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Energy Security of Informal Settlements

A case study of Metro Manila

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Abstract

Energy Security of Informal Settlements: A case study of Metro Manila

Karl Andreasson

This study evaluates the energy security of households in informal settlements through an energy security analysis. This is done as a part of the review process of energy security analysis while giving recommendations towards reducing, replacing and restricting. This data is gathered through quantitative survey of energy consumption patterns of informal settlers in Metro Manila with 168 respondents. The study concludes that a push for modern cooking fuels and legal options of electricity suppliers is beneficial for energy security. This transition could to be encouraged by lowering the cost for entry as well as the price per purchase to make these options more affordable and attractive.

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Sammanfattning

Den här studien analyserar energisäkerheten för invånare av informella bosättningar i Manila, Filippinerna. Energisäkerhet är en term som identifierar tillgängligheten, miljöpåverkan och kostnaderna för energianvändningen. Detta brukar användas av länder och stater för att analysera och säkra sin tillgång till energi men analysen är också applicerbar på utsatta grupper såsom fattiga i urbana områden.

Studien genomfördes i samarbete med The Homeless People's Federation of the Philippines, med en enkätundersökning a 168 informella hushåll i Manila som undersökte kostnaderna för energikällor, hushållets inkomst och vilka typer av energi som användes. Resultaten visade på att en stor mängd av hushållen fortfarande använde traditionella matlagningsbränslen som är associerade med att vara ineffektiva och sämre för hälsan

En oroväckande trend som uppdagades var att det fanns en trend för ekonomiska anledningar att röra sig bort från moderna, effektiva matlagningsbränslen till traditionella såsom kol och ved. Samtidigt visade det sig att en stor andel av elektriciteten i informella bosättningar kom från informella källor; andra hands avtal för elförsörjning eller direkt stöld av elektricitet. Studien kommer fram till att det behövs en satsning att göra moderna matlagningsbränslen attraktiva samt öka tillgången till legala medel av elektricitetsförsörjning för att öka energisäkerheten. Denna övergång kan genomföras med att sänka kostnaderna för att få tillgång till matlagningsbränslen samt sänka kostnaden per köp. Likaså måste legala alternativ för elektricitet bli mer kostnadseffektiva och attraktiva för förhållanden av de som bor i urban fattigdom.

Acknowledgements:

This study would not have been possible without the cooperation and inspiration of a large number of people. First I would like to thank my evaluator, Mikael Höök, who introduced me to the concept of energy security and the possibilities within this field of study. I would like to thank Jiwan Acharya, my supervisor at the Asian Development Bank, and the entire Energy for All team that provided me an introduction and an access point to the Philippines. Similarly I owe a huge debt of gratitude to the team at the Homeless People's Federation of the Philippines who in essence carried me through my field study and provided me with a safe and fascinating introduction to the challenges and opportunities of urban development. Last but definitely not least, I would like to thank the members of the informal settlement communities I visited for their incredible generosity and assistance. Due to the survey anonymity I cannot mention any names or neighborhoods but I will remember the opportunity to meet them very fondly. I hope that the results of this survey, however minutely, assists in the development and empowerment of those communities.

~Scio me nihil scire~

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1. Introduction

This chapter will introduce the issue of informal settlements and energy poverty. It will then continue to describe the situation of the megacity Manila in the Philippines before introducing the concept of energy security. This leads to the aim and research questions as well as the outline of this study.

1.1 Background

The world has not yet built 60% of the urban area needed in the year 2030. That is the equivalent of an area the size of South Africa and will mainly occur in medium sized cities in the global south (Elmqvist, 2012). As urban planners, builders and investors scramble to accommodate this incredible influx the poorest usually end up lacking in options. The poorest struggle to acquire accessible and affordable housing to access job opportunities and overcome transport costs. This struggle results in the poorest members of society congregating in certain urban areas.

The technical for these areas are informal settlements and it's increasingly replacing the much more recognizable, and derogatory, term "slum". Informal settlements are where inhabitants face insecurity of tenure, lack access to services such as water or sanitation, social and economic deprivation, and overcrowding. As most situations, women and children are the most vulnerable and the residents are often victims of stigmatization and segregation from the rest of the city. The United Nations (UN) estimates that almost one billion people live in informal settlements: that is 32% of the world's population, and it is expected to grow. (United Nations Human Settlements Program, 2003)

FIGURE 1VIEW FROM THE 3RD FLOOR IN AN INFORMAL SETTLEMENT IN MANILA (PHOTO BY AUTHOR)

Just because these informal settlements are poor it is not to say that there is no economic activity taking place. In these urban areas markets arise in what has come to be called the urban informal economy. In fact it is the informal economy that arises is one often disliked by governments as it does collect any tax revenue. Similarly in society it is shunned as the black market, the unregulated market or the criminal market. (Neuwirth, 2012) There is an element truth to all this. Informal economies are unregulated without labor protection laws, incomes are low, work related risks are greater and there are poor working conditions. There is also a higher degree of

child workers in the informal economy doing low-paid and hazardous work such as waste picking, domestic work and casual labor. (Becker, 2004)

This is also one of the largest economies in the world. The informal economy employs 1.8 billion people around the world. Together it would become the 2nd largest economy, after the United States. As developing countries are projected to be the bulk of economic development over the next 15 years, their cities will then contain 50% of the world's economic growth. (Neuwirth, 2012)

This description paints a bleak picture of future for informal settlers and the informal economy. In few places is this more apparent than in Manila, the capital of the Philippines. While Manila is the capital, its borders expand into other cities creating a mega city called Metro Manila which encompasses 12 cities and 5 municipalities and an estimated population of 10 million (Porio & Crisol, 2004). In this vast city it is estimated that over 700 000 households are considered to be informal settlements without tenure security spread over approximately 330 communities.

In April of 2012, United Nations Secretary-General Ban Ki-moon said that;

"Energy is the golden thread that connects economic growth, social equity, and environmental sustainability … [But] widespread energy poverty condemns billions to darkness, to ill health, to missed opportunities. Energy poverty is a threat to the achievement of the Millennium Development Goals. It is inequitable and unsustainable." (Secretary-General, 2012)

It is therefore relevant to study the energy consumption of informal settlements as a tool to combat the dangers and problems of this rapidly growing segment of our cities. A tool that has grown out of national insecurity of energy supply and demand is the concept of *energy security*. Defined by the IEA as the reliable supply of energy at an affordable price, it has been used by many organisations and nations as a result of volatility in global energy markets (Hughes, 2009). However as the World Bank points out, it is also a tool for economic development and poverty reduction (World Bank, 2005)

Therefore this study will conduct an energy security analysis, not on a region or nation, but the energy security of the informal settlement households of Metro Manila themselves.

1.2 Aim and research questions

This study will, through the use of an energy security analysis, identify problems concerning energy sources, economic access and power factors of Asia's urban poor through a case study of Manila from the perspective of poverty alleviation, minimizing environmental consequences and effective use of energy. This will be accomplished through the following research questions:

1. What is the current energy consumption patterns in informal housing areas?

2. What are the strengths and weaknesses of the different energy sources of informal settlers from an energy security perspective?

This study will concern itself with the review process of energy security analysis while giving recommendations towards reducing, replacing and restricting. This will be accomplished through a quantitative survey of energy consumption patterns of informal settlers in Manila that is analyzed through the theoretical framework of energy security analysis.

1.3 Outline

This study will obtain the research goals and aim by conducting a survey to examine the energy consumption patterns and then applying an energy security analysis on the results. In order to do this an empirical background is also presented with general research of relevant energy sources and their impact in developing countries.

The approach and outline of this study is shown in the figure below:

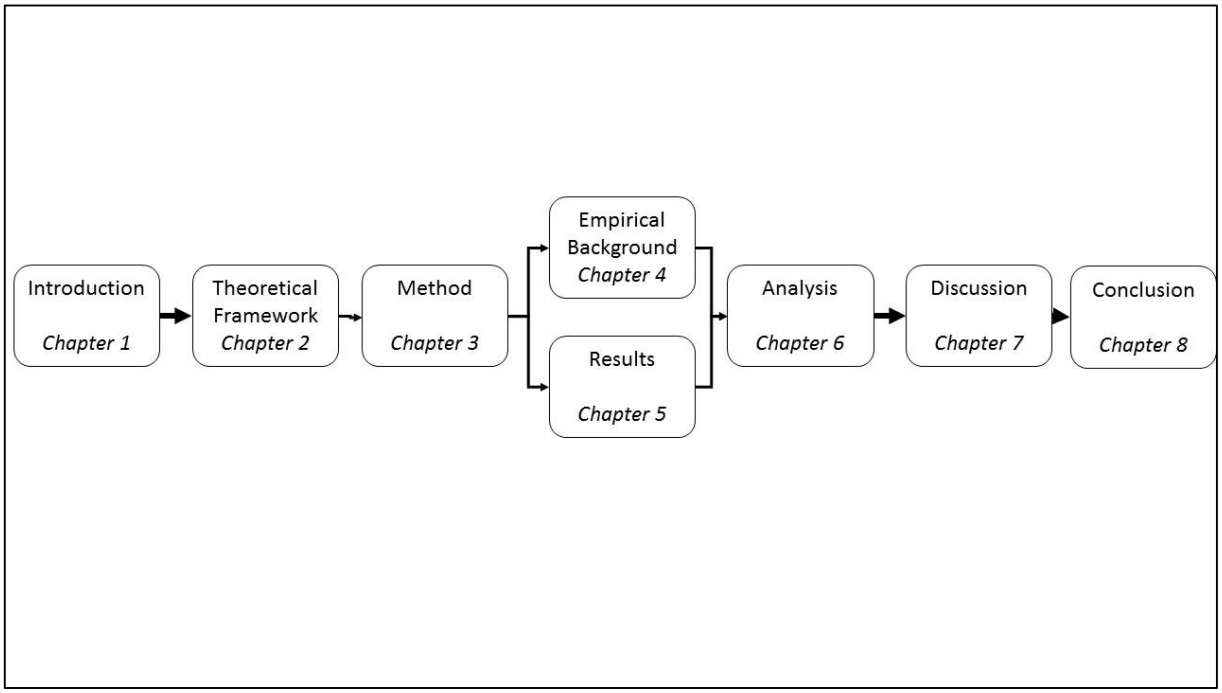

FIGURE 2 STUDY OUTLINE

Chapter 1 provides the background to the study and research motivation. It presents the aim and research questions as well as outline the disposition of the study. Chapter 2 presents the theoretical framework of the energy security analysis by briefly defining the concept and then presenting the analytical framework that will be used in this study.

