THE UNIVERSITY OF TWENTE

SCHOOL OF MANAGEMENT AND GOVERNANCE
CENTRE FOR STUDIES IN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT
MASTER IN ENERGY AND ENVIRONMENTAL MANAGEMENT

ASSESSMENT OF URBAN AIR POLLUTION ABATEMENT POLICY IMPLEMENTATION VIS-Á-VIS THE ROLE OF HOUSEHOLD ENERGY USE IN GER AREAS OF MONGOLIA

By Bulganmurun Tsevegjav

Thesis Submitted in Partial Fulfillment of the Requirements for the MSc. Energy and Environmental Management (MEEM) Degree

Supervisors: Dr. Thomas Hoppe

Dr. Maarten Arentsen

MEEM 2012/2013

PREFACE

"It's always about timing. If it's too soon, no one understands. If it's too late, everyone's forgotten." by Anna Wintour

Like this quote, timing of my research project turned out to be precisely what I experienced throughout the process of its production. This report is focused on the problems of air pollution and greenhouse gas emissions (GHG) that are caused by fossil fuel burning practices in individual houses and particular traditional, commonly-used l Mongolian residential dwellings (Gers) that are not connected to the central heating system. The manifestation of the problem occurs in winter as heating demand increases from those houses.

Equipped with theoretical knowledge gained during the MEEM program I was very excited to proceed with my research project and immediately contacted some of the relevant stakeholders based on my professional network I built while working at Clean Development Mechanism (CDM) of the UNFCCC, Building Energy Efficiency Project (BEEP) of the UNDP and Ministry of Energy in Mongolia.

Hence, when I started designing this project nine months ago as a policy analyst, I wanted to link the potential solutions of the problem to CDM, one of the few carbon market mechanisms currently available internationally that leverages some funding on projects that have potentials to reduce GHG through its activities. To this end, I even managed to have a host organization in Berlin (Green Streams) with substantial experiences working in developing countries that would be interested in supporting potential CDM projects in Mongolia if things happen well. Back in mind I had an optimistic dream to implement the first ever CDM project from the building stock in Mongolia in addition to four other registered projects at the Executive Board of the CDM. Unfortunately, the relevancy of the project came at risk due to sharp decline in the certified emission reduction (CER) market price (from 20 euro in 2008 to 0.40 euro in 2013) caused by EU ETS restrictions on CERs use from May 2013.

Having consulted about these facts with my supervisor Dr. Thomas Hoppe, I restructured my thesis focusing on the same air pollution problem but linking it with existing national policy instruments in Mongolia. So leaving Europe behind, I headed back to Mongolia to start my empirical research in summer 2013. My first plan there, was to meet few experts to get updates on the implementation status of air pollution reduction measures and visit some households to hear their problems associated with air pollution. But when I contacted them, the experts were on their vacation and households whom I approached did not seem to be bothered by my research concerns. They were all enjoying the summer the shortest period of all seasons in Mongolia without wanting any disturbance. Thus, my data collection did not happen until mid-October, where effects of air pollution started to became more visible and people started to complain around as if it was a new problem. There was some media coverage on the front pages of the daily newspapers that officially brought the issue back on the table. Gladly, from then onwards, everything I planned for the research project happened so naturally even coinciding with a terminal evaluation period of the major two projects related to the household energy efficiency, which provided me a great access to review relevant data. Then my last site visit took place two days after the Christmas, the coldest period of the month, where it provided me the least convenient but the best timing to check the functioning of the solar collectors installed in 15 households in *ger* areas of Ulaanbaatar.

ACKNOWLEDGEMENTS

First and foremost, I am very grateful to have Dr. Thomas Hoppe for being my supervisor providing me the most accommodating feedback and understanding support I ever had during the entire period of the report. There are still many more things I would love to learn from him and continue to have his mentorship if opportunities avail.

I would like to express my deepest gratitude to all those who helped me during the process of completing the thesis, where I am mentioning only key people representing as below:

G.Batmergen, Former Energy efficient stove manager, Energy and Environment Project of Millennium Challenge Account – Mongolia

E.Badrakh, Solar Energy Specialist, National Renewable Energy Centre (NREC)

B.Munkhbayar, Project Manager of the UNDP project BEEP

N.Nasanjargal, Officer in charge of Renewable Energy, Air Quality Management Unit of Ulaanbaatar City Government

Enkhtuvshin, Vice Director of the “Solar House, Co. Ltd.,” commissioned company, which was responsible in installing solar collectors in 15 houses in ger districts.

In addition, I would like to express my gratitude to MEEM program coordinators Rinske Koster R.J and Hilde van Meerendonk-Obinna for their administrative and coordinative role that they provided.

I would like to thank my short-time personal assistant Delgermaa Lkhagva, for the support and facilitation she provided during the data gathering period when I was particularly busy with my work.

My final and never ending appreciation goes to my spouse Z. Batsaikhan, who always cares for me. Without his strong support I would not be able to complete this report.

ABSTRACT

Since in the mid-2000s, the issue of air pollution has become a priority on the policy agenda of the Government of Mongolia (GoM). The major contributing factor to the problem is fossil fuel burning practices in residential buildings that are not connected to the central heating system. Today, all residents of Ulaanbaatar somehow contribute to the city air pollution through means of transportation, construction, heating and burning activities. However the premier source is fumes and polluting substances, created by coal and wood burning by over 180 thousand households living in suburban *ger* districts[1] of Ulaanbaatar.

The overall aim of this study is to contribute to the improvement of existing policy programs aimed to reduce urban air pollution, which is caused by existing energy production and usage practices in urban Mongolia. Thus, in the context of Mongolia, where coal is extensively used for heating purpose, the research objectives are twofold:

The first objective is to assess existing policy practices on air pollution reduction aiming at household energy users by identifying a gap between the current situation in relation to the desired situation, where households are enabled to choose from various sustainable energy (SE) options that have benefits of improved air quality, efficient use of energy and improved living condition.

Based on the first objective, the second objective is to provide recommendations to relevant policy makers and development practitioners in their quest to address air pollution problems that are related to the household energy use by drawing lessons learned from current programs and linking them with available best practices.

Based on the above objectives, in this thesis the researcher aims to answer the main question: ***What can be learnt from policies and other measures that have been implemented to reduce effects of air pollution in the housing sector in the ger districts of Ulaanbaatar during the period of 2009 till 2013?***

The study presents in this report included both qualitative and quantitative research methods. The research involved a pre-dominantly quantitative study concerning availability of the SE options among households in *ger* districts. A qualitative research was conducted through questionnaire surveys among 28 households, which benefitted in purchase and installation of SE

[1] The *ger district* is a geographical area within and outskirts of Ulaanbaatar, where approximately 30% of total population of Mongolia is residing in traditional "*ger*s" and in individual detached houses, either built by adobe and bricks. It spans over 8,494 hectares and smokes from heating stoves from these areas contribute to major source of air pollution in Ulaanbaatar. *ger* means in Mongolian language "home". It's a round shaped traditional Mongolian dwelling consisting of a wooden frame beneath several layers of wool felt. The researcher uses *ger*, ger households, *ger districts* and *ger areas* interchangeably to refer those traditional nomadic dwellings and also individual modern houses detached from central heating grid.

options. In 12 of these households solar energy vacuum collectors were installed under a Government-subsidized programme that represent 57% of total households (21 households in total) partcipipated in the programme. 16 households, that had been constructed energy efficiently under the Building Energy Efficient Project were surveyed, representing 15% of total beneficiaries. Furthermore, two expert interviews are conducted to analyze the situation and gaps from the supplier and implementer side.

In the study, the sustainable energy options were grouped into three categories: Energy Efficient Measure (EEM), Renewable Energy solutions (RE) and Clean Fuel switch (CF). After examination of existing legal, policy frameworks, program and project initiatives on each SE options, a gap analysis was conducted in terms of desired and current situations.

The gap assessment demonstrates there is a little gap for EEM policy instruments in terms of availability and affordability desired situation. There is partial satisfaction of EEM policy instruments for all desired situation criteria, except no gap in comfort setting. The RE policy instruments were assessed as 'moderate' in terms of availability and comfort setting, but were considered unsatisfactory in terms of affordability and reliability. Policy instruments on CF show the largest gap in terms of availability, affordability and reliability.

In terms of barriers to adoption, the economic barrier is considered the most critical barrier in adopting all SE options by households. All programs and projects on EEM (Millennium Challenge Account, World Bank, Clean Air Foundation, Building Energy Efficient Project), RE (National Renewable Energy Center) and CF (Clean Air Foundation) used subsidy mechanisms.

The following key recommendations are provided based on the lessons learned from the implementation experiences of the relevant programs:

Create sustainable financial support schemes in adopting energy-efficient systems apart from subsidy (investment in energy efficient houses and renewable energy) and link them with affordable financial mechanisms available in the market, such as the "8 % housing loan scheme", or valuation of land for loan collateral.

Furthermore, following the results of the study it is recommended to reduce cost of energy-efficient products, technology, material and houses, by supporting manufacturers with facilitated loan, tax exemption, marketing and capacity building, and extending consumer base to avoid seasonal impact, for example in cleaner fuels.

TABLE OF CONTENTS

APPENDIXES

LIST OF ACRONYMS

ADB	Asian Development Bank
BCNS	Building Construction Norms and Standards
BEEP	Building Energy Efficiency Project
CAF	Clean Air Fund
CAP	Clean Air Project
CDM	Clean Development Mechanism
CF	Cleaner Fuel
CIT	Contextual Interaction Theory
CO	Carbon Oxide
CO_2	Carbon Dioxide
EBRD	European Bank of Reconstruction and Development
EE	Energy Efficiency
EEM	Energy Efficient Measures
EET	Energy Efficient Technology
ESMAP	Energy Sector Management Assistance Programme
FS	Fuel Switch
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GiZ	German Technical Assistance for International Cooperation
GoM	Government of Mongolia
JICA	Japan International Cooperation Agency
MAQO	Municipality Air Quality Office
MCA	Millennium Challenge Account
MCC	Millennium Challenger Corporation
MNS	Mongolian National Standard
MNT	Mongolian tugrug (currency)
MOE	Ministry of Energy
NCRAP	National Committee on Reducing Air Pollution
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxide
NREC	National Renewable Energy Center
PM	Particulate Matter
SE	Sustainable Energy
SO_2	Sulfur dioxide
SO_x	Sulfur oxide
SVC	Solar Vacuum Collector
UB	Ulaanbaatar
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States dollar (currency)
WB	World Bank
WHO	World Health Organization

1 USD is equivalent to 1,400 MNT as of August 2013

LIST OF TABLES AND FIGURES

Tables

Figures

CHAPTER 1: INTRODUCTION

1.1 Background

Until today Mongolia has been perceived to the outside world as a land of horse riders and of pristine nature. This is because of two distinct facts that can be traced back into Mongolian history and tradition. First, in the 13th century Mongol Empire was established by Genghis Khan, who conquered the world with help of his fellow horsemen. Second, its nomadic lifestyle that has been adopted by traditional Mongols as a way of living in harmony with nature and surroundings.

Nevertheless, despite of this well-kept image, the 21st century Mongolia had gone through different stages of history and development. Today urbanization is playing a major role with dramatic increase of population over the last decade, increased urbanization, which is evidenced by cities occupying 70% of the total national population. To keep up with fast growing urbanization needs, those historic horses are being replaced by four-wheel transports and the valued nomadic lifestyle had been transformed into modern urban lifestyle. Nowadays, Mongolia is no longer pursuing the traditional developmental path based on pastureland livestock, but rather following the mineral based economy. So called "Dutch disease"[2] is leveraging the overall economy due to the abundant mineral resource exploitation practices.

Because of the large energy consumption coming from various sectors, such as construction, transportation, infrastructure and heavy industry to meet demands of the growing population, the effects of urbanization and industrialization have already created visible problems on air, soil and water with enormous implications to the entire society. Thus, in the light of such complex environmental problems, policy makers and development practitioners face constant challenges and pressures from the public.

Among these major environmental problems, this research seeks to address the problem of air pollution in connection with the household energy use, particularly in Ulaanbaatar - the capital city of Mongolia.

1.2 Problem statement

According to the WHO reports, Ulaanbaatar has been ranked one of the top five cities with the worst air quality in the world in 2013. The key indicators of the air quality, such as atmospheric particulate matters including PM_{10} and $PM_{2.5}$ levels[3] were exceeding both national and global air quality standards by 7 to 17 times respectively. The similar problem is observed in other major Mongolian cities, when the peak of the air pollution is visible during the winter season as the consumption of coal and wood fuels are increased to meet the heating energy needs of buildings that are not connected to the central heating system. At the aggregate level, this kind of fossil fuel burning

---

[2] The term Dutch disease was first coined by The Economist referring to the decline of Dutch manufacturing sector due to natural gas discoveries of the nineteen sixties; the term further elaborated by number of economists including W. Max Corden to warn about adverse effects of mining boom.

[3] **PM_{10} $\mu g/m^3$** particulate matters smaller than 10 micrometers in diameter

$PM_{2.5}$ $\mu g/m^3$ particulate matters smaller than 2.5 micrometers in diameter practices contributes substantially to the effects of air pollution with negative implications on health and wellbeing of people with significant socio-economic burden.

According the Public Health Institute of Ulaanbaatar, the number of people affected by respiratory disease increased 45% between 2004 and 2008. A 2011 study by Simon Fraser University in British Columbia, Canada, reported that one in ten deaths in Ulaanbaatar can be attributed to air pollution (Kohn, 2013). Furthermore, WHO estimates that between 9% (direct) and 15% (indirect) of deaths in Ulaanbaatar are related to air pollution.

The Government of Mongolia (GoM), in partnership with national and international organizations, has been dealing with air pollution and subsequent problems in a number of ways, including adoption of law and policy regulations on prohibition of raw coal in certain districts, transfer of new technologies such as energy efficient stoves and adopting polluter pays principles. Despite such efforts, households find it difficult to access SE options that could possibly meet their desired level of situation depending on their different needs and interests.

A reflection on the above problem statement brings to the simplest level consumer rights based approach, which is the importance of providing accessibility to households in making their own choices from various SE options based on their circumstances. Hence, given the benefits of the 21st Century developments characterized by globalized market economy, technological breakthroughs and innovative solutions, what kind of SE options are available to households? Based on this approach and reflection, this study will try to find answers to the question by looking at the existing policies and practices that are being implemented in Ulaanbaatar, Mongolia.

1.3. Research aim and objectives

The overall aim of this research is to contribute to the improvement of existing policy programs aimed to reduce urban air pollution caused by existing energy practices in urban Mongolia.

Research Objectives: In the context of Mongolia (where coal is extensively used for heating purpose) this research objectives are twofold:

- The first objective is to assess existing policy and practices on air pollution reduction aiming at household energy users by identifying gaps between the current situation in relation to the desired situation, where households are enabled to choose from various SE options that have benefits of improved air quality, efficient use of energy, improved living conditions and comfort.
- Based on the first objective, the second objective is to provide recommendations to relevant policy makers and development practitioners in their quest to address air pollution problems that are related to the household energy use by drawing lessons learned from current programs and linking them with available best practices.

1.4. Structure of the report

This report is divided into six chapters and is structured as follows:

Chapter one provides an introduction of this report with general background, the problem statement, and aim and objectives of the research. It will provide the outline and structure of the study that will contribute to answering the main research question.

Chapter two describes the research design and methodology, including the research framework, the research questions, the research strategy and the planning of research activities.

Chapter three provides the literature review and preliminary research results. The first section provides the contextual description of the country and brief overview about the energy sector of Mongolia. The second section provides information on air pollution problems and its assumed link to the *ger* areas household energy situation, known as the main sources of pollution in Ulaanbaatar. In the third section, relevant theoretical frameworks for formulation of key criteria in assessing a gap between the desired and current situations of relevant policy instruments will be discussed.

Chapter four provides deeper analysis and facts on the sources of air pollution in *ger districts* in Ulaanbaatar, its share in overall contributing factor for air pollution in Ulaanbaatar. The second section analyzes the Government efforts on air pollution, including legal, policy and institutional settings with key stakeholders and certain programs, projects and their role in reducing the air pollution.

Chapter five provides a thorough gap analysis between the desired and current situations based on implementation of series of policy programs and projects, which was undertaken between 2009 and 2013.The chapter has different sections to analyze the gap between the desired and current situation, to identify key barriers presented in those gaps and potential drivers that will help solving problems with the gaps.

Chapter six summarizes and assesses an effectiveness of SE policy programs and projects: what worked well and what needs further attention and improvement based on the relevant lessons learned and best practices. Finally, it provides key recommendations to consider in formulation of the new policies on air pollution reduction in Ulaanbaatar.

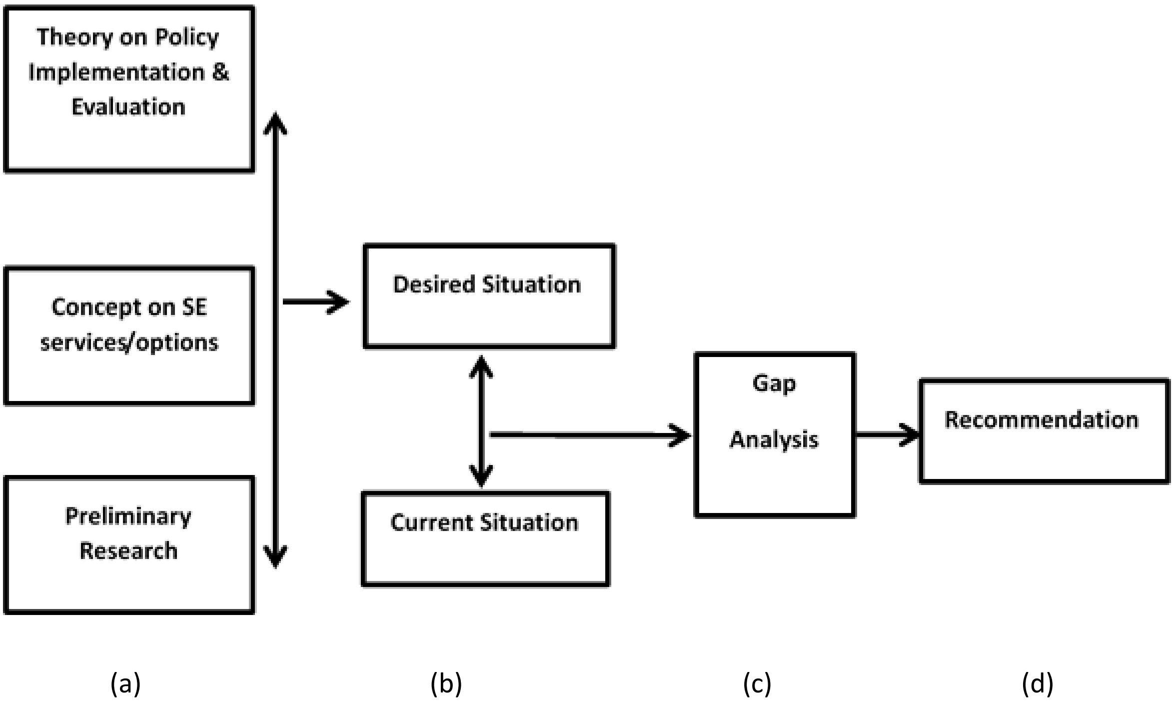
CHAPTER 2: RESEARCH DESIGN AND METHODOLOGY

This chapter describes the research design and methodology, including the research framework, the research questions, the research strategy and planning of the research activities.

2.1 Research framework

The research framework which is developed for this research is adopted from the "Designing a Research Project" book written by Verschuren and Doorewaard (2010) given the objectives and the structure of the report that are matching with the characteristics of the diagnostic gap analysis type of research described by the authors. The framework of this research is schematically presented in Figure 2.1

Figure 2.1 Research framework



The elements of the research presented in Figure 2.1are described as follows:

(a) Exploration of relevant theories on policy implementation/evaluation and concepts on SE with a special focus on household energy use are analyzed through a literature review. Thus, the preliminary desk research yields the key criteria for assessing the current and desired situation.
(b) The current situation is analyzed in relation to the desired situation for implementing relevant policies.
(c) A gap between the desired and current situations is identified and analyzed and based on the experiences of the current situation.
(d) Finally, recommendations for possible policy interventions are provided by looking into insights (lessons learnt and best practice cases) into the improvement of current situation towards the desired situation.

2.2 Research questions

The main question for the study is "What can be learnt from policies and other measures that have been implemented to reduce effects of air pollution in the *ger districts* of Ulaanbaatar during the period of 2009 till 2013?"

Below the central and sub-questions are presented that are used in this study.

<u>Central Questions and sub questions:</u>

1. What are the problems related to current energy use households in *ger district households of Ulaanbaatar*, and what technologies may be used to solve this problem?
   1.1. What kind of challenges do typical households in *ger areas* experience when using fossil fuels?
   1.2. According to the households' experiences, what are the most common problems that are related to the exposure of bad air quality?
   1.3. For a household, what are the key factors for creating a desired situation in relation to the use of sustainable energy?
   1.4. What types of sustainable energy (SE) options are the most applicable to solve the problem of air pollution and at the same time improve the use of energy?

