GOVERNMENT OF MONGOLIA

MINISTRY OF ENVIRONMENT AND GREEN DEVELOPMENT

UNEP

gef

TECHNOLOGY NEEDS ASSESSMENT

VOLUME 2 – Climate Change Mitigation in Mongolia

MINISTRY OF ENVIRONMENT AND GREEN DEVELOPMENT

TECHNOLOGY NEEDS ASSESSMENT

VOLUME 2 - Climate Change Mitigation in Mongolia

Coordinated by Climate Change Coordination Office of the Ministry of Environment and Green Development, Mongolia

MONGOLIA, 2013

“This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP-Risoe Centre (URC) in collaboration with the Regional Centre Asian Institute of Technology, Bangkok for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein are a product of the National TNA team, led by the Ministry of Environment and Green Development of Mongolia.

Disclaimers

The content and views expressed in this publication do not necessarily reflect the views or policies of the Government of Mongolia and the United Nations Environment Program.
Ministry of Environment and Green Development of Mongolia will not guarantee the accuracy or completeness of any information published herein, and thus will not be responsible for any losses or damages arising from the use of this information or from any errors or omissions therein.

FOREWORD

Climate change is an inevitable fact in today's industrial world having serious impacts on countries around the world, particularly developing nations. It increases social, environmental, health and economic risks, to which developing countries are exposed and vulnerable to.

Mongolia is no exception. It is experiencing the impacts of climate change as much as other nations, if not more so. In Mongolia, the annual mean temperature has increased by 2.14°C between 1940 and 2008. This is considerably higher than global averages. Its vulnerability is due in part, to its heavy reliance on its agricultural (arable farming and livestock) sector. One third of the population is employed in this sector and are exposed to the risks of climate induced events and poverty. This reinforces the environmental, economic and social consequences of climate change on the general population. Furthermore, the Mongolian energy sector is very carbon intensive, which has caused serious air pollution in urban centers.

As a result, the Mongolian Government is placing greater emphasis on climate resilient, environmentally friendly, green development. Within the new Government, established in August 2012, the former Ministry of Nature, Environment and Tourism has been restructured as the Ministry of Environment and Green Development with the status of a core Ministry.

After a difficult period of transition to a free market economy with limited financial resources, Mongolia is moving forward setting its goal on sustainable economic growth with strong emphasis on environmental protection. With expected rapid economic growth in Mongolia for the coming years, and with the need to achieve sustainable development, Mongolia is aiming for a Green future that is environmentally friendly and resilient to climate change. It hopes to do so through cooperation with and support from developed economies and the introduction of advanced technologies and know how.

The Ministry of Environment and Green Development of Mongolia through the Climate change coordination office, has assessed and prioritized the technologies that needs to be introduced most urgently both for mitigation and adaptation. The "Technology Needs Assessments and Technology Action Plans Report for Climate Change Mitigation/Adaptation in Mongolia" is the first comprehensive report providing information on the required technologies to adapt to the changing climate, and mitigate GHG emissions along with the action plan to introduce those technologies. We believe that this report will provide valuable guidance for policy makers, budget planners, investors, technology developers, scientists, intelligence and donor communities in Mongolia for making investment decisions and formulating policies and programs for the aim of green development that are resilient to the changing climate and reducing GHG emissions.

In conclusion, I would like to note that this report was prepared by a team of national experts with advice and assistance from international experts, along with the guidance of a Steering Committee led by the Ministry of Environment and Green Development (former Ministry of Nature, Environment and Tourism) and benefited from consultation with a broader set of stakeholders in the TNA process throughout its preparation. I wish to congratulate all the people who involved for their hard work and contribution.

OYUN Sanjaasuren, Ph.D

Member of the State Great Khural (Parliament),
Minister for the Environment and Green Development of Mongolia

PREFACE

The report on Technology Needs Assessment for Climate Change Mitigation in Mongolia is the main output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP-Risoe Centre (URC) in collaboration with the Regional Centre Asian Institute of Technology. It has 4 sections as below:

1. Section 1: Technology Needs Assessment Report describes key mitigation technologies in priority sectors for Mongolia such as large scale Hydro-power plants; Wind parks, Super critical coal fired power plants; energy efficient lighting; and improvement of insulation of panel apartment buildings.
2. Section 2: Barrier Analysis and Enabling Framework Report accesses the barriers and measures identified for all five technologies in the two subsectors that have been selected.
3. Section 3: Technology Action Plan (TAP) Report describes Action Plans for each technology. During the preparation of TAP, measures have been assessed taking into account their priorities, time scale, related stakeholders, key indicators of outputs, implementation and funding resources.
4. Secion 4: Project Idea Report provides project ideas for each technology including concrete actions for realization of the Technology Action Plans for each selected technologies.

The present report is the result of a fully country-driven process and the views and information contained herein are the product of the National TNA team, led by the Ministry of Environment and Green Development of Mongolia.

We extend our appreciation to the mitigation team, the leading authors of this report, Dr. Dorjpurev Jargal (team leader), Prof. Namkhainyam Busjav and Mr.Landannorov Jigmed, as well as contributors, Ms.Delgermaa Dorjpurev, Mr. Munkhzaya Duger, Mr.Gerelt-Od Dash. and Ms.Tsendsuren Batsuuri for their comments and revision all of whom made valuable contribution to the chapters on specific issue areas. Without the generous time and efforts of all authors and contributors, the report could not have been produced.

This report has benefited much from discussions with the expert team, stakeholders, and officials from the Mongolian government. So we extend our appreciation to the stakeholders for their constant support and valuable comments throughout the development of this report.

We would also like to thank Ms.Catherine Tulloh for her assistance on improving the language of the report and Dr.Gerelmaa Shaariibuu, Ms.Tegshjargal Bumtsend and Ms.Undarmaa Khurelbaatar, officers of CDM National Bureau, Climate change coordination office who assisted in consolidating all the reports into a single report.

Our sincere gratitude is extended to the GEF and UNEP for the financial and technical support as well as UNEP-Risoe Centre (URC) and Asian Institute of Technology (AIT), specifically to Mrs.Xianli Zhu from URC and Dr.Abdul Salam from AIT for their constant support, guidance and comments for all the reports without which the development of these reports would not have been possible.

DAGVADORJ Damdin, Ph.D

National TNA project director, Special Envoy for Climate Change, and Chairman, Climate Change Coordination Office, Ministry of Environment and Green Development

CONTENTS

SECTION I.
TECHNOLOGY NEEDS ASSESSMENT

SECTION II.

BARRIER ANALYSIS AND ENABLING FRAMEWORK MITIGATION

SECTION III.
TECHNOLOGY ACTION PLAN

SECTION IV.
PROJECT IDEAS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXES

Abbreviations
List of Abbreviations could follow the format below.

ADB	Asian Development Bank
CDM	Clean Development Mechanism
CCCO	Climate Change Coordination Office
CES	Central Energy System
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power Plant
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
CSP	Concentrated Solar Power
ELI	Efficient Lighting Initiative
ERC	Energy Regulatory Committee
ESCO	Energy Service Company
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse gases
HOB	Heat Only Boilers
HPP	Hydro Power Plant
HVAC	Heating, Ventilation and Air Conditioning
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
ILB	Incandescent Light Bulbs
IPCC	Intergovernmental Panel on Climate Change
LED	Light-Emitting Diode
LHV	Lower Heating Value
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LUCF	Land Use Change and Forestry
MCDA	Multi Criteria Decision Analysis
MEGD	Ministry of Environment and Green Development
MMRE	Ministry of Mineral Resources and Energy
MNET	Ministry of Nature and Environment
MNT	Mongolian Tugrug (unit of currency)
MOE	Ministry of Energy
MUST	Mongolian University of Science and Technology
NAMA	Nationally Appropriate Mitigation Actions
NAPCC	National Action Program on Climate Change
NGO	Non-Governmental Organization
NO_x	Nitrogen Oxides
NREP	National Renewable Energy Program
O&M	Operation and Maintenance
PC	Pulverized Coal combustion
PDD	Project Design Document
PPP	Public Private Partnership
PV	Photovoltaic
RE	Renewable Energy
SC	Supercritical
SC PC	Super Critical Pulverized Coal combustion

SO_2	Sulfur dioxide
SO_x	Sulfur oxides
TNA	Technology Needs Assessment
TPP	Thermal Power Plant
TPS	Thermal Power Station
TRV	Thermostatic Radiator Valves
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USC	Ultra-supercritical
USD	United States Dollar
VLS PV	Very Large Scale Photovoltaics
WP	Wind Park

Units:

Gcal	gigacalorie
Gg	gigagram (=1000 tones)
GW	gigawatt (=1000 MW)
GWh	gigawatt hour
gram-CE	gram coal equivalent
h	hour
kcal	kilocalorie
kg	kilogram
km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
MPa	megapascal (1 MPa ≡ 1,000,000 Pa)
MW	megawatt
MWh	megawatt hour
t	tons
TJ	terajoule
W	watt

Section I.

Technology Needs Assessment

EXECUTIVE SUMMARY

Introduction

The mitigation part of the Technology Needs Assessment (TNA) project, described in this report, aims to identify key mitigation technologies in priority sectors for Mongolia. The TNA process will then inform the development of Technology Action Plans that will seek to facilitate a smooth transfer of the identified technologies. Mongolia is one of 14 countries participating in the global project implemented by the United Nations Environment Programme.

Mongolia is sensitive to climate change because of its geographic location, fragile ecosystems and because a large part of its economy and society is highly dependent on weather and the natural environment .In the last forty years, Mongolian ecosystems have been noticeably altered by increased variability and changes in global climatic conditions. These changes have consequences that negatively affect the national economy and the livelihoods of Mongolian citizens.

The parliament of Mongolia approved the National Action Program on Climate Change in 2011. The goals of the program are to ensure environmental sustainability, encourage development of socioeconomic sectors adapted to climate change, reduce vulnerabilities and risks, and mitigate GHG emissions as well as promoting economic effectiveness and efficiency, and implementing 'green growth' policies. The implementation of the NAPCC to 2021 will help Mongolia create the capacity to adapt to climate change and establish a foundation for green economic growth and development.

A number of official Mongolian documents and policies outline the government's development strategy. Key areas for development include export products, rural development, sustainable development, pollution reduction, renewable energy and mining.

Institutional arrangement for the TNA and stakeholders involvement

The TNA project in Mongolia was overseen by a National Steering Committee, managed by a National TNA Coordinator and implemented by Working Groups.

The National Steering Committee is headed by the Vice Minister of Nature, Environment and Tourism (MNET) and the coordinator was Dr. Dagvadorj, Special Envoy for Climate Change and Chairman of the Climate Change Coordination Office (CCCO).The working group on mitigation was responsible for engaging stakeholders in order to identify, analyze and prioritize key sectors and mitigation technologies.

Stakeholder engagement was the primary tool used during the project. The stakeholders consisted of ministries, government agencies, local governments, academy of sciences, universities, international organizations and projects, NGOs and private companies.

Sector prioritization

The first stage of the TNA process was to identify the sectors in Mongolia that would be the focus of the technology needs assessment. The sectors were selected according to both national development priorities and GHG mitigation potential.

Mongolian total gross greenhouse gas (GHG) emissions were 18,868 gigagrams (Gg) carbon dioxide equivalent (CO_2-eq) in 2006 and net emissions were 15,628 Gg CO_2-eq. 65.4 per cent of net GHG emissions were emitted by the energy sector (including stationary energy, transport and fugitive emissions), and 41.4 per cent by agriculture and livestock. Other relatively minor sources include emissions from industrial processes (5.7 %) and the waste sector (0.9%). In the land use change and forestry sector the total CO_2 removals were more than the total CO_2 emissions, resulting in a net sink of 2,083 GgCO_2-eq (-13.3%) in 2006, (see table 3.1).

GHG emissions in the future are expected to increase gradually, to a large extent due to growth of the energy industry and increased energy consumption by various sectors. Projections indicate that Mongolia's GHG emissions will rise above 2006 levels by a factor of about 2.1 by 2020 and 3.2 by 2030. During the same period, emissions from the energy sector are expected to increase by a factor of 4 while agriculture sector emissions would increase by just 6% annually and emissions from waste by 3.6% annually. Removals from land-use change and forestry are projected to decrease by a factor of 3.

The top four subsectors that contribute more than 88% of the total emissions are (i) energy industries (electricity and heat production), (ii) enteric fermentation, (iii) transport and (iv) energy consumption in commercial, residential sectors. These four subsectors were the focus of the sector selection process.

The following development priorities were identified for selection of priority sectors: economic development; environmental development; social development; and GHG emission reduction potential.

The process for prioritizing subsectors was based on stakeholder opinions. Based on data in the GHG inventory, and in light of development priorities, 13 stakeholders from the Ministry of Mineral Resources and Energy, Ministry of Nature and Environment, and Tourism Energy Authority, Ministry of Food, Agriculture and light industry, universities, project implementation units, citymunicipality, NGOs and private companies were asked to score the subsectors on a scale of 0-5. After the scoring, a criteria contribution graph was made to inform the final decision. The sectors with the strongest contribution to both GHG emission reduction and meeting development priorities were selected as the priority sectors. The energy industry subsector selected as the first priority subsector as it had the highest score (it scored 5 on GHG reduction potential and 13 on the development priorities with an overall score of 18). The residential and commercial subsector scored the second highest so was selected as the second priority sector (score of 4 on GHG reduction potential and 12 on the development priorities with an overall score of 16).

Technology Prioritization for the Energy industries subsector

The energy sector is most significant source of GHG emissions in Mongolia. In 2006, GHG emissions from the energy sector totaled 10,220 $GgCO_2$-eq and energy industries accounted for 62.5% of this. High emissions of carbon dioxide from the energy industries subsector are largely attributable to the coal-fired power and heat generating facilities. The energy sector in Mongolia is dominated by coal-fired Combined Heat and Power (CHP) plants for electricity, domestic hot water and space heating. Access to space heating is vital in Mongolia because of the long and extremely cold winters. Other sources of electricity and heat supply include diesel generators in urban centers not connected to the central grid, small scale hydroelectricity plants, independent small scale solar PV systems, small solar-wind hybrid stations, and heating stations.

The process of identifying the priority mitigation technologies for the energy industries subsector was done in several stages. Firstly a full list of potential mitigation technologies was compiled for consideration. This list was edited, revised and categorized according to the scale and availability timeframe. This list of technologies is in table 4.7 of the full report. Next, 6 related stakeholders from the Ministry of Mineral resources and energy, Ministry of Nature, Environment and Tourism, Mongolian energy association, Energy Authority, private company and city government were asked to assess the technologies and prepare a shortlist. Some technologies were eliminated by the stakeholders because of their unsuitability to Mongolian conditions, long timeframes before becoming commercially available or because of limited mitigation potential. The shortlisted technologies were:

- Large scale dam-based hydro power plant (more than 100MW)
- Wind turbines (onshore, large scale)
- Pulverized Coal Combustion with higher efficiency
- Integrated coal gasification combined cycle
- Medium-sized dam-based hydro for electricity supply (10-100 MW)
- Solar thermal – CSP
- Heat only boilers for space heating

- Pumped storage hydroelectricity
- Solar PV (off grid, grid connected and solar home systems)
- Carbon capture and storage

Technology Fact Sheets (TFSs) were prepared for each of the technologies (see Annex 1) and based on the information in the TFSs stakeholders scored each technology on a number of different criteria - social, environmental and economic development priorities and GHG mitigation potential. A score of 0 was given to the technology option which was least preferred under that criteria and 100 for the most preferred option under the same criteria. The other technology options were scored relative to these two scores. After obtaining a score for each individual technology, a final score sheet was prepared.

The top three scoring technologies were prioritized for future investigation in the energy supply subsector:

- Large hydropower plant;
- Wind turbines (onshore, large scale);
- Pulverized coal combustion technologies.

Technology prioritization for the Residential and commercial subsector

GHG emissions from the residential and commercial subsector in 2006 accounted for 6.25% of total emissions and 11.55% of emissions from the energy sector (see table 5.1). The urban population of Mongolia is 1.6 million or over 60% of the national total.

The residential and commercial sector uses mainly heat, electricity and coal, some fuel wood and dung for its energy needs. Thermal energy is used for heating of buildings, production of goods and services and preparation of hot water for households. Electricity is used for lighting, motors, thermal electric equipment (mostly for cooking) and electric appliances. The efficiency of energy use in the residential and service sector is low. The priority goal of the residential and commercial subsector is to promote efficient use of energy and substitution of coal with relatively clean energy sources.

The majority of apartment buildings in Ulaanbaatar were constructed in the 1970s, 1980s and early 1990s and are in a poor state with no systematic professional maintenance and repair occurring. The energy efficiency in central and district heated buildings leaves much room for technical and managerial improvement. Heat consumption of the buildings is about five times higher than the modern systems in Europe. This can be explained to some extent by the very cold climate, but mainly due to poor technology and a lack of incentives to save energy.

Typically, small heating boilers are used in provincial centers for providing heating for households, schools, hospitals, kindergartens and other public institutions and they are of very low efficiency (40-50%) due to outdated equipment. Individual heat stoves, which burn coal and/or wood to meet residential heating needs, are used in peri-urban areas of cities and in rural areas.

The process of identifying and prioritizing technologies for the residential and commercial subsector was the same as for the energy industries subsector. The technologies analyzed by the 6 stakeholders from the Ministry of Mineral Resources and Energy, National Development and Innovation Committee, Ministry of Nature, Environment and Tourism, Mongolian Energy Association, Energy Authority, city government and private companies were:

- Compact Fluorescent Lighting, LED
- Improved coal fired heating stoves
- Improved building Insulation
- LPG for household and commercial cooking

The government of Mongolia implements air pollution reduction measures and distributes energy efficient and low-smoke stoves for households in ger district areas. The stakeholders considered that the government measures are effective and sufficient and the stakeholders have decided that it is not necessary to include the improved heating stoves in the list of selected technologies for future investigation.

Comparisons of the costs and benefits showed that the LPG for cooking technology has comparatively high costs and very low benefits. Therefore, stakeholders decided to not include the LPG for cooking technology in the final list of selected technologies.

Finally the following two prioritized technologies have been selected for the next step of investigation:

- Efficient lighting and improved insulation of panel apartment buildings

1. Introduction

About the TNA project

The Technology Needs Assessment (TNA) project is a set of country-driven activities that identifies and determines mitigation and adaptation technology priorities and is central to the work of Parties to the UNFCCC on technology transfer. The Project is funded by the Global Environmental Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) through the UNEP Risoe Centre.

The TNA Project aims to identify clean technologies that are best suited for climate change mitigation and adaptation in target countries, and at developing Technology Action Plans (TAPs) to facilitate a smooth transfer of the selected technologies.

The objectives of the project are:

- to identify and prioritize, through country-driven participatory processes, technologies that can contribute to the mitigation and adaptation goals of the participant countries, while meeting their national sustainable development goals and priorities;
- to identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies;
- to develop Technology Action Plans (TAP) specifying activities and enabling frameworks to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies in the participant countries; and
- to prepare project ideas.

In Asia, the project is being implemented in two rounds, with 6 countries in the first round and another 8 countries in the second round. Mongolia among the countries included in the second round.

This report sets out the processes undertaken to identify priority sectors and mitigation technologies for Mongolia.

1.1 Existing national policies about climate change mitigation and development priorities

Mongolia is very sensitive to climate change because of its geographic location, fragile ecosystems and environment-weather dependent socio-economic circumstances. In the last forty years, Mongolian ecosystems have been noticeably altered by increased variability and changes in global climatic conditions. Changes that have been observed include increased desertification, more frequent droughts and dzuds (harsh winters) increased scarcity of water resources and greater biodiversity loss. These changes have negative impacts on the national economy and the livelihoods of Mongolian citizens.

In response to these observed changes, and to contribute toward the global mitigation effort, the parliament of Mongolia approved the National Action Program on Climate Change (NAPCC) in 2011. The goals of the program are to:

- ensure environmental sustainability
- develop socioeconomic sectors that are adapted to climate change
- reduce vulnerabilities and risks
- mitigate GHG emissions
- promote economic effectiveness and efficiency; and
- implement ‘green growth’ policies.

Implementation of the NAPCC to 2021 will help Mongolia create the capacity to adapt to climate change and establish a foundation for green economic growth and development.

A key strategic objective of the NAPCC is to mitigate GHG emissions and establish a low carbon economy through the introduction of environmentally friendly technologies and improvements in energy efficiency. This objective to mitigate GHG emissions will be implemented in two phases. The main measures to be implemented in the first phase (2011-2016) are to:

- increase the efficiency of the energy supply sector;
- increase use of renewable energy resources;
- introduce and disseminate improved technology for coal processing and clean fuel processing in rural areas;

- increase energy efficiency in buildings by improving insulation and lighting;
- improve management systems in the transport sector;
- expand the railway network;
- increase hydrogen and hybrid fuel use in vehicles; and
- encourage low fuel consumption cars.

The measures to be implemented in the second phase (2017-2021) are to:

- use solar and geothermal energy and biogas in the heating and hot water supply of buildings;
- construct hydro power plants in appropriate places;
- explore possibilities to build large scale power and thermal plants using solar power in the Gobi region; and
- build integrated coal gasification combined cycle plants.

Mongolia's development strategy incorporates large elements of climate change mitigation. The overall strategy is defined in a number of documents summarized here:

- *Millennium Development Goals-based Comprehensive National Development Strategy of Mongolia approved by the Mongolian Parliament in 2008:* The strategy defines in a comprehensive manner its policy for the next fourteen years. It aims to promote human development in Mongolia in a humane, civil, and democratic society, and to develop the country's economy, society, science, technology, culture and civilization in line with global and regional development trends. The document emphasizes export oriented economic development, rural development, poverty reduction and human development.
- *Mongolian National Action Program for Sustainable Development for the 21st century (MAP-21):* MAP-21 represents a process with a vital strategic purpose. Building on insights provided during the 1992 Rio Earth Summit, Mongolia launched its own efforts to apply the insights and values of what has come to be known as sustainable development.
- *New Reconstruction Mid-term Development Program approved by the Mongolian Parliament in 2010:* This program focuses on reducing air pollution through urban development and planning, improving infrastructure, expanding housing supply, boosting jobs growth, supporting rural development, incentivizing enterprises and businesses to reduce pollution, and easing internal migration.
- *Mongolian National Livestock Program:* The purpose of this program is to develop a livestock sector that is adaptable to changing climatic and social conditions and create an environment where the sector is economically viable and competitive in the market economy. It also aims to provide a safe and healthy food supply for the population, deliver quality raw materials to processing industries, and increase exports.
- *National Renewable Energy Development Program:* This aims to increase renewable energy penetration in Mongolia's energy system, to diversify energy sources, decrease air pollution and achieve socially and economically sustainable development in rural areas through the introduction of reliable energy sources. The main goal of the program is to increase the percentage share of renewable energy in total energy production to reach a 3-5 percent share in national energy supply by the year 2010, and 20-25 percent share by 2020.
- *Government resolution No:320, 14 Oct 2009 Endorsement of the List of top priority projects to be implemented by Government:* The government decided to open to private tender a number

of the 26 top priority projects within the mining, agriculture, infrastructure, education, tourism and environmental sectors of Mongolia.

- The income from the mining and mineral sector is considered to be the main driver of Mongolia's economic growth. The use of the gold and copper deposits of Oyu Tolgoi and coal deposits of Tavan Tolgoi, copper smelting, manufacturing of value-added products by establishing industrial parks, metallurgical plants and coal-chemical and oil processing factories will be the highest priorities for economic development[1].

Apart from securing energy supply and developing extractive and processing industry for mining products, the Government has approved the following 4 priorities on which the Mongolian science and technology research and development will be primarily focused on between 2010 and 2014:

- Human development and quality of life;
- Sustaining energy supply;
- Protecting environment and balancing ecology
- Intensifying agriculture; and
- Introducing advanced technology and information technology.

"Sustaining Energy supply": The following are the key technology focuses of this priority – power generation, energy efficiency and energy saving technology; technologies for power generation from renewable resources; technology for the exploration, extraction and processing of minerals; coal and oil processing technologies;and technologies for building material production.

"Intensifying agriculture": The following are the main technology priorities– technologies that make livestock disease-free and increase their productivity; technologies that produce, plant, and process high quality wheat, potato, vegetables and livestock supplemental feed; and technologies that process agriculture-originated products and manufacture organic food.

"Introducing advanced technology and information technology": The key technologies under this priority include- nanotechnology, biotechnology; information, microprocessors, software and online services technologies.

Environmental development is becoming a crucial issue to Mongolia. Mongolia's ecosystems are quite vulnerable to climate change. Additionally, the country is facing multiple vital environmental issues such as air pollution in urban areas, forest degradation due to human activities, soil damage because of mineral exploration, extraction and usage, lake and river pollution, and soil degradation due to pasture land usage.

Since air pollution of Ulaanbaatar city has reached disastrous levels, the President initiated a new law which was passed by the State Ikh Khural[2] and is being enforced. Under this law, with the aim of decreasing municipal air pollution, the following actions are being taken:

- expanding the power resources, electricity transmission and distribution network of ger[3] areas;
- introducing new and improved technologies to reduce municipal air pollution;
- developing regional development centers and isolated districts of the capital city;
- avoiding use of raw coal by households and instead supporting the use of electricity, geothermal heat, semi-coking coal and gas; and
- slowing down the population growth of the capital city.

"*Protecting environment and balancing ecology*": Core elements of this priority are- technologies that protect species, reduce environmental pollution and land degradation, and restore degraded and damaged land; technologies that mitigate climate change and desertification and support climate change adaptation; and technologies that protect and utilize water reservoirs.

"*Human development and quality of life*": Considered as core for this priority are-

1. Government resolution No: 320, 14 Oct.2009 Endorsement of the List of top priority projects to be implemented by Government

2. The Parliament of Mongolia
3. A ger is the traditional Mongolian tent used by herders; ger areasin Ulaanbaatar are sections of town where people have settled in theirgers.

technologies that help human development and education reform; technologies that prevent, diagnose and treat diseases; and biotechnologies.

2. Institutional arrangement for the TNA and stakeholders involvement

The task of developing and implementing climate change policy in Mongolia is the responsibility of the National Climate Committee (NCC) and the Climate Change Coordination Office (CCCO). The NCC is headed by the Minister for Nature, Environment and Tourism and the members of the committee are other high level officials such as Deputy Ministers, State Secretaries and Director-Generals of related ministries and agencies. The NCC's role is to coordinate and guide national activities and measures aimed at adapting to climate change and mitigating GHG emissions. It is the responsibility of the NCC to approve climate change policies and programs as well as evaluating and providing guidance to projects. The CCCO was established by the government to carry out day-to-day activities for the implementation of UNFCCC, Kyoto Protocol commitments and national activities. The Office also aims to integrate climate change considerations into various sectors. The CCCO is supervised by the NCC.[4]

2.1 National TNA team

The TNA project in Mongolia is guided by a National TNA Committee, managed by a National TNA Coordinator and implemented by working groups. The mitigation part of the project described in this report was carried out by the Mitigation Working Group.

The National TNA Committee is the top decision making body of the project. It is headed by the Vice-Minister for Nature, Environment and Tourism (MNET) and its members are from the Ministry of Mineral Resources and Energy; Ministry of Food, Agriculture and Light industry; Ministry of Road, Transport and Urban Development; and representatives from the National Renewable Energy Center; National Committee on Air Pollution Reduction; Forest Agency and Energy Association. The National TNA Committee represents political acceptance of the Technology Needs Assessment (TNA) process and the Technology Action Plan in Mongolia.

The TNA coordinator is Dr. Damdin Dagvadorj, Special Envoy for Climate Change and Chairman of the Climate Change Coordination Office (CCCO) of MNET. The TNA Coordinator is a focal point for, and manager of the overall TNA process. There are two Working Groups (WG) established for the project: one on mitigation and one on adaptation. Each of these working groups is working under the TNA Coordinator.

The Working Group on Mitigation consisted of WG leader (Dr. J. Dorjpurev), key experts (B. Namkhainyam, A.Tsogt) and other consultants and assistants. The key responsibilities of the working group is to complete the following tasks through a participatory process involving broad stakeholders:

- identify and categorize priority sectors and technologies for mitigation;
- facilitate the process of analyzing how the prioritized technologies can be implemented in the country;
- facilitate the analysis of how the implementation circumstances could be improved by addressing barriers and developing an enabling framework; and
- prepare the TNA and TAP reports and the final report for the Mongolian part of the project.

The structure of the institutional arrangements for the TNA project in Mongolia is shown in figure 1.

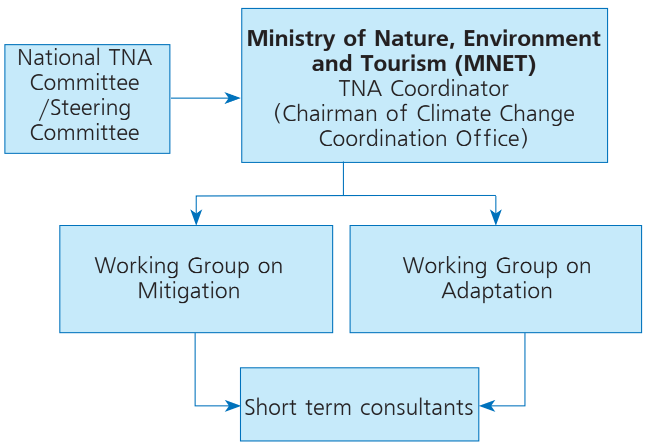

Figure 1: *Institutional arrangement for the TNA project*

4. Mongolia 2nd National Communication to UNFCCC

2.2 Stakeholder engagement process followed in TNA –Overall assessment

The TNA project utilized stakeholder engagement as the primary tool for identifying priority sectors and technologies. Stakeholder engagement is the process by which an organization involves people who may be affected by the decisions it makes,or can influence the implementation of its decisions.

In general terms, potential stakeholders to engage in a technology needs assessment for climate change mitigation could be[5]:

- Government departments with responsibility for policy making and enforcement (e.g., power supply regulation);
- Private and public sector industries, associations, and enterprises;
- Electric utilities and regulators;
- Technology users and/or suppliers who could play a key local role in developing and adapting technologies in the country;
- Organizations involved in the manufacturing, import and sale of technologies for mitigation;
- The financial community, which will likely to provide the majority of capital required for technology project development and implementation;
- Households, communities, small businesses and farmers that are or will be using the technologies and who would be affected by climate change;

Table 1: Stakeholder map for selection of subsectors and technologies

Stakeholders	*Interest in TNA project*			*Influence of stakeholder*		
	Low	*Medium*	*High*	*Low*	*Medium*	*High*
Ministries and President's Office						
Ministry of Mineral Resources and Energy		√				√
Ministry of Food, Agriculture and Light Industry	√				√	
Ministry of Roads, Transportation, Construction & Urban Development		√				√
Ministry of Nature, Environment and Tourism			√			√
President's Office		√			√	
Government agencies						
National Development and Innovation Committee			√			√
Energy Authority		√			√	
Energy Regulatory Authority	√				√	
Academy of Sciences and Universities						
Mongolian Academy of Sciences		√		√		
Mongolian University of Science and Technology		√			√	
Mongolian National University	√				√	
Mongolian State University of Agriculture	√			√		
Mongolian Development Institute	√				√	
International organizations and projects						
UNDP Office in Mongolia		√			√	
Local governments						
The Municipal Government of Ulaanbaatar City		√			√	
NGOs						
Mongolian Chamber of Commerce and Industry	√			√		
Mongolian Energy Association		√				√
Private companies						
Mon-Energy LLC	√				√	
MCS Group		√			√	
Clean Energy LLC		√			√	

5. Handbook for conducting Technology Needs Assessment for Climate Change: November 2010.

- NGOs involved in the promotion of environmental and social objectives;
- Institutions that provide technical support to both government and industry (e.g. universities and consultants);
- Labor unions, consumer groups, and media;
- Country divisions of international companies responsible for investments important to climate policy (e.g., agriculture and forestry); and
- International organizations/donors.

Based on the above possible stakeholder composition and categories, the stakeholder group for the TNA was formulated. This group represented a network for technology development and transfer of climate change mitigation technologies in Mongolia. The stakeholders consisted of representatives from government ministries and agencies, local governments, academy of Sciences, universities, international organizations and projects, NGOs and private companies.

The stakeholder map for selection of subsectors and technologies was prepared based on the consultant's personal observations and analysis in previous TNA projects (table 1). The purpose of the stakeholder map was to visualize each stakeholder's level of interest in, and level of influence over, the project.

Each of the stakeholders has a different area of interest and can offer different perspectives in the engagement process.

- The Ministry of Nature, Environment and Tourism, Ministry of Mineral Resources and Energy, Ministry of Roads, Transportation, Construction & Urban Development are the main government stakeholders interested in climate change mitigation technologies.
- It is important to establish and maintain good working relationships with government authorities at different levels, and to keep them informed of the project's activities and anticipated impacts as the government agencies are likely to play a key role in further activities to mobilize mitigation technologies.
- Cooperation with National Development and Innovation Committee is important as it is responsible for making socioeconomic development plans based on comprehensive and methodical research.
- The Energy Authority is responsible for policy implementation in the energy sector in Mongolia.
- Universities and non-governmental organizations, particularly those affected and interested in climate change mitigation technologies, can be important stakeholders in the selection of subsectors and technologies. They can be sources of local knowledge for the planning, implementing and monitoring of various project-related programs.
- The Mongolian University of Science and Technology, Mongolian Chamber of Commerce and Industry, and Mongolian Energy Association have experience in the implementation of energy planning, and energy efficiency improvement projects.

A communications plan for effective stakeholder engagement was prepared to answer the questions: how (face to face, E-mail or seminars), when (early or later) and how frequent (weekly, monthly or ad-hoc) should stakeholders be engaged. The communications plan schedules and tracks all planned and ad-hoc communications with stakeholders as well as identifying channels for delivery of key messages. The communications plan is shown in table 2, and was prepared based on the consultant's personal experiences and observations.

Table 2: Communications plan with stakeholders

Stakeholders	***How to engage***			***When***		***How often***		
	Face to face	E-mail	Seminars	Early	later	Weekly	Monthly	Ad-hoc
Ministries and President's Office								
Ministry of Mineral Resources and Energy	√	√	√	√			√	
Ministry of Food, Agriculture and Light Industry		√	√	√				√
Ministry of Roads, Transportation, Construction & Urban Development	√	√	√	√			√	√
Ministry of Nature, Environment and Tourism	√	√	√	√	√			√
President's Office		√	√		√			√
Government agencies								
National Development and Innovation Committee	√	√	√	√	√		√	√
Energy Authority		√	√	√	√			√
Energy Regulatory Authority		√	√		√			√
Academy of Sciences and Universities								
Mongolian Academy of Sciences			√		√			√
Mongolian University of Science and Technology		√	√		√		√	√
Mongolian National University			√		√			√
Mongolian State University of Agriculture			√	√				√
Mongolian Development Institute			√	√				√
International organizations and projects								
UNDP Office in Mongolia		√	√	√				√
Local governments								
The Municipal Government of Ulaanbaatar City		√	√				√	
NGOs								
Mongolian Chamber of Commerce and Industry		√	√					√
Mongolian Energy Association		√	√	√			√	√
Private companies								
Mon-Energy LLC		√	√		√			√
MCS Group		√			√			√
Clean Energy LLC		√			√			√

3. Sector selection

The first stage of the TNA process was to identify the sectors in Mongolia that would be the focus of the technology needs assessment. The sectors were selected according to both national development priorities and GHG mitigation potential.

3.1 An overview of sectors, projected climate change, and GHG emissions status and trends of the different sectors

Mongolian total gross greenhouse gas (GHG) emissions were 18,868 gigagrams (Gg) carbon dioxide equivalent (CO_2-eq) in 2006 and net emissions were 15,628 Gg CO_2-eq. 65.4 per cent of net GHG emissions were emitted by the energy sector (including stationary energy, transport and fugitive emissions), 41.4 per cent by agriculture and livestock. For the land use change and forestry sector the total CO_2 removals were more than the total CO_2 emissions, resulting in a net sink of 2,083 GgCO_2-eq (-13.3%) in 2006. This was realized due to an increase in the area of abandoned crop lands and a reduction in newly cultivated land. Other relatively minor sources include emissions from industrial processes (5.7 %) and the waste sector (0.9%), (table 3).

The trend of net greenhouse gas emissions between 1990-2006 indicates an average annual reduction of 2.3% from 22,535 GgCO_2-eq in 1990 to 15,628 GgCO_2-eq in 2006. The reduction of net GHG emissions is mostly due to the socio-economic slowdown during the transition period from centrally planned to free market economy. GHG emissions fell 4.5% annually from 1990 to 2000. Net emissions between 2004 and 2006 have increased. The average annual increase between 2000 and 2006 was 1.6% (table 4).

In 2006 Mongolian GHG emissions per capita were higher than the global average and most other developing countries. GHG emissions are expected to increase in coming years due to the country's ongoing development. Total GHG emissions are expected to increase by 6.00% annually from 2006 to 2015 and by 4.29% from 2015 to 2020. The annual percentage growth rate of total GHG emissions from 2006 to 2030 is projected at 4.90% (MSNC, 2010). Consequently, introducing mitigation policies is urgent such as, development of efficient electric and thermal power generation and consumption, introduction of environmentally sound technologies, improvement of fuel efficiency, promotion of renewable energy sources and reduction of air pollution. The aggregated projections of GHG emissions by sector are shown in table 5.

Table 3: GHG emissions of Mongolia in 2006

Greenhouse Gas Source and Sink	***CO_2 Emissions***	***CO_2 Removals***	***CH_4***	***N_2O***	***HFCs***	***PFCs***	***SF_6***	***Net Emissions***
	Gg							*$GgCO_2$-eq*
Total Greenhouse Gas emissions and removals	**11,113.54**	**–3,239.87**	**310.90**	**1.48**	**0.59**	**0.00**	**0.00**	**15,628**
1. Energy	**9,831.10**	**0.00**	**15.40**	**0.21**				**10,220**
A. Fuel Combustion (Sectoral)	9,831.10		8.24	0.21				10,069
1. Energy Industries	6,366.77		0.07	0.10				6,399
2. Manufacturing and construction	356.92		0.03	0.00				356
3. Transport	1,874.01		0.32	0.02				1,887
4. Residential & Commercial	989.10		7.82	0.09				1,181
5. Others	244.30		0.00	0.00				244
B. Fugitive Emissions from Fuels	0.00		7.16	0.00				150
1. Coal	0.00		7.16	0.00				150
2. Oil and Natural Gas	0.00		0.00	0.00				0
2. Industrial Processes	**125.15**	**0.00**	**0.00**	**0.00**	**0.59**	**0.00**	**0.00**	**892**
A. Mineral Products	125.15							125
B. Chemical Industry	0.00		0.00	0.00	NO	NO	NO	0
C. Metal Production	0.00		0.00	0.00		NO	NO	0
D. Other Production	0.00							0
E. Production of HFCs, PFCs, SF_6					0.00	0.00	0.00	0
F. Consumption of HFCs, PFCs, SF_6					0.59	0.00	0.00	767
3. Solvent and Other Product Use	NE			NE				**0**
4. Agriculture	NE	NE	**288.95**	**1.27**				**6462**
A. Enteric Fermentation			280.72					5895
B. Manure Management			8.19	0.00				172
C. Rice Cultivation			0.00					0
D. Agricultural Soils	NE	NE		1.27				393.7
E. Field Burning of Agricultural Residues	NE	NE	0.04	0.00				0.84
5. Land-Use Change and Forestry	**1157.29**	**–3,239.87**						**–2083**
A. Changes in Forest and Other Woody Biomass Stocks	963.96	0.00						964
B. Forest and Grassland Conversion	193.33	0.00						193
C. Abandonment of Managed Land	0.00	-3,239.87						-3,240
D. CO_2 emissions & Removals from Soil	NE	NE						**0**
E. Others	NE	NE	NE	NE				**0**
6. Waste			**6.55**	**0.0**				**138**
A. Solid Waste Disposal on Land	NE		2.43					51
B. Wastewater Handling			4.12	0.0				87
C. Waste Incineration	NE		NE	NE				0
D. Others	NO		NO	NO	NO	NO	NO	0

Source: MNET, Mongolia's Second National Communication: Under the UNFCCC

Table 4: GHG emissions by source (1990–2006), $GgCO_2$–eq

Sectors	*1990*	*1995*	*2000*	*2002*	*2004*	*2005*	*2006*	*Average Annual Growth Rate, %*		
								1990–2000	***2000–2006***	***1990–2006***
Total Emissions (Source)	23,645	17,205	16,896	16,405	16,910	17,582	18,868	-3.3	1.9	-1.4
Energy	12,529	8,710	8,865	9,418	9,247	9,635	10,220	-3.4	2.4	-1.3
Industrial Processes	326	166	276	451	972	862	892	-1.7	21.6	6.5
Agriculture	7,695	6,964	6,748	5,338	5,518	5,854	6462	-1.3	-0.8	-1.1
Land-Use Change and Forestry	1,887	-906	-1,762	-1,386	-2,112	-1,966	-2083	-	2.8	-
Waste	96	110	120	124	131	134	138	2.3	2.4	2.3
Net Emissions (source and Sink)	22,535	15,044	14,247	13,944	13,755	14,519	15,628	-4.5	1.6	-2.3

Source: MNET, Mongolia's Second National Communication: Under the UNFCCC

Table 5: Aggregated projections of GHG emissions by sector

Sectors	***GHG emissions in Gg CO_2–eq,***						***Average Annual Growth Rate , %***			
	2006	***2010***	***2015***	***2020***	***2025***	***2030***	*2006-2015*	*2015-2020*	*2020-2030*	*2006-2030*
Energy	10,220	14,033	20,233	25,930	32,796	41,815	7.59	4.96	*4.78*	5.87
Industry	891	1,354	1,602	1,836	2,065	2,318	6.52	2.73	*2.33*	3.98
Agriculture	6,462	6,405	6,573	6,657	6,762	6,867	0.19	0.25	*0.31*	0.25
LUCF	-2,083	-1,932	-1,785	-1,420	-1,000	-680	-1.72	-4.58	*-7.36*	-4.66
Waste	138	158	183	209	254	294	3.14	2.66	*3.41*	3.15
TOTAL	15,628	20,018	26,806	33,212	40,877	50,614	6.00	4.29	*4.21*	4.90

Source: MNET, Mongolia's Second National Communication: Under the UNFCCC

The projections indicate that Mongolia's GHG emissions would rise above 2006 levels by around 110% by 2020 and 220% by 2030. During the same period, emissions from the energy sector are expected to increase by a factor of 4 while emissions from the agriculture sector would increase by only around 6% annually and emissions from waste by 3.6% annually. Removals from land-use change and forestry are projected to decrease by around 67%.

Table 6 shows that the energy sector is the most significant GHG emission source in Mongolia emitting 57.7 % of total emissions (without LUCF) in 2006, 74.9% in 2020 and 77.6% in 2030. The second largest sector is agriculture. The share of emissions from the agriculture sector in total emissions (excluding LUCF) was 36.5% in 2006. But the projections show that the share is expected to be reduced to 19.2% in 2020 and 16.2% in 2030.

Table 6: Ranking of sectors by GHG Emissions,$GgCO_2$-eq

	2006			2020			2030		
	Ranking	%	GHG	Ranking	%	GHG	Ranking	%	GHG
Energy	I	57.7	10,220	I	74.9	25930	I	77.6	32800
Agriculture	II	36.5	6462	II	19.2	6657	II	16.2	6870
Industry	III	5	892	III	5.3	1840	III	5.5	2320
Waste	IV	0.8	138	IV	0.6	209	IV	0.7	294

The key subsector analysis of emissions without LUCF is shown in table 7. The first four main categories that contribute to more than 88% of the total emissions are (i) energy industries (electricity and heat production), (ii) enteric fermentation, (iii) transport and (iv) energy consumption in commercial, residential sectors. This analysis shows that these 4 subsectors should be the focus of future investigations for the identification of key subsectors for mitigation action.

Table 7: Key subsector analysis

Sector	Subsector	GHG Emission, $GgCO_2$-eq	Contribution%	Cumulative contribution, %
Energy	Energy Industries	6,399	36.1	36.1
Agriculture	Enteric Fermentation	5,895	33.3	69.4
Energy	Transport	1,887	10.7	80.0
Energy	Residential and Commercial	1,181	6.7	86.7
Industrial Processes	Consumption of HFCs, PFCs, SF_6	767	4.3	91.0
Agriculture	Agricultural Soils	394	2.2	93.3
Energy	Manufacturing and construction	356	2.0	95.3
Energy	Others	244	1.4	96.7
Agriculture	Manure Management	172	1.0	97.6
Energy	Fugitive Emissions from Fuels	150	0.8	98.5
Industrial Processes	Mineral Products	125	0.7	99.2
Waste	Wastewater Handling	87	0.5	99.7
Waste	Solid Waste Disposal on Land	51	0.3	100.0

Source: MNET, Mongolia's Second National Communication: Under the UNFCCC

Energy industries subsector: The largest GHG emitting subsector is the energy industries or energy generation subsector. Coal is the principle primary energy source in Mongolia. The Mongolian energy sector is almost fully dependant on brown coal. Coal fired Combined Heat and Power (CHP) plants produce approximately 98 percent of the country's electricity. Although, Mongolia is rich in renewable energy sources such as wind, solar and water, the utilization of these resources is still in its early stages. Currently, small scaled hydroelectric power plants produce less than one percent of the total electricity generation in Mongolia.

Space heating sustains livelihood and economic activities during the harsh Mongolian winter, which lasts approximately eight months, with extreme temperatures reaching -30 to -40°C. CHPs produce 70 per cent of the country's total heat energy supply, while small and medium capacity boilers and home stoves produce 20 percent and 10 percent respectively. A rapid increase in urban populations, fed by a large influx of migrants in recent years, has resulted in a proliferation of coal-fired heating stoves and small boilers in Ulaanbaatar and other cities, leading to high GHG emissions and serious indoor and ambient air pollution.

According to the infrastructure development program of the Government, in the coming years in order to meet the growing energy demand new energy sources such as coal fired CHPs for heat and electricity generation, coal fired thermal power stations (TPS) for electricity production, and wind farms are expected to be established. It is also expected that the capacity of existing power plants will be increased and renewed. GHG emissions in the energy industries (energy generation) subsector are projected to be 15,560 $GgCO_2$-eq in 2020 and 24,130 $GgCO_2$-eq in 2030 and estimated to increase by a factor of 2.27 compared to 2006 levels by 2020 and 3.52 by 2030. GHG intensity (GHG/energy) is projected to increase by a factor of 1.2 by 2020 and 1.28 by 2030 compared to 2006 levels[6].

Agriculture (Enteric Fermentation) subsector: The second largest GHG emitting source after the energy industry is enteric fermentation. Livestock husbandry is the traditional foundation of Mongolia's economy and still plays an important role in the economy, employment and export revenues of Mongolia. In 2010, 15.9 % of GDP was produced by the agriculture sector, of which 75% was from livestock husbandry. At the end of 2010, a total of 32.7 million head of livestock were counted, of which 1.9 million were horses, 2.2 million cattle, 0.27 million camels, 14.5 million sheep, and 13.9 million were goats.

The majority of GHG from agriculture is methane from enteric fermentation. 33.3% of Mongolia's total GHG emissions (without LUCF) are from enteric fermentation. Projected methane emissions from the agriculture sector depends on changes in the livestock population. According to the Mongolian National Livestock Program, the population of livestock should decrease from 43 million in 2008 to 36 million in 2021 to comply with the actual pasture carrying capacity and to prevent desertification. Despite a recent reduction in the livestock population, methane emissions have slightly increased because of increases in the share of dairy cattle (a more emission intensive animal) in the total number of animals.

Transport subsector: The third largest GHG emitting source after energy and enteric fermentation is the transport subsector. Because of the low density of population and vastness of the territory, transportation is considered essential for socioeconomic development of the country. Since the country's transition to market economy, state-owned transportation enterprises have been privatized and private companies now play a major role in the transportation sector. Today, inter-city passenger and freight transportation, and taxi services are provided by private enterprises.

In 2010, freight turnover reached 12,124.8 million tonne•km, while passenger turnover was 3,372.4 million passenger•km. The total number of vehicles reached 254,500, of which about 172.6 thousand are sedans, 61,800 trucks, 16,400 buses, and 3,700 are specially equipped vehicles. In Ulaanbaatar city there are 162,700 registered vehicles or 63.9 percent of all vehicles in Mongolia. Currently, all liquid fuels are imported from Russia and China.

The Mongolian railway is now executing 92.6 percent of national freight turnover, with 1,815 km of railways connecting with Russia and China. The Mongolian railway plays a critical role in connecting the country with Europe and East and Southeast Asia through our two neighboring countries Russia and China.

10.7% of Mongolia's total GHG emissions (without LUCF) are from the transport sector.

The transport sector is projected to experience a high GHG emissions growth rate due to the relatively high increase of vehicles and demand for freight transport. GHG emissions from fuel combustion in the transport sector are projected to increase by a factor of 2.5 by 2020 and 4.9 by 2030 from 2006 levels.

Residential and Commercial subsector: The fourth largest GHG emitting subsector is the commercial and residential subsector. Energy consumption in the household sector depends on the population growth rate, the number of households and income levels. In 2010, the commercial and residential subsector accounted for 16% of total coal consumption, 69% of total heat distribution and 24% of electricity consumption.

8.1% of total GHG emissions (excluding LUCF) are directly from the commercial and residential subsector. GHG emissions from the residential sector are projected to increase largely due to the expected 3% average annual increase in population. It is estimated that energy consumption in the household sector will increase by a factor of 1.84 by 2020 and 2.55 by 2030 from 2006 levels. GHG emissions from the commercial sector are projected to increase by a factor of 2.9 by 2020 from 2006 levels.

In addition to the GHG mitigation potential in different sectors and subsectors, Mongolia's development strategies for various sectors was considered in choosing the priority sectors. Considerations included economic (e.g. poverty alleviation, green growth, job creation) and also non-economic factors (e.g. energy security, local pollution emissions). The development strategies and priorities are summarized in section 1.2.

6. MNET, Mongolia's Second National Communication: Under the UNFCCC

Based on the key documents which reflect the Mongolian development strategy summarized in section 1.2, other research findings, and stakeholders' recommendations, the following list of development priorities (in terms of GHG mitigation), grouped as economic, environmental and social priorities, from a short and longer term perspective, was developed (table 8).