Chapter 3 covers the method used in this study. This compromises both the methodology of energy security analysis and where this study fits into a comprehensive energy security review, as well as the survey method including the design process and how it was conducted.

Chapter 4 will offer empirical background relevant for this study. This includes various studies and reports that highlight the challenges and dangers of energy sources in developing countries both for cooking and lighting.

Chapter 5 presents the results of the survey questions. Finally, chapter 6 analyses the survey results from the perspective of the energy security analysis framework in order to evaluate the various energy sources from the perspective of households in informal settlements. The discussion is presented in chapter 7 and then concluded in chapter 8 along with some recommendations for further study.

2. Theoretical Framework

This chapter will briefly discuss the definition of energy security and then present a theoretical framework for energy security analysis

2.1 Energy security

Traditionally, nations and governments have used the concept of energy security as a tool to evaluate their energy mix and usage. Society's deepening reliance on energy was built on the idea that energy will always be there. This assumption stands in stark contrast to the growing combination of geopolitical, geological and environmental challenges facing the energy sector of the world today (Bahgat, 2011).

Defined by the IEA as the reliable supply of energy at an affordable price, it has been used by many organisations and nations as a result of volatility in global energy markets (Hughes, 2009). This was most notable after the oil embargo of the 70s as the turmoil in oil supply created a fear of the impact of energy supply disruptions around the world (Bahgat, 2011).

The World Energy Council in London, 2007, defined three sustainability objectives. These are; accessibility to modern, affordable energy for all, availability based on uninterrupted and quality of supply, and acceptability from the perspective of social and environmental goals (World Energy Council 2007, 2007).

This will of course mean different things for different countries but, as the World Bank (2005) stresses, there is a common interest in ensuring that the world can produce and use energy in a sustainable and economic way to ensure the quality of life of the world's people. The World Bank in particular highlights two threats to the current energy paradigm, climate change induced by fossil fuel consumption, and the lack of clean and affordable energy to the poorest in the world community (World Bank, 2005).

This study will take this concept further by applying it instead of a national or regional level, to the household level of informal settlers. Being part of an isolated and segregated community both legally and socially, these marginalized communities face the dangers of energy poverty daily and are therefore suitable candidates for an energy security analysis in order to identify what measures should be taken for a sustainable urban development.

2.2. Energy security analysis.

Energy Security requires a framework in order to use the concept in analysis. Finding a single framework for analysis of widely different systems could prove difficult. The approach for an energy security analysis of a heavily industrialized nation with universal access to electricity may be very different than for a sub Saharan nation with limited electricity access. It is important to stress that changing systems, technologies and social structures may change the requirements for a successful and applicable framework.

This study will utilize the framework presented by Larry Hughes (2011) in his paper "A generic framework for the description and analysis of energy security in an energy system". This consists of a generic framework for an energy security analysis based on three indicators; Availability, Affordability and Acceptability. This mirriors the World Energy Council's goals and follows the definition of the IEA to create a generic framework for study and analysis which will be detailed and defined in this chapter. Larry Hughes metrics are summarized in table 1:

TABLE 1 SUMMARY OF 3 A'S OF ENERGY SECURITY ANALYSIS

Availability	-	Access to energy source
	-	An decrease is detrimental to the energy security
	-	A diversity of availability is positive to energy security as minimizes risk
Affordability	-	Not simply cost of unit of energy but relative to target's purchasing power.
	-	Larger percentage of income needed to meet energy need is regarded as less secure.
Acceptability	-	Security in terms of how energy sources respect environmental concerns.
	-	Also health risks and perceived risk of disasters.

Availability encompasses the access of energy. It is dependent on economic, geographic and technical factors (Hughes, 2011). A decline in the availability of an energy flow can be detrimental to the system's energy security. Similarly an increase in availability diversity is positive to the system in terms of energy security as it minimizes the risks of few sources.

Affordability as an indicator is slightly more complicated as it is not simply defined as the cost of a unit of energy but how affordable it is in terms of the consumer's purchasing power (Hughes, 2011). It is more appropriate to look at the buyer's income and its relation to the cost of energy required. The larger the percentage of income required to meet energy need. Regardless if the base indicator for affordability is on country, supranational or household level; a higher per unit energy cost is regarded as less secure.

Acceptability is the last indicator refers to security in terms of energy sources that respect environmental concerns (Hughes, 2011). The more environmental harmful output from using a certain type of energy in a system the lower the indicator of energy security. This indicator has a political and social aspects that can be based on opinions rather than facts. This includes health risks and risk of disasters. Reasons for acceptability may be stability of supplier or perceived or anticipated environmental impacts.

These 3 A's of Energy Security Analysis; Availability, Acceptability and Affordability, give us a staging point for discussion and analysis of a target group's strengths and weaknesses when it comes to energy consumption.

3. Method

This chapter will first identify the role of this study in the broader context of a complete energy security analysis. Thereafter it will describe the process of designing and conducting the survey utilized in this study.

3.1 Methodology of energy security analysis

As the concept of energy security is become more used several misconceptions arise. In the media many debates rage over issues as varied as nuclear power, climate change and oil prices. As the issue of energy security becomes more important to lawmakers, policymakers and the general public, it is important to clear up any misconceptions and lack of understanding of energy fundamentals. Larry Hughes (2009) presents a methodology for explaining and improving energy security called the four 'R's;

1. Review (understand the problem)
2. Reduce (use less energy)
3. Replace (shifting to secure sources)
4. Restrict (limiting new demand to secure sources)

Review consists of understanding the problem. In this phase energy security is scrutinized for a system by looking at existing sources and suppliers as well the infrastructure supporting this. This includes the energy services such as heating, appliances and lighting, which should be considered individually. Finally other energy sources should be reviewed for feasibility and potential energy security.

Reduce includes actions that reduce demand for energy which in turn has an impact on energy security. The two ways to do this is energy conservation or energy efficiency. Energy conservation means limiting production or services in order to put a cap on energy consumption. Increasing energy efficiency on the other hand keeps the same level of production or services but using less energy to do so. This is more difficult and expensive but is more sustainable and acceptable for society while conservation reduces the lifestyle level and is rather short-lived in a democracy.

Replace means shifting to new sources that have been determined to be more secure in the review phase. This is done through diversifying existing energy sources or by restructuring the infrastructure to support alternative sources. Energy diversification is not a new concept as Winston Churchill said in 1910 "Safety and certainty in oil lie in variety and variety alone". This was also done by the United States during the oil crisis of the 70s when Middle Eastern oil was replaced by supplies from Canada, Venuzuela, Mexico and Nigeria. Altering infrastructure on the other hand is more complicated and expensive but has also been done. Again in the 70s large investments in nuclear and coal plants were made to replace oil.

Restrict, the final phase, is about limiting new demand. Unlike replacing, which refers to existing demand, restriction is used to limit new demand to only use secure sources. This is rather difficult as secure energy sources or infrastructure are scarce and may not meet demand. There is then a choice between limiting growth, or the more commonly chosen alternative; maximizing use of a secure source while allowing the remaining demand to be dependent of an insecure source.

3.2 Survey

This study will conduct a survey of households in informal settlements in Manila in order to assess the current state of energy consumption. This information will then be used in order to analyze the energy security of informal settlers.

3.2.1 Survey Scope and Purpose

The survey was conducted in cooperation with the Homeless Peoples Federation of the Philippines (HPFP). The Federation is a network of 161 communities, encompassing almost 70 000 individuals, of urban poor connecting their various community associations and savings groups (Rayos, 2010, vi). The HPFP stretches across 18 cities and 15 municipalities across the country. The member groups promote community savings internally in order to invest in community development and social cohesion. The HPFP works externally in order to secure land tenure for its members, renovating and building homes, and increasing economic opportunity (Rayos, 2010).

This network of local community groups made the HPFP the ideal partner in conducting the survey. A HPFP agent guided the author to the various research areas and made the introduction to the local HPFP representative who is a member of the community. The local representative in turn acted as guides and made contact with neighbors and households that would offer time to answer the survey.

Figure 3 Road through an Informal Settlement in Manila with kiosk and laundry washing service (Photo by Author)

Working in informal settlements is no easy task and consideration had to be given to several factors. Access was largely defined by the HPFP and their programs and local offices. Without this cooperation it would have been impossible to gain the trust and acceptance necessary for a survey to be conducted by a foreign researcher. Informal Settlements in Manila also pose a considerable security risk to foreigners attempting to gain access due to the high crime rates

and poverty. This was circumvented in part due to the author being a guest of the organizations in question, gaining protection through social structures, as well as strict considerations of which time of day, and areas, to visit.