2. How do relevant policies and their implementation contribute to improving air quality in *ger residential areas*?
   2.1. What types of programs and projects are currently in place in Ulaanbaatar at district levels?
   2.2. Who are the key stakeholders?
   2.3. What are the most used SE options in comparison to the applicable options identified in the RQ 1.4.

3. To what extent do the efforts that follow from current policy on air pollution contribute to meeting the criteria for the 'desired situation'?
   3.1. What is the gap between the desired and current situation?
   3.2. What are the key barriers presented in this gap and what could be the potential drivers that will help solving the gap?

4. What do we learn by analyzing the gap between the desired situation and the current situation in order to make recommendations on how to narrow the gap?
   4.1. What kind of policy interventions can be recommended based on the lessons learned and available best practices?

2.3 Defining concepts

For the purpose of this research and its scope the following key concepts are defined as below:

1. Household:-refers to *gers* (traditional dwellings) and individual houses that are solely used for residential purposes; - refers to residential buildings that is not connected to the central heating system; - limited to households that are located in Ulaanbaatar city of Mongolia.
2. Sustainable Energy (SE) options/services refers to relevant policy programs' activities related to both renewables and energy efficient measures that aim to replace existing household energy heating practices. In addition switch to cleaner fuel options are also considered as one of the SE options/services.
3. Air Pollution Emissions: are limited to the emissions that are caused by coal and wood burning practices in households.

2.4 Research strategy

The study presents in this report included both qualitative and quantitative research methods. The research involved a pre-dominantly quantitative study concerning availability of the SE options among households in *ger* districts. A qualitative research was conducted through questionnaire surveys among 28 households, which benefitted in purchase and installation of SE options. In 12 of these households solar energy vacuum collectors were installed under a Government-subsidized programme that represents 57% of total households (21 households in total) partcipipated in the programme. 16 households, that had been constructed energy efficiently under the BEEP programme were surveyed, representing 15% of total beneficiaries. Furthermore, two expert interviews are conducted to analyze the situation and gaps from the supplier and implementer side.

The case study approach will be used in this research project. Therefore, the strategy will be in-depth and qualitative research approach. In addition to case studies, combination of different strategies such as expert interview, household survey and content analysis will be deployed as triangulation method for further analysis of relevant data.

2.5 Research materials

The identification of required data that would help in answering sub questions and its applicable methods are provided in Table 2.1. and Table 2.2. with respective objectives.

The Research Questions Design Matrix for the Objective 1: to assess the existing policy practices on air pollution reduction aiming at household energy users by identifying a gap between the current situation in relation to the desired situation where households are enabled to choose from various sustainable energy options that have benefits of efficient energy use, improved living condition and health that have improvements in ambient urban air quality.

Table 2.1. The research questions design matrix for the objective 1
Main question: What can be learnt from policies and other measures that have been implemented to reduce effects of air pollution in the *ger district* of Ulaanbaatar during the period of 2009 till 2013?

Research Questions	Chapter	Data/information required to answer the questions	Data Source	Type of data collection / analysis method
4.2.	1, 3	Information regarding difficulties associated to direct use of fossil fuels in *ger* households. Latest data on impacts of air pollution effects in Ulaanbaatar.	Literature/media review, National reports on air pollution impacts	Content analysis Literature review
4.3.	3	Theories and case studies about key advantages of utilizing sustainable energy options in terms of: - health benefits; - improved comfort; -decrease rate of air pollution in the household neighborhood area; and –energy savings.	Literature, Website (online library, e-books and journals)	Desk research Website
2.1. 2.2. 2.3.	4	Relevant policy and regulations on air pollution abatement, studies conducted by expert group. Data on relevant programmes and projects that have been carried out during the period from 2009-2013. List of major actors/stakeholders	Law on air pollution; Project documents; Website of relevant national and international agencies dealing with the issue in Mongolia. E-mail	Content analysis Qualitative analysis Face-to-face interview Site Visit
3.1. 3.2.	5	Barriers and challenges to policy makers and program/project implementers in providing 'desired situations' to households in adopting SE options	Expert group Selected case study	Interview Household survey Qualitative analysis

<u>The Research Questions Design Matrix for the Objective 2</u>: to provide recommendations to relevant policy makers and development practitioners in their quest to address air pollution problems that are related to the household energy efficiency by drawing lessons learned from existing practices and linking them with available best practices. See Table 2.2.

Table 2.2. The research questions design matrix for the objective 2

Questions	Chapter	Data/information required to answer the questions	Data Source	Analysis method type
4.1.	6	Findings of barriers based on previous comparative case studies Available facts and input of data results on selected options given the limited size of objects (selected households)	The results research findings between existing vs desired situation on relevant case studies.	Desk research The comparative case study

CHAPTER 3: LITERATURE REVIEW

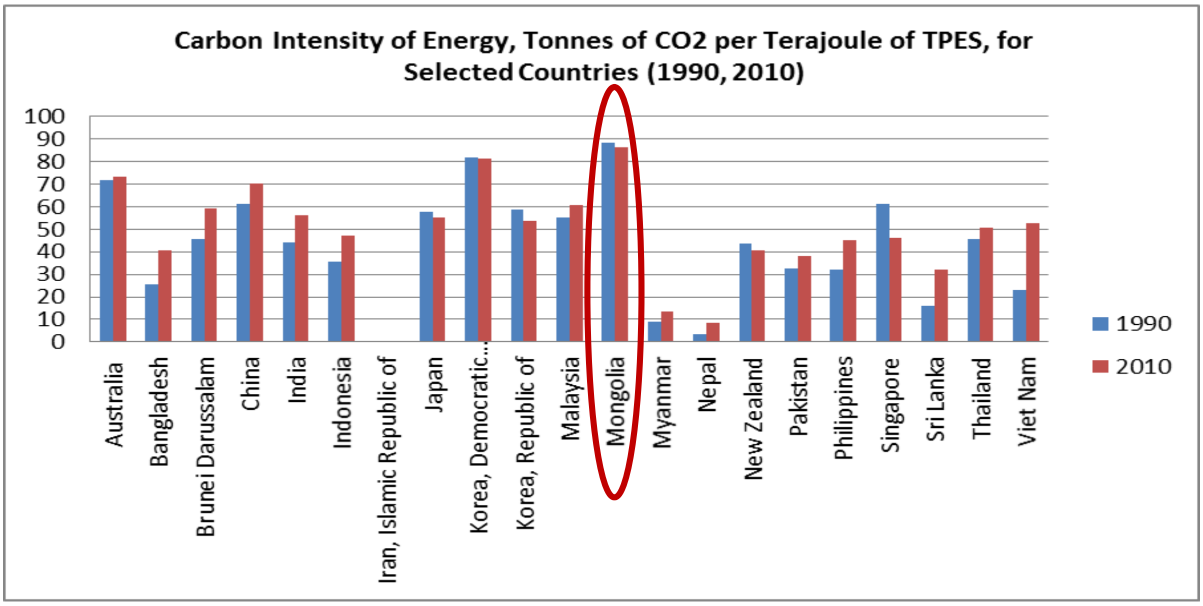
The first section provides the contextual description of the country and brief overview of the energy sector of Mongolia. The second section provides information on air pollution problems and its relation to the *ger* areas households. The third section analyzes relevant theoretical frameworks covering adoption of energy innovations in order to identify applicable sustainable energy options for the problem. It formulates key criteria to assess gaps between the desired and current situations vis-á-vis the existing air pollution reduction policy instruments that can be used in *ger districts* of Ulaanbaatar during the period of 2009 to 2013.

3.1. Contextual description of energy situation in Mongolia

Mongolia is a landlocked country situated in Northeast Asia, between Russia and China. This unique geographical location puts the country in both advantageous and disadvantageous positions with distinct political and economic implications. After the Cold War, Mongolia adopted a democratic governance model with a market oriented economy in 1992.

Ulaanbaatar, Mongolia's capital is home to one third of the total population of Mongolia, which is estimated almost 3 Mln people.[4] With a GDP growth rate of 13% (2013), Mongolian economy is characterized one of the most energy intensive countries and in the Asia Pacific region with 10 times higher CO_2 emission per GDP than the word average (see Figure3.1).

Figure 3.1 Mongolia's carbon intensity as compared to regional countries



Source: IEA 2012 Figure 1.

The high carbon intensity of Mongolia in comparison to other countries can be explained by extensive use of coal for electricity and heat production. At present, energy in Mongolia is provided primarily by

[4] As of 7 January, 2014 updates of the National Statistics Office in Mongolia, the current population is estimated 2,930, 426. Access website: http://www.nso.mn/

coal-burning thermal and electric power stations. Coal accounts for 80% of primary energy supply. Hydro and solar power, imported gas and diesel stations produce the remaining percentage (Wu et al., 2009). The power sector of Mongolia supplies electricity to around 70% of the population, and the rest has not been connected to the grid yet. However, the three most Western-sited provinces have been connected to the Russian electricity network (Wu et al., 2009).

Since the late 1990s, the government of Mongolia has initiated several policies and programs with the aim to improve reliability and cost-efficiency of the energy sector as the sector was previously inefficient and heavily relying on Russia. In early 2000s, energy policy focus was extended by promotion of renewable energy resources in rural areas that are not covered by power grid connections. Some of the key policy documents on renewable energy are “National Programme on Renewable Energy (2006-2020)”, “Law on Renewable Energy (2007) and “Millennium Development Goals based National Comprehensive Policy Strategy”. In its effort to move from fossil fuels into renewable energy, Mongolia has initiated a number of public and private projects in exploring renewable energy resources, such as the hydro-power plants in Eg, Durgun and Taishir rivers, generating 28MW power, and wind farms in Southern and central parts of Mongolia, generating 8MW power. The latest development is a 50MW wind power project that would contribute to GHG emission reductions, approximately 180,000 tons of CO_2 equivalent (tCO_2e) per year and save coal consumption by 122,000 tons annually. Despite the current efforts to increase reliability and use of renewable energy resources, urban Mongolia’s share of renewables is the second lowest in Asia, as shown in Table 3.1.

Table 3.1. Mongolia’s renewables share in total energy production & consumption

Country	Energy Produced	Net imports	Total primary Energy Supply (Mtoe)	Share in Energy Consumption (%)	
				Renewables	Fossils
Bangladesh	24.8	5.0	29.6	30.2	69.8
Cambodia	3.7	1.6	5.2	70.8	27.8
China	2,084.9	274.9	2,257.1	11.9	87.4
India	502.5	182.0	675.8	26.1	73.0
Indonesia	351.8	-153.6	202.0	34.6	65.6
Iran, Islamic Republic of	349.8	-132.1	216.2	0.5	99.7
DPRK	20.3	-1.0	19.3	11.0	89.0
Malaysia	89.7	-21.7	66.8	5.3	94.7
Mongolia	**7.7**	**-4.2**	**3.2**	**3.2**	**96.4**
Myanmar	22.4	-7.2	15.1	72.3	27.7
Nepal	8.8	1.2	10.0	88.5	11.1
Pakistan	64.9	19.8	85.5	37.4	61.8
Philippines	23.5	16.3	38.8	43.0	57.0
Sri Lanka	5.1	4.3	9.3	54.7	45.3
Thailand	61.7	47.4	103.3	20.5	79.4
Vietnam	76.6	-13.8	64.1	43.3	56.2
World	12,292.0	..	12,150.0	13.1	80.7

Source: Asia Pacific HDR, 2009

3.2. The Link between Air Pollution and Household Energy Use

In general, apart from the transportation sector that heavily relies on gasoline and diesel engines, main causes for air pollution in Mongolia are coal-fired power plants, industrial boilers and domestic stoves that burn wood, biomass and coal. This can be explained by country's high dependency on fossils fuels as shown in Figure 3.1. In addition, the geographical location and climate conditions are the main contributing factors. Ulaanbaatar city, for instance is located in between four mountains that create a *black hole* of polluted air that are not easily blown by wind thus preventing them to disburse away. This is shown in Figure3.2.

Figure 3.2. Ulaanbaatar city in a smog blanket in late winter of 2012

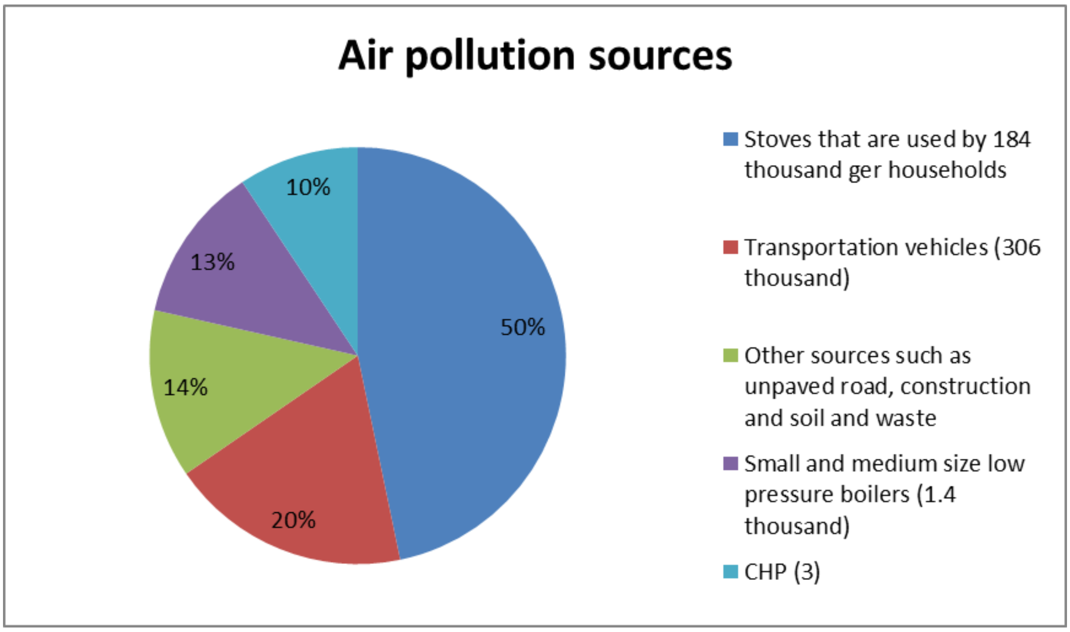
Source: www.worldpolicy.org (access date 07 September, 2013)

Known as the coldest capital in the world, Ulaanbaatar city's average winter temperature ranges about minus 20° to minus 40°Celsius degree (-68°-104° F). Therefore in order to survive the harsh winter conditions, all *ger* area households extensively use coal and wood, contributing to the effects of air pollution. In a latest analytical report "The Results of Air Pollution Reduction Measures and Impacts on Human Health" released by Mongolian State Great Khural (parliament)[5]in November 2013, air pollution problems were categorized according to its sources and contributing percentages, as presented in Figure 3.3.

Many families live in *gers*, traditional Mongolian dwellings consisting of a wooden frame beneath several layers of wool felt. In the *ger areas* of Ulaanbaatar, energy for cooking and heating is provided through indoor coal combustion in metal stoves with chimneys, and in wintertime such stoves may be in use both day and night (Cowlin et al., 2005). Inhabitants in these areas have no choice but to use coal or wood to stay warm during the cold months since there is no central heating system available. The heating season in Mongolia continues around eight months starting from mid- or late- September and continues throughout April. Because of these reasons, buildings in *ger districts* are the main contributors of air pollution, and its neighborhood inhabitants became primary victims to airborne diseases.

[5] State Great Khural refers to Mongolian Parliament, where "Khural" literally means meeting in Mongolian language.

Figure 3.3. Ulaanbaatar Air pollution sources and shares in percentage



Source: "The Results of Air Pollution Reduction Measures and Impacts on Human Health" report, 2013

Confirming the above findings, in a study called "*Air Quality Analysis of Ulaanbaatar: Improving Air Quality to Reduce Health Impacts*" -2011 report commissioned by World Bank, the following facts were presented:

- Ambient annual average particulate matter (PM) concentration in Ulaanbaatar are 20-25 times higher than Mongolian air quality standards, and are among the highest recorded measurements in any world capital.
- *Ger* households are both the main source and the main casualties of air pollution. PM 2.5 concentrations in those areas are much higher than in the center, with an annual average concentration in the range of 200 to 350 µg/m^3.
- The main sources of ground-level air pollution are coal and wood burning for heating of individual residences in *ger areas* and the suspension of dry dust from open soil surfaces and roads, representing 75-95 % of PM concentrations.
- The magnitude of the estimated negative health impacts is large due to the alarming PM concentrations in UB amounting to annual health costs estimated between US$177 and US$727 Mln.[6]. (WB 2011)

3.3. Adoption of innovative energy technologies in the built environment

The built environment is a sector that provides huge opportunity for significant energy conservation. Theoretically application of innovative technical measures, insulation, high-yield heating systems can dramatically improve energy savings up to 90% (Hoppe et al, 2012). Improving the energy performance of dwellings is very important as an effective means to reduce energy poverty

[6]World Bank. 2011. Main report. Vol. 1 of Air quality analysis of Ulaanbaatar: improving air quality to reduce health impacts.

(Healy and Clinch, 2004). Improving energy performance of dwellings is also thought to result in an overall improvement in health (Milne and Boardman, 2000).

Giving importance to a number of preconditions may help in successful local environmental policy. A number of factors are involved are a complex knowledge mix, employment of a full time-expert, the presence of knowledgeable, motivated and experienced people at key positions in the municipal organization, adequate institutional backing of environmental policy targets in the entire municipal organization, a sustainable management style, the presence of political parties that favor ambitious environmental policies, and a manager of official who monitors the policy agenda. Plus, support from higher levels of government is particular importance. (Hoppe et al, 2011)

Policy instruments are used by local governments to influence social behavior of local target groups. Urban energy and environmental policies heavily depend on external incentives in the form of regulations, conditions for public participation in public support programs, monitoring systems, and planning and performance indicators (Nijkamp and Perrels, 1994).

In case of the Netherlands, there are no legal standards for the renovation and maintenance of the existing stock in contrast to newly constructed buildings. Therefore owners in the existing residential sites are expected to act voluntarily and to cooperate with other actors. The Government tries to encourage innovative energy systems by implementing economic policy instruments and providing adequate information (Hoppe and Lulofs, 2008). This is also true for case of Mongolia.

Therefore, due to absence of legal instruments, government needs to rely on communicative and economic instruments, such as subsidy schemes, promotion campaigns, advertisements and energy auditing, to convince house owners and other actors who have a stake in improving the existing housing stock's energy efficiency. Accordingly, the governments are dependent on the willingness of the target groups (Hoppe et al, 2011.) This is the most difficult challenge for the governments, as the target groups are expected to invest in energy efficiency voluntarily (Hoppe et al, 2013).

Owners and occupiers largely decide whether applications of innovative energy measures are desirable. When renovating their homes, they hardly prioritize energy efficiency, especially when energy costs are small part of their total cost of living. Moreover, owners and occupiers have needs that are perceived as more urgent in regard to other issues, such as comfort, health and a return on investment (Hoppe et al, 2012). Environmental policies and energy efficiency goals are not prioritized in large residential settings, but rather social and economic aspects of the living environment is given more consideration (Hoppe and Lulofs, 2011)

From study of practices of innovative energy systems in 11 neighborhood renovation projects in the Netherlands, policy instruments were found to be of prime importance to the appliance of innovative energy systems. Subsidies and communicative policy instruments were necessary, but not sufficient conditions. Covenants were neither necessary nor sufficient, but arose out from previous projects and local experiences (Hoppe et al, 2011).

On lessons learnt from Dutch experiences, most policies and programs on innovative energy application focused on technology and commercial aspects, neglecting end-user aspects. The programs failed to consider human and organizational factors and social acceptance that are necessary to trigger the adoption and diffusion of energy efficient and sustainably oriented innovations Other factors were too ambitious goal setting, the failure to involve key target groups in policy making processes, the predominance of soft policy instruments and the lack of enforcement. Considering, these factors and taking necessary measures will allow greater success for future programs (Hoppe et al, 2013).

3.4. Applicable Sustainable Energy options to solve the the problem with energy use and air pollution in Ger households

Scientific studies revealed that burning of commonly-used fuels, such as coal and wood lead to number of emissions including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter less than 10 µm (PM_{10}). These emissions - when released in the air in excessive amounts- can harm human health. Literature studies reveal that these air pollutants can cause serious, long term diseases such as cancer, birth defects, brain and nerve damages, and short term effects such as burning eyes and noses and irritation to breathing systems. Apart from human health, emissions such as sulfur dioxide can affect plants by causing damage to root and stem weight, thus causing contamination to soil and plant death (Boyce, 1997).

According to WHO studies conducted in Asia, fine particles that have less than 2.5 microns ($PM_{2.5}$) caused 0.8 premature deaths and 6.4Mln. years of life loss annually due to infections in cardiovascular disease, lung cancer and acute respiratory diseases (Wilkinson et al., 2007).

Pioneering studies exploring the link between air pollution and various diseases dates back to 1950s based on experiences from major cities such as Los Angeles, London and New York. First time in England, for instance, Clean Air Act legislation was passed to restrict coal combustion for household use. Later in the USA more standardized approach for major pollutants was taken in 1963 (Bates, 1978).

While there is no single solution to reduce emissions, a combination of measures has been undertaken ranging from public education and awareness raising to strengthening of monitoring and enforcement, to improving technology is necessary in order to successfully address the increasing levels of air pollution (Guttikunda, 2007).