Table 8: Development priorities

Development priorities	***Short term (2007–2015)***	***Long term (2016–2021)***
Economic development priorities		
Economic growth	Mineral deposits of strategic importance shall be exploited.	Intensify exploitation of mineral deposits of strategic importance. Introduce advanced machinery and technologies in mining and natural resource sectors. Expand processing and realization of end products.
	Industry and technology parks shall be established using both domestic and international resources in an efficient manner and harmonizing them to support regional development.	The share of knowledge-intensive, advanced technology-based production shall be strengthened and increased.
	Development of nomadic and intensive animal husbandry and crop-farming production by improving land use and developing irrigated cultivation.	Introduce biotechnology, improve livestock breeds, and raise the volume of crop yield.
Energy supply development	Expand energy supply to meet rapidly increasing energy demand.	Expand energy supply to meet rapidly increasing energy demand by using clean and advanced technology.
Roads and transport development	The road network and quality of public transport services in Ulaanbaatar City will be improved. The capacity of railways and air transport will be increased.	Actions will be taken to expand road and railway networks, develop air and water transport, and complete the work of connecting the capital city, centers of aimags and regions by paved roads.
Environmental development priorities		
Reduction of air pollution	Implement policies and technologies that decrease environmental pollution.	
Reduction of soil degradation	Implement technologies and policies that reduce and prevent soil degradation.	
Reduction of water pollution	Implement technologies and policies to reduce water pollution and improve the effective use of water resources.	
Protection of forestry and reforestation	Implement technologies and policies for the protection of forests and reforestation.	
Social development priorities		
Healthcare improvement	Provide the population with safe and quality-tested medications and medical tools. Introduce proper medical technology and develop infrastructure within the sector.	
Education and human development	Develop and implement open content and flexible forms of education that will allow citizens to improve their education and benefit from re-profiling training.	
Welfare	Improve and implement social welfare policy.	

3.2 Process, criteria, and results of sector selection

Selection of priority subsectors for the TNA was based on key subsector analysis and stakeholder opinions. Stakeholders selected the priority sectors using a scoring system. Before scoring the sectors, definitions of the criteria for scoring were provided so that stakeholders better understood each criterion (table 9).

Based on the GHG inventory data in section 3.1, and in light of the development priorities outlined in section 1.2, the 13 stakeholders (listed in table 1) were asked to score the sectors on a scale of 0-5, where:

0 - no benefit
1 - faintly desirable
2 - fairly desirable
3 - moderately desirable
4 - very desirable
5 - extremely desirable

Table 10 shows the overall list of scores given to the sectors by the stakeholders.

Table 9: Definition of criteria for scoring under economic, environmental and social development priorities

Development priorities	***Definition***
Economic development priorities	
Economic growth	Support for economic development through development of mineral deposits, new industrial parks, investments, develop a processing industry for agricultural products, and increase agricultural productivity
Energy supply development	Improve access, availability and quality of electricity and heating services such as increased coverage and reliability
Roads and transport development	Take actions to expand road and railway networks
Environmental development priorities	
Reduction of air pollution	Improve air quality by reducing air pollutants such as SOx, NOx, suspended particulate matter, non-methane volatile organic compounds, dust, fly ash and others
Reduction of soil degradation	Avoid soil pollution including avoided waste disposal and improvement of the soil through the production and use of manure nutrients and other fertilizers
Reduction of water pollution	Improve water quality by reducing inappropriate cleaning techniques and excessive use of fertilizer that caused water pollution
Social development priorities	
Healthcare improvement	Reduce health risks such as diseases and accidents or improve health conditions through activities such as construction of a hospital, running a health care centre, preservation of food, reducing health damaging air pollutants and indoor smoke
Education and human development	Facilitate education, dissemination of information, research and increased awareness related to e.g. waste management, renewable energy resources and climate change through construction of a school, running of educational programs, site visits and tours
Welfare	Improve local living and working conditions including safety, community or rural development, reduce traffic congestion, poverty alleviation and income redistribution through e.g. increased municipal tax revenues

Table 10: Scoring the sub-sectors within the energy, agriculture, industry and waste sectors

Sector/Subsector	*Economic priorities*	*Social priorities*	*Environ-mental priority*	*Develop-ment priorities sub-total*	*GHG reduction potential*	*Total benefit*
Energy sector						
Energy Industries	*4*	*4*	*5*	**13**	**5**	**18**
Transport	*3*	*3*	*4*	10	4	14
Residential and Commercial	*4*	*4*	*4*	**12**	**4**	**16**
Manufacturing and construction	*2*	*2*	*2*	6	3	9
Fugitive Emissions from Fuels	*2*	*1*	*3*	6	1	7
Agriculture						
Enteric Fermentation	*0*	*1*	*3*	4	3	7
Manure Management	*2*	*2*	*2*	5	2	8
Agricultural Soils	*1*	*1*	*2*	4	2	6
Industrial Process						
Consumption of HFCs, PFCs, SF_6	*1*	*1*	*1*	3	1	4
Mineral Products	*3*	*2*	*3*	8	2	10
Waste						
Solid Waste Disposal on Land	*2*	*3*	*3*	8	2	10
Wastewater Handling	*1*	*2*	*3*	6	1	7

The scores given for potential improvements in, and contributions to, development priorities were justified. Improvement of the energy sector by developing renewable energy resources such as hydro and wind energy and introducing energy efficient coal fired heat and electricity generation technologies could have the following positive impacts, as indicated by the stakeholders:

- *Economic development priorities:* Reduce coal and oil consumption for energy supply, reduce energy losses in energy transmission and distribution.
- *Social development priorities:* Reduce health risks such as diseases or improved health conditions
- *Environment development priorities:* Reduce emissions of pollutants from power plants that will reduce local air pollution

For the agriculture sector, improvement in management of manure use and livestock population can have the following beneficial impacts:

- *Economic development priorities:* Increase energy supply in rural areas through technologies like biogas and biomass energy utilization.
- *Social development priorities:* Improvement in local living and working conditions.
- *Environment development priorities:* Reduce soil degradation by improving management of livestock populations.

Investing in the mineral products industry by introducing modern, efficient technologies can have the following beneficial impacts:

- *Economic development priorities:* Increase productivity and efficient use of materials and energy resources.
- *Social development priorities:* Improve local living and working conditions.
- *Environment development priorities:* Reduce emissions of pollutants from industries that will lead to lower local air pollution.

For the waste sector, improved management of municipal solid waste disposal can have the following beneficial impacts:

- *Economic development priorities:* Increased supply of heat and electricity through technologies like incineration, landfill gas and biogas generation, capture, and use. Also proper segregation of waste enhances recycling of the products thereby lowering production costs. This also promotes development of enterprises hence generating employment opportunities.
- *Social development pri orities:* Better sanitation and better health

conditions.

- *Environment development priorities:* Less solid waste pollution and proper handling of toxic waste can reduce soil pollution and land degradation.

Table 10 clearly shows that the energy sector has a strong contribution to both GHG emission reduction and meeting development priorities. The other sectors (agriculture, industrial processes and waste) are of lower development priorities and also less GHG emission reduction potential. A criteria contribution graph (figure 2) was produced for the energy sector to support the final decision making process. The criteria contribution graph can help the stakeholders decide whether it is desirable to prioritize a sub-sector or not. During decision-making, high scores for a single criterion or an even contribution in all criteria were taken into account. The sectors with a strong contribution to both GHG emission reduction and development priorities were given high priority. However, the sectors which have high development priorities but less GHG emission reduction were not overlooked.

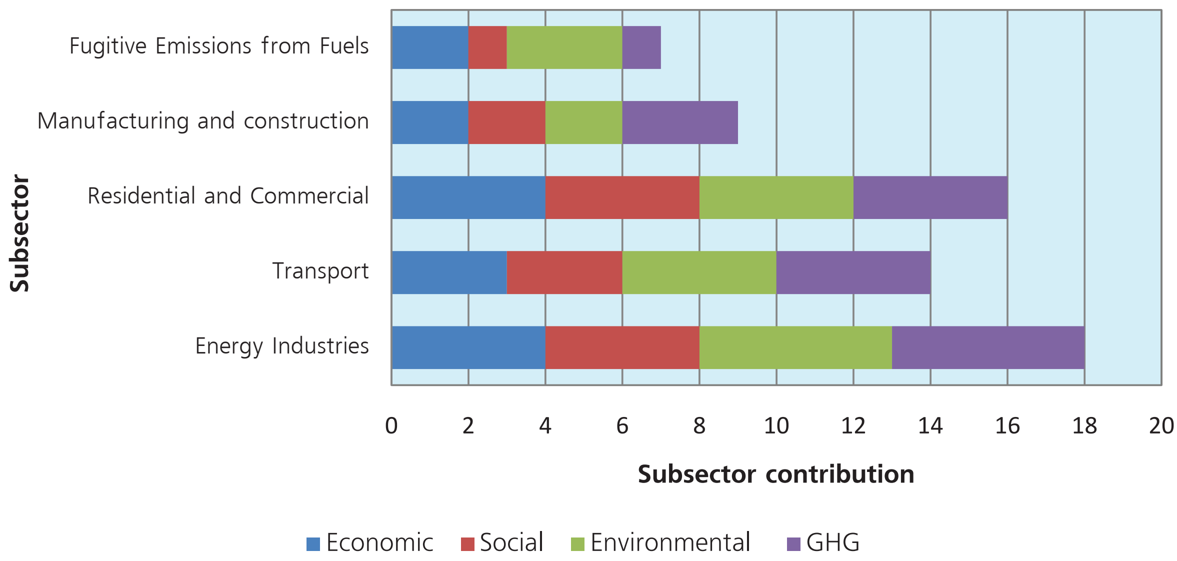

Figure 2: *Criteria contribution graph for energy sector*

Based on these results the energy industry subsector was chosen as the first priority subsector because it scored 5 on GHG reduction potential and 13 on the development priorities. Its overall score was 18, the highest among all subsectors. The residential and commercial subsector was chosen as the second priority subsector with a score of 4 on GHG reduction potential and 12 on development priorities, and its overall score was 16, the second highest among the subsectors.

4. Technology prioritization for the Energy industries subsector

4.1 GHG emissions and existing technologies of energy industries subsector

The energy sector is by far the most significant source of GHG emissions in Mongolia. The emission inventory for energy includes the emissions resulting from fuel combustion as well as the fugitive emissions during extraction of solid fuels. In 2006, GHG emissions of the energy sector totaled 10,220 $GgCO_2$-eq. The energy industries subsector accounted for 62.6% of GHG emissions from the energy sector.

Table 11: Trend of GHG emissions by gas from energy industries subsector

	Unit	*1990*	*1995*	*2000*	*2004*	*2005*	*2006*
Total emissions (gross)	$GgCO_2$-eq	23,645	17,205	16,896	16,910	17,582	18,868
Energy sector	$GgCO_2$-eq	12,529	8,710	8,865	9,247	9,635	10,220
Energy industries subsector	$GgCO_2$-eq	6,585	5,600	6,231	6,247	6,421	6,399
	% in total emissions	*27.9*	*32.5*	*36.9*	*37.0*	*36.5*	*33.9*
	% in energy sector emissions	*52.6*	*64.3*	*70.2*	*67.6*	*66.6*	*62.6*

Source: Mongolia's Second National Communication, Ulaanbaatar 2010.

High emissions of carbon dioxide from the energy industries subsector are largely attributable to the coal-fired power and heat generating facilities. Power and heat generation accounted for about 65% of the carbon dioxide emissions from fuel combustion in 2006, whereas transportation accounted for 19%, manufacturing and construction 4%, residential, commercial 10% and others, including public use contributing to the rest (figure 3).

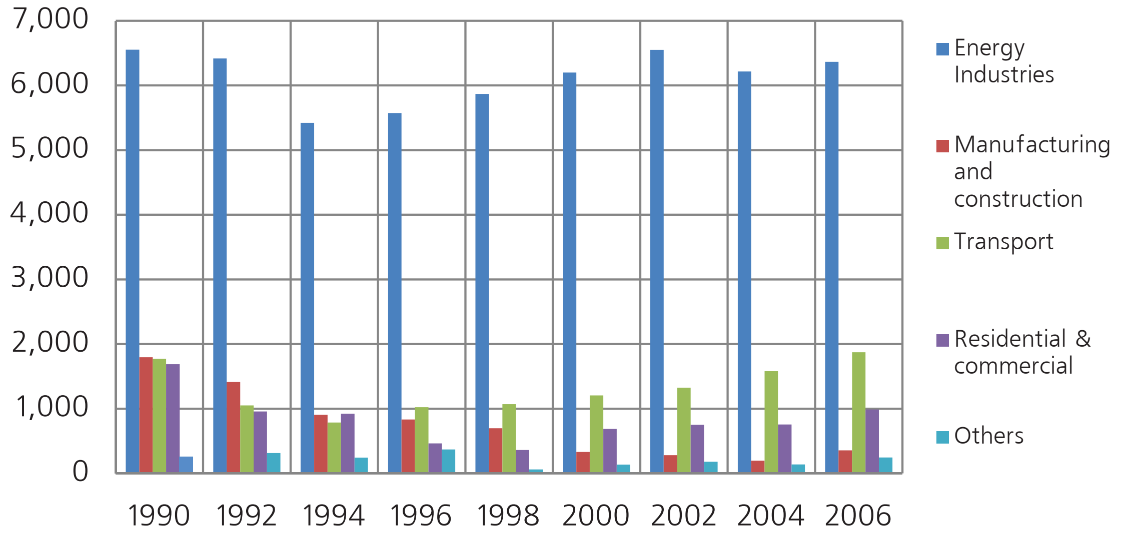

Figure 3: *Carbon dioxide emissions from fuel combustion by source, Gg*

The energy sector in Mongolia is designed around an integrated system of coal production for the generation of power and heat. Coal-fired Combined Heat and Power (CHP) plants produce steam for electricity generation, space heating, domestic hot water supply, and steam for industrial processes. The electric power system in Mongolia consists of four independent electric power systems: Central Energy System (CES), the Western Energy System (WES), the Eastern Energy System and Altai-Uliastai energy system. The majority (79%) of electricity is produced by CHP plants with installed capacity of 823 MW, 4% is produced by 46 MW of diesel plants, and some small hydro, solar and wind plants also operate. Energy shortages during peak load in the CES and about 60% of all electricity demand in the WES is addressed with electricity imports from Russia.

The CES supplies energy to the capital city and 13 aimags in central Mongolia and accounts for over 90% of the country's total energy consumption. The CES power supply is comprised of five coal-fired CHP plants (3 in Ulaanbaatar, one each in Darkhan and Erdenet) and an interconnection to Russia. Ulaanbaatar CHP4 accounts for almost 70% of total generation capacity.

Because of the long and extremely cold winters access to heating is vital in Mongolia. The main sources of space heating in Mongolia are:

- combined heat and power plants, which provide electricity, heat, and hot water to the urban centers in Ulaanbaatar and a few other cities; and
- heat-only boilers, which meet the heating and hot water needs of a small central network of several buildings.

The central heating systems in Ulaanbaatar, Darkhan, Erdenet and Choibalsan are an integral part of the energy industry and supply heat to nearly 40% of the urban population. The combined total capacity of the central heating systems is about 2011 MW thermal, of which Ulaanbaatar accounts for 67%. Most of the district heating systems are highly deteriorated and unable to meet any environmental standards.

Management capabilities in the energy sector are poor and the existing tariff systems can neither recover the cost of energy supply, nor provide any incentive for efficient use of heat energy. Energy loss during heat distribution is high. As a result, heat supply is highly unreliable and it burdens public and private budgets with high costs. Due to the large number of existing heating systems and their low efficiency, heating systems have enormous potential for energy efficiency improvements. Outside of Ulaanbaatar, 19 of the 21 aimags are connected to the Central Energy System and about five aimags have their own central heating plants.

Electricity and heat production and coal consumption of the CHP plants are shown in table 12 and technical details of the installed CHP plants are shown in table 13.

Table 12: Electricity and heat production, and coal consumption of CHPs in 2011

		CHP2	*CHP3*	*CHP4*	*Darkhan CHP*	*Erdenet CHP*	*CES Total*	*Dornod CHP*	*Dalan CHP*	*TOTAL*
Electricity production, million kWh		125.8	685.6	3101.5	266.2	134.6	4313.8	115.8	20.7	4450.3
Electricity distributed, million kWh		106.6	540.8	2690.8	216.5	106.0	3660.6	94.3	15.5	3770.4
Heat distributed, 1000 Gcal.		164.1	1847.8	3128.8	453.6	521.7	6116.1	187.5	17.8	6321.4
From	Water	149.3	1570.6	3003.2	443.0	491.0	5657.1	187.5	17.8	5862.4
	Steam	14.8	277.2	125.6	10.6	30.7	458.9	-	-	458.9
Average calorific value of coal, kcal/kg		3454	3479	3295	3645	4085	3406	2524	4945	3371
Coal consumption, 1000 tons		191.5	1067.5	2899.7	351.9	222.4	4733.0	270.6	39.4	5043

Source: Energy Statistics: 2011, Energy regulatory Agency, Ulaanbaatar, 2012

Table 13: The main installations of the CHPs in Mongolia

Boiler						*Turbine*						*Boiler*			
Type	Number of installations	Year Commissioned	Capacity, t/h	Steam pressure, kg/cm$_2$	Steam temperature, ^{0}C	Type	Number of installations	Year Commissioned	Capacity, t/h	Steam pressure, kg/cm$_2$	Steam temperature, ^{0}C	Type	Number of installations	Capacity, t/h	Steam pressure, kg/cm$_2$
CHP 2															
TC -35-39	2	1961	35	39	440	AK-6-35	1	1961	6	35	435	TQC5466-2	2	6	6.3
BKZ-75-39	2	1969	75	39	440	R-4-35	1	1961	3.5	35	435	T2-12-2	1	12	6.3
						PT-12-35/10	1	1969	12	35	435				
CHP3															
BKZ-75-39FB	6	1968-1975	75	39	440	PT12-5/10M	4	1973-1975	12	35	435	T2-12-2	4	12	6.3
BKZ-220-100-4C	7	1976-1981	220	100	540	PT25-90/10M	4	1977-1979	12	90	535	TBC-32	4	22	6.3
CHP 4															
BKZ-420-140-10C	8	1983-1991	420	140	560	PT80/100-130-13	2	1983, 1991	80	130	555	TBF-120-2UZ	2	80	10.5
						PT80/100-130-13	1	1990	100	130	555	TBF-120-2UZ	2	100	10.5
						T-100-120-130-4	3	1984-1986	100	130	555				
Darkhan CHP															
BKZ-75-39FB	9	1965-1986	75	39	440	APT12-35/10	4	1965	12	35	435	T2-12-2	4	12	6.3
Erdenet CHP															
BKZ-75-39FB	7	1986-1989	75	39	440	PT12-35/10M	1	1987	12	35	435	T2-12-2YZ	1	12	6.3

						R12-35/5M	2	1988-1989	8.4	35	435	T2-12-2	2	8.4	6.3
Dornod CHP															
TP-35U	3	1969-1970	35	39	440	AP6-35/5	2	1969	6	35	435	T2-6-2	2	6	6.3
BKZ-75-39FB	3	1979-1982	75	39	440	PT12-35/10M	2	1980-1982	12	35	435	T2-12-2	2	12	6.3
Dalanzadgad CHP															
UG-27/3.63M	2	1969-1970	35	39	440	AP6-35/5	2	1969	6	35	435	T2-6-2	2	6	6.3
BKZ-75-39FB	2	2000	27	36.3	376.6	DNG-61-55	2	2000	3	36	367	YEC-114-1979	2	3	6.3
SHX25-2.43/400	1	2012	25	24.7	400.0	N3-2.35	1	2012	3	24.7	390	QF-3-2	1	3	6.3

Source: Energy Statistics: 2011, Energy regulatory Agency, Ulaanbaatar, 2012

There are currently 13 hydro plants operating in Mongolia with capacities ranging from 150 kW to 12.0 MW each. The biggest hydropower plants are Durgun HPP (12 MW) and Taishir HPP (11 MW). The technical data for these HPPs are shown in table 14. The smaller hydro plants are of run-of-river designs that provide electricity to neighboring rural areas except during the winter.

Table 14: The main installations of hydro power plants

Name of power plants	*Main installations*	*Type of installations*	*Number of installations*	*Installed capacity, kW*	*Voltage, V*	*Commission year*
Durgun hydro power plant	Hydro turbine	ZZ660-LH-250	3	4260	-	2008
	Generator	SF4000-28-3930	3	4000	6.3	2008
Taishir hydro power plant	Hydro turbine	HLA643-LJ-58	1	650	-	2010
		HLA551-LJ-110	3	3450	-	2010
	Generator	SF-J650-990	1	650	6.3	2010
		SF-J3450-12/2600	3	3450	6.3	2010

The Government of Mongolia adopted the 100 000 Solar Gers programme. 100,000 gers (out of a total 170 000 gers in the whole country) have been provided with independent solar PV systems to supply electricity for lighting and the operation of radios, TVs and satellite dishes.

Wind power is anticipated by the government to play a major role in electrification of rural areas. Recently wind power stations as well as combined solar-wind stations were built in some soum centers.

The construction of a wind power farm with a total capacity of 50 MW has started at "Salkhit Uul", near Ulaanbaatar. This will be a first-of-its-kind project in Mongolia and also will be the first renewable project to be implemented by a private investor, Clean Energy – a local company wholly-owned by the Mongolian Newcom group.

A brief summary of existing technologies for the energy industries subsector is shown in table 15.

Table 15: Brief summary of existing technologies for the energy industries subsector

Service	*Category*	*Technology*	*Brief descriptions*
Electricity supply	Fossil fuel	Combined heat and power, large scale	There are 7 Combined Heat and Power plants (CHP) in Mongolia. They produce the majority of electricity and heat energy.
		Diesel for electricity generation	The province centers which are not connected to the central grid have diesel generators for electricity supply.
	Renewable energy	Small-scale hydropower plant	There are currently 13 hydro plants operating with capacities ranging from 150 kW to 12.0 MW.
		Small-scale solar PV	Most herders have independent solar PV systems to generate electricity for using lights, radios and TVs
		Solar and wind hybrid technologies	Recently, wind power stations as well as combined Solar-Wind stations were built in some soum centers.
Heat supply	Fossil fuel	Combined heat and power, large scale	There are 7 Combined Heat and Power plants (CHP) in Mongolia. They produce the majority of electricity and heat energy.
		Heating stations for space heating and domestic hot water	Heating stations are used in province centers.

4.2 An overview of possible mitigation technology options in the energy supply sector and their mitigation benefits

The identification of technologies to be assessed for the TNA was based on previous experiences and projects implemented in Mongolia, discussion with stakeholders, research on the Climate Tech Wiki technology database and other online and offline information on mitigation technologies.

A prominent feature of the Mongolian energy sector is that coal is the primary energy source at present, covering more than 90 percent of total solid fuel consumption and heat supply. Therefore the priority goal of the energy supply subsector is to ensure energy security, preferably with cleaner energy sources than coal or use coal with a higher efficiency.

Table 16 is the full list of electricity and heat supply technologies considered for the energy industries subsector.

Table 16: List of technologies for assessment for energy supply subsector

Service	Category	Technology
Electricity supply	Renewable energy	Large-scale dam-based hydro for electricity supply (more than 100MW)
		Large-scale run-of-river hydro for electricity supply (15-75MW)
		Medium-sized dam-based hydro for electricity supply (10-100 MW)
		Small-scale hydropower plant (up to 10 MW), including mini hydro (100 kW – 1 MW) and micro hydro (5-100 kW)
		Pumped storage hydroelectricity
		Wind turbines: on-shore, large scale
		Solar PV(off grid, grid connected, solar home system)
		Solar thermal-CSP, central receiver tower, parabolic trough collector and dish
		Biomass combustion and co-firing for electricity and heat
	Fossil fuel	Combined heat and power; large-scale
		Combined heat and power; small-scale
		Coalmine/coalbed methane recovery
		Carbon capture and storage
		Integrated gasification, combined-cycle
		Pulverized coal combustion with higher efficiency
	Other	Fuel cell for stationary applications
		Hydrogen technologies
		Downdraft energy tower
		Methane capture at landfills for electricity and heat
Heat supply	Fossil fuel	Combined heat and power; large-scale
		Combined heat and power; small-scale
		Heat only boilers for space heating and domestic hot water supply
		Coal mine/coal bed methane recovery
	Renewable	Biomass combustion for electricity and heat
		Solar heating technologies
		Heat pump for space heating and water heating
	Other	Fuel cell for stationary applications
		Hydrogen technologies
		Methane capture at landfills for electricity and heat
		Combustion of municipal solid waste for district heating

The initial list of technologies was reviewed and edited by the stakeholders, consultants and experts. In the review technologies were either added or bundled together for the following reasons:

- Technologies for the production of both electricity and for heat were bundled under the energy service category electricity and heat supply.
- Combined Heat and Power (CHP): small scale technologies combined as a single technology entry.

The technologies were then categorized by the expected availability in time and applicability in scale as given in table 17, where:

- Short term means that the technology has proved to be reliable and commercialized in a similar market environment;
- Medium term means that the technology would be pre-commercial in the Mongolian market in the medium term (5 years to full market availability);
- A long term technology is one still at the R&D phase or is a prototype;
- Small-scale technologies are those applied at the household and/or community level, which could be scaled up into a program; and
- All technologies applied at a scale larger than household or community levels are considered large scale technologies.

Table 17: List of edited technologies with their scale and availability in the energy industries subsector

Energy Service	Category	Technology	Scale	Availability potential
Electricity supply	Renewable energy	Large scale dam-based hydro for electricity supply (more than 100MW)	Large	Short
		Large scale run-of-river hydro for electricity supply (15-75MW)	Large	Short
		Medium-sized dam-based hydro for electricity supply (10-100 MW)	Large	Short
		Small scale hydropower plant (up to 10 MW) including mini hydro (100 kW – 1 MW) and micro hydro (5-100 kW)	Small	Short
		Pumped storage hydroelectricity	Small to large	Short
		Wind turbines: on-shore, large scale	Small to large	Short
		Solar PV(off grid, grid connected, solar home system)	Small to large	Short
		Solar thermal -CSP; Central receiver tower, parabolic trough collector and dish	Small to large	Short to medium
	Fossil fuels	Carbon capture and storage	Large	Long
		Integrated coal gasification combined cycle	Large	Long
		Pulverized Coal Combustion with higher efficiency	Large	Short
	Other	Fuel cell for stationary applications	Small	Long
		Hydrogen technologies	Small to large	Long
		Downdraft energy tower	Large	Long
Heating	Fossil fuel	Heat only boilers for space heating and domestic hot water	Small	Short
	Renewable	Solar heating technologies	Small to large	Short to medium
		Heat pump for space heating and water heating	Small	Short
	Other	Fuel cell for stationary applications	Small	Long
		Hydrogen technologies	Large	Long
		Combustion of municipal solid waste for district heating	Large	Short
Electricity and heat supply	Fossil fuel	Combined heat and power (CHP)	Small to large	Short
		Coal mine/coal-bed methane recovery for electricity and heat	Large	Short
	Renewable	Biomass combustion for electricity and heat	Large	Short
	Other	Methane capture at landfills for electricity and heat	Large	Short

This revised list of technologies was assessed by the stakeholders and a short list was prepared based on those technologies that were particularly suitable to Mongolian conditions, that could be introduced in a reasonable timeframe and that could deliver reasonable GHG mitigation.

Technologies were rejected for the following reasons:

- The technologies such as run-of-river hydro power plants, small and mini hydro power plants, solar heating, methane capture at landfills for electricity and heat were rejected as they cannot operate during winter in Mongolia's extremely cold climate conditions. Working only in the short warm period, they are not considered to be of high mitigation potential.
- Fuel cells for stationary applications, hydrogen technologies and the downdraft energy tower were rejected because, these technologies are not available at commercial scale yet.
- The existing technologies such as combined heat and power plants in the energy saving categories were rejected as they are not considered to have high mitigation potential.
- Heat pumps for space heating and water heating, combustion of municipal solid waste for district heating and coalmine/coal-bed methane recovery for electricity and heat technologies have also been rejected by the stakeholders as their mitigation potential are not considered to be high.

Table 18 lists the technologies shortlisted through the stakeholder consultation process.

Table 18: Shortlist of technologies for energy supply subsector after stakeholder consultation

Energy Service	***Category***	***Technology***
Electricity supply	Renewable energy	Large scale dam-based hydro for electricity supply (more than 100MW)
		Medium-sized dam-based hydro for electricity supply (10-100 MW)
		Pumped storage hydroelectricity
		Wind turbines: on-shore, large scale
		Solar PV (off grid, grid connected, solar home system)
		Solar thermal –CSP, central receiver tower, parabolic trough collector and dish
	Fossil fuels	Carbon capture and storage
		Integrated coal gasification combined cycle
		Pulverized Coal Combustion with higher efficiency
Heat supply	Fossil fuel	Heat only boilers for space heating and domestic hot water

National consultants prepared Technology Fact Sheets (TFS) for each of the shortlisted technologies (See Annex 1).

The technology fact sheets include:

- Sector GHG emission
- Short description of the technology option
- Implementation assumptions
- Potential for reducing GHG emissions
- Impacts on the country development priorities
    - Social development priorities
    - Economic development priorities
    - Environmental development priorities
    - Market potential
- Costs
    - Capital costs
    - Operational and Maintenance costs
    - Cost of GHG reduction

4.3 Criteria and process of technology prioritization

The shortlisted technologies next needed to be further prioritized. The stakeholders discussed and finalized the appropriate criteria for prioritization of low emission technologies. The stakeholder group that undertook this task consisted of representatives from the Ministry of Mineral Resources and Energy, Ministry of Nature, Environment and Tourism, Mongolian Energy Association, Energy Authority, private companies and city government.

The prioritization was based on the costs of the technology and the benefits expected in the areas of national social, environmental and economic development. The criteria were clearly defined and categorized to help identify where the largest improvements could be made in terms of GHG mitigation and development priorities.

The technologies were scored on each criterion by the stakeholders on a scale of 0-100 based on the information provided in the TFSs. A score of 0 was given to the technology option which was least preferred under that criterion and 100 for the most preferred option under the same criteria. The other technology options were scored relative to these two scores. This approach of scoring the performance of technologies under the environmental, social and economic categories is referred to as multi-criteria decision analysis (MCDA). Under this approach it is not necessary to monetize the non-economic items.

After determining a score for each individual technology, the final score sheet was prepared. The scores in table 20 were obtained after counting the highest number of stakeholders giving the same score to that particular technology. Scoring was essentially done on the basis of performance matrix.

Table 19: Criteria for technology prioritization in the energy supply subsector

Costs	
Capital Costs (Construction of power/heat supply plants)	These should include both public and private capital costs.
O & M Costs (plus fuel costs)	These include costs incurred to maintain power/heating plants and fuel costs.
Cost effectiveness of mitigation	The technologies being selected are for mitigation therefore it is important to look at the cost effectiveness of the technology in terms of USD per unit of CO_2 mitigation.
Benefits	
Environmental Development Priorities	**Definition**
Reduced air pollution	Improving air quality by reducing air pollutants such as SOx, NOx, suspended particulate matter, non-methane volatile organic compounds, dust, fly ash and others.
GHG emission reduction by 2030	Reduction in GHG emission through promotion of clean energy and efficient technologies in the energy supply subsector.
Social Development Priorities	
Healthcare improvement	Reduction of health risks such as diseases or improvement of health conditions reducing health damaging air pollutants and indoor smoke.
Economic Development Priorities	
Energy supply improvement	Improved access, availability and quality of electricity and heating services.
Balance of Payments	Reduction in the use of foreign exchange through a reduction of imported oil products and electricity in order to increase national economic independence.

Table 20: Scoring for the initial list of priority technologies for energy supply subsector

	Technology Option	**Criteria**							
		Capital Costs	O & M Costs (plus fuel costs)	Cost effectiveness for mitigation	GHG emission reduction by 2030	Reduced air pollution	Healthcare improvement	Energy supply improvement	Balance of Payments
1	Large scale dam-based hydro for electricity supply (more than 100MW)	90	90	100	80	100	100	100	100
2	Medium-sized dam-based hydro for electricity supply (10-100 MW)	80	85	70	60	0	40	70	50
3	Pumped storage hydroelectricity	85	40	0	40	40	50	80	40
4	Wind turbines: on-shore, large scale	90	90	85	70	70	60	80	50
5	Solar PV (off grid, grid connected, solar home system)	0	50	40	50	75	80	70	35
6	Solar thermal –CSP, central receiver tower, parabolic trough collector and dish	30	100	60	70	70	60	70	50
7	Carbon capture and storage	10	0	70	100	70	0	0	0
8	Integrated coal gasification combined cycle	85	70	60	70	50	50	60	60
9	Pulverized Coal Combustion with higher efficiency	80	80	70	90	80	60	80	70
10	Heat only boilers for space heating and domestic hot water	100	70	60	0	60	50	50	60

Based on the scores in table 20, a list of the most and least preferred technologies for each criteria was prepared (table 21).

Table 21: Most preferred and the least preferred technologies

Reference	Capital Costs	O & M Costs (plus fuel costs)	Cost effectiveness for mitigation	GHG emission reduction by 2030	Reduced air pollution	Healthcare improvement	Energy supply improvement	Balance of Payments
Most preferred	HOB	CSP	Large HPP	CCS	Large HPP	Large HPP	Large HPP	Large HPP
Least preferred	Solar PV	CCS	Pumped storage HPP	HOB	Medium HPP	CCS	CCS	CCS

Based on the swing in the values, weights for each criterion were determined. This weight was then normalized and an average weighted score for each technology was calculated.

A summary of weights and normalized weights is given in table 22.

Table 22: Weights and normalized weights

Reference	Capital Costs	O & M Costs (plus fuel costs)	Cost effectiveness for mitigation	GHG emission reduction by 2030	Reduced air pollution	Healthcare improvement	Energy supply improvement	Balance of Payments
Normalized weights	19.6	17.6	17.6	15.7	5.9	5.9	9.8	7.8
Weights	100	90	90	80	30	30	50	40

The overall weighted score was then calculated by combining the weights and scores of the preferred technologies. Table 23 gives the calculated overall weighted score for the technologies.

In table 4.13 the highest overall weighted scores were for large scale dam-based hydro power plants, wind turbines, and pulverized coal combustion with higher efficiency. The technologies listed in order from high priority to low priority are:

1) Large scale dam-based hydro power plant (more than 100MW) (93)
2) Wind turbines (79)
3) Pulverized Coal Combustion with higher efficiency (78)
4) Integrated coal gasification combined cycle (67)
5) Medium-sized dam-based hydro for electricity supply (10-100 MW) (66)
6) Solar thermal – CSP (64)
7) Heat only boilers for space heating (59)
8) Pumped storage hydroelectricity (46)
9) Solar PV (off grid, grid connected, solar home system) (42)
10) Carbon capture and storage (34)

In figure 4 cost information provided in the TFS was compared to the benefit assessments. This figure helps us to visually judge the technologies in a cost benefit framework.

Table 23: Overall weighted score

	Technology Option	Capital Costs	O & M Costs (plus fuel costs)	Cost effectiveness for mitigation	GHG emission reduction by 2030	Reduced air pollution	Healthcare improvement	Energy supply improvement	Balance of Payments	Overall weighted score
		Criteria								
1	Large scale dam-based hydro for electricity supply (more than 100MW)	90	90	100	80	100	100	100	100	**93**
2	Medium-sized dam-based hydro for electricity supply (10-100 MW)	80	85	70	60	0	40	70	50	**66**
3	Pumped storage hydroelectricity	85	40	0	40	40	50	80	40	**46**
4	Wind turbines: on-shore, large scale	90	90	85	70	70	60	80	50	**79**
5	Solar PV (off grid, grid connected, solar home system)	0	50	40	50	75	80	70	35	**42**
6	Solar thermal –CSP, central receiver tower, parabolic trough collector and dish	30	100	60	70	70	60	70	50	**64**
7	Carbon capture and storage	10	0	70	100	70	0	0	0	**34**
8	Integrated coal gasification combined cycle	85	70	60	70	50	50	60	60	**67**
9	Pulverized Coal Combustion with higher efficiency	80	80	70	90	80	60	80	70	**78**
10	Heat only boilers for space heating and domestic hot water	100	70	60	0	60	50	50	60	**59**
Normalized weights		**19.6**	**17.6**	**17.6**	**15.7**	**5.9**	**5.9**	**9.8**	**7.8**	**100**

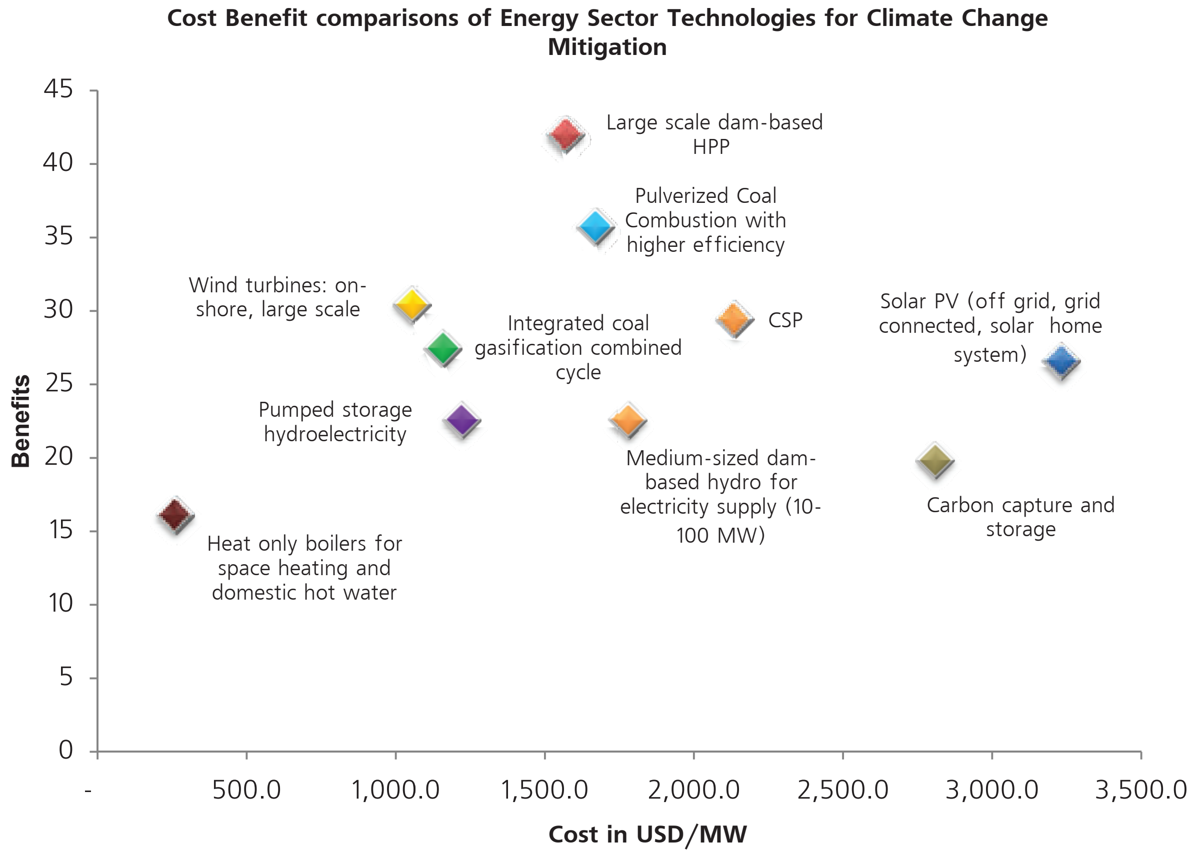

Figure 4: *Cost Benefit comparisons of the energy industry subsector technologies for climate change mitigation*

The large scale HPP has the highest benefit followed by Pulverized Coal Combustion with higher efficiency and wind turbines. Similarly, cost-wise HOB has the least cost followed by IGCC, pumped storage HPP, Large scale HPP and Pulverized Coal Combustion with higher efficiency.

After analyzing and discussing all the technologies the stakeholders decided to consider large scale hydropower plants, wind turbines and pulverized coal combustion technologies as the priority technologies.

4.4 Results of technology prioritization

Using the MCDA approach, the following technologies for the energy supply subsector were prioritized for future investigation:

- Large hydropower plant;
- Wind turbines; and
- Pulverized coal combustion technologies.

Large hydropower plant

Electric power generation in Mongolia is based mainly on generation through the combustion of coal which leads to relatively high emissions of CO_2. Hydropower provides an alternative clean source of energy with no direct GHG emissions. It contributes to GHG emission reduction by supplying electricity that would otherwise have been generated by coal-fired power plants.

There are some technical and economic feasibility studies of large (220 MW and 100 MW) hydropower station projects on rivers with significant hydropower resources such as Selenge, Eg and Orkhon rivers, and studies on how to implement these potential projects have bean done. But there are some challenges to build and implement these projects.

Wind Turbines

Mongolia has considerable wind energy resources that would allow the harnessing of wind energy. It has been estimated that more than 10% of the total territory has good-to-excellent potential for wind energy applications on a commercial scale.

Several wind farm projects with capacity of 30-50 MW each in different parts of Mongolia are under discussion. The objective of these wind farm projects is to generate renewable electricity using wind power resources and to sell the electricity to Mongolia's Central Grid on the basis of a power purchase agreement. The wind farms will lead to GHG emission reductions by replacing electricity generation by the fossil fuel power plants that currently supply the Central Grid of Mongolia.

Wind farm projects will assist Mongolia in stimulating and accelerating the commercialization of grid connected renewable energy technologies and markets. Some private companies are interested in implementing wind farm projects as CDM projects.

Pulverized coal combustion technologies

Coal is the main primary energy source in Mongolia. The share of coal and coal products in total primary energy supply was about 70% in 2008[7] .

Coal is expected to remain the most important primary energy source in the foreseeable future, because of the large coal reserves in Mongolia and the much smaller reserves of oil and gas. The total geological coal reserves are estimated at approximately 150 billion metric tons, including about 24 billion metric tons explored. Over 70 percent of the total domestic coal consumption is consumed at thermal power stations with the remainder going to heating plants, industry, households and the service sector.

The energy consumption will continue increasing rapidly due to population growth and economic development. In particular, energy consumption in the industrial sector is increasing rapidly due to the development of the mining and quarrying industry.

In order to meet this growing energy demand, new energy sources will be needed. Currently a Combined Heat and Power Plant (CHP) in Ulaanbaatar with capacity of 300MW, a wind farm in Salhit Uul near Ulaanbaatar with a capacity of 50MW, and the Tavan Tolgoi thermal power plant (300-600MW) are being planned for the coming years. In the long term, construction of coal fired thermal power plants is being considered. The future coal fired thermal power plants should be modern, energy efficient and environment friendly, such as a Pulverized coalthermal supercritical (or ultra critical) power plant. These technologies can combust pulverized coal and produce steam at higher temperatures and under a higher pressure, so that the efficiency is much higher than traditional coal fired thermal power plants and the environmental pollution is much less.

7. IEA Statistics, 2010

5. Technology prioritization for the Residential and commercial subsector

5.1 GHG emissions and existing technologies in the residential and commercial subsector

GHG emissions from the residential and commercial subsector in 2006 accounted for 6.25% of total emissions and 11.55% of emissions from the energy sector (table 24).

Table 24: Trend of GHG emissions from the residential and commercial subsector

	Unit	1990	1995	2000	2005	2006
Total emissions (gross)	$GgCO_2$-eq	23,645	17,205	16,896	17,582	18,868
Energy sector	$GgCO_2$-eq	12,529	8,710	8,865	9,635	10,220
Residential and commercial subsector	$GgCO_2$-eq	1,895	775	852	1,059	1,181
	% of total emissions	8.03	4.53	5.03	6.03	6.25
	% of energy sector emissions	15.16	8.96	9.58	11.00	11.55

Source: Mongolia's Second National Communication, Ulaanbaatar 2010.

The consumption of coal, electricity and heat by the residential and commercial subsector is shown in table 25. The table shows that the residential and commercial subsector in 2010 accounted for about 44.8% of total coal consumption, 24% of total electricity consumption and 43% of heat consumption by economic sectors.

Table 25: Energy consumption of coal, electricity and heat for the residential and commercial subsector

Type of energy	**Energy consumption**	**Unit**	**2007**	**2008**	**2009**	**2010**
Coal	Total consumption	1000 t	971	993.3	1348.3	1372.6
	Of which: Residential and commercial subsector	1000 t	454.8	580.6	598.2	614.9
		%	46.8	58.5	44.4	44.8
Electricity	Total consumption	million kWh	2829.1	3093.3	3034.1	3375.9
	Of which: Residential and commercial subsector	million kWh	694.6	742.3	727.6	809.7
		%	24.6	24.0	24.0	24.0
Heat	Total consumption	1000 Gcal	7165	7237.9	7828.5	7820.2
	Of which: Residential and commercial subsector	1000 Gcal	3372	3429.8	3573.9	3361.8
		%	47.1	47.4	45.7	43.0

The urban population of Mongolia is 1.6 million or over 60% of the national total. Nearly 72% of urban households in Mongolia live in private houses and gers, and 28% live in apartment buildings, virtually all of which have been privatized.

The majority of pre-cast panel apartment buildings in Ulaanbaatar were constructed in the 1970s, 1980s and early 1990s. They are in a poor state with no systematic professional maintenance and repair occuring. The pre-cast panel apartments generally have excessive heat loss and their cold external wall surfaces subsequently accumulate condensation, leading to poor comfort conditions in Ulaanbaatar's extreme winter conditions (outside design air temperature of -39 °C over the 7 month heating season).

The energy efficiency in centrally and district heated buildings leaves much room for technical and managerial improvement. Heat consumption of the buildings is about five times higher than the modern systems in Europe. This can be explained to some extent by the very cold climate, but mainly due to poor technology and a lack of incentives to save energy.

Heating in Mongolia has traditionally been subsidized by the Government, either through the provision of cheap coal or cheap district heating. As a result, energy conservation and building insulation have not been high priorities for consumers and all buildings suffer from sigificant heat loss during the winter months.

Typically, small heating boilers are used in provincial centers to provide heating for households, schools, hospitals, kindergartens and other public institutions and are of very low efficiency (40-50%) due to outdated equipment. Individual heat stoves, which burn coal and/or wood to meet residential heating needs are used in peri-urban areas of cities and in rural areas.

A brief summary of existing technologies for the residential and commercial subsector is provided in table 26.

Table 26: Brief summary of existing technologies for the residential and commercial subsector

Service	***Category***	***Brief descriptions of existing technologies***
Electricity consumption	Lighting	Most consumers use energy inefficient incandescent lamps.
		Very few consumers use energy efficient compact fluorescent lamps (CFL).
	Electric appliances	Consumers use very different kinds of refrigerators and TVs. There is no control on energy efficiency of electric appliances.
	Electric motors	Most motors are of constant speed.
Heat consumption	District heating	Multi-storey commercial and residential apartment buildings and a small number of private houses are connected to district heating networks for space heating and domestic hot water supply. Insulation of buildings is poor and leaves much room for improvement for reducing energy use for heat consumption in the residential and commercial subsector.
Fuel consumption	Fossil fuel	Small water heating boilers are used in provincial centers for providing heating for households, schools, hospitals, kindergartens and other public institutions. They are of very low efficiency (40-50%) due to outdated equipment.
		Individual heat stoves, which burn coal and/or wood to meet residential heating needs, are used in peri-urban areas of cities and in rural areas.
	Renewable energy	Some individual consumers, especially in rural areas, use biomass for heating and cooking.
		There are a few cases of experimental use of heat pumps for space heating and water heating of kindergartens.

5.2 An overview of possible mitigation technology options in the residential and commercial subsector and their mitigation benefits

As with the technologies for the energy supply subsector, identification of mitigation technologies for the residential and commercial subsector was based on previous experiences and projects implemented in Mongolia, discussion with stakeholders, research on the Climate Tech Wiki technology database, and other online and offline information on mitigation technologies.

The residential and commercial sector uses mainly heat, electricity and coal, some fuel wood and dung for its energy needs. Thermal energy is used for the heating of buildings, production of goods and services and preparation of hot water for households. Electricity is used for lighting, motors, thermal electric equipment (mostly for cooking) and electric appliances. The efficiency of energy use in the residential and service sector is low. The priority goal for the residential and commercial subsector is therefore to increase efficient use of energy and substitute coal with relatively clean energy sources.

Table 27 is a comprehensive list of technologies for the demand-side management of electricity, heating, lighting and cooking. These technologies are mainly energy saving technologies and there are also a few renewable energy technologies.

A similar approach to that used to analyze the energy supply technologies was taken for these technologies. Table 28 is the list of technologies after the review of the long list of technologies for the residential and commercial subsector.

The technologies in the initial list were either added or bundled:

- In the long list of technologies there are some technologies for demand-side management, heating cooking and lighting. These technologies were bundled.
- Different energy storage technologies and smart control and appliances, and ventilations were bundled.

The technologies were also classified by scale and availability using the definitions provided in section 4.2.

Table 27: Long list of technologies for assessment for the residential and commercial subsector

Service	*Category*	*Technology*
Demand-side management for electricity	Energy saving	Building energy management system
		"Smart" appliances and home automation
		Energy efficient refrigerators
		High efficiency televisions
		Compact Fluorescent Lighting, LED
		Variable Speed Motor control
		Energy storage: Batteries
		Energy storage: Capacitors
		Energy storage: Flywheels
Heating and cooling	Energy saving	Ventilation: Air-to air heat recovery, demand control systems
		Improved building insulation
		High efficiency heating, venting, and air conditioning (HVAC)
		Improved coal fired heating stoves
		Energy storage technologies
Lighting	Energy saving	Compact Fluorescent Lighting, LED
		Smart controls
		Day lighting and building design
Cooking	Renewable and fuel switch	Solar heating and hybrid systems with hot water
		Solar cookers
		Biogas for cooking
		Cook stoves on biomass gasification
		LPG and LNG for household and commercial cooking

Table 28: List of edited technologies with their scale and availability in the residential and commercial subsector

Service	*Category*	*Technology*	*Scale of application*	*Short, medium, long term application*
Residential and commercial subsector	Energy saving	Building energy management system	Small	Short
		Smart controls	Small	Short
		Energy efficient refrigerators	Small	Short
		High efficiency televisions	Small	Short
		Compact Fluorescent Lighting, LED	Small	Short
		Variable Speed Motor control	Small	Short to medium
		Improved coal fired heating stoves	Small	Short
		Improved building Insulation	Small	Short
		High efficiency heating, venting, and air conditioning (HVAC)	Small	Short
		Energy storage technologies	Small	Long
		Day lighting and building design	Small	Short
	Renewable and fuel switch	Solar heating and hybrid systems with hot water	Small	Short
		Solar cookers	Small	Short
		Biogas for cooking	Small	Short
		Cook stoves on biomass gasification	Small	Short
		LPG for household and commercial cooking	Small	Short

The technologies were then shortlisted. The shortlisted technologies are listed in table 29 and TFSs are provided in Annex 2. The reasons for rejecting specific technologies were:

- Energy efficient refrigerators and high efficiency televisions were rejected as this will be done by manufacturers, and no refrigerators are manufactured in Mongolia and all refrigerators and most televisions are imported.
- The technologies such as solar heating and hybrid systems with hot water, solar cookers, biogas for cooking and cook stoves on biomass gasification were rejected as they cannot operate in winter at full capacity in Mongolia's very cold climate conditions. Working only in the short warm period they are not considered to have high GHG mitigation potential.
- Energy storage technologies in the residential and commercial subsector were rejected because Mongolia is a developing country and these technologies are still not available at commercial scale.
- The existing technologies such as smart controls, HVAC, day lighting and building design, building energy management systems and variable speed motor control for the residential and commercial subsector were rejected by the stakeholders as they are not considered to have high mitigation potentials

Table 29: List of technologies for the residential and commercial subsector after reviewing and editing through stakeholder consultation

Service	*Category*	*Technology*
Residential and commercial subsector	Energy saving	Compact Fluorescent Lighting, LED
		Improved coal fired heating stoves
		Improved building Insulation
	Fuel switch	LPG for household and commercial cooking

5.3 Criteria and process of technology prioritization

The same approach to technology prioritization was taken for the residential and commercial subsector as was for the energy supply subsector explained in section 4.3. The definitions of the criteria used for prioritizing the residential and commercial subsector technologies are provided in table 30.

