Master Thesis

on

Assessment of Renewable Energy Resources for Rural Village Development in East Java Province, Indonesia

Submitted to

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By

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Submitted to

Institute of Physics at Carl von Ossietzky University of Oldenburg, Germany, and Department of Engineering Physics at Institute Teknologi Sepuluh Nopember of Surabaya, Indonesia, in fulfillment of requirment for the degree in Master of Science in Renewable Energy (2012-14)

Under the supervision of

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Certificate

I hereby state and verify by my signature that I have reviewed this master thesis report. I affirmed that the report contains the true and valid information of the project assigned to the student.

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Declaration

I, the undersigned do hereby declare that this master thesis report was produced by me and comply with the basic guidelines of the scientific research work in master program at Carl von Ossietzky University, Oldenburg, Germany and referred the knowledge sources as cited in the Bibliography section.

DATE:________________________ NAME:_______________________________________

PLACE: _______________________ SIGNATIURE:_________________________________

Preface

The main purpose of this report is to give a detail overview of the tasks completed during the six months tenure of my master thesis starting from 1 September, 2013, which is a mandatory part of the curriculum of Master Programme Renewable Energy (PPRE) at Carl von Ossietzky University, Oldenburg, Germany. The report shall outline my duties, responsibilities, results and conclusion of the research topic “Renewable Energy Resource Assessment for Village Development in East Java Province, Indonesia” conducted under the supervision of Mr. Michael Golba, Prof Dr. Jürgen Parisi, Dr. Ridho Hantoro and Mr. Chayun Budiyono. The overall tasks were completed with literature review and field research in close collaboration with the Department of Engineering Physics at the Institute Technology Sepuluh Nopember (ITS) of Surabaya, Indonesia and the Post graduate Programme Renewable Energy (PPRE) under the Institute of Physics at Carl von Ossietzky University of Oldenburg, Germany.

Author

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In simple words, I could not have accomplished this job without the lots of help I received from the course co-ordinator Edu Knagge and all the members of the Post graduate Programme Renewable Energy at Carl von Ossietzky University of Oldenburg, Germany as well as the entire teaching and administrative staff of the Department of Engineering Physics at Institute Teknologi Sepuluh Nopember (ITS) of Surabaya, Indonesia.

Special thanks go to DAAD for their financial support without which my journey of doing my master program in Germany would not have been fulfilled.

I would specially like to thank Mr. Michael Golba for giving me the valued opportunity to undertake my research work in Indonesia at ITS and assisting me out in every single step while writing my dissertation.

I also offer my sincere thanks to Prof. Dr. Jürgen Parisi for evaluating my report and performance while presenting my result in the department of PPRE.

My sincere gratefulness also goes to Mr. Chayun Budiyono, Dr. Ridho Hantoro, Dr. Risanti and Dr. Aulia SA for their valuable assistance and guidance while conducting and accomplishing my field research at Indonesia. I also express my gratitude to the final year students of Department of Engineering Physics at ITS for devoting their valuable time to take part in my research work as an interpreter while undertaking my field visits.

I am highly indebted to all the contacted persons of the Department of Energy and Mineral Resources, Regional Body for Planning and Development, Agency for Community Empowerment, State Electricity Company and Statistics of East Java Province and non- profit co-operative societies that includes Co-operative Society of WOT Lemah and Kalimaron project and Co-operative Diary Cattle for getting the valuable data related to my field research. My research would be incomplete without the full support of the village heads and villagers of the interviewed places. I offer my genuine tribute to them for their valuable and indefinite supports. I would also like to thank everyone who directly or indirectly renders their support in order to fulfil my objective of my thesis.

My appreciation always goes to my friends of PPRE and my family for their never ending, unrestricted support and providing me valuable insights in any endeavour I take.

Abstract

East Java province, the second largest province in Indonesia depends mainly on fossil fuels as the main source of energy like other regions within Indonesia. With the increase in demand every year and becoming a net importer of oil and gas after discontinuing from the membership of "Organization of the Petroleum Exporting Countries (OPEC) in 2008", the high subsidies by the government on energy produced from fossil fuels for satisfying the local consumer has become a burden on it within the country (Renewable Energy Assessment, May 2010, p. 2).With the government target to diversify energy with "5% bio fuel and 5% on geothermal and other renewable by 2025" (Haeni et.al., 2008, p.28) in the total energy mix, it is known that East Java seems to be one of the major contributor in this regard.

The research question primarily focus on the aspect of which are the main areas of application where renewable energy can play a role and under what conditions the application of renewable energy projects can become feasible. It concentrates mainly on the result after doing a comparative analysis of the impact of the installed renewable energy systems in the selected three different regions of East Java, which simplifies and gives a broader general picture of the role of renewable energy for rural village development in this entire province. The result shows that biogas, solar and micro-hydro are the main potentials for application in rural areas in the field of cooking and electricity. The renewable projects can be implemented and executed effectively in the rural province only if all the stake holders are mutually co-coordinating and taking into account the proper analysis of the social, technical and financial factor in the regions. The independent approach of the stake holders is not a suitable pathway for any rural development in the region to meet their demands in appropriate and efficient manner. This report also provides information on the available potential and installed capacities of renewable energy in the province.

List of Acronyms

APBD	Anggaran Pendapatan dan Belanja Daerah (Budget and Expenditure)
BAPEMAS	Badan Pemberdayan Masyarakat (Agency for Community Empowerment)
BAPPEDA	Badan Perencana Pembangunan Daerah (Regional Body for Planning and Development)
BLH	Badan Lingkungan Hidup (Environment Agency of Java province)
BPS	Badan Pusat Statistik (Statistics of Eats Java Province)
ESDM	Kementerian Energi dan Sumber Daya Mineral (Ministry of Energy and Mineral Resources)
GTZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Co-operation)
HIVOS	Humanistisch Instituut Voor Ontwikkelingssamenwerking (Humanist Institute for Co-operation)
IDR	Indonesian Rupiah
IP	Indonesia Power
ITS	Institute Technology Sepuluh Nopember (Institute of Technology)
JTM	Jaringan Tegangan Menengah (Medium Voltage Network)
JTR	Jaringan Tegangan Rendah (Low Voltage Network)
KLH	Kementarian Lingkungan Hidup (Ministry of Environment)

KPDT	Kementerian Pembangunan Daerah Tertinggal (Ministry of Rural Development)
KPSP	Koperasi Peternakan Sapi Perah (Co-operative Diary Cattle)
kWh	Kilo Watt Hour
MHP	Micro Hydro Project
MW	Megawatt
OPEC	Organizations of the Petroleum Exporting Countries
PEC	Paiton Energy Company
PJB	Pembangkitan Jawa-Bali (Generation of Java-Bali)
PLN	Perusahaan Listrik Negara (State Electricity Company)
PLTA	Pusat Listrik Tenaga Air (Hydroelectric Power station)
PLTU	Pusat Listrik Tenaga Uap (Steam Power Plant)
PLTGU	Pusat Listrik Tenaga Gas dan Uap (Power Plant Gas and Steam)
PPLH	Pusat Pendidikan Lingkungan Hidup (Environmental Education Centre)
PPRE	Postgraduate Program in Renewable Energy
PKM	Paguyuban Kalimaron (Co-operative Society of WOT Lemah and Kalimaron project)
Tr	Trillion

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Chapter 1

1. Introduction

1.1 Background

Access to basic forms of modern energy supply i.e. electricity and heat, is still a challenging process in many rural regions of developing countries and it plays an important role for sustaining our living conditions, including participation and inclusion in modern society. With the access of these basic needs, the living standard and education is improved and hence, it opens different opportunities for improving the low economy of villages. However, many rural areas still lack proper infrastructure. Indonesia is one such archipelago with fragmented geographical conditions, and still many villages scattered in far regions with poor infrastructure. To provide electricity for villages that are situated in remote and difficult terrains is a highly expensive process and requires a huge investment from the government or any other stakeholder on setting up the required infrastructure. The increase in the energy demands due to increasing population and simultaneously becoming a net importer of oil from 2008 (Renewable Energy Assessment, May 2010, p.2), the government of Indonesia is facing a huge burden on the national budget, after putting high subsidies on electricity generated from fossil fuels. So, to meet the challenges in rural areas, the government of Indonesia has already introduced many policies and programs to foster the implementation of renewables in order to meet the demands in the regions of poor infrastructures and shifting partially from fossil fuels. East Java is the second largest province in Indonesia (Zaki, et.al. p. 8) in terms of the economy with many villages remotely situated in small islands. Renewable energy can be a viable solution in off-grid and far remote regions, if applied with better organizational frameworks and concrete, effective and solid foundational initiatives involving the main stakeholders. With “Rural Energy Supply” as the main specialization subject in the second semester of our curriculum and to fulfill the requirement of completing the master degree in Renewable Energy (session 2012-2014), I got an opportunity to choose the topic of “Renewable Energy Resource Assessment for Rural Village Development in entire East Java Province, Indonesia” as my master thesis topic. I was accepted by Institute Teknologi Sepuluh Nopember in Surabaya, Indonesia to do my field research on the above mentioned topic.

The initiatives and implementation of various developmental programs by the government of Indonesia like “Desa Mandiri Energi”, “National Program on Community Empowerment” (Hendrana, et al., p.37), BURI [4] etc. encourages the utilization of available renewable energy resources to fulfill the energy needs of rural inhabitants and aims for village development. After receiving an opportunity to conduct my field research on the above mentioned topic, I got the motivation to understand the energy development in the villages of East Java province. My interest was to get an overview of how the renewable energy systems are playing a major role in the village development of the province, if anywhere installed. While conducting my research, it would give me a platform to get a learning exposure on how such initiatives are implemented in the rural areas of East Java province. So with this, my master thesis topic mainly involves the research study to answer the following question:

- What are the main potential applications of renewable energy technologies for rural village development in East Java?
- What type of renewable energy sources and under which condition the application of renewable energy technology can become feasible in the province?

In conclusion, the report will address the defined analyses and present a way forward for further future research in this field.

1.2 Objective

The specific objectives of my thesis are as follows.

- To get a general overview of the difficulties in rural areas of East Java province when accessing the basic energy need (heat and electricity).
- To find out the potential of renewable energy sources including the already installed capacities in the province in order to meet the energy demand.
- To compare between success and failure in operation of installed renewable energy system in three selected field research locations of East Java and to identify the suitable factors under which the application of available renewable energy technology can become feasible and successful in the future irrespectively from different locations.

1.3 Methodology

Study from desktop and literature review

I started my thesis with the preliminary study of the geography, the demographic and economic, energy situation of both fossil and renewable energies, prices of energy, different governmental, bilateral and multilateral international organization's energy policies, the framework and development programs of Indonesia and East Java in particular. Literature in this relevant field was acquired online from published international journals and papers, reports, websites of private and governmental institutions as well as obtained in personal from universities, research institutions and governmental organizations as discussed in **Chapter 3**.Consequently this laid the basic foundation of preceding my next step.

Design and selection of the instrument

With the objectives set behind my thesis topic and after going through the literature, the main instrument for the research, the questionnaire was designed for the field survey (Refer **Annexure M, N and O**).

Define the selection of field research location

The number of villages is very large in the entire East Java province. The location for doing my field research was selected based on my objectives. It is mainly villages with renewable energy systems already installed (with both success and failure outcomes).

Field interview

The interviews were conducted with the respondents including mainly the heads of the village community, secondary village household inhabitants, and employees in local district governmental and non-profit co-operative societies. The interviews were designed in a focused manner to get a clear and precise output within the pre defined tenure of conducting my research.

Data compilation and evaluation of results

The resource statistics data obtained from the field survey were compiled and evaluated to make the comparison and answer my research questions.

Report editing, assessment and finalization

The report was edited, assessed by the supervisor and emended which reflects the feedback in this final version.

1.4 Report content

This section defines mainly the frame and structure of the report.

Formal endorsement sections

It presents the cover page, certificate, declaration, preface, acknowledgement, abstract, table of contents, list of acronyms, tables and figures, and bibliography that compliment partially in the formal way of editing the report and making the report fully complete, certified and approved.

Chapter 1: Introduction

This chapter primarily focuses on the background, objectives, methodology and brief description of each chapters of the report.

Chapter 2: Overview of East Java

It gives a detailed overall picture of the East Java province in terms of geography, demography, economy and energy policies and programs.

Chapter 3: Overview of the methodological approach for the field research in East Java

Chapter 3 will describe in detail how the research was approached and conducted.

Chapter 4: Results

It will give an overview of the analyses and evaluations of the data obtained after accomplishing the field survey. Results are explained with figures, tables and graphs.

Chapter 5: Conclusion and way forward

This chapter will mainly emphasize on the achieved conclusions and will give an array of future outlook and way forward of this study.

Chapter 2

2. Overview of East Java

2.1 Geography

East Java is the province situated in the eastern part of the Java Island in Indonesia, an archipelago country of South Eastern Asia.

Figure 1: Map of Indonesia [18]

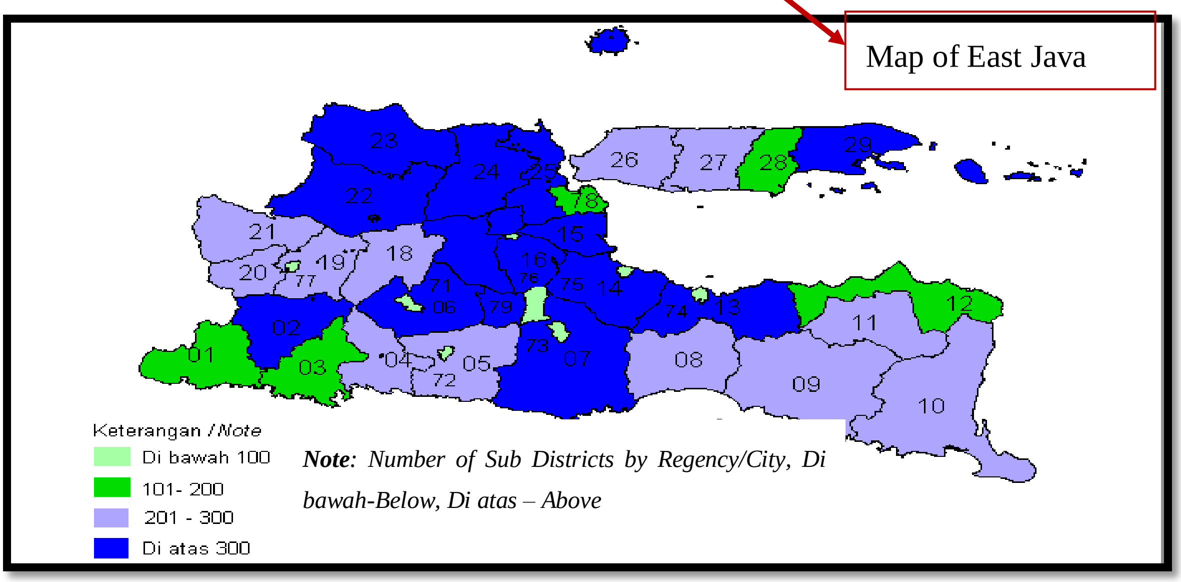

Figure 2: Map of East Java province with numbers of sub districts by regency/city

Source: Provinci Jawa Timur, 2012, p. 35

As seen from **Figure 1**, the province is surrounded by the Java Sea on the north, Bali on the east, Central Java on the west and the Indian Ocean on the south. Surabaya, the second largest city of Indonesia is the capital of the province. The Province lies 110 ° to 114.4° East Longitude and 7.12° to 8.48° South Latitude. It is divided into Java Timur mainland (covers 90% of the province) and Madura Island (covers 10% of the province). “It covers an area of 47,963 km^2 which consist of 29 districts, 9 cities and 8,503 villages” (Provinci Jawa Timur 2012, p. 3).

Table 1: Number of regencies and cities in the East Java province (Provinci Jawa Timur, 2012, p. 35)

KABUPATEN/REGENCY		KOTA/CITY	
01.Pacitan	11.Bondowoso	21.Ngawi	71.Kediri
02. Ponorogo	12.Situbondo	22.Bojonegoro	72.Blitar
03.Trenggalek	13.Probolinggo	23.Tuban	73.Malang
04.Tulugagng	14. Pasuruan	24.Lamongan	74.Probolinggo
05.Blitar	15. Sidoarjo	25.Gresik	75.Pasuruan
06. Kediri	16.Mojokarto	26.Bangkalan	76.Mojokerto
07. Malang	17.Jombang	27.Sampang	77.Madiun
08. Lumajang	18.Nganjuk	28.Pamekasan	78.Surabaya
09. Jember	19.Madiun	29. Sumenep	79. Batu
10. Banyuwangi	20.Magetan		

2.2 Demography

“The total population in the entire province as per census 2011 was about 37,687,622” (Provinci Jawa Timur, 2012, p. 46).

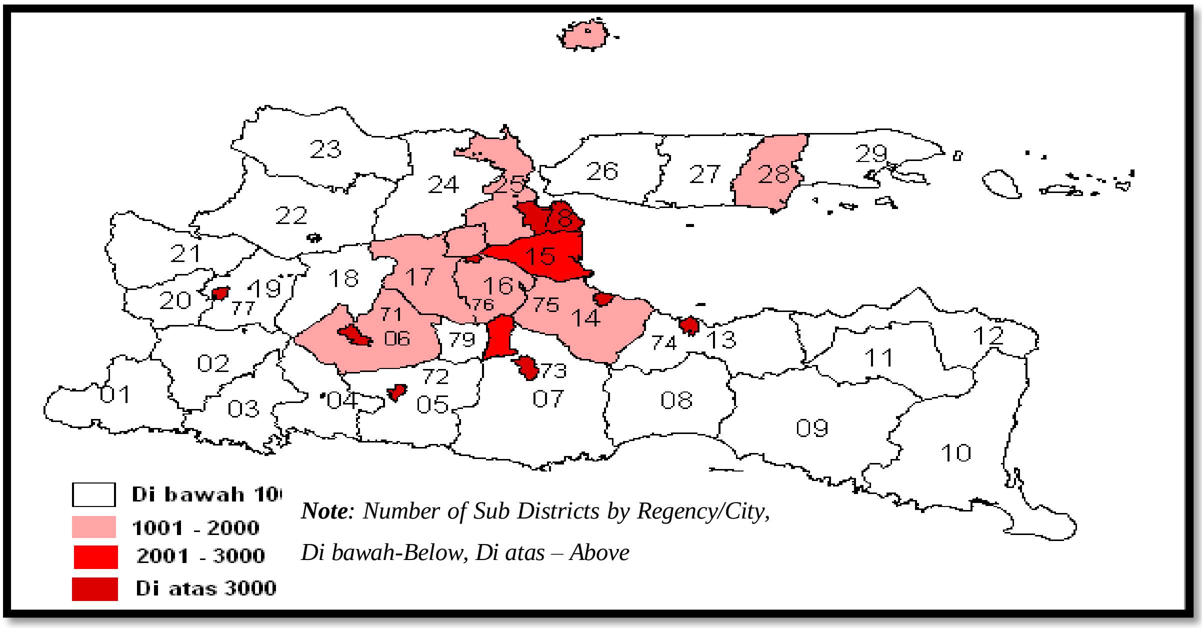

Figure 3: Map of East Java indicating the population densities as of 2011 (Provinci Jawa Timur, 2012, p. 49)

Population densities of the different districts of East Java province are shown in **Figure 3**.

2.3 Economy

The economic growth of East Java was above the average of 5.82% over the last five years [6]. It is seen from **Figure 4**, that 'trade, hotel and restaurant' covers the major share of the total percentage and 'electricity, gas and water services' has the minimal share with only 1.44 %.

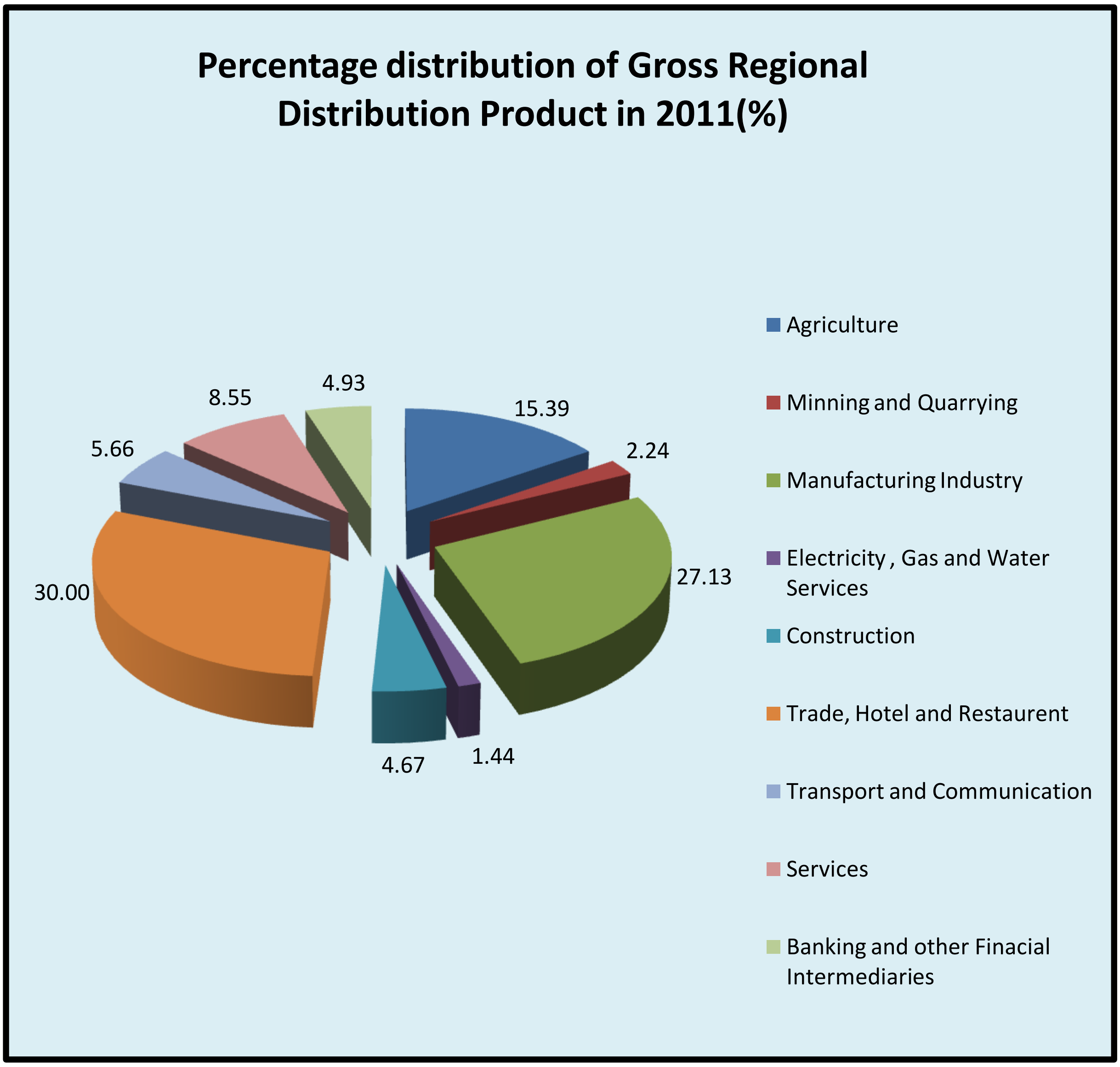

Figure 4: Percentage distribution of Gross Regional Distribution Product based on current market prices in 2011(%) (Provinci Jawa Timur, 2012, p. 519)

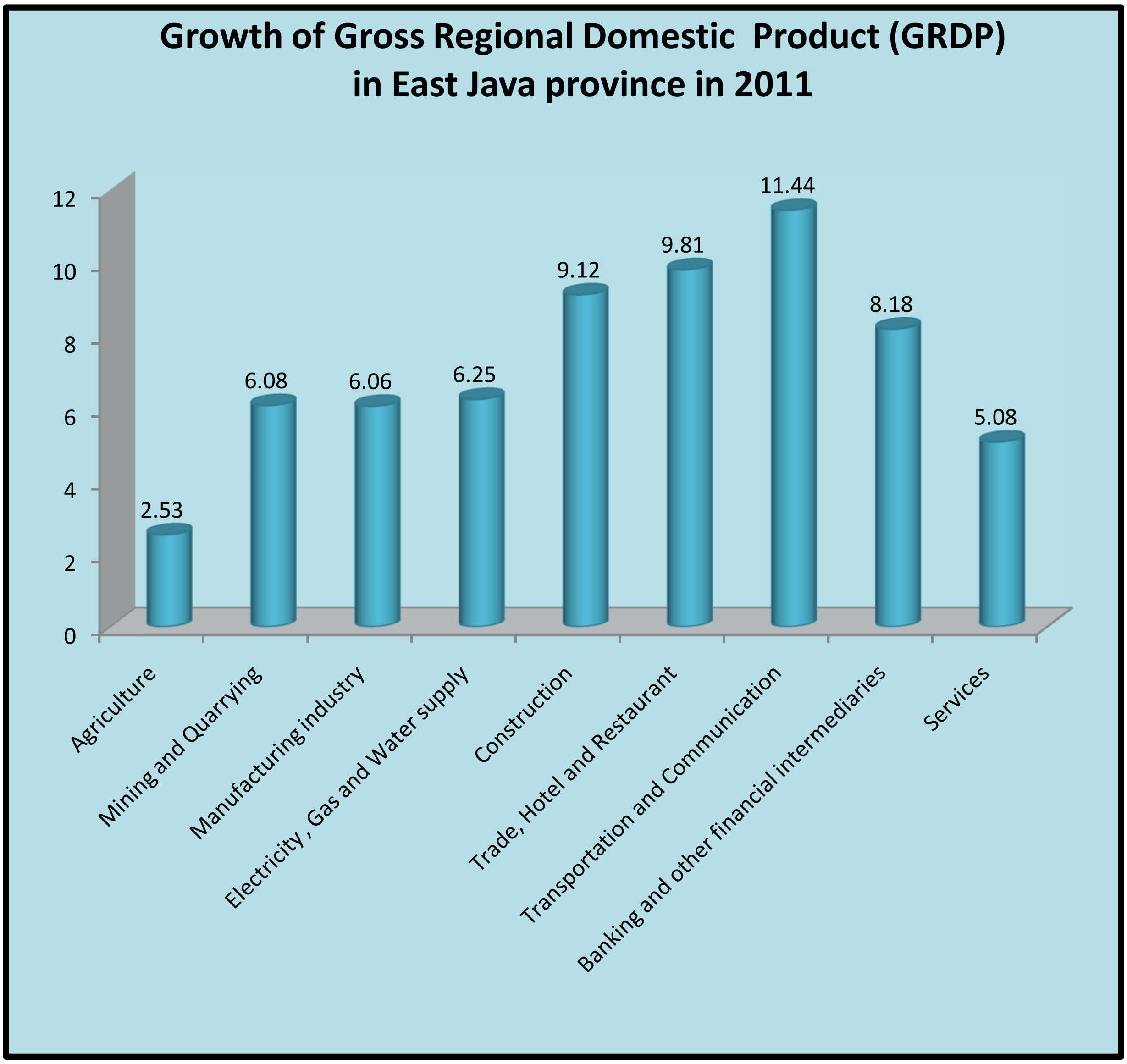

Figure 5: Growth of GDP in East Java for different sectors (Provinci Jawa Timur 2012, p. 521)

The above **Figure 5** shows that the percentage growth is highest in the transportation and communication sector and there is only 6.25 % growth in the electricity, gas and water supply sector.