In Mongolia, a study of relevant policy interventions was part of the Urban Air Pollution Analysis Report commissioned by World Bank in 2007, where all the interventions - ranging from air quality monitoring programs to pollution control technologies, to enforcement mechanisms covering all the activities – were assessed that were in place prior to 2008. The list of interventions, their implementation status and assessment categories are provided in the Appendix 1.

Since this study is mainly focused on implementation of relevant policy programs during 2009 and 2013 and they are targeting to *ger* households as a main causality of air pollution, other causes of air pollution problems such as power plants, transportation sector and industrial boilers are excluded from the study.

In this case, the air pollution problem is strongly linked to the use of coal and wood for space heating practices associated to heavy winter periods in houses that are not connected to the central grid. Therefore, consideration was given in assessment of relevant policy interventions or sustainable energy services aimed at only *ger* households' such as replacement of cooking stoves, introduction of renewable energy sources, cleaner fuel and insulation technologies, as they are most applicable options for the contribution of air quality improvement in the area. The selection of these applicable sustainable energy services can be categorized into the following three options as shown in Table 3.2.

Table 3.2. Selected Sustainable Energy Options for the Policy Implementation Assessment

Applicable Sustainable Energy Options:	Category	Abbreviation Notes for further reference
Replacement of cooking stoves and introduction of insulation materials	Energy Efficient Measures	EEM
Water heating by solar thermal installations or other renewable energy technologies	Renewables	RE
Use of cleaner coal (by removing harmful pollutants) such as briquettes and/or gas	Cleaner Fuel	CF

In order to assess the implementation status of the applicable sustainable options in *ger district*, we need to have selection criteria, which will be explored in the next section for establishing the desired situation for households by considering relevant theories and concepts.

3.5. Insights from theoretical policy frameworks: setting the criteria from household perspective

Based on the research framework (Figure 2.1.) as presented in Chapter 2, a couple of theoretical concepts, namely field of policy evaluation, implementation and concepts on sustainable energy are useful in answering the key research questions. Also, key definitions on sustainable energy services and key factors that influence its sustainability characteristics have been studied in setting the relevant criteria for household's desired situation in relation to the use of sustainable energy options.

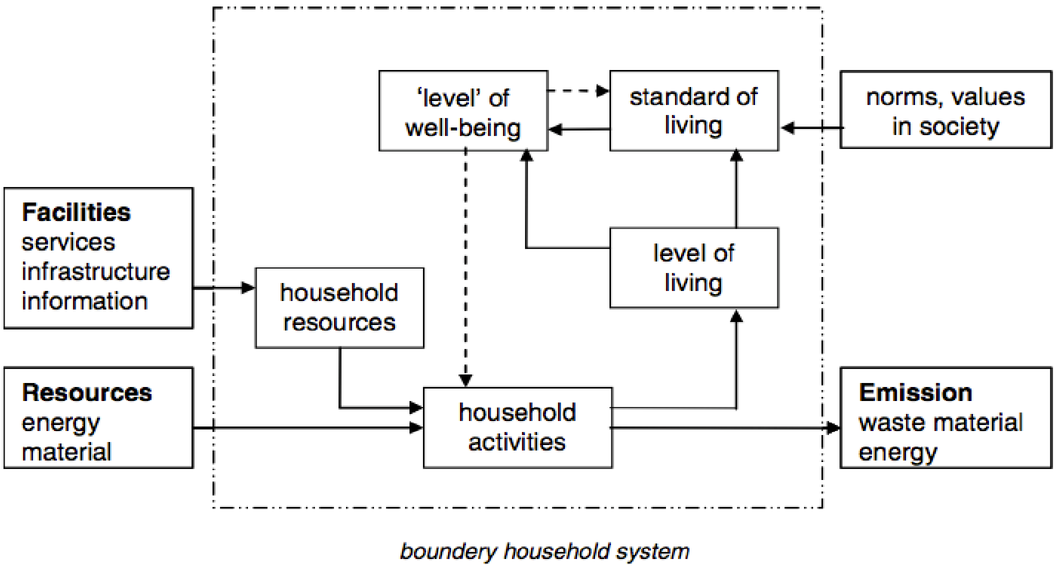
Concepts on policy evaluation suggest that there is a need for certain criteria in order to assess policy impacts in society (Bressers and Hoogerwerf, 1995). The most frequently used criterion in policy effect evaluations is policy goal achievement but another possibility is to set a standard or representation of a desired situation in order to compare with the existing or current situation (Coenen, 2012). So in order to understand relevant policy instruments implemented in various cases in the context of *ger* households, an assessment of policy implementation through comparison of the current situation with a desired situation could be the most suitable approach as it will be difficult to do evaluate effects of relevant instruments through goal achievement since our assessment approach is from the perspective of households' desired situation.

Since the 1980s there has been a lot of attention in the field of Policy Studies on policy instruments. One such theory is called Contextual Interaction Theory (CIT) that uses a deductive, social process approach that employs explicit consideration of several variables, including the policy tools (or "instruments") and the strategic interactions between implementers and target groups over extended periods of time (O'Toole, 2004). The basic assumption of the CIT is that the course and outcome of the policy process depend not only inputs (in case the characteristics of the policy instruments), but more crucially on the characteristics of the actors involved, particularly their motivation, information and power. The theory does not deny the value of a multiplicity of possible factors, but claims that theoretically their influence can be best understood by assessing their impact on the motivation, information and power of the actors involved (Bressers, 2004). According to Bressers other than these 'core' variables there could be other factors that could play an explanatory role but they should be linked to certain circumstances. For instance, "*a factor that exercises a positive influence under certain circumstances may exercise no influence, or indeed a negative influence, under other circumstances"* (Bressers, 2004*).*

Therefore, the complexity situation of the current research, which focuses on the impacts of air pollution abatement policy in *ger* households of urban Mongolia, leads us to search for other distinct factors that are closely linked to both household activities and types of sustainable energy technologies.

Concepts on sustainable energy in relation to household sciences[7], in particularly "Consumer-Technology Interaction Model" (Zuidberg, 1981 and Spijkers-Zwart, 1971) seem to be applicable to explain the change in level of living when a new technology is introduced in household activities. The consequences of certain technology is be assessed against the standard of living and the feeling of wellbeing of the members, thus creating a feedback system in a household activities (Goldsmith, 1996).

Figure 3.4. Consumer-Technology Interaction Model (-> = feedback)



Source: Verbeek and Slob (2006), User Behavior and Technology Development: Shaping Sustainable Relations between Consumers and Technologies, Chapter four: Technology and Household Activities, page 36

[7] Concepts of Household and Consumer Sciences took its roots from Home Economics in 20th century started in US and focuses on households as management systems (Deacon and Firebaugh, 1968 and Gross and Grandall, 1973.)

According to this feedback model (Figure 3.4), the household resources are internally generated and they are dependent on household's characteristics such as "income, space, time, abilities and skills" associated with kind of technology (Groot-Markus et al., 2006). Other external facilities such infrastructure, services, and information contribute to household resources, but they are dependent on the arrangements made by societal institutions. These may cause restrictions when the household system uses them in different modes of application" (Groot et al., 2006). For instance, replacement of coal burning stoves (that used to serve to both heating and cooking purpose) by electric heating facility (e.g. floor heating technology) can maximize comfort but restricts household's practice of using stove for cooking purpose. Another insight from this household feedback system is the so-called "rebound effect" that assumes people's tendency to strive for better conditions in their life, meaning to improve their standards of living. In this respect, change in norms and standards in a society may influence their choice for innovative technology if that technology is accepted as environmentally friendly standards in society. However, the actual behavior is measured best through empirical studies at the level of implementation. At that level, it is easier to recognize the opportunities and constraints when changes are introduced in the household system (Groot-Markus et al., 2006).

The concept of sustainable energy became highly relevant due to environmental problems such as global warming and poor air quality caused by fossil burning practices globally. In the 20th century, a tendency toward fuel de-carbonization, promotion of efficient use of fuels and innovation for alternative sources of energy among many countries highlighted progress in improved pollution control technologies. Therefore, study of relevant definitions on sustainable energy appear to be useful in deriving key criteria for household's desired situation by looking at overlapping conditions and factors that are influencing adoption of applicable technologies. Thus, various definitions on sustainable energy have been developed and the following are some examples of definitions where common characteristics are highlighted in bold:

- "Energy which is replenishable within a human lifetime and causes no long-term damage to the environment" (*Jamaica Sustainable Development Network, 2007).*
- "**Energy efficiency and renewable energy** are said to be the twin pillars of sustainable energy[8].
- "Dynamic harmony between equitable availability of energy-intensive goods and services to all people and the preservation of the earth for future generations." And, "the solution will lie in finding sustainable energy sources and **more efficient means of converting and utilizing energy**." (*S* J. W. Tester, *et al 2005)*.
- In general, Energy services: has been defined as **desired and useful products**, processes or services that result from the use of energy (Sambo, 1997).
- Reddy defined Energy poverty –as the absence of **sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign, energy services to support economic and human development** (Reddy, 2000).
- Unless the increased demand for energy services is met using **cleaner, safer and more efficient energy technologies, associated environmental and health** problems will worsen (The Policies for Sustainable Energy Systems, Section 3).

[8] "The Twin Pillars of Sustainable Energy: Synergies between Energy Efficiency and Renewable Energy Technology and Policy, 2008."

- ADB's energy policy recognizes that access to **modern and reliable energy services is essential for sustainable human development, economic growth, higher quality of life**, and better delivery of education and health services (Asian Development Bank, Energy Policy, 2009).

The above definitions seem to imply important conditions that says "*Unless the increased demand for energy services is met using cleaner, safer and more efficient technologies, associated environmental and health problems will worsen*" (Energy for Sustainable Development, 2002).

In addition, some of the key factors which should be considered as desirable situations when using energy services seem to highlight on accessibility or availability, affordability, reliability and on sustainable factors.

Based on the selection of applicable SE options (Table 3.3) we set the key factors for the desired situation as main assessment criteria for relevant policy programs aiming to reduce *ger* households' contribution to air pollution.

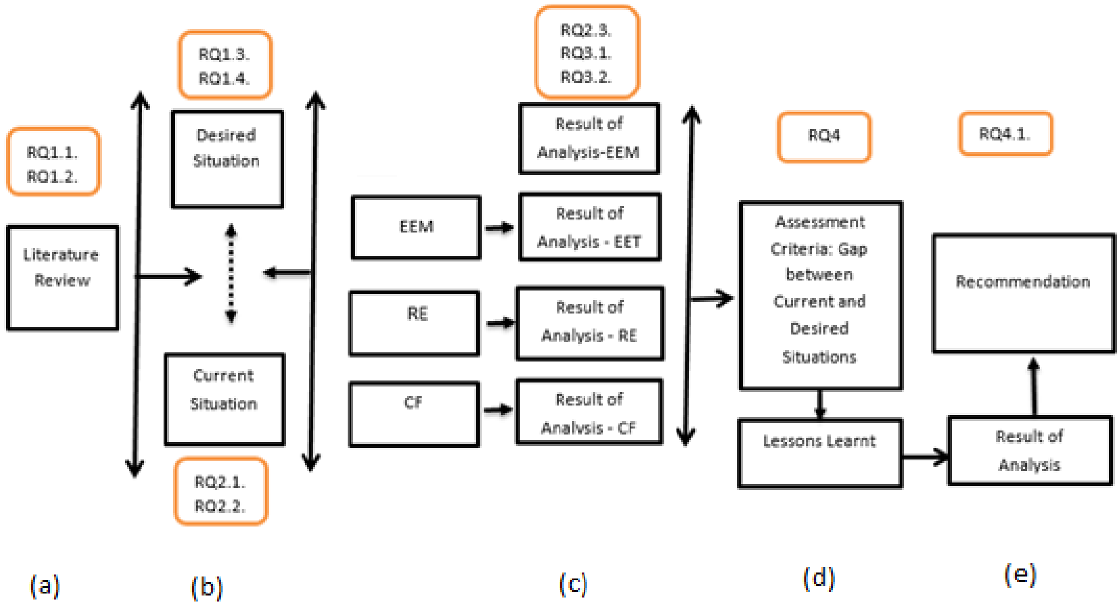
Table 3.3. Selected key factors for a desired situation for using SE options

Key Success Factors:	Indicators for the achievement of programme	Remarks:
Availability	whether those Sustainable energy services are available to all *ger* households through relevant projects	Once a decision to shift for more sustainable measures, relevant options should be available
Affordability	whether relevant economic incentive measures are available (e.g. subsidy, tariff discount etc;)	whether they have more economic value than baseline situation
Comfortable	whether they can provide better comfort such as steady temperature for lon*ger* run. (convenient fuels seem to have unsteady temperature difference), whether they can be cleaner with less pollution and/or no emissions	For example, firing stoves for heating purposes often takes 4-6 times a day consuming time and hard work; Comparison with previous situation
Reliability	Whether those technologies or services can be used for max. long term as possible	Foreign or new technologies need meet local conditions such as repair & maintenance.

3.6. Analytical framework

Based on the theoretical and empirical literature studies, the schematic presentation of analytical framework of the research is presented in Figure 3.5, followed by description of activities at different stages.

Figure 3.5. Analytical Framework of the Research



(a) Firstly, a review of relevant literature and document will be conducted on relevant theories of policy implementation/evaluation and concepts on sustainable energy (SE) with particular focus on household energy use in connection with air pollution.

(b) Secondly, based on literature review and relevant concepts, a formulation of key criteria for the desired situation will be formed. The key criteria for the desired situations are the conditions where households are enabled to adopt sustainable energy options with advantages, such improved indoor quality, health and social benefits, reduced heating cost and etc.

(c) Third, an analysis of the current situations will be done by looking at relevant policy measures and its implementation of SE options in comparison to the desired situation. The following four SE options, by means of which the current situation will be assessed in relation to the desired situation: Energy Efficient Technologies, Energy Efficient Measures, Renewables and Cleaner Fuel.

(d) An analysis will be conducted in order to determine the gaps and possible barriers between the existing and desired situations. A gap analysis will be helpful in drawing up lessons learned and identifying best practices.

(e) The final result of the analysis will further provide insights and recommendations for policy makers and development practitioners in addressing the identified gap of the specified problems.

CHAPTER 4: CURRENT SITUATION

Air pollution in Ulaanbaatar reaches disastrous levels in winter. Today, all residents of Ulaanbaatar somehow contribute to its air pollution through means of transportation, construction, heating and burning, but the major source is fumes and polluting substances, created by burning of coal and wood by over 180 thousand households living in suburban *ger districts* of Ulaanbaatar.

This chapter aims to provide facts on the sources of air pollution in *ger districts* in Ulaanbaatar, and its share in overall contributing factor for air pollution in Ulaanbaatar. The second objective is to analyze the government actions to lower air pollution, including legal, policy instruments, and institutional settings and certain programs, projects and their respective roles in reducing the air pollution.

4.1. Overview of housing sector development in Ulaanbaatar

Ulaanbaatar is expanding enormously, hosting 60 % of Mongolia's total population and producing 60% of the national Gross Domestic Product[9]. Free market economy and several harsh winters triggered many rural herders to abandon traditional nomadic lifestyle and migrate to Ulaanbaatar. In the last twenty years, Ulaanbaatar saw a rapid expansion of its population from 600,000 in 1990 to over 1.2 Mln. in 2010. More than 60% of its residents live in *ger* districts spanning over wide area of 8,494 hectares.

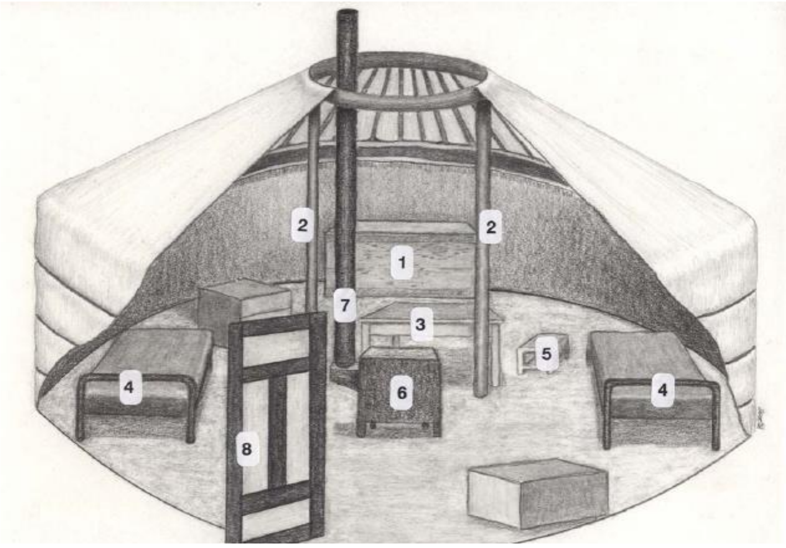
Air quality in Ulaanbaatar is highly seasonal. In summer, there is less pollution due to ambient temperature outside and green parks and forests surrounding Ulaanbaatar. Thus, heavy pollution is witnessed during the long and cold weather that lasts around six months from October to March. Heating season continues approximately for 250-270 days from mid-September to mid-May.[10] Ulaanbaatar is located at attitude in between 600 and 1,000 m above sea level in a large valley between the four mountain hills of Bogd Khan (2,261 m above sea level), Songinohairkhan (1,663 m. above sea level), Chingeltei (1,831 m. above sea level) and Bayanzurkh (1,846 m6 above sea level) and is considered as having calm wind speeds of 1-2 meter per second in winter.

As of January 2012, there are about 307,000 households in Ulaanbaatar with an average family size of 4 people each.[11] The housing stock in Mongolia can be divided into two categories: the first one is called "*apartment buildings*"- usually consists of multi-story apartment complexes (ranging from four to twelve store apartment buildings) and modern individual houses.

[9] National Statistical Office indicators, www.nso.mn
[10] National Committee on Reducing Air Pollution, 2013
[11] National Statistical Office indicators, www.nso.mn

Figure 4.1. *Ger* – Mongolian traditional insulated dwelling

The *ger* consists of round-shaped felt tents, which are a very common housing type among nomads in many Central Asian countries. A *ger* is composed of a primary structure consisting of a circular lattice wall made out of wood. On the top of the wall a number of wood beams are set to create a circular roof with the structural support of two columns and the circular wall. On the top of this igloo-shaped structure, a thick layer of felt and a traditional white cotton fabric complete the ensemble. A *ger* has many advantages: they are portable, made out of traditional materials, structurally sturdy and they are highly resistant to the strong winds of the Mongolian steppes. They are adaptable to the changing weather conditions of the continental climate countries where summers can be hot and winters are very cold. *Source:* Caldieron (2013.)



They represent 40% of total residential area and are generally connected to the central grid that provides both electricity and heat. The remaining 60% are living from so called *ger districts* - located in periphery of UB consisting of traditional nomadic dwellings and individual houses that are not connected to the central heating facility of the city.

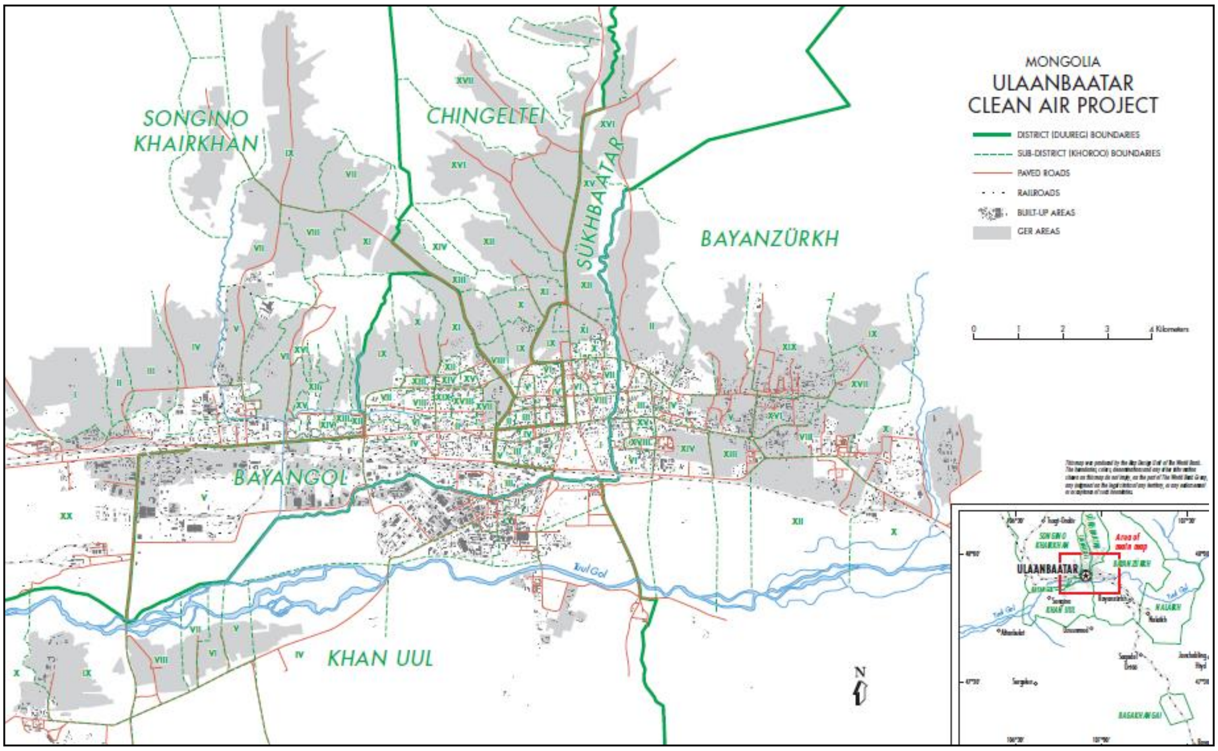
In general, four different types of existing heating systems are used in Mongolia: a) centralized (or district) heating systems; b) small-district heating systems for groups of buildings (heat-only boilers or boiler houses); c) individual heating systems (water heaters); and d) household stoves.