Table 30: Criteria for the residential and commercial subsector

Costs	
Capital Costs	These should include both public and private capital costs.
O & M Costs (plus fuel costs)	These include costs incurred maintaining residential andcommercial energy service equipment and appliances.
Cost effectiveness for mitigation	The technologies being selected are for mitigation therefore it is important to look at cost effectiveness of the technology in terms of USD per unit of CO_2 mitigation.
Benefits	
Environmental Development Priorities	**Definition**
Reduced air quality	Improving air quality by reducing air pollutants such as SOx, NOx, suspended particulate matter, non-methane volatile organic compounds, dust, fly ash and others.
GHG emission reduction by 2030	Reduction in GHG emissions through promotion of energy efficient technologies and fuel switching in the residential and commercial subsector.
Social Development Priorities	
Healthcare improvement	Reduction of health risks such as diseases or improvement of health conditions, reducing health damaging air pollutants and indoor smoke.
Economic Development Priorities	
Energy supply improvement	Improved access, availability and quality of electricity and heating services such as coverage and reliability.
Reduced expenditure on energy consumption	Reduction in the use of electricity, heat and fossil fuels consumption in the residentialand commercial subsector.

The scores (on a scale of 0-100) given to each of the shortlisted technologies for each criteria are shown in table 31, and the most and least preferred technology for each criteria is shown in table 32.

Table 31: Scoring for the initial list of priority technologies for the residential and commercial subsector

	Technology Options	Criteria							
		Capital Costs	O & M Costs (plus fuel costs)	Cost effectiveness for mitigation	GHG emission reduction by 2030	Reduced air quality	Healthcare improvement	Energy supply improvement	Reduced expenditure for energy consumption
1	Improved insulation of panel apartment buildings	0	60	40	100	50	100	100	70
2	Efficient lighting	40	100	100	50	30	0	60	100
3	Improved heating stoves	60	50	60	30	100	60	30	30
4	LPG for cooking	100	0	0	0	0	30	0	0

Table 32: Most preferred and the least preferred technologies

Reference	**Capital Costs**	**O & M Costs (plus fuel costs)**	**Cost effectiveness for mitigation**	**GHG emission reduction by 2030**	**Reduced air quality**	**Healthcare improvement**	**Energy supply improvement**	**Reduced expenditure for energy consumption**
Most preferred	LPG for cooking	Efficient lighting	Efficient lighting	Building insulation	Improved heating stoves	Building insulation	Building insulation	Efficient lighting
Least preferred	Building insulation	LPG for cooking	LPG for cooking	LPG for cooking	LPG for cooking	Efficient lighting	LPG for cooking	LPG for cooking

Based on the swing in the values, weights for each criterion were determined. This weight was then normalized and an average weighted score for each technology was calculated. A summary of weights and normalized weights is given in table 33.

Table 33: Weights and normalized weights

Reference	**Capital Costs**	**O & M Costs (plus fuel costs)**	**Cost effectiveness for mitigation**	**GHG emission reduction by 2030**	**Reduced air quality**	**Healthcare improvement**	**Energy supply improvement**	**Reduced expenditure for energy consumption**
Normalized weights	17.9	16.1	16.1	16.1	5.4	7.1	8.9	12.5
Weights	100	90	90	90	30	40	50	70

The overall weighted scores of the preferred technologies are shown in table 34

Table 34: Overall weighted score

	Technology Options	Criteria								**Overall weighted score**
		Capital Costs	O & M Costs (plus fuel costs)	Cost effectiveness for mitigation	GHG emission reduction by 2030	Reduced air quality	Healthcare improvement	Energy supply improvement	Reduced expenditure for energy consumption	
1	Improved insulation of panel apartment buildings	0	60	40	100	50	100	100	70	**60**
2	Efficient lighting	40	100	100	50	30	0	60	100	**67**
3	Improved heating stoves	60	50	60	30	100	60	30	30	**49**
4	LPG for cooking	100	0	0	0	0	30	0	0	**20**
Normalized weights		17.9	16.1	16.1	16.1	5.4	7.1	8.9	12.5	**100**

The calculation shows that the first priority technology is efficient lighting (overall weight: 67.00). The second priority technology is improved insulation of panel apartment buildings (overall weight: 60.00). The third and fourth priority technologies are the improved heating stoves (overall weight: 49) and LPG for cooking (overall weight: 20.0).

Similar to the energy supply subsector analysis, the technologies were plotted graphically in a cost benefit framework to help visualize the relative benefits of the alternatives (figure 5).

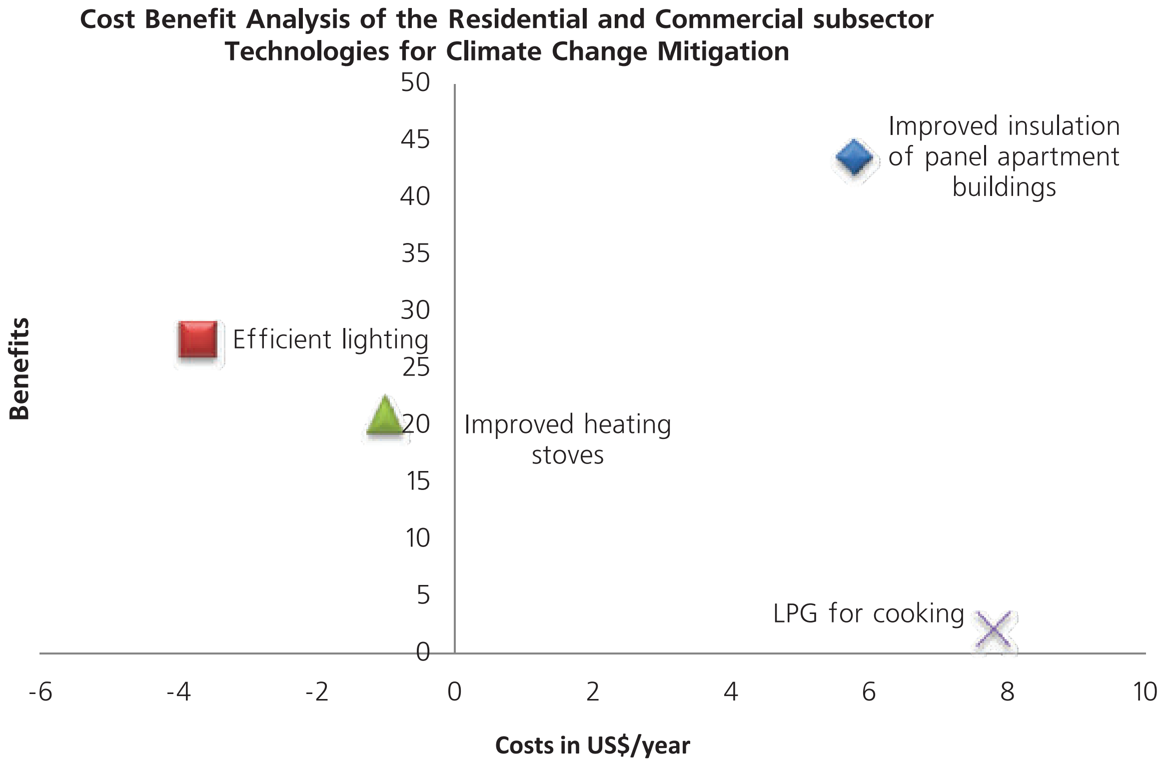

Figure 5: *Cost benefit analysis of residential and commercial subsector technologies for climate change mitigation*

5.4 Results of technology prioritization

As mentioned above, by using the MCDA approach, the following technologies for the residential and commercial subsector have been prioritized for future investigation:

- Efficient lighting;
- Improved insulation of panel apartment buildings;
- Improved heating stoves and
- LPG for cooking

After analyzing and discussing all the technologies the stakeholders decided to consider efficient lighting and improved insulation of panel apartment buildings as selected technologies for future investigation.

The Government of Mongolia implements air pollution reduction measures and distributes energy efficient and low-smoke stoves for households in ger district areas. The modern low smoke stove could reduce GHG emissions and air pollution by reducing coal consumption. The stakeholders considered that the government measures are effective and sufficient and the stakeholders have decided that it is not necessary to include the improved heating stoves in the list of selected technologies for future investigation.

Also, the cost benefit analysis shows that the LPG for cooking technology has comparatively high costs and low benefits. Therefore the stakeholders decided not to include the LPG for cooking technology in the final list of selected technologies.

Finally the following two prioritized technologies were selected for the next step investigation:

- Efficient lighting and
- Improved insulation of panel apartment buildings.

Efficient lighting

Compact Fluorescent Lamp (CFL) technology provides a low energy lighting service through the use of a compact fluorescent light bulb that replaces the normal incandescent light bulb. CFLs contribute to security of energy supply as they make a significant contribution to reducing electricity demand. The higher up-front cost could be a barrier for their implementation, but calculations show that CFLs pay back the initial investment within 900 hours of operation and also contribute to a reduction in the electricity bill over the lifetime of the bulb. The savings can be in the order of 10-20 times the initial cost over the life of the bulb.

Incandescent bulbs are commonly used in Mongolia. Usage of CFLs at household and service sector levels is low due to its relatively high price.

Efficient lighting project can be implemented by promoting consumers to switch from incandescent lamps to more energy efficient lamps (CFLs and LEDs) by providing them with some incentives originated by the Certified Emission Reductions (CERs) revenue as a Clean Development Mechanism Project. Efficient lighting project will reduce greenhouse gas emissions by preventing CO_2 emissions from electricity generation by fossil fuel power plants that supply the Central Energy System of Mongolia. Most CER revenue acquired by this project activity can be designed to be returned to CFLs buyers in the form of the incentive.

Improved insulation of panel apartment buildings

Ulaanbaatar is the world's coldest national capital city with an eight month heating season, winter temperatures frequently falling to -30°C at night and -20°C in the daytime.

Around 500 panel apartment buildings house around 200,000 people or around 20% of the population of Ulaanbaatar. The precast panel buildings have no added external wall insulation, have poorly insulated external doors, poorly insulated roofs, and still have mostly old double wooden framed high air ventilation heat loss windows.

The panel buildings' hot water radiator heating systems have no heat output controls. Apartments have no heat consumption metering fitted. Thus building managers and apartment owners lack both financial incentives and the technical means to reduce excessive heat losses or reduce overheating.

The Ulaanbaatar panel buildings will continue to be used for many years.

GHG reductions will be achieved as a result of energy efficiency measures undertaken at the pre-cast panel buildings. The energy efficiency measures will lead to a reduced demand for apartment space heating in winter from the local heating loop supplied from the heat substation. The reduced heat demand from the heat substation will reduce the heat demand from the primary hot water heating loop supplied from the coal fired Combined Heat and Power plants and Heating boilers.

6. Summary and conclusions

The mitigation technology needs assessment process was successfully completed. Two subsectors were identified as being priority areas for mitigation technologies. These were the energy industries subsector and the residential and commercial subsector. These subsectors were chosen because of their high contribution to Mongolia's national GHG emissions and also their potential to contribute to national development priorities.

Within the energy industries subsector, large hydro power plants, wind turbines and pulverized coal combustion technologies were selected as the priority technologies for further investigation. The technologies were prioritized through stakeholder engagement considering the mitigation potential of the technologies, their suitability to local Mongolian conditions and also their potential contribution to national development priorities. Stakeholders were surveyed and the technologies were analyzed using a MCDA approach.

For the residential and commercial subsector, efficient lighting and improved insulation of panel apartment buildings were selected using the same approach.

List of references 1

CCM Mongolia 2010. Climate change mitigation: Needs and possibilities, 2010 (in Mongolian)

ES Ulaanbaatar 2011. Energy Statistics 2011, Energy Regulatory Committee, Ulaanbaatar, 2011

GHG Mitigation Mongolia 2000. Greenhouse Gas Mitigation Potentials in Mongolia, Ulaanbaatar, 2000.

In–Depth Review Energy charter 2011. In-Depth Review of Energy Efficiency Policies and Programmes: Mongolia, Energy Charter Secretariat, 2011

IPCC Guideline 1997. Intergovernmental Panel on Climate Change. Greenhouse gas Inventory Reference Manual. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

MSNC 2010. Mongolia Second National Communication under the United Nations Framework Convention on Climate Change, Ulaanbaatar, 2010: pp. 56-67

NAPCC 2011. National Action Program on Climate Change, Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2011

NRSD 2010. National report on sustainable development, Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2010

UNDP 2010. Handbook for conducting Technology Needs Assessment for climate change, New York, November, 2010.

Annex 1: Technology Factsheets: Energy supply subsector

Technology 1: **Concentrated solar power**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Concentrated solar power (CSP)**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Concentrated solar power (CSP) systems concentrate the energy from the sun for electricity production. This is done by heating a fluid which is then used to raise steam for a conventional turbine for on- and off-grid electricity provision. These systems can also provide heat, either at high temperatures directly for chemical reactions, e.g., chemical processing, or as a by-product for desalination plants or cooling systems, depending on requirements. They can be installed in deserts or any high insulation area. The size of the area needed for the mirrors varies according to the output required and the type of system. Solar thermal can integrate well with conventional power generation equipment and advanced technology. Conventional materials are used with modular construction. There are three basic designs for CSP, but all use mirrors to concentrate the energy from the sun onto a receptor vessel which may contain a liquid or gas which is heated and then used to power a steam turbine (Dell and Rand, 2004) A simple parabolic dish focuses the sun's energy onto a thermal receiver mounted at the focal point of the dish. Temperatures greater than 1000°C can be reached. Due to its limited size the output from one dish is about 25 kW at maximum. Another type is the 'central receiver' type or solar tower which has thousands of mirrors able to track the sun and these are arranged round a central tall tower. A heat transfer fluid (such as a molten salt, air, water/steam, liquid sodium) flows through the receiver collecting the heat. The temperatures involved are in the range of 300-1000°C. This is then used to make steam to generate electricity with power outputs in the range of 30-200 MW. If air is used at 1000°C then it can be used directly in a gas turbine (60% efficiency) replacing natural gas. The third type of arrangement is the parabolic trough principle. The parabolic trough mirror tracks the sun and may be up to 100 m long. At the focus of the mirror, there is a heat pipe which carries away the heat produced. The temperature range is lower at 200-400°C and arranging the troughs in rows allows a flexible power output ranging from 30 to 350 MW. http://climatetechwiki.org/technology/csp CSP is commercialized and the CSP market has seen about 740 MW of generating capacity added between 2007 and the end of 2010. More than half of this (about 478 MW) was installed during 2010, bringing the global total to 1095 MW. Spain added 400 MW in 2010, taking the global lead with a total of 632 MW, while the US ended the year with 509 MW after adding 78 MW, including two fossil–CSP hybrid plants. http://en.wikipedia.org/wiki/Concentrated_solar_power#Costs

Implementation assumptions, How the technology will be implemented and diffused across the subsector?	The total solar energy resource, evaluated on the annual solar radiation on the entire national territory, has been calculated to have the potential to achieve 2.2 x 1012 kWh. The potential solar energy varies from 1,200kWh/m^2/year to 1,600 kWh/m^2/ year in the different regions of Mongolia. According to the "Master Plan Study for Rural Power Supply by Renewable Energy in Mongolia", up to 20 percent of the country's electrical power energy will be supplied from renewable energy sources by the end of 2020. The huge potential for solar energy in Mongolia makes it possible to implement CSP technology. But it is important to get international support in order to build the solar thermal power plants and to get international grants or soft loans to finance the project. 40 MW CSP capacities have been considered to replace 20 MW conventional coal based power plant in general. The capacity utilizations of CSP and conventional coal power plant are 35% and 70% respectively. The replacement capacity is based on an equivalent energy output by both power plants. The CSP plant will not produce direct GHG emissions
Reduction in GHG emissions	The GHG emissions from a 20 MW coal fired power plant is calculated as follows: The coal fired power plant will generate electricity about 110000 MWh (20MWx5500h) If electricity consumption is converted to CO_2 emissions it will be 121,000 tCO_2 (110,000 MWh x1.103tCO_2/MWh)[8]. The one CSP plant of 40 MW can reduce GHG emissions by 121,000 tCO_2-eq/year. Then 4 CSPs could reduce GHG emissions by 484,00 tCO_2-eq/year
Impact Statements - How this option impacts the country's development priorities	
Social development priorities	
Economic development priorities	Mainly through funding from GEF and other international organizations, private companies and national governments, the following countries have become involved in developing solar thermal power plants based on parabolic trough design: Algeria, Egypt, India, Iran, Mexico, and Morocco. Other countries interested or actively pursuing CSP are Jordan and South Africa. Brakmann et al. (2005) point out that Global Market Initiative recommends that developing countries that are not interconnected to industrialized countries in Europe should have preferential financing with grants or soft loans, etc. http://climatetechwiki.org/technology/csp Although there is a high initial cost for CSP, the construction of CSP could save coal and give economic benefits.
Environmental development priorities	The CSP plant can reduce air pollution by increasing coal consumption in power plants.
Other considerations and priorities such as market potential	Market potential is big

8. Calculated as weighted average of the country specific OM and BM emission factor values provided by Mongolian DNA (1.1501 respectively 1.0559); see website:http://www.cdm-mongolia.com/index.php?option=com_content&view=article&id=75&Itemid=105&lang=en

Costs	
Capital costs	As of 9 September 2009 (2009 -09-09), the cost of building a CSP station was typically about USD2.50 to USD4.0 per watt depending on the local solar resource conditions, while the fuel (the sun's radiation) is free. Thus a 250 MW CSP station would have cost UDS600–1000 million to build. That works out to USD0.12 to USD0.18/kWh. To put this in perspective, Arizona Public Service (APS), Arizona's largest utility company, purchases power from the Palo Verde Nuclear Generating Station at a cost of USD0.0165/kWh. Nonetheless, new CSP stations may be economically competitive with fossil fuels. Nathaniel Bullard, a solar analyst at Bloomberg New Energy Finance, has calculated that the cost of electricity at the Ivanpah Solar Power Facility, a project under construction in Southern California, will be lower than that from photovoltaic power and about the same as that from natural gas. However, in November 2011, Gaoogle announced that they would not invest further in CSP projects due to the rapid price decline of photovoltaics. Google spent USD168 million on Bright Source. http://en.wikipedia.org/wiki/Concentrated_solar_power#Costs 40 MW CSP capacities have been considered to replace 20 MW conventional coal based power plant. The capacity utilizations of CSP and conventional coal power plant are 35% and 70% respectively. The replacement capacity is based on equivalent energy output by both power plants. It is assumed that the capital cost of CSP is 3.1million USD/MW including equipment and construction, planning. The capital cost of conventional coal based power plant is 1 million USD/MW including equipment, construction and planning.
Operational and Maintenance costs	FICAM model is used in order to calculate all costs and emissions. The total annual cost of the CSP plant is USD12 million, compared to the annual cost of USD6 million for the conventional coal based power plant.
Cost of GHG reduction	The reduction of GHG emissions in CO_2-eq is 120384 tons with in annual cost of USD5 million. The cost of GHG reduction is 41.5 USD/ tCO_2-eq.

Technology 2: **Pumped storage Hydroelectricity**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Pumped storage hydroelectricity**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Pumped storage hydro uses two water reservoirs which are separated vertically. In times of excess electricity, often off peak hours, water is pumped from the lower reservoir to the upper reservoir. When required, the water flow is reversed and guided through turbines to generate electricity. Pumped hydro is the most developed energy storage technology, with facilities dating from the 1890s in Italy and Switzerland. Currently, there is over 90 GW of pumped storage capacity in operation worldwide, which is about 3% of global generation capacity. The main applications of pumped hydro are for energy management, frequency control and provision of reserves. Pumped storage plants are characterized by long construction times and high capital expenditure. However, with rising electricity prices and increasing use of intermittent energy sources, it can be very economic to store electricity for later use http://climatetechwiki.org/category/energy-services/electricity?page=1
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	The Mongolian Central Energy System can save the excess electricity generation during off-peak hours for use during peak hours, thereby achieving better demand-supply matching, reducing total electricity generation and CO_2 emissions. In Mongolia all base-load power comes from coal and off-peak generation generally also comes from coal fired power generations and imports from Russia. In the future, after construction of coal fired power plant #5, the Central Energy System probably will not import electricity from Russia because of sufficient generation capacity. The pumped storage hydroelectricity power plant will reduce GHG emissions compared to the coal fired thermal power plants. There is a feasibility study for construction of a new 100 MW pumped storage hydroelectricity power plant in Ulaanbaatar on the Tuul river prepared by Morituimpex company[9]. The feasibility study has been approved by the Government of Mongolia. According to the feasibility study the construction of a pumped storage hydro power plant will reduce coal consumption in contrast to the base line coal fired thermal power plant by 290,000 tCO_2-eq per year by stopping one turbine with capacity of 100 MW that is operating in the peak period or kept in operation as hot reserve.

9. The feasibility study and technical specifications of the 100 MW Ulaanbaatar pumped storage hydro power plant, 2007 Ulaanbaatar

Reduction in GHG emissions	We can calculate CO_2 emissions. The IPCC default CO_2 emission factor for lignite coal is $101tCO_2/TJ$. If we assume the average Net Calorific Value is 3500 kcal/kg then CO_2 will be reduced by 424,300 tCO_2/year (290,000*3,500*4.18/1,000,000). But the pumped storage hydroelectricity power plant consumes electricity during the off-peak period. According to the feasibility study the consumption is 254 million kWh/year. If the electricity consumption is converted to CO_2 emissions it will be 280,000 tCO_2 (254,000 MWh x1.103tCO_2/MWh)[10]. Therefore GHG emissions are expected to be reduced by 144,300tCO_2eq/year.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	The pumped storage hydroelectricity power plant will have two water reservoirs which can improve climate conditions by reducing the dryness of the climate and increasing humidity in Ulaanbaatar city. The two reservoirs will be used to create parks and beaches.
Economic development priorities	Energy storage can reduce costs for consumers of electricity. In general, off-peak electricity is cheaper compared to high-peak electricity. This is due to the base-load characteristics of off-peak electricity. Energy storage in the form of pumped hydro provides customers with off-peak electricity in high-peak situations. In addition to being an economic benefit to the seller of the electricity, it might also be an economic benefit to the customer when the electricity is sold at lower prices compared to the high-peak generated electricity. The pumped storage hydroelectricity power plant can reduce coal consumption in power plants and also can increase electricity reliability.
Environmental development priorities	a. Reduced air pollution: The pumped storage hydroelectricity power plant can reduce air pollution by decreasing coal consumption in power plants. b. Climate: The two water reservoirs can improve environmental conditions of Ulaanbaatar city. The two reservoirs will be used to create green belts, parks and beaches to reduce dry climate and increase humidity.
Other considerations and priorities such as market potential	
Costs	
Capital costs	According to the feasibility study for the construction of pumped storage hydro power plant with capacity of 100 MW, 105 million USD is required. Assuming a life time of 20 years, the annualized cost would be around 5.25 million USD.
Operational and Maintenance costs	According to the feasibility study for the construction of a pumped storage hydro power plant with capacity of 100 MW, the operational and maintenance costs will be 17.1 million USD annually.
Cost of GHG reduction	Annual capital cost 5.25 Million USD plus O&M cost 17.1 million USD. Total cost in the year 2025 is 22.35 million USD. Mitigation achieved is 144,300 tCO_2/year. Therefore cost of GHG reduction is 154.88 USD/ tCO_2

10. Calculated as weighted average of the country specific OM and BM emission factor values provided by Mongolian DNA (1.1501 respectively 1.0559); see website: http://www.cdm-mongolia.com/index.php?option=com_content&view=article&id=75&Itemid=105&lang=en

Technology 3: **Pulverized coal combustion with higher efficiency**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Pulverized coal combustion with higher efficiency**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Pulverized coal power plants account for about 97% of the world's coal-fired capacity. The conventional types of this technology have an efficiency of around 35%. For a higher efficiency of the technology supercritical and ultra-supercritical coal-fired technologies have been developed. These technologies can combust pulverized coal and produce steam at higher temperatures and under a higher pressure, so that an efficiency level of 45% can be achieved (ultra-supercritical plants). Supercritical and ultra-supercritical plants are more expensive (because of the higher requirements to the steel needed to stand the higher pressure and temperature) but the higher efficiency results in cost savings during the technical lifetime of the plants. The emissions of CO_2 per MWh delivered to the grid could be reduced from 830 kg to 730 kg.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	In coming years several Thermal Electric Power Stations will be built with significant capacity near coal mines in Mongolia. There's a project to build a Pulverized coalthermal supercritical power plant with capacity 600 MW at Tavan Tolgoi coal mine.
Reduction in GHG emissions	An efficiency improvement from 30 to 45% would bring about a 33% decrease in CO_2 emissions. As two-thirds of all coal-fired plants are over 20 years old with an average efficiency rate below 30%, replacing this capacity with supercritical and ultra-supercritical plants could contribute significantly to global GHG emission reductions (IEA 2008, p.259). GHG emissions are expected to be reduced by 1.159 million tCO_2/year.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	There will be a new electricity source for mining and chemical plants
Economic development priorities	Supercritical power plants are highly efficient plants with the best available pollution control technology; they reduce pollution levels by burning less coal per megawatt-hour produced and capturing the vast majority of the pollutants.Introduction of the Pulverized coal power plants has the potential to reduce fuel consumption of existing thermal power plants by 25-30 percent.
Environmental development priorities	Because of the above techno-economic benefits, along with its environmentally-friendly cleaner technology, more and new power plants are being developed with this state-of-the-art technology. As environmental legislation is becoming more stringent, adopting this cleaner technology has lead to benefits in all respect. As LHV (lower heating value) is improved (from 40% to more than 45%); a one percent increase in efficiency reduces specific emissions such as CO_2, NO_X, SO_X and particulate matter by two percent. Reduced air pollution: Concentration of noxious gases in flue gas to be decreased by 30 %.

Other considerations and priorities such as market potential	**The market potential is big**
Costs	
Capital costs	Investment costs for supercritical pulverized coal (SPF) power plants is 2.5 million USD or 1.75 million EURO per MW. Source: www.energy.siemens.com/.../power-generation/power-plant.
Operational and Maintenance costs	In a typical case, fuel costs account for 60-80% of the total operating cost of a SPF power plant. Annual electricity production of Pulverized coal power plants is to reach 4800.0 million kWh with installed capacity of 600 MW. Annual coal consumption will be 1.33 million tons. Total coal cost per year is expected to be 40 million USD. Where: coal cost is 30 USD /t. Total operational and maintenance costs will be 101.95 million USD/year. Electricity generation cost of Supercritical pulverized coal power plants will be 0.028 USD/kWh
Cost of GHG reduction	GHG emission reduction cost will be 87.95 USD/tCO_2

Technology 4: **Integrated coal gasification combined cycle**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Integrated coal gasification combined cycle**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Advanced combined cycles, in which the gas turbine exhaust is used as a heat source for a steam turbine cycle, can achieve overall thermal efficiencies in excess of 50%.First, coal is gasified by creating a 'shortage' of air/oxygen in a closed pressurized reactor. This creates a chemical reaction of the coal with the oxygen. This creates a superheated steam with which electricity is generated. Currently, purification takes place at relatively low temperatures (around 50ºC), but techniques to clean at temperatures of around 500-600ºC have been tested. This could increase the overall efficiency of IGCC to over 60%. IGCC plants can also be configured to facilitate CO_2 capture before the combustion of the syngas. In this process, the syngas is 'shifted' using steam to convert CO to CO_2, which is then separated for possible long-term sequestration.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Coal is the main primary energy source in Mongolia at present, accounting for about 98% of total solid fuel consumption. Coal is expected to remain the most important primary energy resource in the foreseeable future, because of the great coal reserves in Mongolia dwarfing the reserves of other energy resources, such as oil and gas. Several thermal electric power stations will be constructed in Mongolia. GHG emissions could be reduced if integrated coal gasification combined cycle technology is applied. A thermal power station with 600 MW capacity is needed to be built using integrated coal gasification combined cycletechnology.
Reduction in GHG emissions	GHG emissions are expected to be reduced by972,000 tCO_2
Impact Statements - How this option impacts the country development priorities	
Social development priorities	The electricity supply will improve.
Economic development priorities	Annual electricity production of power plants is to reach 3,300.0 million kWh. Integrated coal gasification combined cycle power plants have the potential to reduce fuel consumption of existing thermal power plants by 25-30 percent. Coal consumption per kWh will be reduced.
Environmental development priorities	Reduced air pollution:Concentration of noxious gases in flue gas will be decreased by 25 %.
Other considerations and priorities such as market potential	-
Costs	
Capital costs	IGCC costs around USD 2000 per kW. The IGCC power plants will require around 600 MW, therefore an investment of 1.32 billion USD. Assuming a life time of 40 years the annualized cost would be around 33.0 million USD.
Operational and Maintenance costs	Annual coal consumption will be 1.44 million tons. Total coal cost per year is expected to be 43.2 million USD. Where: coal cost is 30 USD /t. Total Operational and Maintenance costs will be 94.0 million USD per year. Electricity generation cost of power plants will be 0.026 USD/kWh
Cost of GHG reduction	Cost of GHG reduction will be 96.7 USD /tCO_2-eq.

Technology 5: **Hydro Power Plant with high capacity**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Hydro Power Plant with high capacity**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Hydro power plants capture the energy released by water falling through a turbine and convert this into mechanical power, which drives generators to produce electricity. About 20% of globally supplied electricity is generated by hydropower and in some countries it provides more than 50% of electricity supply. Hydropower can achieve significant GHG emission reductions as it, depending on the energy mix of the country concerned, could replace fossil based technologies for electricity production.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	About 90 percent of the electrical power generated in Mongolia is produced by coal CHP in Mongolia. It is planned to build hydropower plants in Orkhon or Selenge rivers with 300 MW of capacity to improve the structure of Mongolian central energy system.
Reduction in GHG emissions	GHG emissions are expected to be reduced by1.458.000 tCO_2eq/year.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	• Improved operational conditions of the Central Energy system; • Reduced electricity imports; • Improved energy regime of the Central Grid during peak load
Economic development priorities	-Introduction of the technology has the potential to reduce coal consumption by 1.08 million tons per year; -Production cost of electricity will be reduced.
Environmental development priorities	Reduced air pollution: the technology does not emit any local air pollutants, such as NO_x, CO or particulate matter, thereby helping to improve air quality.
Other considerations and priorities such as market potential	-
Costs	
Capital costs	Investment cost for construction of a Hydro Power Plantwith 300 MW capacity is 750,000 USD. Based on 2000-2500 USD/MW (web: climate technology wiki)
Operational and Maintenance costs	Hydropower projects involve large up-front investment costs, most of which are related to financing the dam and plant construction. The capital required for large dam hydro plants depends on the effective head, flow rate, geological and geographical features, the equipment (turbines, generators, *etc.*) and civil engineering works, and whether water flow is constant throughout the year. Total Operational and Maintenance costs Hydropower Plant is 20.62 million USD -Annual electricity production of hydro power plant is to reach 1800.0 million kWh; -Electricity generation cost will be 0.011 USD/kWh
Cost of GHG reduction	GHG emission reduction cost will be 14.15 USD/tCO_2-eq

Technology 6: **Wind turbines**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Wind turbines**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Wind energy is actually a form of solar energy; the temperature differences caused by the sun shining on the earth act, along with other factors, to cause large bodies of air, winds, to move across the face of the planet. A large wind turbine primarily consists of a main supporting tower upon which sits a nacelle (the structure containing the mechanical to electrical conversion equipment). Extending from the nacelle is the large rotor (three blades attached to a central hub) that acts to turn a main shaft, which in turn drives a gearbox and subsequently an electrical generator
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	There are going be 2 wind parks built, each with 50 MW capacity in the Gobi steppe region of Mongolia
Reduction in GHG emissions	GHG emissions are expected to be reduced by 243.000 tCO_2-eq
Impact Statements - How this option impacts the country development priorities	
Social development priorities	1.The electricity supply of Mongolia will improve. 2. It will demonstrate to the public that a wind park is a viable way to produce electricity.
Economic development priorities	Annual electricity production is 300,000 MWh. - Introduction of wind technologies has the potential to reduce coal consumption by 180,000t per year. - Price of electricity will be reduced (0.075 USD/kWh). (The number of hours of use of installed capacity - 2500) For modern turbines the levelised cost of electricity in 2009 (accounting for capital costs, lifetime O&M and typical financing costs) ranges between USD50 to USD100 per MWh at a good to excellent site.
Environmental development priorities	By acting to displace generation from thermal power plants, onshore wind energy can prevent the emission of roughly 2,200 tons of CO_2 per year per Megawatt (MW) of installed wind capacity (assuming it replaces coal and is located at a reasonable wind energy site). Reduced air pollution:the air will not be polluted with toxins such as NO_x, SO_2 and CO. CO_2 reduction: 243,000 tCO_2-eq /year
Other considerations and priorities such as market potential	
Costs	
Capital costs	Capital costs for wind park with capacity 100 MW will be 150 million USD. Based on the cost of around USD1500.0/MW. Assuming a life time of 30 years the annualized cost would be around 5.0 million USD.
Operational and Maintenance costs	Annual electricity production is 250 000 MWh and capital cost of 1 KW electricity is 0.018 USD. Running cost will be around USD0.007/kW.h. Assuming: 0.05-0.09 USD/kWh(IPCC, 2010). Total annual operational and maintenance costs will be 5.5 million USD.
Cost of GHG reduction	Mitigation achieved 243,000 tCO_2-eq GHG emission reduction cost will be 22.63 USD /tCO_2-eq.

Technology 7: **Very large scale PV system**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Very large scale PV system 100 MW**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Very large scale PV is very likely to play a significant role in climate change mitigation in the future. VLS PV systems could be designed in 2 types: fixed flat plate or with a sun-tracking system. The some studies show that the VLS sun tracking PV power generation system is very promising for energy resource savings and addressing environmental issues[11].
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Solar electricity PV system (Very Large Scale Photovoltaic Power Generation VLS-PG) with capacity of 100 MW is needed to be built in the Gobi region of Mongolia. Annual electricity production of a solar electricity PV system with capacity 100 MW is about 190 million kWh (Source: An analysis of very large-scale tracking PV (VLS-PV) systems in the govi desert)
Reduction in GHG emissions	Emission factors for coal fired plants are more than 900gCO_2 /kWh and for gas fired power stations more than 400 gCO_2 /kWh (Sovacool, 2008) showing the large potential for solar PV to contribute to reductions in carbon emissions from the electricity sector. The emission factor for Mongolian grid is 1.103 tCO_2/1000 kWh. GHG emissions are expected to be reduced by 210,000.0 tCO_2eq/year.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	There will be a new electricity source for mining and chemical plants. New advanced technology will be introduced.
Economic development priorities	Introduction of above technology has a potential to reduce coal consumption by 95,000t per year.
Environmental development priorities	a. Reduced air pollution:the air will not be polluted with toxins such as NO_X, SO_2 and CO; b. A contribution to the goal of GHG emission reduction will be made.
Other considerations and priorities such as market potential	-
Costs	
Capital costs	There has been a large decrease in the cost of solar PV systems in recent decades. Investment cost for installation solar electricity PV system with capacity 100 MW is 400.0 million USD (4,000.0 USD/kW) The average global PV module price dropped from about 22 USD/W in 1980 to less than 4 USD/W in 2009, while for larger grid connected applications prices have dropped to roughly 2 USD/W in 2009 (IPCC, 2010). The annualized capital cost will be 16m USD/year (life time is 25 year).
Operational and Maintenance costs	The total annual cost including O&M, construction, transmission, PV module costs will be 23 million USD per year. (Source: An analysis of very large-scale tracking PV (VLS-PV) systems in the Govi desert) PV system's cost of electricity production is 14.5 cent/kWh
Cost of GHG reduction	GHG emission reduction cost will be 110 .0 USD/tCO_2.

11. An analysis of very large-scale tracking PV (VLS-PV) systems in the govi desert.

Technology 8: **Carbon capture and storage**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Carbon capture and storage**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Carbon capture and storage (CCS) is a combination of technologies designed to prevent the release of CO_2 generated through conventional power generation and industrial production processes by injecting the CO_2 in suitable underground storage reservoirs. Basically,capture technology separates CO_2 emissions from the process, after which the compressed CO_2 is transported to a suitable geological storage location and injected. Feasible methods of transporting of CO_2 include both pipelines and shipping. Appropriate geological storage locations for CO_2 include abandoned oil and gas fields, deep saline formations and unmixable coal seams. The dominant reason to do CCS is for CO_2 emission reductions from industry and power generation; without incentives for such emission reductions, little CCS can be expected. The deployment of CCS in the industrial and power generation sectors would allow fossil fuel use to continue with a significant decrease in CO_2 emissions. However, a full CCS chain has yet to be implemented, and many technical, environmental and economic uncertainties remain (http://climatetechwiki.org/technology/ccs)
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Coal is the main primary energy source in Mongolia at present, accounting for about 98 percent of total solid fuel consumption. Most open cast coal mines in Mongolia are operating at a shallow depth. There are around 320 coal deposits and occurrences (80 deposits and 240 occurrences) according to the Geological Information Center of Mongolia. The total geological coal resources are estimated at approx. 150 billion metric tons, including about 24 billion metric tons explored. Over 70 percent of the total coal production is consumed by thermal power stations with the remainder going to heating plants, industry and individuals. Coal is expected to remain the most important primary energy resource in the foreseeable future because of the great coal reserves in Mongolia dwarfing the reserves of other energy resources, such as oil and gas. Therefore CCS technology in the future could be important technology for Mongolia to reduce GHG emissions. 600 MW conventional coal with CCS power plant has been considered to replace 600 MW conventional coal based power plant. The replacement capacity is based on equivalent energy output by both power plants. It is assumed that the capital cost of conventional coal with CCS power plant is 2.52 million USD/MW including equipment and construction, planning and fixed cost for CCS infrastructure. The capital cost of conventional coal based power plant is 1 million USD/MW including equipment and construction, planning.
Reduction in GHG emissions	GHG emissions are expected to be reduced by 3,676,000 tCO_2-eq/year.
Impact Statements - How this option impacts the country development priorities	

Social development priorities	The environmental and safety risks of CCS depend on the legal regime in which the technology operates. Most experts expect that CO_2 storage can be done safely and permanently, but if the selection of reservoirs is not consistently and strictly regulated, the storage operation not continuously monitored and the site not suitably abandoned, CO_2 seepage may occur which would result in greenhouse gas emissions and in extreme cases could lead to health and other environmental damage (http://climatetechwiki.org/technology/ccs)
Economic development priorities	The level to which CCS supports sustainable development is a widely debated topic. The discussions around allowing CCS into the Kyoto Protocol's Clean Development Mechanism exemplify the varying opinions between stakeholders. It is argued by some that no technology involving the combustion of fossil fuels can be associated with sustainable development, due to the finite nature of such resources. Others point towards the effects of fossil fuel use, beyond emissions of CO_2 alone, including the environmental impacts of coal mining (Coninck, 2008). Currently, by far most applications of CCS are not economically feasible. The additional equipment used to capture and compress CO_2 also requires significant amounts of energy, which increases the fuel needs of a coal-fired power plant by between 25-40% and also drives up the costs (IPCC, 2005). (http://climatetechwiki.org/technology/ccs)
Environmental development priorities	There are a number of negative environmental impacts that cannot be avoided, and a number of others that can be managed. Due to the increased energy requirement of the capture, additional coal will have to be mined, potentially leading to greater landscape deterioration at extraction sites and emissions to air and water. Depending on the type of capture equipment used, spent solvents can lead to effluents of hazardous wastes which may have consequences for the environment, and water use may increase (http://climatetechwiki.org/technology/ccs)
Other considerations and priorities such as market potential	Potential market is medium
Costs	
Capital costs	It is assumed that the capital cost of conventional coal with CCS power plant is 2.52 million USD/MW including equipment and construction, planning and fixed cost for CCS infrastructure. The capital cost of conventional coal based power plant is 1 million USD/MW including equipment and construction, planning.
Operational and Maintenance costs	For calculation of all costs and emissions it is used FICAM model. The total annual cost of the conventional coal with CCS power plant is USD260 million, compared to the annual cost of USD87 million for the conventional coal based power plant.
Cost of GHG reduction	The reduction of GHG emissions in CO_2-eq is 3,676,000 tons with in annual cost of USD173 million. The cost of GHG reduction is 47 USD/ tCO_2-eq.

Technology 9: **Improvement of heat only boilers**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Improvement of heat only boilers**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Approximately 20% of annual coal consumption or over 1.2 million tons are used per year for heating of over 340 residential areas and ger districts of bigger cities of the country. A typical boiler in provincial areas (particularly, in soums centre, an administrative unit) uses 800-1200 tons of coal a year on average. Outdated boilers, installed during a socialist period with lower efficiency (0.4-0.5), provide heating for schools, hospitals, kindergartens and other public institutions. The maximum heat load of a boiler reaches 0.5-0.8 MW.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	One of the biggest problems facing Mongolia is how to raise the efficiency of the boilers. If we can increase the efficiency up to 70% then the coal consumption would decrease by a factor of two, and environmental pollution would dramatically reduce as well. At present, around 30% of soum centers are connected to the central power grid, which is expected to increase. Initially, up to 2020, it is planned to improve 100 HOBs with average capacity of 1.0 MW.
Reduction in GHG emissions	GHG emissions are expected to be reduced by 112,500 tCO_2-eqfor 100 boilers
Impact Statements - How this option impacts the country development priorities	
Social development priorities	• Cost of heating will be resulted in diversification of industries and services; • Products of industries and services could become cheaper; • Quality and efficiency of energy supply will improve.
Economic development priorities	If efficiency of the heating boiler houses with capacity 1 MW increased from 40 to 70 per cent then coal consumption will be reduced by 725 ton/year. Coal consumption of heat generation will decrease from 715 kg/Gcal to 408 kg/Gcal. Less fuel consumption will result in lower heating costs i.e. there is a estimation that the unit cost for heating can be reduced from 22.5 USD/Gcal to 19.0USD/Gcal.
Environmental development priorities	Annual coal saving for 100 HOBs is 72500t. Reduced air pollution: CO-2280 t;NO_X - 101 t; SO_2 - 333 t; Ash-190 t. (air pollutant reduction by 42%) Reduction of CO_2 emissions by 1125 ton per 1.0 MW heat load.
Other considerations and priorities such as market potential	-
Costs	
Capital costs	Investment cost for modern efficientheat only boilers with 1MWheat load is 200.000 USD. Total Investment cost 20 million USD for 100 HOBs.
Operational and Maintenance costs	Operational and Maintenance costs of heat only boilersof 1.0 MWheat load are 60,000.0 USD.
Cost of GHG reduction	GHG emission reduction cost will be 53.3.0 USD/tCO_2-eq

Technology 10: **Small scale hydropower plant**

Subsector	**Energy supply**
Sector GHG emission (tCO_2-eq)	6,399,000 tCO_2-eq from the energy supply subsector in 2006
Technology Name	**Small scale hydropower plant**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Small hydropower here refers to hydroelectric power plants below 15MW installed capacity. Hydroelectric power plants are power plants that produce electrical energy by driving turbines and generators thanks to the gravitational force of falling or flowing water. Through the natural water cycle mainly evaporation, wind and rain, the water is then brought back to its original height. It is thus a renewable form of energy. Small-scale hydro power may be a useful source for electrification of isolated sites and may also provide an extra contribution to national electricity production for peak demand.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Mongolia has experience in construction of hydropower plants with capacity of 11 and 12 MW. The Taishir 11MW hydropower plant is constructed on the ZavkhanRiver with power generation of 37,000 MWh of electricity per year, which is provided to the Gobi Altai and Zavkhan provinces. It achieves CO_2 emission reductions of 29,600tCO_2-eq /yr by displacing electricity that would otherwise be generated by diesel generators (Taishir Project Design Document). The Durgun 12 MW hydropower plant is constructed on the Chono Kharaih River with power generation of 38,000 MWh of electricity per year distributed to Bayan Ulgii, Khovd and Uvs provinces.It achieves CO_2 emission reductions of 30,000 tCO_2-eq /yr by displacing electricity that would otherwise be generated by a coal-fired power plant (Durgun Project Design Document). It is assumed that a 12 MW hydropower plant is compared with a coal-fired power plant.
Reduction in GHG emissions	12 MW hydropower plant will reduce GHG emissions of 30,000tCO_2-eq/yr compared with a coal-fired power plant.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	Small scale hydropower plant could: • displace imported fossil fuel with domestic resources for power generation; • prevent mass migration of local people to urban areas and degradation of remote areas • provide assistance in the development of potential tourist attractions; • be incorporated with other productive water use projects such as water supply, irrigation, tourism and recreation.
Economic development priorities	The electricity can be used to increase income generating activities, in particular it can improve irrigation, crop processing and food production (ESHA, 2005). The income generating activities may provide more jobs to the rural communities. http://climatetechwiki.org/technology/smallhydro

Environmental development priorities	Substituting traditional fuels by the switch to electricity can reduce air pollution, improve health and decrease social burdens, e.g. from collecting firewood.
Other considerations and priorities such as market potential	The market potential is medium
Costs	
Capital costs	The capital cost of small HPPs depends on geographical location. For example, the investment costs for 12 MW Durgun HPP and 11 MW Taishir HPP were 26.5 million USD and 38.9 million USD respectively. We assume the cost of small hydropower plant with capacity 12 MW as average of above 2 plants as 32.7 million. Assuming a life time of 100 years the annualized cost would be around 0.33 million USD.
Operational and Maintenance costs	Operational and maintenance costs can be assumed to be about 300,000 USD as average for Durgun (191000 USD) and Taishir (400,000 USD) HPPs (Source: Durgun and Taishir PDDs).
Cost of GHG reduction	Annual capital cost 0.33 Million USD plus O&M cost 0.3 million USD. Total cost is 0.66 million USD. Mitigation achieved 30,000 tCO_2-eq /year. Therefore cost of GHG reduction is 22 USD/ tCO_2-eq.

Annex 2: Technology Factsheets: Residential and commercial subsector

Technology 1: **Improved insulation of panel apartment buildings**

Subsector	**Commercial, Residential Energy Consumption**
Sector GHG emission (tCO_2-eq)	1,425,000 tCO_2-eq in 2006
Technology Name	**Improved insulation of panel apartment buildings**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Ulaanbaatar is the world's coldest national capital city with an eight month heating season, a winter design temperature of -39°C, and winter temperatures frequently falling to -30°C at night and -20°C in the daytime. Around 500 panel apartment buildings house around 200,000 people or around 20% of the population of Ulaanbaatar.The precast panel buildings have no added external wall insulation, have poorly insulated external doors, poorly insulated roofs, and still have mostly old double wooden framed high air ventilation heat loss windows. The panel buildings' hot water radiator heating systems have no heat output controls. Apartments have no heat consumption metering fitted. Thus building managers and apartment owners lack both financial incentives and the technical means to reduce excessive heat losses or reduce overheating.The Ulaanbaatar panel buildings will continue to be used for many years.
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	GHG reductions will be achieved as a result of energy efficiency measures undertaken at 2 big pre-cast panel buildings with 792 apartments in Ulaanbaatar. The energy efficiency measures will lead to a reduced demand for apartment space heating in winter from the local heating loop supplied from the heat substation. The reduced heat demand from the heat substation will reduce the heat demand from the primary hot water heating loop supplied from the coal fired Combined Heat and Power plant No 4 (CHP No 4) in Ulaanbaatar. The reduced heating demand from CHP No 4 will lead to a reduced demand for coal, which will lead to reduced anthropogenic GHG emissions (1) from the reduced heat losses achieved by adding wall, roof, ground floor and basement insulation, from fitting improved insulation level windows and from reducing uncontrolled air infiltration; (2) from the new ability of the apartment occupants to control their space heating energy supply and (3) from the new incentives for the apartment occupants to manage any overheating by adjusting their thermostatic radiator valves, arising from the fitting of apartment heat consumption meters that measure an apartment's actual space heating use which would then be used in the new heat consumption tariffs.In the future, up to 2030, all panel apartment buildings will be improved by implementing the above energy efficient measures.
Reduction in GHG emissions	GHG emissions are expected to be reduced by 492,000 tCO_2-eq
Impact Statements - How this option impacts the country development priorities	
Social development priorities	- Living conditions of the residents will be improved; - Financial income of the people will be increased;

Economic development priorities	- Heat energy costs of the apartments will be reduced. - Reserve capacity for the city's heat sources will be set up and this reserve source can be used for heating of apartments planned to be built in future.
Environmental development priorities	The project will contribute towards a reduction of the severe winter pollution that causes Ulaanbaatar residents to have winter respiratory problems, causing chronic winter illness and lowered human productivity
Other considerations and priorities such as market potential	-
Costs	
Capital costs	The investment cost of 792 apartments will be 6 million EURO (7.5 million USD) according to the Ulaanbaatar Apartment Buildings Energy Efficiency Project. For improvement of all existing 500 panel apartment buildings (about 30000 apartments) will require 284 million USD. Assuming a life time of 30 year the annualized cost would be around 9.47 million USD.
Operational and Maintenance costs	Ulaanbaatar Apartment Buildings Energy Efficiency Project could save heat energy of 161 kWh/m^{2}year. 792 apartments will save heat energy of 6,377 kWh (5,496 Gcal). Assuming that the real cost of heat energy is 3 times more than existing heat tariffs for households (7.44 USD/Gcal) the cost of saved heat energy will be 122.7 thousand USD. The cost of saved heat energy for 30000 apartments will be 3.68 million USD. The total operational and maintenance costs will be 5.79 million/USD per year.
Cost of GHG reduction	According to the Ulaanbaatar Apartment Buildings Energy Efficiency Project, the GHG emissions from improvement of 792 apartments are 12,988 tons ofCO_2-eq. GHG emissions from 30000 apartments will be 492,400 tons ofCO_2-eq. GHG emission reduction cost will be 11.76 USD /tCO_2-eq

Technology 2: **Efficient lighting (Compact Fluorescent Lighting, LED)**

Subsector	**Commercial, Residential Energy Consumption**
Sector GHG emission (tCO_2-eq)	1,425,000 tCO_2-eq in 2006
Technology Name	**Efficient lighting (Compact Fluorescent Lighting, LED)**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Compact Fluorescent Lamp (CFL) technology provides a low energy lighting service through the use of a compact fluorescent light bulb that replaces the normal Tungsten filament light bulb. Still, there is a whole range of different sorts of lamps from ordinary incandescent tungsten filament bulbs to Tungsten Halogen, Halogen infrared reflecting, Mercury vapor lamps, Compact fluorescent lamps, linear fluorescent, metal halide, compact metal halide, high pressure sodium (High Intensity Discharge lamp) and Light Emitting Diodes (LED). CFLs contribute to security of energy supply as they make a significant contribution to reducing electricity demand. The higher up-front cost could be a barrier for their implementation, but calculations show that CFLs pay back the initial investment within 900 hours of operation and also contribute to a reduction in the electricity bill over the lifetime of the bulb. The savings can be in the order of 10-20 times the initial cost over the life of the bulb. http://climatetechwiki.org/technology/cfl
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	Incandescent bulbs are commonly used in Mongolia. Incandescent bulbs produce 10-15 lumen/W and last for 1,000-2,000 hours. Compact fluorescent lamps (CFLs) produce 50-60 lm/W and last for 10,000-15,000 hours. Moreover, Light-Emitting Diodes (LEDs) produce 100-130 lm/W and last for 35,000-50,000 hours. Usage of CFLs at household and service sector levels is low due to its relatively high price. The project can be implemented by promoting consumers to switch from ILs to more energy efficient lamps (CFLs and LEDs) by providing them with some incentives originated by the Certified Emission Reductions (CERs) revenue as a Clean Development Mechanism Project. The project will reduce greenhouse gas emissions by preventing CO_2 emissions from electricity generation by fossil fuel power plants that supply the Central Energy System of Mongolia. Most CER revenue acquired by this project activity can be designed to be returned to CFLs buyers in the form of the incentive. Currently, 30 % of household consumption of electricity is being used for lighting. When the technology is accomplished, 218 million kWh of energy will be saved per year (Mongolia Second National Communication, 2010)
Reduction in GHG emissions	Converting electricity consumption to CO_2 emissions it will be 240,000 tCO_2-eq (218,000 MWh x1.103tCO_2-eq /MWh). GHG emissions are expected to be reduced by about 240,000 tons CO_2/year.