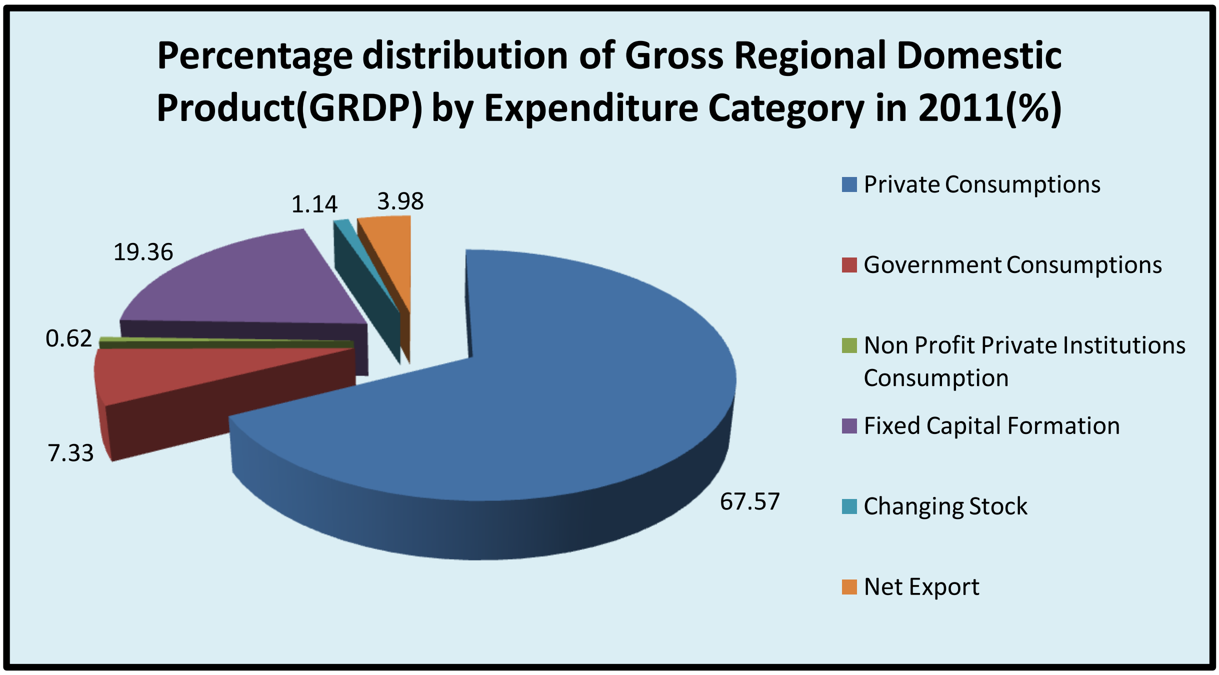

Figure 6: Percentage distribution of GRDP based on different expenditures (Provinci Jawa Timur, 2012, p. 523)

From the above **Figure 6**, private consumption shares the highest percentage of the overall GRDP. Government share is only 7.33 % of the total.

Table 2: Growth of Foreign Direct Investment, Domestic Investment and Regional Investment in 2010-11 [6]

No.	Source of Investment	Year 2010 (Rp Tr)	Year 2011 (Rp Tr)	Year 2012 (Rp Tr)	Third Quarter 2013 (Rp Tr)
1	Foreign Direct investment	16.73	20.07	25.13	20.42
2	Domestic investment	9.95	20.33	28.73	28.32
3	Regional Investment	56.26	70.07	80.00	49
4	Total	82.58	110.47	133.86	97.74

Table 2 shows that regional investment was increasing from 2010 till 2012. It cannot be confirmed about the trend in 2013 as the accurate data for the end of the quarter in 2013 is not available. There is no significant increase in the figures from direct foreign and domestic investments for the same period (2010-2013).

The main potential of the province lies in agriculture, plantation, commerce, fisheries, energy resources, horticulture as well as other industrial areas [6].

2.4 Energy scenario

To get the energy scenario in the East Java province, we have to get an overall overview of the same in the entire country Indonesia. It is seen from **Table 3**, that fossil fuels like coal, crude oil and natural gas are the major sources of supply of primary energy in 2011. The contribution of biomass is highest among the renewables. **Table 4** indicates that the highest final energy consumption type is as fuel. Electricity is the fourth highest type as final energy consumption. All these data are published officially in the website of Ministry of Energy and Mineral Resources. Solar and wind energy production market is yet to be developed in large scales commercially.

Table 3: Indonesia's primary energy supply by source in 2011 (Kurniawan, et.al., 2011, p. 10)

No.	Source type	Unit (%)
1	Coal	23.38
2	Crude oil and product	41.45
3	Natural gas and product	18.31
4	Hydropower	2.19
5	Geothermal	1.15
6	Biomass	13.52

Table 4: Indonesia's share of final Energy consumption by type in 2011 (Kurniawan, et.al., 2011, p. 25)

No.	Type	Unit (%)
1	Coal	18.9
2	Natural Gas	15.9
3	Fuel	47.6
4	LPG	4.8
5	Electricity	12.8

East Java acts as one of the important commercial and industrial centres of Indonesia. To meet the energy demand, the primary source of its supply is mainly fossil fuel. The primary main findings of data (after interviewing the concerned personals from the Department of

Energy and Mineral Resources) of potential and installed renewable energy capacity in East Java province will be discussed in the **Chapter 4**.

The prices of per unit of different type of energies in Indonesia in 2011 are mentioned below. It gives a general idea of the energy price in the East Java province as well.

Table 5: Prices of energy per unit in Indonesia in 2011 (Kurniawan, et.al., 2011, p. 32 to 34)

No.	Type	Unit (IDR/BOE)
1	Gasoline premium	772,201
2	Aviation Turbine fuel	1,352,810
3	Aviation Gasoline	3,553,214
4	Kerosene	421,770
5	ADO	693,684
6	LPG(3 Kg)	498.6
7	LPG(12 Kg)	686.2
8	LPG(50 Kg)	862.8
9	Average of refinery product	849,272
10	Coal	153,559
11	Average electricity(Household)	1,004,763
12	Average electricity(Industrial)	1,078,287
13	Average electricity(Commercial)	1,524,176

Table 5 indicates the different prices of utilities based on the year 2011, as indicated in the source. Latest data is yet to be published from the ESDM. It is seen that aviation gasoline is the costliest. Commercial electricity price is higher compared to household and industrial electricity. The price figures are more or less very near in the province of East Java as well.

2.6 Electricity sector

PT PERTAMINA is the main state owned company that sells and distributes petroleum products and biodiesel to different industries, transportation and communities. Another private company, PT Medco Energy International deals with the production of petroleum oils as well as develops, promotes and produces energy from renewables (Hendrana, et al., p.31) [15].

PLN is the only one major company owned by the state that produces, transmits and distributes electricity to the main users of entire Indonesia (Hendrana, et al., p.32) [16].

"The East Java Electric Power Transmission and Distribution Network Project (under the Stage IV of the National Five Year Development Plan with the beginning of Stage I in 1969) was established to ensure stability of electricity distribution and transmission grid system, minimize grid losses and increase the electrification ratio of the entire province to promote industrialization and public welfare. The project undertaken by PLN started in 1991 and was completed in 1994, with the reduction in distribution and transmission losses from 22.68 % in 1974 to 8.57 % in 2000" (Ikhsan, September 2002, p. 1 to 5).

2.7 Different policies and schemes in the field of renewable energy utilization

As cited from the sources [8], the Government of Indonesia provides high subsidies to low income family and transportation for energy use. With the increase in international price for fuel oil, there is an increase in prices of the same within the country which consequently acted as burden on the national budget. To reduce this impact, the government initiated many policies to encourage the utilization of available renewable energy resources for meeting the energy demand. The Ministry of Energy and Mineral Resources introduced the Green Energy Policy in December 2003, a Renewable Energy Development and Energy Conservation Policy mentioned in the Regulation no. 002/2004 of the Ministry. A national energy mix was targeted in 2006, by the Presidential Regulation no. 5/2006 to increase the percentage of renewable energy use by 15 % at 2025. MEMR with regulation no. 002/2006 gave importance to generate electricity in medium scale range industries (1 to 10 MW) using renewables. With the Ministerial Decree No. 1122/2002 small scale enterprises (less than 1 MW) are encouraged to produce electricity with renewable resources. In 2008, MEMR Decree no. 32/2008 promotes utilization of bio fuels in transportation, electricity production and industries. Various incentives and tax reduction policies were also introduced to achieve the aim of the government and promote the application of renewables. The district and sub district governments of East Java province are actively participating to meet the national targets (Hendrana, et al., p.34 to 40)

Chapter 3

3. Overview of the methodological approach for the field research in East Java

My research was assisted and supported by the students and associated teaching staff of the Department of Engineering Physics at ITS, Surabaya, Indonesia. The field research was conducted based on the following criteria.

Selection of villages in East Java

The final research location was fixed taking into consideration the bureaucracy in the district level, weather scenario, infrastructure availability for transportation and commuting. There was limited time of stay and limited availability of assistance of my interpreters because of their work schedule and since I tried to get as many research data from the public and private organizations situated at the specified location (Refer **Figure 7**) including the village targets.

- Villages where renewable energy systems were already installed, running successfully and in good operation. One chosen village is located in the regency of Mojokerto and the other two villages are situated in the regency of Pasuruan.
- One remote village on an island where renewable energy systems were already installed and showed failure in operation. Mandangin Island, situated in the regency of Sampang was selected.

The main reason behind this selection is, to cover different types of installed renewable energy systems based on solar, biomass and micro-hydro. Secondly it will help me to fulfill my third objective discussed in **Chapter 1**. Consequently, it will provide me a platform to give a broader picture for attaining a definite output and achieve my objectives. The selected villages differ topographically. Villages in Mojokerto and Pasuruan are situated in hilly areas and Mandangin is a humid island with salty atmospheric environment surrounded by Madura Strait. This is another secondary reason for my selection.

Target Groups

Mainly village heads were targeted in order to get a general overview of the situation in terms of accessing basic energy before and after the renewable systems were installed in the region. A village head has firm knowledge and information in different spheres of the varied activities undertaking in the village. He can also provide me valuable information on how communal projects are executed practically. Some villagers additionally to the village head were also targeted to find out the information relating to the average monthly expenses, how the energy demands are met and where problems arise. Target groups are listed in **Annexure D**. The main reason of interviewing only a few villagers is due to the tight availability schedule of the interpreters (Refer **Annexure F**). Language is the main barrier while communicating verbally in villages. It is difficult to proceed without the help of the interpreters. The head or main responsible employees of non-profit co-operative society in the villages (Co-operative

Society of WOT Lemah and Kalimaron project situated in Seloliman and Co-operative Diary Cattle in Nongkojajar) were also another focus to get the main information related to the history and the framework of executing renewable energy projects. Employees of the district governmental organizations Regional Body for Planning and Development (BAPEDA) and Agency for Community Empowerment (BAPPEMAS) both located in Sampang district, Ministry of Energy and Mineral Resources (ESDM), State Electricity Company (PLN) including Statistics of East Java (BPS) situated in Surabaya were also under the target group to fulfill my objectives. Interviewing them helped me to analyse and get all the information on potential sources of renewables and installed capacities in the

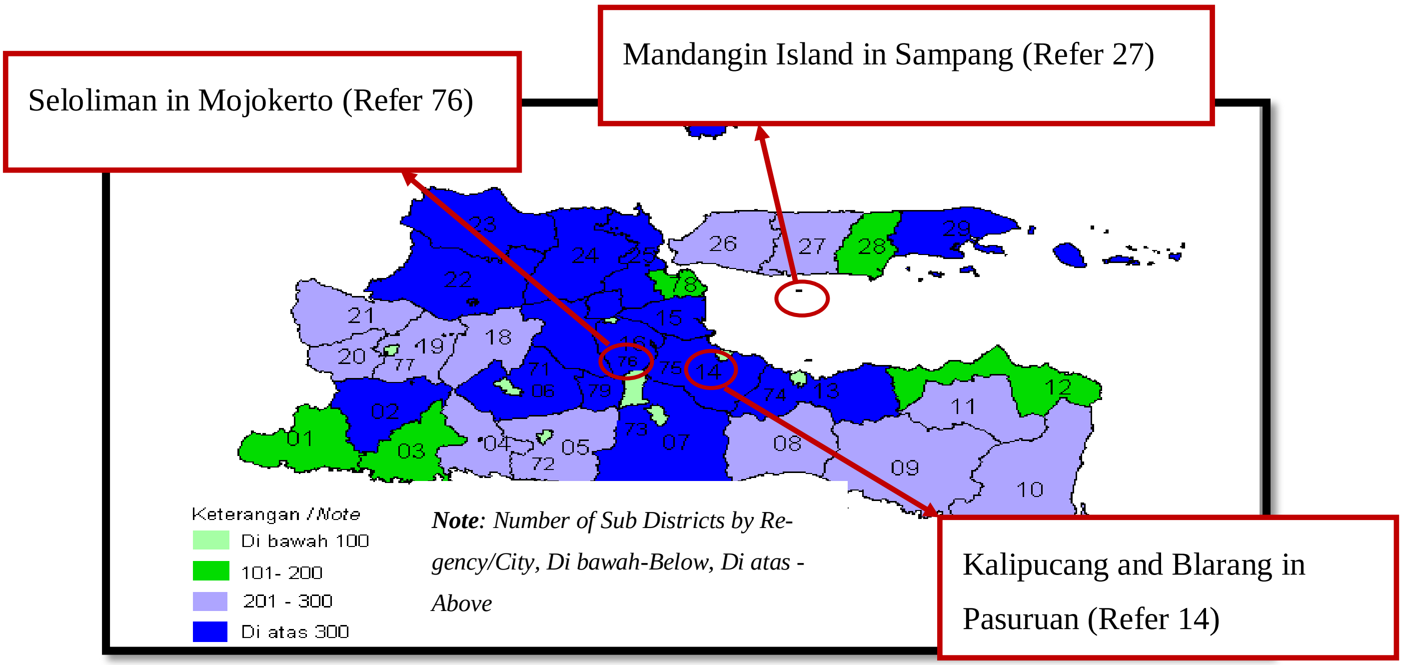

Figure 7: Map of East Java province with indication of number of sub districts by regency/city

Source: Provinci Jawa Timur, 2012, p.35

province as a whole and to find out step by step the implementation procedure and who are the main stake holders in executing a renewable energy project .This findings will finally help me to develop a framework for feasible application of technology during the analysis of my field study .

Problems encountered

The main problem while conducting the survey was the absence of a common language between me and the target groups. Due to the tight schedule of the interpreters, only finite numbers of target groups were interviewed at the three locations. As my field research started at the beginning of the rainy season in Indonesia, I along with the interpreters had to face hard situations while reaching the Mandangin Island by ferry. I had to interview the villagers keeping only very limited time in hand and return safe. High tides in the sea are the common problem during the rainy season. Moreover, bureaucratic formalities took almost one and half day for getting permission to conduct my research at the island. Enough data could not be collected from the island as it needs special permission and its granting itself takes months. I proceeded the survey with my temporary permit. There were bureaucratic formalities to be fulfilled before doing my survey in any governmental organization. The time was also consumed taking into account the availability of the target groups in the organizations and the interpreters.

Evaluation of the result

After completing the interview at the surveyed locations with the questionnaire (Refer **Annexure M, N and O**), I compiled all the gathered data. The data can be accessed in the annexure and in Chapter 4. Some data that were received from the interview of the target groups in the defined locations needed to be analyzed as keeping the range of values, as the villagers could not give correct figures on the questions in the interview. The extreme range will highlight the variation in the data. This can be seen in the graphs discussed in the next chapter. Only simple mathematical calculation like sum and average methods are only applied to plot all the graphs.

3.1 Main approaches of field research

After the location and target groups were defined, I carried out the different steps systematically, which are ordered from initial to final phase and outlined in details as below. The time duration of each interview are highlighted in the table in **Annexure H.**

3.1.1 Statistics of East Java (Badan Pusat Statics, BPS)

I got the statistical data from the office of BPS in Surabaya. There was no requirement of any interview in the office as the data can be bought online as hard copy from the office.

BPS is a non-governmental institution that supports the government and public to access all statistical data of the different provinces and regions in Indonesia. These data include periodical updated data about growth of economy, demographic, and other societal parameters including geography as a whole[1]**[7]**. The data on East Java province in the field of demography, economy and geography as discussed in previous **Chapter 2** are obtained from BPS.

3.1.2 State Electricity Company (Perusahaan Listrik Negara, PLN)

I visited the office of PLN and interacted with the distribution department to understand the entire electricity scenario of the East Java province. I collected all the information related to the electrification scenario, generation capacity and electricity transmission and distribution map as discussed in **Chapter 4**. PLN was monopolized in 1972 as per government regulation No. 17 as the only state owned organization in the entire Indonesia to meet the electricity

[1] Details about the institution available at http://www.bps.go.id (accessed December 2, 2013)

demand of the public. The company mission was developed in order to improve the economy by providing electricity to all and improve the standard of livings [11].

3.1.3 Kementerian Energi dan Sumber Daya Mineral (Ministry of Energy and Mineral Resources, ESDM)

To understand the overall picture of the East Java province in the field of renewable energy, my next destination was the office of the Department of Energy and Mineral Resources (Dinas Energie Dan Sumber Daya Mineral) situated in Surabaya.

The information on installed and potential renewable energies in the province of East Java was gathered. The off-grid and on-grid capacities were also known and collected. I got the information related to funding donors for executing renewable energy projects in the province. All these results are highlighted in my result discussed in the next chapter[2] [8] & [11].

The Department was renamed in 2000 from the earlier name Department of Mines and Energy.

This department looks after the formation and developing policies related to renewables, initiates decisions on forming programs that increase the application of green energy mostly in the different provinces. The main focus is to improve the conditions of regions where electricity is limited from PLN, due to unavailability and difficulties to set up proper infrastructure in the remote regions. Some successes and results can be seen in the next chapter.

3.1.4 Badan Perencana Pembangunan Daerah (Regional Body for Planning and Development)

The purpose of my visit to this organization was to gather all the information related to the societal and economic statistical data of Mandangin Island. It is situated in Sampang regency of East Java province

This organization's main aim is to plan regionally in developing the economy by using all the available resources, formulate policies to distribute budget rationally in improving the society and regional infrastructure and provide a platform to access societal and economic data. It also controls, monitors and evaluates the developmental performance of a society in different parameters and executes policies to improve successful conditions [2] & [3].

3.1.5 Badan Pemberdayan Masyarakat (Agency for Community Empowerment)

I collected information about the objectives and missions of this organization. Data were received on the organizational framework of how the project of solar home systems was exe-

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[2] Details about the department available at http://www.esdm.go.id (accessedJanuary 2, 2014) and http://www.indonesia.go.id (accessed January 10, 2014).

cuted in Mandangin Island. The data gathered was limited because of bureaucratic problems, as the receiving of permission on getting the technical data takes three months. However, the data was enough to get an overview picture.

The main aim of this agency is to improve the rural livelihood, by motivating the villagers to take active participation in community development projects. Importance is also given to proper utilization of available natural resources and inspires utilization of technologies that protect the environment as referred in [1].

3.1.6 Mandangin Island

Mandangin Island is situated in the south of Sampang regency surrounded by the Madura Strait. It consists of three hamlets namely West hamlet, East hamlet and Central hamlet. The population is around 9603 (Female) and 9962 (Male). The data is collected from BAPPEDA.

The head of the village, Mr. Klebun and villager Mr. Jawi were interviewed. Data on the energy situation, problems if any for access to basic energy and the condition of solar home system was collected.

Figure 9: Interview with villagers at Mandangin Island

Figure 9: Interview with villagers and village head at Mandangin Island

Figure 10: Lightning at house in Mandangin Island

Figure 11: Cooking gas with 3.5 kg cylinder in Mandangin Island

Figure 12: Collection of fire woods from surroundings in Mandangin Island

3.1.7 Koperasi Peternakan Sapi Perah (Co-operative Diary Cattle)

Mr. Hariyanto, the Secretary of the Co-operative society was interviewed. The organizational and structural framework for executing biogas projects were known from him. This is explained in the next chapter.

The co-operative society is the main society in Nongkojajar that promotes the utilization of biogas for meeting energy needs. The society got its full existence from 1996 with the main objectives of improving the process of cattle farming, helps to improve the living condition of rural people in twelve villages, provides solutions to improve milk production facilities, increase its business and conserves the environment[3].

Figure 13: Interview with the Secretary of KPSP

3.1.9 Nongkojajar

Nongkojajar district is situated in the regency of Pasuruan. It comprises twelve villages. The villagers interviewed are from the hamlets Cemero in the village Kalipucang and Kuntul in the village Blarang.

[3] More information about the society available at http://www.kpsp-setiakawan.com(accessed December 19, 2013)

Figure 14: Interview with villager at hamlet Kuntul in the village Kalipucang

Figure 15: Interview with villagers at hamlet Cemoro in the village Blarang

Figure 16: Stirring biogas tank

Figure 23: Fixed dome biogas reactor

Figure 18: Lighting lamp from biogas

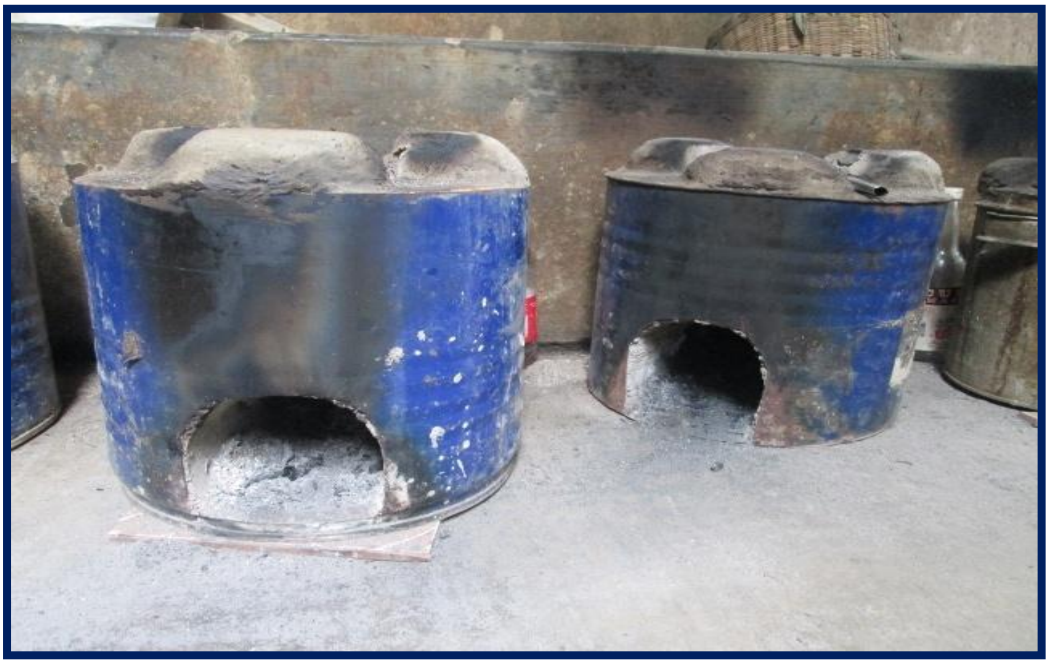

Figure 19: Cooking stoves

Figure 20: Pile of fire wood collection

Figure 21: 3.5 kg cylinder for cooking

3.1.10 Seloliman Micro-Hydro Project (MHP)

Seloliman is situated in the district Trawas in the regency of Mojokerto. The populations consist of 1159 (male) and 1267 (female) as per 2013. The main hamlets are Balekambang, Biting and Sempur.