Figure 4.2 Growth of households in Ulaanbaatar by dwelling type

Source: The municipality statistical bulletin – 2011

Centralized heating is limited to the apartment blocks and highly dense areas in the city center. Due to rapid expansion of *ger districts* (about increase in 30,000 households from 2008 to 2012) and reaching approximate population of 800,000 people, it was impossible to connect to central heating. The main reason for the lack of availability of central heating to the growing population in *ger areas* was no plan of construction and development of new power plants during this period. In addition, unorganized, illegal and sparse distribution of buildings made it impossible economically and technically to connect to the central heating system.

Figure 4.3. Map of Ulaanbaatar depicting *ger* area in grey



Source: Ulaanbaatar Clean Air Project, 2012

4.2. Contribution of *ger districts* in air pollution of Ulaanbaatar

In major urban areas of Mongolia, the peak of air pollution takes place during the winter as the consumption of coal and wood fuels are increased to meet the heating energy needs of houses that are not connected to the central heating system. At the aggregate level, this kind of fossil fuel burning practices are detrimental to the air quality with negative impacts on health and wellbeing of people, and in turn with significant socio-economic burden.

Sources of air pollution in Ulaanbaatar are classified as point source, area source and line sources. The point sources include thermal power plants and large water heating boilers that release high concentrated agents from single sources. Area source of air pollution is family and residential boiler houses. Linear source of air pollution is vehicle emission.

The stationary sources of air pollution, such as households in *ger districts*, three thermal power plants and 1,200 water boilers used in public and residential houses consume about 6.1 Mln. tons of coal and release 244.0 thousand tons of toxic substances in the environment annually, which is equivalent to 203 kg of toxic substances per each city resident.[12]

Table 4.1 Air pollutant emissions in Ulaanbaatar each year, by source

Source	Air pollutants (tons per year)			
	SO_2	PM_{10}	CO	NO_x
Thermal Plants	13,282.29	11,551.03	50,819.16	13,282.29
Medium water boiler heaters	1,369.82	2,811.86	5,249.22	264.01
Small water boiler heaters	313.09	130.79	463.3	103.04
***Ger* district**	**4,675.14**	**3,654.39**	**151,128.74**	**2,006.47**
Road	203.23	199.64	31,998.73	5,111.76
Narrow dirt road	66.55	65.38	10,479.19	1,674.04
Dust	0	9,266.10	0	0
Ashes from Thermal plants	0	2,560.36	0	0
Total	**19,910.13**	**30,239.55**	**250,138.34**	**22,636.11**

Source: Municipality Air Quality Office (MAQO), 2013

The air pollution created by burning of fossil fuels, raw coal and wood, by households living in *ger area*, contributes to 50 % of overall pollution. 20 % is emission from 306,000 vehicles moving in Ulaanbaatar, 14 % is dust and particulate matters from construction and soil, 14 % from small and medium sized heat-only boilers.

Table 4.2 Comparison of ratios of PM in "Central" and *ger* areas

Area	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	Exceedance ratio to Air Quality Standards	
			Mongolian	WHO
Central Ulaanbaatar	150-250	75-150	3-6 times	7-15 times
Ger districts	350-700	200-350	7-14 times	17-35 times

Source: Municipality Air Quality Office, 2013

Ground-level air pollution in Ulaanbaatar during winter is three to six times higher than the recommended level in Europe and USA and ten to twenty times higher than the World Health Organization (WHO)'s recommended standards. A WHO survey on outdoor air quality, published online in 2010, revealed Ulaanbaatar as the second worst city among 1,100 cities surveyed in terms of air quality (Particulate Matter-PM_{10})[13]. The table 4.2. verifies comparative measurements of PM_{10} and $PM_{2.5}$in central and *ger* districts of Ulaanbaatar. Both locations far exceed international and national air quality standards, central Ulaanbaatar is being two times better than *ger* districts in terms of air quality.

[12]MAQO (2013), Report on air quality and activities undertaken to reduce air pollution in Ulaanbaatar city. Ulaanbaatar: Municipality of Ulaanbaatar. (In Mongolian)

[13]WHO, Survey 2010 http://www.who.int/phe/health_topics/outdoorair/databases/en/

Figure 4.4. Contrast of *ger* areas in summer and winter

Most households in *ger districts* use the same type of traditional heating stove that burn large amounts of wood or coal and produces a high quantity of smoke and pollutants. This kind of practice is common throughout the country, however high-density urban settlements are highly concerned.

180,000 households in the *ger districts* consume approximately 0.4 Mln. tons of coal per year in addition to the 5.4 Mln. tons consumed by commercial coal combustion. By products of coal combustion are known to have detrimental effects include carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (PM) (Sinton, Smith, Hu and Liu 1995).

4.3. Government policy to address the problem of air pollution

4.3.1. Legal Framework

There are numerous laws and regulations related to energy, energy efficiency, such as Law on Energy (1 Feb 2001), Law on Renewable Energy (11 Jan 2007); and addressing problems of air pollution in Mongolia, such as revised Law on Air of Mongolia (17 May 2012), Law on Air Pollution Reduction of the Capital City (enacted on 10 Feb 2011 and dismissed in line with adoption of the New Law on Air), Law on air pollution payment (24 June 2010) and Law on Special Government Funds, governing foundation of Clean Air Fund (CAF).

The issue of air pollution is closely linked with energy supply and energy efficiency. In 2001, the Law on Energy (2001) was approved to regulate energy use, generation, transmission and distribution activities and supporting construction of efficient, reliable and sustainable energy resources. The Law supported the creation of subsidized energy tariffs for households in *ger districts* in order to initiate use of affordable electric energy resources for heating and cooking rather than traditional use of coal and burning of woody biomass.

The Law on Renewable Energy (2007) aims to regulate the generation and distribution of electricity created by renewable energy resources and gives special priority to wind and solar energy resources. The law set the Government guarantee and feed-in tariffs for renewable energy power sources and set-up a renewable energy fund.

The Law on Air Pollution Reduction of the Capital City (2011) aimed to significantly reduce air pollution levels in Ulaanbaatar and introduce policy measures, such as introduction of spatial in which use of raw coal is prohibited, support to the use of electricity, coking coal and gas for heating and improve existing standards of on energy efficiency.

The New Law on Air (2012) aims to regulate actions related to the protection of ambient air, prevention from air pollution, and reduction and monitoring of emissions of air pollutants. The Law mandates the role and responsibilities of not only the Parliament, the President, the Government, but specific sectors, whose activities are directly linked to air pollution, such as energy, environment, local government and companies. It governs an establishment of professional agency, which is responsible for defining the air quality, carrying out control and monitoring, and preparation of relevant reports and conclusions. In addition a network of air quality monitoring stations and units to be established to conduct regular monitoring, measurements, observations, and assessments of air quality, negative physical impacts on the air, acidic precipitation, stratospheric ozone, and greenhouse gas contents and provide the public with reports and updates.

The Law framed actions to systematically reduce air pollution, such as expansion of cleaner energy sources and electricity distribution infrastructure and capacity, identify air quality improvement zones in *ger* districts, apply discounted electricity rates, support households, companies and institutions applying advanced technologies towards reducing emissions. The latest ongoing efforts are to introduce long-term mortgage mechanisms to support procurement of energy saving and energy efficient houses for *ger* district households and support migration of households and companies to less polluted areas and decentralize Ulaanbaatar population concentration.

The Law set-up an establishment of the Clean Air Fund (CAF), under the Environment Minister, that mandated to regulate, finance and monitor implementations of projects and policies to reduce air pollution in 2011. The operation and budget of the Clean Air Fund are regulated by the Law on the Government Special Funds.

4.3.2. Policy Framework

Adoption of the laws, mentioned above, act as a strong basis of developing effective policies and programs. Based on the legal framework, a number of policy instruments to support the effective implementation of the law was introduced, such as National Mid-Term Development Plan “New Reconstruction” 2010-2016 (approved by Parliament decree in June 2010), Government decrees to set payment rates for air pollution (Oct 2010, decree number 273), payment rates for polluting substances emitted from big pollution sources (March 2011, decree number 92) and Parliament decree on certain measures to be taken in line with the approval of “the Law on Air Pollution Reduction of the Capital City” (Feb 2010).

In 2011, the Sub-committee on Air Pollution was established in the Parliament that emphasized inseparable role and need for law-makers in setting up effective and collaborated measures on air pollution.

In addition the Government endorsed a number of regulations, such as “Regulation to provide incentives to *ger district* households in the air quality improvement zone”, ‘Regulation to provide incentives to individuals companies and institutions that are engaged in air pollution reduction, energy efficiency and electricity saving activities”, ‘’Regulation for individuals, companies and institutions located in the air quality zone”, “Regulation to store and supply processed coal for distribution in *ger districts*”, “Regulation to provide front financing to establish a processed fuel store in the air quality zone”, “Regulation of conduct of inspectors to work in the air quality zone” and “Regulation on receiving air pollution payment rates from individuals, companies and institutions, who are using air polluting substances.” The table 4.3 provides summary of the regulatory frameworks.

Table 4.3. Summary of regulatory frameworks for reduction of air pollution at *ger* districts

Name of instrument	Type of instrument	Description
Energy Laws	Legal	The Law on Energy (2001) supports creation of subsidized energy tariffs for households in *ger districts.* The Law on Renewable Energy (2007) regulates the generation and distribution of electricity created by renewable energy resources and gives special priority to wind and solar energy resources. The law set the Government guarantee and feed-in tariffs for renewable energy power sources and set-up a renewable energy fund.
Laws on Air	Legal	The Law on Air Pollution Reduction of the Capital City (2011) aims to reduce air pollution level in Ulaanbaatar and introduce policy measures, such as introducing zonation to prohibit use of raw coal, support use of electricity, coking coal and gas for heating and improve existing standards of on energy efficiency. The New Law on Air (2012) aimed to to regulate the actions related to the protection of ambient air, prevention from air pollution, and reduction and monitoring of emissions of air pollutants.
Parliament and Government decrees	Legal	National Mid-Term Development Plan “New Reconstruction” 2010-2016 (June 2010), Government decrees to set payment rates for air pollution (Oct 2010), payment rates for polluting substances emitted from big pollution sources (March 2011) and Parliament decree on certain measures to be taken in line with the approval of “the Law on Air Pollution Reduction of the Capital City” (Feb 2010).
Government Regulations	Legal and Regulatory	“Regulation to provide incentives to *ger* district households in the air quality improvement zone”, ‘Regulation to provide incentives to individuals companies and institutions which is engaged in air pollution reduction, energy efficiency, electricity saving activities”, ‘’Regulation for individuals, companies and institutions located in the air quality zone”, “Regulation to store and supply processed coal for distribution in *ger* districts”, “Regulation to provide front financing to establish a processed fuel store in the air quality zone”, “Regulation of conduct of inspectors to work in the air quality zone” and “Regulation on receiving air pollution payment rates from individuals, companies and institutions, who are using air polluting substances.”
Standards	Regulatory (mandatory and voluntary)	Standards on household stoves, semi-coked coal, semi-coked coal briquettes, patent fuel, maximum allowed level of pollutant substances in fumes of household stoves and general standard on *ger* and household building structure insulation. (Codes of Standards related to Stoves MNS5045:2001, MNS5087:2001, MNS5086:2001, MNS5041:2001, MNS5043:2001, MNS ISO5667-7:2002, MNS5919:2008, MNS 5216-1:2011, MNS EN 13240:2011, MNS6280:2011)

Approval of new standards and re-development of the existing standards was key to improve safety, compliance and cost of outdated technological solutions for energy efficiency and fuel switch. The relevant standards are standards on household stoves, semi-coked coal, semi-coked coal briquettes, patent fuel, maximum allowed level of pollutant substances in fumes of household stoves and general standard on *ger* and household building structure insulation.

4.3.3. Institutional Framework

The National Committee on Reducing Air Pollution (NCRAP) was established in 2009 under the Office of the President of Mongolia that is responsible for coordinating the policy to enforce air pollution reduction and for ensuring and overseeing interrelations of operations. The National Committee is re-shifted to the Cabinet of the Government recently. The Law on Air governs establishment of regional and district committees. As part of the initiative, District Committees were established in 6 districts of Ulaanbaatar and chaired by the District Governors. In 2012, 50 sub-districts formed and activated 484 unit heads and 51 sub-districts employed non-permanent 654 “air quality inspectors”.

The Clean Air Foundation (CAF) was established to initiate operations and programs approved by series of laws: Air Law, Law Special Government Agency, Air Pollution Fee Law and the City Air pollution Law. In addition, the Clean Air Foundation is to host of fundraising activities. The priority of the Clean Air Foundation is to maintain fresh air in our environment, prevent it from getting polluted, and develop the Foundations’ procedures to put it under control. Furthermore it supports individuals and companies whose operations decrease air pollution, by creating fund and new jobs. The Clean Air Foundation has a Governing committee with 9 members.

The Municipality Air Quality Office (MAQO) is key municipality office, which is responsible for the air quality, air pollution monitoring and research, sources of pollution, environmental and public health threats. The Office has been introducing new technologies to reduce the negative impacts of air pollution and implementation of government policy and decisions from Ulaanbaatar City Mayor.

The National Renewable Energy Center (NREC), with its main goals to achieve the goals of the Renewable Energy National Program; to do detailed study on renewable energy resources and utilization; to introduce new technology of renewable energy; to carry out research on introducing new technology that is suitable to the special feature of our climate; implement projects, programs and measurements over the whole country and to put technical control, carries out activities with two main divisions: Research & Business Development and Production & Technology conducting research works on study, production, testing, consumption of renewable energy - solar, wind, geothermal, and new energy source and CDM.

4.4. Policy programs and applications of Sustainable Energy (SE) options aimed to reduce air pollution in residential areas in 2009-2013

The Government of Mongolia aims to reduce air pollution derived from *ger districts* by 30 % every year until 2014, and by 10 % every following year starting from 2014. The table below analyzes of the relevant policy instruments being used to reduce air pollution caused by inefficient household energy use. These instruments were implemented by the GoM since 2009, with financial support of

Millennium Challenge Account (MCA), the World Bank, in partnership with Japan International Cooperation Agency (JICA), Khaan Bank, Xas Bank, MCS, Selenge Construction LLC, Royal Ocean LLC, and many other international and national entities. The role of se other entities are involved in the policies mainly to produce and import energy efficient products, to sell and distribute these product to households, to provide loans and products with reduced prices, and by other means. The policies are planned and realized at short and long terms and at various implementation stages.

Table 4.4. Main programs and projects aimed to reduce air pollution in *ger* districts

Name of Programs/Projects	Category	Policy Instruments Involved	Objectives/ Activities/Description	Stakeholders / Funds
-BEEP (Building Energy Efficiency Project) Duration: Apr 2009 – Dec 2013	EET, EEM	Regulation, Financial Incentive,	Reduction of GHG emissions through the transformation of the Mongolian building market towards more energy-efficient building technologies and services (Design and introduction of new energy efficient houses, energy efficiency standards, insulation materials and vestibules for existing *ger*s)	UNDP, Xas bank (provides loans), 3,815,000 US$
Clean Air Project (CAP) Duration: 2010-Sept 2013	EET, EEM, RE	Regulation, Financial Incentive, Social Instruments	Sustainable reduction of air pollution in UB by increasing the adoption of energy efficient products and homes in the *ger* districts, and supporting the development of renewable energy. Provided with subsidy 97,787 stoves, 21,090 *ger* insulations, 5,222 vestibules, 109 EE buildings, in total 124,208 energy efficient products.	Millennium Challenge Account (MCA) Government of Mongolia 32,000,000 US$
Ulaanbaatar Clean Air Project Duration: Sept 2013 to Sept 2017	EET	Regulation, Financial Incentive, Social Instruments	The project was continued with support from the GoM and WB to supply 4 types of (Olzii, Dul, Talst and Bekas 107) the energy efficient stoves for the remaining households in *ger* district. Expects to distribute 45,000 cook stoves that save 30-50% of energy efficiency.	World Bank – 50% (US$15 Mln. loan), 50% (GoM Clean Air Foundation (CAF)), Mongolian University of Science and Technology as technological partner
Clean Air Fund (CAF)	EET, EEM, RE and CF	Regulation, Financial Incentive, Social Instruments	Large portion of the fund is spent subsidizing cleaner coal fuel for the *ger districts* to use in their stoves. As of October 1 2013, the initiative has spent 67 Bln. MNT of its allocated fund.	Government of Mongolia 90 Bln.Bln. MNT (64 Mln. US$)
Ulaanbaatar Clean Air	EET	Regulation, Social Instruments	Develop protocols and manuals for stove testing is developed. Mechanism for promoting stove production and distribution were piloted. Established Stove Emissions	ADB, WB, World Vision, XasBank,

			and Efficiency Test Laboratory (SEET). Training for stove producers was conducted. Since 2010, the SEET tested about 20 different fuel-stove combinations.	
Ulaanbaatar Clean Air Initiative Aug 2011 – Feb 2013	CF	Regulation	Developed Law on Air in 2012, Draft Law on Clean Air, supported establishment of Clean Air Foundation and formulation of new standards on clean fuel.	EBRD Ulaanbaatar Municipality Ministry of Nature and Green Development National Committee on Reduction of Air Pollution
Capacity Development Project for Air pollution in Ulaanbaatar 2013-2016	EET	Regulation, Social Instruments	The project supports capacity development of stakeholders to develop emission inventory system and air quality evaluation capacity, to train stack gas measurement techniques, to improve emission control system by administration and to support dissemination of project outcomes	JICA Ulaanbaatar Municipality

4.4.1. Energy Efficient Measures and Technologies

4.4.1.1. Energy Efficient Houses and Construction Technologies

There are a number of programs funded by international organizations that strive to improve energy efficiency directly. The UNDP has funded US$3.815Mln. to establish the Building Energy Efficiency Project (BEEP) in Ulaanbaatar for 2009 and 2013. The project is targeted at new buildings as well as improving the energy efficiency existing residential buildings in urban areas.

The project revised 60 Building Construction Norms and Standards (BCNS) of Mongolia and addressed the availability of key building materials, developed designs of energy efficient houses, developed labels for locally produced building materials that conform to the BCNS. BEEP promoted new design of energy efficient homes with floor area varying between 30-90m^2.The energy intensity in buildings complying with the new BCNS were measured to be 155 kWhr/m^2 as compared to the baseline of 200 kW/hr measured at the beginning of the project. Energy savings were observed due to reduced coal consumption in 223 new individual houses, which were built with technical assistance of BEEP, and according to new BCNS. People who shifted from *ger* to energy efficient homes reported reduction in their annual coal consumption by 50% for space heating. 6,387 new apartments (average floor area of 50 m^2) were built according to new BCNS, about 64% have been occupied in 2013 and contributed to reduced energy consumption and GHG emissions.[14]

[14] Terminal Evaluation Report, UNDP/GEF Project: Energy Efficiency in New Construction in the Residential and Commercial Buildings Sector in Mongolia (Building Energy Efficiency Project), MON/09/301, Dec 2013

The BEEP was further supported and continued by Clean Air Project implemented funded by MCA. In total 109 EE buildings were built with the similar design and approach. More details can be found in Appendix 5.

4.4.1.2. Replacement of Stoves

Since 2009, there have been a number of programs to reduce air pollution. The development of several technologies has supported this. The German Technical Cooperation (GTZ) developed a new *ger* stove model in 2009. The stove includes insulating bricks to retain heat, and thus uses less fuel, and two air intake channels to raise the combustion temperature and cut emissions. The stoves can burn all types of fuel, even high quality semi-coke coal. The energy efficient stoves subsidized by the project use 20% to 30% less fuel, and emit 70% to 90% less pollution than traditional stoves.

The subsidized *ger*-stoves program grew substantially in 2009, when the U.S. Government's MCC funded subsidies for energy efficient *ger* stoves through its Energy and Environment Project. It is largest point, the program had 42 sales centres and 150 dedicated staff. The program funded a 90% subsidy of the *Ger* stoves, reducing the cost of the cheapest stove models to about $20, one-tenth of their original price. MCC financed US$47Mln. or about 80% of the project while the Mongolian government funded the remaining 20%.

The program finished in November 2012. During the course of the project, the program sold nearly 120,000 improved stoves, 20,000 *ger* insulation kits, 4500 entrances, and 100 energy efficient homes were subsidized, helping nearly 100,000 households of Ulaanbaatar's *ger* districts to save money and help contribute to a cleaner environment.

As a follow up of the MCA project, the Ulaanbaatar Clean Air Project funded by the World Bank will continue the *ger* stove subsidies program.

There are three components to the project.