Impact Statements - How this option impacts the country development priorities	
Social development priorities	Significant energy savings will help to free up energy resources that can be spent on other national, social and human development goals.
Economic development priorities	The lighting service improvement technology can reduce electricity generation in power plants and save a significant amount of fossil fuels for electricity generation and for transport of coal from coal mines to power plants.
Environmental development priorities	The lighting service improvement technology can reduce air pollution in big cities.
Other considerations and priorities such as market potential	The market potential is big
Costs	
Capital costs	Required investment cost will be about USD 16 million. The annualized capital cost will be USD3.2 million with efficient lighting life time of 15000 hours.
Operational and Maintenance costs	The cost of saved energy will be 6.9 million USD. The total operation and maintenance cost will be -3.7 million USD.
Cost of GHG reduction	Cost of GHG reductions is expected to be about US -15.4/tCO_2-eq

Technology 3: **Improved heating stoves**

Subsector	Commercial, Residential Energy Consumption
Sector GHG emission (tCO_2-eq)	1,425,000 tCO_2-eq in 2006
Technology Name	**Improved cook stoves**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Among the various technologies introduced in the realm of efficient household heating and cooking methods, stoves are the most popular and widespread in both urban and rural communities. Especially in developing countries, stoves occupy a central place in the health, environmental, economic and social domains of life. A good cooking stove is defined as one that meets technical, scientific and safety standards, and has high combustion quality, technical efficiency, minimal smoke emission, ergonomics and structural stability. Since about 1.5 billion people in the world use traditional stoves for cooking and heating, efforts to improve the efficiency of cooking and heating stoves have been increasingly popular in the developing world. Improved stoves come in different forms and sizes. http://climatetechwiki.org/technology/imcookstoves
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	The government of Mongolia implements air pollution reduction measures and distributes energy efficient and low-smoke stoves for households in ger district areas. The efficient coal stoves could reduce coal consumption by 30-50%. We assume that the household with an inefficient traditional stove uses 5 tons of coal per year. The modern low smoke stove could reduce coal consumption by 30%. There are 100000 household in which energy efficient coal stoves should be installed.
Reduction in GHG emissions	GHG emissions are expected to be reduced by 210.000 tCO_2/year

Impact Statements - How this option impacts the country development priorities	
Social development priorities	For about eight months of the year heating is essential for the survival of residents. 60 percent of the city's residents live in peri-urban *ger* districts; areas populated in the main by poor people from Mongolia's rural areas who are arriving in a steady flow. UB's population has expanded by 70 percent over the last 20 years and unfortunately the city's infrastructure has not been able to keep up with the growth. In these areas, which are mainly located upwind of the city, the only sources of heating are poor quality stoves or individual household boilers fueled by coal, wood.
Economic development priorities	
Environmental development priorities	Ulaanbaatar is the coldest capital city in the world and during the coldest months of the year - December, January and February - the air quality is dangerously low. By improving the efficiency of fossil fuel burning heating and cooking stoves, the air pollution of the urban city will be reduced and also the amount of toxic smoke produced can be reduced and health risks to citizens minimized.
Other considerations and priorities such as market potential	-
Costs	
Capital costs	It is assumed that the capital cost of the traditional inefficient stove is about 60USD. The cost of the energy efficient stove is 260 USD depending on the capacity. With assumed average lifetime of 10 years the annualized capital cost would be 20USD. The total annualized capital cost for 100000 stoves will be 2 million USD.
Operational and Maintenance costs	Coal saving will be 150000 t/year. Cost of coal savings will be 3.0 million USD/year. Operational and Maintenance costs will be -1 million USD.
Cost of GHG reduction	The cost of GHG reduction is expected to be - 4.7 USD/tCO_2

Technology 4: **LPG for household and commercial cooking**

Subsector	**Commercial, Residential Energy Consumption**
Sector GHG emission (tCO_2-eq)	1,425,000 tCO_2-eq in 2006
Technology Name	**LPG for household and commercial cooking**
Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Liquefied petroleum gas (LPG) is a mixture of propane and butane, which are gases that become liquid under pressure and can then be stored in pressurized containers (Dell and Rand, 2004). The proportion of each gas varies depending on the source and climate. Propane is preferred where the climate is cold and butane where it is warm. LPG has a high energy per unit volume and is convenient to use. Its calorific value per unit volume is about 2.5 times larger than that of natural gas (methane). It is used for road transport, cooking, heating, refrigeration, air conditioning and in spray cans. It is a portable source of energy used for remote and leisure applications in the EU and in cooking and transport in developing countries. LPG is manufactured during the refining of crude oil (40%) or from natural gas during extraction (60%). http://climatetechwiki.org/technology/lpg_lng_cooking
Implementation assumptions, How the technology will be implemented and diffused across the subsector?	In Mongolia the main benefits of LPG in rural areas, especially in Gobi region, are in helping people to switch from unsustainable biomass use to a clean and safe cooking fuel. In urban areas, the use of LPG for cooking could reduce electricity consumption. For calculation of CO_2 emissions, we assume that LPG for cooking technology will be implemented in 50% of the urban residential and commercial sector by 2020. The electricity consumption for the residential and commercial sector was 809.7 million kWh in 2010 (Mongolian Statistical Yearbook). It is assumed that 30% of this consumption is used for cooking. The substituted electricity by LPG will be about 121,500 MWh.
Reduction in GHG emissions	LPG has a typical specific calorific value of 46.1 MJ/kg (http://en.wikipedia.org/wiki/Liquefied_petroleum_gas) or 12.8 kWh/kg 1kWh LPG consumption emits 0.24 $kgCO_2$http://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html 1kWh electricity consumption from grid emits 1.103 $kgCO_2$. GHG emissions are expected to be reduced by 105.000 tCO_2/year.
Impact Statements - How this option impacts the country development priorities	
Social development priorities	In developing countries the main benefits of LPG are in helping people to switch from unsustainable biomass use, to a clean and safe cooking fuel. This provides enormous health benefits helping to avoid the 1.6million deaths/year from respiratory problems caused by smoke and other pollutants released by inefficient biomass burning in enclosed spaces. It also releases women and children from the drudgery of collecting firewood and health problems associated with carrying heavy bundles long distances. There are also benefits for local ecology and biodiversity. The UN Millennium project recommends that globally the number of households using non-sustainable biomass for cooking should be halved by 2015. http://climatetechwiki.org/technology/lpg_lng_cooking
Economic development priorities	

Environmental development priorities	In Mongolia the main benefits of LPG in rural areas, especially in Gobi region, are in helping people to switch from unsustainable biomass use to a clean and safe cooking fuel. In urban areas, use of LPG can reduce air pollution of big cities.
Other considerations and priorities such as market potential	The market potential is big
Costs	
Capital costs	We assume that the capital cost of LPG cooker and electric cooker is about same.
Operational and Maintenance costs	Recently, the LPG cost in the Mongolian market was 1800 MNT/kg (1.28 USD/kg). 1kg LPG is equal to 12.8 kWh electricity. As mentioned above the annual electricity consumption to be replaced by LPG is 121,500 MWh. This amount of electricity could be substituted by 9490 tons of LPG fuel. The cost of LGP will be 17.1 million USD. The cost of electricity will be 9.3 million USD.
Cost of GHG reduction	The GHG reduction cost will be 74.3 USD/tCO_2

Annex 3: List of stakeholders engaged for selection of subsectors and technologies for climate change mitigation

Stakeholders		***Representatives***	
Organization	***Department***	***Name***	***Position***
Ministry of Mineral Resources and Energy	Energy Policy Department	Y. Enkhtuya	Energy efficiency officer
	Fuel Policy Department	N. Boldkhuu	Deputy director
Energy authority	Renewable energy division	Bayasgalanbaatar	Chief
	Energy department	S. Purevdash	Officer
Ministry of food, agriculture and light Industry	Livestock policy implementation and coordination Department	B. Binye	Deputy director
Ministry of Nature, Environment and Tourism	CDM National Bureau	B. Tsendsuren	Head
	CDM National Bureau	B. Bat-Ulzii	Officer
	Climate Change coordination office	E. Ganhuyag	Officer
	Green growth committee	Ts. Gerelt-Od	Secretary
	Strengthening *Environmental* Governance in Mongolia *Project*	A.Enhtsetseg	Project consultant
National Development and Innovation Committee	Industrial Development Department	B. Ganbaatar	Director
		G. Misheelt	Fuel and Energy policy officer
UNDP in Mongolia	Building Energy Efficiency project (BEEP)	Munkhbayar	Project manager
Mongolian University of science and Technology	Energy Institute	Ch. Zunduisuren	Professor
Mongolian Academy of Sciences	Institute of Botany	Ch. Dorjsuren	Head of Forest Department
	Energy corporation	M. Bum-Ayush	Director
National *Emergency*Management *Agency*.	Project Implementation unit	Delgermaa	Project officer
Mongolian National University	Energy Institute	Y. Gantogoo	Consultant
The government office of Ulaanbaatar city the capital of Mongolia	The government office	Ch. Tsogtsaikhan	Officer
Techno-trans Co., Ltd	Private company	D. Borchuluun	Director
Mongolian National Chamber of Commerce and Industry	Clean production and Energy Efficiency Center	G. Tumenjargal	Head
Mongolian Millennium Challenge Corporation	Clean Air project	B. Tamir	Project officer
	Project Implementation Office	N. Tsolmon	Project officer
Mongolian Energy Association	Non-governmental Organization	G. Purevdorj	General secretary
President office	National air pollution reduction committee of Mongolia	B. Ganbat	Energy expert
Mon-Energy Co., Ltd	Private company	D. Sod	Energy and Environment expert
MCS Group	MCS International Co., Ltd	G. Tulga	Coal expert

Section II.

Barrier Analysis and Enabling Framework

EXECUTIVE SUMMARY

The barriers and measures for all five selected technologies under the two subsectors have been identified as follows:

- The TNA local consultants prepared the long list of barriers, and measures to overcome these barriers, on the basis of own experience, existing studies and policy documents and UNEP RISOE Centre Guidebook "Overcoming Barriers to the Transfer and Diffusion of Climate Technologies". The list consists of barriers, elements of barriers and dimensions of barrier elements (see Annex I).
- The list of economic and financial barriers has been discussed with stakeholders to identify the essential barriers which definitely need to be addressed for technology transfer and diffusion to occur, and the non-essential barriers, which are to be discarded and subsequently ignored.
- All possible barriers were entered in random order in the long list, and each workshop participants was asked to give each barrier a score from 1 to 5, according to how important the barrier is from the participant's own perspective.

Energy industries

Large hydro power plants, wind turbines and super critical pulverized coal combustion technologies were selected as the priority technologies for further investigation.

Preliminary targets

Following preliminary targets for technology transfer and diffusion for energy industries subsector were identified:

- to construct large scale HPPs with total capacity 620 MW in 2020 in order to implement Renewable energy national program by annually generating 1372 million kWh electricity from large scale HPPs.
- to construct wind parks with total capacity 354.4 MW in 2020 in order to implement renewable energy national action program by generating electricity 708 million kWh annually from wind parks
- to construct super critical and ultra-super critical thermal power plants with total capacity of 1200 MW in 2020 and 3200 MW in 2030 in order to meet growing energy demand of 7800 million kWh annually in 2020 and 13200 million kWh annually in 2030.

Barrier analysis

Barriers faced by different prioritized technologies in the energy industry sub-sector appear to be very similar. But priorities of barriers are different in many cases.

The common economic and financial barriers are inappropriate financial incentives; high cost of capital; high transaction cost; lack or inadequate access to financial resources and uncertain macro-economic environment.

Common barriers regarding the policy, legal and regulatory aspects are lack of long-term political commitment and uncertain government policies (political risks for investors); lack of government control for implementation of laws and regulations; government or utility monopoly of energy sector.

Common barriers regarding the market and network aspects are underdeveloped competition, insufficient coordination between relevant ministries and other stakeholders.

The priorities of barriers are different in many cases in selected specific technologies.

Regarding the large scale HPP technology, policy-related barriers have first priorities.

The stakeholders participated in the barrier analysis giving the highest score, 4.75, (from maximum 5) to the barriers "Lack of long-term political commitment" followed by barriers "Officials make arbitrary decisions on their own will", "Uncertain government policies (political risks for investors)", and "Insufficient willingness or ability to enforce laws and regulations"

Decision makers and experts in the energy sector understand the need for developing large scale hydro power plants in the current energy system of Mongolia. However, these kinds of projects have not materialized due to political reasons and special interests. The plans on building large scale hydro power plants are reflected in every policy document on the energy sector. The discussions on the required investment and projects have taken place a few times in parliament and cabinet meetings. Even so, it still has not moved forward due to political reasons. For HPPs, politics is the main barrier.

Regarding the wind park, barriers of the highest priority are system constraints (capacity limits of the grid system).

Wind parks adversely affect the energy system stability as their operations and electricity supply depends on irregular wind availability. Especially for a country like Mongolia whose energy system consists of small sized coal fired power plants, connecting many high capacity wind power plants will destabilize the system.

The main difficulty hindering the implementation of large hydro power plant projects is the low electricity tariff. Even though in the renewable energy law, it is mentioned that feed in tariff to be provided for electricity supplied by renewable energy resources, the electricity generated by HPPs with capacity of more than 5MW is not covered under this feed in tariff. The low tariff hinders investment in hydro power plant projects as the power purchase agreement doesn't reflect feed in tariff mentioned in the renewable energy law. On the other hand, there are many companies who are interested in developing wind parks because the renewable energy law has explicitly stated the feed in tariff to be provided for electricity supplied by wind. As of 2012, there are 5 companies which have obtained special licenses to construct wind parks and the planned installed capacity of all these wind parks are 500 MW.

Enabling framework for overcoming the barriers in Energy sector

In order to encourage the development of climate technology in the energy industry subsector, the government should implement the concession law which was adopted by Parliament in 2010. The law allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession. The climate technologies such as large scale HPP, Wind Park and Efficient coal fired power plant projects should be included in this list of concessions which is approved by the Mongolian Government. The government needs to give the necessary guarantees to attract foreign investors.

Another way to get financial sources of investment in climate technologies is to use the Development Bank of Mongolia. According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament. The list of projects and programs to be financed shall be approved by parliament on an annual basis. The Development Bank may finance those projects and programs for which the government issued guarantees.

The climate technologies are often capital-intensive and almost all of the components are imported from abroad. The Government should issue regulation on the exemption of import duty of machinery, and goods for climate technologies.

The government should introduce environment tax for conventional energy (coal fired power plants). The environment tax for conventional energy should be included in law on fees for air pollution.

The Energy Regulatory Committee should increase energy tariffs which do not allow the licensed energy companies to recover their costs and expenses. By setting tariffs, the ERC should ensure the financial viability and sustainable operation of the licensees, whilst balancing their interests with those of the consumers.

Tariff levels are very sensitive issue in Mongolia and are subject to intense political pressure, making it difficult to propose and implement changes. However, the tariff level should at least reach the level of cost recovery. After reaching cost recovery tariffs, cross-subsidies currently existing between industry and residential tariffs should be removed.

The government should continue the planned efforts in energy pricing reform (eventual cost recovering level of price and removal of cross subsidies.

The government should have long-term political commitment especially regarding the implementation of large scale HPP projects.

The government should have strong control for implementation of laws and regulations.

The government should ensure sufficient coordination between relevant ministries and other stakeholders. The government should take responsibility when no measures are taken to implement the laws and regulations.

Development plan and programs of the energy sectors shall be designed consistant with environmental and green development principles. The government should establish an energy research institute under the Ministry of Energy.

Cooperation between the Ministry of Energy and other relevant Governmental institutions should be enhanced. Cooperation with other actors such as NGOs, donor organisations, and private actors should also be improved

In order to encourage the development and utilization of large-scale HPPs in Mongolia, the government needs to have long term political commitment. It is important to have clear government policies with no political risks for investors. There is a strong need for government control over implementation of laws and regulations.

In order to reduce or overcome these technical difficulties, we need to improve the energy generation mix. We need to increase the share of manageable or flexible sources for generation in the energy system. Especially, if we connect large hydro power plants into the current energy system, system stability will increase which create suitable conditions for more wind parks to be connected to the system

Residential and commercial sector

Efficient lighting and insulation of panel apartment buildings were selected as the priority technologies for further investigation.

Preliminary targets

Following preliminary targets for technology transfer and diffusion for residential and commercial sector were identified:

- One prioritized technology for the residential and commercial sector is promoting the use of energy-efficient compact fluorescent lamps (CFL) to replace inefficient incandescent light bulbs (ILB). CFLs provide the same level of illumination as an incandescent lamp but use roughly 70% less electricity. Although CFLs are more expensive than ILBs, they are more economical on a life-cycle basis due to savings in electricity costs. Currently, most households and about 30% of service and commercial buildings use incandescent bulb lamps and the rest use fluorescent bulbs. After stakeholder consultation, it is assumed that 60% of households in Ulaanbaatar by 2020 will be supplied by CFLs as a preliminary target of efficient lighting technology transfer and diffusion.
- The majority of the apartment buildings in Ulaanbaatar were constructed in the 1970s, 1980s and early 1990s and are in a poor state, without systematic professional maintenance and repair. The energy efficiency in centrally and district heated buildings leaves much room for technical and managerial improvement. Heat consumption of the buildings is around five times higher than the modern systems in Europe. This, to some extent, is due to the cold climate in Mongolia. However, the main reason is poor technology and a lack of incentives to save energy. A recent study on heat losses concluded that nearly 40% of the heat is lost in houses and buildings. The heat losses occur through windows, walls and doors as the design and construction of old apartment buildings in bigger cities are very similar to buildings found in many places of the former Soviet Union.There are around 500 panel apartment buildings that house around 200,000 people or around 20% of the population of Ulaanbaatar. It is assumed that 300 existing panel apartment buildings will be insulated in 2020 as a preliminary target of building insulation technology transfer and diffusion.

Barrier analysis

Barriers faced by efficient lighting and building insulation technologies in the residential and commercial sector appear to be quite similar.

The common economic and financial barriers are inappropriate financial incentives, lack of adequate access to financial resources and uncertain macro-economic environment.

Common barriers regarding the policy, legal and regulatory aspects are mismanaged energy sector; lack of laws and regulations on energy efficiency.

Common barriers regarding the market and network aspects are insufficient coordination between relevant ministries and other stakeholders, lack of professional institutions;

and lack of confidence in new climate technologies

The priorities of barriers are different for the two specific technologies.

For the efficient lighting technology, the most important barriers are low electricity tariff and lack of management for implementation of the technology.

For the building insulation technology, the barriers of highest priority are high cost of capital and low fixed tariff not depending on actual heat consumption.

Enabling framework for overcoming the barriers

The Government should finalise the Energy Conservation Law as soon as possible. Promulgating the Energy Conservation Law will send a strong signal to energy stakeholders and the wider public about the importance of energy efficiency. The Government should reinforce cooperation with all relevant Governmental institutions and other stakeholders in drafting the Energy Conservation Law.

Upon the adoption of the Energy Conservation Law the Government should further develop secondary legislation and regulations in different sectors, in close cooperation with relevant actors.

The Energy Regulatory Committee (ERC) should increase energy tariffs, so that the tariff can be high enough to allow the licensed energy companies to recover their costs and expenses. The tariff level should reach at least the level of cost recovery. After reaching cost recovering tariffs, cross subsidies currently existing between industry and residential tariffs should be removed.

The government should hold government agencies accountable for the enforcement of laws and regulations.

The Government should examine the possibilities of introducing tax incentives for energy efficiency projects. The government could support the insulation of apartment buildings and should try to attract foreign aid and soft loan.

The government should establish a formally mandated agency in the country, delegated to develop and implement the national and sectoral energy efficiency policies and programs.

The Government should make efforts to provide incentives to residents to improve insulation of their apartments, using such instruments as subsidies and micro credits.

The Government should consider consolidating the Green Credit Guarantee Fund and other similar funds in order to create revolving credit liquidity.

The Government should put strong emphasis on implementation and enforcement of adopted building regulations.

Background

The Technology Needs Assessment Report (TNA) for Climate Change Mitigation in Mongolia was finalized in June 2012. The TNA Report aimed to identify key mitigation technologies in priority sectors for Mongolia. Two subsectors were identified as priority areas for mitigation technologies. These were the energy industries subsector and the residential and commercial subsector.

Within the energy industries subsector, large hydro power plants, wind turbines and super critical pulverized coal combustion technologies were selected as the priority technologies for further investigation. For the residential and commercial subsector, efficient lighting and improved insulation of panel apartment buildings were selected using the same approach.

In order to identify barriers it is important to classify the technologies as technologies which are transferred and implemented under different market conditions, and the barriers to their transfer and diffusion are linked to market characteristics. It is therefore useful to categorize technologies according to the types of goods and services they belong to as the different types of goods and services have distinct market characteristics.

The category of the selected technologies are shown as follows:

Table 35: The category of the selected technology

	Selected technologies	*Category of the technology*	*Remarks (classification)*
1	Large scale hydro power plants	Non-market	Publicly provided goods
2	Grid connected wind park	Non-market	Other non-market goods
3	Pulverized coal combustion technologies	Non-market	Publicly provided goods
4	Efficient lighting technology	Market	Consumer goods
5	Insulation of panel apartment buildings	Market	Consumer goods

The barriers and measures for all five selected technologies under the two subsectors have been identified as follows:

- The TNA local consultants have prepared a list of barriers and measures to overcome the barriers on the basis of own experience, existing studies and policy documents and UNEP RISOE Centre Guidebook "Overcoming Barriers to the Transfer and Diffusion of Climate Technologies". The long list consists of barriers, elements of barriers and dimensions of barrier elements (see Annex I).
- The long list economic and financial barriers has been discussed with stakeholders to identify the essential barriers which definitely need to be addressed for technology transfer and diffusion to occur, and the non-essential barriers, which are to be discarded and subsequently ignored.
- All possible barriers were entered in random order in the long list, and each workshop participants was asked to give each barrier a score from 1 to 5, according to how important the barrier is from the participant's own perspective.

1. Energy industry sector

1.1 Preliminary targets for technology transfer and diffusion for energy industry sector

1.1.1 Large scale HPP

At present, there are 13 hydro power plants (HPPs) installed in Mongolia. Most of these are small and mini-hydropower stations with Durgun HPP the biggest, with an installed capacity of 12 MW and HunguinGol HPP to be the smallest and its installed capacity is only 115 kW **(ES 2011).**

Of these, only 4 of the small hydro power stations are connected to independent grids (Western and Altai-Uliastai), whilst the rest are isolated systems serving the nearby soums[12].

The oldest HPP is the Harhorin (528 kW) Hydropower Plant built in 1960 while the latest one is Taishir HPP (11 MW), which was commissioned in June 2011 **(ES 2011).** Since 2005, 7 HPPs have been installed in the country with the country's 2 largest power stations, Durgun and Taishir, commissioned during this period.

At present, there is no hydropower plant (HPP) being constructed that is connected to the Central Energy System[13] (CES) of the country, though various studies have been carried out in the past to develop hydropower projects from the country's main river basin (Selenge River Basin) and its sub-basins (Egiin, Ider, Orkhon and Tuul River Basins).

Mongolia's major rivers with highest hydropower resource potential such as Selenge, Egiin and Orkhan are situated northeast of the capital city Ulaanbaatar. These resources could potentially supply electricity to CES.

The National renewable energy program approved by parliament in 2005 indicates:

"Gradually implement goal in increasing percentage share of renewable energy in the total energy production and reach 3-5 percent share in the national energy by the year 2010, 20-25 percent share by 2020". But this target has not been achieved. As of 2011, the share of renewable energy in total electricity production is 1.11%. In the future, the electricity generation will be increased gradually and will reach 7800 million kWh in 2020. In order to reach the 20% target, the electricity generation from renewable energy sources should reach 1560 million kWh.

According to the government policy Shuren HPP (300 MW), Egiin HPP (220 MW) and Orkhon HPP (100 MW) will be constructed before 2020. The electricity consumption of HPPs will be 1372 million kWh which will be 17.5% of total electricity consumption.

Table 36: National overall target for the share of electricity production from renewable sources in 2010 and 2020 according to the National Renewable energy program

1	Target of electricity from renewable sources in total electricity production in 2010		3-5 %
2	Share of electricity production from renewable sources in total electricity production in 2011.		1.11%
	From this	*Hydro*	*1.1%*
		Wind and Solar	*0.01%*
3	Target of electricity from renewable sources in total electricity production in 2020		20-25%
4	Expected total electricity consumption in 2020 (million kWh)		7800.0
5	Expected amount of electricity from renewable sources corresponding to 2020 target (million kWh)		1560.0

12. The soum is a second level administrative subdivision of Mongolia. The 21 aimags of Mongolia are divided into 329 soums.
13. Central Energy System (CES) is the biggest national grid covering central part of Mongolia. There are several small grids called Western energy system, Eastern energy system, Altai-Uliastai energy system.

The preliminary target for technology transfer and diffusion of large scale HPP is to construct large scale HPPs with total capacity 620 MW in 2020 in order to implement Renewable energy national program by annually generating 1372 million kWh of electricity from large scale HPPs.

1.1.2 Wind Park

The Wind Atlas of Mongolia shows that the country has huge potential for wind power generation. The resource potential classified as excellent for utility scale applications (power density of 400-600 W/m^2) occupies around 10% of the total land area and could potentially supply over 1,100 GW of installed capacity. All of the aimags[14] have at least 6,000 MW of wind potential each. There are 13 aimags in Mongolia, with at least 20,000 MW of wind potential and 8 aimags with more than 50,000 MW, of wind potential.

The existing wind energy projects in Mongolia are small in scale and were initially developed to provide energy services to isolated rural areas. These are either installed as stand-alone systems or as wind-solar-diesel hybrid systems.

With grid connection either to the Mongolian national grid or to the grid of neighboring countries, the isolated wind power systems were either disassembled or are no longer in operation. Moreover, some systems were damaged and were not repaired due to lack of government financing.

Various problems exist in the present wind power systems, ranging from technical (low technical quality) to operational (insufficient training for system operators) and financial (lack of government financing).

With a combination of various factors such as a policy and regulatory framework that provides private sector investment incentives (feed-in tariff), and access to electricity markets, high wind energy resource potential, high electricity demand growth, and projected short to long-term capacity shortage, various large-scale wind power projects were proposed and are being developed by the private sector in the country. Most of these projects aim to cater the electricity market of the Central Energy System and South Gobi.

Most of the private sector-sponsored large-scale grid-connected wind power projects are being proposed along the CES north-south grid network corridor, mainly from the south of the capital city, Ulaanbaatar, to Southern Gobi bordering China. The aim is to service the impending mine development in the South as well as the electricity market in Northern China.

In order to implement the target of National Renewable Energy Program (***NREP, 2005***), the Energy Regulatory Committee gives licenses to 5 private companies for construction of wind parks with total capacity 354.4 MW. The electricity generation of WPs will be 708 million kWh. The share of electricity generation from WPs will be 9.1 % if these projects are indeed successfully implemented.

The preliminary target for technology transfer and diffusion of Wind Park is to construct wind parks with total capacity 354.4 MW in 2020 in order to implement renewable energy national program by generating 708 million kWh of electricity annually from wind parks.

1.1.3 Efficient coal fired power plant (Super criticalPulverized coal combustion technologies)

Coal is the main primary energy source in Mongolia. The share of coal and coal products in total primary energy supply is about 70% **(MSNC,2010).**

Coal is expected to remain the most important primary energy source in the forseeable future, because of the large coal reserves in Mongolia and the much smaller reserves of oil and gas. The total geological coal reserves are estimated at approximately 150 billion metric tons, including about 24 billion metric tons explored **(MSNC,2010).** Over 70 % of the total domestic coal consumption happens at thermal power stations with the remainder going to heating plants, industry, households and the service sector.

The energy consumption will continue to increase rapidly due to population growth and economic development. In particular, energy consumption in the industrial sector is increasing rapidly due to the development of

14. The aimag is a first level administrative subdivision of Mongolia. Mongolia is divided into 21 aimags

the mining and quarrying industry.

In order to meet this growing energy demand, new energy sources are needed. Currently, a 600MW Combined Heat and Power Plant (CHP) is planned to be constructed in Ulaanbaatar in the coming years. In the long term, construction of more coal-fired thermal power plants is being considered. The future coal fired thermal power plants should be modern, energy efficient and environment friendly, such as pulverized coal thermal supercritical (or ultra-critical) power plants. These technologies can combust pulverized coal and produce steam at higher temperatures and under higher pressure, so that the efficiency is much higher than traditional coal-fired thermal power plants and the environmental pollution is much less.

The following target is based on energy sector development calculations and stakeholder discussions.

The preliminary target for technology transfer and diffusion of super critical and ultra-super critical thermal power plants is to construct thermal power plants with total capacity of 1200 MW in 2020 and 3200 MW in 2030 in order to meet growing energy demand 7800 million kWh annually in 2020 and 13200 million kWh annually in 2030.

1.2 Barrier analysis and possible enabling measures for large-scale HPP

1.2.1 General description of large-scale HPP

The large-scale HPP refers to the dam-based hydro for electricity supply with more than 100MW of installed capacity and usually feeding into a large electricity grid.

Hydropower is currently the second most widely used renewable energy source in the world, just behind solid biomass. In terms of electricity production, hydropower is the most important renewable energy source, both in the European Union and globally. Around 20% of global electricity supply is generated from hydropower, and in some countries, it provides more than 50% of total electricity supply. Hydropower can achieve significant GHG emission reductions as it, depending on the energy mix of the country concerned, could replace fossil based technologies for electricity production.

Presently, at least 35,000 large dams exist in the world. The number and size of large dams have increased in recent decades, with most of them in developing countries. Most industrialized countries have either developed large hydropower projects at sites with high potential or have excluded them from development because of environmental concerns.

Large hydropower remains one of the lowest-cost energy technologies, although environmental constraints, resettlement impacts, and the availability of sites have limited further development of large hydro power projects in many countries.

There is significant potential in Mongolia for hydropower generation. The hydropower potential source will most likely be a significant factor in Mongolia's medium term energy mix.

There are around 3,800 small rivers in Mongolia with a total length of 65,000 km with gross theoretical hydropower potential of about 6.2 GW. At present, more than 1 GW of these hasbeen identified **(Renewable energy, 2008).**

Hydropower resources can be found in the Altai ranges, Tagna and Khan Khukhii ranges, in the mountainous areas of Khuvsgul, Khangai, Khentii and the Khalkh Gol river.

There are 13 hydropower stations in Mongoliain operation, most of them are small or medium sized plants.Only four plants are connected to local grids while the rest serve isolated grids of nearby soums.There are three plants larger than 1 MW, namely Durgun (12 MW), Taishir (11 MW) and Bogdiin gol (2 MW)**(ES 2011).**

Various studies have identified within Central Energy System(CES) regionprospects to develop several projects in the Selenge river system. These are Shuren 300 MW, Orkhon 100 MW, Egiin 220 MW, Buring 161 MW, and Artset 118 MW hydropower projects. In addition 100 MW pumped-storage HPP close to Ulaanbaatar has often been mentioned among the most likely ones for mid-term implementation.

1.2.2 Identification of barriers for large-scale HPP

In order to identify barriers for large scale HPP it is important to classify the technology as various technologies are transferred and implemented under different market conditions, and the barriers to their transfer and diffusion are linked to market characteristics.

Large scale hydro power plants are categorized as non-market publicly provided goods. The market characteristics of large scale HPPs are that there are very few sites, large investment, government/donor funding, public ownership or ownership by large companies. Large scale HPP as non-market goods are primarily diffused through political decisions. Government therefore has a direct influence on the diffusion on large scale HPPs.

The list of barriers with elements of barriers and dimensions of barrier elements for large scale HPP technologies was prepared by TNA mitigation team (see Annex I). The long list of economic and financial barriers have been discussed with stakeholders to identify the essential barriers.

The list of barriers for large scale HPP is presented in different categories.

I. Financial barriers

1. Economic and financial barriers

a. Lack or inadequate access to financial resource

b. High capital cost

c. High transaction costs

d. Inappropriate financial incentives and disincentives

e. Uncertain financial environment

f. Uncertain macro-economic environment

II. Non-financial barriers

2. Market failure

a. Poor market infrastructure

b. Underdeveloped competition

c. Domestic restricted access to technology, no experience

3. Policy, legal and regulatory

a. Insufficient legal and regulatory framework

b. Inefficient enforcement

c. Policy intermittency and uncertainty

d. Highly controlled energy sector

4. Network failures

a. Weak coordination between actors favoring the new technology

5. Institutional and organizational capacity

a. Lack of professional institutions

6. Human skills

a. Inadequate training facilities

b. Inadequate personnel for preparing project documents such as Feasibility Studies

7. Social, cultural and behavioral

a. Traditions and habits

8. Information and awareness

a. Lack of confidence in new climate technologies

9. Technical

a. Technology not reliable

b. Poor O&M facilities

c. System constraints

10. Other

a. Environmental impacts

1.2.2.1 Economic and financial barriers

The specific economic analysis has not been conducted for identification of barriers because the feasibility studies and pre-feasibility studies of most planned large scale HPPs have been done already **(Egiin HPP 2006; FS Orkhon HPP 2001; FS Shuren HPP 2011).** The stakeholders have been introduced to the economic analysis of large scale HPPs.

Stakeholders were asked to rank the barriers and then the average score for the barriers were taken as a basis to rank them.

The six economic and financial barriers from above long list were ranked and are shown in Table 37.

Table 37: Economic and financial barriers with scores given by stakeholders (large Scale HPP)

	Barriers	***Average Scores***	***Rank***
	Economic and financial		
1	Lack of or inadequate access to financial resource	2.6	4
2	High capital cost	3.3	2
3	High transaction costs	3.1	3
4	Inappropriate financial incentives and disincentives	3.4	1
5	Uncertain financial environment	2.4	5
6	Uncertain macro-economic environment	2.2	6

The ranked barriers were discussed again with main stakeholders and consultants and the following most priority barriers were selected for future analysis:

- Inappropriate financial incentives
- High cost of capital
- High transaction cost
- Lack of inadequate access to financial resources

Inappropriate financial incentives

Due to relatively lower costs of electric power generation from conventional coal-burning power plants and the governmental support towards this kind of the plants, there is no incentive to use technologies of greenhouse gas emission reduction such as large-scale HPPs.

The government provides subsidy to Combined Heat and Power plants (CHPs): e.g., a total of 14.7 billion MNT[15] were provided to small scale power companies as subsidy in 2011 (***ES 2011)***. The tariffs paid by users for electricity and heat are lower than the energy generation costs. The government will not provide subsidy to power plants such as large scale HPPs. This is why, it is impossible for HPPs to repay its upfront investment.

Electric power generation costs of the Central Energy System are 6.32 cents/kWh while electric tariff of households is 5.68 cents/kWh on average. In the Western Energy System, costs of distributed electricity are 12.1US cent/kWh whilst household electric tariff is 5.68 US cents/kWh ***(ES 2011)***.

The low electricity tariff is hindering foreign investment in hydro power plants. Even though in the renewable energy law, it is mentioned that higher feed-in tariff should be provided for electricity supplied by renewable energy resources, the electricity generated by HPPs with capacity more than 5MW is not eligible to receive high feed-in tariff (***RE Law 2007***). The low tariff hinders investment in hydro power plant project as the power purchase agreement doesn't reflect the feed-in tariff mentioned in the renewable energy law.

High capital cost

A huge amount of investment is required to construct large-scale HPP. It is difficult to raise such investments in Mongolia with such a small economy. To date, there are no large-scale HPPs in Mongolia. For instance, USD 300 million is required to build the Egiin River HPP, with a total capacity of 220 MW (***Egiin HPP 2006***). There is no option to get long-term, discounted loan to build HPPs of such large-scale.

High transaction cost

There is no capacity in Mongolia to do a feasibility study for the construction and operation of large scale HPP.There lacks domestic technical capacity on the installation and operation of large scale HPP. Therefore selection of technology, equipment purchase, contracting will require study, time and high transaction costs.

Bureaucracy is high in the energy sector as it is in the public sector. The bureaucracy itself limits possibilities to implement projects and increases costs to conduct project baseline surveys.

Lack of or inadequate access to financial resources

The capital market is not well developed in Mongolia. It is impossible to raise capital for large-scale HPP through the Mongolian Stock Exchange (MSE). Only stocks, bonds and shares are traded at the MSE.

15. 1 USD = 1392 MNT as of 02 January 2013

Root causes of the economic and financial barriers

Due to these economic and financial barriers, large-scale HPPs have not been implemented in Mongolia. Such conditions have negative impacts on the Mongolian economy, including:

- Import of high-priced electricity from Russia has increased from year to year. This negatively affects the economy by increasing the costs of heat and power energy.
- There are no power plants to cover peak demand of national grid; therefore it is impossible for CHPs to operate at economically efficient regime.
- Power supply in rural areas is not reliable due to insufficient capacity of grid. This is one of major reasons behind migration to urban areas from country side.

Table 38: Non-financial barriers with scores given by stakeholders (large Scale HPP)

	Barriers	*Average Scores*	*Rank*
	Market failure/ imperfection		
1	Poor market infrastructure	3.1	9
2	Low competition	3.3	5
3	Restricted access to technology, no experience	2.1	17
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	2.6	13
5	Inefficient enforcement	4.0	2
6	Policy intermittency and uncertainty	3.9	3
7	Highly controlled energy sector	3.3	6
	Network failures		
8	Weak coordination among actors favoring the new technology	3.5	4
	Institutional and organizational capacity		
9	Lack of professional institutions	3.1	7
	Human skills		
10	Inadequate training facilities	2.8	10
11	Inadequate personnel for projects designing	2.7	12
	Social, cultural and behavioral		
12	Traditions and habits	2.5	15
	Information and awareness		
13	Lack of confidence in new climate technologies	3.1	8
	Technical		
14	Technology not familiar in Mongolia	2.0	18
15	Poor O&M facilities	2.3	16
16	System constraints	2.6	14
	Other		
17	Environmental impacts	2.7	11

1.2.2.2 Non-financial barriers

The ranking of the non-financial barriers scored by stakeholders are shown in the Table 38.

The following barriers were selected as the most significant priority barriers for future analysis:

1. **Policy, legal and regulatory**
   a. Inefficient enforcement
   b. Policy intermittency and uncertainty
   Highly controlled energy sector
2. **Market failures**
   Underdeveloped competition
3. **Network failures**
   a. Weak connectivity between actors favoring the new technology
   b. Incumbent networks are favored by legislation

Policy, legal and regulatory aspects

Policy intermittency and uncertainty

There is no long-term political commitment and government policies are uncertain (which means political risks for investors).The large-scale HPP in Egiin River(Egiin HPP) was planned for construction in the 1990s. The feasibility study of Egiin HPP was carried out with grants from the Asian Development Bank (ADB) in 1992. In 1996, the Mongolian Government announced the construction of the Egiin HPP. The Mongolian government gave a second priority to hydropower development, following the rehabilitation of the coal-fired power plant #4 in Ulaanbaatar (CHP4). In November 1996, construction of the 220 MW Egiin HPP was selected as an important state project based on the 1992 Feasibility Study and 1996 detailed design (both were conducted with ADB's grants).

However in 2000, the Mongolian government showed a strong interest in the 100 MW Orkhon HPP constructions using the environmental loan from Japan. As a result, the Egiin HPP construction project became a low priority.

In 2006, the Mongolian government decided to construct 220 MW Egiin HPP on the bases of the previous feasibility study and a detailed design, using a Chinese soft loan of 300 million USD, instead of the Orkhon HPP. However, in 2008 the Mongolian Government stopped the Egiin HPP construction project.

Although the Action Program of the newly-established Government in 2012 highlights the importance of renewable energy development, there is no specific statement in the Program about plans for building HPPs. However, the Government Action Implementation Plan shall be released soon where the specific statements will be elaborated in more detail regarding where and what kinds of energy sources shall be constructed.

According to the newspaper interview with the Minister of Energy, the government plans to construct large-scale HPP in the Siren Segment of the Selenge River and the technical-economic baseline survey on this project has just started with support from the World Bank.

Ineffective enforcement

There is insufficient willingness or ability to enforce laws and regulations. The attitude to such enforcement is also lax. There are no initiatives and commitments to enforce laws and regulations. For instance, the Law on Renewable Energy was adopted in January 2007, which provides the basis for the establishment of the Fund for Renewable Energy. Only in May 2011, 5 years after the Law adoption, a regulation to raise and administrate capital of the Fund for Renewable Energy was approved by the Minister Order of the Minerals and Energy. It is still unclear if the operation of such fund has begun.

Lack of government control for implementation of laws and regulations: There are many plans and programs but no effective implementation observed.

The National Program of Renewable Energy adopted by the Government in 2005 states the plan to construct the Orkhon HPP of 100 MW in Central Region between 2005 to 2010. But no construction took place.

The Program "Mongolian Energy Consolidated System" adopted by the Government in 2007 aimed to construct the Egiin River HPP of 220 MW and connect it to the Central Energy System via 220 kVlines between 2007 to 2012. But no implementation of this plan has taken place yet.

The control and commitments from the Government to clarify reasons and enforce the implementation are weak.

Highly controlled energy sector

There is a utility monopoly in the energy sector. Though it has been assumed that the Energy Sector is privatized, it is still under state control. All of the operating HPPs are owned by the Government.

Market aspects

Underdeveloped competition

Evidences of market control by dominant incumbents: policy documents of the energy sector highlight the importance and need of constructing large-scale HPPs since 1980s and 1990s, but due to political reasons, no achievements have been made yet.

Inability or unwillingness to pay among consumers: the monthly income of the majority of population is below the minimum living standards. Poverty rate is 29.8% (2011).

The minimum living standards are– (75-85) USD per month.

The energy market of Mongolia is very small in comparison to developed countries. To date, the total installed capacity of the energy systems is only 1,000MW.

Network aspects

Lack of involvement of stakeholders in decision-making

The roles and responsibilities of stakeholders and parties in the implementation of large-scale HPP construction are still unspecified. The decisions to start and cancel implementation of such projects are often made suddenly. The local communities and residents are not involved in such decision-making.

Insufficient coordination among relevant ministries and other stakeholders: The roles and involvements of relevant ministries, agents, local authorities and local community are unclear. Cooperation among such organizations is weak.

Root causes of non-financial barriers

The non-financial barriers stated above significantly hinder the development of large-scale HPP in Mongolia. The unstable and unclear laws and legislation on the construction of large-scale HPPs provide an unattractive environment for foreign investment. As a result potential investors are not interested in construction of large scale HPP in Mongolia.

No strategy and policy for the long-term sustainable development of the energy sector has beenadopted yet and no large-scale HPPs have beenconstructed yet in Mongolia.

The energy sector is owned by the Government - the energy market is under-developed and lacks market competition. This results in a lack of incentive in the system for energy supply in an economically efficient manner. The supply of the energy is becoming insufficient and the reliability of the system's operation is worsening.

Cooperation and communications among the stakeholders to construct HPPs is very weak and no major agreement can be made: capacity and location of the potential HPPs are still under discussion.

The Figure 1.1 in Annex 1 outlines problem tree and causal relation for transfer and diffusion of large-scale of HPP technology.

1.2.3 Identified measures

1.2.3.1 Economic and financial measures

According to Feasibility studies **(Egiin HPP 2006; FS Orkhon HPP 2001; FS Shuren HPP 2011)**, the required investment costs for proposed large scale hydropower plants are as follows:

Shuren HPP (300 MW)– USD450 million

Egiin HPP (220 MW) – USD314 million

Orkhon HPP (100 MW)– USD314 million

The total amount for development of large scale HPPs in Mongolia for years 2014 – 2030 is about USD1078 million.

Possible economic and financial measures to address the barriers for the transfer and diffusion of large-scale HPP are given below.

Barrier: Inappropriate financial incentives

Measure:

According the Energy Law, the Energy Regulatory Committee (ERC) is the authority to develop methodology todetermine tariffs, define the structure of tariffs and review, approve, inspect andpublish tariffs of licensees. The tariffs are then discussed at the Regulatory Board meetings and final decisions are issued in the form of resolutions. Originally, tariffs were set at an artificially low level, which did not allow the licensed energy companies to recover their costs and expenses. By setting tariffs, the ERC now aims to ensure the financial viability and sustainable operation of the licensees, while balancing their interests with those of the consumers.Tariff levels are a very sensitive issue in Mongolia and are subject to strong political pressure, making it difficult to propose and implement changes. However, the tariff level should reach at least 8 US cents/kWh which is deemed as the level for cost recovery. After reaching cost recovery tariffs, cross subsidies currently existing between industry and residential tariffs should be removed.

The government should promote climate-friendly technologies such as renewable energy generation capacities. The government should introduce feed-in tariff for medium and large scale HPPs.

The government should reduce subsidy for conventional energy.

Barrier: High cost of capital

Measure:

The energy sector needs innovation, and out-of-date equipment must be replaced with new technology such as large-scale HPP in order to enhance production capacities for sustainable development in the energy sector. However, there is a lack of financial support for large-scale HPP construction project. These issues should be solved through public-private partnerships (PPPs). Introducing PPPs to implement HPPs would increasethe possibility of providing reliable energy services, reducing air pollutions for citizens, while increasing electricity supply to rural regions.

The concession law was adopted by the parliament in 2010**(CL 2010)**, which allows the State Property Committee to implement projects that are listed in the State Property Concession. 16 projects are included in the energy sector part on the list ratified in 2010, according to the 198th Resolution. Large-scale HPP projects should be included in this list of concessions which is approved by the Mongolian Government.

HPP technology is a capital-intensive technology and most of the equipment and machinesare imported from abroad. The import duty rate for hydro machinery is 5% in average. To reduce the cost of imported machinery and equipment, the Government should issue regulation on the exemption of import duty of machinery, and goods and materials for HPPs for development of industries in the framework of investment enhancement.

Barrier: High transaction cost

Measure:

The government should build capacity for hydro power project development by establishing energy research institution under the Ministry of Energy. There is a need for skilled local experts who could develop project studies including carrying out feasibility studies.

Barrier: Lack access to financial resources

Measure:

In Mongolia, raw coal is used for power and heat generation. Renewable energy projects, such as large-scale HPPs, can directly contribute to air pollution abatement. Air pollution, especially in winter in UlaanBataar and inside homes heated withcoal stoves, is a significant cause of health problems. Addressing the issue of air pollution can bring aboutsignificant environmentaland social benefits.It is important to impose environment tax onconventional energy (coal-fired power plants). There is a law on fees for air pollution. The main concept of the law is that a person or an organization that causes air pollution will pay a fine, and this money will be used to reduce air pollution. A charge imposed on each kilogram of pollutants that is emitted by the industry. Power stations and coal-fired boilers are subject to the fee because they emit smoke and dust.However, no environmental charges have so far been imposed on coalfired power plants. It is important to levy environmental fees and to reduce or stop providing subsidies for conventional energy in order to encourage renewable energy sources, especially large-scale HPPs.

In order to attract foreign direct investment for large-scale HPPs, it is necessary to increase the tariff for electricity consumption.

The government should develop a capital market in Mongolia so that large scale projects, such as HPP, can raise capital from the domestic market. The Government should the strengthen Mongolian stock exchange.

The Figure 1.2 in Annex 1 shows translated problem to solution of large-scale HPP technology.

1.2.3.2 Non–financial measures

Possible non-financial measures to address the barriers for the transfer and diffusion of large-scale HPPs are shortlisted as follows.

Policy, legal and regulatory aspects

Barrier: Policy intermittency and uncertainty

Measure:

In order to encourage the development and utilization of large-scale HPPs in Mongolia, the government needs to have long-term political commitment. It is important to have clear government policies to reduce political risks for investors. The government should formulate a new national renewable energy program.

Barrier: Inefficient enforcement

Measure:

The government needs to strengthen the implementation of laws, national programs and regulations. The government should establish a renewable energy fund according to the Renewable energy law, which was adopted in 2007(**RE Law 2007**).

The government should have strong control on implementation of renewable energy law.

Barrier: Highly controlled energy sector

Measure:

There is a little competition in the energy sector. In order to improve market administration and remove utility monopoly in the energy sector, the government should continue to support the liberalization of the energy market, at the same time as ensuring private energy investment.

Market aspects

Barrier: Underdeveloped competition

Measure:

The government should continue to support the liberalisation of the energy market, at the same time as ensuring private energy investment

Barrier: Weak connectivity between actors favoring the new technology

Measure:

The government should clearly define the responsibilities and roles of different ministries and other stakeholders regarding the selection and implementation of large-scale HPP projects. Cooperation between the Ministry for Energy and othe rrelevant governmental agencies should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should also be improved.

Introducing suitable knowledge, skills and management would influence the government's involvement while benefiting society with efficient, environmentally technologies such as large-scale HPPs.