In the early 1993, a proposal and a feasibility study was carried out in order to establish MHP in Seloliman with the main objective to provide electricity to the Janjing community and Pusat Pendidikan Lingkungan Hidup (Environmental Education Centre /PPLH). Seloliman Kalimaron MHP was installed by Micro Hydro Power project (MHPP)-Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Co-operation) on the river Kalimaron in the east coast of East Java in early September of 1994. In 1999, with funding from the Global Environment and MHPP-GTZ, the capacity was expanded to 30 kW. PLN grid connection came to Seloliman in the same year. In 2 June, 2002, ESDM formulates rules to PLN to buy electricity produced from this small capacity hydro project. Paguyuban Kalimaron (Co-operative Society of WOT Lemah and Kalimaron project, PKM) was established officially in 15 April, 2003 to look after all the operation of the plants. The plant sells electricity to PLN of 19 kW at day time and 9 kW at night time.

The micro-hydro plant WOT Lemah was visited by me. Its main source is Kalimaron river. The concept for its installation stems from 2007 and the operation started in 2008. The capacity of the plant is 20 KW. Both, the micro-hydro projects are meant to supply electricity to families, who cannot afford the electricity from PLN. Each plant supplies electricity to 25 families. WOT Lemah is providing electricity to families in Balekambang and Biting.

Data on problems related to energy access and average energy expenditure of the villagers were collected. Also, an overview regarding after the social impact after the implementation was gathered.

The treasurer of PPLH and villager, Mr. Ahmed Maksum, and the plant operator of WOT Lemah, Mr. Sukadi, another villager were interviewed.

3.1.11 Paguyuban Kalimaron (Co-operative Society of WOT Lemah and Kalimaron project, PKM)

The main objectives of the society are to empower the community in the rural area and conserve the natural resources, through the protection of the environment by wise management of natural resources, by the promotion of a model of an environmental education and media that inspires the use of alternative energy, encouraging self reliance by the use of electricity for small business purposes and by giving access for promotion for new jobs. I visited the office to understand the structure of the society and the motivation and objectives behind its formation. The structure is shown below,

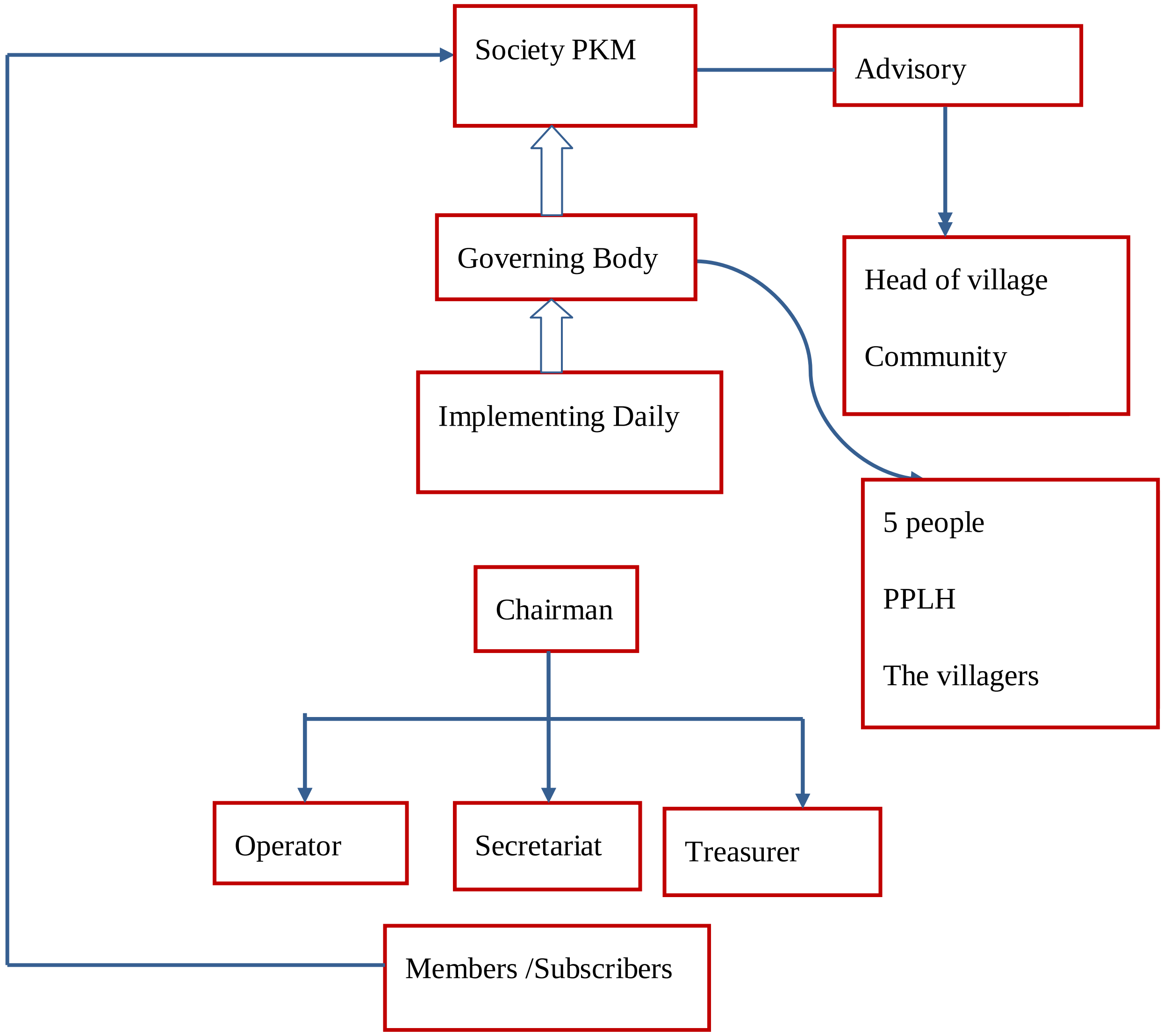

Figure 22: Flow diagram of the structure of PKM

Figure 23: Interview with the operator of WOT Lemah micro-hydro plant and the head of PKM

Figure 24: WOT Lemah micro-hydro generating house

Figure 25: Penstock in WOT Lemah micro-hydro system

Figure 26: Canal in WOT Lemah micro-hydro system

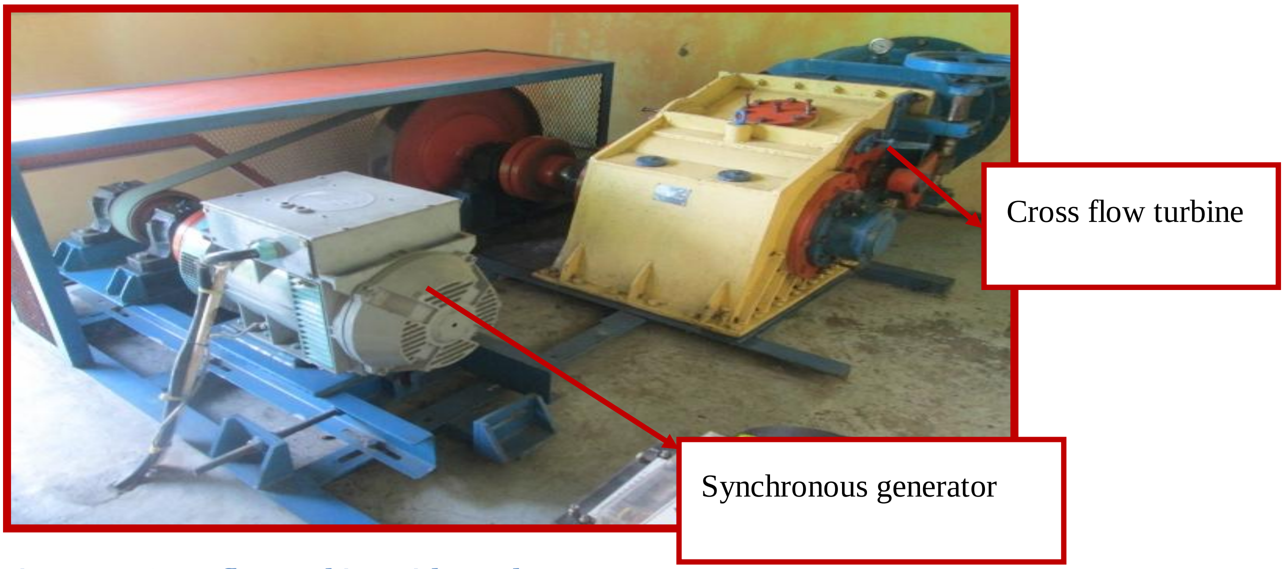

Figure 27: Cross flow turbine with synchronous generator

Chapter 4

4. Results

4.1 Electricity scenario in East Java

Figure 28: Map showing the different distribution units of PLN in the province of East Java[4].

As seen in the figure, there are in total 16 PLN distribution units in the province and 112 sub-station units as of 30 June, 2013.

Table 6: Electricity distribution in East Java

Description	JTM	JTR	Peak Load	Energy Sales	Power con-nected	Customer
Units	kms	kms	MW	GWh	MVA	
Total	32,463	64,336	4605	14,033	13,772	8,775,243

Table 6 shows the electricity infrastructure in the province as per 30 June, 2013.

[4] Source: Obtained from the office of PLN (reference is confidential)

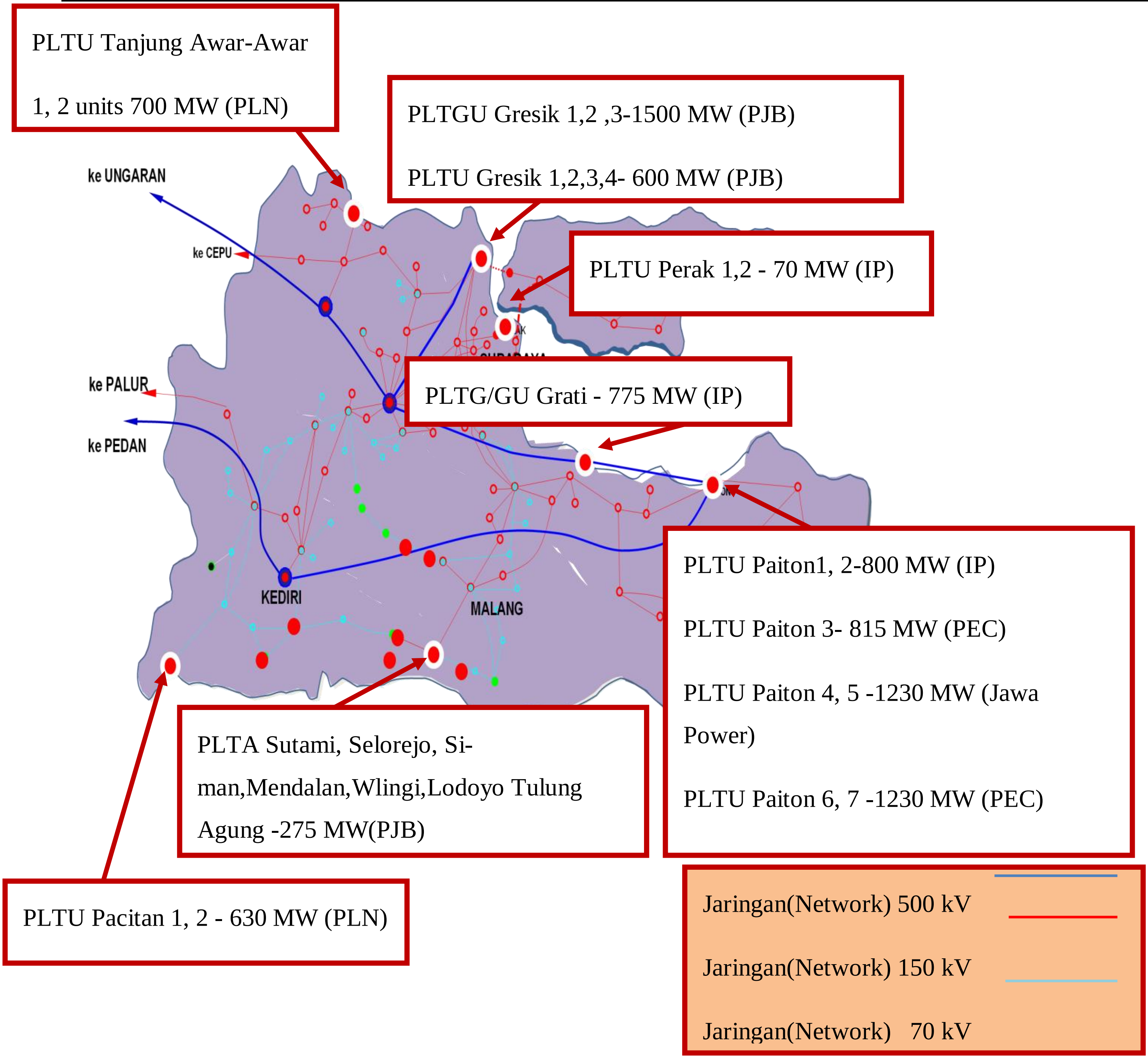

Figure 29: Map showing the transmission lines of PLN in the province of East Java [Source obtained from PLN] [5]

[5] Information about IP, Jawa Power and PJB available at http://www.indonesiapower.co.id(accessed January 15,2014); http://www.jawapower.co.id(accessed January 15,2014); http://www.ptpjb.com(accessed January 12, 2014)

The total electricity capacity in East Java province is 8615 MW as of 2013.The generating capacity by fuel type on oil, gas and coal is 5465 MW. Combined cycle power plant capacity is 2875 MW. Hydropower generating capacity is 275 MW located in Blitar, Tulungagung and Bondowoso regencies. The generating companies use fuel, hydro and steam for producing electricity. The main players in operation and generation of power in East Java are PEC, PLN, Java Power, IP and PJB.

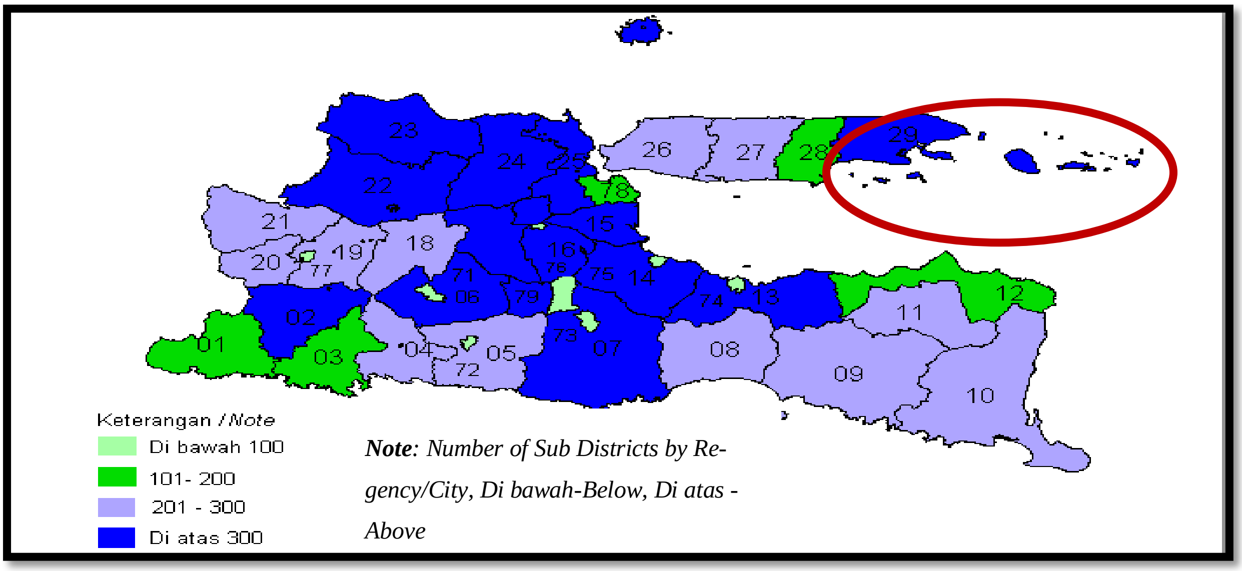

Figure 30: Map showing the different distribution units of PLN in the province of East Java.

Source: Provinci Jawa Timur, 2012, p .35

Figure 29 shows the transmission lines of PLN in the East Java province. The map indicates the connection of grids in different regions of the province. The dark blue indicates the transmission lines of 500 KV, the red lines indicates network of 150 kV and the light blue shows of 70 kV lines. There is almost no distribution in the remote islands near to the Madura strait as referred in **Figure 29** and highlighted in red in **Figure 30**. Some of the islands are Raas, Sapudi, Gili Iyang, Payangan, Bulumanuk, and Raja and so on due to low infrastructure and very high cost of installation in remote areas. Diesel gensets are the main source of electricity in these regions.

There are substation units as follows:

Substation units 500 kV = 5 units

Substation units 150 kV = 70 units

Substation units 70 kV = 24 units

Substation units from middle to low voltage (20 kV to 220 V) = 44, 370 units

Table 7: Peak load in East Java

Description	Year 2010 (MW)	Year 2011 (MW)	Year 2012 (MW)	Year 2013 (MW)
Day	3502.8	3750.5	4226.6	4213.2
Night	3820.0	4163.3	4513.9	4604.8

Table 7 gives an overview of the peak load from 2010 till 2013. The load is increasing with the exception of day load from 2012 to 2013.

Table 8: Total subscribers and additional customers in East Java for electricity from PLN

Year	Number of subscribers	Number of additional Customers
2009	7,079,390	189,139
2010	7,459,745	380,355
2011	7,875,039	415,294
2012	8,462,380	587,341
June 2013	8,775,243	312,863

Table 8 shows the total number of subscribers and additional customers for electricity from PLN. It is increasing from the year 2009 till 2013. This is mainly due to increasing population and increasing trade and commercial application in the province each year. The province acts as one of the good centres with better infrastructure in the coming years. It is expected that the number will keep on increasing.

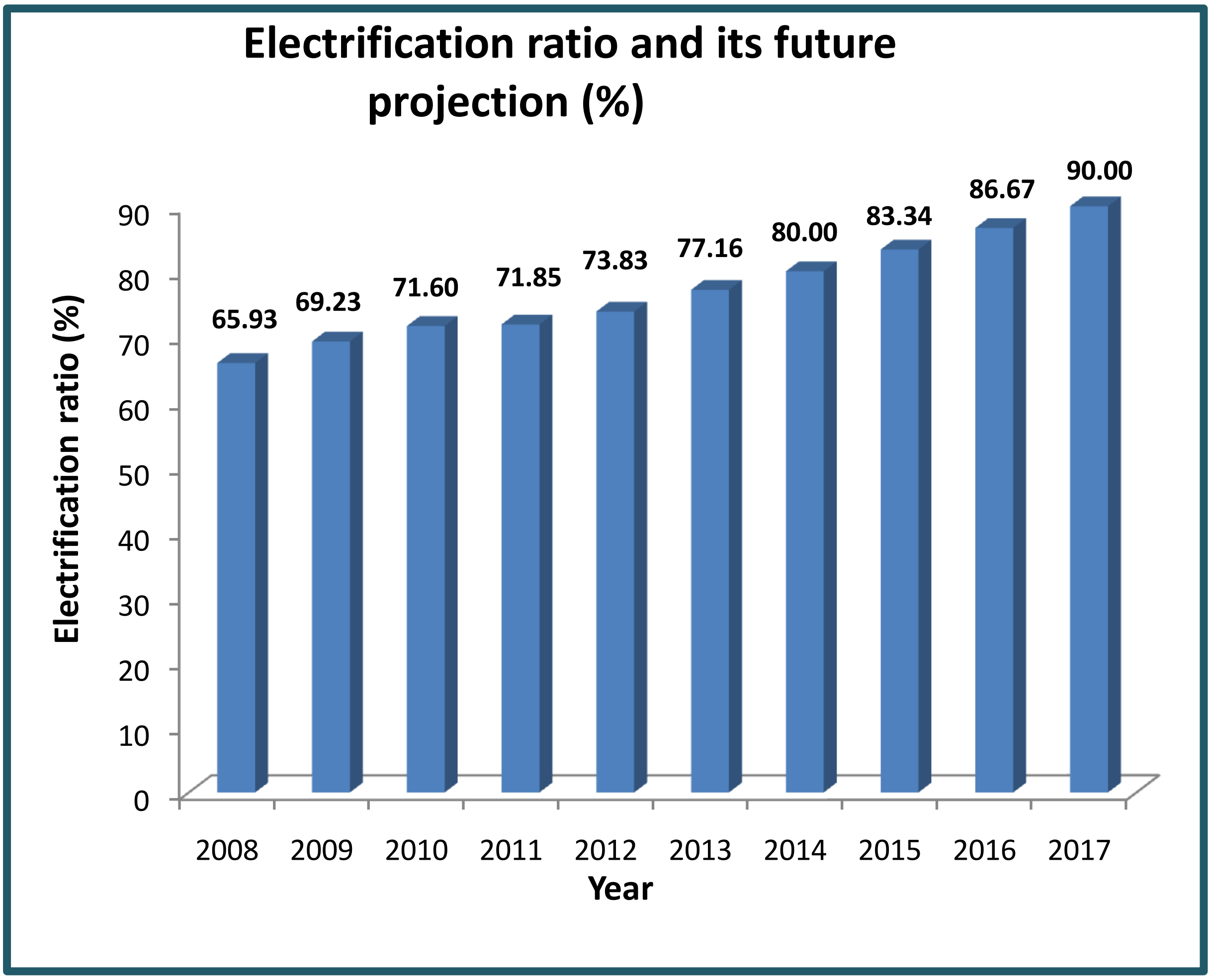

Figure 31: Electrification ratio and its future projection in the province of East Java as obtained from the ESDM (Refer Annexure E).

The graph shows that the electrification ratio in the province is 77.16 percent. The trend is increasing gradually from the year 2008 till at present. With the government initiatives to improve the economy of the entire Indonesia, various steps were undertaken to improve the electricity scenario of the country. The different electricity generating units including the state company PLN along with the government are taking various steps in this field. With the introduction of renewables after the Green Energy policy from the government, the future projection is expected to be 90% in the year 2017. ESDM is taking the main role in meeting the future targets along with the department of the State Power. ESDM shows a surplus of electricity of 4245.2 MW in 2013. At present 8437 villages are electrified.

4.2 Renewable Energy scenario in East Java

4.2.1 Potential of Renewable Energy

Table 9: Main potentials of renewable energy

Sr. No.	Type	Potential (MW)
1	Hydro	138
2	Wind	165
3	Biogas	390
4	Biomass	32
5	Solar	25
6	Wave energy	145
7	Geothermal	1200
8	Total	2645

The above table shows that the highest potential lies in geothermal. Biogas takes the second position. Solar potential is the minimum. These are the updated findings from the ESDM. The total potential is around 2645 MW, which is a big figure that can be exploited only under feasible economic condition and with better participation of public and private organization to achieve the set national target.