1. The first component of the project is *ger* area particulate matter mitigation.
2. The second component of the project is particulate matter mitigation in Central Ulaanbaatar. This component has four sub-components:
    a. mitigation of fugitive dust from lack of city green;
    b. mitigation of dust from power plant emissions and ash ponds;
    c. district heating feasibility studies and knowledge building; and
    d. technical assistance for affordable housing policy

In regards to the *ger* stove subsidies, the World Bank is sharing the costs 50-50 with the Mongolian government. With the support of the World Bank, the Government of Mongolia has mobilized about $45 Mln. in donor assistance. The Bank also approved an additional US$15 Mln. credit for the Ulaanbaatar Clean Air Project, which is implemented by the Ulaanbaatar Municipality.

4.4.1.3. Improved Insulation

There was also the development of *ger* blankets which were designed by the United Nations Development Program but produced locally in Mongolia. The *ger* covers are essentially large insulating blankets composed of three separate layers that wrap the entire outside of the *ger*. The specialized insulation helps to keep heat within the *ger* and results in a 50% reduction in fuel burned each month.In the implementation of MCC Energy and Environment Project 20,000 *ger* blankets were sold to households with subsidized price.

4.4.2. Renewable energy

The utilization of renewable energy has been emphasized as one of the priority areas of the energy industry in the government policy documents such as the Government Action Plan, Millennium Development Goals, Sustainable Development Program of Mongolia for 21st century, Regional Development Concept, Consolidated Energy System Program of Mongolia and Sustainable Energy Development Strategy of Mongolia. Mongolia has vast resources of renewable energy and has favourable climatic and weather conditions for effective use of these resources.

With regard to generation and use of energy utilizing renewable energy resources at household level in Ulaanbaatar city, Solar Vacuum Collector for heating purposes is being piloted. From 270 to 300 days in average year on entire territory of the country are estimated as sunny and yearly average daylight time is estimated as 2250-3300 hours. The yearly radiation is estimated as 1200-1600 kW per square meter and its intensity is estimated as more than 4.3-4.7 kWh. In scope of this pilot program Solar Vacuum Collectors have been installed at 21 households in *ger* areas of 5 districts of the city in the beginning of heating season of 2011 by NREC and the MAQO. The main objective of the pilot program is to study the effectiveness and financial feasibility of solar energy resources for heating at household level. The follow up feasibility study is being conducted. The details of the program are given in Appendix 4 and 6.

4.4.3. Cleaner Fuel

The Government of Mongolia views production and utilization of cleaner fuel as one of the prior activities to reduce air pollution of Ulaanbaatar city by 50%.

The Clean Air foundation approves centrally located sub-districts of Bayangol district as “Air quality improvement zone of Ulaanbaatar city” and prohibits the utilization of raw coal for household heating purposes since the beginning of the heating season of 2011. In the heating season of 2012-2013, the “air quality improvement zone” includes 9 sub-district of Bayangol district. The 12,461 households in this zone (about 5% of total *ger* area households) are using cleaner fuel for heating and cooking. They purchase the fuels from 2 *ger* centers in each sub-district, specifically established to distribute improved fuels with discounted voucher and government incentives.

Furthermore, in the long run, the *ger* area households are going to use such cleaner fuel and utilization of raw coal will be banned in all *ger* areas of the city.

4.4.3.1. Coking and semi-coking coal

Production and utilization of coking and semi-coking coal at household level is one of the efficient and effective ways to air pollution reduction of Ulaanbaatar city. Coking and semi-coking coal is cleaner fuel abstracted by dissociating and redeveloping raw coal at 500^0-600^0C heat and is used for domestic and heating purposes. The "Semi-coke; technical requirements" standard was developed and approved by the committee consisting representations from the Ministry of Minerals and Energy, Standardization and Measurement Department, General Inspection Office, Mineral Resources Authority, and Academy of Science on September 29, 2011.

Establishment of an improved fuel factory which is expected to produce 210 tons of semi-coke fuel per year is under construction since 2010. Therefore, the delay of this particular measurement has caused reduction of the size of air quality improvement zone of Ulaanbaatar city. Today, there are a few SMEs that are producing coking coal and wooden pellets locally in a little amount and supplying them to *ger* households.

4.4.3.2. Wooden pallets

On average, wooden pellet burning produces 3 times less pollutant substances than burning raw coal in a regular cook stove. But economically, due to its incapability to keep the heat lon*ger*, it requires 1.5 times more fuel, i.e., 1.5 times more expenses for heating season. There are 8 local producers of wooden pallets, most of them located in Selenge and Bulgan aimags, and one in Ulaanbaatar city.

4.4.3.3. Gas

In Mongolia, the import of gas has increased 3.7 times in 2012 compared to 2006. But most of the gas is used for cars. There are about 10 entities doing business in the sector of gas. The number of clients has reached to 7000 which increased 18 times compared to 2000. The following two companies are the major importers of gas, in different forms and purposes (*ger* heating, house heating, cooking, etc). 1 Kg of gas fuel costs about MNT 2,150 (US$ 1.26) and the installation costs depends on the size of the house. Approximately MNT 2.5 Mln. is required for installation to heat a $70m^2$ house. For the house of this size 1440 kg gas fuel is needed for a whole heating season, which will cost about MNT 3 Mln. (economically 5.5 times more costly than using raw coal for heating, and 3.5 times more costly than using improved wooden pellet for heating). In addition, due to absence of serious consideration of choosing natural gas for heating supply in long term energy strategy of Mongolia at any time of the history, the infrastructure for natural gas via to buildings does not exist in Mongolia. Therefore, opting for imported gas instead of domestic coal could be extremely costly but considering the greater GHG emission reduction potentials and other societal benefits of using should be studied in the future.

4.4.4. Financing mechanisms to support the SE introduction

The establishment of the Clean Air Foundation, which is mandated to manage the Clean Air Fund (CAF), opened an opportunity to fund air pollution reduction activities from the budget. This fund was allocated 92.5 Bln. MNT (US$ 56 Mln. US$) from Government budget between 2011 and 2013. It is particularly focused on subsidizing cleaner coal fuel for the *ger* districts to use in their stoves.

In addition to the government budget, donor aid projects, such as Mongolia MCA funded 32.0 Mln. US$ for replacement of stoves.

Following these technological development, Khasbank has started offering eco-microloans to make these eco products financially accessible to the residents of the UB *Ger* Districts. Khasbank currently offers three types of green loans for personal consumption: energy efficient stoves, *ger* covers and energy efficient fuel. Khasbank also provided start-up loans to local producers to increase production of both the stove and the *ger* cover.

In scope of the Energy Efficient Housing program, the Clean Air Project (MCA 2010-2013) offered affordable, well insulated, energy saving houses and *ger* insulations. The project offered incentives of MNT 5 Mln. (US$3,750) to households purchasing energy efficient houses, and Xas Bank provided discounted loan for 1-10 years.

Chapter 5. GAP ANALYSIS

This chapter aims to analyze the gap between the desired and current situations as of today, after implementation of series of policy programs and projects undertaken between 2009 and 2013.

This chapter aims to address extent of the efforts that follow from current policies on air pollution contribute in meeting the criteria for the 'desired situation'. The chapter has different sections to analyze the gap between the desired and current situation, to present key barriers presented in those gaps and potential drivers that will help solving problems with the gaps. This helps the next chapter to identify lessons learnt and key aspects to consider when new policies on air pollution reduction are formulated.

The research design is based on a quantitative study concerning availability of the SE options among households in *ger* districts. Further, the qualitative study is conducted through questionnaire surveys among 28 households, which benefitted in purchase and installation of SE options. In 12 of these households solar energy vacuum collectors were installed under a Government-subsidized programme that represent 57% of total households in the demonstration project program (which included 21 households in total) partcipipated in the programme. 16 Households, who built energy efficient houses under the BEEP programme were surveyed, representing 15% of total beneficiaries. Additionally, two expert interviews were conducted to analyze the situation and gaps from the supplier's and implementer's perspectives.

Finally, a case study complements the conclusions from qualitative study. The combination of different strategies such as the case study, the set of expert interviews, and the household survey will be deployed as triangulation method for further analysis of relevant data.

5.1. Results

Available, sustainable and affordable SE options bring long-term economic, health and social benefits to families. It was noted in many studies that it has a strong impact on poverty alleviation through direct means of cost-saving, labor facilitation and indirect benefits on health and education.

As described in chapter 3, criteria for desired situation for families are many, but a few key criteria have been selected: availability, affordability, comfort and reliability. The availability can be identified as physical availability of options, products, spare parts, repair and maintenance options in the market, government efforts to facilitate the process of procurement, installment and user advice for households. The affordability can be measured by the cost of options, products, fuel and technology against purchasing powers of households in the area, and Government economic incentives, such as tax redemption, facilitated loans and subsidies. The comfort can be defined as improved indoor air quality, cleanliness of options and fuel, steady temperature for long run, compliance of new options and technologies to standards of quality living. The reliability is the reliable performance of the options and technologies, continued and regular supply of cleaner fuel, up-to standard local repair and maintenance, and sustainability of government support and financial incentives.

The desired situations and its descriptions may not always fully be on list of objectives and agenda of the policies, but in overall achievement of the desired situations can be considered as positive impacts of the policies on beneficiaries. The analysis on availability is conducted in quantitative study and affordability, comfort and reliability is derived from qualitative methods through surveys, interviews and case studies.

5.1.1. Results of the study on availability

Ulaanbaatar is divided into 9 administrative districts. All districts have *ger* households, however their share and distribution greatly varies from one district to another. Songinokhairkhan (Eastern) and Bayanzurkh (Western) districts have more than 40,000 households living in a *ger* area because of a stretched expansion of Ulaanbaatar due to rural to urban migration since 90s. 3 administrative districts, namely Nalaikh, Baganuur and Bagakhangai are satellite small towns built near coal mines and former army base, and located geographically distant from Ulaanbaatar. For example, Nalaikh is located 30 kilometers and Baganuur is located 120 kilometers far from Ulaanbaatar. In practice, due to distance of those districts from Ulaanbaatar, no specific air pollution policies were directed to those districts.

Specific policies on application of EEM and RE, such as cooking and heating stove replacement, construction of energy efficient houses and installation of solar panels and heaters did not require specific limitation to zonation. Table 5.1. shows assessment of application of SE options in all districts of Ulaanbaatar, shows availability and penetration of specific SE options, initiated by specific policy programs and projects for *ger* districts.

Table 5.1. Assessment of application of SE options in all districts of Ulaanbaatar

		Ger HHs		Application of EEM (stoves)		Application of EEM (energy efficient house)		Application of RE		Application of CF	
Districts	Total Number of HHs	*Number of HHs*	*% in total ger HHS*	Number of HHs	% in total *ger* HHS	Number of HHs	% in total *ger* HHS	Number of HHs	% in total *ger* HHS	Number of HHS	% in total *ger* HHS
Bayanzurkh	73,056	*47,661*	*65*	29,317	62	4	0	6	0	-	-
Songinokhairkhan	62,820	*45,231*	*72*	37,354	83	6	0	5	0	-	-
Chingeltei	36,856	*29,133*	*79*	24,622	85	18	0	8	0	-	-
Sukhbaatar	36,343	*20,045*	*55*	15,205	76	13	0	-	0	-	-
Khan-Uul	31,517	*18,490*	*59*	6,835	37	63	0	1	0	-	-
Bayangol	48,596	*12,028*	*25*	1,377	11	5	0	1	0	12,028	100
Nalaikh*	8,996	*6,798*	*76*	-	-	-	-	-	-	-	-
Baganuur*	7,570	*4,410*	*58*	-	-	-	-	-	-	-	-
Bagakhangai*	1,045	*433*	*41*	-	-	-	-	-	-	-	-
TOTAL	306,795	*184,229*	*60*	114,710	62	109	0	21	0	12,028	6.5

Note: * These districts are geographically located outside of lar*ger* Ulaanbaatar area, in distance of 40-150 kilometers from Ulaanbaatar. Therefore they are not considered as being affected by seriously by urban air pollution.

Sources: Ulaanbaatar Air Quality Office, 2013, BEEP Mongolia Project, 2013, MCA Clean Air Project, 2013, National Renewable Energy Center, 2013

A wide range of commercial SE solutions and products are available in the market, such as solar panels, small-size wind turbines, felt and woolen house insulation, energy-efficient electric heaters and etc. However, there is a limitation of research for those options as there is mixed clientele, including rural households, apartment residents who use those options in their summer houses outside Ulaanbaatar, small scale commercial enterprises and *ger district* households. Thus, it is not possible to directly link their impacts on reduction of air pollution in Ulaanbaatar.

EEM

Replacement of stoves was implemented and subsidized by a number of institutions, including the Government Clean Air Foundation, MCA and WB. The policy created a strong institutional base at each sub-district and engaged sub-district administrative staff and social workers to promote purchase and installment of new stoves. The stoves were available in three different sizes (Ulzii (meaning in English - Blessing), Khas (Jasper) and Dul (Flame)) and in different prices (subsidized prices of 27,000MNT (19.3US$) for Ulzii, 57,700MNT (41.2 US$) for Khas and 28,300MNT (20.2US$) for Dul).

The replacement of stoves reached as high as 83 to 86 % in key districts. In spite of being a voluntary regulation, the success of high application may be linked to other desired situation criteria, such as affordability and reliability. The program is continued being supported by the Government and donors and aims to reach full coverage of *ger* households through mandatory requirements in some areas.

The BEEP energy-efficient houses action plan started in April 2009 with the goal of reducing the annual growth rate of GHG emissions through transformation of the Mongolian buildings market to provide with more energy efficient energy building technologies and services, sustainable private house insulation and energy efficiency financing mechanisms. Construction of subsidized energy-efficient houses is targeted in 6 main districts only with no indication of financial ceiling for the program. In total 109 energy-efficient houses were built, of which 60 % were located in the Khan-Uul district, which is comparatively well-off district. 15% of the households that constructed energy-efficient houses were surveyed and 31% moved from *gers*, 13% were before rented, 44% old detached house and rest lived either with parents or relatives.

RE

Ulaanbaatar has high potential in solar energy. The city experiences on average 250 days (2791.5 hours) of clear sun and on average there is 156.4 hours of sun in December and 299.3 hours of sun in May. Ulaanbaatar Air Quality Office and National Renewable Energy Center initiated a demonstration project program to install solar vacuum collectors for heating purposes. The technology was installed in 21 households in 6 different *ger* districts by end of 2011, out of which 15 were financed by the Air Quality office of Ulaanbaatar, and 6 were financed by NREC. The technologies were imported from China and were installed and maintained by a local company. Even though no limitation on area and zonation was set, specific criteria were defined, such as size of house to be less than 60m^2, suitable location of houses for solar sources, acceptable heat losses.

CF

Application of CF is limited to one district, which is close to central Ulaanbaatar – Bayangol district. Only one fourth of residents of the district are residing in *ger* districts. In April 2011, a joint decree by Minister of Nature and Tourism and Mayor of Ulaanbaatar governed prohibition of use of raw coal in specific locations of Bayangol district. Traditional raw coal and wood has been replaced with coal briquettes and coking coal. These cleaner fuels are available to other districts too, but the residents do not benefit from the subsidy. The improved fuel is produced by 10 small and medium sized companies with annual production of 8,000 tons of improved sawdust and coal briquettes. However, the current production cannot meet overall demand of Bayangol district *ger* residents, which is estimated around 20,000tons.[15]

Other types of clean fuels, such as imported natural gas is available in Mongolia. However, due to poor infrastructure, lower maintenance and high cost of liquefied natural gas (LNG), it is not widely used in Mongolia. Mongolia imported 15,920m^3 of LNG in 2011 and 33,375m^3 of LNG in 2012. The majority of LNG users in Ulaanbaatar are Korean Hyundai cars that are primarily used in the taxi industry.

5.1.2. Results of the study on affordability

The rapid growth of the Ulaanbaatar population is to a large extent related to urbanization and migration of the poor section of rural households to *ger districts* of Ulaanbaatar. Poor regulations on land allotment and ownership in outskirts of city, unplanned infrastructure development in early years of transition after the 1990s led to a three- to fourfold increase of *ger districts* sizes. A number of studies concluded that the majority of households living in *ger areas* are either at medium and lower income levels and average household income is twice lower than those living in the city center. Present report by a leading property company in Mongolia, estimated that an average household income in *ger* areas stand at around 470,000MNT (US$338) per month or 5,640,000MNT (US$4,030) per Annum and possessing property, including *ger* and buildings, estimated at around US$13,000 and liquid assets at just US$935.[16]

In terms of baseline energy costs for households in *ger* district, it greatly varies based on number of individuals in a household, size of *ger* and building and using pattern of energy. On average a typical five-wall *ger* is estimated to be 28m^2 and average number of individuals living in a *ger* is from 4 to 5. In terms of detached houses in *ger* districts, the majority or 70 % of the detached houses has floor space of more or less than 42m^2. Average number of residents in a single house is same as *gers* (4.4)[17].

A World Bank survey noted that on average, households used 4.19 tons of raw coal and wood from September till April of next year.[18] The Municipality Air Quality Office estimated that on average, a household living in a *ger* uses 3.88 tons of coal, a household in detached house use 4.84 tons of raw coal per year and spends 81,544 MNT (US$58) per month and households in detached houses spend 83,731 MNT (US$60) per month for purchasing coal for heating purposes. According to this estimate,

[15]Author's estimation from calculations, Ulaanbaatar Air Quality Office Annual Report, 2013
[16]National Statistical Office, Household Income and Employment Survey, 2008 and 2012; and MAD Mongolia Real Estate Report, August 2013
[17] Mongolia, Heating in Poor, Peri-Urban *Ger* Areas of Ulaanbaatar, World Bank, Asia Sustainable and Alternative Energy Program, 2009
[18] Idem.

around 30-20% of total household income is spent on heating needs without taking into account the use of electricity.[19]

EEM

The price for a traditional stove ranges between 50,000 and 150,000 MNT (US$35-US$105), including chimneys. In a *ger* setting, stove and chimneys are placed in the middle and are required to heat the *ger* evenly. As described in chapter 4, the replacement of stoves was initiated to reduce the indoor and outdoor emissions by 80-90% and reduction of fuel use by 30%.

The policy introduced three different types of improved stoves, namely Ulzii (Blessing), Khas (Jasper) and Dul (Flame). The actual price of the Ulzii stove is 357,720 MNT (US$255), the price for the Khas stove is 484,560 MNT (US$350), and the price for the Dul stove is 383,767 MNT (US$275). Considering actual prices of improved stoves against the price of traditional stoves and household income, it is unlikely that the stoves would be sold without a subsidy.

Table 5.2. Subsidy scheme of the improved stoves under Clean Air Project, 2009-2013

From Table 5.2. the subsidy scheme of the improved stoves, it is very clear that the replacement cost of stoves is extremely affordable, paying around 7.4 to 12.0 % of the actual fee. The households in *ger* districts are entitled to only one stove at a subsidized fee. Comparing to household income, the cost of replacement is only 6 to 13%. As the program is initiated with support from the US-funded MCA

		Types of improved stoves					
		Ulzii - Blessing		Khas-Jasper		Dul-Flame	
		MNT (US$)	%	MNT (US$)	%	MNT (US$)	%
1	Actual price	357,720 (255)	100.0	484,560 (350)	100.0	383,767 (275)	100.0
2	*"Clean Air" project subsidy*	*279,000 (200)*	*78.0*	*223,600 (160)*	*46.1*	*244,100 (175)*	*63.6*
3	*Government subsidy*	*51,220 (35)*	*14.3*	*203,260 (145)*	*41.9*	*111,367 (80)*	*29.0*
4	**Client's end price**	**27,500 (20)**	**7.7**	**57,700 (45)**	**12.0**	**28,300 (20)**	**7.4**

grant project, there is no clear indication how the subsidy scheme and client's end price was actually agreed upon. During 2008, when the program is initiated, the cost of traditional stove was around 35,000 MNT (25 US$). Setting the prices below the traditional stove price might be a good (economic) reason to motivate *ger district* households to replace their stoves.

Four types of pre-designed energy-efficient houses were constructed in different materials of brick, wood, concrete and magnesite and sizing from 34.58 to 63.42 m^2. The cost for construction of the

[19] Mongolia, Heating in Poor, Peri-Urban Ger Areas of Ulaanbaatar, World Bank, Asia Sustainable and Alternative Energy Program, 2009

houses ranged for 22 to 35 Mln. MNT (US$15,000 to US$24,100). A subsidy of 5 Mln. MNT (US$3,500) is provided to households who contracted under the BEEP to construct an energy-efficient house. The program was complemented with long-term mortgage loans, provided by a commercial Khasbank. The loan requires front payment of at least 30 %, which is 6.6 Mln. MNT to 10.5 Mln. MNT (US$4,700 to US$7,500).

The price of standard *gers*, ranges from US$1,500 to US$2,000, based on size of walls. There is a large difference between *ger* and energy-efficient house in terms of security, heating, comfort and cost of living. The key difference is that houses have windows, which allows more light and passive solar heating.

The prices of energy-efficient houses are almost 10 times higher than prices of *gers*, but their size and structure is much stron*ger*, more durable, convenient and comfortable. A *ger* requires replacement of felt covers at least once in every 3-4 years, which require major maintenance frequently. BEEP aimed to lower the cost of energy-efficient houses at the lowest level. But due to energy-efficient aspects and local unavailability of construction materials and technology, the price is considered as the most suitable.