1.3 Barrier analysis and possible enabling measures for Wind Park

1.3.1 General description of Wind Park

Wind energy actually originates from solar energy; the temperature differences caused by the sun shining on the earth, along with other factors, cause large bodies of air, winds, to move across the face of the planet. Due to these factors, high wind speeds, and thus wind energy resources, can be found in regions at high latitudes, however there are also many areas with good wind speeds for electricity generation close to the equator.

The conversion of the kinetic energy in wind into electrical power is known as wind energy. There are a number of ways in which the conversion can be done; however after a period of experimentation and development, beginning primarily in the 1970s, one design has come to dominate the market.

A large wind turbine primarily consists of a main supporting tower upon which sits a nacelle (the structure containing the equipment to convert mechanical energy to electrical energy). Extending from the nacelle is the large rotor (three blades attached to a central hub) that acts to turn a main shaft, which in turn drives a gearbox and subsequently an electrical generator. In addition to this there will be a control system, an emergency brake (to shut down the turbine in the event of a major fault) and various other ancillary systems that act to maintain or monitor the wind turbine.

Modern wind turbines have main towers that are typically 50 to 100 meters high, supporting rotors with a similar range of diameters. Inside the tower there is a mechanism that ensures that the nacelle/rotor faces into the wind (i.e. is yawed correctly) to give maximum generation and maintain symmetric loads on the three blades and drive shaft. Generally the three blades are constructed from composites which provide a relatively high strength (required due to the large bending moments they experience) whilst maintaining a low weight and size given their length. Modern designs have a relatively low rotational speed in the order of 10 revolutions per minute (partly due to the desire to keep noise levels low) and thus typically require a gearbox to increase the speed of the drive shaft to match the rated generator speed. Whilst most wind turbines use gearboxes (or indirect drive systems) there also exist direct drive configurations whereby the generator is coupled directly to the slow moving rotor. These types of designs do not require gearboxes and thus avoid the reliability issues that have been known to trouble certain gearbox designs. However the large generator size that is required in order to obtain the correct generation frequency faces its own challenges in regards to construction and cost.

1.3.2 Identification of barriers for large scale Wind Park

In order to identify barriers for Wind Park it is important to classify the technologies as technologies are transferred and implemented under different market conditions, and the barriers to their transfer and diffusion are linked to market characteristics.

Wind parks are categorized as non-market. The market characteristics of wind parks are large investment, government/donor funding, public ownership or ownership by large companies. Wind parks as non-market goods are primarily diffused through political decisions. Government therefore has a direct influence on the diffusion on wind parks.

The long list of barriers with elements of barriers and dimensions of barrier elements for wind park technologies was prepared by TNA mitigation team (see Annex I). The long list economic and financial barriers have been discussed with stakeholders to identify the essential barriers.

The long list of barriers for WP is presented in different categories.

Financial barriers

1. **Economic and financial barriers**
    a. Lack or inadequate access to financial resource
    b. High cost of capital
    c. High transaction costs
    d. Inappropriate financial incentives and disincentives
    e. Uncertain financial environment
    f. Uncertain macro-economic environment

Non-financial barriers

2. **Market failure**
   a. Poor market infrastructure
   b. Underdeveloped competition
   c. Restricted access to technology, no experience
3. **Policy, legal and regulatory**
   a. Insufficient legal and regulatory framework
   b. Inefficient enforcement
   c. Policy intermittency and uncertainty
   d. Highly controlled energy sector
4. **Network failures**
   a. Weak connectivity between actors favoring the new technology
   b. Incumbent networks are favored by legislation
5. **Institutional and organizational capacity**
   a. Lack of professional institutions
6. **Human skills**
   a. Inadequate training facilities
   b. Inadequate personnel for preparing projects
7. **Social, cultural and behavioral**
   a. Traditions and habits
8. **Information and awareness**
   a. Lack of confidence in new climate technologies
9. **Technical**
   a. Technology not reliable
   b. Poor O&M facilities
   c. System constraints
10. **Other**
   a. Environmental impacts

1.3.2.1 Economic and financial barriers

The list of economic and financial barriers has been discussed with stakeholders to identify the essential barriers which definitely need to be addressed for technology transfer and diffusion.

The specific economic analysis has not been done for identification of barriers because some economic analysis has been already done (**OT WP 2012; GCWF 2006; S-WP 2012**). The stakeholders have been introduced about the economic analysis of wind parks.

Stakeholders were asked to rank the barriers and then the average score for the barriers were taken as a basis to rank them.

Economic and financial barriers with scores giving by stakeholders are shown in Table 39.

Table 39: Economic and financial barriers with scores given by stakeholders (WP)

	Barriers	*Average Scores*	*Rank*
	Economic and financial		
1	Lack or inadequate access to financial resources	3.2	4
2	High cost of capital	3.9	1
3	High transaction costs	3.4	3
4	Inappropriate financial incentives	3.6	2
5	Uncertain financial environment	3.1	6
6	Uncertain macro-economic environment	3.2	5

The ranked barriers were discussed again with main stakeholders and consultants and the following most priority barriers were selected for future analysis:

- High cost of capital
- Inappropriate financial incentives
- High transaction cost
- Lack orinadequate access to financial resources

High cost of capital

Due to the small economy, it is difficult to raise funds in Mongolia for wind parks to pay for their high upfront investment cost. The initial investment cost of the first large scale wind park in Mongolia of 50 MW called "Salkhit wind farm" is 120 million USD. As it is almost impossible to raise this amount of funds domestically, the financing has been made by foreign investors through a Mongolian private company.

Inappropriate financial incentives

The energy sector is highly controlled by the government and is slow to respond to changing circumstances due to heavy bureaucratic processes. Such bureaucratic structure limits project opportunities and increases cost for project studies. Because there is no manufacturer of large scale wind power plant equipment and technology in Mongolia, it requires detailed studies and takes time to select technologies and equipment suitable to the Mongolian conditions.

Lack of access to financial resources

In Mongolia, the capital/financial market is not well developed and there is noopportunity to raise funds for Wind Park projects in Mongolia at the Mongolian stock exchange. Currently the Mongolian stock exchange is only limited to trade in few types of stock assets.

There are volatile inflation rate and high price fluctuations:

Annual inflation rates (%) in 2008, 2009, 2010, and 2011 are respectively 28.0; 8.0; 10.1; and 9.2. Another barrier is unstable currency and exchange rates: in August 2009, the exchange rate is1448 MNT/USD; and by 8 August 2010, it has been changed to -1360 MNT/USD;August2011-8 -1253 MNT/USD; August 2012-8 -1358MNT/USD

Root causes of the economic and financial barriers

Due to the financial and economic barriers facing development of Wind Park in Mongolia, the following costs are incurred in the Mongolian economy:

- Deteriorated energy security due to insufficient capacity of national grid compared to actual demand.
- Expensive electricity import from Russia is increasing year by year. This is affecting the country economy for the worse due to increases in the cost of electricity and heat production.

1.3.2.2 Non financial barriers

The ranking of the barriers scored by stakeholders are shown in the Table 40.

Table 40: Non-financial barriers with scores giving by stakeholders (WP)

	Barriers	*Average Scores*	*Rank*
	Market failure		
1	Poor market in energy sector	2.8	16
2	Underdeveloped competition	3.1	10
3	Restricted access to technology, no experience	2.5	17
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	2.8	15
5	Inefficient enforcement	3.1	11
6	Policy intermittency and uncertainty	3.4	4
7	Highly controlled energy sector	3.4	6
	Network failures		
8	Weak connectivity between actors favoring the new technology	3.9	2
9	Incumbent networks are favored by legislation	3.7	3
	Institutional and organizational capacity		
10	Lack of professional institutions	3.3	7
	Human skills		
11	Inadequate training facilities	3.2	8
12	Inadequate personnel for preparing projects	2.9	13
	Social, cultural and behavioral		
13	Traditions and habits	2.4	18
	Information and awareness		
14	Lack of confidence in new climate technologies	3.1	12
	Technical		
15	Technology not reliable	3.2	9
16	Poor O&M facilities	3.5	5
17	System constraints	4.0	1
	Other		
18	Environmental impacts	2.9	14

The following barriers were selected as most priority barriers for future analysis:

1. Technical

a. System constraint

2. Network failures

a. Weak connectivity between actors favoring the new technology

b. Incumbent networks are favored by legislation

3. Policy, legal and regulatory

a. Policy intermittency and uncertainty

b. Highly controlled energy sector

4. Institutional and organizational capacity

a. Lack of professional institutions

Technical aspects

System constraint

There are many companies who are interested in developing wind parks because the renewable energy law has explicitly stated the feed-in tariff to be provided for electricity supplied by wind. As of 2012, there are 5 companies which have obtained special licenses to construct wind parks and the planned installed capacity of all these wind parks are 500 MW. However, due to the size of current energy system, the grid has limited technical capacity for accommodating fluctuating electricity supply from many large scale wind parks.

Wind parks adversely affect the energy system stability as their operation and electricity supply depending on wind availability. Especially for countries like Mongolia where the energy system mainly consists of small sized coal-fired power plants, connecting many high capacity wind power plants will destabilize the system.

Currently, the total installed capacity of the energy systems in Mongolia is less than 1000 MW. Even though the installed capacity of energy systems is expected to increase in the future, it will still limit the number of wind parks that can be connected to the grid.

The national dispatching center recommends that share of wind parks in the energy system should be no more than 10% of total installed capacity of the system.

Difficulties that can arise when connecting renewable energy stations to the central energy system include:

- Difficulties in load regulation when working in combination with coal-fired power plants;
- Difficulties in dispatching in the most economical way.

Network aspects

Weak coordinationamong supporters of the new technology

It is unclear who should be involved in the implementation of large scale wind park projects and what would be their roles.

Lack of involvement of stakeholders in decision-making and incumbent networks

There is no involvement of public and local stakeholders in the decision making process. Officials make arbitrary decisions.

Policy, legal and regulatory aspects

Policy intermittency and uncertainty

There is limited interest from foreign investors in the large scale renewable energy development projects due to the lack of long term stable government policy on energy sector development. For wind parks, some conditions are created as the electricity purchase tariff is clearly stated in the law, but due to unstable policies, investors are still not fully confident.

Highly controlled energy sector

High degree of government or utility monopoly in the energy sector: Even though it is said that energy sector is deregulated, it is still under strict state control. All the power plants currently operating which are connected to the grid are state owned.

Institutional and organizational capacity

Lack of professional institutions

There is no research institution in the energy sector on wind park designing and construction and to support policy makers for making long-term sustainable energy development policy.

Root causes of non–financial barriers

Due to the above mentioned non-financial barriers facing the development of wind power stations in Mongolia, no real opportunity is coming for the implementation of wind park projects.

Lack of long-term political commitment and government utility monopoly give no policy on sustainable energy development and no construction of Wind Park.

Lack of stakeholder participation and incumbent networks give and incumbent networks give no optimal decision marking for sustainable energy development.

The Figure 1.3 in Annex 1 outlines problem tree and causal relation for the transfer and diffusion of Wind Park technology.

1.3.3 Identified measures

1.3.3.1 Economic and financial measures

According to the Energy Regulatory Committee's resolution #1/341 (***REC 2012***), the following companies have received special licenses for construction of Wind Parks in Mongolia:

Sainshand Co., Ltd: Wind Park (52 MW) – USD125 million

AB Solar Wind Co., Ltd:Wind Park (100 MW) – USD240 million

Aydiner Global Co., Ltd: Wind Park (50.4 MW) – USD120 million

The total amount for development of Wind Parks in Mongolia for years 2014 – 2030 is about USD485 million.

Barrier: High Capital cost

Measure:

There is currently no financial mechanism other than foreign direct investment for wind parks. Right now, the first Wind Park in Mongolia with capacity of 50MW is being constructed with foreign investment by a private company **(S-WP 2012)**.

More financial mechanisms other than foreign direct investment such as Public Private Partnership (PPP), shall be made available to finance the upfront investment cost for wind parks such as PPP, direct investment by the government or financing through the national development bank.

Barrier: Inappropriate financial incentives

Measure:

There is a lack of financial support for the construction of Wind Parks. One way to solve these issues is through a public-private partnership (PPP). The concession law allows the State Property Committee to implement projects that are listed in the State Property Concession. There are a total of 16 projects included in the category of the energy sector on the list ratified in 2010, according to the 198th Resolution. The WP projects should be included in this list of concessions.

Another way to get financial source for investment in wind parkprojects is to use the Development Bank of Mongolia. According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament and the list of projects and programs to be financed shall be approved by the Parliament on an annual basis. The Development Bank may finance those projects and programs for which the government providesguarantees. The Government guarantee shall be limited to the share owned by the Government in those projects and programs. The Government guarantee shall be issued to only insured projects and programs. Financial support may be provided from the state budget to implement those projects and programs guaranteed by the Government. The Development Bank may work in cooperation with state and private sector entities on projects and programs to be financed by the Development Bank.

It is important to increase electricity tariffs and take measures to implement renewable energy technology. The Government should continue implementing the planned efforts in energy pricing reform. The tariff should be able to cover the costs of electricity generation from renewable sourcesand the cross subsidiesto coal-fired power generation should be removed.

Barrier: High transaction cost

Measure:

The government should build capacity for wind power development projects by establishing energy research institutions under the Ministry of Energy. There need skilled local experts who could develop project study, including Feasibility Studies.

Construction of Wind Park is a capital-intensive technology and most of the components are imported from abroad. Associated with imported machinery and equipment, the Government should issue regulation on the exemption of import duty of machinery, and goods and materials for Wind parks.

1.3.3.2 Non-financial measures

Technical

Barrier: System constraints

Measure:

Wind parks adversely affect the energy system stability as their operation and electricity supply depends on irregular wind availability. Especially for countries like Mongolia where energy system consists of small sized coal-fired power plants, connecting many high capacity wind power plants will destabilize the system.

In order to reduce or overcome these technical difficulties, we need to improve the energy generation mix. We need to increase the share of manageable or flexible sources for generation in the energy system. Especially if we connect large hydro power plants into the current energy system, system stability will increase which create suitable condition for more wind parks to be connected to the system.

Network aspects

Barrier: Weak connectivity between actors favoring the new technology

Measure:

The main assignment for the high level decision maker should be to organize a knowledge base by compiling information regarding renewable energy projects including lessons learned. This could assist the Government in developing a strategy and prioritising of Wind Park projects.

Barrier: Lack of involvement of stakeholders in decision-making and incumbent networks

Measure:

Another assignment of the government should be to clearly definethe responsibilities and roles for different ministries and other stakeholdersregarding selection and implementation of renewable energy projects. Cooperation between the Ministry for Energy and otherrelevant governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should alsobe improved.

Introducing suitable knowledge, skills and management would influence the government's involvement while benefiting society with efficient, environmentally technologies such as Wind Parks.

Policy, legal and regulatory

Barrier: Policy intermittency and uncertainty

Measure:

In order to encourage the development and utilization of Wind Park in Mongolia, the government needs to have long term political commitment. It is important to have clear government policies with no political risks for investors.

Barrier: Highly controlled energy sector

Measure:

There currently is no competition in the energy sector. In order to develop market control and remove utility monopoly in the energy sector, the government should continue to support the liberalization of the energy market, at the same time as ensuring private energy investment.

Barrier: Lack of professional institutions

Measures

The government should establish an energy research institute under the Ministry of Energy for research and development activities to support policy makers for making long-term sustainable energy development policy.

The Figure 1.4 in Annex 1 outlines the translated problem to solution of Wind Park.

1.4 Barrier analysis and possible enabling measures for Pulverized coal combustion technologies with higher efficiency (Super critical)

1.4.1 General description of pulverized coal combustion technologies with higher efficiency

Pulverized coal power plants account for about 97% of the world's coal-fired capacity. The conventional types of this technology have an efficiency of around 35%. For a higher efficiency supercritical and ultra-supercritical coal-fired technologies have been developed. These technologies can combust pulverized coal and produce steam at higher temperatures and under a higher pressure, so that an efficiency level of 45% can be achieved (ultra-supercritical plants). Supercritical and ultra-supercritical plants are more expensive because of the higher requirements to the steel needed to withstand the higher pressure and temperature, but the higher efficiency results in cost savings during the technical lifetime of the plants. The emissions of CO_2 per MWh delivered to the grid could be reduced from 830 kg to 730 kg. Pulverized coal power plants can have a size of up to 1000 MW and are commercially available worldwide.

Mongolian coal-fired combined heat and Power plants produce 98 % of total electricity. Diesel power plants and renewable energy sources produce less than 1% of total electricity each. Negative impacts of the energy sources on environment depend on technology and their efficiency. This depends on the coal quality, combustion technology and level of exploitation and maintenance for steam boilers.

In 2012, the total installed power generation capacity became 764 MW. The installed capacity has increased 2.3 times from that in 1980 as a result regular measures taken by the government to meet the increasing demand for electricity. The installed capacity has not changed since 1990. The energy system consists of several plants, all the same type of CHP that operate on coal but with different efficiencies. The results of a study in 2006 showed that the CHPs work on less than 70-75 percent of their capacity. From 1995 onwards, a rehabilitation project funded through a concessional loan has been implemented in 3rd and 4th CHP in Ulaanbaatar, and CHPs in Darkhan, and Choibalsan. As a result, there has been progress in the development of effective capacity.

Out of the total installed electricity capacity of turbines of CHPs 60% is currently under operation of 13 MPa, 22% is 3.5 MPa, and 18% is 9.0MPa.

Specific fuel consumption for electricity generation decreased since 1975 when medium pressure CHP-3 and high pressure CHP-4 established but it is still burning more coal by 80-100 gram-CE/kWh compared to Russian CHPs.

Among the challenges facing the Mongolian government, as well as the government's of other countries, are GHG emission reduction and the reduction of the cost of energy generation by reducing fuel consumption.

In the near future electricity demand will increase several times because of constructing large scale mining and chemical industries in Mongolia. Also coal export increases continuously. These features provided an added stimulus for increasing the efficiency of the thermal power plants.

1.4.2 Identification of barriers for Pulverized coal combustion technologies with higher efficiency (supercritical)

In order to identify barriers for supercritical coal combustion technologies it is important to classify the technologies as technologies are transferred and implemented under different market conditions, and the barriers to their transfer and diffusion are linked to market characteristics. Supercritical coal combustion technologies are categorized as non-market publicly provided goods.

The market characteristics of supercritical coal combustion technologies are that there are very few sites, large investment, government/donor funding, public ownership or ownership by large companies. Supercritical coal combustion technologies as non-market goods are primarily diffused through political decisions. Government therefore has a direct influence on the diffusion on supercritical coal combustion technologies.

The long list of barriers with elements of barriers and dimensions of barrier elements for supercritical coal combustion technologies was prepared by TNA mitigation team (see Annex I). The long list economic and financial barriers have been discussed with stakeholders to identify the essential barriers.

A discussion organized among experts and researchers of the energy and environmental sectors revealed a list of potential barriers of introduction of the advanced technology. It has been confirmed that efficient coal combustion technology with higher efficiency (super critical TPP)is suitable for large- scale TPPs in Mongolia. The barriers are explained in details below.

The long list of barriers for coal- fired super critical TPP power plant is presented in different categories.

I. Financial barriers

1. Economic and financial barriers

a. High cost of capital

b. High transaction costs

c. Inappropriate financial incentives and disincentives

d. Uncertain financial environment

e. Uncertain macro-economic environment

f. Lack or inadequate access to financial resource

II. Non–financial barriers

2. Market failure

a. Poor market infrastructure

b. Underdeveloped competition

c. Restricted access to technology, no experience

3. Policy, legal and regulatory

a. Insufficient legal and regulatory framework

b. Inefficient enforcement

c. Policy intermittency and uncertainty

d. Highly controlled energy sector

4. Network failures

a. Weak connectivity between actors favoring the new technology

5. Institutional and organizational capacity

a. Lack of professional institutions

6. Human skills

a. Inadequate training facilities

b. Inadequate personnel for preparing projects

7. Information and awareness

a. Lack of confidence in new climate technologies

8. Technical

a. Technology not reliable

b. Poor O&M facilities

c. System constraints

9. Other

a. Environmental impacts

1.4.2.1 Economic and financial barriers

The list of economic and financial barriers has been discussed with stakeholders to identify the essential barriers which definitely need to be addressed for technology transfer and diffusion.

The specific economic analysis has not occured for identification of barriers. The stakeholders have been introduced to some studies about the different coal fired power plants.

About 5.0 billion USD is required to construct Coal-fired super critical TPP with total capacity of 2800 MW. It is expected that annual electricity production of the plant will be approximately 12.0 million MWh. With introduction of such advanced technology, approximately 3.0 million tons of coal can be saved and the fuel cost of electricity production will be 0.03 USD per kWh. The only concern here is that, it is very difficult for Mongolia to raise such big amount of funding.

Stakeholders were asked to rank the barriers and then the average score for the barriers were taken as a basis to rank them.

Economic and financial barriers with scores given by stakeholdersare presented in Table 41.

Table 41: Economic and financial barriers with scores given by stakeholders (Efficient Coal fired power plant)

	Barriers	*Average Scores*	*Rank*
	Economic and financial		
2	High cost of capital	3.5	3
3	High transaction costs	3.7	2
4	Inappropriate financial incentives	3.3	4
5	Uncertain financial environment	2.6	6
6	Uncertain macro-economic environment	2.8	5
1	Inadequate access to financial resources	3.9	1

The ranked barriers were discussed again with main stakeholders and the following most priority barriers were selected for future analysis:

- Inadequate access to financial resources
- High transaction costs
- High cost of capital
- Inappropriate financial incentives.

Lack of adequate access to financial resources

The capital market is not well developed in Mongolia. It is impossible to raise capital for large-scale TPP in Mongolian stock market. Only stocks, bonds and shares are traded at the Mongolian stock market.

High cost of capital

A start-up investment is required for constructing large-scale, high-efficiency TPP is huge in comparison with relatively small market of Mongolia. This raises financial barriers.

High transaction cost

Bureaucracy is high in the energy sector as it is in the public sector. The bureaucracy itself limits possibilities to implement projects and increases costs to conduct project baseline surveys. The technology, techniques and equipment of large-scale TPPs are not available in the country and it is anticipated that selection of such technology suitable in the Mongolian conditions is to be both time and labor consuming.

Inappropriate financial incentives

Specific fuel consumption for electricity generation is the major criteria to show the efficiency of CHP. Specific fuel consumption for electricity generation was decreased since 1975 when established medium pressure CHP-3 and high pressure CHP-4 but it is still higher by 80-100 gram.CE/kWh compared to Russian CHPs.

The policy of the Ministry of Energy does not clearly state improving this situation. Because there is no specific objective to improve energy efficiency, there is no interest at the decision-making level to construct high-efficiency Thermal Power Plants (TPPs).

Root causes of the economic and financial barriers

There has been an intensive discussion about the construction of large-scale TPPs in Mongolia in near future. Inevitably, it would require big amount of investment. With no possibilities to raise such investment capital in the country, Mongolia is trying to attract foreign investment in the sector. However, up to date, both the location and capacity of the large-scale TPP are still unclear, and the potential investors lack of such information. Such conditions negatively impact upon the Mongolian economy in the following aspects:

- Import of high-priced electricity from Russia has being increasing from year to year. This negatively affects the economy of the country.
- Domestic capacity is insufficient to meet growing electricity demand of OyuTolgoi and Tavan Tolgoimines and its infrastructure system. In order to provide electricity to Oyu Tolgoi mine, a power purchase agreement has been made with China.
- Power supply and coverage in rural areas is weak due to insufficient capacity of the energy systems. This is one of major reasons behind migration to urban areas from the country side.

1.4.2.2 Non-financial barriers

The non-financial barriers with scores given by stakeholders are shown in the Table 42.

Table 42: Non-financial barriers with scores giving by stakeholders (Efficient Coal fired power plant)

	Barriers	*Average Scores*	*Rank*
	Market failure		
1	Poor market infrastructure	3.7	4
2	Underdeveloped competition	3.1	9
3	Restricted access to technology, no experience	3.0	12
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	2.6	17
5	Inefficient enforcement	3.4	5
6	Policy intermittency and uncertainty	3.3	6
7	Highly controlled energy sector	3.1	8
	Network failures		
8	Weak connectivity between actors favoring the new technology	3.9	3
9	Incumbent networks are favored by legislation	4.1	1
	Institutional and organizational capacity		
10	Lack of professional institutions	4.0	2
	Human skills		
11	Inadequate training facilities	3.1	11
12	Inadequate personnel for preparing projects	2.7	16
	Information and awareness		
13	Lack of confidence in new climate technologies	3.1	10
	Technical		
14	Technology not reliable	2.8	14
15	Poor O&M facilities	3.0	13
16	System constraints	2.7	15
	Other		
17	Environmental impacts	3.2	7

The ranked non-financial barriers were discussed again with main stakeholders and consultants and the following most priority barriers were selected for future analysis:

1. Network failures

a. Incumbent networks are favored by legislation

b. Weak connectivity between actors favoring the new technology

2. Institutional and organizational capacity

a. Lack of professional institutions

3. Market failure

a. Poor market infrastructure

4. Policy, legal and regulatory

a. Inefficient enforcement

b. Policy intermittency and uncertainty

Policy, legal and regulatory aspects

Inefficient enforcement

There are many plans and programs but most of them are not implemented. The government takes insufficient actions to implement the laws and regulations. Thus, lower-level organizations are poor in taking initiatives and commitments

Policy intermittency and uncertainty

There is insufficient willingness or ability to enforce laws and regulations.

There are no strong commitments and interests in enforcingthe laws and regulations. The Action Program of newly-established Government in 2012 aims to construct a number of large-scale TPPs in the Gobi region, close to the mining sites. However, there are several uncertain issues. For example, no technical and economical evaluation of such decision has been conducted and it is still unclear what scale of TPPs are to be built and in which areas.

This technology has not been applied in Mongolia and there is no experience of constructing and operation such power plantsin the country. Furthermore, Mongolia has no general policy that covers future tendency of the energy sector development with no appointed research institute in charge of conducting research and development on improvement of the sectoral efficiency and introduction of advanced technology in place. Currently, it is getting nationwide to construct numerous small and medium –scale Heat Only Boilers in order to meet growing demand of the country, but with no baseline evaluation and with lowefficiency. This could explain why the country has no strong support to introduce the above-mentioned advanced technology.

Market failure

Poor market infrastructure

Though it has been assumed that the Energy Sector is commercialized, it is still under the State control. All of the operating TPPs are owned by the Government.

TPPs are to be built. No measureable actions are taken in this regard.

Network failures

Incumbent networks are favored by legislation

The administration of the Ministry of Energy is often interrupted by government changes; each time after the political elections, non-professional and political activists are appointed to major positions. They in turn build their own team consistingof non-professionals with limitedexperience.

Weak connectivity between actors favoring the new technology

The Law of Foreign Investment has a number of uncertain and confusing articles. For example,the roles of stakeholders in implementation of large-scale projects are not specified; the terms to terminate and cancel investment agreement are unclear. The general public and local population are not involved in the designing, selection and implementation of large-scale projects.

Initiators of this project - the ministries and authorized agents – do not invite and take into account inputs and suggestions of scientists, local authorities and community in the decision-making and this results later on in unexpected barriers during the implementation, in some cases even lead to cancellation and termination ofthe project implementation.

Institutional and organizational capacity

Lack of professional institutions

The number and capacity of technical experts at the Ministry is not strong enough. It is common to appoint officialsbased on their political stands,not according to their technical knowledge and experience.

During the socialist period, there was a research institute operating under the Ministry of Energy and the research institute has been cancelled. There currently is no reseach institute to define energy sector development tendency based on scientific research and development of the energy sector.

The Figure 1.5 in Annex 1 outlines problem tree and causal relation for the transfer and diffusion of coal fired supercritical power plants

1.4.3 Identified measures

1.4.3.1 Economic and financial measures

Possible economic and financial measures to address the barriers for the transfer and diffusion of large scale TPP

Options to raise capital for construction of large-scale TPPs:

- To request for loan from international financial institutes for the certain part of the investment;
- Foreign investment pursuant to the Law on Concession. The concession law was adopted by parliament in 2010, which allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession.

Barrier: Lack of adequate access to financial resources

Measure:

The country's export has increased thanks to the intensive development of the mining sector in the last few years. At the same time, the political parties distribute cash to the population so they can fulfill election campaign promises. This cash distribution activity shall be stopped and instead a fund to develop the country shall be established to make better use of the new financial resources.

Barrier: High cost of capital

Measure:

In order to raise the capital, attracting foreign investment or applying for international soft loans are essential for implementing the TPP projects.

Barrier: High transaction cost

Measure:

The Ministry of Energy is the policy-making authority for the energy sector; It is important to build a team of national experts and professionals able to study country demand, review and select technologies appropriate for country's circumstances, and to design project and provide recommendations And introduce practice that supports active involvement of national expert team in design of large-scale projects, and applies responsibility mechanisms.

Barrier: Inappropriate financial incentives

Measure:

The Government of Mongolia shall include improving the utilizing efficiency of specific fuel consumption in energy production as a major activity of the Ministry of Energy, and shall focus on building a performance-based evaluation system. In this way, the interest in saving fuel while producingelectricity and heatcan be increased country-wide.

1.4.3.2 Non–financial measures

Policy, legal and regulatory aspects

Barrier: Inefficient enforcement

Measure:

The government needs to strengthen the implementation of the policy for highly efficient coal fired thermal power plants.The government should have strong control on implementation of highly efficient coal fired thermal power plant projects.

Barrier: Policy intermittency and uncertainty

Measure

The new Government of Mongolia and the Ministry of Energy shall focus on eliminating this barrier.

Intensify the Energy Ministry and Agency policy activities to introduce new advanced technology, and increase energy efficiency; and improve overall implementation control. A practice to follow and enforce action plans stated in the sectoral policy and programmer shall be introduced and responsibility mechanism, furthermore, shall be established.

Market failure

Barrier: Poor market infrastructure

Measures:

To build mechanism that supports active and initiatives to increase production efficiency of the state-owned TPPs. The privatization is the solution of the problem. There are many successful experiences to operate state-owned TPPs in other countries. There shall be asystem with a clear allocation of roles and responsibilities among differentsectoral organizations. Ascientific approach shall be applied to selections of project technologies.

Network failures

Barrier: Incumbent networks are favored by legislation

Measures:

It is necessary to support employment of skilled and experienced engineers and scientists at the Ministry of Energy and to improve their professional skills.

Barrier: Weak connectivity between actors favoring the new technology

Measures:

It has been some time since the adoption of the Law on Investment of Mongolia. Some articles difficult to enforce shall be revised and amended. At the project design stage, the following shall be considered as mandatory.

- Public opinions, local community requests shall be included;
- Recommendations and requests of scientists and researchers of project-implementing sectors, especially involvement of relevant scientific and research institutes shall be reflected in the project designs.

The country should establish a working group of national scientists and experts to conduct technical research on the energy sector, specifically on thermal Power Plant technology and its efficiency. Regular discussions and meetings shall be organized for information exchange as well. Currently, a research team of foreign experts conduct technical baseline survey of larger-scale research project of the energy sector – theresults often fail to meet special conditions of Mongolia.

Institutional and organizational capacity

Barrier: Lack of professional institutions

Measures:

A system that carries out regular research on determining solutions for energy sector barriers, and development tendencies shall be introduced using existing capacity of scientists' team of the Mongolian University of Science and Technology (MUST). Final results of the new energy projects highly depend on implementing personnel itself; preparation of engineer and technical staff shall take place based on MUST capacity.

The Figure 1.6 in Annex 1 outlines the translated problem to solution of coal fired supercritical power plants.

1.5 Linkages of the barriers identified

Barriers faced by different prioritized technologies in the energy industry sub-sector appear to be very similar however priorities of barriers are different in many cases.

The common economic and financial barriers are inappropriate financial incentives; high cost of capital; high transaction cost; lack or inadequate access to financial resources and uncertain macro-economic environment.

Removing above common economic and financial barriers (high cost of capital; high transaction cost; lack or inadequate access to financial resources) will help for implementation of all three selected technologies.

Common barriers regarding the policy, legal and regulatory aspects are lack of long-term political commitment and uncertain government policies (political risks for investors); lack of government control for implementation of laws and regulations; government or utility monopoly of energy sector.

Common barriers regarding the market and network aspects are underdeveloped competition, insufficient coordination between relevant ministries and other stakeholders.

Removing above mentioned common barriers related to policy legal and market aspects also will help for implementation of all three selected technologies.

The priorities of barriers are different in many cases in selected specific technologies.

Regarding the large scale HPP technology, policy-related barriers have first priorities.

The stakeholders participated in the barrier analysis gave the highest score 4.75 (from maximum 5) to the barriers "Lack of long-term political commitment" followed by barriers "Officials make decisions on their own will", "Uncertain government policies (political risks for investors)", and "Insufficient willingness or ability to enforce laws and regulations".

Decision makers and all the experts in the energy sector understand the need for developing large scale hydro power plants in the current energy system of Mongolia. However, these kinds of projects are not moving forward and materialized due to political reasons and special interests. The plans on building large scale hydro power plants are reflected in every policy documents of energy sector. The decision on the required investment had been made and projects had been discussed few times in parliament and cabinet meetings. Even so, it still didn't move forward due to political reasons. For HPPs, politics is the main barrier.

Regarding the wind park, barriers of the highest priority aresystem constraints (capacity limits of the grid system).

Wind parks adversely affect the energy system stability as their operations and electricity supply depends on irregular wind availability. Especially for a country like Mongolia whose energy system consists of coal fired power plants, connecting many high capacity wind power plants will destabilize the system.

The main difficulty hindering the implementation of large hydro power plant projects is the low electricity tariff. Even though in the renewable energy law, it is mentioned that feed in tariff to be provided for electricity supplied by renewable energy resources, the electricity generated by HPPs with capacity of more than 5MW is not covered under this feed in tariff (**RE Law 2007**). The low tariff hinders investment in hydro power plant project as the power purchase agreement doesn't reflect feed in tariff mentioned in the renewable energy law. On the other hand, many companies are interested in developing wind parks because the renewable energy law has explicitly stated the feed in tariff to be provided for electricity supplied by wind. As of 2012, there are 5 companies who obtained special license to construct wind parks and the planned installed capacity of all these wind parks are 500 MW.

It is possible to achieve synergy between the identified barriers as all three technologies are currentlycoordinated by one organization – the Ministry of Energy. Therefore, network aspect and capacity building barriers of the three technologies may be addressed within onemeasure. Along with this, the barrier related to tariff regulations may be addressed jointly to hydro and wind and coal fired power plants.

1.6 Enabling framework for overcoming the barriers in Energy sector

Enabling framework for overcoming the common barriers of the prioritized technologies

In order to encourage the development of climate technology in energy industry subsector, the government should implement the concession law which was adopted by parliament in 2010. This law allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession. The climate technologies such as large scale HPP, wind parksand efficient coal fired power plant projects should be included in this list of concessions which is approved by the Mongolian Government. The government could give necessary guarantees to attract foreign investors.

Another way to get financial source for investment in climate technologies is to use Development Bank of Mongolia. According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament and the list of projects and programs to be financed shall be approved by parliament on an annual basis. The Development Bank may finance those projects and programs for which the government issued guarantees.

The climate technologies are often capital-intensive and almost all of the components are imported from abroad. The Government should issue regulation on the exemption of import duty of machinery, and goods for climate technologies.

The government should introduce environment tax for conventional energy (coal fired power plants). The environment tax for conventional energyshould be included in law on fees for air pollution.

The Energy Regulatory Committee should increase energy tariffswhich did not allow the licensed energy companies to recovertheir costs and expenses. By setting tariffs, the ERCshould ensure the financialviability and sustainable operation of the licensees, while balancing their interestswith those of the consumers.

Tariff levels are a very sensitive issue in Mongolia and are subject to a heavily politicalpressure, making it difficult to propose and implement changes. However, the tariff level should reach at least the level of cost recovery. After reaching cost recovery tariffs, cross-subsidies currently existing between industry and residential tariffs should be removed.

The government should continue the planned efforts in energy pricing reform (eventual cost covering level of price and removal of cross subsidies.

The government should have long-term political commitment especially regarding the implementation of large scale HPP projects.

The government should have strong control for implementation of laws and regulations.

The government should insure sufficient coordination between relevant ministries and other stakeholders. The government should take actions of responsibility when no measures are taken to implement the laws and regulations.

Development plan and programs of the energy sectors shall be designed in consistent with environmental and green development principles. The government should establish energy research institute under the Ministry of Energy.

Cooperation between the Ministry of Energy and otherrelevant Governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should alsobe improved

Enabling framework for overcoming the technology specific barriers of the prioritized technologies

In order to encourage the development and utilization of large-scale HPPs in Mongolia, the government needs to have long term political commitment. It is important to have clear government policies with no political risks for investors. Need government control for implementation of laws and regulations.

In order to reduce or overcome these technical difficulties, we need to improve the energy generation mix. We need to increase the share of manageable or flexible sources for generation in the energy system. Especially if we connect large hydro power plant into the current energy system, system stability will increase which create suitable condition for more wind parks to be connected to the system.

2. The residential and commercial sector

2.1 Preliminary targets for technology transfer and diffusion

2.1.1 Efficient lighting

The efficiency of electricity use in the residential and commercial sector is also low. One prioritized technology for the residential and commercial sector is promoting the use of energy-efficient compact fluorescent lamps (CFL) to replace inefficient incandescent light bulbs (ILB). CFLs provide the same level of illumination as an incandescent lamp but use roughly 70% less electricity. Although CFLs are more expensive than ILBs, they are more economical on a life-cycle basis due to savings in electricity costs. Currently, most households and about 30% of service and commercial buildings use incandescent bulb lamps and the rest use fluorescent bulbs

The first phase implementation plan of the national action program on climate change approved by the government indicates to limit incandescent light bulb usage during the period 2012-2016.

The Mongolia Nationally Appropriated Mitigation Actions (NAMA) to the UNFCCC secretariat also includes measures such as lighting efficiency in buildings **(MSNC 2010)**.

After stakeholder consultation it is assumed that 60% of households in Ulaanbaatar by 2020 will be supplied by CFLs as preliminary target of efficient lighting technology transfer and diffusion.

2.1.2 Insulation of panel apartment buildings

The residential and commercial sector uses mainly heat, electricity and coal, some fuel wood and dung for meeting its energy needs. Thermal energy is used for heating of buildings, production of goods and services and preparation of hot water for households. Electricity is used for lighting, motors, thermal electric equipment (mostly for cooking) and electric appliances. The efficiency of energy use in the residential and service sector is low. The priority goal of the residential and commercial subsector is to promote efficient use of energy and substitution of coal with cleaner energy sources.

The majority of the apartment buildings in Ulaanbaatar was constructed in the 1970s, 1980s and early 1990s and is in a poor state, withoutsystematic professional maintenance and repair. The energy efficiency in centrally and district heated buildings leaves much room for technical and managerial improvement. Heat consumption of the buildings is about five times higher than the modern systems in Europe. This to some extent is because of the cold climate in Mongolia, but the main reason is poor technology and a lack of incentives to save energy.

A recent study on heat losses concluded that nearly 40% of the heat is lost in houses and buildings (**Panel Building 2010**). The heat losses occur through windows, walls and doors: the design and construction of old apartment buildings in bigger cities are very similar to buildings found in many places of the former Soviet Union.

A study of local building standards indicated that heat demand in multi-family buildings could be reduced by about 60% (**Panel Building 2010)**. There are around 500 panel apartment buildings house around 200,000 people or around 20% of the population of Ulaanbaatar.

The first phase implementation plan of the national action program on climate change approved by the government mentions the insulation of existing buildings with high heat losses during the period 2012-2016.

Mongolia's Nationally Appropriated Mitigation Actions (NAMAs) submitted to the UNFCCC secretariat also include building energy efficiency improvement measures such as the improvement of insulation in existing buildings **(MSNC 2010)**.

After stakeholder consultation it is assumed that 300 existing panel apartment buildings will be insulated in 2020 as preliminary target of building insulation technology transfer and diffusion.

2.2 Barrier analysis and possible enabling measures for efficient lighting

2.2.1 General description of technology efficient lighting

Compact Fluorescent Lamp (CFL) technology provides more energy efficient lighting than the normal incandescent light bulbs. There are a whole range of different sorts of lamps from ordinary incandescent tungsten filament bulbs to Tungsten Halogen, Halogen infrared reflecting, Mercury vapor lamps, Compact fluorescent lamps, linear fluorescent, metal halide, compact metal halide, high pressure sodium (High Intensity Dischargelamp) and Light Emitting Diodes (LED). CFLs contribute to security of energy supply as they make a significant contribution to reduction in electricity demand for lighting. The higher up-front cost could be a barrier for their implementation, but calculations show that for CFLs, the pay-back period for the initial investment is within 900 hours of operation due to reduction in the electricity bill over the lifetime of the bulb. The savings can be in the order of 10-20 times the initial cost over the life of the bulb **(Climate Techwiki)**[16]**.**

Not all forms of lighting can substitute each other. But large gains could be achieved, for example, by substituting lower-efficiency versions of a given lamp and ballast technology for higher-efficacy equivalents from within the same technology. Lighting technologies such as incandescent, tungsten halogen and high-pressure mercury are considered mature technologies with little room for luminous efficiency improvement, whereas semi conductor (e.g. LED) and metal halide lamps are considered to offer high potential for further technical improvements. In the near term, however, the greatest gains from lamp changes are to be had from substituting new high quality CFLs for inefficient standard incandescent lamps, from phasing out mercury vapor lamps, and from using higher efficiency ballasts and linear fluorescent lamps (IEA, 2008). Still, the potential for market penetration of this technology is large, as the worldwide learning rate of CFLs is only around 10% (IEA, 2010).

16. http://climatetechwiki.org/technology/cfl).

2.2.2 Identification of barriers for efficient lighting technology

The Market mapping technique is used to identify the barriers for the market goods. The market map consists of three main parts. The central part illustrates the market chain and the principal market actors; the top part shows the enabling environment; and the bottom part indicate the support services that support the market chain's overall functioning. Through participatory action, the market actors collectively identify all the important elements of each part of the market map.

The enabling environment is the infrastructure and policies, institutions and processes that constitute the market environment. The core market actors are the chain of economic actors who own the products as it moves from primary producers or exporters to final consumers. The service providers are the business or extension services that support the chain's operation.

Figure 2.1 in Annex 1 shows a market map for the efficient lighting technology which involves all the actors, support services, and the enabling framework.

The market map was discussed among the consultants and stakeholders to identify the possible barriers that exist in the market. The list of all possible barriers was identified.

The long list of barriers for efficient lighting technology is presented as follows:

I. Financial barriers

1. Economic and financial barriers

a. Lack or inadequate access to financial resource
b. High cost of capital
c. Inappropriate financial incentives and disincentives
d. Uncertain macro-economic environment

II. Non-financial barriers

2. Market failure

a. Poor market infrastructure
b. Underdeveloped competition
c. Market size

3. Policy, legal and regulatory

a. Insufficient legal and regulatory framework

4. **Institutional and organizational capacity**
    a. Lack of specialized ESCOs
5. **Human skills**
    a. Inadequate personnel for preparing projects
6. **Information and awareness**
    a. Lack of awareness about the technology
7. **Technical**
    a. Product not reliable

2.2.2.1 Economic and financial barriers

The ranking of economic and financial barriers scored by stakeholdersis shown in the Table 43.

The ranked barriers were discussed again with main stakeholders and consultants and the following most priority barriers were selected for future analysis:

- Inappropriate financial incentives
- High cost of capital

Inappropriate financial incentives

The consumers are not interested in implementing energy efficient technology such as energy efficient lights because of electricity tariff is low.

According to the Energy law, the Energy Regulatory Committee (REC) is the authority to develop the methodology to determine tariffs, to define the structure of tariffs and review, and to approve, inspect and publish tariffs of licensees. The tariffs are then discussed at the Regulatory Board Meetings and final decisions are issued in the form of resolutions. Before, tariffs were artificially low, which did not allow the licensed energy companies to recove rtheir costs and expenses. By setting tariffs, the ERA aimed to ensure the financial viability and continuous operation of the licenses, whilst balancing their interests with those of the consumers. The tariff levels are a very sensitive issue in Mongolia and are subject to intense political pressure, making it difficult to propose and implement changes.

Currently the electricity tariff for households varies depending on the amount of electricity used. If the electricity used is not more than 150 KWh per household, tariff is 0.053USD per kWh, for every additional usage of electricity between 150-250 KWh per household, the tariff is 0.057USD per kWh and for any amount of electricity used more than 251 kWh per household, the tariff is0.06USDper kWh. The current tariff is less than the cost per kWh electricity generation in the central energy system, which is 0.063USD per kWh. Due to the very low tariff for electricity consumption, consumers have no incentiveor willingness to replace current incandescent lamps with more energy efficient lamps.

Table 43: Economic and financial barriers with scores giving by stakeholders

(Efficient lighting)

	Barriers	*Average Scores*	*Rank*
	Economic and financial		
1	Lack of adequate access to financial resources	2.6	3
2	High cost of capital	3.4	2
3	Inappropriate financial incentives	3.0	1
4	Uncertain macro-economic environment	2.4	4

High capital cost

Unlike large scale projects such as HPP and WP, the CFL technology isessentially consumer goods. Unlike consumer capital goods like refrigerator or television,CFL bulbs are not sold on hire purchase or credit schemes. There are no measures or policies on restricting the import of energy inefficientand technologically backward products and goods. Current the market price for ILB is 5-10 times lower than CFL. Also there are no initiatives for financing modern, reliable and energy efficient lightning.

There is no tax exemption for importing of energy efficient appliances and equipment according to current law on customs tax and tariff. Customs tax for most of the goods is 5% while VAT is usually 10%.

2.2.2.2 Non financial barriers

The ranking of non-financial barriers scored by stakeholdersis shown in the Table 44.

Parliament.No specific Ministry or Agency in Mongolia is mandated to develop and implement the national and sectoral energy efficiency policies. The Ministry for Energy is the main government body involved in energy

Table 44: Non-financial barriers with scores giving by stakeholders (Efficient lighting)

	Barriers	*Average Scores*	*Rank*
	Market failure		
1	Poor market infrastructure	2.8	6
2	Underdeveloped competition	3.1	5
3	Market size	2.6	7
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	4.3	1
	Institutional and organizational capacity		
5	Lack of specialized ESCOs	3.4	4
	Human skills		
6	Inadequate personnel for preparing projects	2.3	8
	Information and awareness		
7	Lack of awareness about climate technologies	3.8	2
	Technical		
8	Product not reliable	3.7	3

The ranked barriers were discussed with the main stakeholders and themost priority barriers were selected for further analysis below:

Policy, legal and regulatory

- Insufficient legal and regulatory framework;

Information and awareness

- Lack of awareness about climate technologies;

Technical

- Product not reliable;

Institutional and organizational capacity

- Lack of professional institutions (ESCO).

Policy, legal and regulatory

Insufficient legal and regulatory frameworks

The ministry of energy has been drafting an energy efficiency law since 2003, but till now there is no approved law on energy efficiency yet.

Whilsr several drafts of an Energy Efficiency Law had been developed, they have not been approved by the Government and the efficiency policy.Different Ministries and other organisationswere involved in drafting of the law on energy efficiency but usually there is no coordination going on among the different stakeholders.

Although energy saving and energy efficiency are among the high priorities for environmental protection, there are no central or local government policies on energy saving and efficiency and the issue is primarily handled by NGOs like the Mongolian National Chamber of Commerce. Some private sector companies are supporting energy efficiency improvement in the residential and commercial sector through, for example, the import of energy-saving home appliances and lamps.

Technical

Low reliability of products

There is no quality control for imported CFLs.

Various electric lightning equipment and appliances are imported by private business entities and some of them do not meet international quality requirements. There is no national quality control system in place.

Institutional and organizational capacity

Lack of specialized ESCOs

The Dutch-Mongolian project "ESCO Development in Mongolia" tried to introduce ESCOs in Mongolia. The objective of this project was to overcome the barriers for implementation of energy efficiency projects in Mongolia, by creating a basis and concept for the development of ESCOs. But recently there aren't any specialized ESCOs which finances energy efficiency projects, including energy efficient lighting technology. A Green Credit Guarantee Fund, which has been established by the Dutch government to support energy efficiency in industrial sector and has obtained 800.000 USD loan from the Mongolian Government.However, as of July 2010, the fund is illiquid with all its funding being committed to anumber of small and medium enterprises

Information and awareness

Lack of awareness about climate technologies

There is no integrated information system for energy sector and even though theEnergy Regulatory Committee of Mongolia publishes the "Energy statistical yearbook" annually, Information in this publication is limited only to financial, technical and economic indicators and energy tariffs of special energy license holders. Information about energy efficient technology for consumers is not available in this publication and other public sources of information.

The problem tree and causal relation for the transfer and diffusion of efficient lighting technology are shown in Figure 2.2.in Annex 1.

2.2.3 Identified measures

2.2.3.1 Economic and financial measures

According to preliminary targets 500000 incandescent bulbs will be changed by compact fluorescent lamp (CFL) by 2020. The required investment cost for this project will be USD2.5 million.

Barrier: Inappropriate financial incentives

Measure:

It is important to increase electricity tariffs and implement measures to prevent outdated technology in the market.

The government should continue implementing the planned energy pricing reform. The tariff should be high enough cover the electricity generation and transmission costsand the cross subsidies for coal-fired power generation should be removed.

The Government should continue to support the liberalisation of the energymarket, at the same time as ensuring private energy investment.

Barrier: High capital cost

Measure:

The Government should examine possibilities of introducing tax incentives forenergy efficiency products and projects.

The Government should continue its efforts in attracting Clean DevelopmentMechanism (CDM) or Nationally Appropriate Mitigation Actions (NAMA) financing for energy efficiency projects including efficient lighting technology. The Government should consider consolidating the Green Credit Guarantee. The Green Credit Guarantee Fund (GIGF) has been established at the Mongolian National Chamber of Commerce and Industry with support from the Royal Netherlands with the initial fund capital of 400,000 USD. GCGF supports entities (companies/organizations) that invest in either energy efficiency or cleaner production during their debt financing/bank borrowing process

2.2.3.2 Non-financial measures

Policy, legal and regulatory

Barrier: Insufficient legal and regulatory frameworke

Measure:

Mongolia needs to improve the legal environment for implementation of policy on energy efficiency.

The Government should finalise the Energy Conservation Law as soon as possible. Promulgating the Energy Conservation Law should senda strong signal to energy usersand the wider public about the crucialimportance of energy efficiency. The Government should reinforce cooperation with all relevant governmental institutions and other stakeholders in draftingthe Energy Conservation Law.

Upon the adoption of the Energy Conservation Law, the Government should develop secondary legislation and regulations indifferent sectors, in close cooperation with relevant actors.

Technical

Barrier: Low reliability of products

Measures:

Special attention should be given for importing energy efficient bulbs and lighting equipment which meet specific quality standard. Quality standards should be approved and strictly enforced

Institutional and organizational capacity

Barrier: Lack of specialized ESCOs

Measure:

It is important to establish specialized at the planning level and operational level Energy Service Companies (ESCOs).