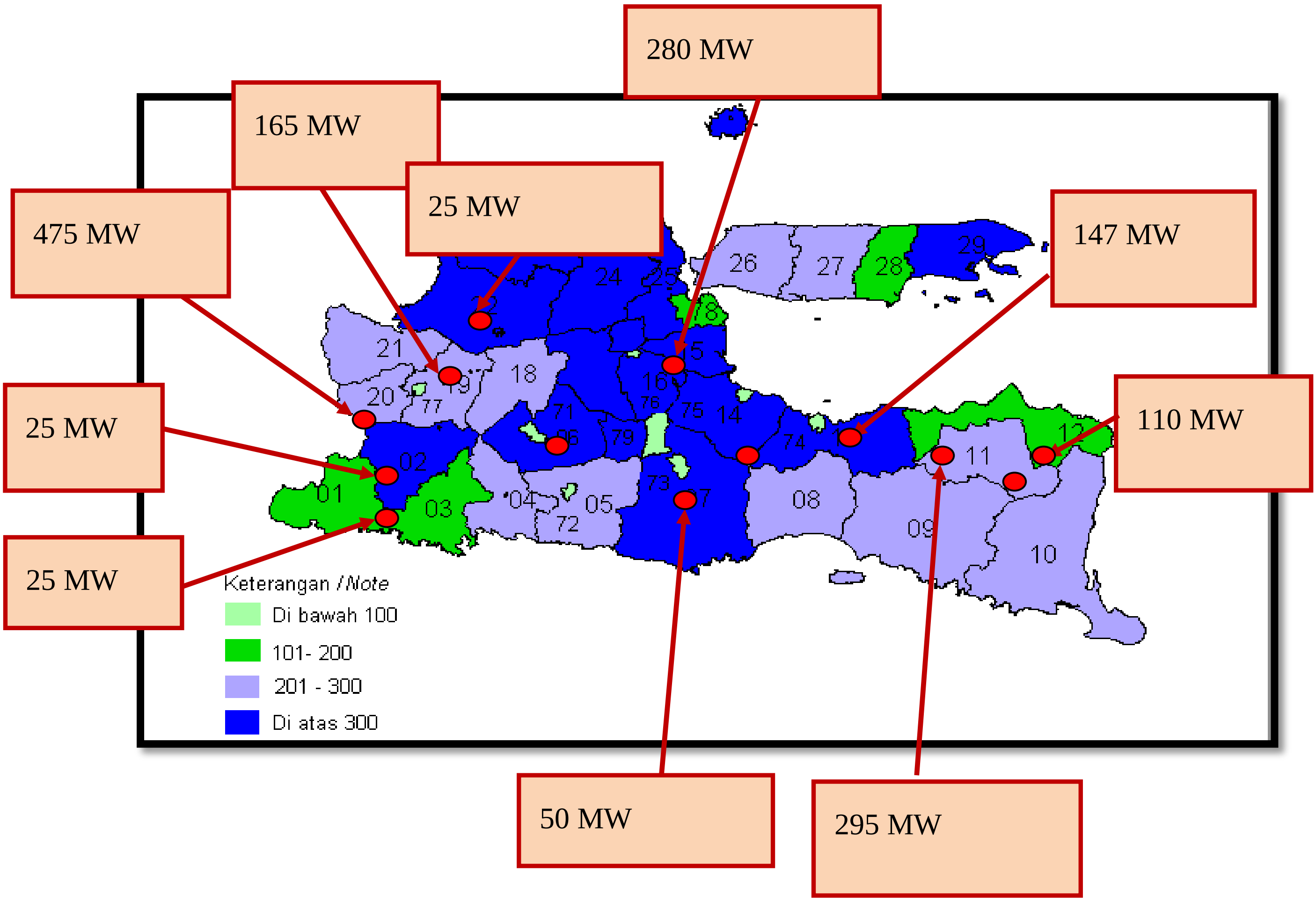

Figure 32: Geothermal potential in East Java

Source: Provinci Jawa Timur 2012, p. 35

The above figure shows the geothermal potential in the different regions of the province. There are no geothermal plants set up in the province so far. These are the result of a survey by the government conducted through the Geochemistry Geology and Geophysics Agency in 2010 and the magnetotelluric survey by the Government of East Java in 2012.The highest potential is found in Gunung Lawu situated in the districts of Karanganyar and Magetan. Others are followed by Arjuno-Welirang (in the districts of Mojokerto, Pasuruan and Malang), Songgoriti Kawi (in the districts of Batu and Malang), Gunung Pandan-25 MW (in the districts of Madiun Bojonegoro) , Melati-25 MW (in the district of Pacitan), Rejosari-25 MW (in the district of Pacitan), Ngebel Wilis (in the districts of Ponorogo and Madiun), Blawen Ijen (in the districts of Bondowoso, Banwyuwani and Situbondo), Iyang Argopuro (in the districts of Probolinggo and Lumajang)and Tiris Gunung Lamongan (in the districts of Probolinggo and Lumajang). The potential of other sites Gunung Raung (in the districts of Banwyuwani, Bondowoso and Jember), Pengunungan Bromo Tengger (in the districts of Pasuruan, Probolinggo, Lumajang, Malang and city Malang) and Gunung Wilis (in the districts of Ponorogo, Madiun, Nganjuk, Kediri, Tulungagung and Trenggalek) are not known.

4.2.2 Installed capacity of Renewable Energy systems

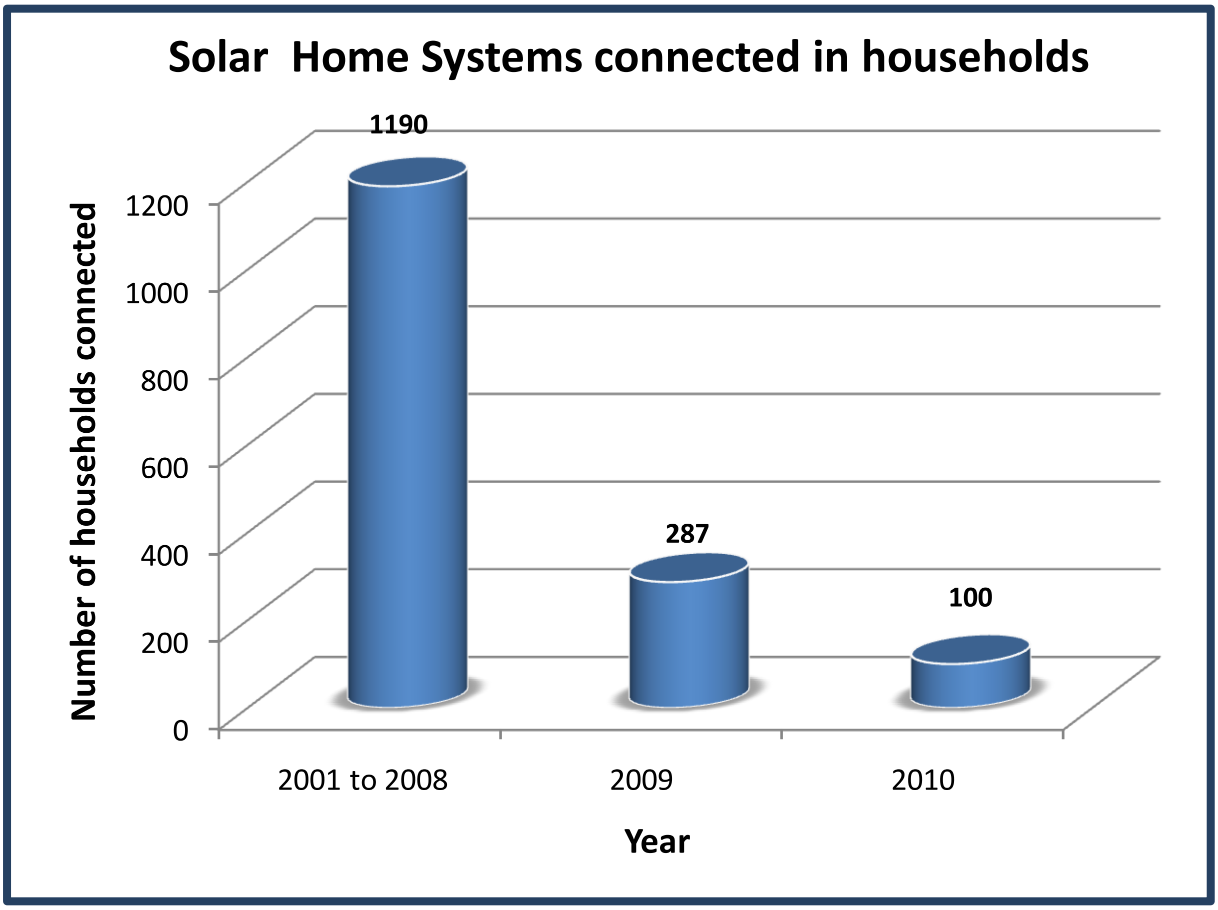

Figure 33: Installed solar home systems connected in various regencies of the province (Refer Annexure J).

The above graph shows the total number of solar home systems installed so far from 2001 till 2010. The data after 2010 is not available in ESDM. Most of the systems installations were installed in the first eight years starting from 2001. Based on the energy situation and funding distribution from the government, fixed targets are made every year for the instalment of solar home systems. The decreasing trend is due to the meeting of energy demands in the required regions by other type of renewables. Proper community participation is necessary in addition to the initiatives taken by the government to meet the basic energy need. The capacity of a single system in the entire installation period is 50Wp. From 2001 to 2008, these 1190 units were installed in 23 districts, followed by 9 districts in 2009 and only in Madiun and Pacitan in 2010. These projects are funded by ESDM from Jakarta, Kementerian Pembangunan Daerah Tertinggal, KPDT (Ministry of Rural Development[6]) and Anggaran Penda-

[6] Information on KPDT available at http://www.kpdt.bps.go.id(accessed January 17, 2014)

patan dan Belanja Daerah, APBD (Budget and Expenditure of local Indonesian government approved by the Legislative Council).

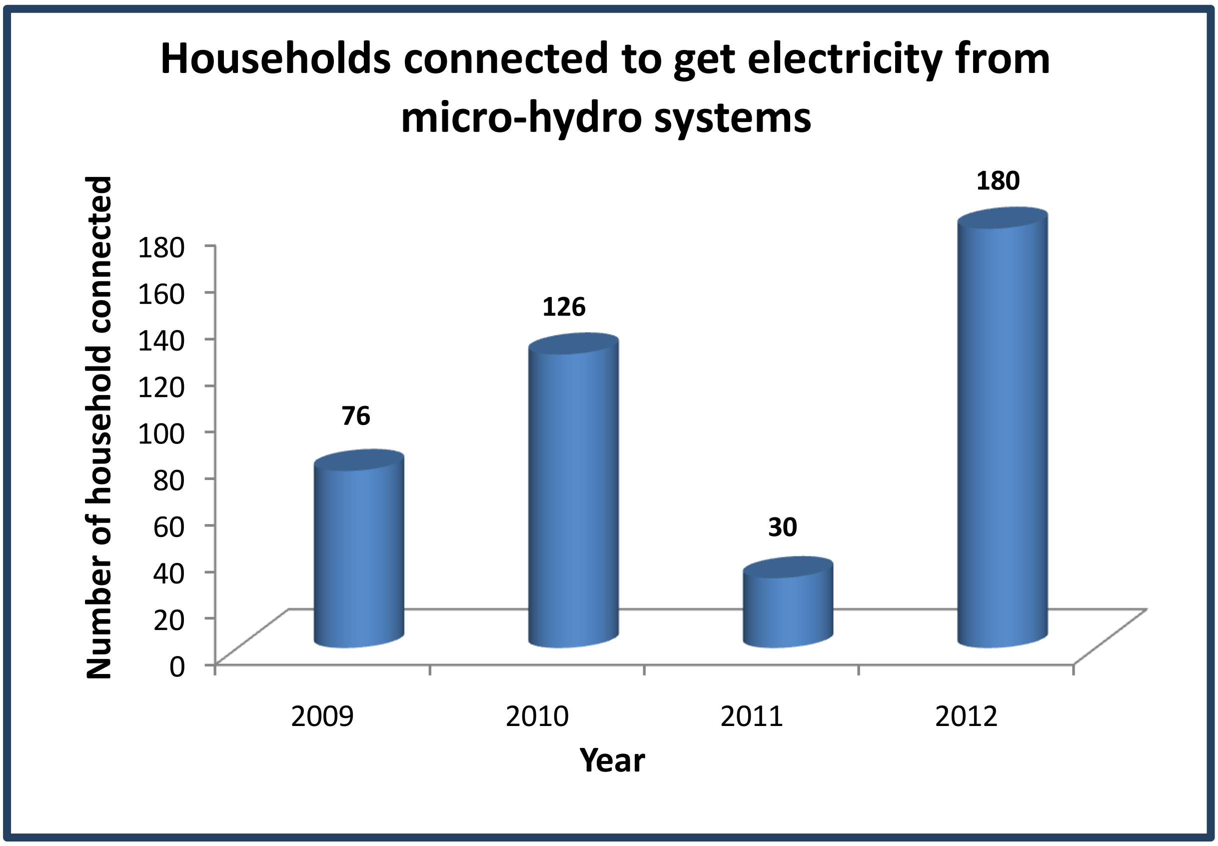

Figure 34: Installed micro-hydro systems funded by ESDM only and connected in various regencies of the province (Refer Annexure J)

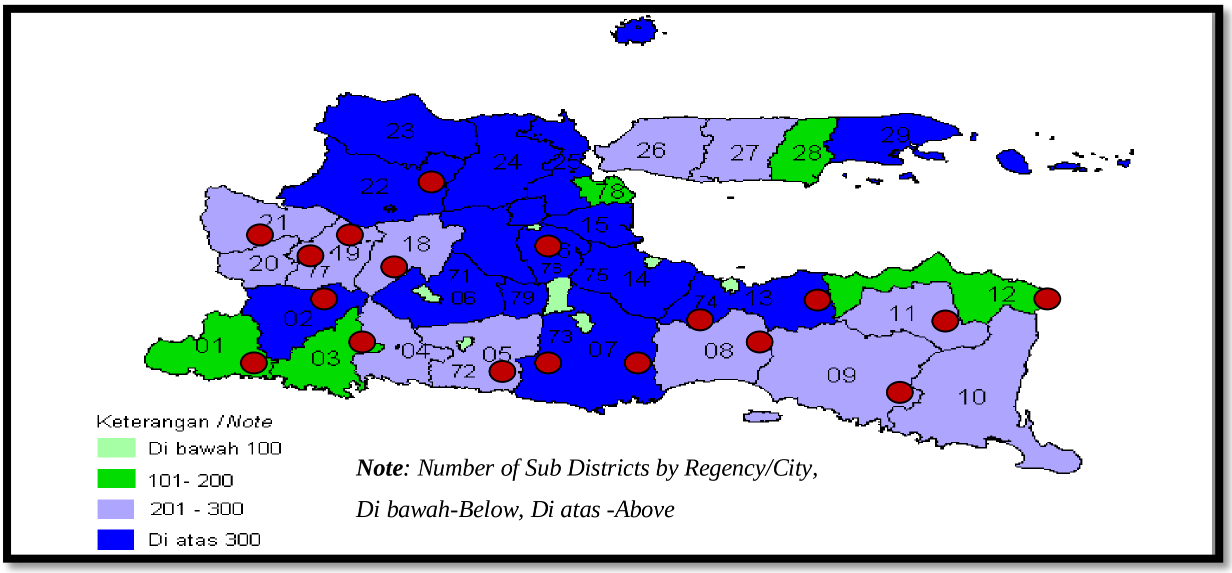

Figure 35: Map of installed micro-hydro systems connected in various regencies of the province.

Source: Provinci Jawa Timur 2012, p. 35

Figure 34 highlights how many households are connected to micro-hydro systems from 2009 till 2012 that are initiated by ESDM. It is seen that the highest number of connection was in the year 2012 with 180. The government is taking influential step to meet the energy demand of the rural population from the available resources in an effective manner. The future projection seems to be positive in the entire province.

Figure 35 shows where the micro-hydro systems are installed so far from 1994 till 2013 (highlighted in red) in the province. The micro-hydro systems are mainly installed in various regencies like Bojonegoro, Mojokerto, Nganjuk, Ngawi, Ponorogo, Pacitan, Malang, Jember, Situbondo, Bondowoso, Blitar, Lumajang, Trenggalek and Probolinggo. The total capacity in 2013 is around 972 kW (Refer **Annexure C**) that can serve about 4017 houses as shown below in **Figure 36**.

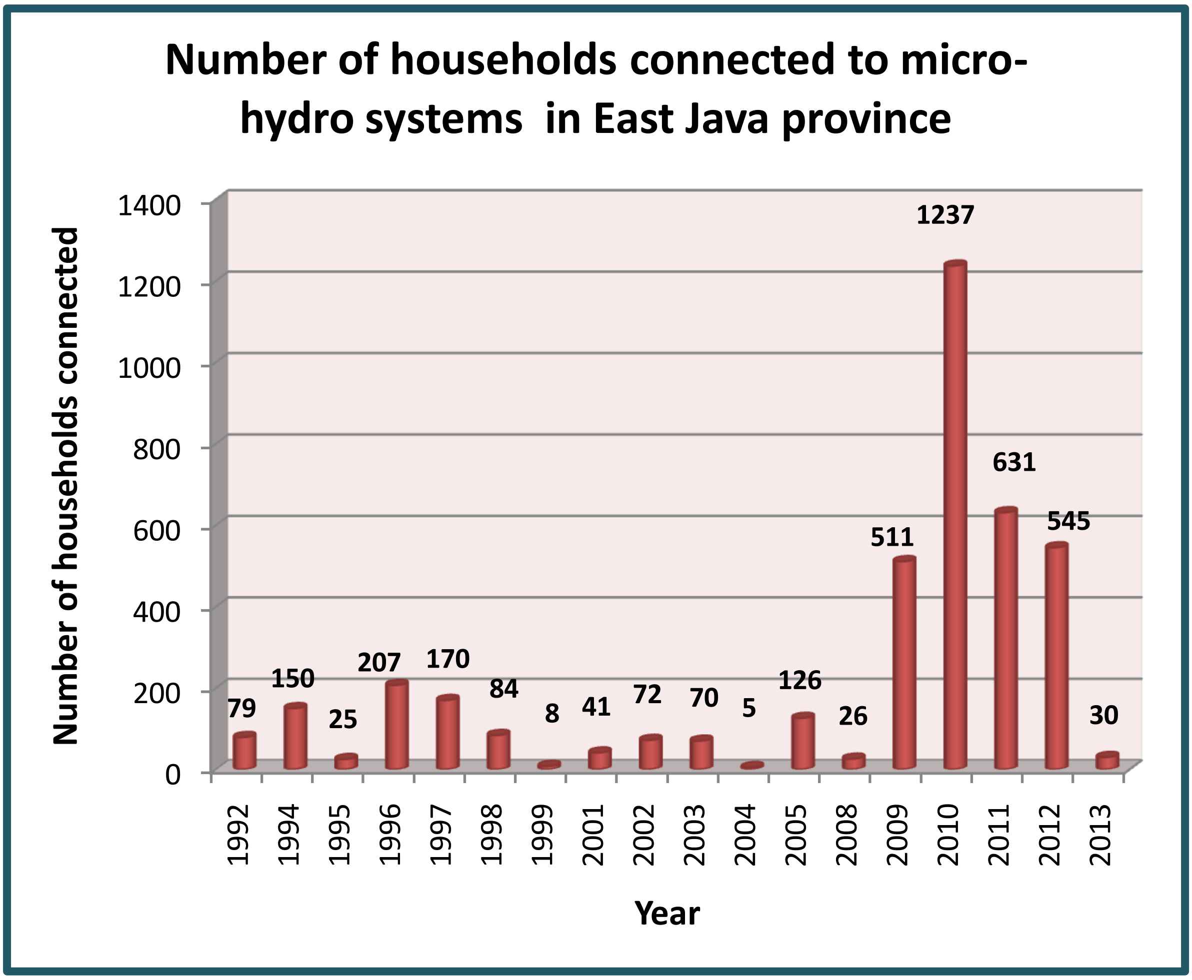

Figure 36: Total number of households connected to micro-hydro systems in various regencies (Refer Annexure G).

These projects are initiated not only by ESDM, but many other district and sub-district governmental organization departments including PPLH.

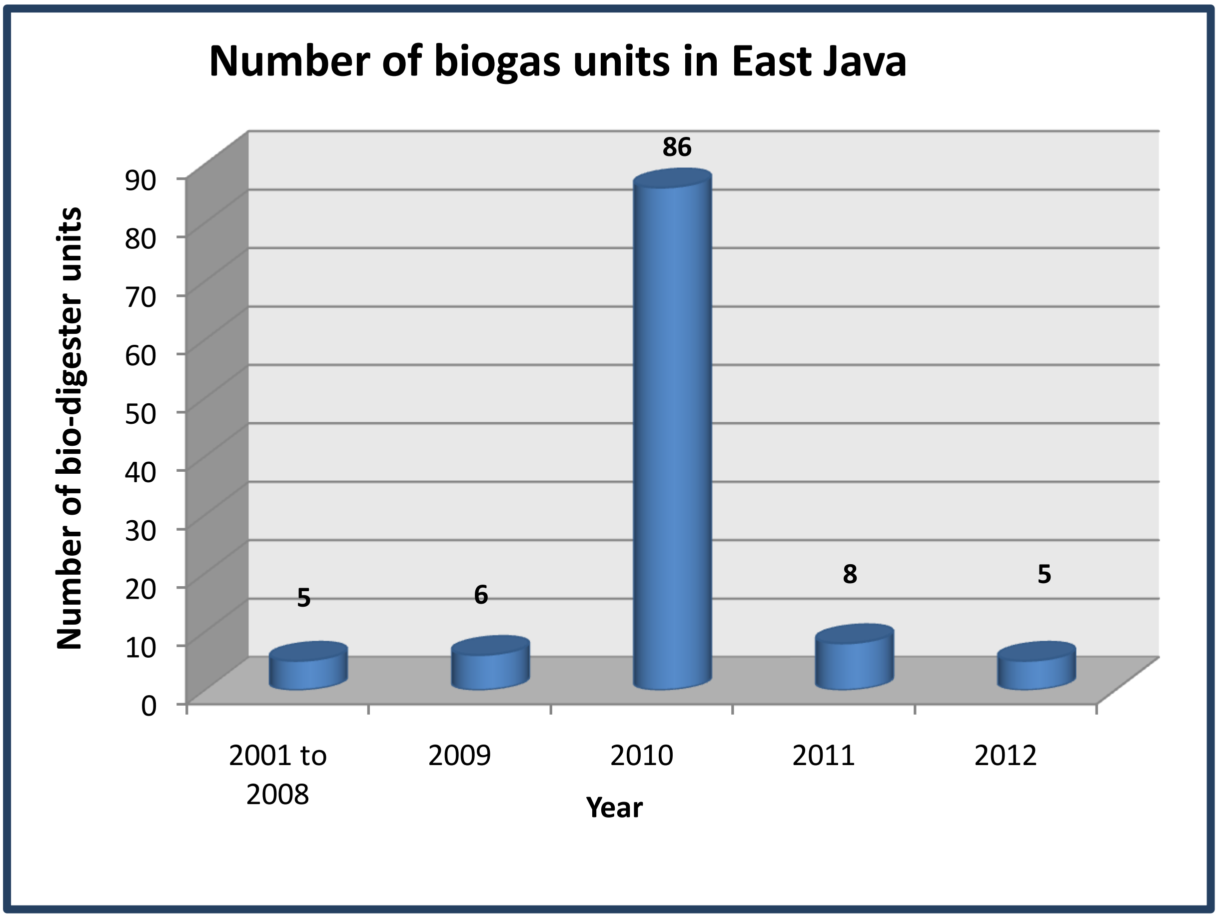

Figure 37: Number of biogas units in the province of East Java with ESDM funding and initiatives (Refer Annexure J).

The graph shows many biogas units are currently installed in the province. The highest number was installed in 2010 with 86 plants. The main reason behind this is that the initiatives took a drastic change and rapid development due to the influence of the biogas program called the Indonesia Domestic Biogas Program known as BIRU program[7]. This program was undertaken by HIVOS in close association with ESDM and the SNV Netherland Development organization that aimed to set of bio digesters in different places from the initial first phase year 2009 to 2012.

The capacity of biogas digester is 40 m^3 from 2001 till 2011 and 10 m^3 in 2012. From 2001 till 2008, it was only present in 5 regencies, followed by 2 regencies (in 2009), 31 regencies and districts (in 2010), 4 regencies (in 2011) and one regency in 2012.