According to the survey conducted from 15 households that participated in the BEEP, the key challenge with affordability of the energy-efficient houses is availability of the long-term facilitated loan mechanisms. The current MNT loan rate is around 20-24 % per annum, which is comparatively high comparing to the international practice (US$ appreciation against MNT is in average 9-10 % per annum). In addition, bank loans are tied to collateral requirements other than the house constructed, which make it impossible for elders, disabled and poor people.

RE

Despite its good potential and abundant solar and wind resources, renewable energy options are comparatively expensive comparing to use of traditional fuel and electricity. Mongolia successfully implemented its “100,000 solar home” program in 2004-2008, targeting nomadic mobile rural households, that do not have an access to electricity at all. A similar approach could be targeted to urban *ger district*, but comparison of costs of renewable energy to coal fuel and electricity rates remain high.

From surveys conducted among 15 households, who installed a solar vacuum collector heating system (combination of solar energy collector and house heating system), the overall cost of the system were considered to be very expensive, unless subsidized. In NREC program, the cost of the system for a house in *ger district* of size of 50-60 m^2 was 7.5 Mln. MNT (US$5,350). This was comparatively expensive for households, which would require 8-10 years to recover its initial cost. The government supports a reduction of 50 % of night tariffs for electricity for households who installed the renewable energy systems. The NREC program was available to households with considerable subsidy sums of up to 70 % of the system’s actual cost.

The initial investment in installation of Solar Vacuum Collectors is very costly. The instalment costs depend on location, size and type of housing and heat loss percentage of the house. There are only two local producers of solar panels in Mongolia, and most solar panels are imported from *Ger*many, Switzerland, and China. The prices of solar panels differ by their capacity, and the countries in which the solar panels were produced. Not many *ger area* residents are able to afford the adoption of the technology.

CF

There has been a strong government effort to produce and switch to clean fuels. However, the clean fuel cannot be widely marketed due to limited infrastructure for production, marketing and distribution. Despite zoning requirements and strong demand by households, there is mismatch in terms of supply and demand, which makes market pricing for such products comparatively higher than traditionally used raw coal. Average market price of raw medium quality coal costs around 90,000-100,000 MNT per ton as of November 2013. The market price for improved fuels, such as cost for sawdust briquettes was 150,000 MNT per ton, for coal briquettes was 170,000 MNT per ton and for bulk semi-coking coal was 150,000 MNT in 2012. At the same time price for raw coal was 80,000 MNT per ton. This implies that improved or processed fuel costs as twice expensive as raw coal, which make it unviable to market it commercially. The cost for such fuels is unlikely to go down shortly due to insufficient production and supply.

In order to close the pricing gap, the Clean Air Foundation provided vouchers to households residing in the specific zonation (only Bayangol district *ger* zone), which allowed them to buy improved sawdust briquettes, semi-coking coal briquettes and bulk semi-coking coal with a subsidized fee of 10,000 MNT-30,000 MNT (US$7-US$21) per ton during 2011-2012 heating season and 60,000 MNT - 90,000 MNT (US$43-US$64) per ton during the 2012-2013 heating season.[20] However, households outside the zonation cannot benefit from this subsidy.

LNG remains an expensive option for families, as recent studies concluded that families using gas heating stoves spend 3.4 to 6.3 times more for fuel cost. There are different types of gas stoves available in the market made in Mongolia, Korea, Russia and China and average cost families spending for gas heating ranges from MNT 278,640 (US$200) to MNT 516,000 (US$370) per month.[21]

5.1.3. Results of the study on comfort setting

Comfort is defined as improved indoor air quality, cleanliness of options and fuel, steady temperature for the long run, compliance of new options, and technologies to standards of quality living. A number of studies concluded on negative impacts of the existing fuel, heating practice and air pollution on human health, which is directly linked to comfort too. From the survey conducted among *ger* households, it was revealed that the most common problems they encounter living in *gers* and detached houses is frequent fuelling of their stoves for heating and cooking purposes, regular exposure to indoor air pollution whenever fuelling the stove and time spent on procurement, transportation, storing and handling fuel.

EEM

The Air Quality Office of Ulaanbaatar in cooperation with the Clean Air Project conducted measurements in 135 sample households, who use a mix of traditional and improved stoves. 38 of the

[20] Ulaanbaatar Air Quality Office Annual Report, 2013
[21] World Bank Clean Air Project, 2013

households used their traditional stoves, 47 used Ulzii stove, 23 used Khas stove and 27 used Dul stove. After technical measurement it was concluded that CO emission was reduced by 16 % and PM2.5 emission was reduced by 63 % (Table 5.3.).

Table 5.3. Improvement in reduction of CO and $PM_{2.5}$ in the energy-efficient improved stoves

	Type of Stove	Sample	Average emission	Standard deviation	Difference	Reduction
CO (gr/kg coal)	Traditional	98	68.4	30.6		
	Energy-efficient	104	57.1	31.5	11.3	16 %
$PM_{2.5}$ (gr/kg coal)	Traditional	98	6.2	6.9		
	Energy-efficient	98	2.3	4.2	3.9	63%

Source: Air Quality Office of Ulaanbaatar, 2013

The result implies improvement in indoor and outdoor pollution, efficient use of fuel and improved comfort level among households. Another study conducted by the National Air Pollution Reduction Committee, measured that on average household in *ger* district consume 20 kg of raw coal per day for heating and cooking purposes. It was observed that on average Ulzii stove consume 14 kg, Khas stove consume 17 kg and Dul stove consume 16 kg of raw coal to meet the same heating and cooking needs of a household in a day.

This result was supported by the survey conducted among 16 households on comfort. With application and use of new energy-efficient stoves the frequency of fuelling of stoves is reduced. On average a household add fuels 2-3 times in fall and spring and 4-5 times in winter, depending on outdoor temperature and varying on size of stove and house. In qualitative survey, they responded the fuelling duration is extended.

In addition, the improved energy-efficient stoves are in compliant with the existing standards and cases related to safety and fire is less comparing to traditional stoves. There is no difference in terms of cleanliness due to no change in fuel type.

Energy efficient houses provide superior comfort comparing to traditional *ger.* An average size of energy efficient houses ranged from 35 to 63 m^2, 1.3 to 2.2 times greater than size of five-walled *ger,* which is 28 m^2. Another advantage is better energy efficiency of the houses. The terminal evaluation of the project and technical measurements showed the energy saving of households was increased as high as 50 %. A survey was conducted among 16 households; it concluded that it created an “alike an apartment” environment, with better lights due to windows, heat preservation due to separated chambers and saved their energy costs due to efficient heating system. However based on contractor’s quality, some houses had problems with proper ventilation and humidity.

RE

Renewable energy options, in our case SVC provide good indoor comfort opportunities. 15 households, who installed SVCs and participated in our survey, responded they benefitted from radically reduced indoor air pollution, supply of hot water for domestic use, cost efficiency due to combined energy source and improvement in living conditions.

Renewable energy provides clean and sustainable energy options for households and greatly improves its living standard. The respondents mentioned about health benefits, such as improved indoor air quality, sanitation and hygiene, related with provision of hot water for domestic use.

CF

There are a number of advantages in terms of comfort setting of cleaner fuel compared to traditional raw coal and wood. The national standard requires the cleaner fuel to have some characteristics, such as easiness to transport, load and store, durability, higher energy efficiency, reduced waste particulate amount, easiness to burn, no harmful odor and improved humidity.

Regarding sawdust briquettes, the amount to be used is the same as raw coal. However, energy efficiency is 1.3 times greater, humidity is 2-3 times lower and ash level is 2-5 times lower than the traditional coal. The PM, SO_2, NO_x and CO emissions were reduced from 2 to 4 times when compared to using raw coal.

Table 5.4. Comparison of PM, SO_2, NO_x and CO emissions among different types of fuel

No		Emission coefficient			
	Fuel type	PM (kg/ton)	SO_2 (kg/ton)	NO_x (kg/ton)	CO (kg/ton)
1	Traditional Nalaikh raw coal	4.4	1.2	1.1	58
2	Sawdust briquette	1.0	0.42	0.35	32
3	Semi-coke briquette	0.79	n/a	n/a	n/a

Source: JICA project measurement, March 2013

The World Bank ASTAE report (2009) mentioned that users of sawdust briquettes have different perceptions towards performance of the fuel. 40 % of respondents perceived sawdust briquettes burn longer, 60 % it has low heating value and half it is expensive.[22]

Gas is considered as the most clean conventional fuel and is widely used in Europe. As mentioned before, the use of gas fuel is rather limited in Mongolia. However, it was noted that it radically improves comfort level of households due to smokeless, waste less and without producing ashes. It saves time and does not require bulk transportation and fuelling. It improves indoor air quality. The only concern families responded was safety in using and storing the gas balloons. As it penetrated to

[22] Mongolia: heating in Poor, Peri-urban *Ger* Areas of Ulaanbaatar, Asia Sustainable and Alternative Energy Program, World Bank, October 2009. Pp 44

market recently, there is not much experience among households on properly maintaining use of gas fuel. Therefore, there is a need for further studies and programs to consider above aspects given the potential solutions of the gas for heating purpose.

5.1.4. Results of the study on reliability

The reliability can be measured by consistent performance of options and technologies, continued and regular supply of energy resources, up-to standard local repair and maintenance, and sustainability of Government support and financial incentives.

EEM

Replacement of stoves has high reliability when used and maintained according to its instructions. As the technology uses similar methods and same fuel as traditional stove, the majority of households does not require special skill and knowledge to fuel the stove. In addition, there has been a strong advocacy and information campaign on the use and maintenance of the stoves.

Over 120,000 stoves were marketed by 4 local companies, which import the stoves from China, Russia and Turkey. Only one type of the improved stove is locally produced. All companies have maintenance centers, which provide on average a guarantee of 1 year.

In terms of price, the cost of stoves range from MNT 350,000 (US$250) to MNT 500,000 (US$360). This may be attributed to recent technology and importing from other countries. Without government and donor subsidy, commercial sale of the stoves is unlikely. Thus, energy efficient stove does not have commercial sustainability without financial incentive mechanism from the Government.

Establishment of a local research and production facility for energy-efficient stove might be reliable long-term solution for the problem to reduce price and develop the technology. From the user side, there should be facilitated long-term loan mechanism, where the households can repay from their fuel savings.

Based on local contractors, design and materials used, energy-efficient houses have different guarantee periods. The BEEP evaluation report concluded there were different contractors involved, which had different quality of houses, despite similar size and design.

Energy efficient buildings are partially financed by the UNDP and MCA Clean Air Project. The BEEP project also proposed Khasbank to facilitate access to finance EE building approaches, technologies and systems by bringing the gap between EE supply and demand. Today Khasbank is dedicated to provide on-going “Eco mortgage product” of US$ 2 Mln. of its own funds for building EE loans with normal commercial interest rates and long duration periods. Furthermore, the GoM was discussing “Building EE incentives scheme”, but it has been in a stagnant situation until now. I think this kind of incentive scheme is very important for the building energy efficiency from the state. Otherwise, households will not be able to afford energy efficient homes.

RE

From a survey among 15 households, who installed SVC heating system, the majority of the respondents highlighted energy and time saving benefits of the technology. However, RE can be used as a parallel substitute of the existing system and requires high maintenance.

The existing renewable energy systems in Mongolia cannot fully provide 100 % reliable energy supply to households, but can provide as substitute and alternative energy for special duration. First of all, the solar energy collector cannot provide all heating demand during the coldest winter time. According to a study conducted on solar energy heat production, the technology could provide only 33% of required heating during January. Another problem is regular maintenance and cleaning. Due to dust and air pollution in Ulaanbaatar, solar panels need frequent cleaning. As dust particles radically decrease the capacity of sun light collection. Third, it requires basic skills and knowledge of electricity, such as reading the temperature board and regulating it accordingly and fixing basic electric connections.

In terms of maintenance and repair, there are number of local companies who provide good quality service at comparatively higher price.

The central government of Mongolia promotes the use of renewable energy among households by providing discounted night-time electricity tariffs up to 50% and have introduced renewable energy feed-in tariffs for local companies.

CF

Reliability on supply and pricing of cleaner fuel remains a problem. Despite strong demand at competitive market price, there are challenges in production and distribution. From the supplier side, use of sawdust briquette, coal briquette and semi-coke coal is highly seasonal and there is not strong demand in summer. In order to compensate seasonal variation in demand, the producers and suppliers are not willing to increase their capacity and charge much higher prices comparing to raw coal.

In terms of government support, the Municipality promotes use of cleaner fuels and plans to extend the zonation districts in line with production and supply capacity. In addition, the CAF provides facilitated loans and financial support to producers.

5.2. SE option and gap matrix

Based on quantitative and qualitative assessment of different SE options, the study aimed to define gaps between desired situation criteria with each option policy instruments. The gap is evaluated in three levels: High, Medium and Low. “No Gap” means the existing energy options and policy instruments fully or satisfactorily meets the desired situation criteria. “Medium Gap” means the existing energy options and policy instruments partially meet the desired situation criteria. “Strong Gap” means the existing energy options and policy instruments somehow or insufficiently meets the desired situation criteria. The table 5.5. shows the Gap matrix between the existing different policy instruments on SE options and desired situation criteria, such as availability, affordability, comfort setting and reliability.

Table 5.5. SE options and the desired situation criteria gap matrix

Desired situation criteria	EEM	RE	CF
Availability	No Gap	Medium Gap	Strong Gap
Affordability	Medium Gap	Strong Gap	Strong Gap
Comfort setting	Medium Gap	Medium Gap	Medium Gap
Reliability	Medium Gap	Strong Gap	Strong Gap

The gap assessment demonstrates there is a little gap for EEM policy instruments in terms of availability and affordability desired situation. There is partial satisfaction of EEM policy instruments for all desired situation criteria, except no gap in comfort setting. The RE policy instruments were assessed as 'moderate' in terms of availability and comfort setting, but were considered unsatisfactory in terms of affordability and reliability. Policy instruments on CF show the largest gap in terms of availability, affordability and reliability.

Based on these assessments of this Chapter, the following section provides a brief analysis on barriers to the application of the SE options in terms of widely used approaches on barriers for energy improvements.

5.3. Barriers to the application of the SE options

Various barriers to energy efficiency and renewable that may lead actors not to pursue the energy options were defined, such as technical, knowledge, economic, organizational, landlord-tenant and lack of interest barriers (Blok, 2006). The table 5.6. depicts the different barriers in adopting the SE options. The information provided in the table is analyzed through interviews on EEM and RE options and reports and literature related to CF options.

Table 5.6. Barriers for each SE options

Barriers	Technical	Knowledge	Economic	Organizational	Lack of interest
EEM	Low to Medium	Low	Medium to High	Medium	Low
RE	High	Low	Very High	Medium	High
CF	Low	Low	High	Low	Low

In terms of technical barriers, there are limited options for most of the producers and distributors, who are involved in policy implementation. For example, almost 90 % of 120,000 distributed improved stoves were made abroad and imported and sold at the subsidized rate. In terms of energy-efficient housing and renewable energy solutions, the majority of contractors rely on imported construction materials and spare parts. Thus, technical barriers exist for all options at the supply level. For households, now there are different technical options are available comparing ex-ante situation before the programs were undertaken. There are limited barriers to install, adopt and use these SE options.

There is few knowledge barriers among households in *ger* districts. All projects on EEM and RE had components on public information and advocacy and different types of media (TV, newspaper, internet, forums, local community meetings, SMS) were widely used to inform the target population.

Economic barrier remain the most critical barrier in adopting all SE options by households. All programs and projects on EEM (MCA, World Bank, CAF, BEEP), RE (NREC) and CF (CAF) used subsidy mechanisms. Without financial incentives and support, it is unlikely the program will be widely accepted by the households in *ger* districts.

There is little evidence of existing organizational barriers. Different actors, such as Government (President Office, the Cabinet, the Municipality), donors (UNDP, MCA, WB, ADB, JICA, EBRD and GiZ), private sector, including commercial banks (contractors, producers and service providers, Khasbank) and local community, all actively and collaboratively promote programs and projects.

There is no information on landlord and tenant barriers, as majority of *ger* households owns their land and property.

In many surveys, strong willingness of households to try and adopt new SE options was addressed. There are strong interests for all options, except for RE. Households are strongly aware of the benefit renewable energy technologies have, however they consider them (only) as future options due to high investment and maintenance costs.

Chapter 6. CONCLUSIONS AND RECOMMENDATIONS

This chapter aims to summarize and analyze an effectiveness of SE policy programs and projects: what worked well and what needs further attention and improvement. This will be deduced from the gap analysis made in the previous chapter and examine how to narrow the gaps identified. Finally, it will provide key recommendations to consider in formulation of the new policies on air pollution reduction in Ulaanbaatar.

6.1. Analysis on lessons learnt and best practices

In Mongolia, policy measures (2009-2013) aimed at reducing urban air pollution from *ger* areas, provided first ever learning-experience in dealing with impacts of household energy use for most of the policy makers if not all. In particularly, Ulaanbaatar has become the starting point for major stakeholders to exercise policy instruments to influence house owners in adopting sustainable energy options.

The key actors involved in practicing those policy measures were both governmental organizations and international donor organizations. The initial approach of government organizations was to provide legal and institutional framework in order to create enforcement mechanisms for laying the necessary ground works. The role of international organizations was important in implementing those policy instruments through sustainable energy programs and projects. Such initiatives provided a favourable conditions other stakeholders such as private sector, civil society and financial institutions to enter the joint efforts to realize Sustainable Energy (SE) programs at household level.

Based on gap matrix in Chapter 5, it can be concluded SE policy programs on EEM was successful fully and partially meeting the required “desired situation criteria” for *ger* households. Programs on RE and CF had biggest gap in meeting affordability and reliability criteria within the set of criteria.

The strongest points for SE policy programs can be summarized as the followings:

- Good planning of the programs with strong technical support from donors and other countries: EEM based on best practices experienced by donors before in other countries. Replacement of stoves was initiated under MCA Clean Air project and designed by international and local consultants. Energy efficient houses (EEM) projects were practiced in some Eastern European countries by UNDP.

- Strong coordination and implementation of the institutional mechanisms: EEM projects had dedicated Project Coordination Committees (PCC) and Project Implementation Unit (PIU), which regularly monitor and assess impact of the projects. PCCs and PIUs were crucial to maintain strong involvement and cooperation among different stakeholders, such as government officials, academic institutions, professionals such as designers, engineers; manufacturing companies and their associations, donors and agencies;

- Regular measurements of energy savings and dissemination of results: Despite limited technical and laboratory capacity, all programs and projects had very good measurement and direct reporting of results to target beneficiaries. For example, the stove replacement program achieved direct fuel saving of 3-6 kg of raw coal per day for households, while BEEP achieved to reduce energy consumption of houses from 200 kWhr/m^2 to 165kWhr/m^2.

The weakest points for SE policy programs can be summarized as the followings:

- Insufficiently structured and underdeveloped supply side: Despite good formulation and implementation of the SE programs, all SE policy programs faced challenges with supply side. Almost all technological inputs and materials, such as stoves, solar panels, insulation materials for EE construction and gas were imported from abroad. In addition, the local companies who produced cleaner fuel faced problems in producing and supplying the intended amount. Imported products and materials and shortage in supply impacted the cost of SE options.

- Limited sustainable financial mechanisms: The most critical component in all SE options is heavy subsidy from the government and donors, which amounted to 70-80 % in some cases. The mechanism is not sustainable and viable in the long run and its impact is limited to the program duration. In some programs, such as replacement of stoves, the impact can be longer linked to durability and use of stoves. Apart from BEEP (EEM), there was no facilitated long-term loan mechanism available for households.

- Lack of motivation and knowledge on long-term benefits of SE options: despite many programs having high advocacy and information sharing potentials, it is mostly directed to the actual program and its process rather than long-term benefits to households, such as health, social and financial benefits. This limits motivation for consumers to seek for alternative SE options at an added cost.

6.2. Recommendations on policy interventions

The gap analysis concluded strong points on motivation and information, but limited positive link in terms of balance of power. The following recommendations are made to

- Create sustainable financial support schemes in adopting energy-efficient systems apart from subsidy (investment in energy efficient houses and renewable energy) and link them with affordable financial mechanism available in the market, such as “8 % housing loan scheme”, valuation of land for loan collateral and etc.

- Reduce cost of energy-efficient products, technology, material and houses, by supporting manufacturers with facilitated loan, tax exemption, marketing and capacity building, and extending consumer base to avoid seasonal impact, for example in cleaner fuels.

- Extend size and duration of programs to achieve greater impact and cost saving through benefitting from carbon credit facilities.

- Focus on promotion of “energy saving habits” among *ger* households, such as improving insulation of the existing housing and *ger* stocks, replace energy.

- Link future SE programs with ongoing “*ger* district re-development” plans.
- In narrowing the gaps of SE, there is a need to pay more attention in extending RE and CF options as given their greater potentials for GHG emission and other pollutants’ reduction.