One of the assignments for the government should be organising a knowledge base by compiling information regarding energy efficiency projects (including donor financed projects), including lessons learned. This could assist the Government in developing a strategy and prioritising futuredonor financing for energy efficiency projects;

Information and awareness

Barrier: Lack of awareness about climate technologies

Measure:

Cooperation between the Ministry for Energy and other relevant Governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should alsobe improved. The Government should promote energy efficiency awareness raising andtraining for Government officials and the wider public at local, regional andnational level.

The Figure 2.3 in Annex 1 outlines translated problem to solution of efficient lighting techno-logy.

2.3 Barrier analysis and possible enabling measures for improved insulation of panel apartment buildings

2.3.1 General description of technology – Improved insulation of panel apartment buildings

Ulaanbaatar is the world's coldest national capital city with an eight month heating season, and winter temperatures frequently falling to -30°C at night and -20°C in the daytime.

There are around 500 panel apartment buildings which house around 200,000 people or around 20% of the population of Ulaanbaatar.The precast panel buildings have no added external wall insulation, have poorly insulated external doors and roofs, and most of them have old double wooden framed windows of high heat loss through ventilation.

The panel buildings' hot water radiator heating systems are not equipped with any heat use controlling device. The apartments are not fitted with any heat consumption metering equipment. Thus building managers and apartment owners lack both financial incentives and the technical means to reduce excessive heat losses or avoidoverheating.

The Ulaanbaatar panel buildings will continue to be used for many years. GHG emission reductions can be achieved through implementing energy efficiency measures at the two big pre-cast panel buildings with 792 apartments in Ulaanbaatar. The energy efficiency measures will lead to a reduced demand for space heating in winterfrom the local heating supplied from the heat substation. The reduced heat demand from the heat substation will reduce the heat demand from the primary hot water heating loop supplied from the coal fired Combined Heat and Power Plant No 4 (CHP No 4) in Ulaanbaatar. The reduced heating production from CHP No 4 will lead to a reduced demand for coal, which will lead to reduced anthropogenic GHG emissions: (1) from the reduced heat losses achieved by adding wall, roof, ground floor and basement insulation, from fitting improved insulation level windows and from reducing uncontrolled air infiltration; (2) from the new ability of the apartment occupants to control their space heating energy supply and (3) from the new incentives for the apartment occupants to manage any overheating by adjusting their thermostatic radiator valves, arising from the fitting of apartment heat consumption meters that measures an apartment's actual space heating use which would then be used in the new heat consumption tariffs.

By 2030, all panel apartment buildings will be improved by implementing the above energy efficient measures.

2.3.2 Identification of barriers for the technology – Improved insulation of panel apartment buildings

The Market mapping technique is used to identify the barriers for the market goods for technology Improved insulation of panel apartment buildings.

The Figure 2.4in Annex 1 shows a market map which involves all the actors, support services, and the enabling framework.

The market map was discussed among the consultants and stakeholders to identify the possible barriers that are included in the market. The list of all possible barriers was identified.

The list of barriers for Insulation of panel apartment buildings is presented as follows.

I. Financial barriers

1. Economic and financial barriers

a. Lack or inadequate access to financial resource

b. High cost of capital

c. Inappropriate financial incentives and disincentives

d. Uncertain macro-economic environment

II. Non-financial barriers

2. Market failure

a. Poor market infrastructure

b. Underdeveloped competition

c. Market size

3. Policy, legal and regulatory

a. Insufficient legal and regulatory framework

4. Institutional and organizational capacity

a. Lack of professional institutions

5. Human skills

a. Inadequate personnel for preparing projects

6. Information and awareness

a. Lack of awareness about climate technologies

7. Technical

a. low reliability of product

Table 45: Economic and financial barriers with scores giving by stakeholders (Insulation of panel apartment buildings)

	Barriers	***Average Scores***	***Rank***
	Economic and financial		
1	Lack of adequate access to financial resources	3.8	2
2	High cost of capital	3.7	3
3	Inappropriate financial incentives	4	1
4	Uncertain macro-economic environment	2.6	4

2.3.2.1 Economic and financial barriers

Economic and financial barriers with scores giving by stakeholders for insulation of panel apartment buildings are shown in Table 45.

The ranked barriers were discussed again with main stakeholders and consultants and the following most priority barriers were selected for future analysis:

- Inappropriate financial incentives
- Lack or inadequate access to financial resources
- High cost of capital

Inappropriate financial incentives and disincentives

Residents have limited interest in paying huge amount of money for the insulation of their buildings. When the heating expenditure is calculated based on the area of the apartment, heating cost will not decrease as a result of better insulation.

Lack of access to financial resources

The financing of energy efficiency activities in Mongolia are mainly provided through international financial and donor organizations. The Mongolian government provides co-financing for a number of projects. But there have been no projects for insulation of existing apartment buildings financed by those organizations.

A Green Credit Guarantee Fund, which has been established by the Dutch government to support energy efficiency in industrial sector and has obtained 800 000 USD loan from the Mongolian Government. However, as of July 2010, the fund is illiquid with all its fundingbeing committed to a number of small and medium enterprises.

High cost of capital

Precast panel buildings are all privatized. Even though the residents maybe have interest in insulating their buildings, they do not have the financial resources to pay for the investment cost. Public financing is also difficult. Insulation of these old precast panel buildings is very expensive requiring huge amount of capital expenditures.

The investment cost of 792 apartments will be 6 million EURO (7.5 million USD) according to the estimate by the Ulaanbaatar Apartment Buildings Energy Efficiency Project. To improve the insulation of all existing 500 panel apartment buildings (about 30000 apartments), the investment is about 284 million USD. By insulating currently used apartment buildings to the standard level, the heat losses could be reduced by 40 percent.

Table 46: Non-financial barriers with scores giving by stakeholders (Insulation of panel apartment buildings)

	Barriers	*Average Scores*	*Rank*
	Market failure		
1	Poor market infrastructure	3.8	1
2	Underdeveloped competition	3.6	3
3	Market size	2.7	7
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	3.6	2
	Institutional and organizational capacity		
5	Lack of professional institutions	3.5	4
	Human skills		
6	Inadequate personnel for preparing projects	2.6	8
	Information and awareness		
7	Lack of awareness about the technology	3.5	5
	Technical		
8	Quality of technology	3.2	6

2.3.2.2 Non-financial barriers

The ranking of non-financial barriers scored by stakeholdersis shown in the Table 46.

The ranked barriers were discussed with main stakeholders and following most priority barriers were selected for future analysis:

1. **Market failure**
   - Poor market infrastructure
   - Underdeveloped competition
2. **Policy, legal and regulatory**
   - Insufficient legal and regulatory framework
3. **Institutional and organizational capacity**
   - Lack of professional institutions
4. **Information and awareness**
   - Lack of awareness about the technology

Market failure

Poor market infrastructure

Because the Energy Regulatory Committee of Mongolia evaluates the performance of energy producers, transmission and distribution companies against indicators on energy production, transmission and distribution, these organizations have no incentive or motivation to support saving energy among consumers. The measures to save energy at consumer sites will decrease energy demand and thus adversely affect the performance of reaching the target numbers for production, transmission and distribution.

Under-developed competition

Property developers and rental market actors have no incentive to invest in insulation of buildings. The energy efficiency in centrally and district heated buildings leaves much room for technical and managerial improvement.

Policy, legal and regulatory

Insufficient legal and regulatory framework

There are no laws and regulations on energy efficiency.

The Ministry of energy has been working on drafting an energy efficiency law since 2003, but there is no approved law on energy efficiency yet.

Whilst several drafts of an EnergyEfficiency Law have been developed, they have not been approved by the Government and the Parliament.No specific Ministry or Agency in Mongolia is mandated to develop and implement the national and sectoral energy efficiency policies. The Ministry for Energy is the maingovernment body involved in energy efficiency policy making and implementation. Different Ministries and other organisations were involved in drafting of law on energy efficiency but usually there is no coordination going on among the stakeholders.

Although energy saving and energy efficiency are among the high priorities for environmental protection, there are no central or local government policies on energy saving and efficiency andthe issue is primarily handled by NGOs like the Mongolian Chamber of Commerce.

Institutional and organizational capacity

Lack of professional institutions

There are no sufficient human and financial resources withinthe Ministry for Energy for overall energy efficiency policy. Also there isn't a high-level decision maker for energy efficiency policy, who should have sufficient authority and resources;

Information and awareness

Lack of awareness about this technology

Thermal energy is used for heating private and public buildings, production of goods andservices, and for heating water for householduse. It is special in Mongolia that 90 percent of the overall energy consumed isfor space heating of buildings.Therefore, the introduction of technologies that help to improve building insulation is critical for achieving increased energyefficiency. The loss of heat in buildings is highand residential consumers have no means ofregulating the temperature inside their homes.There is a great potential for saving energyand reducing GHG emissions if buildinginsulation can be improved.

The problem tree and causal relation for the transfer and diffusion of efficient lighting technology are shown in Figure 13.

Rootcauses of the economic and financial barriers

Poor insulation of apartment buildings leads to high coal consumption in the power plants. Large amount of coal consumption in power plants leads to more air pollution in the cities which causes negative impacts on the health conditions of local residents.

There is still no law on energy efficiency.

Due to the absence of government policy on energy saving, the enforcement of building norms and standards is weak with no initiatives for better insulation of buildings. Also there is no organization in charge of the research and studies on technologies for energy efficiency and due to lack of public awareness raising activities no initiative is coming from consumers. There is also no incentive for consumers to insulate their building as the heating tariff is fixed according to size of their apartment, not depending on their actual consumption of heat.

The problem tree and causal relation for the transfer and diffusion of building insulation technology are shown in Figure 16 in Annex 4.

2.3.3 Identified measures

2.3.3.1 Economic and financial measures

The objective of the technology for insulation of the panel apartment buildings is to make additional insulation for 300 existing apartment buildings in Ulaanbaatar in order to ensure thermal comfort of residents who live in these residential old buildings. The requested investment is about USD100 million.

Barrier: Inappropriate financial incentives and disincentives

Measure:

It is important to replace the existing floor-area based fixed heat tariff with tariff calculation based on actual heat consumption. This can make the residents more willing to insulate their apartments. The government should provideadequate access to financial sources and establish financial mechanism such as soft loans to residents. Those actions would help reduce the capital cost reasonably.

Barrier: Lack or inadequate access to financial resources

Measure:

The Government should continue its efforts in attracting Clean Development Mechanism (CDM) or Nationally Appropriate Mitigation Actions (NAMA) financing for energy efficiency projects including efficient lighting technology. The Government should consider consolidating the Green Credit Guarantee Fund and other similar funds in order to create revolving credit liquidity.

Barrier: High cost of capital

Measure:

The Government should provide incentives for residentsto improve insulation of their apartments, suchincentives can be subsidies and micro credits. The Government should take action to develop building insulation projects and organize the implementation.

2.3.3.2 Non-financial measures

Market failure

Poor market infrastructure

The government should remove energy production planning policies which discourage energy efficiency improvement in power plants. The government policy should focus on energy efficiency in energy production and energy saving among consumers. The energy producers and distributers should be encouraged to support energy saving among consumers, including energy saving in buildings. The Government should put strong emphasis on the implementation andenforcement of building regulations and policies.

The Government should introduce individual apartment heat metering in apartment buildingswhere this istechnically possible.

Under-developed competition

It is necessary to provide incentives for property developers and rental market actors to invest in insulation of buildings. The government should havea strong policy in place to enforce building standards and improve the energy efficiency for existing un-insulated buildings. Technical and managerial improvement in district heating buildings is necessary.

Policy, legal and regulatory

Insufficient legal and regulatory framework

The Government should finalise the Energy Conservation Law as soon as possible. The Energy Consideration Law should send a strong signal to energy stakeholders and the wider public about the importance of energy efficiency improvement. The Government should reinforce cooperation with all relevant Governmental institutions and other stakeholders in drafting the Energy Conservation Law.

Upon the adoption of the Energy Conservation Law, the Government should further develop secondary legislation and regulations indifferent sectors, in close cooperation with relevant actors.

Institutional and organizational capacity

Lack of professional institutions

It is important to establish specialized level Energy Service Companies (ESCOs) focusing on energy efficiency planning and operation.

The government should organise a knowledge base by compiling information regarding energy efficiency projects (including donor financed projects), including lessons learned. This could assist the Government in developing a strategy and prioritising future donor financing of energy efficiency projects.

Information and awareness

Lack of awareness about the technology

Cooperation between the Ministry for Energy and otherrelevant Governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should alsobe improved. The Government should promote energy efficiency awareness raising, and training for Government officials and the wider public at local, regional andnational level.

The identification of solutions for the identified barriers for the building insulation technology is shown in Figure in Annex 4.

2.4 Linkages of the barriers identified

Barriers faced by efficient lighting and building insulation technologies in the residential and commercial sector appear to be quite similar.

The common economic and financial barriers are inappropriate financial incentives, lack of adequate access to financial resources and uncertain macro-economic environment.

Common barriers regarding the policy, legal and regulatory aspects are mismanaged energy sector; lack of laws and regulations on energy efficiency.

Common barriers regarding the market and network aspects are insufficient coordination between relevant ministries and other stakeholders, lack of professional institutions; and lack of confidence in new climate technologies

The priorities of barriers are different for the two specific technologies.

For the efficient lighting technology, the most important barriers are low electricity tariff and lack of management for implementation of the technology

For the building insulation technology, the barriers of highestpriority are high cost of capital and law constant tariff not depending on actual heat consumption.

Removing above common economic and financial barriers (inappropriate financial incentives, lack of adequate access to financial resources) will help for implementation of all selected technologies in residential and commercial sector.

2.5 Enabling framework for overcoming the barriers in the Residential and commercial subsector

The Government should finalise the Energy Conservation Law as soon as possible. Promulgating the Energy Conservation Law should send a strong signal to energy stakeholders and the wider public about the importance of energy efficiency. The Government should reinforce cooperation with all relevant Governmental institutions and other stakeholders in drafting the Energy Conservation Law.

Upon the adoption of the Energy Conservation Law the Government should further develop secondary legislation and regulations indifferent sectors, in close cooperation with relevant actors.

The Energy Regulatory Committee (ERC) should increase energy tariffs, so that the tariff can be high enough to allow the licensed energy companies to recovertheir costs and expenses. The tariff level should reach at least the level of costrecovering. After reaching cost recovering tariffs, crosssubsidies currently existing between industry and residential tariffs should be removed.

The government should take hold the government agencies accountable for the enforcement of laws and regulations

The Government should examine the possibilities of introducing tax incentives for energy efficiency projects.The government could support the insulation of apartment buildings and should try to attract foreign aid and soft loan.

The government should establish formally mandated agency in the country, delegated to develop and implement the national and sectoral energy efficiency policies and programs.

The Government should make efforts to provide incentives to residents improve insulation of their apartments, using such instruments as subsidies and micro credits;

The Government should consider consolidating the Green Credit Guarantee Fund and other similar funds in order to create revolving credit liquidity.

The Government should put strong emphasis on implementation and enforcement of adopted building regulations.

List of references 2

TNA Guidebook 2012 - Overcoming Barriers to the Transfer and Diffusion to Climate Technologies, UNEP, January 2012.

MSNC 2010 - Mongolia Second National Communication under the United Nations Framework Convention on Climate Change, Ulaanbaatar, 2010.

NAPCC 2011 - National Action Program on Climate Change, Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2011

NRSD 2010 - National report on sustainable development; Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2010

CCM Mongolia 2010 - Climate change mitigation: Needs and possibilities; 2010 (in Mongolian)

ES 2011 - Energy Statistics 2011, Energy Regulatory Committee (in Mongolian); Ulaanbaatar, 2011

Renewable Energy 2008 – Renewable energy utilization and Development of CDM Projects in Mongolia;DorjpurevJargal, Northeast Asia Energy Focus,Vol.5 No.1 Spring 2008

CL 2010 – Law of Mongolia on Concessions

http://www.legalinfo.mn/law/details/312?lawid=312

REC 2012– The companies newly received licenses (in Mongolian) http://www.erc.mn/mn/tz_buildings

Energy Charter2011 - In-Depth Review of Energy Efficiency Policies and Programmes; Mongolia, Energy Charter Secretariat, 2011

GHG Mongolia, 2000 - Greenhouse Gas Mitigation Potentials in Mongolia; Ulaanbaatar, 2000.

Compendium 2007 - Compendium of energy related laws (in Mongolian); Ulaanbaatar, 2007.

RE Law 2007 - Law on Renewable energy of Mongolia (in Mongolian) http://www.legalinfo.mn/law/details/465?lawid=465

NREP 2005– Mongolia National Renewable Energy Program (in Mongolian) http://www.legalinfo.mn/law/details/6485?lawid=6485

EIS 2007 –Mongolia's energy integrated system(in Mongolian) http://www.legalinfo.mn/annex/details/3244?lawid=6206

Egiin HPP 2006–220 MW Egiin Hydropower Project, Ministry of Fuel and Energy, Mongolia; 2006

FS Orkhon HPP 2001 - The Feasibility Study on Orkhon Hydropower Plant in Mongolia; Japan External Trade Organization (JETRO), 2001

FS Shuren HPP 2011– Summary of Feasibility Study of the Shuren Hydro Power Station on the river Selenge, Mongolia;

OT WP 2012 - OyuTolgoi wind power project 250MW

http://www.monwea.org/index.php?none=55&newsid=192

GCWF 2006 – Grid Connected Wind Farm in Govi Region: A Feasibility Study Report: PREGA 2006

S-WP 2012 – Developing Mongolia's First Wind Farm – NEWCOM's Experience, B.Byambasaikhan, Ulaanbaatar 2012

Panel Building 2010 - CDM Baseline Study for Thermo Technical Rehabilitation ofPre-Cast Panel Buildings in Ulaanbaatar, 2010

Climate Techwiki http://climatetechwiki.org/technology/cfl

Annex 4: List of Barriers, Market Maps and Problem Trees

1. List of Barriers

Table 47: List of Economic and financial barriers discussed with stakeholders (Large scale HPP)

Barriers	***Elements of barriers***	***Dimensions of barrier elements***
Lack or inadequate access to financial resources	Lack of financing instruments and institutions	Financial capacity to implement large-scale project is very low. Development bank was established in 2010 but no achievements yet.
	Under-developed or distorted capital market (poor creditworthiness, poor recovery regulations)	Mongolian Stock Exchange trade is limited only by stocks and bonds.
	Lack of access to credit for certain consumers	It is impossible in Mongolia to get long term credit for construction of large scale HPP
High cost of capital	Scarcity of cheap capital (high interest rates due to high risk perception by financial institutions)	Loan interest rate of commercial banks in Mongolia is 1.5 % per month.
	High up-front costs	Example: Construction of the 220 MW Egiin HPP requires more than 300 million USD.
	High resource costs (material, labor)	Most of construction materials and labor sources will be imported from other countries.
High transaction costs	Gathering and processing information (feasibility studies; due diligence)	There is no capacity in Mongolia to do Feasibility Study for construction of large scale HPP.
	Technology acquisition	There is no technology and installations of large scale HPP. Therefore selection of technology will require study and time.
	Bureaucracy	Bureaucracy in energy sector is high due to

Inappropriate financial incentives and disincentives	Favorable treatment for conventional energy and large-scale projects (subsidies, low taxes)	Example: Subsidies in energy sector in 2011 were 14.7 billion MNT (11 million USD)
	Insufficient incentives to develop climate technologies	National Action program on Climate Change in Mongolia
	Non-consideration of externalities (negative externalities (pollution, damage from this) from conventional energy not considered in pricing, positive impacts of climate technologies not valued)	Law on fees for air pollution: A fee of Tg1-2 is imposed on each kg of coal being extracted by coal mines
	Taxes on climate technologies (high import duties on equipment, duty exemption limited to small products, other direct or indirect taxes on climate technologies)	There is no reduction of import taxes for climate technologies. Import taxes – 5%; VAT – 10%.
	Consumers pay below marginal cost	Example: The electricity production cost in Central grid is 88 MNT/kWh. However electricity tariff for households is 79 MNT/kWh. The electricity production cost in Western energy system is 168.46 MNT/kWh. However electricity tariff for households is only 60 MNT/kWh.
Uncertain financial environment	Uncertain electricity tariffs (e.g., non-transparent tariff adjustment procedure)	Electricity tariff for enterprises: 45.0 MNT/kWh in 2001; 47.0 MNT/kWh in 2002; 51.0 MNT/kWh in 2005; 68.0 MNT/kWh in 2008; 79.8 MNT/kWh in 2010; 88.0 MNT/kWh in 2011.
Uncertain macro-economic environment	Volatile inflation rate and high price fluctuations	Annual inflation rate: 2006-4.3%; 2007-9.6%; 2008-28.0%; 2009-8.0%; 2010-10.1%; 2011-9.2%.
	The tariff level in Mongolia much lower than in other countries	The low tariff is main barrier for investment and for making Power Purchase Agreement for construction of HPP in Mongolia.
	Unstable currency and exchange rates	Currency exchange rate: 2007-8 -1175; 2008-8 -1154; 2009-8 -1448; 2010-8 -1360; 2011-8 -1253; 2012-8 -1358
	Balance of payment problems and uncertain economic growth	Mongolian macro-economic structure is weak and in high dependence from foreign markets.

Table 48: List of non-financial barriers discussed with stakeholders (Large scale HPP)

Barriers	*Elements of barriers*	*Dimensions of barrier element*
Market failure/ imperfection		
Poor market infrastructure	Lack of liberalization in energy sector	Energy regulathory authority is established with privatization of the energy sector but do not market competition is introduced fully. State-owned few oligopoly suppliers are on the market and no fair competition in place.
	Mismanaged energy sector	Policy to improve energy generation efficiency and introduce advanced technology is unclear. Roles and responsibilities matrix of the sectoral administration and regulatory authorities is inefficient. No authorized research institute to design the energy sector development policy with scientific approach
Underdeveloped competition	Insufficient number of competitors (property developers and rental market have no incentive to invest	Companies and entities interested in and capable to construct large-scale thermal power plant.
	Market control by dominant incumbents implies	Considerable importance is given to large scale hydro power plants in almost every energy sector policy documents. Even though it has been discussed since 1980 and 1990ies, it is yet to materialize. The main reason for this delay is of political nature.
	Market size small (small market potential, low density of consumer demand, limited or difficult access to international market)	The energy market size is small. The total installed capacity of energy system is about 1000 MW.
	Low ability or willingness to pay among consumers	Majority of the population live at the below the average level with lower monthly income. Poverty level is 29.8% as of 2011. Lowest living level of the population is 103 000 to 118 000 tugrugs per month.
Restricted access to technology, no experience	Technology not freely available in the market	There is no large scale HPP technology in Mongolia. The technology depends on specific geological location.
	Lack of product visibility	The large scale HPP is not familiar in Mongolia.
	Experience of new technologies cannot be achieved	Only two medium-sized HPP have been constructed in Mongolia. There isn't any HPP with capacity above 100 MW in Mongolia
Policy, legal and regulatory		
Insufficient legal and regulatory framework	Absence of laws and regulations on climate technologies	The Mongolian National Action Program on Climate Change approved by Parliament in 2011.
	Lack of government faith in climate technologies, unsupportive policies	There is National Renewable Energy Program (NREP), National program on Climate Change, Law on Renewable Energy. But the implementation status is low.

Inefficient enforcement	Lack of government control for implementation of laws and regulations	The National Program of Renewable Energy adopted by the Government in 2005 states constructing Orkhon HPP of 100 MW in Central Region during 2005-2010. But no construction took place. The Program "Mongolian Energy Consolidated System" adopted by the Government in 2007 aimed to construct Egiin River HPP of 220 MW and connecting it to the Central Energy System via 220 kW lines during 2007-2012. No implementation of this plan has taken place.
	Insufficient willingness or ability to enforce laws and regulations	Control and commitments from the Government to clarify reasons and enforce the implementation is weak.
	Lax attitude	No initiatives and commitments to enforce laws and regulations. For instance, the Law on Renewable Energy was adopted in January 2007 that legislated establishment of the Fund for Renewable Energy. Only in May 2011 of after 5 years from the Law adoption, a regulation to raise and control capital of the Fund for Renewable Energy was approved by the Minister Order of the Minerals and Energy. It is still unclear if the operation of such fund has begun.
Policy intermittency and uncertainty	Uncertain government policies (political risks for investors)	In 2006, the Mongolian government has decided to construct 220 MW Egiin HPP on the bases of previous feasibility study and detailed design by Chinese soft loan 300USD, instate of Orkhon HPP construction project low installed capacity. But 20008 the Mongolian Government has stopped the Egiin HPP construction project.
	Lack of long-term political commitment	Paper versions of long-term projects and programs are available but their implementaion strategy and solutions are uncertain.
	Stability of laws (frequent amendments).	The Law on Energy was amended in December 2011.
Highly controlled energy sector (may lead to lack of competition and inefficiency)	Government or utility monopoly of energy sector	The energy sector is commercialized but it is still considered as a public sector. Existing power plants are owned by the State.
	Private sector entry restricted (e.g., independent power producers)	State policy on private and public sector and the law on Concession support private sector investment in the sector. Financial capacity to implement large scale projects is weak.
Network failures		
Weak connectivity between actors favoring the new technology	Stakeholders dispersed and poorly organized	Roles of the stakeholders in implementation of large scale HPP projects are uncertain.
	Insufficient coordination between relevant ministries and other stakeholders	No coordination between relevant ministries and other stakeholders
	Lack of involvement of stakeholders in decision-making	No role of stakeholders in decision making for the construction of HPPs

Incumbent networks are favored by legislation	Incumbent networks are favored by legislation	Administration of the Energy Ministry is unsustainable; it tends to change after each political election with appointment of non-professional but politically -supporting specialists and officers whom in turn build their own team selected with same criteria. This tendency is becoming very common. Having non-professionals in decision making and design level of the sectoral policy is inappropriate
Institutional and organizational capacity		
Lack of professional institutions	Lack of specialized research institutes	There is no specialized research institute in energy sector
Human skills		
Inadequate training facilities	The educational system may fail to react quickly enough to the emergence of new generic technologies	High-expertise professionals to conduct workshop and training on implementation of TPP project are very few in the country; and not training system is set up.
Inadequate personnel for preparing projects	Lack of domestic consultants (to reduce transaction costs)	Lack of local consultants for construction of HPP
	Lack of entrepreneurs (relatively low profitability, unwieldy or restrictive regulations; may lead to lack of competition and supply constraints)	No HPP construction company in Mongolia
Social, cultural and behavioral		
Traditions and habits	Resistance to change, due to cultural reasons	To preserve the birthplace of its ancestors in its natural form
	To protect archeological findings and historical sites	There are many archeological sites around the river basins in Mongolia
Information and awareness		
Lack of confidence in new climate technologies	Lack of media interest in promoting technologies	No activities to increase public awareness about the importance of hydro power plants and its negative impacts have been carried out. Thus, objections and oppositions of the local community is common.
Technical		
Technology not reliable	Lax quality control and poor documentation of reliability	At design level of energy projects, no recommendations and review of the professional team is included in and if made then only with lower quality. This is very common. Having foreign experts to design large-scale project creates number of problems in practice
Poor O&M facilities	Lack of skilled personnel	No skilled personnel for large scale HPPs
	Limited availability of spare parts	All of spare parts and equipment of HPPs are imported.

System constraints	Capacity limitation with grid system	Electric power demand of the country is approximately 800MW and tends to grow fast in coming future. In case of constructing large-scale plant, limitations of capacity are inevitable.
Other Barriers		
Environmental impacts	Climate change and global warming	Over the last 70 years, an average air temperature has increased by 2.14^{0}C in Mongolia.
	Site selection	Not many big rivers for construction of large scale HPPs
	Specific climate conditions	It is difficult to conduct construction work in winter season.
	Detailed environmental impact assessment	Detailed environmental assessment is essential
	Divergent plans, incentive structures and administrative requirements from different donors, finance institutions and government branches	There is high probability that donor and funding organizations might put additional requirements on reducing negative impacts on environments

Table 49: List of economic and financial barriers discussed with stakeholders (Wind Park)

Barriers	***Elements of barriers***	***Dimensions of barrier element***
Inadequate access to financial resources	Lack of financing instruments and institutions	The first Mongolian WP 50 MW is financed by private companies. There no other experiences and financial mechanisms for Wind Parks.
	Under-developed or distorted capital market (poor creditworthiness, poor recovery regulations)	Mongolian Stock Exchange trade is limited only by stocks and bonds. It is impossible to finance big projects such as Wind Park from Mongolian Stock Market.
	Lack of access to credit for certain consumers	It is impossible in Mongolia to get long term credit for construction of Wind power plant
High cost of capital	Scarcity of cheap capital (high interest rates due to high risk perception by financial institutions)	Loan interest rate of commercial banks in Mongolia is 1.5 % per month.
	High up-front costs	Example: Construction of the 50 MW Salkhit WP requires 175 billion MNT (130 million USD).
	High resource costs (material, labor, capital)	Most of construction materials and labor sources for construction of Wind power plants will be imported from other countries.
High transaction costs	Gathering and processing information (feasibility studies; due diligence)	There is no capacity in Mongolia to do Feasibility Study for construction of Wind power plant.
	Technology acquisition	There is no technology and installations of Wind power plant. Therefore selection of technology will require study and time.
	Bureaucracy	Bureaucracy in energy sector is high due to state monopoly in energy sector

Inappropriate financial incentives and disincentives	Favorable treatment for conventional energy and large-scale projects (subsidies, low taxes)	Example: Subsidies in energy sector in 2011 were 14.7 billion MNT (11 million USD)
	Insufficient incentives to develop climate technologies	The National Action Program on Climate Change in Mongolia
	Non-consideration of externalities (negativeexternalities (pollution, damage from this) from conventional energy not considered in pricing, positive impacts of climate technologies not valued)	Law on fees for air pollution: A fee of Tg1-2 is imposed on each kg of coal being extracted by coal mines
	Taxes on climate technologies (high import duties on equipment, duty exemption, other direct or indirect taxes on climate technologies)	There is no reduction of import taxes for climate technologies. Import taxes – 5%; VAT – 10%.
	Consumers pay below marginal cost	Example: The electricity production cost in Central grid is 88 MNT/kWh. However electricity tariff for households is 79 MNT/kWh. The electricity production cost in Western energy system is 168.46 MNT/kWh. However electricity tariff for households is only 60 MNT/kWh.
Uncertain financial environment	Uncertain electricity tariffs (e.g., non-transparent tariff adjustment procedure)	Electricity tariff for enterprises: 45.0 MNT/kWh in 2001; 47.0 MNT/kWh in 2002; 51.0 MNT/kWh in 2005; 68.0 MNT/kWh in 2008; 79.8 MNT/kWh in 2010; 88.0 MNT/kWh in 2011.
Uncertain macro-economic environment	Volatile inflation rate and high price fluctuations	Annual inflation rate: 2006-4.3%; 2007-9.6%; 2008-28.0%; 2009-8.0%; 2010-10.1%; 2011-9.2%.
	Unstable currency and exchange rates	Currency exchange rate: 2007-8 -1175; 2008-8 -1154; 2009-8 -1448; 2010-8 -1360; 2011-8 -1253; 2012-8 -1358
	Balance of payment problems and uncertain economic growth	Mongolian macro-economic structure is weak and in high dependence from foreign markets.

Table 50: List of non-financial barriers discussed with stakeholders (Wind Park)

Barriers	*Elements of barriers*	*Dimensions of barrier element*
Market failure		
Poor market in energy sector	Lack of liberalization in energy sector	The Energy Regulathory Committeeis established with commercialization of the energy sector but do not market competition is introduced fully. There a few State-owned oligopoly suppliers on the market and no fair competition in place.
	Mismanaged energy sector	The matrix of roles and responsibilities of the sectoral administration and regulatory authorities is inefficient. There is no authorized research institute to design the energy sector development policy with scientific approach. There is the National Renewable Energy Center but the center does not belong to the Ministry of Energy. The center is a self-financed institution belonging to the State property committee.
Underdeveloped competition	Insufficient number of competitors (property developers and rental market have no incentive to invest)	There are companies and entities interested in construction of WP, but they don't have the capacity to construct Wind park
	Market size small (small market potential, low density of consumer demand, limited or difficultaccess to international market)	The energy consumption market of Mongolia is relatively small in comparison with developed countries. As of 2011, the in-use capacity was 800 MW. Currently, installed capacity of the energy systems is 1000MW.
	Low ability or willingness to pay among consumers	A large proportion of the population live below the national poverty line. Poverty level is 29.8% as of 2011. Lowest living level of the population is74-85 UDS per month.
Restricted access to technology, no experience	Technology not freely available in the market	Wind park technology not freely available in the market
	Lack of product visibility	Construction of 50 wind park gives possibility to introduce related technology in Mongolia.
	No experience of new technologies	The 50MW wind park is constructing by foreign companies while Mongolia hasn't anyexperience.
Policy, legal and regulatory		
Insufficient legal and regulatory framework	Absence of laws and regulations on climate technologies	The Mongolian National Action Program on Climate Change approved by Parliament in 2011.
	Lack of government faith in climate technologies, unsupportive policies	There are National Renewable Energy Program, the National Action Plan on Climate Change and the Renewable Energy Law.
Inefficient enforcement	Lack of government control for implementation of laws and regulations	The implementation of these law and programs is insufficient.
	Insufficient willingness or ability to enforce laws and regulations	No review and responsibility measures are taken place in absence of enforce projects and programms.
	Lax attitude	The Renewable Energy Law was adopted by Parliament in Jan. 2007 and the law states to establish renewable energy fund. But the Ministry of Energy doesn't work on this matter until now.

Policy intermittency and uncertainty	Lack of long-term political commitment	Paper versions of long-term projects and programs are available but their implementaion strategy and solutions are uncertain.
	Stability of laws (frequent amendments)	The Law on Energy was amended in December 2011
Highly controlled energy sector	Government or utility monopoly of energy sector	The energy sector is commercialized but it is still considered as a public sector. Existing power plants are owned by the State.
	Private sector entry restricted(e.g., independent power producers)	State policy on private and public sector and the law on Concession support private sector investment in the sector. However financial capacity to implement large scale projects is weak.
Network failures		
Weak connectivity between actors favoring the new technology	Stakeholders dispersed and poorly organized	Roles of the stakeholders in implementation of large scale energy projects are uncertain.
	Insufficient coordination between relevant ministries and other stakeholders	Roles and inputs of relevant ministries and authories, local administration and local community is uncertain. Interrelation among these organizations are weak.
	Lack of involvement of stakeholders in decision-making	No involvement of public and local population in the desicion-making to implement construction project of a new energysector.
Incumbent networks are favored by legislation	Arbitrary decision making by officials	Administration of the Energy Ministry is unsustainable. It tends to change after each political election with politicized appointments of non-professional specialists and officers whom in turn build their own team selected by the same criteria. This tendency is quite common. Having non-professionals in decision making and design level of the sectoral policy is inappropriate.
Institutional and organizational capacity		
Lack of professional institutions	Lack of institutions or mechanisms to generate and disseminate information	No consolidated information database of the energy sector is available. The Energy regulatory authority issues the "Energy Sector Bulletin" every year, but this only covers financial, economical and technical information and price/ tariff aspects of the special-license holders. This is why there are no bulletins for policy-implementing specialists that can used for conducting technical evaluation and problem-solving .
	Lack of research institutions in energy sector to support policy makers and to develop Feasibility studies and technical standards	No reseach institute to define energy sector development tendency based on scientific research and development of the energy sector. During socialist period, there was a research institute operating under the Ministry of Energy.
Human skills		
Inadequate training facilities	The educational system may fail to react quickly enough to the emergence of new generic technologies	High-expertise professionals to conduct workshop/ training on implementation of WP project are very few in the country; and not training system is set up.
Inadequate personnel for preparing projects	Lack of domestic consultants (to reduce transaction costs)	Capacity of national consultants is not strong enough to implement WP projects
	Lack of entrepreneurs (relatively low profitability, lack of competition)	a 50 MW WP is under construction by General Electric and New Com Company
Social, cultural and behavioral		
Traditions and habits	Resistance to change, due to cultural reasons	To preserve the birthplace of its ancestors in its natural form
Information and awareness		

Lack of confidence in new climate technologies	Lack of media interest in promoting technologies	No activities to increase public awareness about the importance of thermal power plants and its negative impacts have been carried out. Thus, objections and oppositions of the local community is common.
Technical		
Product not reliable	Lack of quality control and Poor documentation of reliability	The quality control at design level of energy projects is very low.
Poor O&M facilities	Lack of skilled personnel	No training systems for profession workers and specialists
	Limited availability of spare parts	All spare parts will be from outside.
System constraints	Capacity limitation with grid system	The capacity of the national grid is only about 1000 MW.The capacity of WP to be connected to grid can be limited because of non-consistency of working WP working regimes with CHPs.
Other Barriers		
Environmental impacts	Climate change and global warming	Over last 70 years, an average air temperature has increased by 2.14⁰C in Mongolia.
	Specific climate conditions	More wind resource is in southern area. But most consumers are in the central area.
	Site selection	It is difficult to conduct construction work in winter season.
	Detailed environmental impact assessment	Detailed environmental assessment is essential
	Divergent plans, incentive structures and administrative requirements from different donors,finance institutions and government branches	There is high probability that donor and funding organizations might put additional requirements on reducing negative impacts on environments

Table 51: List of economic and financial barriers discussed with stakeholders (Efficient Coal fired power plant)

Barriers	***Elements of barriers***	***Dimensions of barrier element***
Lack or inadequate access to financial resources	Lack of financing instruments and institutions	Financial capacity to implement large-scale project is very low. Development bank was established in 2010 but no achievements yet.
	Under-developed or distorted capital market (poor creditworthiness, poor recovery regulations)	Mongolian Stock Exchange trade is limited only by stocks and bonds.
	Lack of access to credit for certain consumers	It is impossible in Mongolia to get long term credit for construction of large scale HPP
High cost of capital	Scarcity of cheap capital (high interest rates due to high risk perception by financial institutions)	Loan interest rate of commercial banks in Mongolia is 1.5 % per month.
	High up-front costs	TPP pulverized coal combustion technologies operating with super-critical steam parameters - Up-front investment required to construct TPP is 2.5 USD million/MW.
	High resource costs (material, labor)	Most of construction materials and labor sources will be imported from other countries. Though, price of fuel and raw materials is not so high, spare parts and equipment is imported with a higher price.
High transaction costs	Gathering and processing information (feasibility studies; due diligence)	There is no capacity in Mongolia to do Feasibility Study for the construction of large scale Thermal Power Plants. Technical and Economic Feasibility study of large-scale TPP is conducted by foreign experts and costs more.
	Technology acquisition	There is no technology and installations of large scale Thermal Power Plants. Therefore selection of technology will require study and time. Purchasing technology and equipment from foreign market is costly, has considerable risks and is time consuming
	Bureaucracy	The energy sector is a public sector and the bureaucracy level of the sector is high

Inappropriate financial incentives and disincentives	Favorable treatment for conventional energy and large-scale projects (subsidies, low taxes)	Interests to replace conventional methods and technology with new, advanced ones are not so high - caution to do so is high.
	Insufficient incentives to develop climate technologies	National Action program on Climate Change in Mongolia The Ministry of the Environment and Green Developments focuses on Reduction of Greenhouse Gas Emission, but no joint measures together with the Ministry of Energy has taken place yet. The National Program on Climate Change was adopted in 2011.
	Non-consideration of externalities (negative externalities (pollution, damage from this) from conventional energy not considered in pricing, positive impacts of climate technologies not valued)	Law on fees for air pollution: A fee of Tg1-2 is imposed on each kg of coal being extracted by coal mines The law on air pollution fee: A fee of MNT 1-2 is imposed on each kg of coal being extracted by coal mines
	Taxes on climate technologies (high import duties on equipment, duty exemption limited to small products, other direct or indirect taxes on climate technologies)	There is no reduction of import taxes for climate technologies. Import taxes – 5%; VAT – 10%.
	Consumers pay below marginal cost	Example: The electricity production cost in Central grid is 88 MNT/kWh. However electricity tariff for households is 79 MNT/kWh. The electricity production cost in Western energy system is 168.46 MNT/kWh. However electricity tariff for households is only 60 MNT/kWh.
Uncertain financial environment	Uncertain electricity tariffs (e.g., non-transparent tariff adjustment procedure)	Electricity tariff for enterprises: 45.0 MNT/kWh in 2001; 47.0 MNT/kWh in 2002; 51.0 MNT/kWh in 2005; 68.0 MNT/kWh in 2008; 79.8 MNT/kWh in 2010; 88.0 MNT/kWh in 2011.

Uncertain macro-economic environment	Volatile inflation rate and high price fluctuations	Annual inflation rate: 2006-4.3%; 2007-9.6%; 2008-28.0%; 2009-8.0%; 2010-10.1%; 2011-9.2%.
	The tariff level in Mongolia much lower than in other countries	The low tariff is the main barrier for investment and for making Power Purchase Agreement for construction of TPP in Mongolia.
	Unstable currency and exchange rates	Currency exchange rate: 2007-8 -1175; 2008-8 -1154; 2009-8 -1448; 2010-8 -1360; 2011-8 -1253; 2012-8 -1358
	Balance of payment problems and uncertain economic growth	Mongolian macro-economic structure is weak and in high dependence from foreign markets.

Table 52: List of non-financial barriers discussed with stakeholders (Efficient SC and USC Coal fired power plant)

Barriers	***Elements of barriers***	***Dimensions of barrier element***
Market failure		
Poor market infrastructure	Lack of liberalization in energy sector	Energy regulatory authority is established with privatization of the energy sector but market competition is not introduced fully. State-owned few oligopoly suppliers are on the market and no fair competition in place.
	Mismanaged energy sector	Policy to improve energy generation efficiency and introduce advanced technology is unclear. Roles and responsibilities matrix of the sectoral administration and regulatory authorities is inefficient. No authorized research institute to design the energy sector development policy with scientific approach.
Underdeveloped competition	Insufficient number of competitors (property developers and rental market have no incentive to invest)	Companies and entities interested in, and capable of constructing large-scale thermal power plant.
	Market size small (small market potential, low density of consumer demand, limited or difficult access to international market)	Energy consumption market of Mongolia is relatively small in comparison with developed countries. As of 2011, used capacity was 800 MW. Currently, installed capacity of the energy systems is 1000MW. This expected to increase two to threefold in 2020-2030.
	Low ability or willingness to pay among consumers	Majority of the population live at, or below the average monthly income. The poverty level is 29.8% as of 2011. Lowest living level of the population is 103 000 to 118 000 tugrugs per month.
Restricted access to technology, no experience	Technology not freely available in the market	With no large-scale TPP in Mongolia, there was no need to introduce this advanced technology.
	Lack of product visibility	TPP high-efficiency technology operating with super-critical parameter steam is very new to Mongolia and public awareness of the technology is low.
	Experience of new technologies cannot be achieved	Mongolia has rich experience of operating conventional or Coal-Fired TPPs but is not experienced in constructing and operating supercritical high-efficiency TPPs of supercritical steam parameters

Policy, legal and regulatory		
Insufficient legal and regulatory framework	Absence of laws and regulations on climate technologies	The Mongolian National Action Program on Climate Change approved by Parliament in 2011.However, no statements to introduce this technology in the Energy Sector Development Policy.
Inefficient enforcement	Lack of government control for implementation of laws and regulations	Too many plans and programs of the energy sector development, but no implementation.
	Insufficient willingness or ability to enforce laws and regulations	No review and responsibility measures are taken place in absence of enforce projects and programms.
	Lax attitude	Mongolian Energy sector Consolidated system adopted in 2007 has objectives to construct 300MW Power Plant in Gobi during 2007-2012 and TPP with capacity of at least 300MW in Ulaanbaatar city, but none of it is implemented or at start-up stage. Action plan 2008-2012 of the Mongolian Government has statements to construct new thermal and power energy source in the Central and Western energy systems and increase operating capacity of existing energy sources. Also, it states to construct a new thermal and power energy source in Ulaanbaatar city. But, again, none of it has been implemented.
Policy intermittency and uncertainty	Lack of long-term political commitment	Paper versions of long-term projects and programs are available but their implementaion strategy and solutions are uncertain.
	Stability of laws (frequent amendments)	The Law on Energy was amended in December 2011.
Highly controlled energy sector	Government or utility monopoly of energy sector	The energy sector is commercialized but it is still considered as a public sector. Existing power plants are owned by the State.
	Private sector entry restricted(e.g., independent power producers)	State policy on private and public sector and the law on Concession support private sector investment in the sector. But financial capacity to implement large scale projects is weak.
Network failures		
Weak connectivity between actors favoring the new technology	Stakeholders dispersed and poorly organized	Roles of the stakeholders in implementation of TPP projects are uncertain.
	Insufficient coordination between relevant ministries and other stakeholders	Roles and inputs of relevant ministries and authories, local administration and local community is uncertain. Collaboration among these organizations are weak.
	Lack of involvement of stakeholders in decision-making	No involvement of public and local population in the desicion-making to implement construction project of a new energysector.
Incumbent networks are favored by legislation	Албан тушаалтнууд дур мэдэн шийдвэр гаргадаг	Administration of the Energy Ministry is unsustainable. It tends to change after each political election with the politicized appointment of non-professional specialists and officers whom in turn build their own team selected by the same criteria. This tendency is quite common. Having non-professionals in decision making and design level of the sectoral policy is inappropriate.