[7] Information on HIVOS available at http://www.hivos.org (accessed January 20,2014) and on BIRU program available at http://www.biru.or.id (accessed January 15,2014)

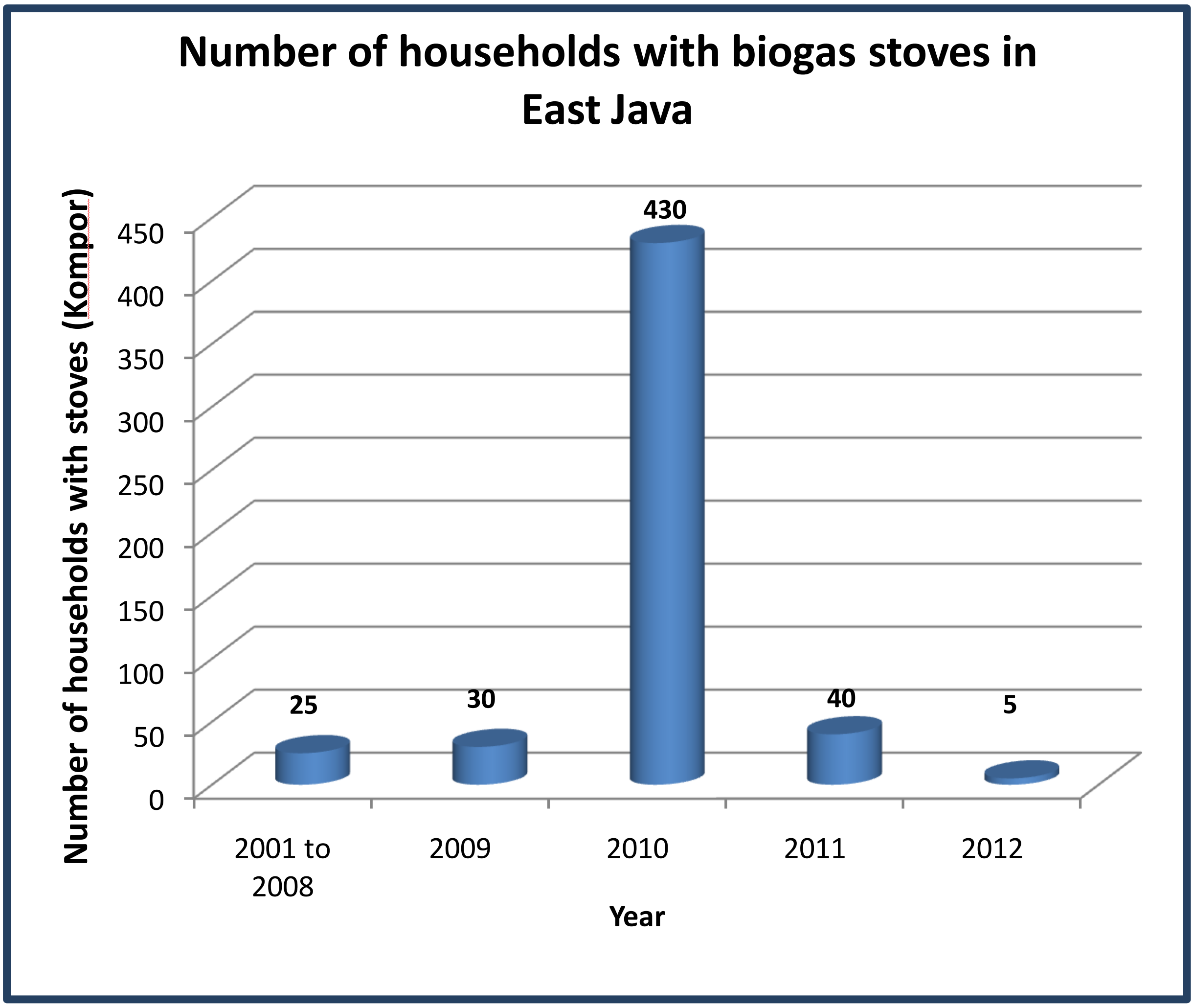

Figure 38: Number of households with biogas stoves in East Java (Refer Annexure J).

The above graph depicts the same pattern of behaviour for biogas stoves as already discussed in the previous graph for biogas digesters (Refer **Figure 37**). The highest number of households is in the year 2010. Minimum is in the year 2012.

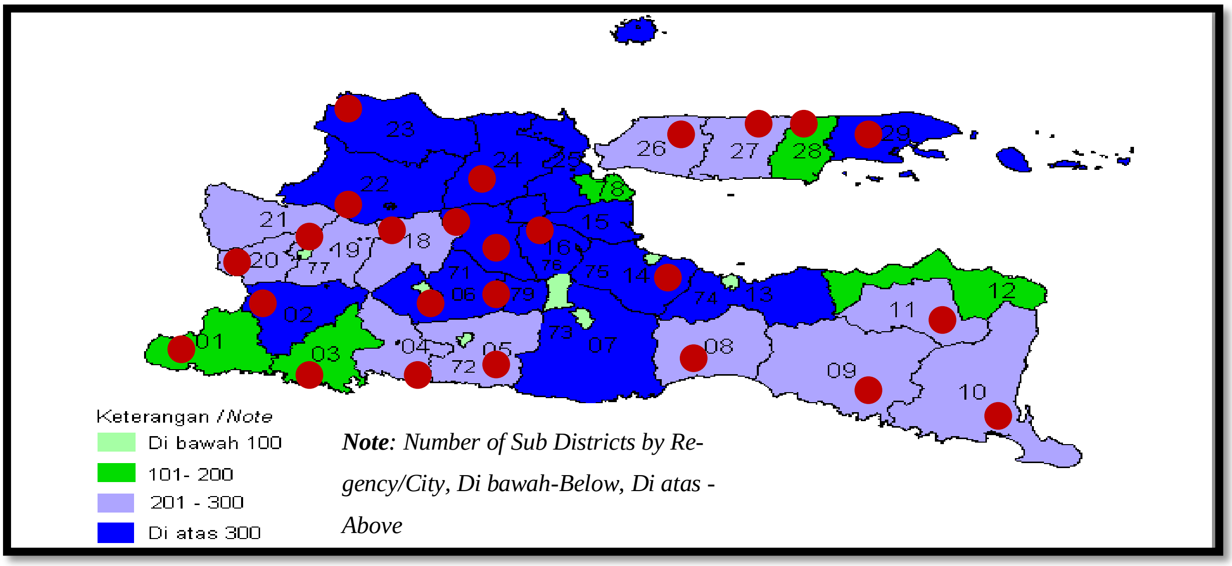

Figure 39: Map of installed bio-digester units located in various regencies of the province initiated by different organizations including ESDM.

Source: Provinci Jawa Timur, 2012, p. 35

Figure 35 highlights where the main installations lie in the province till 2013. There are in total 5612 biodigester units in East Java. Some of the projects are initiated and funded by HIVOS, APBD, and Province Jatim BLH [5]. They are mainly located in Bojonegoro, Malang, Mojokerto, Probolinggo, Pauruan, Sampang, Madiun, Lumajang, Batu, Pacitan, Pamekasan, Sumenep, Kediri, Nganjuk, Ponorogo, Tuban, Gresik, Bondowoso, Blitar, Kediri, Jember, Lumajang, Banyuwangi, Sidoarjo, Magetan, and Jombang

4.3 Survey results

4.3.1 Mandangin Island

- 90 % of the population in the island has access to electricity. The population without electricity does not have enough income to buy electricity from PLN which is the main service provider in the island.
- Main occupation of livelihood in the villages is fishing while other jobs percentage is very minimal.

4.3.2 Seloliman

- PLN is the main electricity provider in the village which started from the year 1993. MHP provides electricity to 50 households from the year 1996 and 2008. The village is fully electrified.
- Agriculture is the main source of income.
- LPG started to be used in the village for cooking from 1994.
- For cooking, uses of fire woods are minimal. They are used during occasion.

4.3.3 Nongkojajar

- Main source of income in the villages of Nongkojajar are cattle farming and agriculture.
- PLN is the main source of electricity provider since the year 1989.

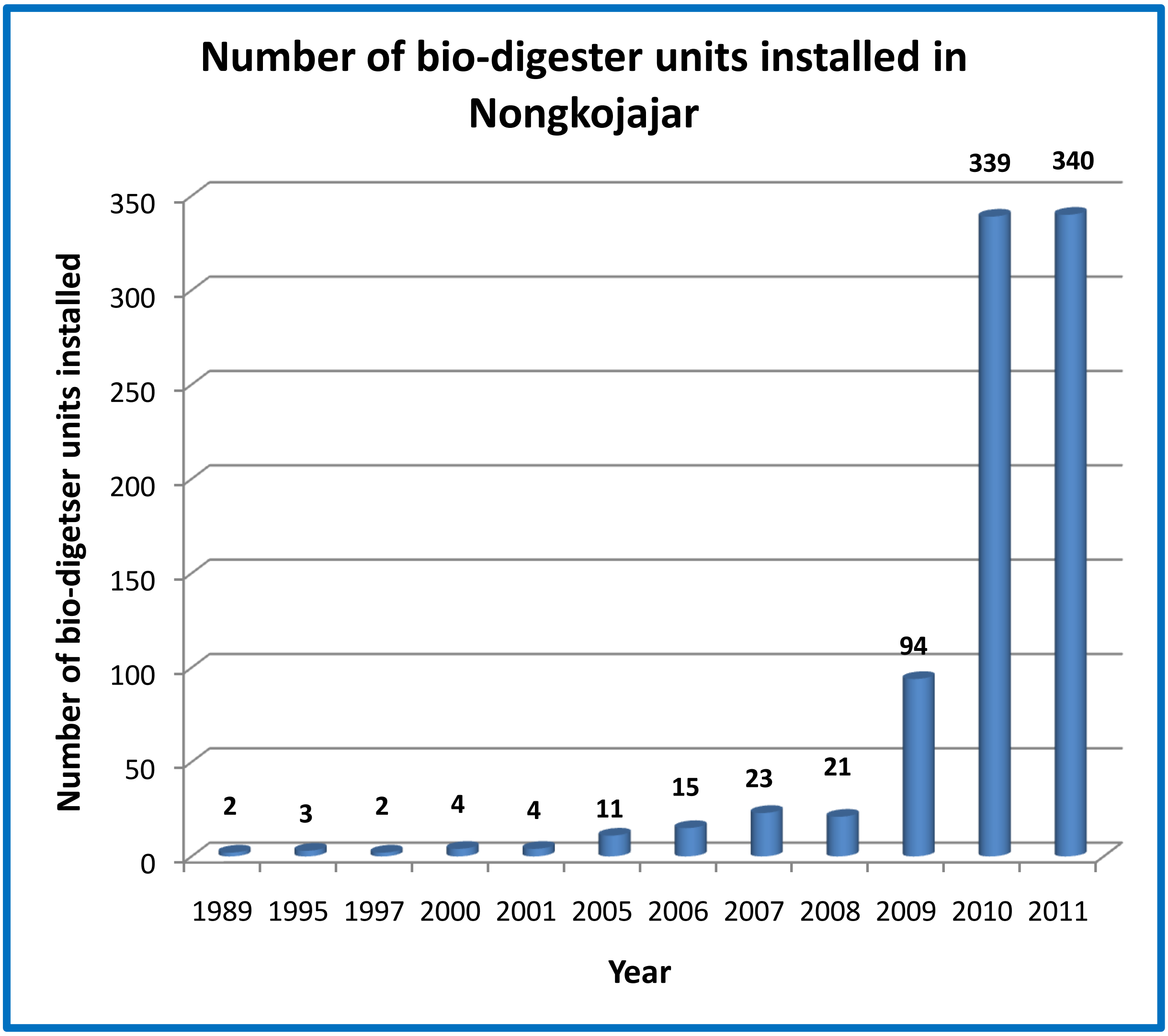

Figure 40: Total number of bio-digester units installed in Nongkojajar from 1989 to 2011 (Refer Annexure H)

The above graph indicates how many installations are done in the district of Nongkojajar within 10 years. From 2009, there is a drastic increase in the installation compared to the previous nine years. The main reason behind it is the influence of the Indonesia Domestic Biogas Program initiated by HIVOS which is also one the funding organization for the society of KPSP in Nongkojajar that looks after biogas units' installations. The highest is indicated in the year 2011. As cattle farming is the primary occupation of the villagers, there seems to be a significant potential for installation of biogas digesters. This motivates the villagers to use the cow dung to meet the demands of energy of the people and improve the energy scenario in the region. There seems to be also the motivation from one villager to another in installing the biogas digester unit in their houses which makes their life simpler. These biodigester units operates on cow dung from village cattle in which each cow gives 20 to 25 kg of cow dung that feeds into the digester every morning in 24 hours.

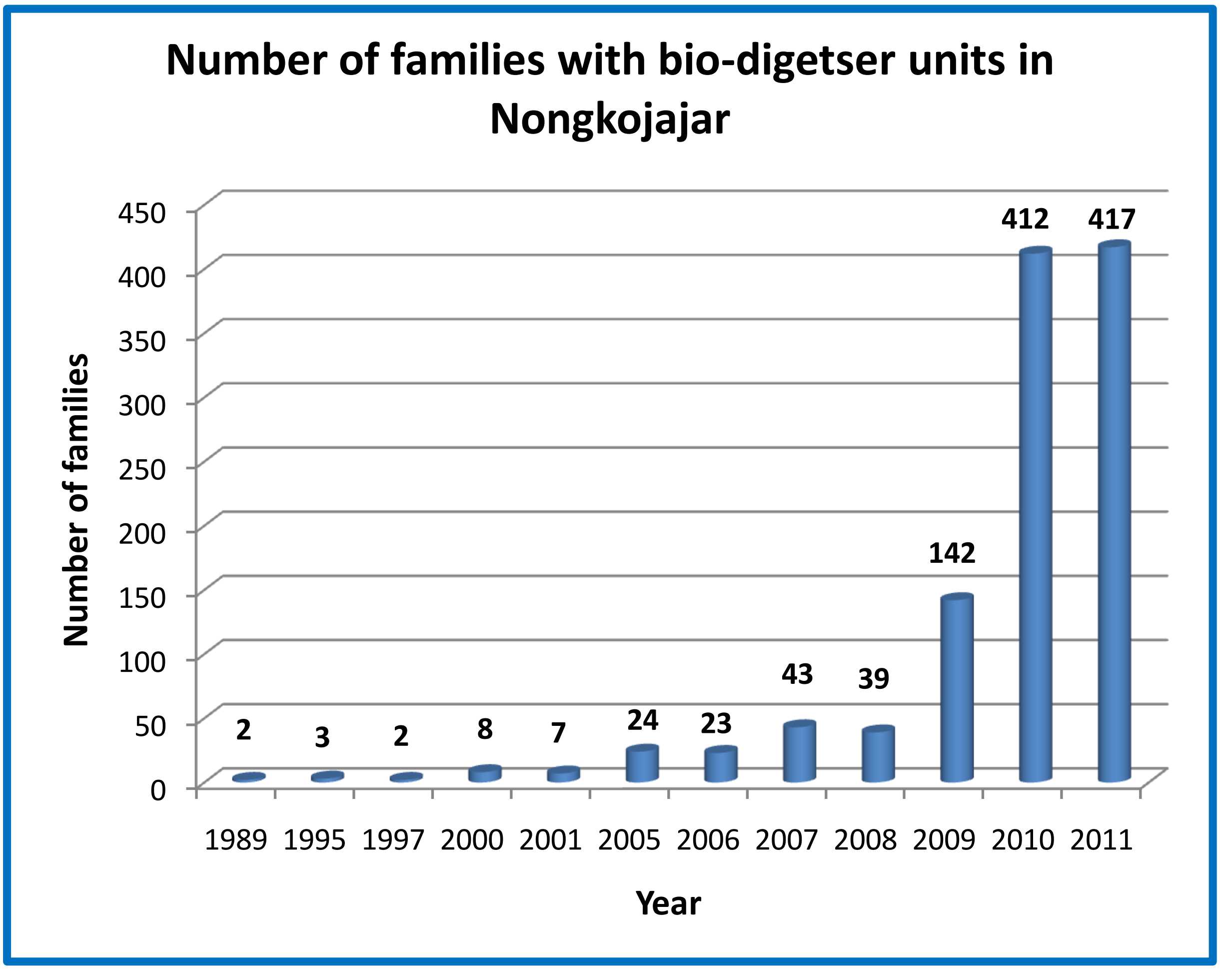

Figure 41: Total number of families with biogas digester units installed in Nongkojajar from the year 1989 to 2011 (Refer Annexure H)

Figure 41 highlights the increasing number of families installing bio-digester units in their houses. The main technology is the fixed dome reactor which is taken from Nepal and manufactured in Indonesia. The trend is expected to increase drastically from 2009 and it increases with big figures in the year 2011. This is mainly due to the BIRU program[8]. Also, societal influence to improve the standard of living, the cravings for easy life and better access of energy is another major contributor for such an increasing trend.

[8] Information on BIRU available at [4]

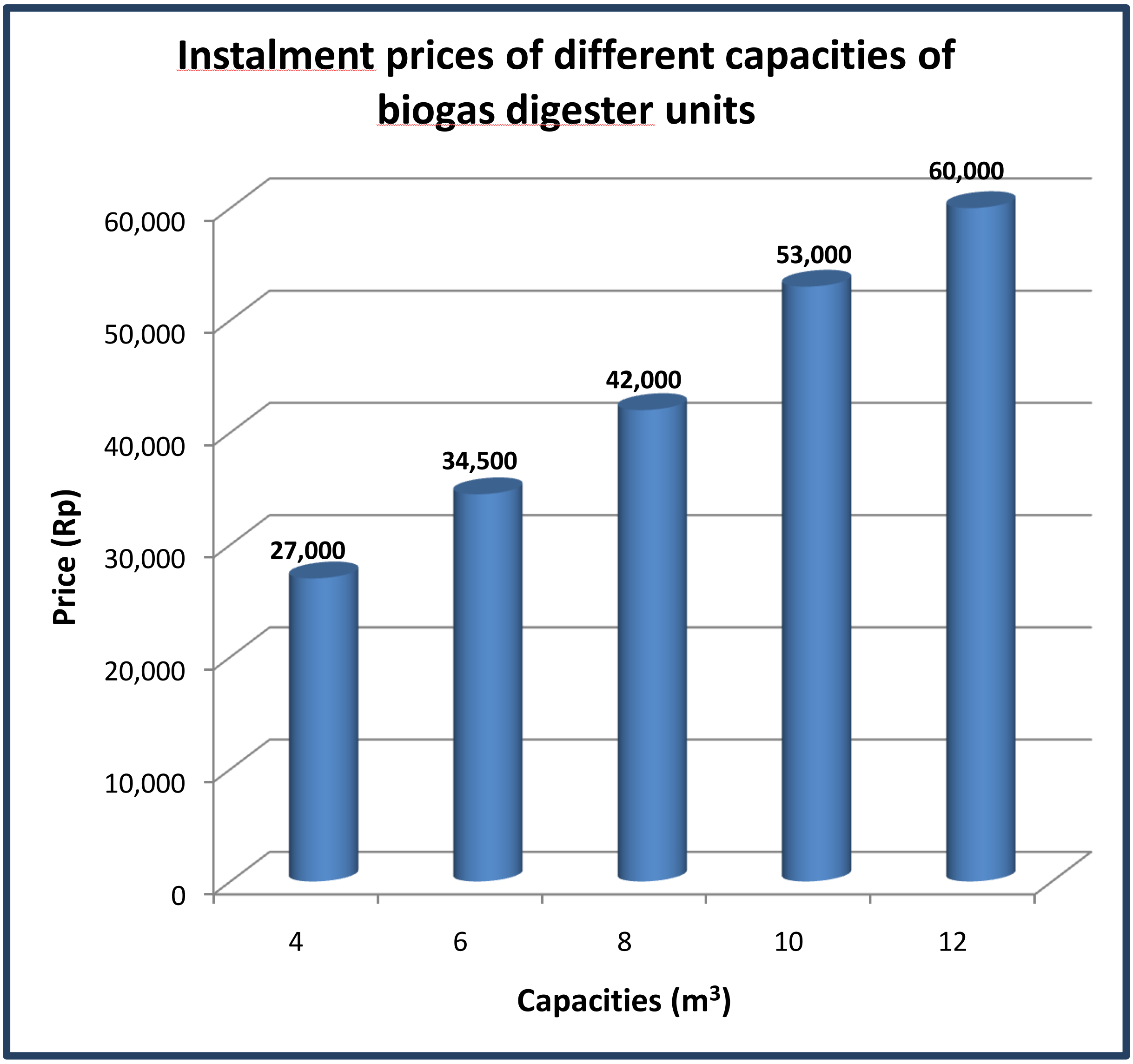

Figure 42: Total instalment prices of different biogas digester units (Refer Annexure I)

As seen from the above graph, the capacities of the digesters installed in Nongkojajar are mainly of 4 m^3, 6 m^3, 8 m^3, 10 m^3 and 12 m^3. Based on the capacity to afford, the families in the village select the type of biogas digester units to meet their demands. The main source of subsidy comes from HIVOS and government with a fixed amount of 2 million IDR for any capacity digester. The remaining credit for the total price of digester is paid by the customer after being registered with the KPSP for 5 years contract with equal monthly instalments. The indicated figures in the graph are the instalment fees paid after every 10 days based on the size of the digester bought by the villagers.

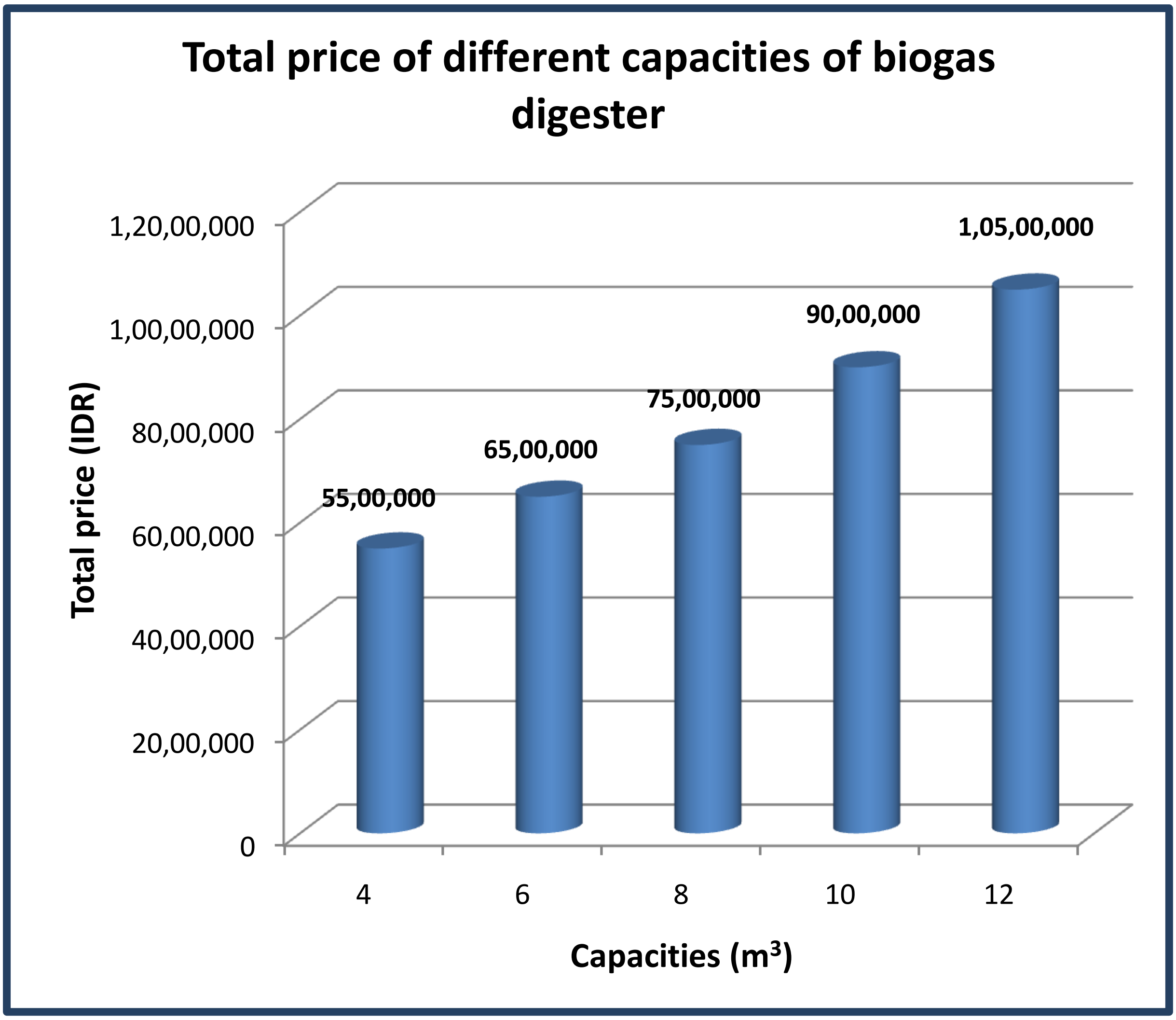

Figure 43: Total prices of different biogas digester units (Refer Annexure I)

The above figure shows the prices of bio-digester in Nongkojajar for the available capacities. This a current indicative price in the year 2013. The price of each digester increases based on their increasing sizes.