REFERENCES

1. Asian Development Bank (2009), Energy Policy, June 2009.
2. Bates, D.V. (1995), The Effects of Air Pollution on Children. *Environ Health Prospect, 103* (Suppl 6): 49–53, 1995
3. BEEP (2013), Terminal Evaluation Report, UNDP/GEF Project: Energy Efficiency in New Construction in the Residential and Commercial Buildings Sector in Mongolia (Building Energy Efficiency Project), MON/09/301, Dec 2013
4. Boyce, A., 1997. Introduction to Environmental Technology. s.l.: John Wiley & Sons, Inc.
5. Bressers, H. (2009). From public administration to policy networks: Contextual interaction analysis. In Nahrath, S., & Varone, F. (Eds.), *Rediscovering Public Law and Public Administration in Comparative Policy Analysis: Tribute to Peter Knoepfel.* Chapter 8.
6. Bressers, H., (2004) Implementing Sustainable Development: How to know what works, where, when and how. In Lafferty, W.M., *Governance for Sustainable Development: Challenge of Adapting Form to Function,* (pp.284-318), Michigan: Edward Elgar Publications.
7. CAF (2013), Clean Air Foundation website. Available: http://caf.mn/eng/index.php (Accessed 22 December 2013)
8. Caldieron, J.M. (2013), *Ger* Districts in Ulaanbaatar, Mongolia: Housing and Living Condition Surveys. *International Journal of Innovation and Applied Studies,* 4(2), pp.465-476
9. Coenen, F.H.J.M. (2013). *Evaluating Policy.* (Lecture in Introduction to Public Administration, MEEM Programme*)*, University of Twente.
10. Cowlin, S.S. et al, (2005), *Impact of Improved Stoves in Indoor Air Quality in Ulaanbaatar, Mongolia.* Ulaanbaatar. Energy Sector Management Assistance Program (ESMAP), World Bank
11. De Bruijn, T.J.N.M., Coenen, F.H.J.M., & Lulofs, K.R.D. (1996). Pollution prevention projects in the Netherlands. *J. Cleaner Production. Vol 4, No.1,* 41-53.
12. Faber, A., & Hoppe, T. (2013), Co-constructing a sustainable built environment in the Netherlands – Dynamics and opportunities in an environmental sectoral innovation system. *Energy Policy, 53*, 628-638.
13. Goldsmith, E. B. (1996), *Resource Management for Individuals and Families.* New York: West Publishing Company.
14. Groot-Markus, J.P. et al, (2006). Technology and household activities. In Verbeek and A. Slob (Eds.) *User Behavior and Technology Development: Shaping Sustainable Relations Between Consumers and Technologies.* Dordrecht: Springer. Chapter 4.
15. Guttikunda, S. (2007), *Urban Air Pollution Analysis for Ulaanbaatar,* World Bank Consultant Report, Washington: World Bank Healy, J.D. and J.P.Clinch (2004). *Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland*, Energy Policy, 32 (2), pp.207-20.
16. Hill, M. & Hupe, P. (2002),. *Implementing Public Policy: Governance in theory and Practice.* CA: SAGE
17. Hoppe, T. et al, (2013), Energy Efficiency in the Dutch Residential Sector: reflections on policy implementation, *Policy Quarterly, Volume 9, Issue 1, 9-15.,*
18. Hoppe, T., & Lulofs, K. (2011), *Project management and institutional complexity in domestic housing refurbishment with innovative energy solutions. A case study analysis.* Paper presented at the World Renewable Energy Congress 2011, Panel on Sustainable Cities and regions, May 8-11, 2011, Linköping.
19. Hoppe, T., Bressers, H., & Lulofs, K. (2012), The Practice of Innovative Systems Diffusion in Neighborhood Renovation Projects: A Comparison of 11 Cases in the Netherlands. In Vazquez-Brust, D.A & Sarkis, J. (Eds.), *Green growth: Managing the Transition to Sustainable Economy,* (pp. 265-85). Dordrecht: Springer Science + Business Media.

20. Hoppe, T., Bressers, J. Th., & Lulofs, K.R.D. (2011), Local government influence on energy conservation ambitions in existing housing sites – Plucking the low-hanging fruit? *Energy Policy, 39,* 916-925.
21. Hoppe, T. (2012), Adoption of innovative energy systems in social housing: lessons from eight large-scale renovation projects in the Netherlands, Energy Policy, 51, 791-801.
22. Kohn, M. (2013), *Severely Polluted Mongolia Tries a Cleaner Power Source*, New York Times, 2012
23. Kornelis Blok, K. (2006), Introduction to Energy Analysis. Amsterdam: Techne Press.
24. Larson, B.A., & Rosen, S. (2002), Understanding household demand for indoor air pollution control in developing countries. *Social Science & Medicine, 55,* 571-584.
25. Lulofs, K.R.D. (2013), *Policy: Its background and structure.* (Lecture in Introduction to Public Administration, MEEM Programme*)*, University of Twente. MAD (2013) Mongolia Real Estate Report
26. MAQO (2013), Municipality Air Quality Office website. Available: http://www.airquality.ub.gov.mn/ (Accessed 15 November 2013)
27. MAQO (2013), *Report on air quality and activities undertaken to reduce air pollution in Ulaanbaatar city.* Ulaanbaatar: Municipality of Ulaanbaatar. (In Mongolian)
28. MCA (2013), Millennium Challenge Account Project Website. Available: http://www.mca.mn/index.php?option=news&parent=91&id=425&task=detail (Accessed 08 October 2013)
29. Milne G. and B.Boardman (2000), *Making cold homes warmer: the effect of energy efficiency improvements in low-income homes,* Energy Policy, 28(6), pp. 411-24.
30. National Statistical Office (2008), Household Income and Employment Survey
31. National Statistical Office (2012), Household Income and Employment Survey and
32. NCRAP (2013), National Committee on Reduction of Air Pollution website. Available: http://air.president.mn/ (Accessed 25 October 2013)
33. NCRAP (2013), *NCARP report: yesterday – dangerous polluted air, today – right solution and collaboration, tomorrow – clean air and healthy living.* Ulaanbaatar: NCARP (In Mongolian)
34. Nijkamp, P., and Perrels, A. (1994). *Sustainable cities in Europe. A comparative analysis of urban energy-environmental policies*. London: Earthscan
35. NSO (2013), National Statistical Office of Mongolia website. Available: http://www.nso.mn/ (Accessed 7 January 2014)
36. O'Toole, L. (2004). *The Theory-Practice Issue in Policy Implementation Research*. Public Administration 82(2): 309–329.
37. Reddy A K N (2000), *Energy and Social Issues in "World Energy Assessment",* UNDP, New York.
38. Research Center of the Parliament Office of Mongolia (2013), *Analysis on efficiency of air pollution reduction measures and its impact on human health,* Ulaanbaatar: Parliament of Mongolia. (In Mongolian)
39. Sambo, A.S. (1997). *Energy Options for Sustainable National Development: Resources, Issues, and the Position of Renewable Energy Technologies.* University Inaugural Lecture Delivered on 17th January, 1996 at Abubakar Tafawa Balewa University, Bauchi.
40. Spijkers-Zwart, S.I. De huishouding (1973), *Een oriënterende studie naar de toepasbaarheid van concepten en theorieën in niet-westerse samenlevingen.* Landbouwhogeschool, Huishoudkunde, Publicatie no. 1, Wageningen
41. Tester, J. W. et al, (2005). *Sustainable Energy: Choosing Among Options*. Cambridge, MA: MIT Press
42. UNDP (2007), Energy Efficiency in New Construction in the Residential and Commercial Buildings Sector in Mongolia, Project Document. Ulaanbaatar
43. van Bueren, E.M. (2009) *Greening Governance: An evolutionary approach to policy making for a sustainable built environment,* Ph.D. thesis. Delft University of Technology.
44. Verbeek and A. Slob (Eds.) (2006). *User Behavior and Technology Development: Shaping Sustainable Relations Between Consumers and Technologies*. Dordrecht: Springer.

45. Verschuren, P & Doorewaard, H. (2010). *Designing a Research Project.* The Hague: Eleven International Printing.
46. Waals, J.V.D. (2001). CO2 Reduction in Housing: Experiences in building and urban renewal projects in the Netherlands, *Energy Policy, 2001, pp none.*
47. Wilkinson P, Smith KR, Beevers, Tonne C, Oreszcayn T (2007). *Energy, energy efficiency, and the built environment*, Series on Energy and Health #4. Lancet: 42–54.
48. World Bank (2009), *Discussion paper: Ulaanbaatar Air Pollution – Research Work on Efficiency of Air Reduction Measures,* presented in Air Pollution Reduction Forum, December 2009. Ulaanbaatar. (In Mongolian)
49. World Bank (2009), Mongolia, Heating in Poor, Peri-Urban Ger Areas of Ulaanbaatar, Asia Sustainable and Alternative Energy Program (ASTAE)
50. World Bank (2011), *Air Quality Analysis of Ulaanbaatar: Improving Air Quality to Reduce Health Impacts.*
51. WHO (2010), Survey on Outdoor Air Quality, http://www.who.int/phe/health_topics/outdoorair/databases/en/ (Accessed 25 October 2013)
52. Wu, K., Usukh, B., & Tsevegjav, B. (2009). Energy Cooperation in Northeast Asia: Role of Mongolia. *Ritsumeikan Journal of Asia Pacific Studies (RJAPS),* 26, 83-98.
53. Zuidberg, A.C.L., (1981). *Het verzorgingsniveau van huishoudens*, 4, 's Gravenhage (SWOKA).

APPENDIXES

Appendix 1. Assessment of Policy Options by World Bank
Appendix 2. Survey Report – Solar Vacuum Collectors (RE option)
Appendix 3. Site visit (RE option)
Appendix 4. Interview – BEEP (EEM option)
Appendix 5. Interview – NREC (RE option)
Appendix 6. Interview – MCA EEP (EEM option)

Appendix 1. Assessment of Policy Options by World Bank

Previous work done prior to 2008 on the assessment of relevant interventions provided in the Urban Air Pollution Analysis Report by World Bank in 2007.

Table 3.1. Level of Impact of interventions on air quality in Ulaanbaatar

Intervention	**Status**	**Impact on air quality**	**Comments**
PM monitoring	Current capacity to monitor PM pollution in the city is low. Programs in place to setup seven new stations and to conduct source apportionment study for further analysis by National University of Mongolia.	Low: Enhances the Institutional capacity of air quality division in identifying the pollution hot spots.	Air quality monitoring is essential to evaluate the impact of air pollution reduction measures.
Public awareness	Media, public, and political demands. There is increased awareness in the local media for air pollution	Low: Enhances institutional capacity for regulation and enforcement.	An essential part of the campaign to promote energy efficiency at the household and industrial level.
Improved cookstoves	Pilot program to promote improved stoves is under implementation. A total of 20,000 improved stoves were distributed with 50 percent subsidy (GEF, 2000). Programs are in place for scaling up and introducing new and improved stoves.	High: This intervention is expected to have an immediate impact on ground level concentrations. Full conversion is estimated to reduce ~11,000 tons of total PM_{10}emissions or ~9 percent from business as usual in 2010.	Cooking stoves are a low lying source and contribute significantly to indoor and outdoor air pollution, especially in the winter months. Also impact of black carbon or soot due to inefficient coal combustion in stoves and efforts are underway to received financial support under clean development mechanism.
Fuel substitution - briquettes	Private and small scale projects are in place producing charcoal briquettes using sawdust. Among the scale-up programs, three programs are in place for production of 300,000 tons a year coal fired briquettes.	High: Upon full implementation, clean coal technology briquettes for cooking stoves and industrial HoBs is expected to have high impact on ambient PM. Full conversion is estimated to reduce ~12,500 tons of total PM_{10} emissions or ~10 percent from business as usual in 2010.	This intervention has the largest impact among the cookstoves and HoBs, for not only emissions are reduced from scattered low-lying sources, but also a single point source offering better control options.

Source: Urban Air Pollution Analysis Report by World Bank in 2007

Pollution control at power plants	Only CHP-4 is using ESP at 95 percent PM capture efficiency. One of the clean coal briquette manufacturing plant is planned at the power plants for efficient production and pollution control.	High: Although this is an elevated source and doesn't contribute as much as low-lying sources to ambient levels, it is still the largest emitter in the vicinity. Implementation of ESP for other and new power plants will result in 10-20 percent of ambient PM concentrations. Estimated reductions are ~21,500 tons or ~20% of the 2010 BAU.	Technology for ESPs and FGDs is mature and available internationally at efficiencies higher than 95 percent.
Garbage collection	Limited program in place with substantial amount being burnt in-situ	Medium: Impact of this intervention on air quality is immediate, but small in proportion.	This requires institutional set-up for garbage collection and landfill management.
Liquefied petroleum gas	Half of official taxis are converted to LPG.	Low: Conversion of a larger fleet in the next decade will have significant impact on air quality.	This intervention needs pricing and supply reforms, to make it more widely available. Can be costly to low-income households and high-volume commercial users. Most readily option to replace coal in cooking in the housing sector.
Controlling fugitive dust on paved and unpaved roads	Manual sweeping on the main corridors in the center of the city are in place.	Medium: A larger intervention for capture of fugitive dust via wet sweeping and conversion of a large section of unpaved roads to paved roads will have the largest impact in the Ger areas.	This intervention is expected to reduce spring and summer time on-road fugitive source. Heavy-duty vehicles for this purpose are available internationally.
Going to unleaded gasoline	There is no testing facility for lead in gasoline.	High: Reduction in lead content in ambient air.	Gasoline is imported and city lacks testing facilities to check lead content in gasoline. This intervention requires a strong resolution to import unleaded gasoline only.
Energy efficiency at	A large of old technology boilers are in use operating at 40-50 percent efficiency.	High: Improving efficiency of existing boilers, replacement	Nearly 800 small boilers are operated in the city for heating purposes. This intervention can reduce

heat only boilers		of old heating boilers or connecting to new centralized district heating facilities, will have an immediate 30-40 percent reduction in HoBs contribution to ambient air pollution.	dispersed pollution by abolishing small scale boilers and upgrading them to district heating system. Increased demand for district heating is expected increase the coal consumption at power plants.
Solar water heating systems for new housing complexes	No known activity in place.	No activity: Impact on air quality will be immediate due to reduction in demand of district heating when possible. Since Ulaanbaatar experiences on average 250 days of sunlight, this is a likely intervention for new housing complexes.	This is an expensive and a possible short term intervention. With the new 40,000 housing system in plan, the solar water heating can reduce the load on district heating system and power plants. Technology is available internationally.
Gasification of urban solid waste	Small scale projects in place using livestock waste.	No activity: Impact on air quality is small compared to other sources in place, but a good in-situ source of energy, improving household and industrial efficiency.	In combination with garbage and solid waste management, can supply for small scale energy needs and heating. Technology is well documented and available internationally.
Ash ponds at power plants	No known activity in place.	No activity: This intervention is expected to reduce spring and summer time fugitive source out of power plants ash ponds. This is a very uncertain source dependant on meteorological conditions.	Technology for using fly ash to make bricks and construction material is well studied and available internationally (TIFAC, 2005).
Bus rapid transport	A feasibility study of allowing bus rapid transport is underway.	No Activity: Fleet is small and their effect may be counteracted by growth in the passenger vehicles and barriers.	This intervention needs further institutional setup and lacks policy frameworks for inspection and maintenance for buses.

Note: High indication indicates immediate and large reductions; Medium indicates moderate and sporadic reductions; Low indicates less or non-direct reductions in air quality

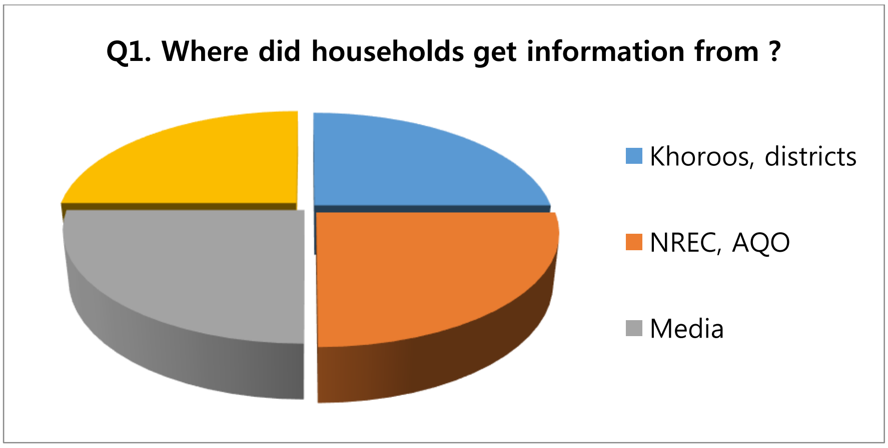
Appendix 2. Survey Report – Solar Vacuum Collectors (RE option)

The National Renewable Energy Center (NREC) works to introduce sustainable development principles to Mongolia; achieve the goals of the Renewable Energy National Program; complete a detailed study on renewable energy resources and utilization; introduce new renewable energy technologies in Mongolia; undertake research on introducing new technology suitable to the special features of Mongolia's climate; implement projects, programs and surveys throughout the country; and develop Mongolia's technical capacity.

The main goals of the center's activities are sustainable development principles of Mongolia; to achieve the goals of the Renewable Energy National Program; to do detailed study on renewable energy resources and utilization; to introduce new technology of renewable energy; to carry out research on introducing new technology that is suitable to the special feature of our climate; implement projects, programs and measurements over the whole country and to put technical control. The center carry out activities with two main divisions: Research & Business Development and Production & Technology. Recently we employ 49 staffs. The center's R&BD division conducts research works on study, production, testing, consumption of renewable energy - solar, wind, geothermal, and new energy source and CDM. We employ highly educated and skilled staffs: 2 doctors, 1 consultant engineer of renewable energy, 9 masters and 8 bachelors. The Center's Production & Technology division has PV factory, and Technical Drawing and Controlling group.

The solar energy production is under investigation and research. At domestic level, the NREC in cooperation with Air Quality Office of Ulaanbaatar city have started to pilot Vacuum Solar Energy Collector for domestic heating purposes and installed the technology in 21 households in 6 different ger districts of the city in the end of 2011, out of which 15 of them were financed by the Air Quality Office of Ulaanbaatar city and 6 were financed by the NREC. The technologies were imported from China which is distributed by a local Solar House LLC. Now, we are conducting studies to evaluate the impact of the technology, to assess its economic and other characteristics, to see whether it is economically efficient and feasible in domestic use. It is again difficult to estimate its efficiency in general, because it is calculate differently in each cases depending on many different indicators and characteristics of houses. 12 of these households (57%) were randomly selected for interview.

According to survey Q1, households have received information on solar panels from different sources.



Q2. The overall family size varies between 3 and 5 persons per household. (3-2; 4-5; 5-5)

Q3. The following requirements were set for the households to apply Solar Energy Heating Collector:

- Size of the house (less than $60m^2$) - 9
- Location of the house - 3
- Heat loss percentage (minimum) - 8
- Down payment – 30% - 7
- Heating radiator and connection - 2
- Good electricity capacity and network – 1

Q4. How many days did it require to install the solar collector?

2-3 days – 3

A week - 4

More than a week – 2

Q5. Household's previous heating situation:

Indoor brick stove – 5 – 42%

Boiler – 5 – 42%

Electric heating (floor) – 1 – 8%

Усан халаалт isn't it НДЗ? – 1 – 8%

Q6. Do the household use other heating aside from Solar Vacuum Collector?

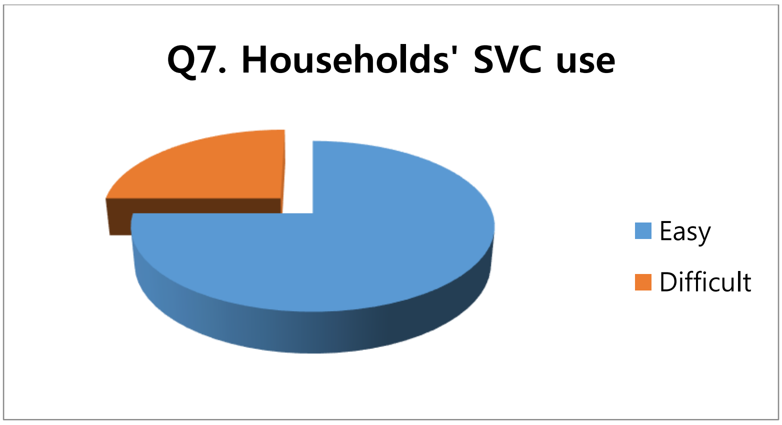
No, SVC provides 100% heating – 2 – 17%

Stove – 5 – 42%

Electric heating – 4 – 33%

Boiler – 1 – 8%

Q7. According to the households' experience in using SVC, is it easy or difficult to use the SVC technology for heating their homes?



Some of the households reported that it is complicated to use the technology as it requires additional devices to run properly. They contact the supplier company for help and services. But overall households (75%) report that Supplier Company provides adequate guidance and instruction on how to use the technology.

The following two tables show households satisfaction in using SVC for heating their homes.

Q8. What are the advantages households benefit from while using SVC?	Percent
Domestic conditions improved (less indoor air pollution, hot water for domestic use)	100%
Cost efficiency (electricity and fuel consumption costs less than before installing solar collector)	33%
No cost efficiency (electricity and fuel consumption costs more than before installing solar collector), but satisfied with the improvement in living conditions	50%
Saves time	25%

Q9. What are the disadvantages households experience in using SVC?	Percent
Unsafe maintenance operations required (cleaning, covering in the night, unsafe conditions in case of hail storm and other natural conditions, etc)	25%
Helplessness in case of power cut	33%
Incapability to provide 100% heating in the coldest months of winters	17%
High electricity cost	33%

Q10. Households overall attitude toward SVC technology was positive, and they highlight its significant contribution to air pollution reduction in Ulaanbaatar city. But many of the respondents have emphasized on two major challenges in installing SVC for other households in ger areas: high installation cost (42%) and high electricity consumption cost (42%).