In order to sustain the trust and cooperation necessary when researching sensitive topics such as income, economic status, energy use and the potential for illegal electricity access there is a large risk associated with answering the survey. It could either incriminate households or even neighborhoods to electricity theft. Therefore this study ensured complete anonymity for both the individual households and which areas were visited. This was agreed upon by both the HPFP and the author before the study was conducted. With all this in mind and the time available for field work, a goal of 150 survey responses was set which eventually was exceeded with 168 respondents from eight different settlements.

According to Robert Groves (2009), there are 5 primary questions to ask when conducting a new survey. The questions and responses for this study are found below:

1) What is the target population? (Whom is it studying?)
    - Informal settler households associated with the areas networked into the HPFP
2) What is the sampling frame (how do they identify the people who have a chance to be included in the survey)?
    - Any household in the identified informal settlements were eligible. However as far as it was possible, care was taken to maintain a sample size of approximately twenty in each area visited so no one area would gain undue influence in the statistics. In the end 168 respondents were drawn from 8 areas.
3) What is the sample design (how do they select the respondents?)
    - Sample design was due to the changing situations of the field study primarily random and circumstantial. It is possible preference was given to community members thought more likely to cooperate by the HPFP local representative. Therefore effort was taken to randomize the path in the informal settlement by the author.
4) What is the mode of data collection (how do they collect data)?
    - The data was collected through short interviews fulfilling the survey by the author. In most cases the HPFP agent was used as a translator except in the circumstances when the interviewee spoke English or Spanish.
5) Is it an ongoing survey or one-time survey?
    - This was a one-time survey providing a brief reflection for the review process of energy security analysis. It resulted in 168 responses from four informal settlement areas in the greater Manila area.

This survey therefore had the aim of identifying the income and size of each household, the energy sources used for both cooking and lighting, the cost and procurement methods for each energy source as well as which appliances were available.

3.2.3 Survey Design

In evaluating the survey questions Robert Groves (2009) identify three distinct standards that the survey questions should meet.

1. Content standards (e.g., are the questions asking about the right things?)
2. Cognitive standards (e.g., do respondents understand the questions consistently; do they have the information required to answer them; are they willing and able to formulate answers to the questions?)

3. Usability standards (e.g., can respondents and interviewers, if they are used, complete the questionnaire easily and as they were intended to?)

In order to achieve these goals the survey was co-created with representatives from ADB's "Energy for All" team with experience with surveys and the situation in the informal settlements of Manila. Together with the author, this influenced the content standard and what questions were required to acquire an understanding of the household's energy consumptions.

Secondly, the formulations of the questions were iteratively redesigned in order to improve the cognitive standard and usability standard in cooperation with experts from ADB. A great instance of this is the question of household income, which was redesigned several times before the survey was conducted. There are numerous problems with this question; many work intermittently, some activities are not considered work yet generate income and there may be stigma associated with some types of jobs. Now, this formulation does not solve all those problems but it does attempt to circumvent the bias. If the survey asks what your household's monthly income is, the answer would be an estimate or only take into consideration the primary income generator. By instead splitting it up into the household's members, as well as having a time frame that the respondent present themselves, the monthly income can be calculated afterwards.

For example, a household with a taxi driver as main income provider could calculate or estimate the monthly income themselves. Instead, by splitting up household member, how often they work, and income the respondent answers in numbers that are familiar to them. Say the taxi driver works 6 days a week and they expect x pesos a day, the monthly income can then be calculated. At the same time more information may be offered such as that their brother also works part time as in construction.

Finally the survey was translated into the local *lingua franca* of Tagalog as seen in italics under the questions. This was done in order to minimize any misunderstanding between the author and HPFP agent in order to make sure the translations and technical terms aligned.

Similarly, after the first two field days where the survey was conducted, the survey was reviewed by the same team at ADB and the preliminary results investigated. From this discussion the decision was made to add the question concerning if the respondent had changed their cooking fuel in the last five years. This had arisen from comments and observations in the field as people utilized charcoal but owned a gas stove. The possibility of people moving from more advanced to less advanced cooking fuels worried the ADB team and was decided to be incorporated

This iterative design process resulted in the survey shown in full in Appendix A.

4. Empirical Background

In this chapter the study will present and analyze current trends in energy solutions worldwide and its repercussions on development. The dangers and benefits of each energy source is examined by relevant literature and studies.

4.1 Traditional Cooking Fuels

Traditional cooking fuels are generally composed of biomass. The survey respondents used primarily two types of traditional cooking fuels that will be discussed here; charcoal and what was called "fuelwood". Charcoal is usually harvested from trees outside of the city, burnt to produce the coal and then transported in for sale. However, fuelwood was a generic term encompassing both biomass, such as branches and logs, gathered by those living in the outskirts of the city, and wood collected through scavenging activities among the city's dumpsites.

Traditional cooking fuels are regarded as negative in the development context. This is not for the use of biomass but rather the unsustainable gathering of biomass and the dirty and inefficient conversion to useful energy during small scale combustion. (Foell, et al., 2011)

Globally approximately 1.5 million people die every year prematurely due to exposure to indoor air pollution as a result of the inefficient combustion of traditional cooking fuels. This affects disproportionally women and children as they are considered responsible for the cooking as well as the physical labor of collecting biomass. (Foell, et al., 2011) In fact this outstrips both deaths from Tuberculosis and Malaria but lags behind HIV/AIDS. Unfortunately even as the deaths from these diseases are all expected to drop according by 2030, the premature deaths from air pollution are expected to continue to rise as can be seen in the figure below.

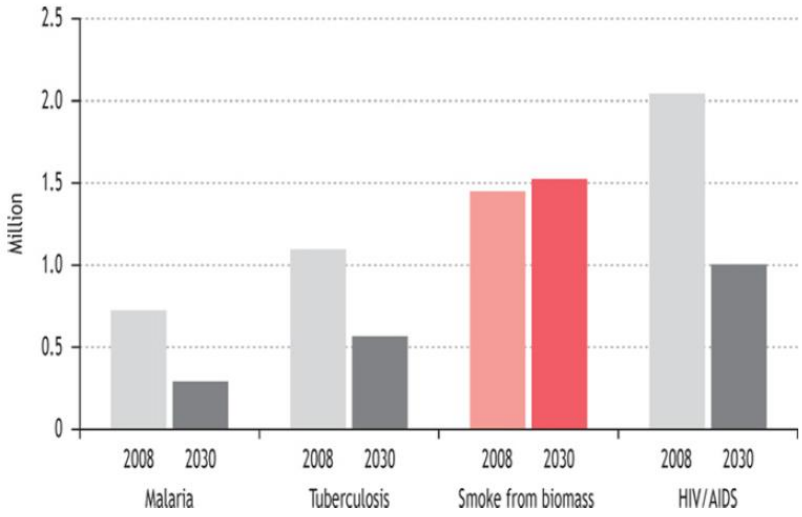

FIGURE 4 PREMATURE ANNUAL DEATHS FROM HOUSEHOLD AIR POLLUTION AND OTHER DISEASES (FOELL, ET AL., 2011, P7488)

Traditional cooking fuels also put a huge pressure on the environment both locally and regionally contributing to deforestation and putting pressure on the ecosystem. (Foell, et al., 2011) This is especially true in urban areas with high population density and thus high demand. This can lead to weakening of the soil causing mudslides, soil degradation or even desertification. (Global Alliance for Clean Cookstoves, n.d.)

Similarly inefficient cooking contributes to climate change. By not completely combusting the biomass, the carbon is not released purely as CO2 but also as methane and particulates known as black carbon. Both methane and black carbon have short lifespans in the atmosphere but are estimated to contribute to between 25-50% of global CO2 warming. (Global Alliance for Clean Cookstoves, n.d.)

In order to address this problem two complementary approaches are proposed (Foell, et al., 2011).

1. "Promoting more efficient and sustainable use of traditional biomass;
2. Encouraging people to switch to modern cooking fuels and technologies."

More efficient stoves could minimize the health and environmental impacts due to burning the biomass more efficiently as well as requiring less fuel. However this still has an impact. Secondly one could promote the transition to modern cooking fuels and technologies. These are primarily considered to be LPG and kerosene but could also apply to a range of modern biofuels such as ethanol and biogas. (Foell, et al., 2011)

4. 2 Modern Cooking Fuels

Modern cooking fuels in the development context are considered to be a "step up" the energy ladder. These fuels typically consist of Liquid Petroleum Gas (LPG) and Kerosene, sometimes known as paraffin. LPGs are, as the name suggests, is a petroleum gas that is liquefied under pressure as it otherwise boils at regular temperature and atmosphere. This is stored in a metal pressurized canister where the gas is then combusted for heat. Kerosene is a petroleum liquid that sometimes is used to power jet engines but is used to cooking, lighting and heating around the world. In figure 5, we can see the comparative exposure of particulate matter (PM) of traditional cooking fuels compared to kerosene and LPG.