4.3.4 Comparative result of range of families income and monthly expense on access to energy in cooking and electricity

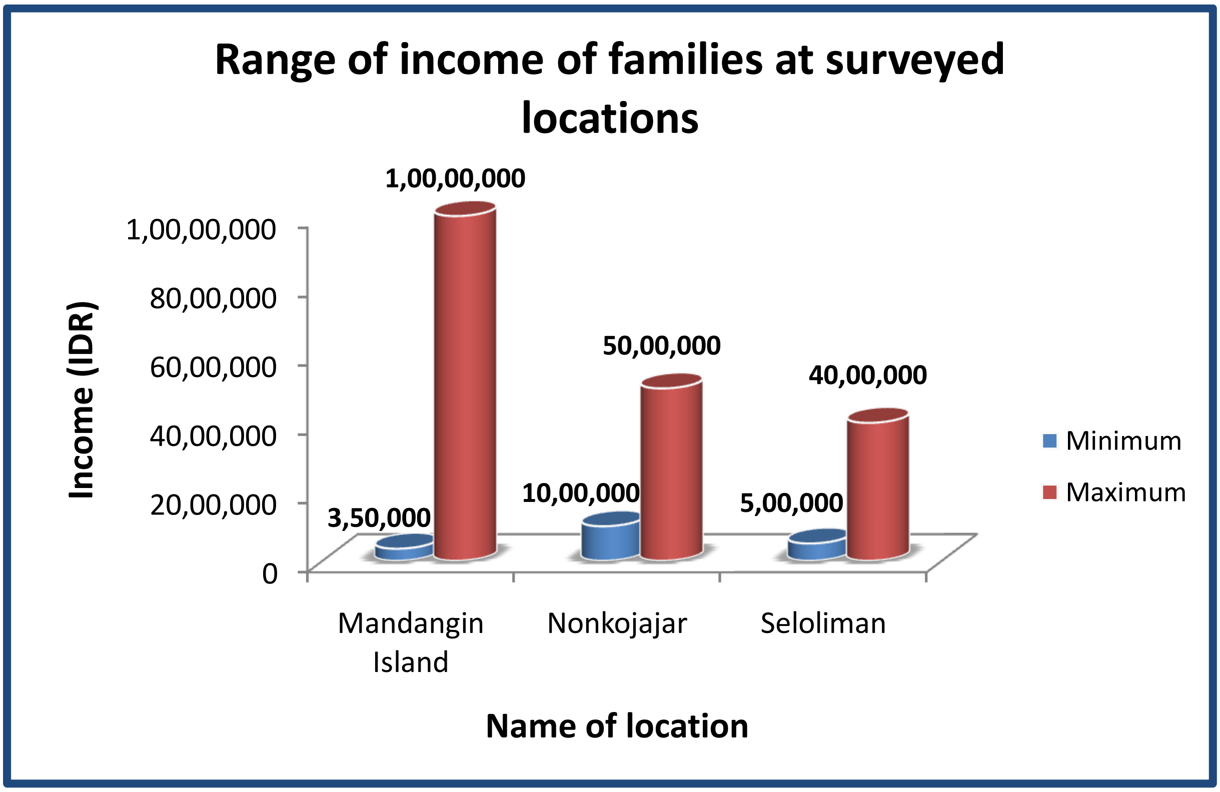

Figure 44: Range of families income at surveyed locations (Refer Annexure K)

Based on the methodological approach achieved and described in Chapter 3, the above graph shows the entire range of monthly income of families after interviewing the target groups at the surveyed location. The difference in range is highest at the Mandangin Island compared to the two other locations. The main occupation of the village is fishing **(**Refer **Appendix L)** and the income varies mainly on the availability of varied fishes and also on the market condition to sell the fishes at the optimum price thereby satisfying the customer. It also depends on the weather condition because of the occurrence of high tides during rainy season in the Java Sea and hence the sellers cannot commute in ferry and sell them in the city of Sampang district. In Nongkojar, cattle farming and agriculture are the main occupations. The income is earned by selling milk products and growing cassava, coffee and seasonal tropical fruits. The inhabitants at Seloliman are mainly dependent on agriculture. They grow cassava, different types of seasonal fruits, coffee etc. Their income is generated by selling those products in the markets. However, the variation of income in the families of Nongkojajar and Seloliman is due to the availability of land to grow food stuffs, their purchasing and ownership power of lands and also on the weather conditions. It is seen that the range of incomes of families at Nongkojajar and Seloliman is not very high. This is because of their common type of earning methods. The income ranges in the graph give an overview of their purchasing power and the ability to spend a fraction of the total in meeting their energy demands in the daily consumption of a single family. The portion spent on the same especially in cooking and electricity are discussed in the following **Figure 45** and **Figure 46**.

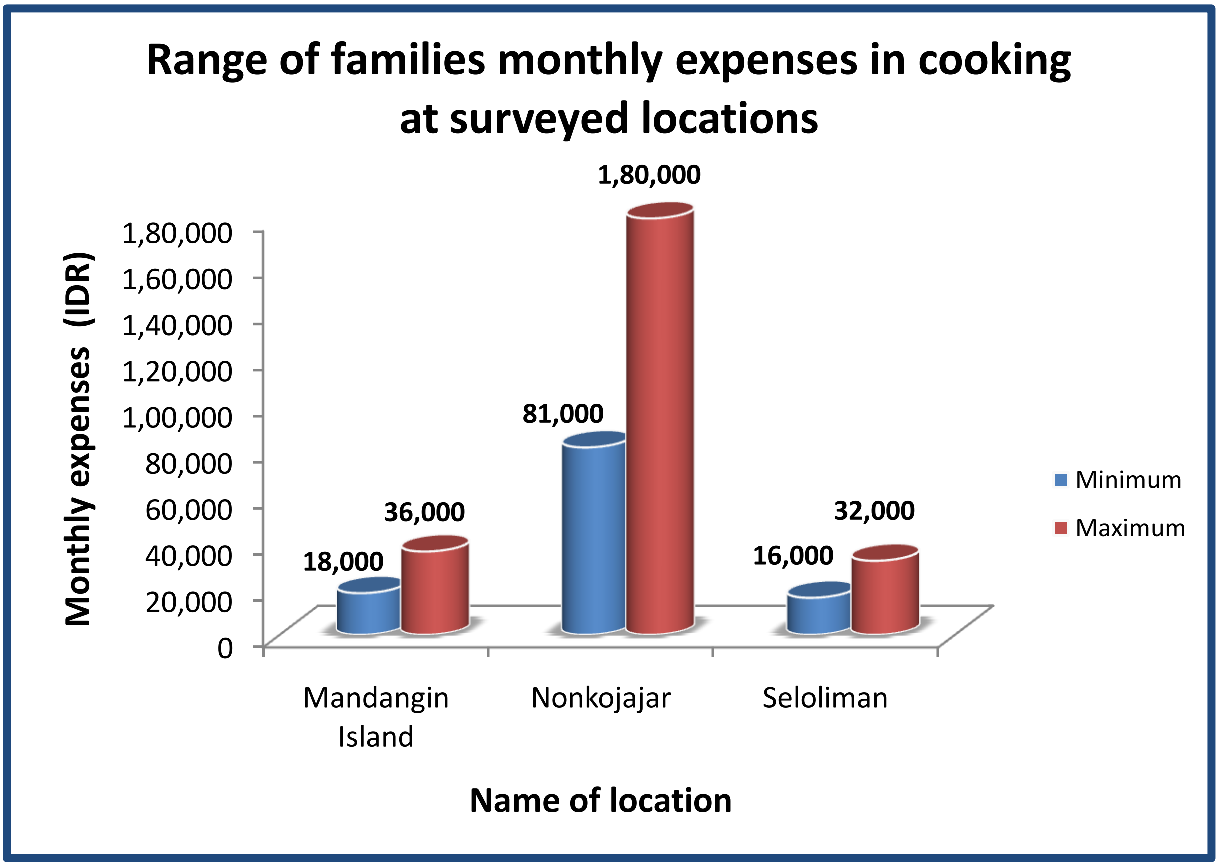

Figure 45: Range of monthly expenses in cooking by a single family at surveyed locations (Refer Annexure K)

Figure 45 indicates the minimum and maximum monthly spending of a family (4 to 5 members) for cooking using 3.5 kg LPG cylinder (Liquefied Petroleum Gas) and biogas digester(in Nongkojajar) at the surveyed locations. These figures do not take into account the money spent in consumed food. Woods are used only in rare occasion of family gatherings, parties and during emergencies in Mandangin Island, Seloliman and Nongkojajar. Electric cooker are used for cooking their main staple food i.e. rice. The minimum spending in a family is at least one cylinder, which cost 18,000 IDR at Mandangin Island and 16,000 IDR at Seloliman. The price of LPG at Island Mandangin is higher than in the cities in Sampang district because of the transportation cost to supply these cylinders to the island. It can be seen from the graph, that a single family consumes two cylinders at a maximum in a month. The families at Nongkojar who cannot afford biogas digester use 3.5 kg LPG cylinder for cooking which is fully subsidized by government. The consumption quantity is in the same range as in Mandangin Island and Seloliman. The higher spending range is in Nongkojar which is an indicative figure only for families that have bio digester systems at homes. These minimum and maximum values are the spending of the families based on the size of the digester they use for cooking. The range of spending varies accordingly and the instalment price of the system is paid only for five years. The families do not spend a single penny after the end of tenure of loan offered by the KPSP society and then the system is completely owned by them. Families start to collect and use woods who cannot afford double quantities of LPG cylinders in a month due to low earning outputs.

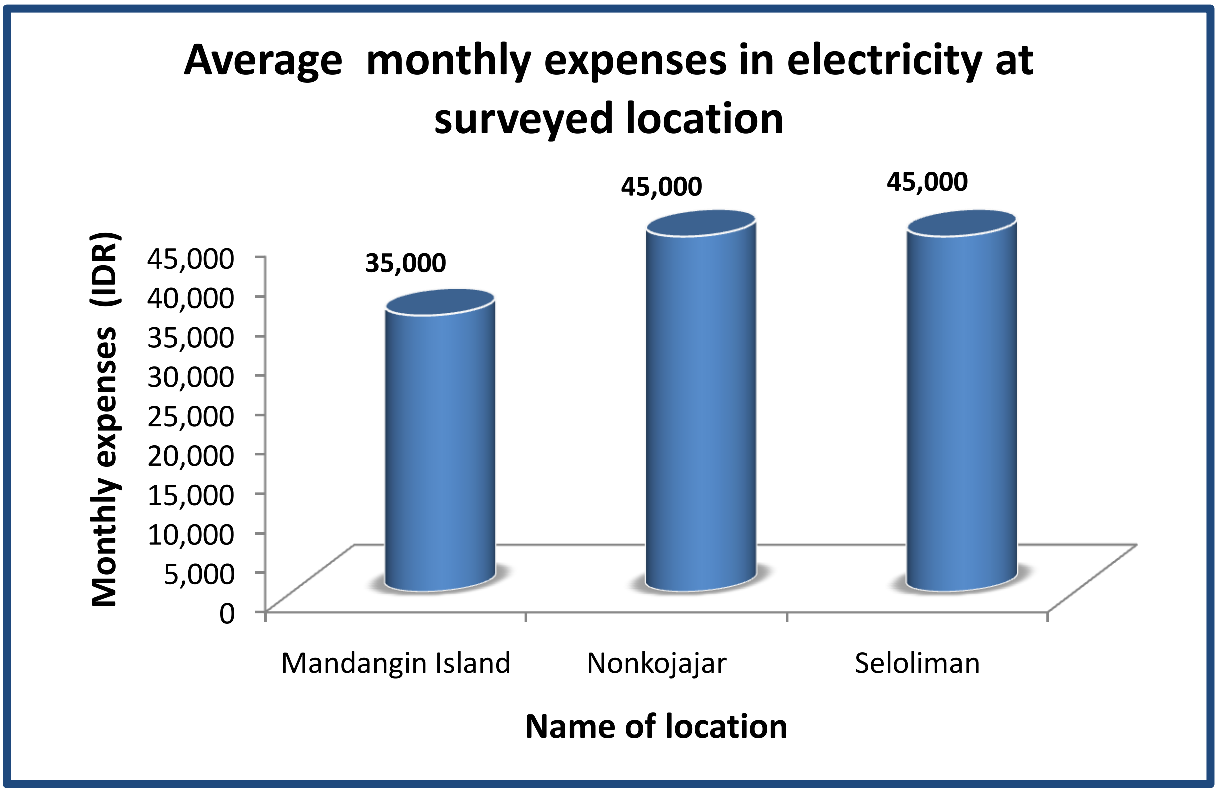

Figure 46: Range of families monthly expense in electricity at surveyed locations (Refer Annexure K)

The above graph shows the average monthly expense of a single family in consuming electricity at the surveyed locations. It is seen that their expenses mainly depend on the consumption pattern of the families. The source of electricity is mainly PLN for Mandangin Island, Seloliman and Nongkojajar. The average figures seem to be more or less in the same range. The main consumption lies in mobile charging, electric cookers, and lighting three to four room houses with CFL bulbs (Generally 5 watts), fluorescent lamps, of four to six in quantities, watching 14" or 21"color television based on their requirement and choice of entertainment. However, in Nongkojajar, families who own biogas digester systems also use lamps from biogas for lighting, apart from the commercial standard bulbs during emergencies. The average figure from the graph in Seloliman is for families with electricity from micro-hydro system. As the standard of living of people in the surveyed locations are similar, and comparing their earning income and living styles, it can be predicted that the average monthly expense of families who get electricity from PLN in Seloliman is similar to the families connected to micro-hydro system. PKM decides the fixed feed in tariff for customers at Seloliman (Refer **Appendix A**).

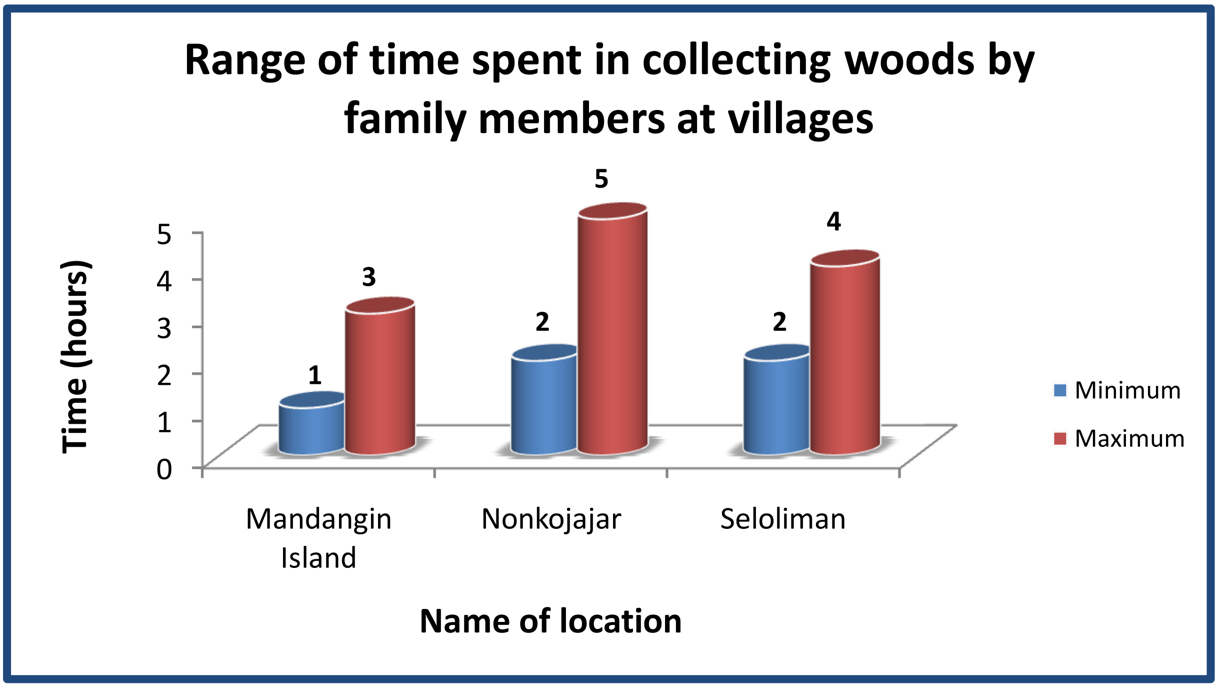

Figure 47: Range of time spent in collecting woods by families at surveyed locations (Refer Annexure K)

Figure 47 highlights the spending hours of a single family in collecting fire woods. The range is slightly lower in Mandangin Island compared to the other two locations, because of the topographical condition. The villagers spent on an average two hours in searching wood at the plain areas. It takes longer by walking in valleys and hilly areas of Nongkojajar and Seloliman for collecting woods and hence the values are slightly higher in these regions. Both female and male including children engage in this activity depending on their availability. This was a common problem of the families before the renewable energy systems were installed at Nongkojajar and Seloliman. However, low income families still prefer collecting and using woods for cooking in Mandangin Island. At present, this shows an opposite situation at Nongkojajar and Seloliman after the installation of renewable energy system. Consumption of woods is now only for cooking food during family gathering parties and emergency. The average price range is 7000 to 8000 IDR for a 35 kilos bundle of woods (at present) which can be used for cooking food for six to seven people. There are markets for selling woods in Nongkojajar; the same is not available in Seloliman and Mandangin Island.

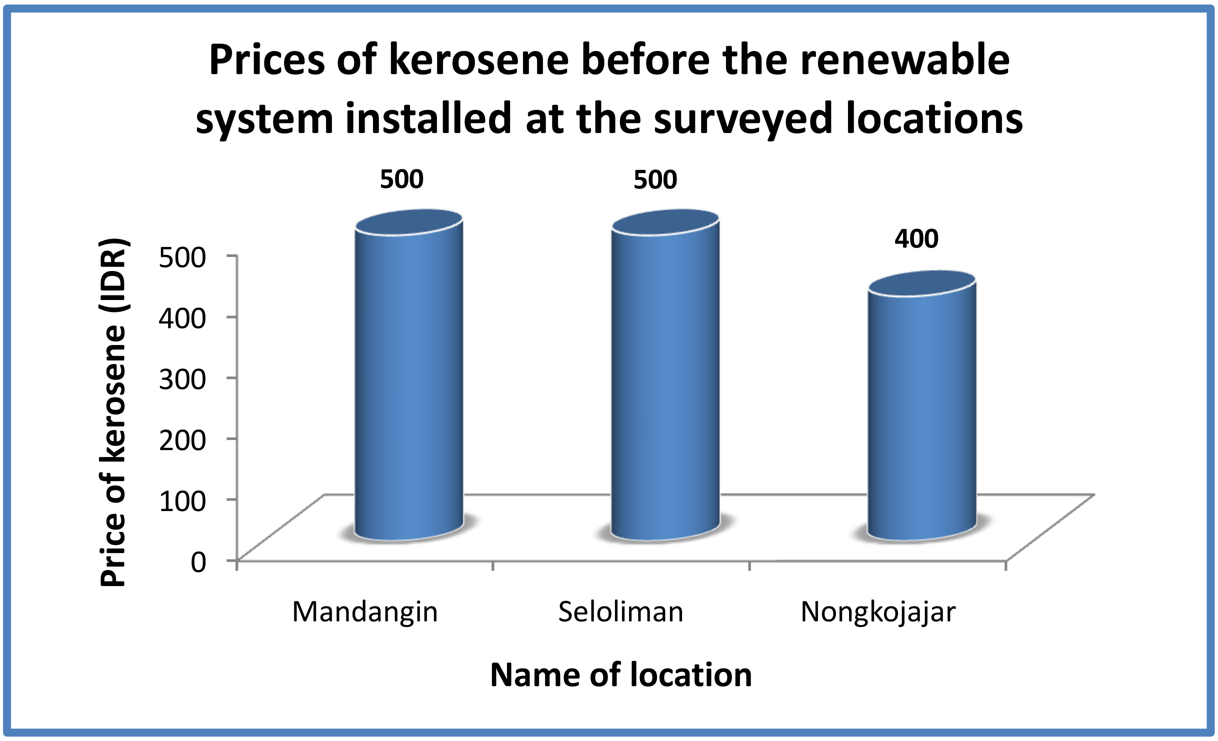

Figure 48: Prices of kerosene at the three surveyed locations before renewable energy systems were installed (Refer Annexure K)

The above figure shows the prices of kerosene before the renewable systems were installed and when there was no electricity in the surveyed locations. It is seen that the figures in the three locations are nearly the same which is partly subsidized by government. But it was found after interviewing the target groups, that the price was high and a huge burden for the family to meet their basic needs. Generally they use four to five lamps for lighting the houses apart from igniting the fire while cooking using fire woods. To meet that demand was a difficult process during that time. All the figures are in the years of the early eighties and nineties.

4.3.5 Findings of common problems while accessing basic energy in Mandangin Island, Seloliman and Nongkojar villages

- When analyzing the data from **Figure 45** and **Figure 47**, collecting fire woods from hills, forest and surrounding areas are based on the geographical site conditions and it took on an average of two to three hours for a single family in a day. Both man and woman take active participation including their children and hence there is a lack of free time. Children cannot involve in education. This was the scenario in the surveyed location of Nongkojajar and Seloliman before the installation of renewable energy systems. The problem still exists for low income families at Mandangin Island. From this it can be interpreted , the task of collecting wood is still time consuming , loss of productive working hours and free leisure time for the poor and low income families in the regions with installed solar home systems in the different region of East Java,. This is also applicable to any rural villages with or without solar home systems or any other renewables installed in the province while accessing their basic energy heat for cooking. Fully subsidizing the LPG cylinders at present, as in the case of Nongkojajar is not supportive while it lacks in the other two locations. There should be an optimum fixed subsidy for the LPG cylinders in the difficult regions where collecting woods are becoming a priority for meeting their needs. It is still an ongoing activity among the villagers of rural regions in East Java. Moreover, buying wood from market if not available in the surroundings, give a huge burden to the family's monthly expense.

- Before electricity was not available, it was found that kerosene was an expensive source for most of the families (used for cooking and lighting) due to poor income and high fuel cost based on poor infrastructure of supply to meet their needs. This was a difficult situation for sustaining a basic lifestyle in remote islands of Mandangin. This indicates how other remote islands situated in the Madura strait are facing the problems at present with electricity generated from diesel gensets. And high kerosene price and other fuels, frequent shut down of electricity generated from diesel machines is an added disadvantage to meet the demands of the community. Due to lack of infrastructure, the price of the fuel also goes higher. The tentative average price of diesel is around 6500 IDR in remote areas compared to of 5500 to 6000 IDR in main cities of various regencies. It can be followed that the situation is still hard in different villages in the East Java where diesel gensets are the producer of electricity. Also, the same hard situation was prevalent in the villages of Nongkojajar and Seloliman when electricity was out of their access.

4.3.6 Main type of renewables and its application in rural areas in East Java province

After evaluating the previous discussed analysis, it is seen that mainly biomass, micro-hydro and solar have the main potentials for application of meeting the energy demands of the rural population in East Java. Many installations of micro-hydro and biogas digesters in various regions in the province show a promising potential in the coming future. As the needs are limited to basic consumption patterns of an average income family, the major percentage of the rural population, the energy extracted from these renewables lies mainly in the application of cooking and generating electricity. Solar home system can be used for basic lighting purposes of small families. However, if the performance of the system and the use of the technology can meet the basic demands in a smooth way with less difficulty, then there lays the probability to use the excess final energy generated from the renewable system in other applications of small entrepreneurial businesses opened up in the region, which brings additional income to the respective family and the village, add new jobs for the unemployed generation apart from selling to the State Electricity Company.

4.4 Comparative analysis of the implementation procedures of renewable energy projects in Mandangin Island, Seloliman and Nongkojajar at surveyed locations

Table 10: Comparison of the installed renewable energy systems in the three different regions.

Description	Mandangin Island	Seloliman	Nongkojajar
Type	Pilot Solar Home system	Communal micro-hydro project	Communal biogas projects
Capacity	15 X 60 Wp	20 KW, Head-14 m, Flow-305 l/s	4m^3, 6 m^3,8 m^3 ,10 m^3 and 12 m^3 (883 units in 2011)
Stakeholders	BAPPEMAS (Development agency), local supplying contractor, Village development units, local regulatory body, Regional budget development planning unit, District and Development Units (Refer 4.4.1)	Community, MHPP-GTZ, GEF, Ministry of Energy and Mineral Resources, PT-PLN and technology suppliers (Refer 4.4.1)	Co-operative Society Setia Kawan, ESDM, HIVOS, Bank Mandiri Syariah, PT Nestle , Debt for Nature Swept(DNS) and technology suppliers(from Nepal) (Refer 4.4.1)
Funding source	APBD	GEF, MHPP-GTZ	PT- Nestle Indonesia, Bank Mandiri Syariah, HIVOS, DNS, Ministry of Environment.
Year of instalment	2011	2008	1989
Co-operative society if any	No	PKM	KPSP
Outcome	Failure	Successful	Successful

The above table is a brief summarization of the differences to give an overview of the installed renewable energy systems.