Institutional and organizational capacity		
Lack of professional institutions	Lack of institutions or mechanisms to generate and disseminate information	No consolidated information database of the energy sector is available. The Energy regulatory authority issues "Energy sector bulletin" every year, but this only covers financial, economical and technical information and price/ tariff aspects of the special-license holders.This is why there are no bulletins for policy-implementing specialists that can be used for conducting technical evaluation and problem-solving .
	Lack of research institutions in energy sector to support policy makers and to develop Feasibility studies and technical standards	No reseach institute to define energy sector development tendency based on scientific research and development of the energy sector. During socialist period, there was a research institute operating under the Ministry of Energy.
Human skills		
Inadequate training facilities	The educational system may fail to react quickly enough to the emergence of new generic technologies	High-expertise professionals to conduct workshop/ training on implementation of TPP project is very few in the country; and not training system is set up.
Inadequate personnel for preparing projects	Lack of domestic consultants (to reduce transaction costs)	Capacity of national consultants is not strong enough to implement project of supercritical or joint cycle thermal power plant.
	Lack of entrepreneurs (relatively low profitability, lack of competition)	MCS LLC initiated and mplemented a project to construct 18MW thermal power plant (efficient rate is not good enough) of lower parameters with own private funding in the country.
Information and awareness		
Lack of confidence in new climate technologies	Lack of media interest in promoting technologies	No activities to increase public awareness about the importance of thermal power plants and its negative impacts have been carried out. Thus, objections and oppositions of the local community is common.
Language		There are certain language barriers.
Technical barriers		
Product not reliable	Lax quality control Poor documentation of reliability	At design level of TPP projects, no recommendations and review of the professional team is included in and if made then only with lower quality. This is very common. Having foreign experts to design large-scale project creates number of problems in practice.
Poor O&M facilities	Lack of skilled personnel	Training institute for preparing professionals to work at the TPPs exists; but, at the moment, no trainers at the institute to acquire and learn this supercritical steam parameter technology.
	Limited availability of spare parts (few suppliers, long supply routes)	All of spare parts and equipment of TPPs are imported.
System constraints	Capacity limitation with grid system	Electric power demand of the country is approximately 800MW and tends to grow fast in coming future. In case of constructing large-scale plant, limitations of capacity are inevitable.
Other Barriers		

Environmental impacts	Environmental pollution	Coal-fired TPP has negative impacts on surrounding environment.
	Climate change and global warming	Over last 70 years, an average air temperature has increased by 2.14^{0}C in Mongolia. Over 50 % of the GHG is emitted from only coal firing of Thermal Power Plants in the country.
	Site selection	Large-scale TPP with above-mentioned high efficiency technology shall be constructed next to coal mining deposit.
	Specific climate conditions	It is difficult to conduct construction work in winter season.
	Ecological aspects	Construction of large-scale TPP in Gobi region has water supply problems.
	Detailed environmental impact assessment	Comprehensive environmental evaluation is essential
	Divergent plans, incentive structures and administrative requirements from different donors, finance institutions and government branches	There is high probability that donor and funding organizations might put additional requirements on reducing negative impacts on environments

Table 53: List of Economic and financial barriers discussed with stakeholders (Efficient lighting)

Barriers	***Elements of barriers***	***Dimensions of barrier element***
Lack or inadequate access to financial resources	Lack of financing instruments and institutions	There is very low implementation of energy efficiency projects because of no financial mechanisms
	Under-developed or distorted capital market (poor creditworthiness, poor recovery regulations	Mongolian Stock Exchange trade is limited only by stocks and bonds.
	Lack of access to credit for certain consumers	It is impossible in Mongolia to get long term credit for implementation of energy efficiency projects
High cost of capital	Scarcity of cheap capital (high interest rates due to high risk perception by financial institutions)	Monthly interests rate at the Mongolian commercial banks is high – 1.5% per month at the lowest.
Inappropriate financial incentives and disincentives	The consumers are not giving high priority for implementation of energy efficient technology.	Low interest of consumers to use efficient lighting because of electricity tariff is low.
	Lack of measures to prevent energy inefficient technology	Efficient lighting is much costly than incandescent lamps.
	Taxes on energy efficient technologies	There is no tax empty for energy efficient technologies. Recently, the custom tax is 5%, VAT- 10%.
	Low electricity tariff	Residential electricity tariff : – 74 MNT/kWh (if monthly consumption less than 150 kWh; –79MNT/kWh (if monthly consumption 150 kWh 250 MNT/kWh); – 84MNT/kWh (if monthly consumption more 250 MNT/kWh).
Uncertain macro-economic environment	Volatile inflation rate and high price fluctuations	Annual inflation rate: 2006-4.3%; 2007-9.6%; 2008-28.0%; 2009-8.0%; 2010-10.1%; 2011-9.2%;
	Unstable currency and exchange rates	Currency exchange rate: 2007-8 -1175; 2008-8 -1154; 2009-8 -1448; 2010-8 -1360; 2011-8 -1253; 2012-8 -1358

Table 54: List of non– financial barriers discussed with stakeholders (Efficient lighting)

Barriers	*Elements of barriers*	*Dimensions of barrier element*
Market failure/ imperfection		
Poor market infrastructure	Mismanaged energy sector	The Energy regulatory Committee, energy producers and distributers are not interested in reducing energy consumption because in order to meet the energy production plans, the producers and distributers should produce more energy.
Underdeveloped competition	Insufficient number of competitors (property developers and rental market have no incentive to invest)	There aren't any energy efficiency specialized companies such as ESCOs
Market size	Economies of scale and experience of new technologies cannot be achieved	No big efficient lighting projects were implemented
	Market size small (small market potential, low density of consumer demand, limited or difficultaccess to international market)	The market size is very low if compare with other countries
	Low ability or willingness to pay among consumers	Majority of the population live at the below the average level with lower monthly income. Poverty level is 29.8% as of 2011. Lowest living level of the population is 103 000 to 118 000 tugrugs per month.
Policy, legal and regulatory		
Insufficient legal and regulatory framework	Lack of legal environment for implementation of energy efficiency measures	Whilst several drafts of an Energy Efficiency Law were developed, they were not approved by the Government and the Parliament.
Institutional and organizational capacity		
Lack of professional institutions	Lack of information collection system	The Energy regulatory authority issues "Energy sector bulletin" every year, but this only covers financial, economical and technical information and price/ tariff aspects of the special-license holders.This is why there are no bulletins for policy-implementing specialists that can used for conducting technical evaluation and problem-solving .
	Need for specialized agencies at planning level and operational level (ESCOs)	No reseach institute exists to define energy sector development tendencies based on scientific research and development of the energy sector. During the socialist period, there was a research institute operating under the Ministry of Energy.
	Lack of technical standards	Lack of technical standards
Human skills		
Inadequate personnel for preparing projects	Lack of domestic consultants (to reduce transaction costs)	Lack of domestic consultants (to reduce transaction costs
	Lack of entrepreneurs (relatively low profitability, unwieldy or restrictive regulations; may lead to lack of competition and supply constraints)	There is no energy saving specialized organizations such as ESCOs
Information and awareness		
Lack of confidence in new climate technologies	Lack of media interest in promoting technologies	Lack of media interest in promoting technologies
Technical		
Product not reliable	Lax quality control	Low quality of efficient lights imported by individuals and private companies

Table 55: List of economic and financial barriers discussed withstakeholders (Insulation of panel apartment buildings)

Barriers	***Elements of barriers***	***Dimensions of barrier element***
Lack or inadequate access to financial resources	Lack of financing instruments and institutions	The panel apartment buildings are privatized. The owners of the apartments are not financial sources for insulation of the apartments
	Under-developed or distorted capital market (poor creditworthiness, poor recovery regulations)	Mongolian Stock Exchange trade is limited only by stocks and bonds.
	Lack of access to credit for building insulation	It is impossible in Mongolia to get long term credit for implementation of energy efficiency projects
High cost of capital	Scarcity of cheap capital (high interest rates due to high risk perception by financial institutions)	Monthly interests rate at the Mongolian commercial banks is high – 1.5% per month at the lowest.
	High initial capital cost	The initial investment for insulation of the buildings are high
Inappropriate financial incentives and disincentives	The consumers are not giving high priority for implementation of energy efficient technology.	The residents are not interested in insulating their apartments. One reason is that the tariff for heat consumption is constant not depending on actual heat consumption.The insulation will not reduce payment for heat consumption.
	Taxes on energy efficient technologies	There is no tax empty for energy efficient technologies. Recently, the custom tax is 5%, VAT- 10%.
	The heat tariff is constant not depending on actual heat consumption.	Heat tariff(without VAT) -341 MNT/m^2(for residential consumers, -323 MNT/m^2(for other consumers)
Uncertain macro-economic environment	Volatile inflation rate and high price fluctuations	Annual inflation rate: 2006-4.3%; 2007-9.6%; 2008-28.0%; 2009-8.0%; 2010-10.1%; 2011-9.2%;
	Unstable currency and exchange rates	Төгрөгийн доллартай харьцах ханш: 2007-8 -1175; 2008-8 -1154; 2009-8 -1448; 2010-8 -1360; 2011-8 -1253; 2012-8 -1358

Table 56: Long list of non-financial barriers discussed withstakeholders (Insulation of panel apartment buildings)

Barriers	*Elements of barriers*	*Dimensions of barrier element*
Market failure/ imperfection – Зах зээлийн хүндрэл		
Poor market infrastructure	Mismanaged energy sector	The Energy Regulatory Committee, energy producers and distributers are not interested in reduction of energy consumption because in order to meet the energy production plans, the producers and distributers should produce more energy.
Underdeveloped competition	Insufficient number of competitors (property developers and rental market have no incentive to invest)	There aren't any energy efficiency specialized companies such as ESCOs
Market size	Market size small (small market potential, low density of consumer demand, limited or difficultaccess to international market)	The market is limited
	Low ability or willingness to pay among consumers	Majority of the population earn at, or below the average monthly income. The poverty level is 29.8% as of 2011. Lowest living level of the population is 103 000 to 118 000 tugrugs per month.
Policy, legal and regulatory		
Insufficient legal and regulatory framework	No legal environment to implement energy efficieny measures/activities and policies	While several drafts of an Energy Efficiency Law were developed, they were not approved by the Government and the Parliament.
Institutional and organizational capacity		
Lack of professional institutions	Need for specialized agencies at planning level and operational level (ESCOs)	No reseach institute to define energy sector development tendencies based on scientific research and development of the energy sector. During socialist period, there was a research institute operating under the Ministry of Energy.
Human skills		
Inadequate personnel for preparing projects	Lack of domestic consultants (to reduce transaction costs)	Lack of domestic consultants
	Lack of entrepreneurs (relatively low profitability, unwieldy or restrictive regulations; may lead to lack of competition and supply constraints)	Lack of ESCOs, lack of interests among the residents
Information and awareness		
Lack of confidence in new climate technologies	Lack of media interest in promoting technologies	Lack of media interest in promoting technologies
Technical		
Quality of technology	Lack of quality control	Lack of quality control

Market maps and problem trees for technologies

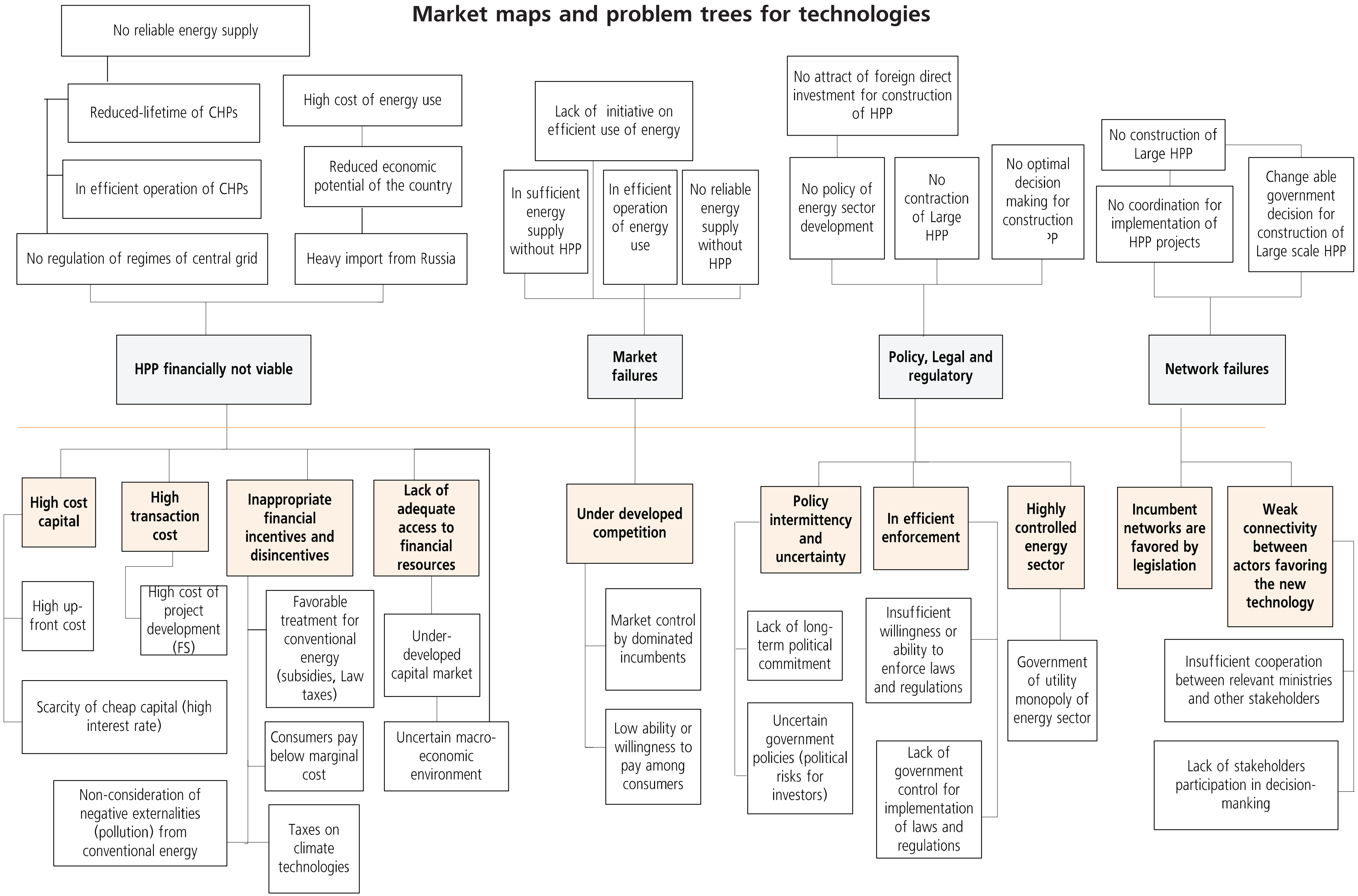

Figure 6: *Problem tree and causal relation for the transfer and diffusion of large-scale of HPP technology*

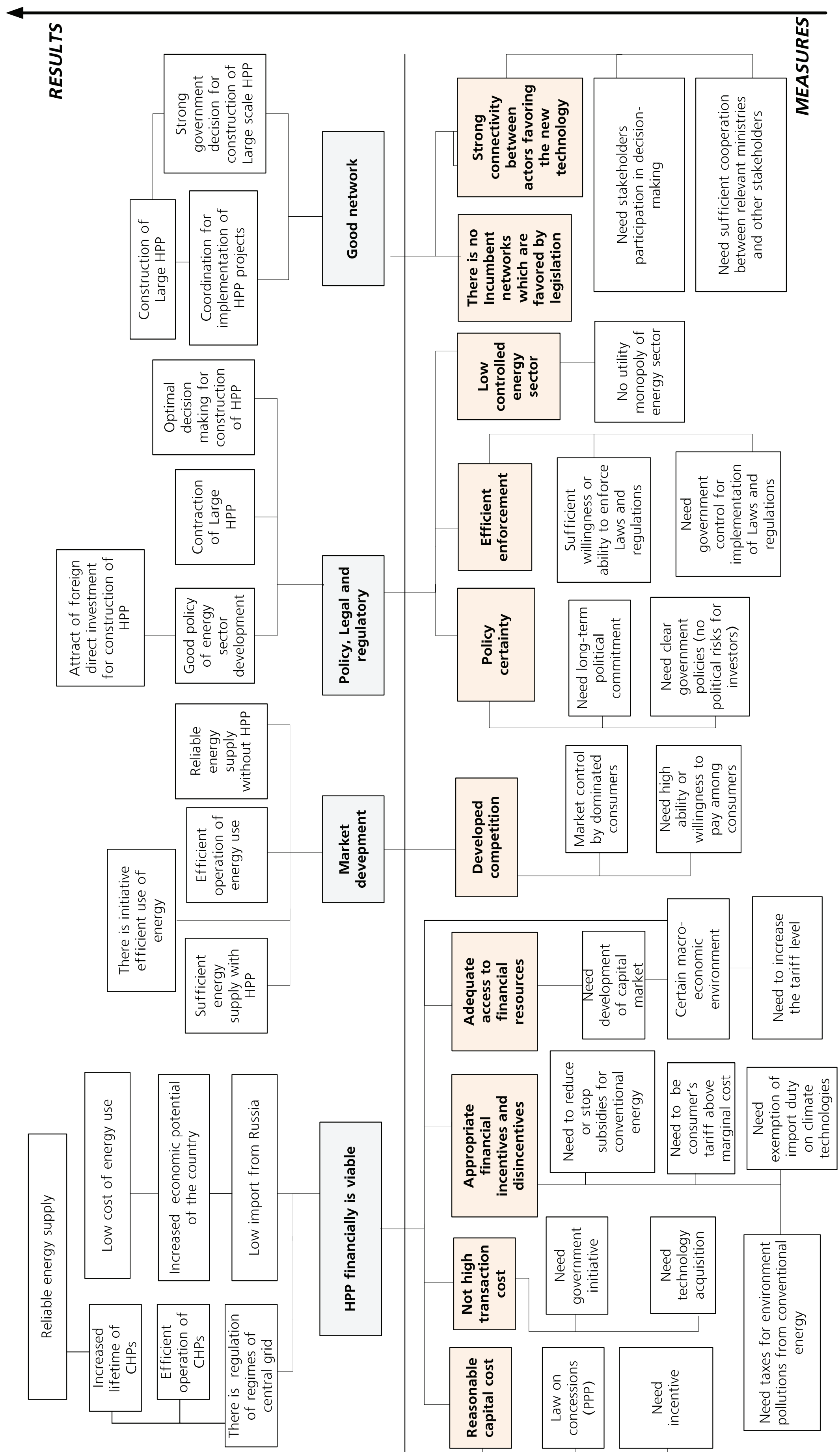

Figure 7: *Translated problem to solution of large-scale HPP technology*

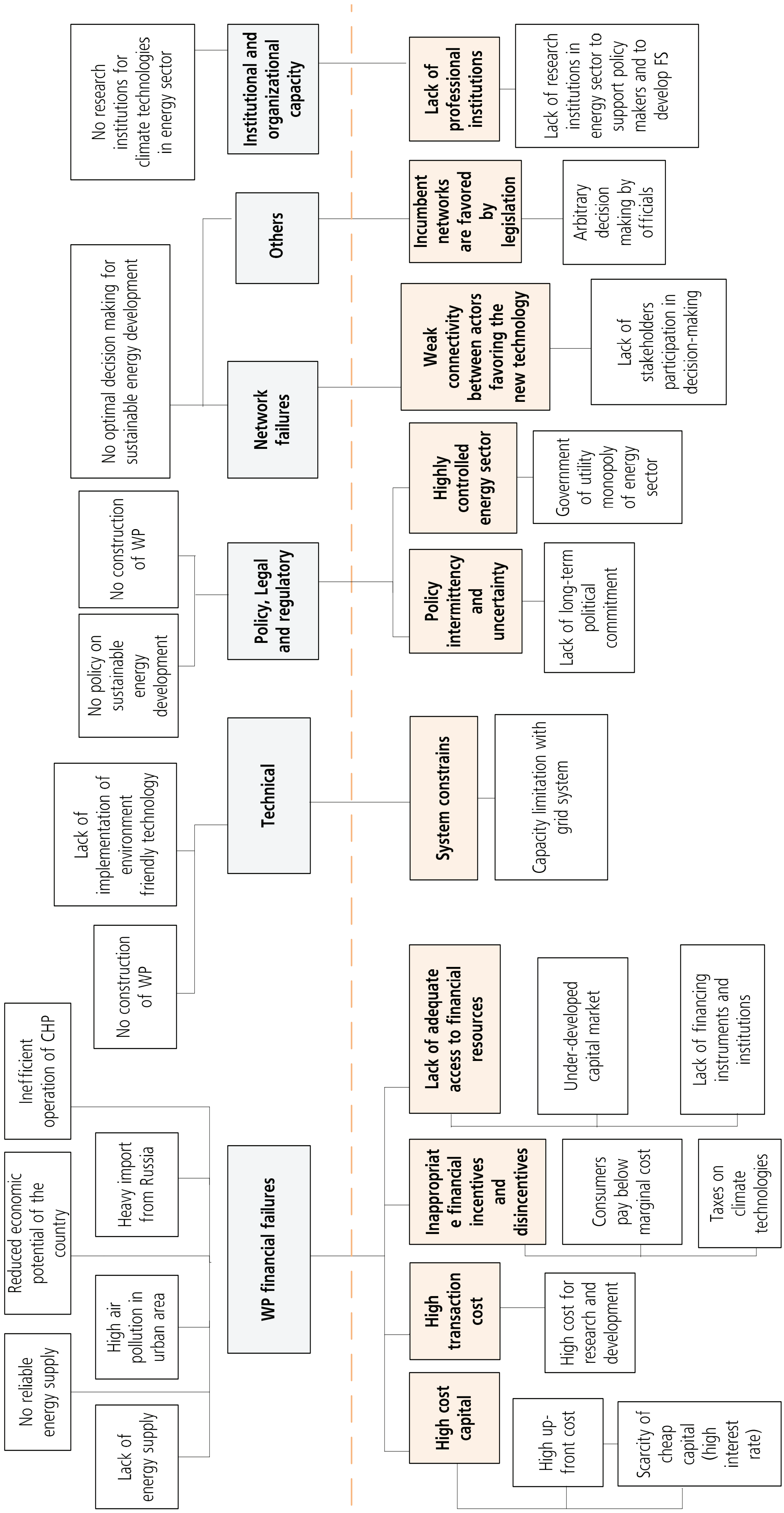

Figure 8: *Problem tree and causal relation for the transfer and diffusion of large scale of Wind Park*

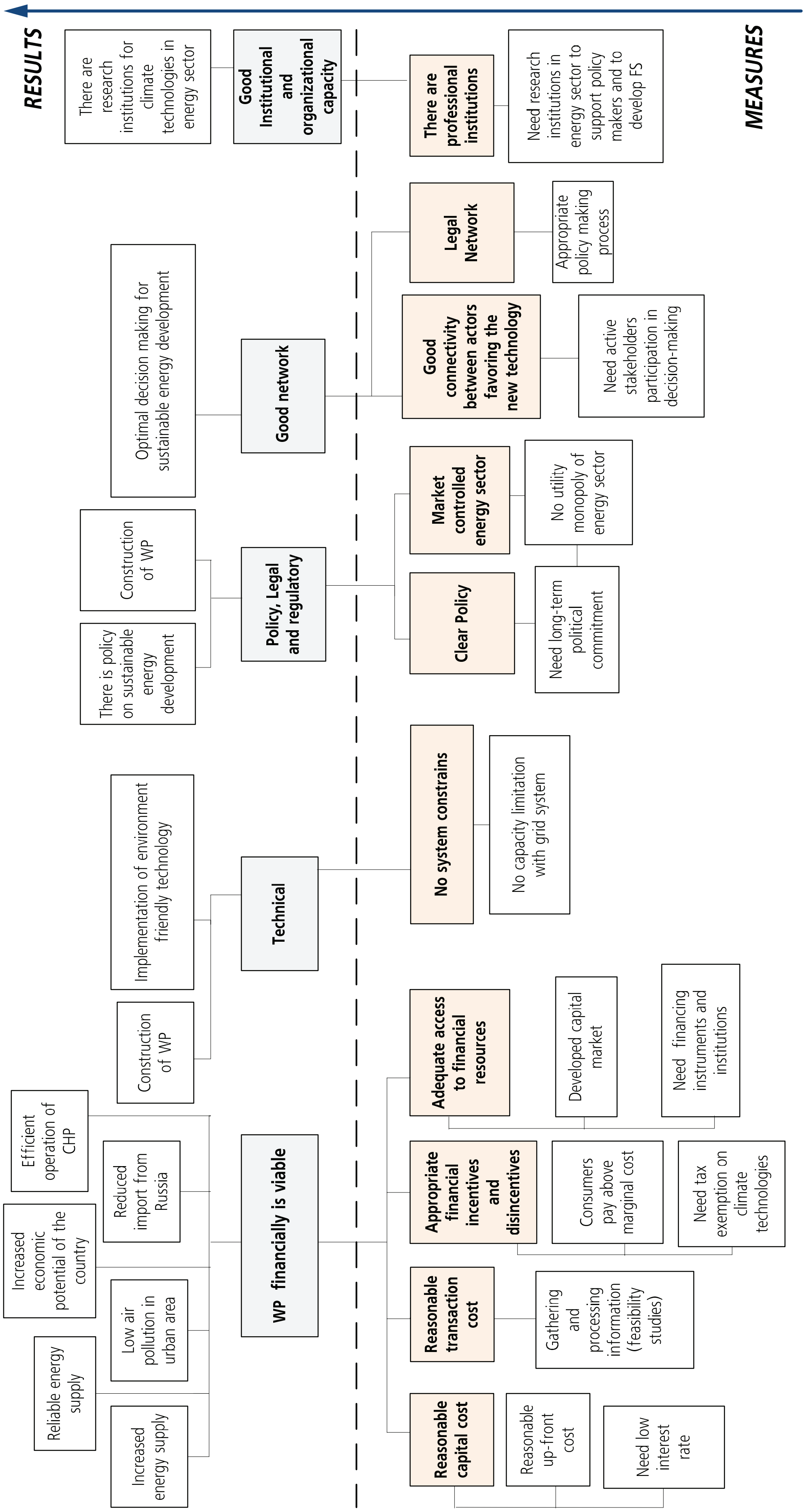

Figure 9: *Translated problem to solution of Wind Park*

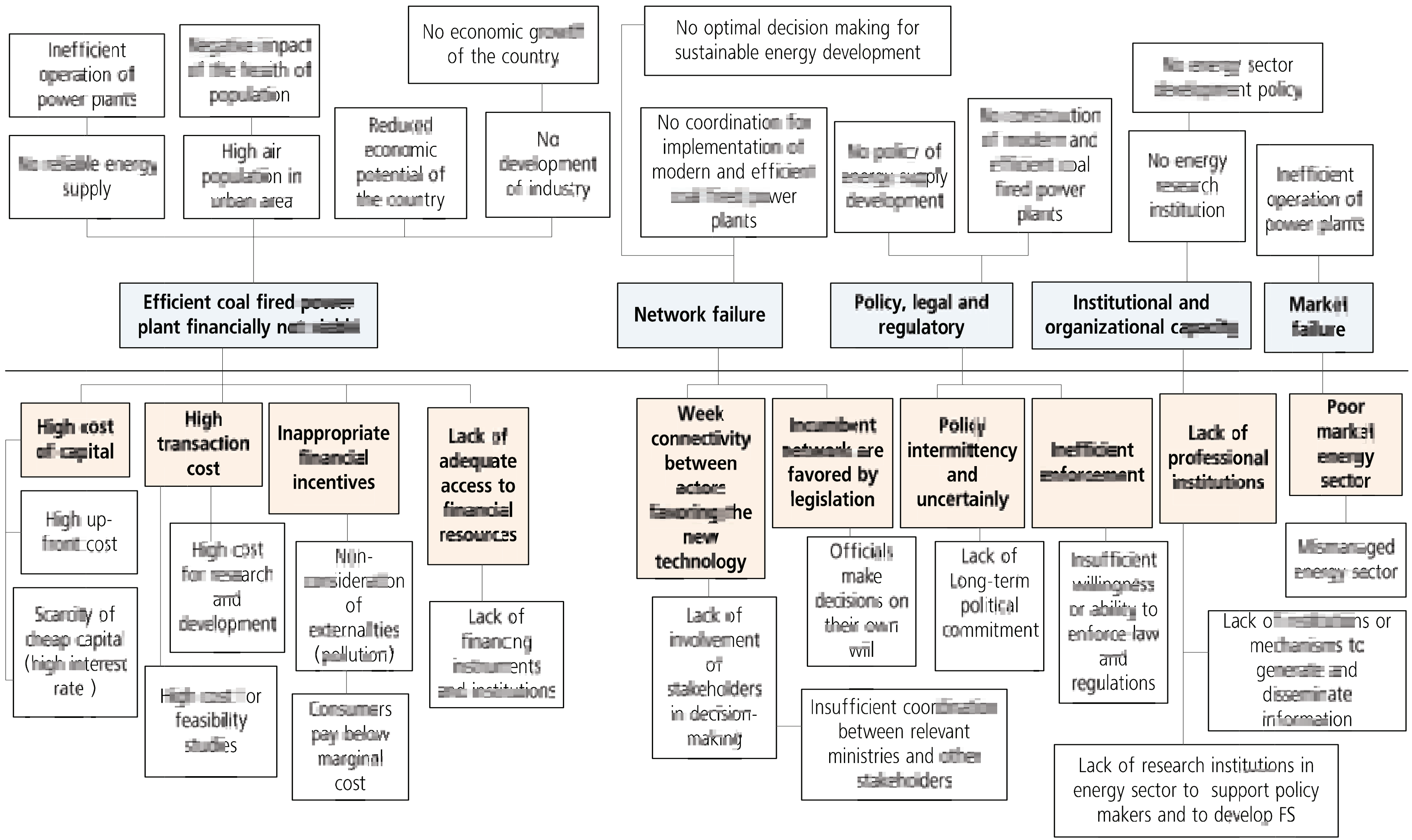

Figure 10: *Problem tree and causal relation for the transfer and diffusion of efficient coal fired power plant*

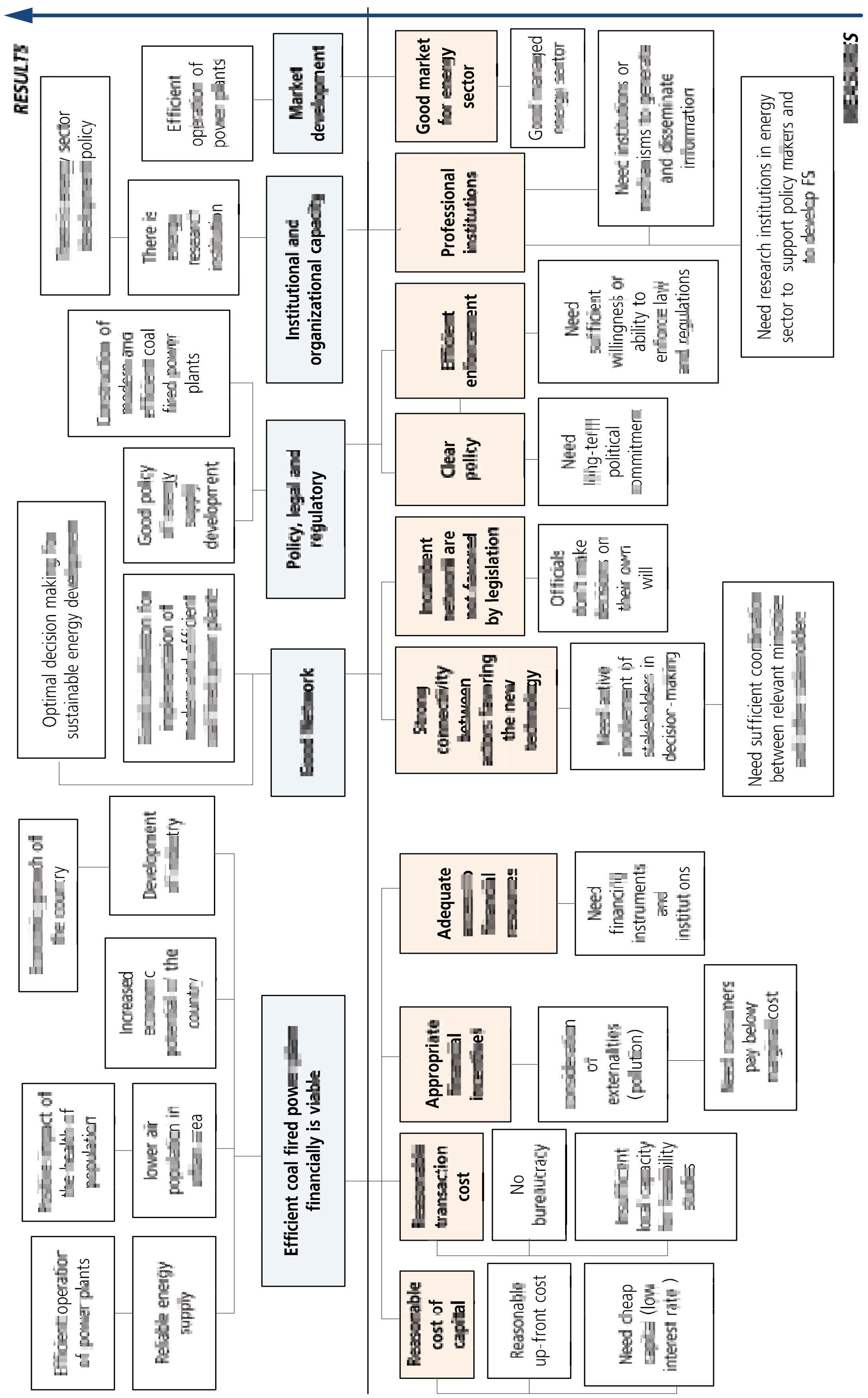

Figure 11: Translated problem to solution of efficient coal fired power plant

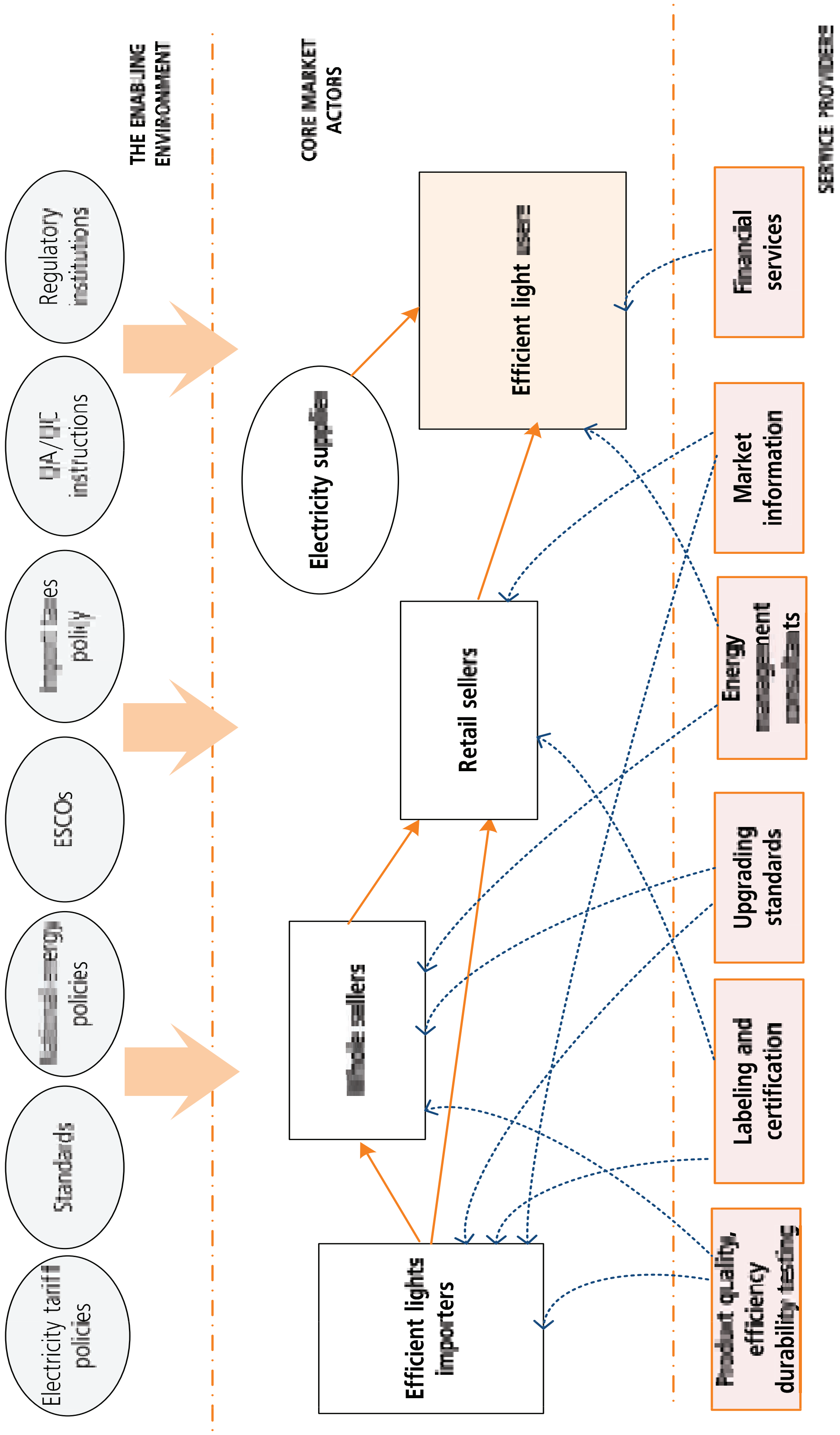

Figure 12: Market map for the efficient lighting technology

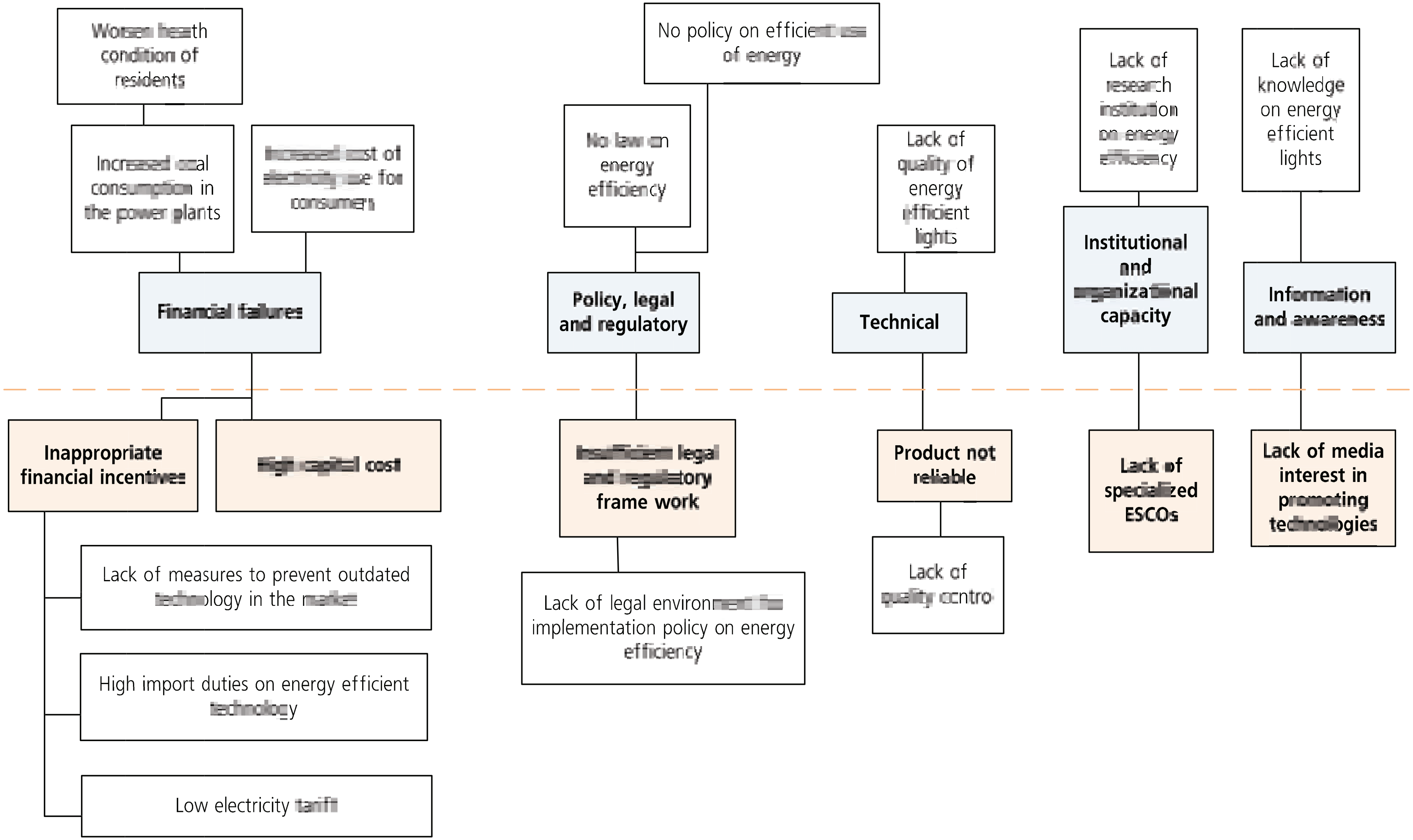

Figure 13: *Problem tree and causal relation for the transfer and diffusion of efficient lighting technology*

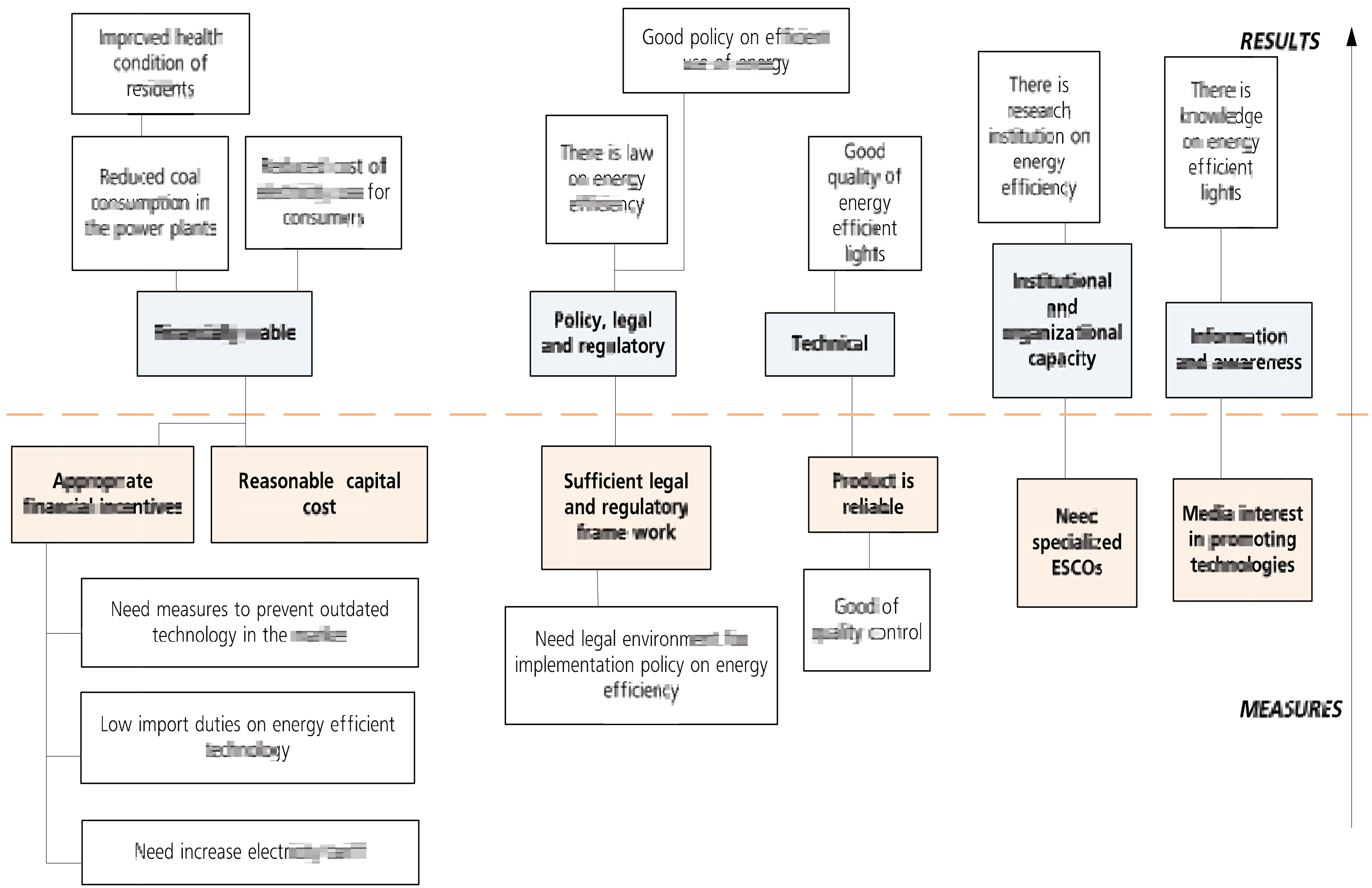

Figure 14: *Translated problem to solution of efficient lighting technology*

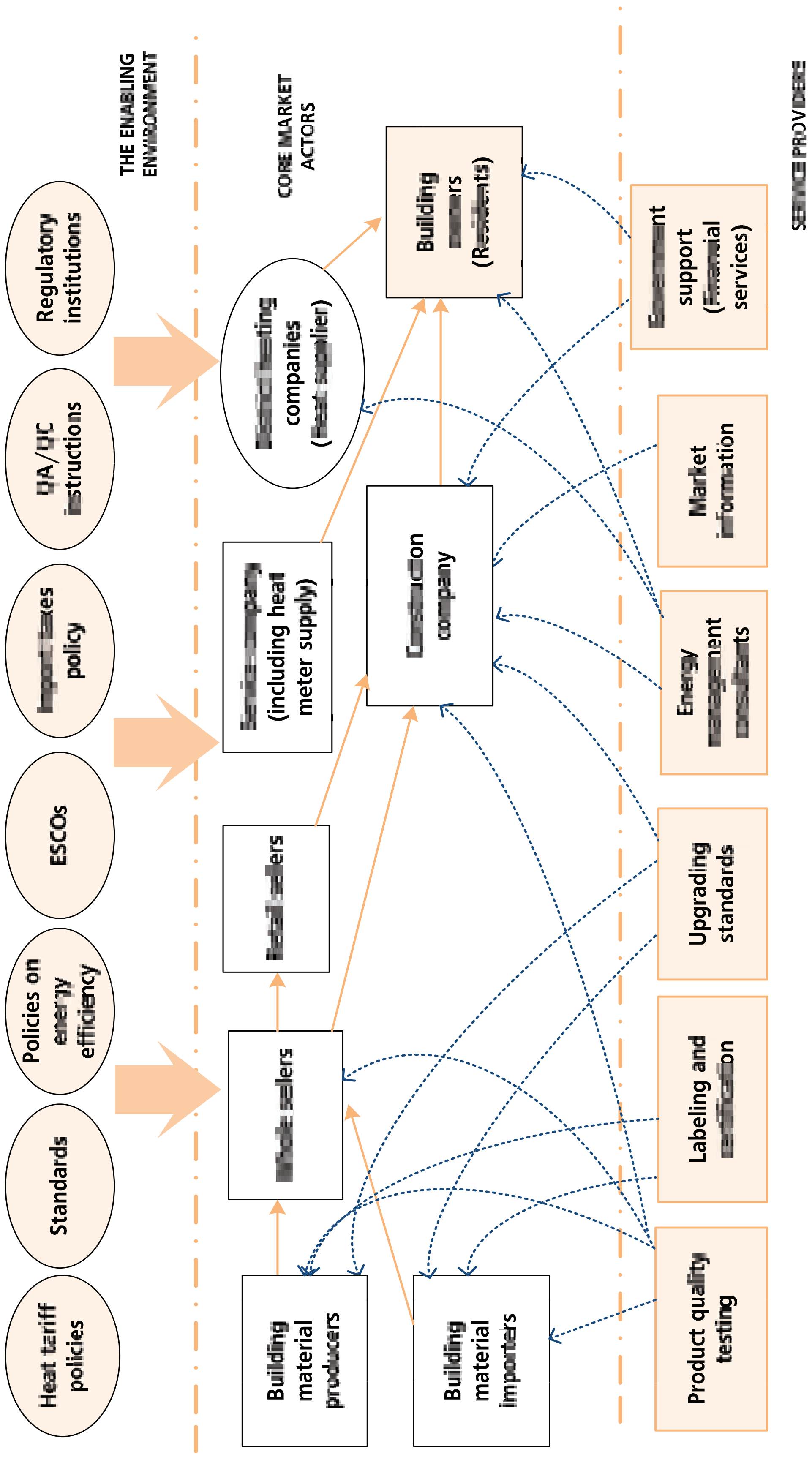

***Figure 15:** Market map for the efficient lighting technology*

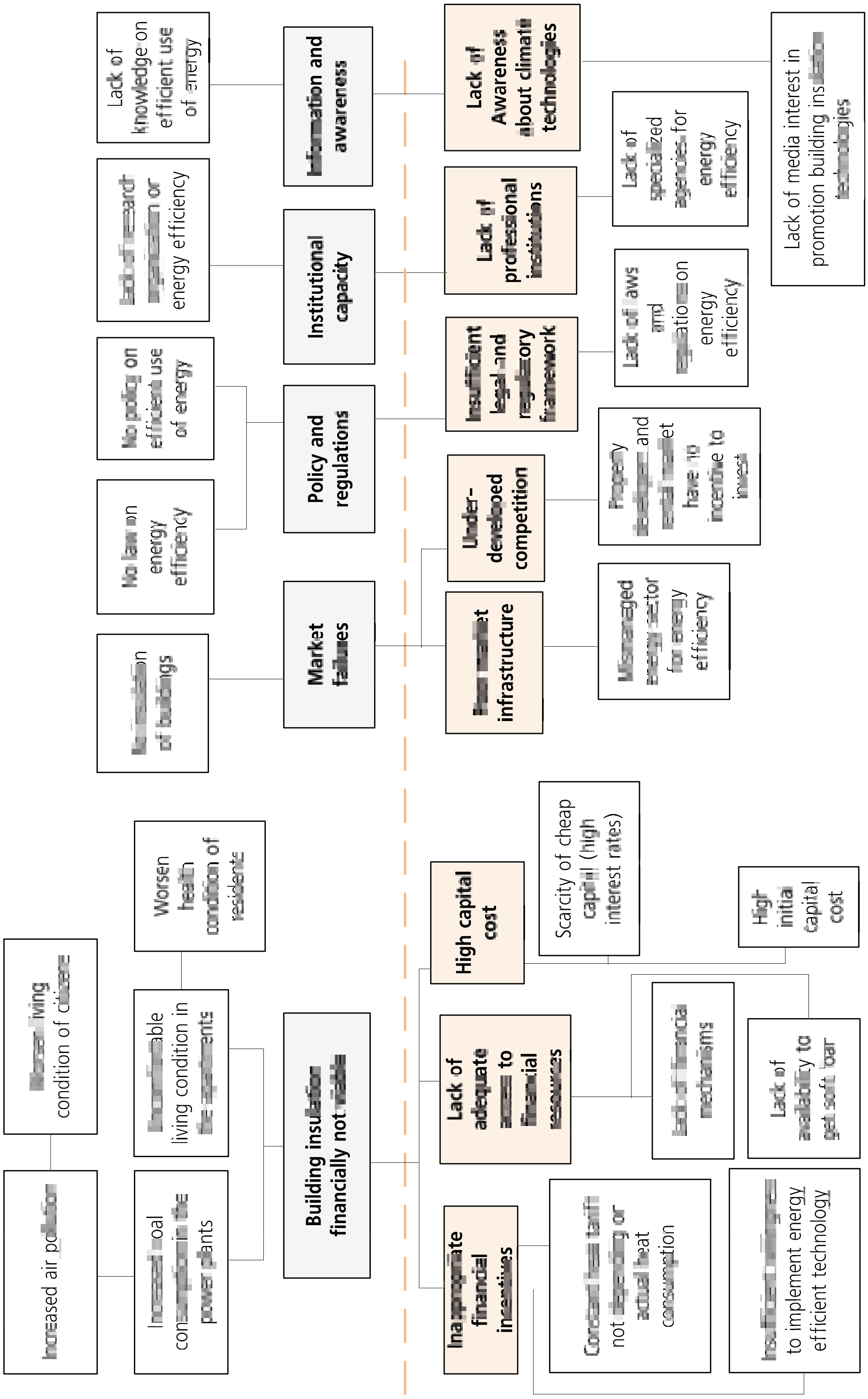

Figure 16: *Problem tree and causal relation for the transfer and diffusion of Building insulation technology*

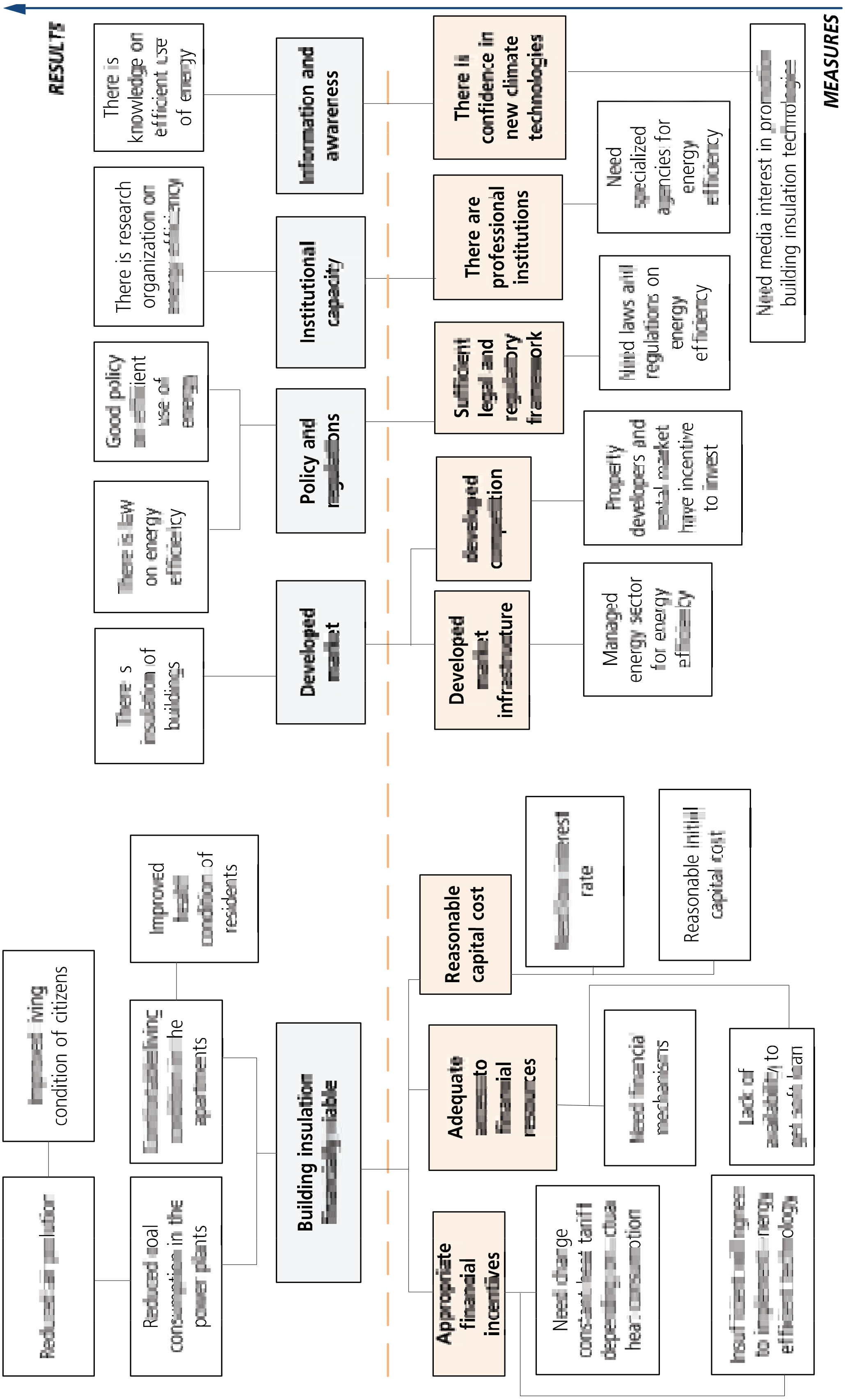

Figure 17: Translated problem to solution of building insulation technology

Annex 5: List of stakeholders involved and their contacts

Stakeholders		Representatives		Approach of consultation
Organizations	Departments	Name	Position	
Ministry of Mineral Resources and Energy	Energy Policy Department	Y. Enkhtuya	Officer	meeting discussion, questionnaire
	Fuel Policy Department	N. Boldkhuu	Deputy director	meeting discussion, questionnaire
Energy authority	Renewable energy division	Bayasgalanbaatar	Chief	meeting discussion, questionnaire
	Energy department	S. Purevdash	Officer	meeting discussion, questionnaire
		Baatar	Consultant	meeting discussion, questionnaire
		Ochirjav	Consultant	meeting discussion, questionnaire
Ministry of Nature, Environment and Tourism	Climate Change coordination office	D. Dagvadorj	Chairman	meeting discussion, questionnaire
	CDM National Bureau	B. Tsendsuren	Head	meeting discussion, questionnaire
	CDM National Bureau	B. Bat-Ulzii	Officer	meeting discussion, questionnaire
	Strengthening *Environmenta l* Governance in Mongolia *Project*	A.Enhtsetseg	Project consultant	meeting discussion, questionnaire
National Development and Innovation Committee	Industrial Development Department	B. Ganbaatar	Director	meeting discussion, questionnaire
		G. Misheelt	Fuel and Energy policy officer	meeting discussion, questionnaire
UNDP in Mongolia	Building Energy Efficiency project (BEEP)	Munkhbayar	Project manager	meeting discussion, questionnaire
Mongolian University of science and Technology	Energy Institute	Ch. Zunduisuren	Professor	meeting discussion, questionnaire
Mongolian Academy of Sciences	Energy corporation	M. Bum-Ayush	Director	meeting discussion, questionnaire
Mongolian National University	Energy Institute	Y. Gantogoo	Consultant	meeting discussion, questionnaire
The government office of Ulaanbaatar city the capital of Mongolia	The government office	Ch. Tsogtsaikhan	Officer	meeting discussion, questionnaire
Mongolian National Chamber of Commerce and Industry	Cleaner production and Energy Efficiency Center	G. Tumenjargal	Head	meeting discussion, questionnaire
Mongolian Millennium Challenge Corporation	Clean Air project	B. Tamir	Project officer	meeting discussion, questionnaire
	Project Implementation Office	N. Tsolmon	Project officer	meeting discussion, questionnaire
Mongolian Energy Association	Non-governmental Organization	G. Purevdorj	General secretary	meeting discussion, questionnaire
President office	National air pollution reduction committee of Mongolia	B. Ganbat	Energy expert	meeting discussion, questionnaire
Mon-Energy Co., Ltd	Private company	D. Sod	Energy and Environment expert	meeting discussion, questionnaire
MCS Group	MCS International Co., Ltd	G. Tulga	Coal expert	meeting discussion, questionnaire
MCS Group	MCS International Co., Ltd	G. Tulga	Coal expert	meeting discussion, questionnaire

Annex 6: Policy Factsheets

1. National Action Program on Climate Change

Name of Policy	***National Action Program on Climate Change***
Date Effective:	2011
Date Ended:	In force
Unit:	Climate Change
Country:	Mongolia
Year:	2011
Policy Status:	In force
Agency:	Ministry of Nature, Environment and Tourism of Mongolia
Funding:	
Further Information:	http://www.legalinfo.mn/insys/list.php?tabclick1=0&vlett=У
Policy Type:	Incentives
Policy Target:	The policy target of the program is to ensure environmental sustainability, development of socio-economic sectors adapted to climate change, reduction of vulnerabilities and risks, and mitigation of GHG emissions as well as promoting economic effectiveness and efficiency and implementation of "green growth" policies.
URL:	http://www.legalinfo.mn/insys/list.php?tabclick1=0&vlett=У
Legal References:	
Description:	The implementation of the NAPCC to 2021 will help Mongolia create the capacity to adapt to climate change and establish a foundation for green economic growth and development. The strategic objectives of the program are: • Set the legal environment, structure, institutional and management frameworks for addressing on climate change; • Ensure environmental sustainability is maintained and reduce socio-economic vulnerabilities and risks through strengthening the national climate change adaptation capacity • Mitigate GHG emissions and establish a low carbon economy through the introduction of environmentally friendly technologies and improvement in energy effectiveness and efficiency • Enhance the national climate observation, research and monitoring network and strengthen employees' capacity • Conduct public awareness campaign and support citizen and community participation in actions against climate change • Implementation period phases of the program.

