	104948.767	9	.000
Linear-by-Linear Association	33755.891	1	.000
N of Valid Cases	224203917		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 279177.6.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.021	.000
	Cramer's V	.021	.000
	Contingency Coefficient	.021	.000
N of Valid Cases		224203917	

6.5.A.6. Chi Square test for Firewood vs Income 2007

Crosstab

			DECILE07										
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	Total
FW07	.00	Count	2287213	4225914	5918639	7152593	8969709	11240629	12872190	14806903	16880038	18477474	102831302
		Expected Count	11563262.3	11067113.6	10707763.0	10420415.1	10367035.0	10156402.4	9921609.4	9681844.2	9627950.9	9317906.2	102831302.0
	1.00	Count	22924261	19903803	17427583	15567122	13633621	10903457	8759975	6302500	4111861	1838432	121372615
		Expected Count	13648211.7	13062603.4	12638459.0	12299299.9	12236295.0	11987683.6	11710555.6	11427558.8	11363948.1	10997999.8	121372615.0
Total		Count	25211474	24129717	23346222	22719715	22603330	22144086	21632165	21109403	20991899	20315906	224203917
		Expected Count	25211474.0	24129717.0	23346222.0	22719715.0	22603330.0	22144086.0	21632165.0	21109403.0	20991899.0	20315906.0	224203917.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	61324272.073[a]	9	.000
Likelihood Ratio	67705001.724	9	.000
Linear-by-Linear Association	60978387.135	1	.000
N of Valid Cases	224203917		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9317906.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.523	.000
	Cramer's V	.523	.000
	Contingency Coefficient	.463	.000
N of Valid Cases		224203917	

6.5.B. Chi Square test for Energy vs Income in 2011

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
ELEC11 * DECILE11	241133779	100.0%	.100	0.0%	241133779.100	100.0%
LPG11 * DECILE11	241133781[a]	100.0%	0	0.0%	241133779.100	100.0%
NG11 * DECILE11	241133780[a]	100.0%	0	0.0%	241133779.100	100.0%
KERO11 * DECILE11	241133779[a]	100.0%	.100	0.0%	241133779.100	100.0%
BC11 * DECILE11	241133781[a]	100.0%	0	0.0%	241133779.100	100.0%
FW11 * DECILE11	241133779[a]	100.0%	.100	0.0%	241133779.100	100.0%

a. Number of valid cases is different from the total count in the crosstabulation table because the cell counts have been rounded.

6.5.B.1. Chi Square test for Electricity vs Income 2011

Crosstab

			DECILE11										Total
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	
ELEC11	.00	Count	1847093	2279895	2210138	1991824	1690663	1492999	1302591	1050979	823003	474008	15163193
		Expected Count	893367.3	1334702.8	1480154.2	1518033.6	1554302.9	1577799.5	1582628.6	1620086.3	1652434.5	1949683.2	15163193.0
	1.00	Count	12359746	18945314	21328121	22148816	23026752	23598072	23865276	24712561	25454957	30530971	225970586
		Expected Count	13313471.7	19890506.2	22058104.8	22622606.4	23163112.1	23513271.5	23585238.4	24143453.7	24625525.5	29055295.8	225970586.0
Total		Count	14206839	21225209	23538259	24140640	24717415	25091071	25167867	25763540	26277960	31004979	241133779
		Expected Count	14206839.0	21225209.0	23538259.0	24140640.0	24717415.0	25091071.0	25167867.0	25763540.0	26277960.0	31004979.0	241133779.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4262679.614[a]	9	.000
Likelihood Ratio	4462545.294	9	.000
Linear-by-Linear Association	4208299.128	1	.000
N of Valid Cases	241133779		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 893367.3.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.133	.000
	Cramer's V	.133	.000
	Contingency Coefficient	.132	.000
N of Valid Cases		241133779	

6.5.B.2. Chi Square test for LPG vs Income 2011

Crosstab

			DECILE11										Total
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	
LPG11	.00	Count	11133738	13934321	13630500	12678565	11470371	11009362	9988607	9310270	8369204	6567344	108092282
		Expected Count	6368455.5	9514558.2	10551420.9	10821448.8	11079997.9	11247495.5	11281921.1	11548941.1	11779538.5	13898504.5	108092282.0
	1.00	Count	3073102	7290889	9907758	11462075	13247044	14081709	15179261	16453270	17908756	24437635	133041499
		Expected Count	7838384.5	11710651.8	12986837.1	13319191.2	13637417.1	13843575.5	13885946.9	14214598.9	14498421.5	17106474.5	133041499.0
Total		Count	14206840	21225210	23538258	24140640	24717415	25091071	25167868	25763540	26277960	31004979	241133781
		Expected Count	14206840.0	21225210.0	23538258.0	24140640.0	24717415.0	25091071.0	25167868.0	25763540.0	26277960.0	31004979.0	241133781.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22277776.624[a]	9	.000
Likelihood Ratio	23134854.571	9	.000
Linear-by-Linear Association	21501021.197	1	.000
N of Valid Cases	241133781		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6368456.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.304	.000
	Cramer's V	.304	.000
	Contingency Coefficient	.291	.000
N of Valid Cases		241133781	