4.4.1 Planning and executing structure of the three installed renewable energy projects

Solar Home System at Mandangin Island

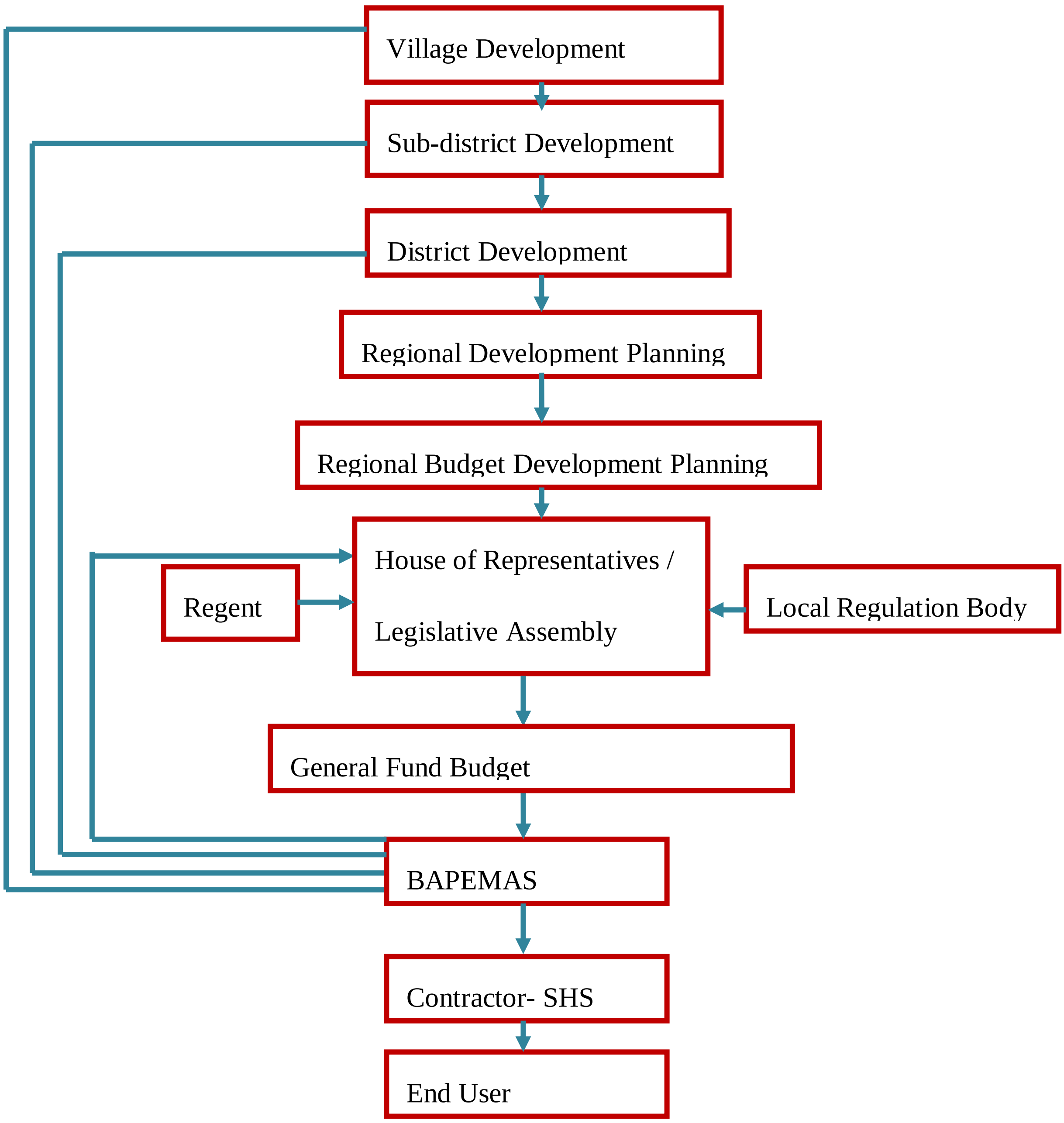

Figure 49: Flow chart of the planning and execution units for a pilot project of Solar Home Systems at Island Mandangin

The above figure gives an overview of the main stakeholders of the pilot project of solar home systems at Mandangin Island. A discussion held at the village development, sub-district and district development offices, which gave proposal to BAPEMAS citing the feasibility condition of the project. The planning of the project was done by the Regional Development Planning and Regional Budget Development bodies. The Legislative House took the responsibility of how to allocate the funds and select the main execution body in co-operation with the regent of the district. BAPEMAS came as the main execution body after getting funds from APBD and gave contract to Calang Cipta for engineering, erection and commissioning including the training of end users for Solar Home system. Local regulation body gave the final approval after all technical conditions were met. In 2011, the pilot project was completed. The performance of the system only lasted eight months. Due to the failure of the systems which were hundred percent subsidized could not meet the expectation of the end user. The main failure was improper charging operation of the battery due to lack of proper training from the supplier as well as the panels got corroded due to the salty atmospheric environment. The villagers sold the system in exchange of other goods to meet their daily demands because of their poor income. Consequently, this is another reason why there is no system in operation during my survey at the location.

Micro-hydro system i.e. WOT Lemah

Figure 50 shows the chain of stake holders for the WOT Lemah micro-hydro project.GEF and MHPP-GTZ are the main financiers apart from ESDM. PLN is the buyer of electricity from the micro-hydro systems.PKM and PPLH interact together in jobs related to environment conservation. In 1976, the government started a campaign and tried to study the environmental conditions of the different districts in East Java and after 10 years, micro- hydro projects seems to come into bigger picture. PPLH give information and informal education to PKM how to engage better composting methods, how deforestation and micro-hydro projects are interrelated and how to support such projects without affecting the environment.

Generally villagers are the members of the PKM society. Before the society was formed they pay a fixed amount of 2000 IDR to the sub-district development unit in Janjing for development of infrastructure of the village. PPLH paid for maintenance of the micro hydro system.

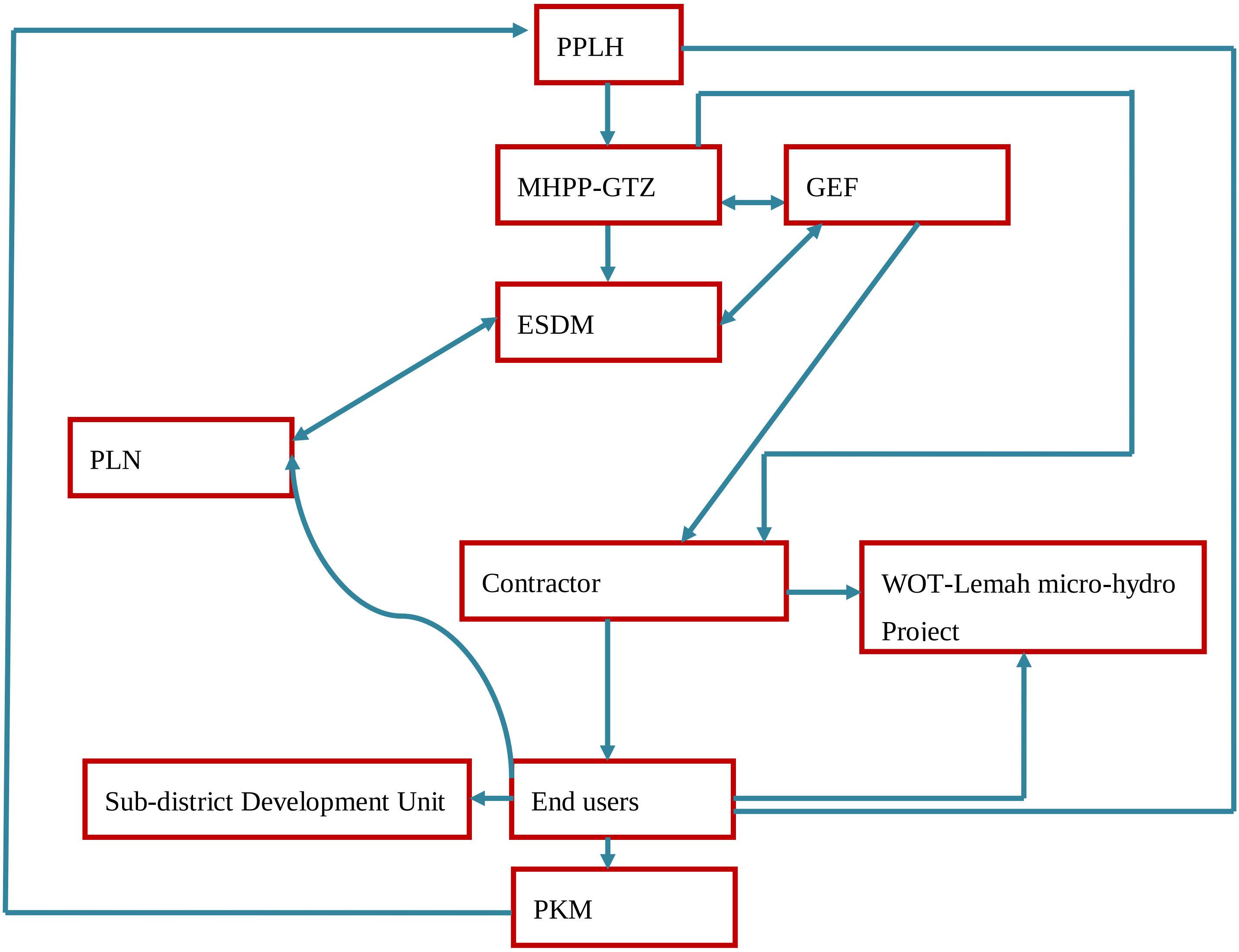

Figure 50: Flow chart of the planning and execution units for communal micro-hydro project of WOT-Lemah at Seloliman

The villagers after the formation of the society, paid directly to the society based on the fixed tariff of the energy consumption. The tariff for electricity is decided by the society. Villagers paid 30,000 IDR to install electricity at their houses.

Biogas in Nongkojajar

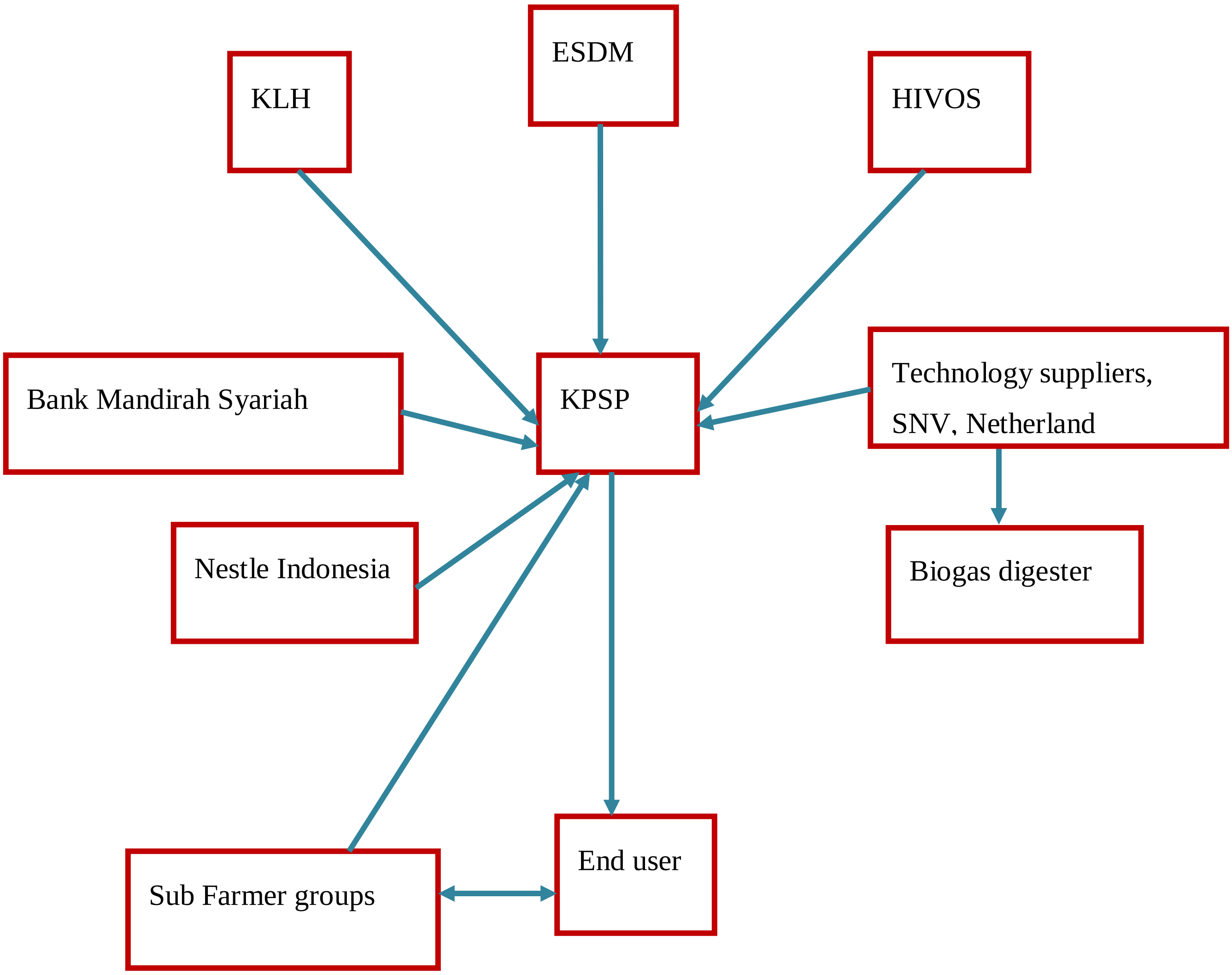

Figure 51: Flow chart of the planning and execution units for communal biogas projects at Nongkojajar

The history of the co-operative society goes back to the formation of a dairy farm in 1911 by Dutch people. With time, the business grows for creating a market for milk and fertilizer distribution for agricultural purposes. Due to the lack of proper marketing technical skills of the entrepreneurial farmers, another co-operative group of farmers was formed with members of 50-60 in 1964 in Nongkojajar at Wonosari. There were many organizational changes and finally KPSP was formed in the year in 1966 after the appeal of the East Java government. KPSP is a partner to Nestle Indonesia selling all milk products and increasing the income of its members who are mainly villagers of Nongkojajar district. Sub farmer groups of 50 to 100 were formed in each village. A new group is formed after every five years. It provides financial loan to the members, facilitates proper health services for cattle, and helps to promote milk products. The money comes from the society. With the biogas objective program initiated by HIVOS and supported from ESDM, HIVOS, Bank Mandirah Syariah which is a local Indonesian branch, KLH provides funding and loans to villagers for becoming owner of biogas plants. KPSP in general also provides training to conserve the environment by utilization of available resources to meet the demand in a sustainable way. The villagers register in the society to become member and to become owner of a biogas digester by paying a percentage of the total amount in the form of loans for five years.

4.5 Distinctive impacts of the renewable projects at Mandangin Island, Seloliman and Nongkojajar from the survey

Parameter	Mandangin Island	Seloliman	Nongkojajar
Technical	a. Even with abundant supply of solar energy, the solar home system technology failed. b. Technical failure of the system especially of the batteries, corrosion of the panels and overcharging and discharging of the batteries. The corrosion of the panels was mainly due to the supply of low quality materials of panels that are not suitable for environmental condition with salty atmosphere near the island. Materials of the solar panel were not manufactured taking into consideration of the corrosion atmosphere. c. Need of proper maintenance and operation of the technology was lacking due to the absence of mutual co-ordination between the solar home system contractors and the end users. There was no efficient training provided to the users.	a. The micro hydro system shuts down during low level in the flow of water. The shutdown for maintenance is generally ten times in a year b. The system was maintained by efficient and experienced technical operator and hence maintenance was not a problem.	a. The biogas digester uses minimum cow dung of 20 to 25 kg per day per cow and on an average each family has a minimum of two cows. Each cow gives 20 to 25 kg cow dung per day. b. The system does not need any maintenance.
Financial	a. The system was fully subsidised by government. There was no investment from the villagers.	a. Multilateral grants (GEF) and funding from bilateral organization such as MHPP-GTZ were involved.	a. A fixed amount was subsidised by HIVOS and government of 2 million IDR. The rest is paid by the owner of the system as a loan granted by the KPSP for a period of five years.

Social	a. Use of wood is still prevailing at low income houses. Families with electricity, use electric cookers to cook rice thereby saving wood and time of cooking. b. Less free time for entertainment and leisure. c. After service of the system is poor. Minimum knowledge of the user is an added disadvantage. Limited and short training period of three hours provided to users by the contractor. Lack of proper detailed training to users. d. Lack of awareness of public participation in various decision making processes while executing the pilot project.	a. Use of wood for cooking was reduced. People use electric cooker for cooking their staple food rice thereby saving woods. b. More free time to do other productive works c. There is saving of money with minimal use of kerosene for lighting and cooking. People can save money with less expense incurred on buying fuel. d. Use of entertainment medium like television, mobile phones is increasing based on their affordability. Living standard improved.	a. Minimal time spent on collecting woods with their reduced dependency on woods. b. People actively participate in other activities. More free time of the families to engage in education of children and initiate agricultural farming of different fruits, vegetables and coffee. c. Higher income of families after owning cattle and becoming member of the co-operative society KPSP (Average 4 million IDR from cattle milk per month and 50 million IDR from growing coffee per year). d. Co-operative society, KPSP involves in welfare of each member, provide loans and initiate reforestation for conserving nature spring. e. Market facilities of fresh milk and farming improved with training given by KPSP. Improved waste management of fertilizer and biogas. Entrepreneurship skill of farmers improved. Sub groups formed comprising of farmers which take care of financial help and everything related to condition of cattle. g. Communal participation is increasing more awareness to improve and develop the living

			condition and infrastructures of the village.

4.6 Suitable framework for executing feasible renewable energy projects in East Java after comparative analysis of the surveyed locations

4.6.1 Finding the stakeholders

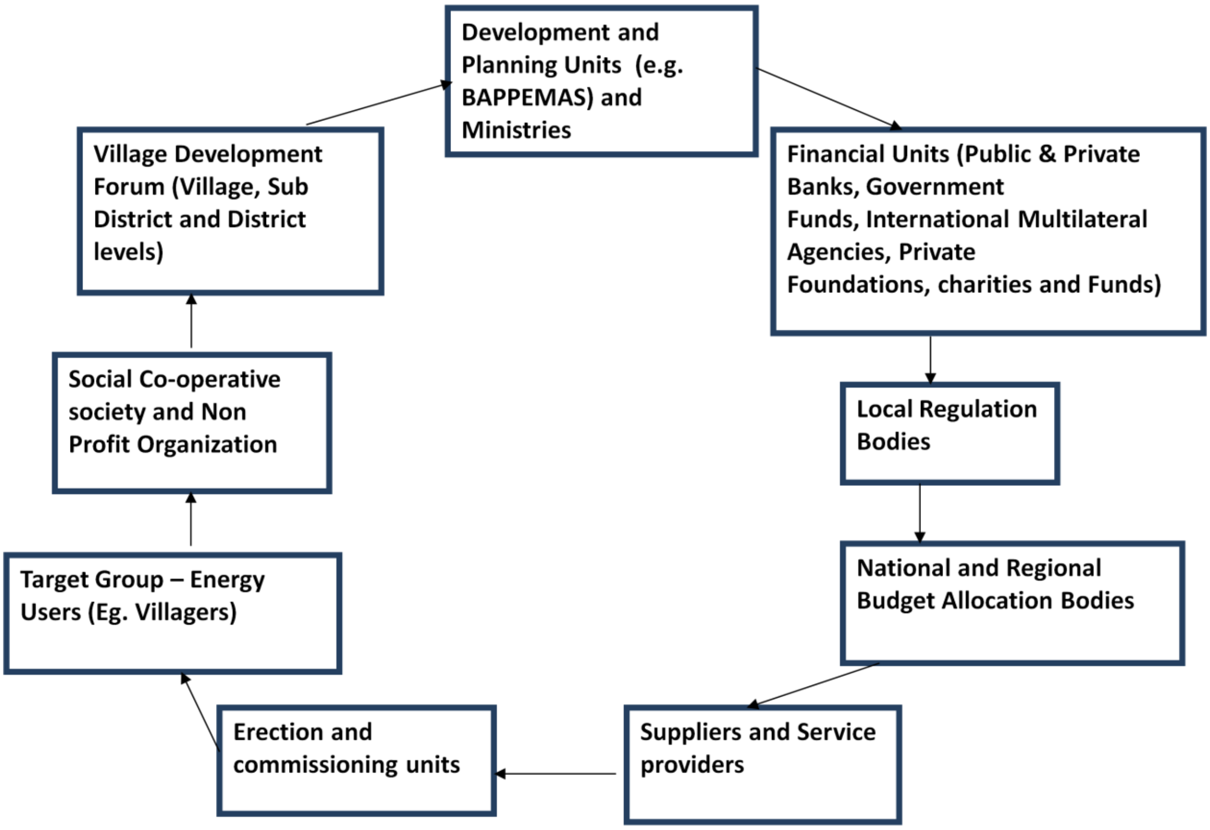

Figure 52: Flow chart of the main stakeholders of renewable energy projects in East Java

After doing a comparative survey analysis of the renewable projects at the defined locations, it is seen and incorporated in the above figure that these are the main stakeholders that are mainly involved for planning, executing and commissioning a renewable energy project in East Java. Based on the project types, whether communal or pilot projects, they play a major distinctive role to install, develop the market of the technology in the desired region and meet the demands of the rural population in terms of accessing energy. It is not mandatory that all stakeholders will be present in a single project. It depends on the previous condition, energy situation of the village, need of the rural inhabitants to actively participate and the history of the location. However, the main stakeholders that is the finance providers be it governmental, multilateral funding, donation, private charities of different organization, villagers and public or private banking institutions is the backbone of any project. Erection and commissioning units including the suppliers of technologies plays a crucial role in the project. The project cannot be completed without them.

4.6.2 Developing a framework after analyzing from the overall impacts of the installed renewable energy system at the three surveyed locations

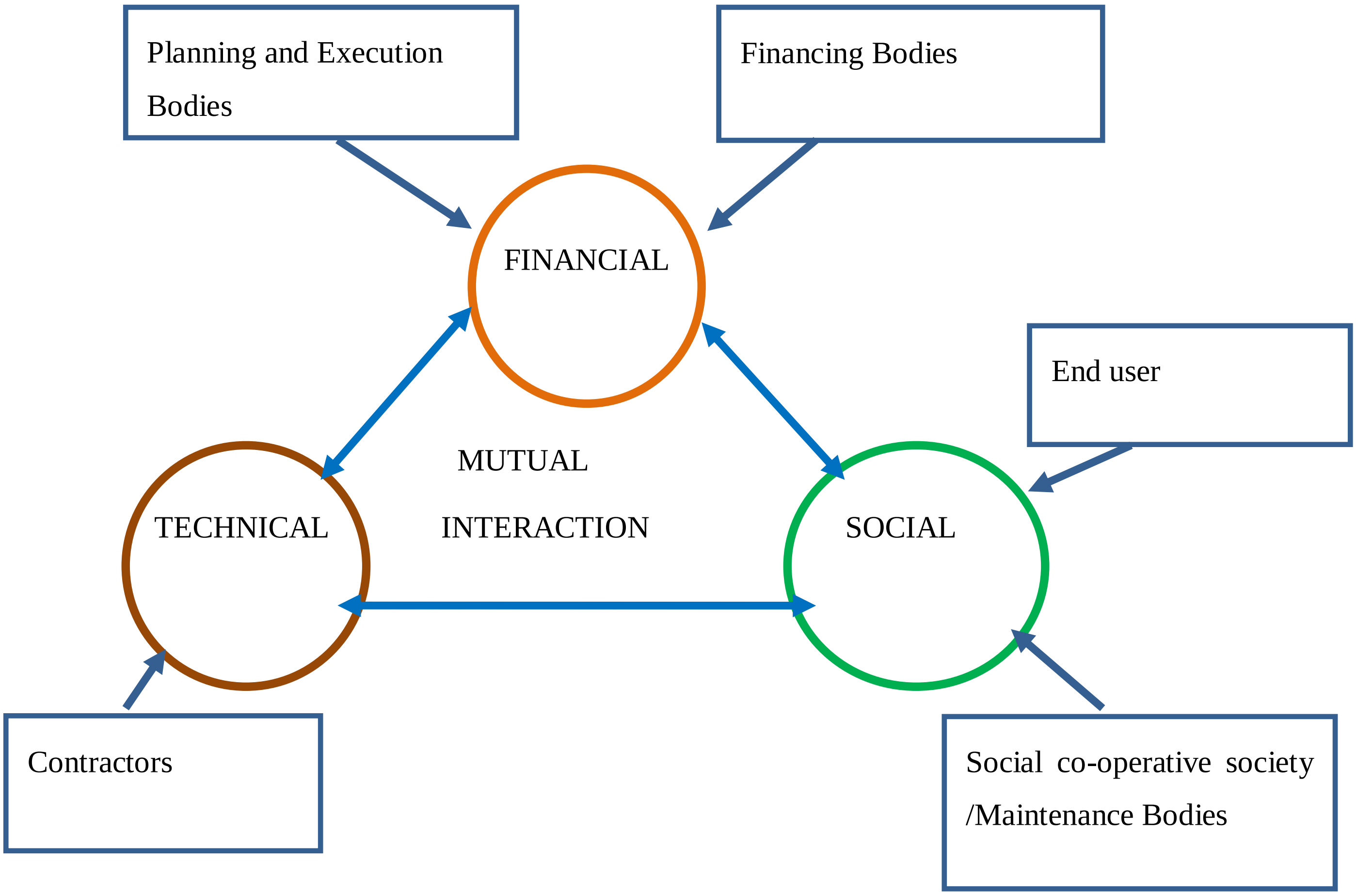

Figure 53: Flow chart of the feasible framework for successful application of renewable energy technology

The above figure is the flow chart of the framework for feasible installations and applications of renewable energy system in rural areas which is developed after my survey analysis at Mandangin Island, Seloliman and Nongkojajar. The objectives for successful feasible application of this technology lies in the mutual interaction and better co-ordination of the involved stakeholders defined under financial, social and technical condition

- It was seen from the survey that there was no proper co-ordination between the contractors and end users in the installed solar home systems pilot project at Mandangin Island. There was a lack of formation of any co-operative society or management group to maintain the project. Active participation of villagers was lacking too. Therefore it lacks inspiration to motivate the villagers who can help indirectly in up scaling the project. Hence there was a failure in the system and the objectives of the pilot project could not be achieved effectively despite the project was executed successfully at the initial stage with the help of the stakeholders previously discussed. This shows that, all the stakeholders should be involved in a closed loop instead of behaving independently and linear way.