Appendix 3. Site visit and Interview Report for the Solar Collector Households

A day site visit to *ger* households who agreed to install Solar collectors was conducted in cooperation with the Air Quality Management Unit of Ulaanbaatar City Government on 27 December, 2013. The purpose of the visit was to check the functionality of the installed solar collectors in housing site and hear from family members on their experiences related to using the new technology. The site visit covered 5 families out of total 15 families and some of the photos from the visit were provided as follows.

Prior to this site visit a phone survey was conducted from 12 households, a background information about RE and the results of the household interview is compiled with the household survey in the appendix-3 of this report.

In addition to the site visit the following experts were interviewed in relation to the programme on RE:

Ms. N.Nasanjargal (hereinafter will be noted as N)

Officer in charge of Renewable Energy, Air Quality Management Unit of Ulaanbaatar City Government

Mr. Enkhtuvshin (hereinafter will be noted as E)

Vice president of the "Solar House, Co. Ltd.," commissioned company, which was responsible in installing solar collectors in 15 houses in *ger* districts.

Q1. As you mentioned there are in total 21 households selected in your demonstration project for implementation of Solar Collector Systems in Ulaanbaatar ger districts. Could you please describe me how these families were selected and what were the key criteria for selection of the houses?

N: I think I should clarify one thing, as I mentioned before, installation of solar collectors implemented by two companies where they shared 15 and 6 houses respectively making in total 21. So, this site visit that we are now is part 15 houses.

Regarding the information dissemination, first we provided our announcement through officials who work at *ger* districts. They organized a campaign event on air pollution reduction measures in each district where households received initial information and relevant criteria. The basic criteria we provided to households were related to the roof direction of the houses and overall efficiency of the houses that should meet the minimum efficiency requirements.

E: Also, since it was our first project, we planned to locate solar collectors in as many districts as possible rather than concentrating in one district. Therefore, as you can see our household locations are spread in various locations of highly polluted districts such as Songino-Khairkhan, Chingeltei and Bayanzurkh regardless of their remote distance.

Q2. How you organized the process of installment of those solar technologies in selected household? When installment started and when it completed?

E: In our case our company selected in the bidding to provide solar collectors in 15 households. We started in November 2012 and completed our installment in next year December.

We were divided into three groups when installing our technologies. Some installment processes were not only dependent on ourselves, because some families were not available sometimes and also there was delay in supply of equipment spare parts occurred.

Q3. What kind of advantages do the households with solar technologies have in comparison to other households?

N: There is already discounted electricity night tariff (50%) for ger households. In addition those households with solar technology can have benefits of another 50% discount from their electricity bill?)

Q4. Other than the current solar technologies that are in place in ger districts, does AQMU relevant plans of implementing other types of renewables to solve ger districts heating needs in winter?

N: Apart from households, we plan to install combination of solar water heaters and solar collectors in in sub district (khoroo) no 7 building and other authority buildings of other districts. In terms of other technologies other than solar collector, there was a company (Steppe Solaire) that installed such as geothermal heating facility in Sod kindergarden building (ali dyyrgiin xeddygeer tsesterleg) couple of years ago (yag xeden on gedgiig n medex yy**)** and it was very costly. So we came to the conclusion that at the moment installing other renewables could be very costly for households since they are small and separated units because separately their energy consumption is low and pay back period will be very long.

Also, so far, we haven't conducted any cost benefits analysis yet. We would like to do one such study in the future.

Q5. What is the market price for purchasing the average solar collector? According to your estimation, can you provide an approximate payback period?

E: In general, the estimation can be made per squire floor area (1 m^2 = 150.000 MNT-. In a building that range 50-60 m^2 area is about 7.5 million MNT. (1USD=1700MNT)

Q6. When these solar collectors are made? And how does your company manage assembly, operation and maintenance of the equipments?

E: The technology is originated from Germany, but they are made in China. In terms of operation and maintenance of equipments, we provide one year guarantee to households.

Q7. Since its installment in households, what kind of knowledge and skills do they need to operate the system?

Upon installment, we provide brief manual and guidance how to operate the technology. The most important skill is to learn reading the board that shows the temperature range.

Some families have no difficulties but some families do not follow relevant instructions from our experiences. So it really depends on household's willingness of learning and adopting that technology in their homes.

Q8. It has been a year since you provided services to households, could you please provide difficulties and challenges that you experienced during this period?

N: Unlike apartments, working with ger districts are the most difficult challenges. For example, finding a location of certain house is very difficult. For our independent auditing team it took so much time and effort to cover all the families as they are scattered around different districts.

E: Yes, that was challenging for us too. When there is a problem we receive a call and have visit the family and to check the problem. Sometimes, just for minor problem we have to travel long distance. So, our operation expenses (e.g. travelling by car) are very high.

Appendix 4. Interview – Building Energy Efficiency Project (EEM option)

B.Munkhbayar – Project Coordinator of BEEP project
Interview date, place: June 27, 2013 & January 16, 2014, University of Science and Technology

1. **We understand that the most important achievement of BEEP project is development and update of BCNSs. Could you tell us about the development, update and approval procedure of BCNSs?**

In the implementation of BEEP project, we developed 6 mandatory building norms, 1 voluntary energy efficiency guidelines, 2 recommendations, and 58 new energy efficiency mandatory standards. The Mongolian National Center for Standardization and Metrology is responsible for the implementation, application, monitoring and reporting system of these BNCSs. The norms are developed and approved by Professional and Scientific Technical Committee of the Ministry of Construction and Urban Development. And the technical committee develops the standards proposals and the Construction Development Committee, further, National Standard Committee of National Center for Standardization and Metrology approve them. These norms and standards are put effective by the Decree of the Minister of Construction and Urban Development. These committees usually consists of about 10-20 member representatives of different types of government agencies and scientific and technical institutions.

2. **Please share your thoughts on compliance mechanism of construction requirements and BCNS in Mongolian construction sector before and after the BEEP project.**

Mongolia's system of building control, based on the former Soviet Union's system of building energy efficiency Norms, Regulations and Standards from the 1960-70's is very outdated and excessively complicated. The BCNS energy efficiency requirements also largely referred to socialist period construction methods and materials that are no longer used. Hence, the project focused to remove barriers identified to the widespread adoption of energy efficient technologies and practices in buildings through the development and implementation of updated mandatory energy efficiency measures for the large numbers of new apartment and commercial buildings, and private houses that are being built and that are included in the current formal "construction" sector where around 40% of urban Mongolians live, and where there is an existing BCNS enforcement system in place that can be used as the basis to effectively implement the measures; and also developing updated, more stringent, and more accessible voluntary energy efficient guidance for the rapidly growing number of houses where 35% of urban Mongolians now live in urban ger areas, and which will over time be gradually covered by the Mongolian mandatory BCNS system. With the above mentioned new energy efficiency BCNS, the state, specially the body in charge which is the National Center for Standardization and Metrology needed to build capacity and strengthen its enforcement system. We have trained and provided technical support to construction sector stakeholders, testing and certification bodies and providers, designers, specifiers, construction companies, and building owners and tenants. We have also established 4 Energy Conservation Centers (ECC) in Ulaanbaatar city and provided them with necessary tools and equipment to test and certify thermal resistance and conducted relevant trainings. Furthermore, the compliance mechanism requires constant attention until its regular operations.

3. **In the terminal evaluation report of BEEP project it has been mentioned that all building drawings and design need to be reviewed and approved by the Administration for Land Affairs, construction, Geodesy and Cartography. But in real life, residents of ger districts build their houses without any approval, appropriate technical drawing and design, without considering and complying BCNSs, which may lead to energy inefficiency and can have bad impact on human health and the environment. What are the measures taken in scope of BEEP project implementation to reduce such risks? Can you tell us about "Green Housing" labelling that the project has introduced?**

Although it is enregistered in the Mongolia Law on Building that building drawing shall be reviewed and approved by formal technical expedition prior to construction, apartment and commercial buildings were complying the available BCNSs, but there weren't monitoring systems for compliance of BCNSs for ger district private houses. And the legal environment is unclear as well in such cases. In other words, there is no clear liability towards households building their homes without any formal approval. Since ger district households did not apply any norms and standards, their homes were built energy inefficient and wrong. Therefore, one of the project's outcomes was that we developed 16 types of energy efficient houses designs of size varying between 30-90 m2 and offered them to interested households.

Another important and sustainable outcome of the project is the design and production of Energy Passport for the building i.e. the Green Building label, a document intended to verify energy performance on design, construction, and operation. Energy Passports also give potential buyers and resident's information on what they can expect regarding the building's energy efficiency and real costs, helping to stimulate market preferences for high-performance buildings. There are 5 (A. B. C. D. E) classes in the Building thermal performance standard and the building of all types (apartment, commercial, private) should comply the indicators of the first three (A, B, C) in order to receive Green Building label.

Also, a research regarding the possibilities of commercializing high quality, affordable construction materials was carried out among the potential building material manufacturers and suppliers and labels were issued for companies that produce and supply building insulation materials in compliance with required BCNSs. All construction materials need to have labels according to their BCNS compliances and the National Center for Standardization and Metrology and the State Inspection Agency are responsible for its issuance and implementation.

These initiatives are laid out under the BEEP project implementation. Now respective government agencies and bodies need to continue further the implementation, application, monitoring and reporting systems of these measures. A law draft on Energy efficiency has been introduced, so depending on the approval and enforce of the law things should become clearer.

4. **Can you specify about trainings and awareness and capacity building activities of BEEP project? And I think the best practice case of the project is the www.beep.mn website.**

The project has succeeded to build capacity of professionals, engineers and technicians in construction sectors and officers of regulatory bodies. Throughout the project implementation period about 500 professionals from construction design companies, architects, and heat, ventilation, and air conditioner engineers and representatives from policy making and regulatory bodies benefits from a large number of technical and methodological training activities. Through such capacity building activities the trained officials and professionals are effectively working in the sector to enhance the effectiveness and efficiency of the new practices.

In course of the project implementation we have launched and hosted a web page www.beep.mn and made all relevant books, manuals, and materials available for interested audience for free of charge on the website. And I agree with you that it was our best practice case. Therefore, as the project terminated by the end of 2013, we have decided to keep the website and operate it regularly for the next five years by the ECC in Ulaanbaatar, Darkhan, Erdenet cities.

5. **Can you give me some information on the further management and operation of these ECCs now that the project is terminated?**

Well, the project is no longer responsible for any further activities of the ECCs. The ECCs were established in affiliation with the Mongolian Association of Civil Engineers. And based on the availability of materials, technologies, books and methodologies developed and practiced under the BEEP project we think that ECCs have the potential to raise funds for their operations and sustainably function independently. For example, they can financially support their operations by offering services of energy auditing with the technology and equipment provided under the project.

6. **Can you please share your thoughts on the financial aspect of the project? Many households were very interested to build their houses with the support of the project and I found out that most of the households that have built their homes with the assistance of the project were satisfied of the outcome while conducting a household survey interviewing households. I know that the Clean Air Project has provided subsidies for EE house owners. Can you give us some information if there is a possibility to sustainably continue such financial mechanism?**

The project was financed by the UNDP. And building of private houses of ger area households covered 223 households provided them with technical, technological and engineering assistance and support, out of which 108 of these households received financial subsidies of about 5 million MNT from the Clean Air Project of MCA as these households were living in the MCA Clean Air Project's target area (69 khoroos of 6 centrally located districts). The MCA Clean Air Project terminated in September 2013. The BEEP project also proposed XacBank to facilitate access to finance EE building approaches, technologies and systems by bringing the gap between EE supply and demand. Today XacBank is dedicated to provide on-going "Eco martgage product" of USD 2 million of its own funds for building EE loans with normal commercial interest rates and long duration periods. Furthermore, the GoM was discussing "Building EE incentives scheme", but it has been in a stagnant situation until now. I think this kind of incentive scheme is very important for the building energy efficiency from the state. Otherwise, households will not be able to afford energy efficient homes.

Appendix 5. Interview – National Renewable Energy Center (RE option)

Mr. E.Badrakh – Solar Energy Specialist, National Renewable Energy Center (NREC)
Interview date: December 2, 2013, NREC office

Q. Can you briefly tell us what does the NREC do?

- A. The NREC conducts all kinds of studies on renewable energy resources in Mongolia. Mongolia is potentially rich with solar energy resources with about 300 sunny days a year. But due to Mongolia's extreme weather conditions solar energy is not considered the best renewable energy resource.

- **Q. What kind of activities are being implemented on in the fields of solar energy production at a domestic (ger area household) level?**
- A. The solar energy production is under investigation and research. At domestic level, the NREC in cooperation with Air Quality Office of Ulaanbaatar city have started to pilot Vacuum Solar Energy Collector for domestic heating purposes and installed the technology in 21 households in 6 different ger districts of the city in the end of 2011, out of which 15 of them were financed by the Air Quality Office of Ulaanbaatar city and 6 were financed by the NREC. The technologies were imported from China which is distributed by a local Solar House LLC. Now, we are conducting studies to evaluate the impact of the technology, to assess its economic and other characteristics, to see whether it is economically efficient and feasible in domestic use. It is again difficult to estimate its efficiency in general, because it is calculate differently in each cases depending on many different indicators and characteristics of houses.
- **Q. As a specialist what would you say the advantages and disadvantages are there of solar energy at domestic level?**
- A. Of course there are a lot of environmental and economic advantages in using solar energy, but there are challenges to use it effectively at domestic level. For example, the very first investment in installation of solar energy collector is very costly. The cost of instalment depends on a lot of things: the location of the house, size and type of housing, heat loss percentage of the house, etc. Based on these indicators the cost and size of solar energy collector installation is calculated. There are only 2 local producers of solar panels in Mongolia, and mostly solar panels are imported from Germany, Switzerland, and mostly from China. The prices of solar panels differ by their capacity, and producing countries. Not many ger area residents are able to afford it. Secondly, the solar energy collector is less likely to provide heating 100% especially in the coldest time of winter. For example, according to study conducted on solar energy heat production, at the

coldest month of the year – which is January, the technology can provide only 33% of heating. This means that the solar energy collector needs to have an alternative heat production alongside it to provide 100% heating in the coldest months of winter when it is below -20 degrees, and at night. Another problem is derived from air pollution of Ulaanbaatar city. Solar panels need frequent cleaning due to air pollution. Dust particles due to air pollution are gathered and cover solar panels and decrease the capacity of sun light collection. And air pollution itself blocks sun light by 10% during winters.

- **Q. Do you think other renewable energy resources are applicable for domestic use?**
- A. Geothermal heat pump, wind energy resources are applicable and effective. But as I mentioned earlier, the initial installation cost is very high, higher than solar energy technologies at domestic level. These are better suitable for bigger houses, such as for schools, hospitals etc, but not for individual residential small houses. We are still studying to suggest the most effective renewable energy production at domestic level.
- **Q. In scope of the operations of NREC, what kind of international cooperation and support would NREC need?**
- We, as the department of research and project implementation of NREC, are working with several international research teams from Japan, Germany and Spain that provide us with technical assistance on our research studies. As of now, we have very few pilot projects being implemented such as Solar Vacuum Collector, so we have international cooperation only on research level. But we are always open to working with international organization at every level in the future.
- **Q. Tell us about challenges you have experienced piloting 21 household Solar Vacuum Collector project?**
- 15 were installed by the AQO of Ulaanbaatar City. These 15 collectors were imported from China by its official distributor Solar House LLC in Mongolia. We were responsible for the installation of 6 collectors. They were imported from our Chinese partner company Sun Rain LLC and our specialists installed them at selected households. Since this was completely free for the households we have kept the selection of households quite high. The main challenges we have had were due to weather conditions and geographic locations of households. The overall work, especially selection of suitable households were quite time consuming.
- **Q. Based on your experience on piloting Solar Vacuum Collector project, what kind of state policy do you think is most needed to support this kind of activities to reduce air pollutions derived from ger areas?**
- The main challenges households face using Solar Vacuum Collector is high cost of electricity. In my opinion, first of all, the state should strengthen the electricity cost incentives policies for households using clean energy resources. Secondly, as the first investment for solar vacuum collector installation is very costly for households in ger district, the government should also financially support households that are willing to use clean energy resources. Thirdly, the impact of installing solar vacuum collectors in few households in ger districts is clearly too limited. It would be more effective if these technologies are used in a wider scope.

Appendix 6. Interview – Millennium Challenge Account Energy Efficient Project (EEM option)

Mr. G.Batmergen – Former Energy efficient stove manager, Energy and Environment Project of Millennium Challenge Account – Mongolia

Interview: November 26, 2013, Ulaanbaatar Services Improvement Project Management Unit

- **Please give us some information on the Clean Air project?**
- The project aims at reducing air pollution of Ulaanbaatar city by implementing various activities. I will give answers to your questions concerning energy efficient stove program of Clean Air Project, MCA. The energy efficient stove program of MCA Clean Air project went on for 3 winters and distributed 97877 stoves, which means the coverage of 60% of households of 6 districts of Ulaanbaatar city. The program is now continued by the Ulaanbaatar Services Improvement Project Management Unit of Clean Air Project financed by World Bank. Clean Air project will be implemented until 2017, but we are planning to complete the distribution of energy efficient stoves to rest of the households of Ulaanbaatar city by the end of winter 2014.
- **Can you specify about the energy efficient stoves the project distributes, and its relevant details?**
- This year we have chosen to distribute 4 types of stoves: Ulzii, Dul, Talst and Bekas-107. These stoves are tested in laboratory and meet the requirements we set for energy efficient stoves in Ulaanbaatar city. These stoves differ slightly one from another, for example Dul stove is suited for small detached houses, and the other three types are installed and used in gers. The most important and common specification of these stoves are that they burn fuel completely, which means there is less ash, less smoke while fuelling, less consumption of fossil fuel, and decreases indoor air pollution. The stoves are being distributed to households with discounted prices. Incentives are provided from the Clean Air Foundation, GoM, and World Bank. Households must have proper address and statement from respective khoroos to apply for the stove. A stove is allotted only once for a household with discounted price, and the household cannot missuse the stove (i.e. sell it, gift it, etc).
- **Was there a target percentage that the project was aiming for in terms of air pollution reduction through distribution of energy efficient stoves for ger area households? Would you share with us the latest results and outcomes of the project?**
- Before starting the energy efficient project, MCA has conducted a study on the usage of stove at a household level and piloted it in 12 khoroo of Chingeltei District. This study resulted 30% fuel consumption decrease compared to tradition stoves, which convinced us that this will result in air pollution reduction. So there was an estimated expectation that if energy efficient stoves are distributed in all ger area household the air pollution will be reduced by roughly 10%. But there was not any official target as such. I would like to emphasize that the outcome of the project directly depends on the proper usage of these stoves by the household according to its

specifications. After the implementation of MCA project the monitoring and evaluation team has delivered an outcome of air pollution reduction of about 13%.

- **Where are the stoves imported from? And is there a possibility to produce energy efficient stoves in the country?**
- There are 4 types of stoves being distributed through the project now. # out of them are produced and imported from Turkey. And the other is invented by Mongolian engineers and produced in China. Since we do not produce steel it is unlikely possible to produce stoves in Mongolia. Plus, if it is produced locally we need at least 100-200 stoves produced a day based on the distribution of stoves. But we do not have factories of such capacity. So it is logical to import it from abroad. Plus, the distribution of energy efficient stoves in entire Ulaanbaatar city will be completed by the end of heating season of 2014.
- **The energy efficient stoves are currently being distributed with discounted price. But this kind of subsidies solution is mostly short term. What do you think about selling these stoves without such subsidies in the long run?**
- The MCA project has distributed stoves to 60% of its target households. Now, the WB financed project is distributing stoves to the rest of the households of ger areas in Ulaanbaatar city. And it is focusing more on households with low income and trying to tackle them and make sure they get stoves. There are households that buy stoves without the subsidies, but very few. It will be very hard for most households to buy stoves without any financial support given the original price of this kind of stoves.
- **Would you share with us the key lessons learned of the project, based on your experience?**
- I have learnt a lot of things. I would like to mention, first of all, that the marketing plan and product selling mechanism is the most important part of the job, given the cause and the audience. Also, MCA project was implemented in a very tight time frame. Therefore, there were a lot of challenges and difficulties. But now the USIP is working very carefully, focusing on quality rather than quality, based on MCA experience. The AQO of the city and Institute of Meteorology and Environment will evaluate and finalize the outcome of the project.
- **Based on your experience, what do you think are the other activities and policies needed from the Government to reduce air pollution?**
- Internationally funded projects and programs are being implemented and constantly working to produce outcome. But the Government does not fulfil their responsibilities, which it is supposed to produce outcome coupled with these projects and programs. For example, the government has planned to start producing and supplying standard cleaner fuel, so the energy efficient stoves make better impact on air pollution reduction. But production of cleaner fuel has even started yet. The government also plans redevelopment of ger areas, but from economic and technical viewpoint it requires more research and planning than the government is conducting. I think the government should be more responsible, active and vocal about their plans.