6.5.B.3. Chi Square test for Natural Gas vs Income 2011

Crosstab

			DECILE11										Total
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	
NG11	.00	Count	14175623	21176405	23467944	24066840	24644700	25021077	25071984	25662075	26151421	30687833	240125902
		Expected Count	14147459.0	21136493.0	23439875.1	24039737.3	24614102.5	24986196.7	25062672.7	25655854.9	26168124.8	30875386.1	240125902.0
	1.00	Count	31217	48804	70315	73799	72715	69994	95884	101465	126539	317146	1007878
		Expected Count	59381.0	88716.0	98383.9	100901.7	103312.5	104874.3	105195.3	107685.1	109835.2	129592.9	1007878.0
Total		Count	14206840	21225209	23538259	24140639	24717415	25091071	25167868	25763540	26277960	31004979	241133780
		Expected Count	14206840.0	21225209.0	23538259.0	24140639.0	24717415.0	25091071.0	25167868.0	25763540.0	26277960.0	31004979.0	241133780.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	343861.323[a]	9	.000
Likelihood Ratio	275523.595	9	.000
Linear-by-Linear Association	198313.013	1	.000
N of Valid Cases	241133780		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 59380.99.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.038	.000
	Cramer's V	.038	.000
	Contingency Coefficient	.038	.000
N of Valid Cases		241133780	

6.5.B.4. Chi Square test for Kerosene vs Income 2011

Crosstab

			DECILE11										
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	Total
KERO11	.00	Count	10509887	15668662	17056488	17280563	17616274	17436234	17383916	17776825	18326710	24018277	173073836
		Expected Count	10196963.3	15234399.6	16894591.9	17326950.3	17740931.4	18009123.1	18064243.4	18491787.9	18861013.0	22253832.2	173073836.0
	1.00	Count	3696953	5556547	6481771	6860076	7101141	7654837	7783951	7986715	7951250	6986702	68059943
		Expected Count	4009876.7	5990809.4	6643667.1	6813688.7	6976483.6	7081947.9	7103623.6	7271752.1	7416947.0	8751146.8	68059943.0
Total		Count	14206840	21225209	23538259	24140639	24717415	25091071	25167867	25763540	26277960	31004979	241133779
		Expected Count	14206840.0	21225209.0	23538259.0	24140639.0	24717415.0	25091071.0	25167867.0	25763540.0	26277960.0	31004979.0	241133779.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	889484.642[a]	9	.000
Likelihood Ratio	908594.572	9	.000
Linear-by-Linear Association	132.789	1	.000
N of Valid Cases	241133779		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 4009877.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.061	.000
	Cramer's V	.061	.000
	Contingency Coefficient	.061	.000
N of Valid Cases		241133779	

6.5.B.5. Chi Square test for Kerosene vs Income 2011

Crosstab

			DECILE11										
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	Total
BC11	.00	Count	14121155	21099441	23377828	23946649	24529247	24855354	24936505	25532681	26047257	30786592	239232709
		Expected Count	14094834.8	21057872.8	23352686.0	23950317.9	24522545.6	24893255.8	24969446.3	25560423.1	26070787.5	30760539.2	239232709.0
	1.00	Count	85685	125769	160431	193991	188168	235717	231362	230859	230703	218387	1901072
		Expected Count	112005.2	167337.2	185573.0	190322.1	194869.4	197815.2	198420.7	203116.9	207172.5	244439.8	1901072.0
Total		Count	14206840	21225210	23538259	24140640	24717415	25091071	25167867	25763540	26277960	31004979	241133781
		Expected Count	14206840.0	21225210.0	23538259.0	24140640.0	24717415.0	25091071.0	25167867.0	25763540.0	26277960.0	31004979.0	241133781.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42522.974[a]	9	.000
Likelihood Ratio	43364.715	9	.000
Linear-by-Linear Association	12380.105	1	.000
N of Valid Cases	241133781		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 112005.2.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.013	.000
	Cramer's V	.013	.000
	Contingency Coefficient	.013	.000
N of Valid Cases		241133781	

6.5.B.6. Chi Square test for Firewood vs Income 2011

Crosstab

			DECILE11										
			10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	Total
FW11	.00	Count	2294955	5193536	7587590	9459249	11744267	13799115	15601349	17730358	19970829	26973475	130354723
		Expected Count	7680088.2	11474154.5	12724567.7	13050209.4	13362009.8	13564004.3	13605519.5	13927534.9	14205625.7	16761009.0	130354723.0
	1.00	Count	11911885	16031673	15950668	14681390	12973149	11291956	9566518	8033182	6307131	4031504	110779056
		Expected Count	6526751.8	9751054.5	10813690.3	11090429.6	11355406.2	11527066.7	11562347.5	11836005.1	12072334.3	14243970.0	110779056.0
Total		Count	14206840	21225209	23538258	24140639	24717416	25091071	25167867	25763540	26277960	31004979	241133779
		Expected Count	14206840.0	21225209.0	23538258.0	24140639.0	24717416.0	25091071.0	25167867.0	25763540.0	26277960.0	31004979.0	241133779.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	44337283.756a	9	.000
Likelihood Ratio	47518135.447	9	.000
Linear-by-Linear Association	44249576.441	1	.000
N of Valid Cases	241133779		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6526752.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.429	.000
	Cramer's V	.429	.000
	Contingency Coefficient	.394	.000
N of Valid Cases		241133779	

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