- This was in contrast to the Seloliman and Nongkojajar projects. Both the initiated projects have active participation of stake holders in a communal and interactive way. There was active participation of end user from the beginning till the end of the execution of the projects. Hence, the energy demands of the rural community in those areas are met effectively and without compromising all the technical, social and financial factors. End users are inspired by learning from each other difficult situations and co-operating well with other stake holders. Consequently, the projects are spread in many villages meeting the needs of the people in particular regency. There is a proper management group and skilled technicians from the village itself, who look after the technology. Because of the monitoring services offered technically and socially which are made available by the societies PKM and KPSP, these projects are running smoothly. The main positive effect comes from the active participation of the inhabitants i.e. the end users in all these decision making process from maintaining, operating and after service of the technical system, fixing the tariff of electricity and proper utilization of the generated incomes.

Chapter 5

5.1 Conclusion

The conducted analysis of my research data has led to the following conclusions.

- The governmental departments and other private national and international groups have installed many renewable energy systems in various regencies of the East Java province over the last two decades. The province shows a significant potential in different types of renewable energies. Biogas, micro-hydro and solar are exploited well to meet the energy demand in the rural fragmented regions of the province over the last two decades. Wind and geothermal energies are not utilised so far to meet their energy demand. Based on the experiences of many installations and its specific applications, the main type of renewables that can play a significant role to meet the energy demand in the rural areas of the province are solar, micro-hydro and biogas. Other types of renewables may need time to develop and increase its application market for the rural development.
- Agriculture is one of the common occupations amongst the rural population of the province. However, this is an exception in remote salty islands. The survey results show that the average income earned in a single family is spent mainly to meet their basic demands of lighting their houses and for cooking. Biogas, solar and micro-hydro are used to meet these demands. And, the market of its application mainly lies in providing electricity for lighting and heat for cooking in the remote rural areas because of the low average incomes and lifestyles.
- It is seen that, collecting fire woods for cooking and buying kerosene for lighting houses are the major difficulties for an average and low income family in a village. Members in the family spent many hours to collect fire wood and hence, lost productive working hours. Children could not participate actively in education without electricity. These experiences existed in the surveyed villages before the installation of renewable energy systems. The living condition and other social factors in the villages improved after its installation as seen in Chapter 4. This signifies that proper successful application of renewable energy technology can play a distinctive role in the development of rural regions in the East Java province.
- The different developments of the surveyed locations such as lack of end users training on system's operation and maintenance which decreases the confidence of the user's application of the system, poor support of the after services of the technical suppliers to its users, supply of low quality systems which will undermine its performance, absence of mutual co-operation of different stakeholders with end users in important decision making processes, will hinder the successful application of renewable energy technologies. Better management through establishment of co-operative societies and monitoring services in the application of these technologies and with active participation of villagers in all important spheres, will help to develop the rural conditions in the villages. All these are the main pros and cons of successful application of this technology in the development of rural regions.

5.2 Way forward

I finally come up with the following recommendations after concluding my research work.

- The governmental and other responsible bodies can learn from the success stories of the executed projects in the different regencies of the East Java province. Mistakes learned from the previous projects in Mandangin Island should be taken care of while starting a new project. Fully subsidizing a project by the government will not make it successful, if other pros and cons are neglected. The suppliers of the technologies should keep the requirement of the customer before their needs. Poor supply of technical systems should be prohibited. Better after services for proper operation and maintenance of the technology is a must from the suppliers by proper interaction with the end users. Technical training should be provided wherever needed.
- There should be more budget allocation from the government for conducting developmental research in order to facilitate the market conditions for the above mentioned main renewable types. Various non profit organizations, research institutes governmental departments and universities can play a significant role in this field.
- Research should be conducted to understand how mini grids can be incorporated in remote islands by installing hybrid systems combining solar, biogas and diesel gensets. This can reduce the dependency on diesel gensets for meeting the energy demands in very remote Islands e.g. Sapudi and Raas. As derived from the information of the Department of Engineering Physics in ITS, some research studies are being initiated to analyze the optimum power system for providing the basic energy in those remote islands around Madura strait. The regional government should provide funding for encouraging more research in order to find a solid based result that can be implemented practically in those underprivileged areas.
- Utilization of improved monitoring systems to monitor the performance at both organizational and project level should be emphasized. Lessons can be learned from the situations in Nongkojajar and Seloliman, where the income in the co-operative societies is utilized in development of infrastructure and living condition of the rural villages. Interviewing the villagers to assess the optimum utilization and performance of the technical system will help in monitoring the progress of the output of the initiated projects. The concept of capacity building should be integrated to improve the market share of the technology both at organizational and technical levels.

Chapter 6

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7. Annexure

A. Table of tariffs for electricity from micro-hydro projects at Seloliman

Description	Price per kWh (IDR)
Class households - 200 W	
1-30 kWh	203
31-80 kWh	248
81 and above	270
Class households - 400 W	
1-30 kWh	248
31-80 kWh	278
81 and above	320
Class social business - 900 W	
1-20 kWh	270
21-80 kWh	330
81-200 kWh	390
201 and above	450
Class social business - 1350 W	
1-20 kWh	330
21-80 kWh	380
81-200 kWh	440
201 and above	500
Class social business - 2550 W	
1-20 kWh	440
21-80 kWh	500
81-200 kWh	540
201 and above	558
Class social business - 3550 W	
1-20 kWh	500
21-80 kWh	550

81-200 kWh	570
201 and above	600

B. Table with the installed bio-digesters in Nongkojajar

Year	Location	Total numbers
1989	Village Tutur Sub-district Tutur Village Gendro Sub district Tutur	1 unit for 1 family 1 unit for 1 family
1995	Village Gendro Sub-district Tutur Village Tutur Sub-district Tutur Village Tlogosari Sub-district Tutur	1 unit for 1 family 1 unit for 1 family 1 unit for 1 family
1997	Village Wonosari Sub-district Tutur Village Tlogosari Sub-district Tutur	1 unit for 1 family 1 unit for 1 family
2000	Village Tlogosari Sub-district Tutur Village Tutur Sub-district Tutur	2 units for 4 families 2 units for 4 families
2001	Village Tutur Sub-district Tutur Village Pungging Sub-district Tutur	2 units for 3 families 2 units for 4 families
2005	Village Tutur Sub-district Tutur	11 units for 24 families
2006	Village Blarang Sub-district Tutur Village Ngembal Sub-district Tutur Village Tutur Sub-district Tutur Village Andonosari Sub-district Tutur	1 unit for 1 family 1 unit for 2 families 12 units for 18 families 1 unit for 18 families
2007	Village Gendro Sub-district Tutur Village Wonosari Sub-district Tutur Village Kalipucang Sub-district Tutur Village Tutur Sub-district Tutur Village Andonosari Sub-district Tutur	2 units for 5 families 5 units for 9 families 2 units for 4 families 12 units for 20 families 2 units for 5 families
2008	Village Gendro Sub-district Tutur Village Tlogosari Sub-district Tutur Village Andonossari Sub-district Tutur Village Pungging Sub-district Tutur	5 units for 12 families 2 units for 5 families 2 units for 4 families 1 unit for 2 families

	Village Wonosari Sub-district Tutur Village Tutur Sub-district Tutur	1 unit for 2 families 10 units for 16 families
2009	Village Gendro Sub-district Tutur Village Tlogosari Sub-district Tutur Village Wonosari Sub-district Tutur Village Tutur Sub-district Tutur Village Blarang Sub-district Tutur Village Ngembal Sub-district Tutur	9 units for 13 families 15 units for 32 families 14 units for 22 families 11 units for 18 families 15 units for 22 families 8 units for 16 families
2010	Village Wonosari Sub-district Tutur Village Gendro Sub-district Tutur Village Tlogosari Sub-district Tutur Village Blarang Sub-district Tutur Village Kayukebek Sub-district Tutur Village Andonosari Sub-district Tutur Village Pungging Sub-district Tutur Village Tutur Sub-district Tutur Village Kalipucang Sub-district Tutur Village Sumberpitu Sub-district Tutur Village Ngembal Sub-district Tutur Village Tempuran Sub-district Tutur	18 units for 22 families 13 units for 17 families 64 units for 74 families 50 units for 62 families 3 units for 6 families 6 units for 8 families 9 units for 15 families 86 units for 90 families 45 units for 55 families 16 units for 20 families 6 units for 10 families 23 units for 23 families
2011	Village Wonosari Sub-district Tutur Village Gendro Sub-district Tutur Village Tlogosari Sub-district Tutur Village Blarang Sub-district Tutur Village Kayukebek Sub-district Tutur Village Andonosari Sub-district Tutur Village Pungging Sub-district Tutur Village Tutur Sub-district Tutur Village Kalipucang Sub-district Tutur Village Sumberpitu Sub-district Tutur Village Ngembal Sub-district Tutur	4 units for 6 families 52 units for 62 families 56 units for 66 families 63 units for 86 families 6 units for 12 families 4 units for 9 families 21 units for 30 families 22 units for 34 families 38 units for 72 families 41 units for 64 families 19 units for 24 families

	Village Tempuran Sub-district Pasrepan	14 units for 20 families

C. Table with installed micro-hydro systems in East Java

Serial No.	District	Name of location	Year	Capacity (kW)	Number of house-holds connected
1	Lumajang	Gunung Sawur	1992	15	79
2	Ponorogo	Hamlet Salam	1994	5	30
3	Ponorogo	Hamlet Klitik	1994	20	70
4	Ponorogo	Juruh Bawar	1994	15	50
5	Ponorogo	Tempuran	1996	10	56
6	Trenggalek	Pakoran Pakoran	1996	15	70
7	Ponorogo	Dung Kajang	1996	5	40
8	Trenggalek	Pakel	1996	3	16
9	Ponorogo	Nggalh	1996	5	25
10	Trenggalek	Dung Epyek	1997	3	22
11	Trenggalek	Dung Sapi	1997	5	30
12	Trenggalek	Pakoran	1997	3	20
13	Ponorogo	Dung Klendo	1997	5	40
14	Trenggalek	Pajringan	1997	10	58
15	Lumajang	Poncokusumo	1998	9	84
16	Probolinggo	Hamlet Andag Biru	2009	30	400
17	Lumajang	Rojopolo	2001	2.2	11
18	Ponorogo	Juruk Wawar	2001	5	30
19	Lumajang	Kajar Kuning	2002	7	58
20	Jember	Puring	2002	3	14
21	Ponorogo	Hamlet Pucung Village Sendang	2002	20	Data not confirmed from ESDM
22	Ponorogo	Kelung	2003	9	50
23	Trenggalek	Pakuren	2003	7.5	20
24	Lumajang	Rojopolo II	2004	1	5

25	Probolinggo	Sumberkapung	2005	5	21
26	Lumajang	Kalipoh	2005	1.6	7
27	Lumajang	Tempursari	2005	7	30
28	Ponorogo	Bonduk	2005	11	48
29	Trenggalek	Pajringan	2005	3	20
30	Ngawi	PT Candi Loka Kabun	2008	88	0 (For factory)
31	Lumajang	Hamlet Mlambing Village Burno	2009	15	86
32	Probolinggo	Hamlet Rabunan Village Kalianan	2010	40	285
33	Pacitan	Hamlet Tempel Village Tokawi	1999	5	8
34	Pacitan	Hamlet Josokidul Village Tokawi	2008	7.5	26
35	Pacitan	Hamlet Duwet Village Tokawi	2010	22	97
36	Pacitan	Hamlet Kedung Pasang	2011	20	60
37	Bondowoso	Tol-Tol	2010	1.2	30
38	Mojokerto	Seloliman	1995	30	25
39	Mojokerto	Seloliman	2009	20	25
40	Lumajang	Hamlet Rojopolo	2011	30	68
41	Bondowoso	PTPN XII KBN BLAWAN KEC. SEMPOL	2011	200	-
42	Nganjuk	Hamlet Kalongan Village Bareng	2011	20	38
43	Bojonegoro	Hamlet Glinseng and Kalimati	2010	40	582
44	Malang	Hamlet Pendem Tmn Bali	2010	12	25
45	Probolinggo	Hamlet Raek	2010	12	0 (for other use)

	Bondowoso	Hamlet Alas Lan-jeng Village Blimbing	2010		Not in use
47	Situbondo	Hamlet Samir Village Bentel	2010	12	112
48	Jember	Hamlet Baba-timur	2010	12	106
49	Madiun	Hamlet Kandan-gan	2012	68	51
50	Probolinggo	Hamlet Sumber-kapung Village Skapu	2011	15	65
51	Probolinggo	Village Ttlogosari	2011	25	150
52	Probolinggo	Village Andang	2011	20	250
53	Probolinggo	Village Batur	2012	12	400
54	Probolinggo	Village Kertosuko	2012	5	50
55	Madiun	Village Kare	2012	12.5	17
56	Madiun	Village Kare	2012	12.5	7
57	Madiun	Village Kare	2012	7.5	10
58	Madiun	Village Kare	2012	3.5	10
59	Blitar	Hamlet Telogo-sari Village Sumber	2013	20	30

D. Table with the target groups while interviewing at the surveyed locations

Name	**Location**	**Duration in hours**
Suto (Village head)	Blarang village	2.5
Sutrikno and his colleague	Kalipucang village	3
Hariyanto	KPSP	2.

Jawi and family	Mandangin	2.5
Klebun (Village head)	Mandangin	4
Candra Ali	Mandangin	2
Deddy	Mandangin	3
Ahmed Taufikurahman	Mandangin	2
Putut Tri Cahyono	Mandangin	2
Sandy and his colleagues	Surabaya	8
Zainuddin and his colleagues	Surabaya	6
Suroso	Seloliman	2
Mohammed Maksum	Seloliman	2
Rais (Village head)	Seloliman	Not available
Sukadi	Seloliman	3
Abdul Salam	Seloliman	0.5

E. Table with electrification scenario and its future projection (Data obtained after interview at PLN)

Year	Electrification ratio (%)
2008	65.93
2009	69.23
2010	71.60
2011	71.85
2012	73.83
2013	77.16
2014	80.00
2015	83.34
2016	86.67
2017	90.00

F. Table of the assistant interpreters

Name	Location	Occupation
Danang	Surabaya (Mandangin Island)	Student at ITS
Fahmi	Surabaya(Mandangin Island)	-do-
Epri	Surabay (Seloliman and Nongkojajar)	-do-
Fitri	Surabaya (PLN)	-do-
Ika	Surabaya (BPS and ESDM)	-do-

Dita	Surabaya (PLN)	-do-
Esti	Surabaya (Mandangin Island)	-do-

G. Table with the number of households connected to micro-hydro systems in East Java obtained from ESDM

Year	**Number of Households connected**
1992	79
1994	150
1995	25
1996	207
1997	170
1998	84
1999	8
2001	41
2002	72
2003	70
2004	5
2005	126
2008	26
2009	511
2010	1237

2011	631
2012	545
2013	30

H. Table with the number of bio-digester units installed and the number of families having bio-digesters in Nongkojajar. Data obtained from KPSP

Year	Number of bio-digester units	Number of families
1989	2	2
1995	3	3
1997	2	2
2000	4	8
2001	4	7
2005	11	24
2006	15	23
2007	23	43
2008	21	39
2009	94	142
2010	339	412
2011	340	417

I. Table with the total prices and instalment prices of different capacities of bio-digesters. Data obtained from KPSP

Capacity of bio-digester (m^3)	Total price (IDR)	Instalment price (IDR)
4	55,00,000	27,000
6	65,00,000	34,500
8	75,00,000	42,000

10	90,00,000	53,000
12	1,05,00,000	60,000

J. Table with the total numbers of bio-digester units and households having the biogas stoves in East Java which is mainly initiated by ESDM. Data obtained from ESDM

Year	Number of bio-digester units	Number of households with biogas stoves
2001 to 2008	5	25
2009	6	30
2010	86	430
2011	8	40
2012	5	5

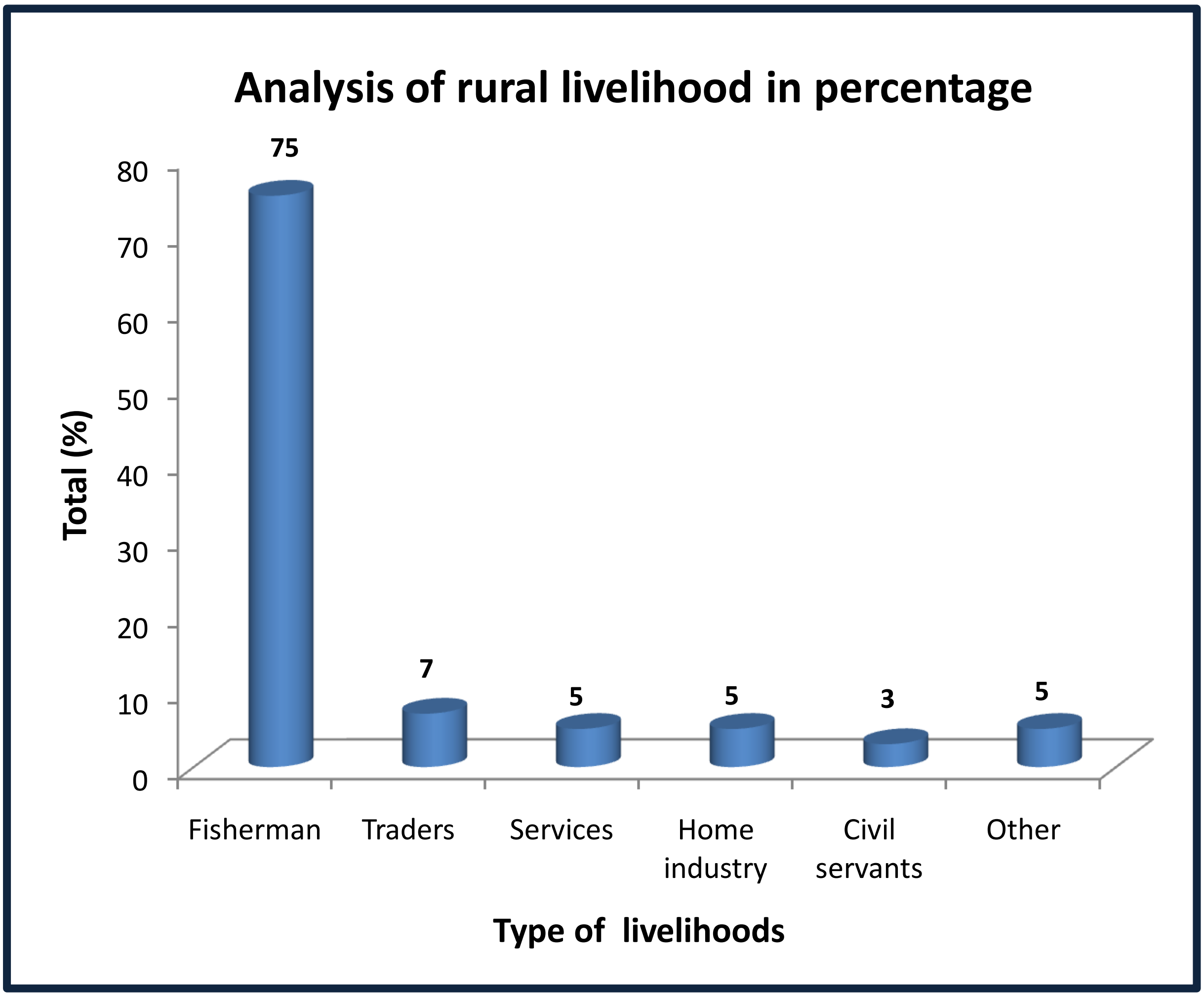
J. Table with the total number of households connected to solar home systems and micro-hydro systems in East Java which is mainly initiated by ESDM. Data obtained from ESDM

Year	Number of households with solar home systems	Number of households connected to micro-hydro systems
2001 to 2008	1190	
2009	287	76
2010	100	126
2011		30
2012		180

K. Table with data of the average income, expenses on cooking, electricity and time spent for collecting wood obtained from interviews at three locations

Name of person	**Total income per month (IDR)**	**Number of cylinders used per month**	**Average electricity expense per month (IDR)**	**Collecting time for wood(hour)**
Maksum (PKM treasurer) and Suroso (From villagers point of interview)	500,000 to 40,00,000	1 to 2	30,000 to 50,000	2 to 4
Sutrikno	30,00,000 to 50,00,000	1 to 2	40,000 to 45,000	3 to 4
Suto (Head of village) (From villagers point of interview)	10,00,000 to 50,00,000	1 to 2 (Fully subsidised for low income families)	35,000 to 45,000	2 to 5
Klebun (head of village) (From villagers point of interview)	3,50,000 to 1,00,00,000	1 to 2	35,000 to 45,000	1 to 3
Jawi	3,50,000 to 6,00,000	1 to 2	35,000	2 to 3

L. Type of livelihoods in Mandangin Island obtained from BAPPEDA at Sampang district in East Java, Indonesia



M. Type of questionnaire used in the survey to interview village head/operators

Survey with village head/technical operator of installed RE system to find the energy situation and difficulties faced in the village

1. Name of village :

2. Name of the village head/technical operator :

3. Location :

4. Available conventional resources type in village :

5. Available non-conventional resources type in village :

6. Future installation of any renewable plant/ program : Yes ☐ No ☐

7. If yes, program type :

Capacity :

Application :

8. Source of income mainly in village :

9. Use of energy type in village : Electricity ☐ Heat ☐

10. Who is the service provider of electricity? :

11. Area of application of RE :

12. Installed when? :

13. History of formation :

14. Energy situation before installed RE system :

15. Energy situation after installed RE system :

16. Manufacturer :

17. Installed capacity of the system :

18. Opinion about renewable energy sources :

19. Other remarks

N. Type of questionnaire used in the survey to interview at co-operative society /governmental organization

Survey for getting energy data from the non-profit society/public governmental organization

1. Location :

2. Name of the organization :

3. Name of the person :

4. Role of the organization :

5. How the society/organization formed? :

6. Role associated with Renewable energy :

7. Installed RE system capacity :

8. Installed Non – RE system capacity :

9. Potential RE capacity :

10. Transmission distribution electrical scenario of the region :

11. Electrification scenario of the region :

12. How RE projects are initiated :

13. Funding source of RE projects :

14. Other remarks :

O. Type of questionnaire used in the survey to interview villager

Survey with villagers including village head to find the energy scenario in households

1. Name of village :

2. Name of the person :

3. Location :

4. Any lake / river stream : Yes ☐ No ☐

5. Number of members in the family :

6. Head of the family : M ☐ F ☐

4. Source of income :

Salary :

No. of persons employed :

5. You own a private business : Yes ☐ No ☐

Type:

Earning in Rp:

☐

6. Your children are in high school and universities? : Yes ☐ No

7. Use of energy type : Electricity ☐ Heat ☐

8. Source of energy and type :

Conventional -

Non-conventional- Mixed -

9. Who is the service provider of electricity? :

10. Area of application :

Lighting ☐ Cooking ☐

Crop curing ☐ Entertainment ☐ Education ☐

Others ☐ Transport ☐

11. Type of lighting

Not available ☐

LED qty ☐ Rating (W) =

Fluorescent Bulb qty ☐ Rating (W) =

Tube light qty ☐ Rating (W) =

CFL qty ☐ Rating (W) =

12. Lighting for entertainment

TV, size:

Qty: Rating (W) =

Radio, size:

Qty: Rating (W) =

13. Other instruments and equipments:

Type:

Type of energy use

Application

Qty Rating (W) =

14. Method of cooking:

Open fire ☐ LPG ☐

Efficient stove ☐ Normal Stove ☐

Others ☐

15. If wood, price of wood bought in market :

Qty used in kg per day :

Access to wood :

Shop ☐ From surrounding Area ☐

Time spent in collecting wood :

16. Electricity rent per month paid average :

17. Average money spent on LPG gas if used :

18. Any installed RE in the house?

19. Capacity rating of RE :

20. Area of application of RE :

21. Installed when? :

22. Technicians if available for maintenance during :

break down.

23. What is the reason of less technician availability?

24. How many times after service available?

25. Any subsidy available? If yes, from where?

26. Any problem with the installed system? What?

27. What is the reason of not repairing the system again?

28. Are you satisfied with the system?

29. What is the inspiration of installation behind it?

30. Do you have interest for reliable electricity supply? If so, where to use?

31. How much you pay for electricity at present? How much you can afford to pay in future for good electricity supply?

32. Opinion about renewable energy sources.

33. Other remarks.