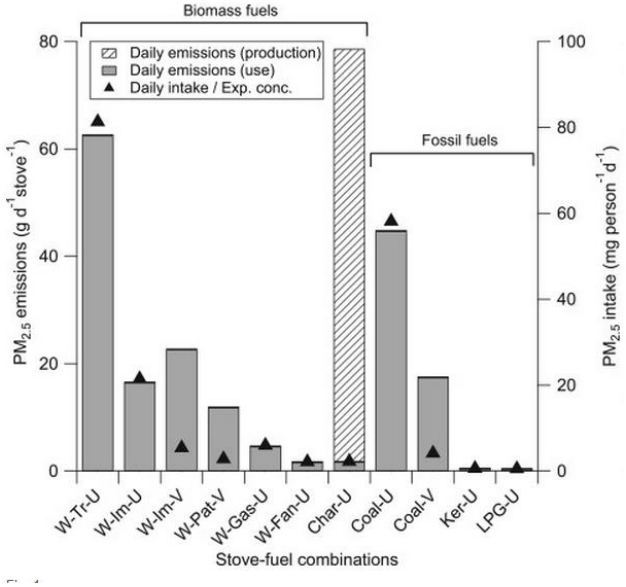

FIGURE 5 CALCULATIONS OF PARTICLE MATTER EMISSIONS AND INDIVIDUAL INTAKE FOR VARIOUS COOKING FUELS. ADAPTED FROM (GRIESHOP, ET AL., 2011)

These modern fuels are still fossil fuels and do impact climate change but they have a lesser impact on health and climate than traditional cooking fuels, even the most efficient ones. One study compared the Global Warming Commitment (GWC) and Particulate Matter exposure of

both LPG and Kerosne and concluded that they have "… the lowest GWC other than the cleanest biomass-burning stoves operating on renewable biomass. These stoves also yield the lowest exposures. Perhaps, counterintuitively, fossil fuel options may be the cleanest options for health and for climate change. (Grieshop, et al., 2011)" This result can be seen in figure 6 which compares the same cooking fuels and stoves to GWC.

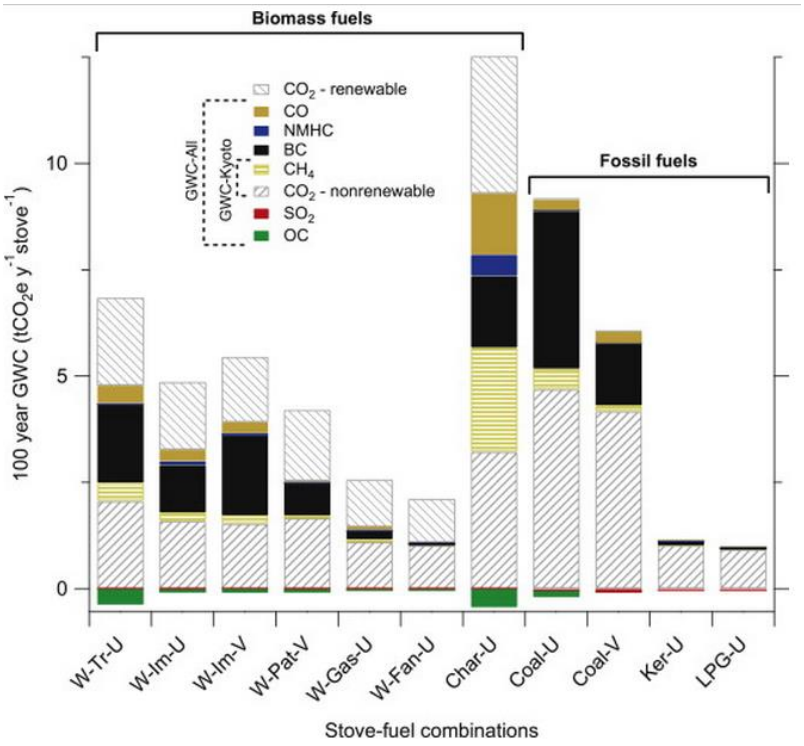

FIGURE 6 CALCULATIONS FOR GLOBAL WARMING COMMITMENT FOR VARIOUS COOKING FUELS (GRIESHOP, ET ., 2011)

In order to aid the transition to LPG and modern cooking fuels, one study analysed the measures necessary to make it easier to adapt, and pay for LPG technology in poor areas. These suggestions included reducing the price or deposit for the LPG container and burner to make it easier to adopt the technology. Similarly it encourage the production of smaller LPG containers in order to make the cost of each purchase decrease. It also encouraged the development of local knowledge of the technology as well as local manufacturing and bottling in order to decrease costs. (Bazilian, et al., 2011)

4.3 Electricity from the grid

Electricity is the energy source and fuel we take most for granted in the West. However in the setting of informal settlements it becomes an incredibly complex and difficult resource to manage due to the lack of centralized electricity grids and monitoring. In order to gain a deeper understanding for these issues this study will present a leading report on the current trends regarding informal settlements and electricity access.

The United States Agency for International Development (USAID) report (2004) to innovative approaches to slum electrification details the challenges facing informal settlement electrification from a consumer and provider perspective through analysis of five innovative programs providing electricity to low income households.

Traditional approaches for providing electricity to urban poor usually involves three stakeholders; the government, the electricity provider, and the low income informal settler

(USAID, 2004). The problem is that in informal settlements this approach fails due to the socioeconomic conditions and governing structure. Due the highly informal economy, unregulated by government, governments are uneager to promote electricity as that is an indication of a settlements permanency. Therefore services that are provided to regular residential areas are not provided for slums. The informal market then rises to meet the demand providing illegal vital services such as water and electricity.

Similarly electricity suppliers are unwilling to invest in informal settlements. This is due to the challenging physical conditions and the question if legal tenure. This makes it difficult to guarantee long payback times for capital costs while also making right of way issues for distribution infrastructure legally difficult. The narrow alleys and paths typical in informal settlements make traditional approaches to electrification difficult and raises costs. Even if these challenges are met, electric companies are unsure of a customer base that at best can provide low revenue as large amounts of energy are generally unaffordable.

The paper presents five different case studies of what they call innovative approaches to slum electrification from three different continents. Two from Brazil in the efforts of supplying the favelas with electricity, both in Rio and Salvador and one each on slum electrification from; Manila in the Philippines, Cape Town in South Africa and Ahmedabad in India. Although the programs varied they all provided lessons to what approaches were successful and which challenges are faced. USAID identifies 6 lessons from these case studies (USAID, 2004).

1) *Engaging all stakeholders:* The successful case studies made an effort to reach out to a broader range of stakeholders. By including government, electricity suppliers, communities and consumers. Government these approaches were a mean of meeting service targets for the urban poor. Electricity suppliers were interested in reducing non-technical losses and increase revenues. Communities saw an opportunity for increased socioeconomic status and consumers found a legal way of acquiring a service.
2) *Designing for Slum Conditions:* The challenging physical conditions of informal settlements such as narrow paths, poor materials and unsafe wiring need to be considered in the solution.
3) *Partnering with Intermediaries:* All successful programs used intermediaries to varying degrees in order to make sure the electricity supplier and other stakeholders understood the starting conditions for the program, identified the problems with traditional connection and supply that often made the stakeholders suspicious of each other, coordinate the various interest in program design. The particular form of intermediaries varies in each case study and in several cases programs questioned if the intermediary is even necessary. However in the cases that tried without an intermediary the same results were not achieved.
4) *Competing with Illegal Service Providers and Controlling Theft:* The study identifies that electricity theft is so commonplace because in many situations it is simply easier to obtain power illegally due to so many limitations and barriers to legal connection. Each electricity supplier must compete with illegal access in terms of; price, ease of payment, quality, reliability and accessibility of service. Similarly each program had to design specific program components and technology to overcome the already entrenched practice of theft and hinder its proliferation.
5) *Making it Easier to Pay for Electricity:* Common to all case studies the electricity supplier had to redesign their payment scheme to adapt to the uncertain income of informal settlers. Making customer service centers easily available was also a common theme. All case studies involved subsidizing or financing of connection fees.
6) *Lowering Costs to the Electricity Company:* Common to all electricity suppliers was that they identified ways to reduce the cost of connection to informal settlers.

4.3 Energy Efficiency

Energy efficiency is a vital tool as it leads to increased energy security. However it is not completely simple despite its many positive benefits. The IEA report "Spreading the Net: The multiple benefits of energy efficiency improvements" (Cambell, 2012), details the various levels where energy efficiency has a positive impact. This chapter will outline the various benefits identified by the authors for the IEA as well as a mayor detraction from seeing benefits in energy efficiency also known as the rebound effect. The IEA summarize these benefits in figure 7(Campbell, 2012, p8)

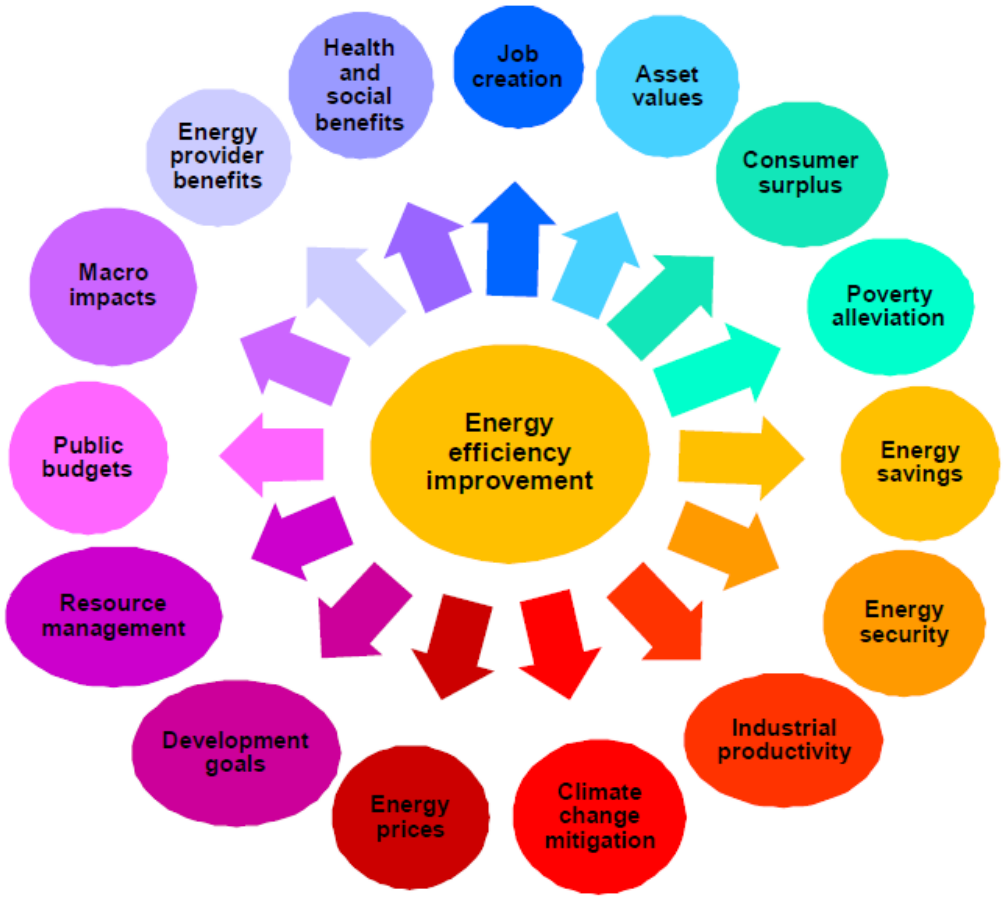

Figure 7 The multiple benefits of energy efficiency (Cambell, 2012, p8)

4.3.1 Benefits of Energy Efficiency

The full range of outcomes from energy efficiency is not often evaluated. This is due to several factors influencing such calculations. Several benefits are not directly related to the market, instead improving social or environmental factors. This renders some traditional accounting models non-applicable. Similarly many such benefits are not easily traced in terms of causality. Nevertheless the IEA identifies four levels of benefits; individual, sectoral, national and international. Due to the scope and limits of this study focus will lie on individual and sectoral benefits. It is important to note that benefit from supply or consumption side efficiency has a ripple effect that carries over into other levels. For example efficiency on the consumer side

leads to individual increase in disposable income which in turn leads to macroeconomic benefits. (Cambell, 2012) For the scope and relevance to this study, the individual and sectorial benefits will be discussed.

Individual level
Individual level benefits are those applicable that aid individuals, households and companies. This report identifies three main types. Firstly there is a strong resulting benefit for health and wellbeing from energy efficiency in residential sectors. In particular respiratory illnesses and asthma from poorly heated houses or air pollution from transport can be mitigated with energy efficiency efforts. (Cambell, 2012) For example replacing traditional biomass cook stoves with energy efficient ones would reduce fuel costs as well as the burden on time, health and the environment.

The second benefit retains to poverty alleviation in the sense of access to energy services. Adequate energy services provide the raw materials for social and economic development. This is mostly related to developing countries that can see the benefit of efficiency to increase access to energy. By increasing supply side efficiency one can reach more households by freeing up additional resources and reducing technical losses (Ibid).

Finally energy efficiency leads to an increase in disposable income. More efficient energy use will result in a reduced energy bill for the same consumption. This in turn translates to a more readily available disposable income. This surplus can result in three actions by the consumer; save the money, spend the money on non-energy activities, or spend the money on more energy intensive activities. The last option is a direct rebound effect as energy efficiency results in more energy used (Cambell, 2012).

Sectoral level
Benefits on a sectoral level are benefits that occur at the scale of a sector such as residential or industrial. These benefits may trickle up to the national level but can also be offset by a decrease in other sectors. There are three main benefits for the sectoral level (Cambell, 2012).

Firstly industrial productivity and competitiveness increases with energy efficiency. These could be increased profit, improved quality and quantity of output and reduced operating costs. This also leads to reduced pollution and reduced resource use. All of these benefits are positive for productivity and competitiveness and it is interesting to note that these improvements are motivated by company gain not governmental regulation.

These type of energy efficiency programs could seem to be detrimental to the energy sector. However studies show that as much as 10% of energy efficiency benefits go directly to the providers. By researching more customers, reducing operating cost a company can improve the profit margin. This is the second benefit; Energy provider and infrastructure

The last benefit to the sectoral level is an increase in asset value. This is simply due to evidence that investors are likely to pay a higher rental and price for energy efficient property and assets. "Green" buildings have increased resale value and rental rates. This is also reflected in the transport industry with consumer choice of vehicles.

4.4.2 The Rebound Effect
The IEA report does admit that despite the large number of benefits to energy security as discussed above, there is legitimate criticism that these benefits are not realized. The claim is that improvements in energy efficiency does not translate into benefits but are instead undermined by increased consumption and expenditure is called the rebound effect (Cambell, 2012).

However the criticism is slightly misleading. The multiple benefits of energy efficiency improvements suggests according to this reports that energy savings can push the progress of other policy goals. Many benefits such as poverty alleviation, health improvements, increase in disposable income, and development goals have an energy consumption requirement and drive the rebound effect. But from a societies perspective these are part of the positive overall outcome. If the effects are positive to society this criticism is largely invalid. It still remains important to consider the rebound effect in energy saving policy planning and accounting but it does not impede the achievement of socioeconomic goals (Ibid).

5. Results

This chapter will detail the results from the survey as well as additional relevant information to put the information in context. This will be presented by the three main groupings of questions: Income, Cooking and Lighting. The survey had 168 responses from 7 areas of four informal settlements in the greater Manila area. Due to the necessity of anonymity, due to the fear of retribution, there is no breakdown of different areas or any identification of those areas.

5.1 Household and Income

This section will focus on the size of the household and the income of each household as per the results in the survey. For reference, at the time of writing, the exchange rate is approximately 43PHP to 1 US$ or 6.5 PHP to 1 SEK. .The mean size of each household is 5.7 members with a standard deviation (σ) of 2.6. The mean income of each household is 12 533 Philippine Pesos (PHP) with σ = 9721 PHP.

FIGURE 8 YOUNG MEN SCAVENGING RECYCLABLE MATERIALS FROM A CANAL FLOWING THROUGH AN INFORMAL SETTLEMENT IN MANILA (PHOTO BY AUTHOR)

This large standard deviation is unsettling and is descriptive of the uncertainty of the income gathering data. This is due to many factors, some may exaggerate their wealth as a status symbol whilst others may hide income that is generated from illegal or socially unacceptable activities. The distribution is seen in figure 9:

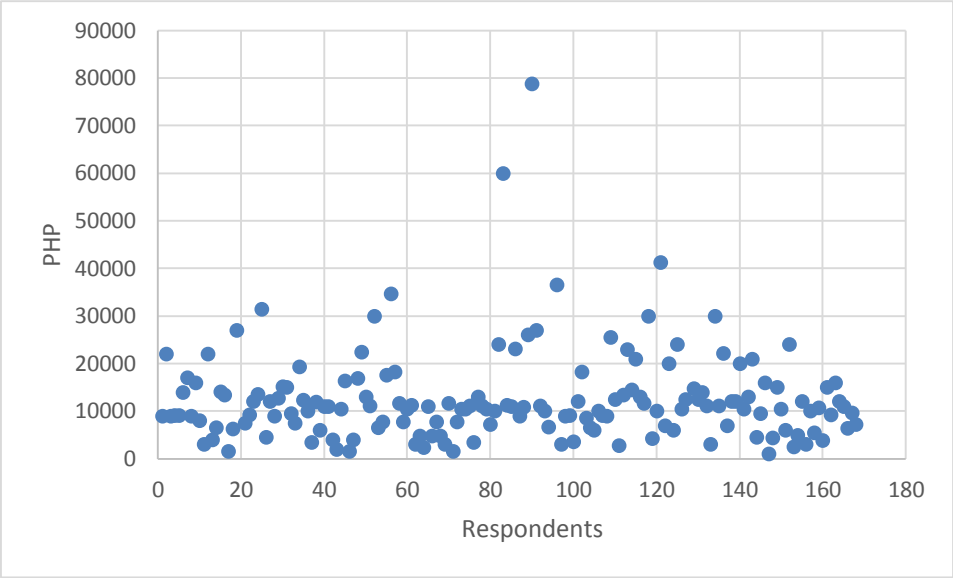

FIGURE 9 HOUSEHOLD INCOME AND RESPONDENTS

In this graph we can see two clear outliers with an income of above 60 000 PHP and almost 80 000 PHP apiece. These may be exaggerated numbers or true but they are not indicative of the general trend and are removed for this data set. Without the outliers the mean household income is 11 836 PHP and σ = 7377 PHP

This is still a large deviation but it is indicative of the variety of the informal settlements. However this number hides a stark reality. At current exchange rates at time of writing this converts to a mean income of 282 US$ per month. With a mean household size of 5.7 this translates to only 1.65US$ per person per day. The UN defines extreme poverty as living on less than 1.25US$ per day (United Nations, 2013).

5.2 Cooking

This section will detail the fuel types and their costs. Figure 10 shows the various cooking fuels used;

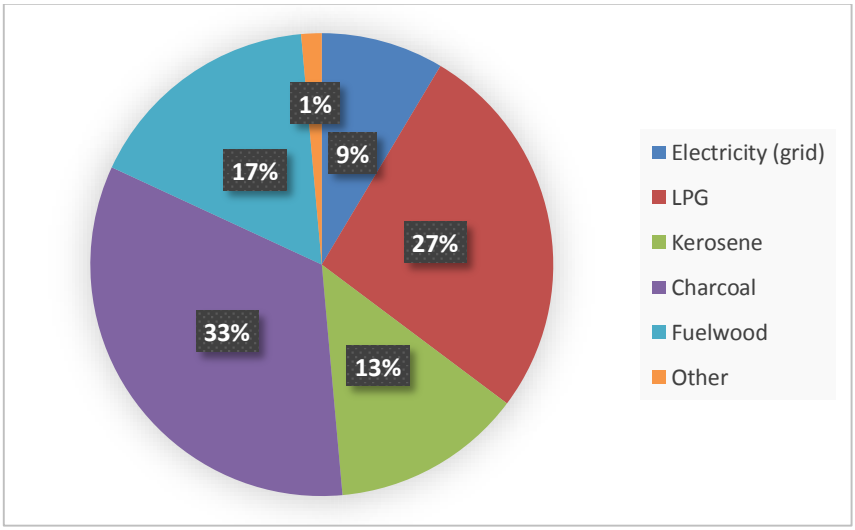

FIGURE 10 COOKING FUEL

As you can see above the most common form of cooking fuel in the survey is charcoal with 33% of respondents. This is closely followed by the modern cooking fuel LPG before fuelwood and Kerosene respectively.

Table 2 summarizes the mean and standard deviation of the cost of the cooking fuel as a percentage of the household's income.

TABLE 2 COOKING FUEL COSTS AS PERCENTAGE OF INCOME

Cooking Fuel	Mean cost (% of income)	σ (%)
Charcoal	9.2	11.2
Fuelwood	0	-
LPG	4.4	4.4
Kerosene	6.8	6.1
Electricity (Grid)	0	-

In this table we can see that fuelwood and electricity do not have any cost associated with them. This is because fuelwood is commonly gathered, either as biomass from trees or shrubs, or it is scavenged from dumpsites as old furniture or building materials. The increased health hazard of burning refined wood and construction materials is hard to quantify but must be considered a danger due to the other additives that produce harmful smoke such as paint or glue. Electricity is also at 0 simply because the respondents using electricity for cooking were getting their electricity for free by stealing it off other power lines.

FIGURE 11 LPG COOKING STOVE (PHOTO BY AUTHOR)

Figure 12 illustrates the changes in household cooking fuel over the past 5 years. Each fuel source indicates what the respondent was using before and is then no longer using, having replaced it with another fuel.

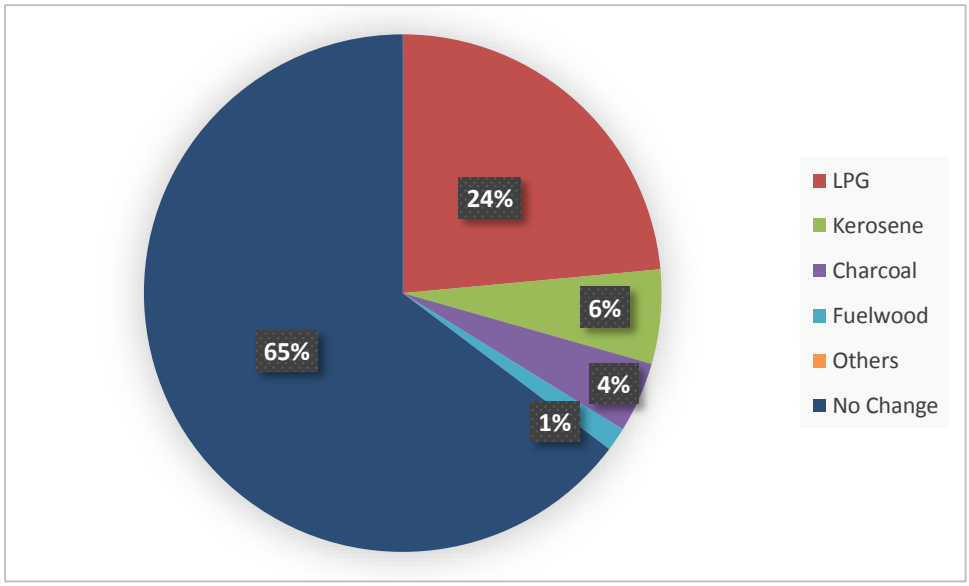

FIGURE 12 CHANGE IN COOKING FUEL (PAST 5 YEARS)

As we can see a majority, 65% have had no change in their fuel source over the last five years. There are a few traditional fuel users who have changed with respondents answering charcoal and fuelwood with 4% and 1 % respectively. Unfortunately 30% of respondents have indicated a change away from the modern cooking fuels of LPG (24%) and Kerosene (6%).

5.3 Lighting

This section will present the data concerning lighting; its energy types, costs and what other appliances the households have.

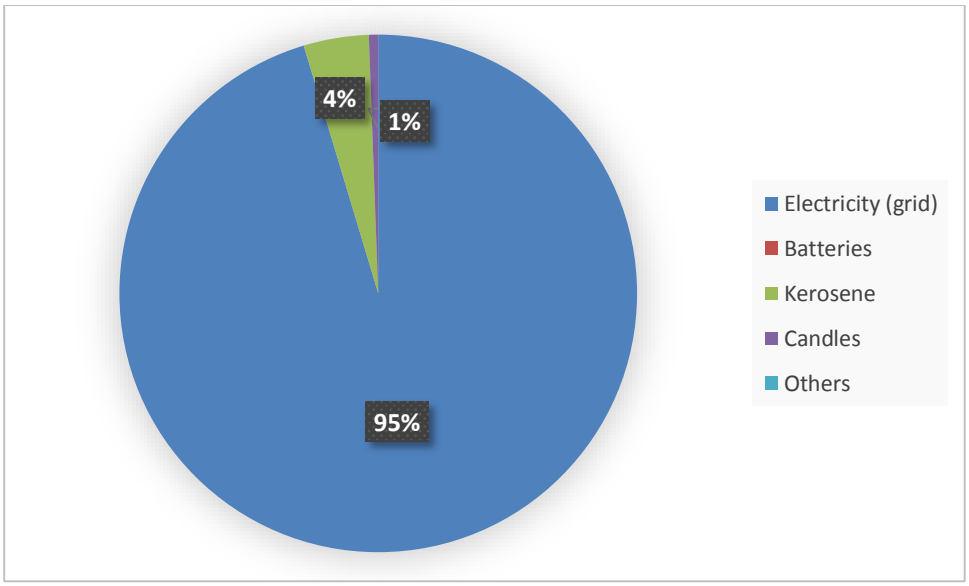

FIGURE 13 LIGHTING FUELS AS PERCENTAGE OF TOTAL RESPONDENTS

As seen in figure 13 the overwhelming majority of the respondents utilize electricity from the grid for their lighting needs. A few use kerosene and one respondent used candles but this is a minute minority. However that is not the complete picture as there are several ways for informal settlers to acquire electricity. During the course of the survey, and through informal talks with the ADB team and respondents in the informal settlements, three ways to acquire electricity was identified; Formal, Informal and Free. The ratios of each are shown in figure 14.

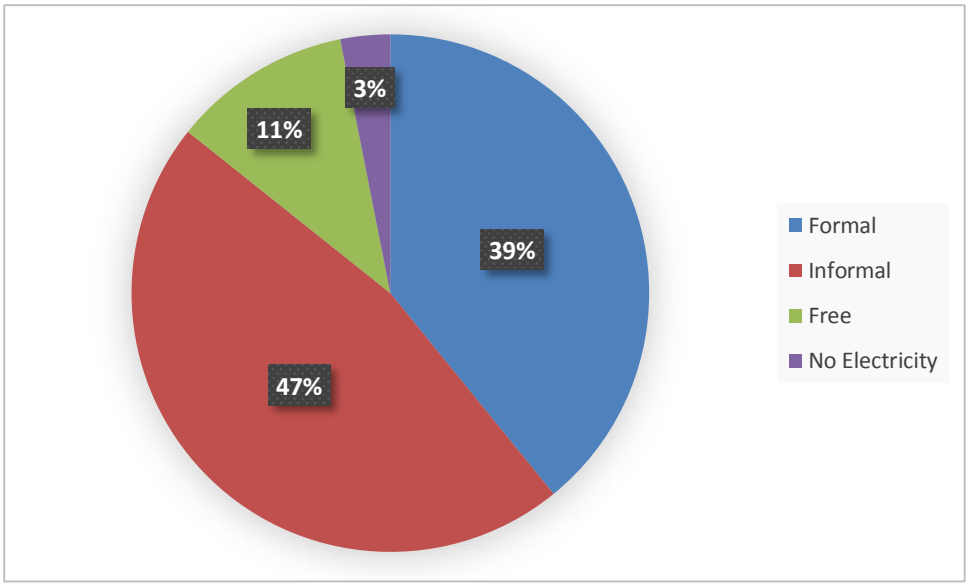

FIGURE 14 ELECTRICITY SOURCES BY PROVISION TYPE

Formal electricity sources encompass 39% of respondents and is when the household has a direct contract with an electricity service providers. This usually entails a meter that details the amount consumed and payments are done accordingly.

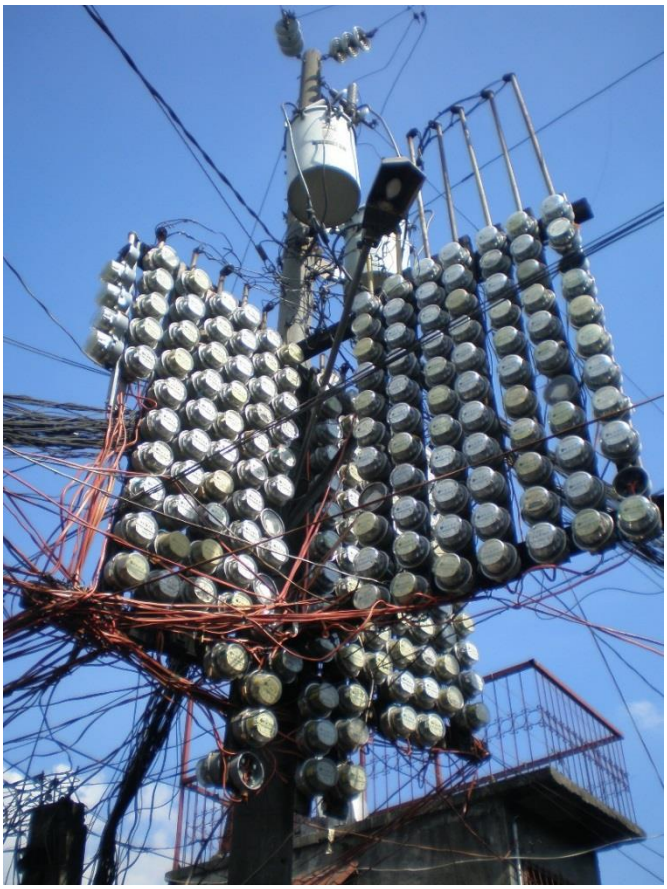

FIGURE 15 METERS AND SUBMETERS IN AN INFORMAL SETTLMENT (PHOTO BY AUTHOR)

Informal electricity provision is the largest group with 47% of respondents. However it does not necessarily mean it is illegal. By informal electricity sources the household acquires electricity through a 3rd party that is not an electricity service providing company. This could

be an individual that has a formal electricity provision and then in turn sells it forward to other households for a profit, which sometimes occurs with the parent company's blessing as a means of increasing distribution. It could also entail individuals who tap into the electric wires and steal electricity before selling it on to other households.

Last is the group of households that have free electricity which encompasses 11% of respondents. This is probably an underrepresented group as it was difficult for the author to gain the amount of trust necessary for respondents to confide to stealing electricity. It is very possible that this is overlapping with the respondents who identified as informal electricity consumers. Similarly the fear of retribution by electricity companies or informal providers may have impacted the accuracy of this number. This was conveyed using a number of descriptions such as "unlimited electricity" or that they had "a good deal". This is a risky endeavor as electricity providers may find and disconnect illegal connections as well as the increased risk of fires due to faulty wiring.

Table 3 summarizes the mean and standard deviation of the cost of the electricity provision as a percentage of the household's income.

TABLE 3 ELECTRICITY COSTS AS % OF INCOME

Electricity provision	Mean cost (% of income)	σ (%)
Formal	8.5	5.4
Informal	6.6	5.4
Free	0	-
No Electricity	12.7	16.1

The vast majority of households in the informal settlements studied have access to electricity and, in most cases, are prepared to pay a large amount of their incomes for this energy source. Although the questions were centered on lighting, it is important to note that the electricity is used for a wide range of appliances. The most common of which can be seen in figure 16.

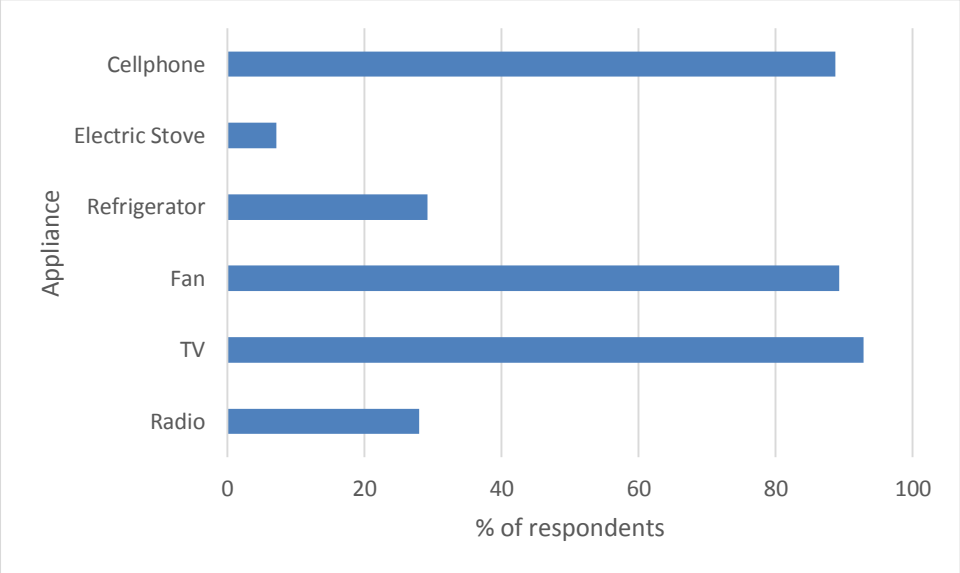

FIGURE 16 OWNERSHIP OF APPLIANCES

As we can see from figure 16, appliances such as cellphones, televisions and fans are almost universal even in informal settlements. There is also the presence of various appliances such as radios or refrigerators.

6. Analysis

This chapter will analyze the findings of the survey and case study of Manila from an Energy Security perspective. There are two main groupings of energy uses; Cooking and Lighting. Each one of these will be reviewed from the three A's of Energy Security; A3 A's of Energy Security Analysis; Availability, Acceptability and Affordability.

6.1 Cooking Fuels

As we can see in the results chapter there is a definitive distinction between cooking fuels exist between traditional cooking methods, primarily charcoal and fuelwood in this survey, and modern cooking fuels, primarily LPG and kerosene. These will each be analyzed separately from an energy security standpoint and the results discussed. Table 4 summarizes the traditional cooking fuels from an energy security perspective.

TABLE 4 ENERGY SECURITY ANALYSIS OF TRADITIONAL COOKING FUELS

	Charcoal	**Fuelwood**
Availability	- Easily accessible and established market - Bought in small quantities almost daily.	- Availability widely varies, - Large amount of work required to collect both from recycling trash and from forests or trees.
Affordability	- Despite a small daily cost the percentage of income per month is relatively high at 9.2%	- Picked up for free, - This does not factor in lost productivity while scavenging
Acceptability	- Health risks of when poorly combusted. - Leads to local and regional deforestation as well as contributing to climate change	- Health risks when poorly combusted. Health risks of burning scavenged wood is undocumented - Leads to local and regional deforestation as well as contributing to climate change

Opposed to this are the modern cooking fuels such as LPG and Kerosene. The analysis of modern cooking fuels can be seen in table 5:

TABLE 5 ENERGY SECURITY ANALYSIS OF MODERN COOKING FUELS

	LPG	Kerosene
Availability	- Easily accessible and established market - Higher capital investment to acquire stove and container.	- Easily accessible and established market - Higher capital investment to acquire stove and container.
Affordability	- Despite capital cost LPG has the lowest percentage of income at 4.4%	- Has a medium cost as percentage of income at 6.8%
Acceptability	- Low contribution to climate change.	- Low contribution to climate change - Small health risks of inhaling smoke.

The *availability* of the studied fuel sources are similar due to them all being established in the market already and no hypothetical alternative is being studied. Fuelwood appears to be the most insecure cooking fuel in terms of availability, especially as scavenging for fuelwood requires a lot of time and effort. A diversity of availability is positive from an energy security standpoint however and the competition between these four alternatives increases energy security if capital is available.

The *affordability* of each cooking fuel various greatly and are subject to high standard deviations. It is important to note that traditional cooking fuels are associated with small daily expenditure while modern cooking fuels require higher cost per purchase. However, we can generalize from these results that on a monthly cost as percentage of income basis, modern cooking fuels have a lower cost associated with them: LPG has the lowest followed by kerosene. Fuelwood, although essentially free, does have a loss of productivity associated with it, which makes it an uncertain in terms of affordability.

In terms of *acceptability*, we see a clear advantage in energy security in modern cooking fuels, as could be expected. This is mainly due to the high health costs of burning traditional cooking fuels in unventilated houses or ineffective stoves. Similarly, modern cooking fuels have a relatively smaller climate change impact by being more energy efficient and do not contribute to local deforestation.

One worrying result from the survey is the fact that 30% of respondents indicated a shift from modern cooking fuels, primarily moving away from LPG. This is a clear negative development for the energy security of these households. One contributing factor may be the affordability. Although LPG and Kerosene have a lower cost as percentage of income per month, they do require large payments each time a canister is filled or a new one is bought. Traditional fuels such as charcoal, have the advantage of requiring smaller payments daily or weekly which is extremely desirable when facing income uncertainty.

Overall, it seems that modern cooking fuels in general and LPG in particular, are more beneficial to energy security in informal settlements of Metro Manila, particularly if the problem of high one time payments are addressed.

6.2 Lighting Fuels

As discussed in the survey, lighting fuels truly boil down to various forms of electricity provision with 95% of respondents having access to the grid. For this analysis it is therefore most relevant to analyze the various forms of electricity sources as seen in the table below:

TABLE 6 ENERGY SECURITY ANALYSIS OF ELECTRICITY SOURCES

	Formal	**Informal**	**Free**
Availability	- Difficult to acquire and higher capital investment to acquire meter	- Lower capital investment, someone else acquires contact to the formal service provider. - Dependent on 3rd party and potential for poor quality or intermittent access.	- Danger of disconnection or legal retaliation. - Requires some knowledge.
Affordability	- Has the highest cost as percentage of income at 8.5%	- Has a medium cost as percentage of income at 6.5%	- Is free apart from work of acquiring connection
Acceptability	- Clear accountability and provision. - Safe connection	- Unclear accountability, possibility of 3rd party abuse. - Varying safety of connection	- Risk of fires - Unsafe connection

The *availability* of the various electricity sources each have their own advantages and disadvantages. Formal connections require a contract and monthly payments with the risk of being disconnected creating obstacles to access. Informal connections are more varied in their use and are difficult to generalize. It depends on the 3rd party provider and whether they are a sub-service of an established service provider or simply the sale of stolen electricity. Free connections require a certain amount of knowledge to create and are susceptible to disconnection and possible legal ramifications from electricity service providers.

The *affordability* analysis is obviously heavily favored to the free electricity connections although this survey does not take into account the time required to maintain a free connection. It is interesting to note that despite going through a 3rd party, informal connections are cheaper as a percentage of income than formal connections. This may be due to the diversity of informal connections encompassing both secondary providers and illegal connections.

The *acceptability* of each type of connection shows the importance of the quality of connection. Poor connections and faulty wiring can cause fires which are devastating in the tight confines and high density of informal settlements. For this sake alone, the energy security is helped by ensuring formal, safe connections. Informal connections through a 3rd party are difficult to judge as it depends on each situation.

This is a difficult analysis due to the fact that the most acceptable connection, the formal one, is the least available and affordable. As discussed earlier this is related to the large difficulties and obstacles surrounding for energy companies to deliver to informal settlements. However, taking into account the high risk of faulty illegal connections, there is an argument to be made to encourage formal connections by improving its availability and affordability as alternative methods of informal settlement electrification are being tested and implemented.

It is important to note the very high levels of appliances reported in the survey, this indicates a strong desire of informal settlers to partake in the benefits of urban lifestyles with greater communication and entertainment options. It is therefore safe to assume that most informal settlers will acquire electricity access through legal or illegal means. It therefore falls upon NGOs, governments and the private sector to provide more attractive legal options instead of only combating illegal connections.

7. Discussion

This study is limited by the survey data and the large potential for inaccuracy inherent in such an endeavor. The difficulties of gaining trust and gathering accurate data for such sensitive topics such an income and legality of energy sources makes it difficult to support the conclusions. Further studies are required to gain a clearer picture of the energy consumption patterns of informal settlements.

Another aspect that effects energy security is the rebound effect (Cambell, 2012). This is that increased affordability or energy efficiency can lead to a greater energy use overall. Having more disposable income would be positive for the households in question as it would increase security of an otherwise unsecure income environment.

However due to the recorded large utilization of appliances there is a possibility of a rebound effect into powering these devices. The rebound effect then takes on the duality the IAE mentions. Increased energy efficiency has many advantages on a micro scale that leads to higher energy savings and higher quality of living. However this is connected to a macro increase in energy use which depending on the energy mix of the nation as a whole could have negative effects.

It is interesting to note that among cooking fuels it is the rather unintuitive modern cooking fuels which are based on fossil fuels that both are more beneficial for the health of the household but also have the lowest global warming commitment ((Grieshop, et al., 2011). This emphasizes the potential benefits, not only for local actors, but global development groups, to aid in the transition to modern cooking fuels.

Unfortunately, this study did not review alternative energy solutions which, if implemented, could increase the energy security of informal settlers. Existing efforts in the Philippines include such innovations as the solar bottle;, a two liter plastic bottle, filled with water and bleach, is inserted into the tin roof of informal housing and when the sun shines outside it provides light inside. Although not encountered during the survey, these type of efforts are capable of diversifying the energy mix and increasing energy security and should be studied further.

8. Conclusion

8.1 Conclusion

This study concludes that there can be two main recommendations to be drawn to increase the energy security of informal settlement households in Metro Manila. These are divided into cooking fuels and lighting fuels due to the various energy sources used and the different requirements for each.

Encouraging modern cooking fuels over traditional ones is vital in increasing the energy security of cooking fuels. In particular the worrying trend of households moving away from modern fuels needs to be reversed. This can be done by minimizing the capital cost of stove and canisters as well as promoting smaller canisters that in part mimic the small, incremental payment method preferred by informal settlers.

Providing legal alternatives to electricity theft is vital, both through formal and informal channels, in order to increase energy security. This is either through direct deals with electricity providers or a regulated partnership with the informal economy utilizing sub-meters with safe connections. Similar to cooking fuels this primarily requires payment methods to be tailored for the needs of informal settlers such as pre-paid systems and increased availability.

A common problem inherent in both the recommendations is the preferred payment method. With uncertain incomes it is difficult to plan ahead and gather enough capital to pay a larger fee once a month. As was seen with charcoal and LPG, a smaller fee every day was preferable to many respondents than to pay a larger one even if the smaller fees accumulated to be more costly per month. Identifying these customer preferences are vital for any company or service provider trying to engage with the informal economy. Similarly NGOs or government agencies need to learn how to create solutions that take these preferences into account.

8.2 Scope for future work

One aspect that remains outside of the scope of this study that is extremely interesting is the role of transport and the costs of such to the energy security of a household. This requires a more extensive study as transport costs go up the further from the place of work you are and is a driving factor for informal settlements in central areas.

Although the study did find evidence that households are moving from modern back to traditional cooking fuels this alarming fact requires further study. Similarly a quantitative study of lighting fuels is not comprehensive enough to understand the complex perspectives of both users and providers. It would be of interest to see a qualitative study to find underlying motivations and the decision making process for informal settlers in choosing their cooking and lighting fuels.

Appendix A

The survey questionnaire used in the study is shown in full below:

1) How many people live in your household? ☐
Ilang tao ang nakatira sa inyong bahay?

People in household who generate income? *Mga taong may hanap-buhay.*				
Occupation? *Uri ng hanap-buhay*				
How often do they work every month? *Gaano kadalas silang nagtatrabaho kada buwan?*				
Income? *Magkano ang kinikita nila sa bawat trabaho nilang binanggit sa.*				

On average, what is your entire household's income per month? (Calculated from table) ☐
Kadalasan, magkano ang kinikita ng buong sambahayan kada buwan?

2) What type of fuel do you use for cooking? (Check any that apply)
Ano ang ginagamit ninyo sa pagluluto?

☐ Electricity (Grid) *Kuryente* ☐ LPG *LPG* ☐ Kerosene *Gaas* ☐ Charcoal *Uling* ☐ Fuelwood *Kahoy*

☐ Other (Specify) _____
Iba pang uri, ilagay sa patlang ang sagot

Fuel type *Uri ng pangluto*		
Amount/Cost of each purchase *Magkano ang nagagastos sa bawat bili?*		
Lasts how long? *Ilang araw tumatagal ang bawat bili?*		

On average, amount spent on cooking fuel per month (calculated from table) ☐
Kadalasan, magkano ang nagagastos sa pagluluto kada buwan?

3) Have you changed your cooking fuel in the last five years? If so what did you use before
Nag palit ka na ba ng panluto sa nakaraang limang taon? Ano ang ginamit mo?

☐ Electricity (Grid) *Kuryente* ☐ LPG *LPG* ☐ Kerosene *Gaas* ☐ Charcoal *Uling* ☐ Fuelwood *Kahoy*

☐ Other (Specify) _____
Iba pang uri, ilagay sa patlang ang sagot

☐ No change
Walang pagbabago

4) What type of fuel do you use for lighting? (Check any that apply)
Ano ang ginagamit ninyo sa pag-ilaw?

☐ Electricity (Grid) *Kuryente* ☐ Batteries *Baterya* ☐ Kerosene *Gaas* ☐ Candles *Kandila* ☐ Solar bottle bulb *Solar bottle bulb*

☐ Other (Specify) _____
Iba pang uri, ilagay sa patlang ang sagot

Fuel type		
Amount/Cost of each purchase *Halaga ng binabayad kada bili/singil?*		
Lasts how long? *Gaano kadalas maningil ng kuryente?/Gaano kadalas bago maubos and bawat bili? (Gaas, kandila, baterya)*		

On average, amount spent on lighting fuel per month (calculated from grid)
Kadalasan, magkano ang nagagastos sa pang-ilaw kada buwan?

5) What appliances do you currently use in your household (check any that apply)
Anong uri ng appliances ang inyong ginagamit sa ngayon?

☐ Radio ☐ TV ☐ Fan ☐ Refrigerator

☐ Electric stove ☐ Cell phone ☐ Others (Specify) _____

6) Where do you get your electricity?
Saan kayo kumukuha ng kuryente?

☐ Formal Sector
Nagbabayad sa MERALCO

☐ Informal Sector
Sa Kapitbahay, atbp.

☐ No electricity
Walang kuryente

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