2. *Law of Mongolia on Renewable energy*

<table>
<tr><td>Name of Policy</td><td>Law of Mongolia on Renewable energy</td></tr>
<tr><td>Date Effective:</td><td>2007</td></tr>
<tr><td>Date Ended:</td><td>In force</td></tr>
<tr><td>Unit:</td><td>Renewable energy</td></tr>
<tr><td>Country:</td><td>Mongolia</td></tr>
<tr><td>Year:</td><td>2007</td></tr>
<tr><td>Policy Status:</td><td>In force</td></tr>
<tr><td>Agency:</td><td>Ministry of Mineral Resources and Energy of Mongolia</td></tr>
<tr><td>Further Information:</td><td>http://www.legalinfo.mn/insys/list.php?tabclick1=0&vlett=C</td></tr>
<tr><td>Policy Type:</td><td>Incentives/subsidies
Feed-in tariffs</td></tr>
<tr><td>Policy Target:</td><td>Grid connected renewable energy power sources:
- Wind power
- Hydropower
- Solar Photovoltaic
Independent renewable energy power source:
- Wind power
- Hydropower
- Solar Photovoltaic</td></tr>
<tr><td>URL:</td><td>http://www.legalinfo.mn/insys/list.php?tabclick1=0&vlett=C</td></tr>
<tr><td>Description:</td><td>The purpose of the law is to regulate aspects regarding the generation of power using renewable energy sources and its delivery.
The law primarily stipulates a feed-in tariff for the grid and independent power generation from renewable energy, as indicated in following table.

Feed-in Tariffs, USD/kWh
<table>
<tr><th>Type of RE generation</th><th>Capacity</th><th>Connected to Grid</th><th>Independent power generation</th></tr>
<tr><td>Wind power</td><td>-</td><td>0.08 – 0.095</td><td>0.1-0.15</td></tr>
<tr><td rowspan="4">Hydro power</td><td>up to 5000 kW</td><td>0.045-0.060</td><td>-</td></tr>
<tr><td>up to 500 kW</td><td></td><td>0.08-0.10</td></tr>
<tr><td>501-2000 kW</td><td></td><td>0.05-0.06</td></tr>
<tr><td>2001-5000 kW</td><td></td><td>0.045-0.05</td></tr>
<tr><td>Solar power</td><td>-</td><td>0.15-0.18</td><td>0.20-0.30</td></tr>
</table>
The renewable energy fund shall be maintained through the following sources:

State budget for renewable energy development
Grants from donors, other countries, and foreign and local organizations.
Fifty percent of the proceeds assigned to the state, local property entities and institutions from the sale of certified emission reductions (CER) to other countries in complian ce with the Kyoto protocol.
Other sources
</td></tr>
</table>

3. *National Renewable energy program*

Name of Policy	***National Renewable energy program***
Date Effective:	2005
Date Ended:	In force
Unit:	Renewable energy
Country:	Mongolia
Year:	2005
Policy Status:	In force
Agency:	Ministry of Mineral Resources and Energy of Mongolia
Funding:	
Further Information:	http://www.legalinfo.mn/insys/lawmain.php?vlawid=7926
Evaluation:	
Policy Type:	Incentives/subsidies
Policy Target:	The policy target of the program is to increase the percentage of the renewable energy share in the total generation to 3–5 percent by 2010 and 20–25 percent by 2020.
URL:	http://www.legalinfo.mn/insys/lawmain.php?vlawid=7926
Legal References:	
Description:	In approving the National Renewable Energy Program, the Parliament expressed the policy objectives of the state in promoting renewable energy which are the following: • Increase the penetration of renewable energies in energy system • Diversify energy sources • Decrease air pollution • Achieve social economic sustainable development of rural areas NREP specified various performance targets for the government related to renewable energy, energy efficiency and the environment.

4. *Mongolia's Strategy for Sustainable Development of the Energy Sector*

Name of Policy	***Mongolia's Strategy for Sustainable Development of the Energy Sector***
Date Effective:	2002
Date Ended:	In force
Unit:	Energy
Country:	Mongolia
Year:	2002
Policy Status:	In force
Agency:	Ministry of Energy of Mongolia
Funding:	
Further Information:	http://pdf.usaid.gov/pdf_docs/PNADB440.pdf
Evaluation:	
Policy Type:	Incentives
Policy Target:	The aim of the "Mongolia's Strategy for Sustainable Development of the Energy Sector:2002-2010" is to provide sustainable development of the energy sector, reduce poverty and increase the involvement of the private sector and public interest in thesector by improving effectiveness of the energy supply. It also aims to promote economic efficiency in the energy sector and improve environmental conditions by introducing new technological achievements based on regional energy sector collaboration. The implementation of the Strategy shall be organized by the State Central Administrative Authority in charge of energy based on collaboration between theGovernment of Mongolia, international financial organizations, donors, local andinternational non-government organizations and energy sector entities.
URL:	http://pdf.usaid.gov/pdf_docs/PNADB440.pdf
Legal References:	
Description:	"Mongolia's Strategy for Sustainable Development of the Energy Sector: shall be based on 5 main principles: • To provide a stable and independent financial system for the energy sector • To complete implementation of the energy sector restructuring • To improve energy conservation and efficiency • To improve capacity building within the energy sector • To improve energy supply in rural areas and introduce price and tariff mechanismsreflecting the payment ability of the consumers.

5. *Program on Integrated Power System of Mongolia*

Name of Policy	***Program on Integrated Power System of Mongolia***
Date Effective:	2007
Date Ended:	In force
Unit:	Energy
Country:	Mongolia
Year:	2007
Policy Status:	In force
Agency:	Ministry of Energy of Mongolia
Funding:	
Further Information:	http://www.legalinfo.mn/annex/details/3244?lawid=6206
Evaluation:	
Policy Type:	Incentives
Policy Target:	The purpose of this program is to form the Integrated Power System of Mongolia that enhances reliability of power supply in order to secure economic development of Mongolia, improve efficiency and loss reduction, uses and uses and maintains export of energy resources effectively in harmonization with socio-economic development of the country.
URL:	http://www.legalinfo.mn/annex/details/3244?lawid=6206
Legal References:	
Description:	The program shall be implemented in three phases: 1. The first stage (Sort-tern 2007-2012): Provide all soums and settlements with permanent supply of power from central and renewable energy sources on the bases of reliability advancement of power supply in regions and construction of new generating sources and transmission lines; 2. The second stage (Mid-term: 2012-2022): In order to supply regions with reliable energy supply, construct new power generating sources and electricity transmission lines and connect Western, Eastern and Central Energy Systems by high voltage transmission lines and create conditions for formation of the integrated energy system. 3. The third stage (Long-term: 2022-2040): Formation of the Integrated Energy System by connecting Central and Western energy systems with a high voltage transmission lines.

Section III.
Technology Action Plan

EXECUTIVE SUMMARY

Based on Technology Needs Assessment report (Report I) and Barrier Analysis and Enabling Framework report (Report II) the following technologies are subject for preparation of Technology Action Plan (TAP):

- Energy supply Sector
    - Large scale Hydro power plants
    - Wind parks
    - Pulverized coal combustion technologies (Super-critical)
- Residential and commercial Sector
    - Efficient lighting
    - Improved insulation of panel apartment buildings

For the organization of the TAP process, a sectoral/technology working group representing relevant stakeholders was formed. National consultants have applied a participatory approach during the stakeholder consultation process.

Energy supply, and use, is by far the most significant source of GHG emissions in Mongolia. High emissions of carbon dioxide from the energy industries subsector are largely attributable to the coal-fired power and heat generating facilities. Power and heat generation accounted for about 65% of the carbon dioxide emissions from fuel combustion in 2006

About 90 percent of the electrical power generated in Mongolia is produced by coal CHP in Mongolia.

There are currently 13 hydro plants in operation, with capacities ranging from 150 kW to 12.0 MW in Mongolia. Most of the power plants do not operate in winter season because of extreme cold climate condition.

References for a typical small hydro power plant were sought from the CDM documentation of Taishir 11 MW and Durgun 12 MW plants, which were built in 2011 and 2008 respectively.

Large hydropower plants have been proposed for Mongolia in several previous power sector studies. Particular proposals have been put forward for Shuren 330 MW, Egiin 220 MW and Orkhon 100 MW Power Plants.

The Wind Atlas of Mongolia shows that the country has huge potential for wind power generation. The resource potential is around 10% of the total land area and is classified as excellent for utility scale applications (power density of 400-600 W/m^2) and could potentially supply over 1,100 GW of installed capacity.

With a combination of various factors such as a policy and regulatory framework that provides private sector investment incentives (feed-in tariff) and access to electricity markets, high wind energy resource potential, high electricity demand growth, and projected short to long-term capacity shortage, various large-scale wind power projects were proposed and are being developed by the private sector in the country. Most of these projects aim to cater the electricity market of the Central Energy System and South Gobi.

Themajor coal based technologies that are available today at various stages of development include (i) conventional pulverized coal combustion (PC), (ii) circulating fluidized bed combustion (CFB), (iii) supercritical (SC) and ultra-supercritical (USC) PC combustion, and (iv) integrated gasification combined cycle (IGCC). The IGCC technology, whilst already demonstrated in several plants, is not yet fully commercial.

The conventional pulverized coal combustion technology is used in Combined Heat and power plants in Mongolia.

SC and USC plants are already commercially available, cost effective, and worldwide operational experience of USC and SC plants is rapidly accumulating. The design efficiencies of SC and USC plants are between 39% and 46%. This stands in an apparent contrast with the typical efficiencies of 30% to 37% of the conventional PC and CFBC technologies. Therefore SC and USC technology will be implemented in future in Mongolia.

Measures for overcoming existing barriers of prioritized technologies have been grouped as follows:

- Economic/financial
- Policy/regulatory
- Market/network

Technological Action Plans have been prepared for each technology. During the preparation of TAP, measures have been assessed taking into account their priorities, time scale, related stakeholders,key indicators for measuring implementation and funding resources.

There are several cross cutting issues that constitute common barriers for all technologies prioritized under TNA process. These issues result in insufficient development of climate change mitigation technologies in Mongolia.

Absence of appropriate national legal and policy frameworks prohibits technology development and its implementation.

The solutions of some cross-cutting barriers are only at policy level, for example, policy frameworks on enhancing fundamental research, policy framework on implementing technologies, and public perception and education on new technologies. Absence of appropriate national legal and policy frameworks on enhancing fundamental research prohibits technology development as well as its implementation.

Effective technology implementation requires a solid national plan, ensuring sufficient budgets, manpower, and resources. In addition, various activities to promote public awareness in science and regulation

The common economic and financial barriers are inappropriate financial incentives; high cost of capital; high transaction cost; lack or inadequate access to financial resources and uncertain macro-economic environment.

The above barriers have resulted in a lack of state policies and action plans for climate technology development. As a consequence there are no effective fiscal mechanisms of tax breaks, state subsidies organs involved to support the deployment and dissemination of climate change mitigation technologies. Introduction of such support mechanisms should be justified by understanding of environmental economic, social and political aspects related to continued use of traditional energy sources such as coal.

The existing legal framework permit foreign investors to invest in the climate technologies without significant risks. Access to credits in Mongolia is expensive and difficult, and long-term loans are scarce. This is a common barrier for all technologies implementation. Protection of foreign investments and improvement of local crediting conditions are crucial. Common barriers regarding the market and network aspects are underdeveloped competition, insufficient coordination between relevant ministries and other stakeholders.

1. Technology Action Plan for the Energy industries subsector

1.1 Actions at sectorial level

1.1.1 Short sector description

Energy supply and use is by far the most significant source of GHG emissions in Mongolia. In 2006, greenhouse gas emissions of energy supply and use totaled 10,220 $GgCO_2$-eq. The energy industries subsector accounted for 62.6% of GHG emissions from energy supply and use.

Table 57: Trend of GHG emissions by gas from energy industries subsector

	Unit	1990	1995	2000	2004	2005	2006
Total emissions (gross)	$GgCO_2$-eq	23,645	17,205	16,896	16,910	17,582	18,868
Energy supply and use	$GgCO_2$-eq	12,529	8,710	8,865	9,247	9,635	10,220
Energy industries subsector	$GgCO_2$-eq	6,585	5,600	6,231	6,247	6,421	6,399
	% in total emissions	27.9	32.5	36.9	37.0	36.5	33.9
	% in energy sector emissions	52.6	64.3	70.2	67.6	66.6	62.6

Source: Mongolia's Second National Communication, Ulaanbaatar 2010.

High emissions of carbon dioxide from the energy industries subsector are largely attributable to the coal-fired power and heat generating facilities. Power and heat generation accounted for about 65% of the carbon dioxide emissions from fuel combustion in 2006, whereas transportation accounted for 19%, manufacturing and construction 4%, residential, commercial 10% and others, including public use contributing to the rest (Figure 18).

The top four subsectors that contribute more than 88% of the total emissions are (i) energy industries (electricity and heat production), (ii) enteric fermentation, (iii) transport and (iv) energy consumption in commercial, residential sectors. These four subsectors were the focus of the sector selection process.

Mongolia energy sector emits 57.7 % of total emissions (excluding LUCF) in 2006, 74.9% in 2020 and 77.6% in 2030. The second largest sector is agriculture. The share of emissions from the agriculture sector in total emissions (excluding LUCF) was 36.5% in 2006. However, the projections show that the share is expected to decline to 19.2% in 2020 and 16.2% in 2030 (Table 58). Existing main policies and laws relevant to the energy industry sector are shown in Table 59.

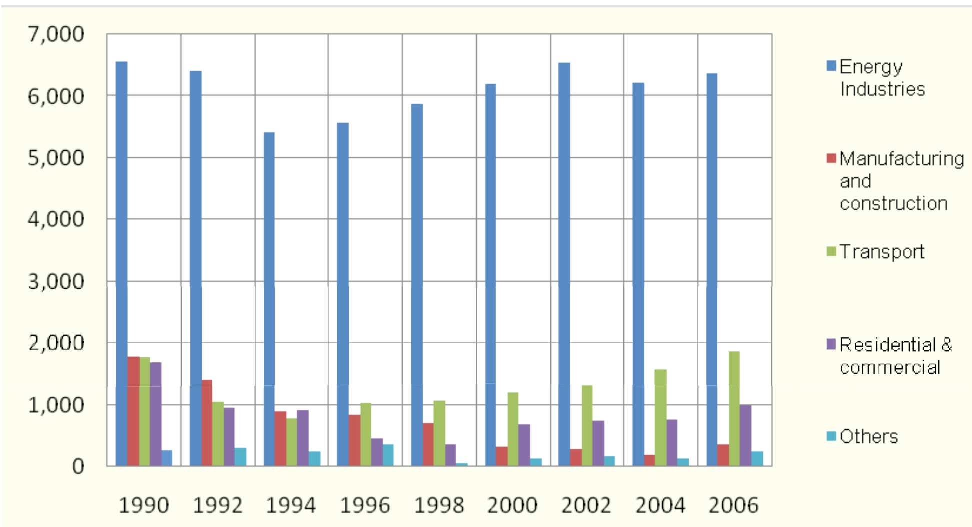

Figure 18: *Carbon dioxide emissions from fuel combustion by source, Gg*

Table 58: GHG Emissions by sectors, $GgCO_2$-eq

	2006		*2020*		*2030*	
	GHG	*%*	*GHG*	*%*	*GHG*	*%*
Energy	10,220	57.7	25930	74.9	32800	77.6
Agriculture	6462	36.5	6657	19.2	6870	16.2
Industry	892	5.0	1840	5.3	2320	5.5
Waste	138	0.8	209	0.6	294	0.7

Table 59: Existing main policies and laws relevant to the energy industry

Name of policy documents and date of enactment	*Contents/targets*
The National Renewable Energy Program 2005	For long-term development, the Parliament aimed at increasing the share of renewable energies in the country's total energy production to 20-25 percent by 2020. The current share is 1.4% Other targets: • Undertake economic feasibility studies of large hydropower stations Egiin, Artsat and Orkhon rivers • Complete construction and put into use the 100 MW Orkhon hydropower plant • Construct small and medium capacity energy generating facilities in Ulaanbaatar and other cities and towns to reduce air pollution using solar, wind, hydrogen and geothermal resources • Construct medium capacity grid-connected wind parks in sites with proven potential • Implement pilot projects in Gobi region on very large scale PV power generation system.

<table>
<tr><td>The Renewable Energy Law of Mongolia

2007</td><td>To stimulate investments in renewable energies, the Parliament enacted the Renewable Energy Law, which specified the following: i) reference tariffs for renewable energies, and ii) electricity market access rules for grid connected renewable energy projects.

<table>
<tr><th colspan="2">Transmission Network Connected</th><th colspan="2">Distribution Network Connected</th></tr>
<tr><td colspan="2">To be set by the Energy Regulatory Agency</td><td colspan="2">To be set by Regulatory Boards of Aimags[17] and the Capital City</td></tr>
<tr><th>Technology</th><th>USD/kWh</th><th>Technology</th><th>USD/kWh</th></tr>
<tr><td>Wind</td><td>0.080-0.095</td><td>Wind</td><td>0.100-0.150</td></tr>
<tr><td>Hydropower</td><td></td><td>Hydropower</td><td></td></tr>
<tr><td>capacity up to 5 MW</td><td>0.045-0.060</td><td>capacity up to 5 MW</td><td>0.080-0.100</td></tr>
<tr><td></td><td></td><td>2MW 0.50MW < capacity ≤ 2 MW</td><td>0.050-0.060</td></tr>
<tr><td></td><td></td><td>2 MW < capacity ≤ 5 MW</td><td>0.045-0.050</td></tr>
<tr><td>Solar power</td><td>0.0150-0.180</td><td>Solar power</td><td>0.200-0.300</td></tr>
</table></td></tr>
<tr><td>The Energy Law

2007</td><td>The purpose of this law is to regulate matters relating to energy generation, transmission, distribution, dispatching and supply activities, construction of energy facilities and energy consumption that involve utilization of energy resources.</td></tr>
<tr><td>The Government Program (2012-2016)

2012</td><td>• Lay down favorable conditions to attract domestic private sector investment in renewable energy sector;
• Construct the thermal power station No 5 and expand the installed capacity of the thermal power station No 4 by 100 MW in order to provide energy infrastructure that can boost economic growth;
• Construct mid-level power stations with a capacity of 60-100 MW relied on the coal deposits of the western region; and
• Take measures to enable the country to be self-sufficient in terms of power supply and eventually become a power-exporting country.</td></tr>
<tr><td>National Action Program on Climate Change

2010</td><td>Strategic Objective 3 - “Mitigate GHG emissions and establish a low-carboneconomy through the introduction of environmentally friendly technologies andimprovement in energy effectiveness and efficiency”:
• Establish a renewable energy fund;
• Develop wind and solar energy production systems;
• Expand hydro power generation
• Explore possibilities to build large scale combined power and thermal plants using solar powerin the Gobi region;
• Set up integrated gasification combine cycle plants;
• Build coalmine methane-fired power plants for electricity generation</td></tr>
</table>

17. The soumis a second level administrative subdivision of Mongolia. The 21 aimags of Mongolia are divided into 329 sums.

A profile of existing technologies for the energy industry sector is provided in Table 60.

Table 60: Profile of existing technologies for the energy industries subsector

Service	Category	Technology	Brief descriptions
Electricity supply	Fossil fuel	Combined heat and power, large scale	There are 7 Combined Heat and Power plants (CHP) in Mongolia. They produce the majority of electricity and heat energy.
		Diesel for electricity generation	The province centers which are not connected to the central grid have diesel generators for electricity supply.
	Renewable energy	Small-scale hydropower plants	There are currently 13 hydro plants in operation, with capacities ranging from 150 kW to 12.0 MW.
		Small-scale solar PV	Most herders have independent solar PV systems to generate electricity for using lights, radios and TVs
		Solar and wind hybrid technologies	Recently, wind power stations as well as combined solar-Wind stations were built in some soum[18] centers.
Heat supply	Fossil fuel	Combined heat and power, large scale	There are 7 Combined Heat and Power plants (CHP) in Mongolia. They produce the majority of electricity and heat energy.
		Heating stations for space heating and domestic hot water	Coal fired heating stations are used in province centers.

Brief descriptions of the selected climate technologies is shown in the following.

Hydropower generation in Mongolia

About 90 percent of the electrical power generated in Mongolia is produced by coal CHP in Mongolia.

There are currently 13 hydro plants in operation, with capacities ranging from 150 kW to 12.0 MW in Mongolia. Most of the power plants do not operate in winter season because of extreme cold climate condition.

References for a typical small hydro power plant were sought from the CDM documentation of Taishir 11 MW and Durgun 12 MW plants, which were built in 2011 and2008 respectively.

The deployment of the future target of hydropower generation technology:

It is planned to build large scale hydropower plants in Orkhon or Selenge rivers. Large hydropower plants have been proposed for Mongolia in several previous power sector studies. Particular proposals have been put forward for Shuren 330 MW, Egiin 220 MW and Orkhon 100 MW Power Plants.Studies and reports have indicated the capital costs ranging from 1,300 US$/kW to 1,600 US$/kW, and load factors of 40%, 25% and 25% for Sheuren, Egiin and Orkhon respectively. There are several ways to optimize the available water flow of a hydro system. For example it has been suggested to have a small unit running as a base load plant in parallel with the large turbine unit which would be dimensioned to capture the seasonal high water flows, albeit with low load factor. A pumped storage scheme of about 100 MW has also been proposed.

Wind power generation technology in Mongolia

The Wind Atlas of Mongolia shows that the country has huge potential for wind power generation. The resource potential is around 10% of the total land area and is classified as excellent for utility scale applications (power density of 400-600 W/m^2) and could potentially supply over 1,100 GW of installed capacity. All the aimags[19] have at least 6,000

18. The soumis a second level administrative subdivision of Mongolia. The 21 aimags of Mongolia are divided into 329 sums.
19. The aimag is a first level administrative subdivision of Mongolia. Mongolia is divided into 21 aimags

MW of wind potential each. There are 13 aimags with at least 20,000 MW of wind potential and 8 aimags with more than 50,000 MW of wind potential.

The deployment of future target of wind power generation technology:

With a combination of various factors such as a policy and regulatory framework that provides private sector investment incentives (feed-in tariff) and access to electricity markets, high wind energy resource potential, high electricity demand growth, and projected short to long-term capacity shortage, various large-scale wind power projects were proposed and are being developed by the private sector in the country. Most of these projects aim to cater the electricity market of the Central Energy System and South Gobi.

Coal fired power plant's technology in Mongolia

The major coal based technologies that are available today at various stages of development include (i) conventional pulverized coal combustion (PC), (ii) circulating fluidized bed combustion (CFB), (iii) supercritical (SC) and ultra-supercritical (USC) PC combustion, and (iv) integrated gasification combined cycle (IGCC). The IGCC technology, whilst already demonstrated in several plants, is not yet fully commercial.

The conventional pulverized coal combustion technology is used in Combined Heat and power plants in Mongolia.

The deployment of future target of coal fired power generation technology:

SC and USC plants are already commercially available, cost effective, and worldwide operational experience of USC and SC plants is rapidly accumulating. The steam parameters of typical sub-critical power plants are 150 to 180 bar pressure and 540 to 565 ѳC temperature; SC plants operate at around 245 bar pressure and 540 to 570 ѳC temperatures, and USC plants have temperatures of around 600 ѳC or higher. Supercritical pressure is reached at 221 bar, above which level water/steam reaches a state where there is no distinction between liquid and gaseous state. Consequently the boiler does not need to separate steam from water and the substance is heated in a once-through process. The design efficiencies of USC plants are between 39% and 46%. This stands in an apparent contrast with the typical efficiencies of 30% to 37% of the conventional PC and CFBC technologies. Therefore SC and USC technology will be implemented in future in Mongolia.

1.1.2 General barriers and proposed measures

General barriers for energy industry subsector

Barriers faced by different prioritized technologies in the energy industry sub-sector appear to be quite common, but priorities of barriers are different in many cases.

The common economic and financial barriers are inappropriate financial incentives, high cost of capital, high transaction cost; lack or inadequate access to financial resources, and uncertain macro-economic environment.

Common barriers regarding the policy, legal and regulatory aspects are lack of long-term political commitment and uncertain government policies (political risks for investors), lack of government control for implementation of laws and regulations, and government or utility monopoly of energy sector. Common barriers regarding the market and network aspects are underdeveloped competition, insufficient coordination between relevant ministries and other stakeholders.

The priorities of barriers are different in many cases in selected specific technologies.

Regarding the large scale HPP technology, policy-related barriers have first priorities.

The stakeholders participated in the barrier analysis gave the highest score of 4.75 (from a maximum of 5) to the barriers "Lack of long-term political commitment" followed by barriers "Officials make decisions on their own will", "Uncertain government policies (political risks for investors)", and "Insufficient willingness or ability to enforce laws and regulations."

Decision makers and experts in the energy sector understand the need for developing large scale hydro power plants in the current energy system of Mongolia. However, these kinds of projects are not moving forward and materialized due to political reasons and special interests. The plans on building large scale hydro power plants are reflected in every policy documents of the energy sector. The decision on the required investment had been made and projects had been discussed few times during the Parliament and Cabinet meetings. Even so, it still hasn't moved forward due to political reasons. For HPPs, politics is the main barrier.

Regarding the wind park, barriers of the highest priority are system constraints (capacity limits of the grid system).

Wind parks adversely affect the energy system stability as their operations and electricity supply depends on irregular wind availability. Especially for a country like Mongolia whose energy system consists of coal fired combined heat and power plants, connecting many high capacity wind power plants will destabilize the system.

The main difficulty hindering the implementation of large hydro power plant projects is the low electricity tariff. Although in the Renewable Energy Law, it is mentioned that the feed-in tariff to be provided for electricity supplied by renewable energy resources, the preferential feed-in tariff is not applicable to the electricity generated by HPPs with capacity of more than 5MW. The low tariff hinders investment in hydro power plant project because the tariff could not cover the costs or the profit margin is too low to attract investment. On the other hand, there are many companies who are interested in developing wind parks because the Renewable Energy Law has explicitly stated the feed-in tariff to be provided for electricity supplied by wind. As of 2012, there are 5 companies who had obtained special licenses to construct wind parks and the planned installed capacity of all these wind parks are 500 MW.

Proposed measures for the energy industry subsector

In order to encourage the development of climate technology in the energy industry subsector, the government should implement the Concession Law which was adopted by the Parliament in 2010. The law allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession. The climate mitigation technologies such as large scale hydropower plant, Wind Park and efficient coal fired power plant projects should be included in this list of concessions, which has been approved by the Mongolian Government. The government could give the necessary guarantees to attract foreign investors.

Another way to get financial sources for investment in climate technologies is to use the Development Bank of Mongolia. According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament, and the list of projects and programs to be financed shall be approved by the Parliament on an annual basis. The Development Bank may finance those projects and programs for which the government has issued guarantees.

The prioritized mitigation technologies are, and almost all of the components, need to be imported from abroad. The Government should issue regulations to exempt the import duty on machinery, and goods for climate technologies.

The government should introduce environment tax for conventional energy (coal fired power plants). The environment tax for conventional energy should be included in law on fees for air pollution.

The Energy Regulatory Committee (ERC) should increase energy tariffs to allow the licensed energy companies to recovertheir costs and make at least an average level of profit. By setting tariffs, the ERC should ensure the financial viability and sustainable operation of the licensees, while balancing their interests with those of the consumers.

Tariff levels are very sensitive issue in Mongolia and are subject to intense political pressure, making it difficult to propose and implement changes. However, the tariff levels should reach a level of cost recovery. After the tariffs reach cost recovery levels, the cross-subsidies currently existing between industry and residential tariffs should be removed.

The government should continue the planned efforts in energy pricing reform (eventual cost covering level of price and removal of cross subsidies).

The government should have long-term political commitment especially regarding the implementation of large scale hydropower plant projects.

The government should improve the enforcement and implementation of laws and regulations.

The government should insure sufficient coordination between relevant ministries and other stakeholders. The government should take actions of responsibility when no measures are taken to implement the laws and regulations.

The development plan and programs of the energy sectors shall be designed in consistent with environmental and green development principles. The government should establish an energy research institute under the Ministry of Energy.

Cooperation between the Ministry of Energy and otherrelevant Governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should alsobe improved

1.2 The Action Plan for Large Scale Hydropower Plant

1.2.1 Description of the technology

Hydropower plants capture the energy released by water falling through a turbine and convert this into mechanical power, which drives generators to produce electricity. About 20% of globally supplied electricity is generated by hydropower and in some countries it provides more than 50% of electricity supply.

Hydropower can achieve significant GHG emission reductions as it, depending on the energy mix of the country concerned, could replace fossil based technologies for electricity production

Hydropower is a fully commercial, and well-established mature technology, although there is scope for further improvement in efficiency and costs and, in particular, for developing more cost-effective technologies for small-capacity and low-head applications. Hydropower can provide a very flexible source of renewable energy, capable of delivering base load power, meeting peak demand, or being used as a storage system. Hydro's quick-start capability helps to cope with fluctuations in supply or demand. Production can be put at risk, however, when drought limits the supply of water within a catchment area, and annual hydro production in many markets varies seasonally and from year to year, depending on rainfall levels.

The three main types of hydro schemes are storage, run-of-river and pumped storage. In storage schemes, a dam impounds water in a reservoir that feeds the turbine and generator. Run-of-river schemes use the natural flow of a river and may employ a weir to enhance flow continuity. Either of these types can involve diversion, where water is channelled from a lake, river or reservoir to a remote powerhouse containing the turbine and generator. Pumped storage schemes involve two reservoirs. At times of low demand and usually low electricity prices (often at night); electricity is used to pump water from the lower to an upper basin. Then the ward stored in the upper basin is used for electricity generation in times of high electricity prices or electricity shortage.

GHG emissions are expected to be reduced by 1.458.000 tCO_2eq/year from the construction of 300 MW Hydropower plant in Mongolia.

Large scale Hydropower plants will give following economic, environmental, and social benefits:

- Improved operational conditions of the Central Energy system;
- Reduced electricity imports;
- Improved energy regime of the Central Grid during peak load;
- Introduction of the technology has the potential to reduce coal consumption;
- Reduced air pollution: the technology does not emit any local air pollutants, such as NO_X, CO or particulate matter, thereby helping to improve air quality.

1.2.2 Target for technology transfer and diffusion

The National renewable energy program approved by parliament in 2005 indicates: "Gradually implement goal of increasing the share of renewable energy in the total energy production and reaching 3-5 percent in the national energy by the year 2010, 20-25 percent share by 2020". But the target for 2010 has not been achieved. As of 2011, the share of renewable energy in total electricity production is 1.11%. In the future, the electricity generation will increase gradually and reach 7800 million kWh in 2020. In order to reach the 20% target, the electricity generation from renewable energy sources should reach 1950 million kWh (Table61).

Table 61: National overall target for the share of electricity production from renewable sources in 2010 and 2020 according to the National Renewable energy program

No.	Target for Renewable Sources		Share in total Electricity Production
1	Target of electricity from renewable sources in total electricity production in 2010		3-5 %
2	Share of electricity production from renewable sources in total electricity production in 2011.		1.11%
	From this	Hydro	*1.1%*
		Wind and Solar	*0.01%*
3	Target of electricity from renewable sources in total electricity production in 2020		25%
4	Expected total electricitydemand in 2020 (GWh)		7800.0
5	Expected amount of electricity from renewable sources corresponding to 2020 target (GWh)		1950.0

According to the government policy, the Shuren Hydropower Plant (300 MW), the Egiin Hydropower Plant (220 MW) and the Orkhon Hydropower Plant (100 MW) will be constructed before 2020. The electricity supply from hydropower plant will be 1372 GWh, which will be 17.5% of total expected electricity demand in the table above.

The target for technology transfer and diffusion of large scale hydropower plants is to construct large scale hydropower plants with total capacity 620 MW in 2020, in order to implement the National Renewable Energy Program by annually generating 1372 GWh of electricity from large scale hydropower plants.

A short summary of hydropower projects that are under consideration is shown in Table 62.

Table 62: Short summary of hydropower projects that are under consideration

Project name	Project situation	Installed capacity, MW	Annual electricity generation, GWh	Estimated capital cost, million USD	Capital cost per MW USD/kW
Up to 2020					
Egiin Hydropower Plant	The Feasibility Study of the project was carried out in 1992 and final design and tender documents have been prepared.	220.0	412.0	313.6	1425.5
Shuren Hydropower Plant	The pre-feasibility study has been carried out by the Energy Authority in 2011	300.0	800.0	450.0	1500.0
Orkhon Hydropower Plant	The Feasibility study of the Orkhon hydropower project has been carried out by prepared by the Japanese Chubu Electric Power Inc. and the Japanese External Trade Organization (JETRO), Japan.	100.0	160.0	219.0	2190.0
Up to 2030					
Chargait Hydropower Plant	The feasibility study of the Chargait Hydropower Project in Mongolia was carried out with support from the European Commission under the Framework Contract AMS/451 - Lot 4 by ESB International Dublin in joint venture with Fechner, Stuttgart in 2004-2005.	15.0	68.0	57.5	3833.0
Erdeneburen Hydropower Plant	The feasibility study of the Erdeneburen Hydropower project has been prepared by the MCS International, Kyushu Electric Power Co., West Japan Engineering Consultants, Inc. Industrial Decisions, Inc. in 2007-2008	64.2	242.7	286.0	4454.8

1.2.3 Barriers to the technology's diffusion

Short description of the identified barriers and overall enabling framework for meeting the specified targets for large scale HPP projects is shown in Table 63.

Table 63: Barriers to the technology's diffusion

Key barriers identified		Enabling measures
Category	**Barriers**	
Economic and financial	Inappropriate financial incentives	- Introduce feed-in tariff for medium and large scale HPPs; - Reduce subsidy for conventional energy; - Finance from Development Bank
	High cost of capital	Introduce public-private partnership for implementation of the hydropower plant projects. The Concession Law allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession. The large-scale hydropower plant project should be included in this list of concessions which is approved by the Mongolia Government. The Government should check out the possibility to fund the project through Development Bank. The Government should issue regulation exempt the import duty on machinery, and goods and materials for large hydropower plants.
	High transaction cost	The government should build capacity for hydro power development projects by establishing an energy research institution under the Ministry of Energy. There is need to train skilled local experts who could develop project development study, including Feasibility Studies.
	Lack of adequate access to financial resources	The government needs to levy environmental pollution fees and to reduce or stop subsidies for conventional energy, in order to encourage renewable energy sources especially large-scale hydropower plants. The government needs to increase the low tariff for electricity consumption. The Government should develop capital market in Mongolia to raise capital for large scale projects such as hydropower plants.
Policy, legal and regulatory	Policy intermittency and uncertainty	The government needs to have long term political commitment. Need clear government policies with no political risks for investors. The government should formulate a new National Renewable Energy Program.
	Ineffective enforcement	The government should enhance the enforcement and implementation of laws, national programs and regulations. The government should establish a renewable energy fund according to the Renewable Energy Law which was adopted in 2007. The government should have strong control and commitments to clarify reasons of ineffective enforcement and implementation and take actions to address this.
	Highly controlled energy sector Measure	In order to improve market competition and remove utility monopoly in the energy sector, the government should continue to support the liberalization of the energy market, at the same time as ensuring private energy investment.

Market	Underdeveloped competition	The Government should continue to support the liberalisation of the energy market, at the same time improving conditions for private investment in the energy sector
Network	Incumbent networks are favored by legislation	The main assignment for the high level decision makers should be to organizeaknowledge base by compiling information regarding large-scale hydropower plant projects, including lessons learned. Thiscan assist the government in developing a strategy and prioritising of hydropower plant projects
	Weak connectivity between actors favoring the new technology	The high level decision maker should clearly define the responsibilities and roles for different ministries and other stakeholders regarding selection and implementation of large-scale hydropower plant projects. Cooperation between the Ministry for Energy and other relevant governmental institutions should be enhanced. Cooperation with other actors such as NGOs, donor organisations, and private actors shouldbe improved. Introducing suitable knowledge, skills and management would influence the government's involvement while benefiting society with efficient, environmentally technologies such as large-scale hydropower plants.

1.2.4 Proposed action plans for Large scale HPP

Proposed action plans for large scale HPP are provided in Table 64.

Table 64: Proposed action plans for large scale HPP

Measures	Actions	Why the actions need	Responsible organization	Time frame	Expected budget, 1000USD	How can be fund
Economic and financial measures						
Introduce feed-in tariff for medium and large scale HPPs	Amend the Renewable Energy Law: add in Chapter 4 Article11 (Renewable energy tariffs and prices) feed-in tariffs for medium and large scale HPPs	The RE law includes feed-in tariff for HPP with up to 5000 kW only.	Ministry of energy, Government, Parliament	1 year	No need	-
Reduce subsidy for conventional energy	Increase the tariffs of electricity and heating every year and reach its cost	In 2011, 13 companies received 2.2 million USD subsidies from the state budget and 1.6 millions USD of them went to rural plants and companies.	Energy Regulatory Committee	1-3 years	No need	-
Introduction of PPP model for implementation of HPP projects	In accordance with the law on concessions, implement the biggest HPP project, using public and private partnership (PPP) mechanism of the sector (e.g. Egiin HPP)	Although since 1992, research works have been done in order to implement a project of large-scale HPP and projects have been developed,so far none has been implemented.	Government, Ministry of Energy	(5-10) years	313600 (Egiin HPP)	Private investment
To get financial source for investment of large HPPs from the Development Bank of Mongolia.	To be approved by the Parliament the construction of large scale HPP and include in list of projects to be financed by Development Bank of Mongolia	According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament	Government, Ministry of energy	(5-10) years	450000 (Shuren HPP) 219000 (Orkhon HPP)	Development Bank of Mongolia

Exemption of import duty of machinery, and goods and materials for HPPs.	To enact a policy on exemption of import duty of machinery, and goods and materials for HPPs.	In order to decrease the initial investment of large-scale HPP, import tax exemption or softening should be applied	Government, Ministry of Energy	(5-10) years	No need	-
Establish energy research institute under the Ministry of Energy	To do research work on energy sector development					
Prepare skilled local experts who could develop project development study including Feasibility Studies	Strengthen national capacities ensuring available specialists trained from national and foreign universities and train highly qualified technicians and engineers in developed countries	Due to the lack of specialists who will implement a project of large-scale HPP project, the national specialists should be educated and trained in developed countries	The Government, Ministry of Education, culture and sports, Ministry of Energy	5-10 years	20000	State budget
Need to have environmental fees and to reduce or stop subsidies for conventional energy	Take measures to enforce law on imposing penalty for polluting air for power plants that use solid fuel	Although the environmentand soil are heavily polluted by power plants, Heat Only Boilers (HOB) no penalty is levied on the polluters. Even though there is a law on penalty for air pollution, the enforcement of this law is not satisfactory.	The Government, Ministry of Environment and Green Development	1-2 years	-	-

To increase the low tariff for electricity paid by consumers and industries. Develop capital market in Mongolia to raise capital for large scale projects such as HPP	Gradually increase the tariffs of electricity and heating every year, to enable the suppliers cover their costs	Low electricity tariff is a main obstacle against implementing a project of large-scale HPP	Energy Regulatory Committee	1-3 years	No need	
Policy, legal and regulatory						
Long term political commitment.	Design and adopt long-term policy documents to guide energy sector development up to 2030	There are two major documents: central energy system and national program of renewable energy. However these two have very weak consistency and no strong background for the development. Based on Updating Master Plan of energy sector, ADB-funded project, these documents shall be designed and adopted by the Parliament and the Government.	Ministry of Energy is in charge with relevant ministries and agencies.	1 year	100.0	State budget

Clear government policies with no political risks for investors.	During the election period, issue a decree of the Parliament to develop the Government manifesto by synchronizing it with long-term objectives of developing the energy sector until 2030	The Government is obliged to implement long-term policies that were adopted by the Government and the Parliament. Any large-scale HPP project has not been implemented for last 20 years. Egiin River HPP, which has been the sensation ever since 1993, has not been constructed. This implies that there is no long-term, consolidated policy on hand and reveals negative impacts of not implementing the policy written on the paper.	The Government and Ministry of Energy	1 year	No need	-
Newly formulate National renewable energy program.	The national program of renewable energy should be rephrased and make it the inseparable part of the policy of developing the energy sector until 2030	Need to renew the national program of renewable energy 8 years have elapsed since the document was approved. Moreover,it should be coherent with long-term policy of energy sector	The Government and Ministry of Energy	1-2 year	10	State budget

Establish a renewable energy fund according to the Renewable energy law which was adopted in 2007	Establish the foundation of renewable energy	It is stated in the Law on Renewable Energy, which was approved by January 2007, the Law on Special Foundation of the Government shall regulate the establishment of the renewable energyfoundation and its expenditure, and performance reporting. The Law on special foundation of the Government includes regulation of legal framework of establishing renewable energy foundation. However, the Ministry of Energy, who is in charge of this matter, is not performing.	Ministry of Energy	1 year	10	State budget
Strong control and commitments to clarify reasons of non-performance and enforce the implementationof laws and programs.	It should be applied that every year, the result of programs to be implemented in the energy sector should be made available to the public, and accountability mechanism should be applied if the planned works are not completed.	The public understands that there is no penalty for public servants who is irresponsible and don't implement law, regulations, programs and plans of the energy sector.	The Government and Ministry of Energy	1 year	100	State budget

Support the liberalization of the energy market and private energy investment.	Implement policy to support private sector investment in energy sector	There is good practice for implementation of 50 MW WP by private sector investment	Ministry of Energy	1 year		
Network						
High level decision makers should be to organizeaknowledge base	Establish and operate a professional but informal council that will solicit high-profile decision makers about policy and strategy to implement large-scale HPP project	High-profile decision makers in the energy sector are elected politically. Thus, most of them are unfamiliar with energy sector. Therefore, having a council that helps those decision makers is crucial.	Ministry of Energy	1 year	10.0	State budget
Clearly definethe responsibilities and roles for different ministries and other stakeholdersregarding selection and implementation of large-scale HPP projects.	The Government should issue a decree to define the duties and responsibilities of stakeholders that implements large-scale HPP project	In order to implement a large-scale HPP project, many stakeholders such as many professional ministries, agencies, private companies, NGOs and international organizations should take part in.	The Government and Ministry of Energy	1-2 year	-	-

1.3 Action Plan for Wind Park

1.3.1 Description of the technology

Wind power is a proven and mature renewable energy technology that is being deployed globally on a mass scale. Wind turbines extract kinetic energy from moving air flow (wind) and convert it into electricity via an aerodynamic rotor, which is connected by a transmission system to an electric generator. Today's standard turbine has three blades rotating on a horizontal axis, upwind of the tower, with a synchronous or asynchronous generator connected to the grid. Two-blade and direct-drive (without a gearbox) turbines are also available.

The electricity output of a turbine is roughly proportional to the rotor area; therefore, fewer, larger rotors (on taller towers) can use the wind resource more efficiently than more numerous, smaller turbines. The largest wind turbines today are 5-6 MW units, with a rotor diameter of up to 126 metres. Typical commercial wind turbines have a capacity between 1.5 MW and 3 MW.

Turbines have doubled in size approximately every five years, but a slowdown in this rate is likely for onshore turbines, due to transport, weight and installation constraints.

Wind power is among the most cost-competitive renewable energy sources in areas where the wind resource is good.

The Construction of Wins Parks in Mongolia will give following economic, environmental, and social benefits:

- The electricity supply of Mongolia will improve;
- Coal consumption will be reduced;
- Air pollution will be reduced

1.3.2 Target for technology transfer and diffusion

In order to implement the target of the National Renewable Energy Program, the Energy Regulatory Committee has given licenses to 5 private companies for constructing wind parks with total capacity 354.4 MW (Table 65). The expected annual electricity generation of these wind parks will be 708 million kWh. The share of electricity generation from wind will reach 9.1 % if these projects are successfully implemented.

The preliminary target for technology transfer and diffusion of Wind Park is to construct wind parks with total capacity 354.4 MW in 2020 in order to implement renewable energy national action program by generating electricity 708 million kWh annually from wind parks.

Table 65: Wind Park projects to be implemented up to 2020

Company name	WP Capacity, MW	WP Location (aimag and soum)	Permission from energy ministry (Date and number)	License from Energy Regulatory Committee (Date and term)	Remark
"Glean Energy"	50	Tuv, Sergelen	2007-03-02, a/304	2007-03-27, 5 years 2012, 1 year	To be connect to central grid
"Glean tech"	250	Umnugovi, khanbogd	2008-10-13, a/82	2008-12-18, 5 years	102 MW to be connected to central grid, 148 Mw to export to China
"Sainshand wind park"	52	Dornogovi, Sainshand	2010-11-01, a/3418	2011-03-19, 5 years	To be connect to central grid
"AB solar and wind"	100	Dornogovi, Dalanjargalan	2008-10-13, a/81	2011-11-22, 5 years	To be connect to central grid
"Idiner global"	50.4	Govisumber, Sumber	2011-11-18 a/4059	2011-12-13, 5 years	To be connect to central grid

1.3.3 Barriers to the technology's diffusion

Table 66: Barriers to the technology's diffusion

Key barriers identified		Enabling measures
Category	**Barriers**	
Economic and financial	High Capital cost	More financial mechanisms other than foreign direct investment shall be made available to finance the upfront investment cost for wind parks such as public-private partnership (PPP), direct investment by government or financing through the national development bank.
	Inappropriate financial incentives	One way to solve these issues is through a PPP. The concession law allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession. Wind park projects should be included in this list of concessions. Another way to rise funding for investment in wind part project is to use funding fromDevelopment Bank of Mongolia. According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament. Financial support may be provided from the state budget to implement those projects and programs guaranteed by the Government. It is important to increase electricity tariffs and take measures to implement renewable energy technology. The Government should continue the planned efforts in energy pricing reform. The tariff should cover the level of electricity generation costsand the cross subsidies should be removed. The Government should continue to support the liberalisation of the energymarket, at the same time encourage private investment in the energy sector.Also it is important to exempt the taxeson climate technologies.
	High transaction cost	The government should build capacity for wind park development projects by establishing an energy research institution under the Ministry of Energy. There is a need for training skilled local experts who could develop project study including Feasibility Studies. Government should issue regulation on the exemption of import duty of machinery, and goods and materials for wind parks.
	Lack of inadequate access to financial resources	One way to solve these issues is through a PPP. The concession law allows the State Property Committee to implement projects that are listed within the articles of the State Property Concession. Wind park projects should be included in this list of concessions
Technical	System constrain	Wind parks adversely affect the energy system stability as they only operate when there is wind and wind availably is irregular. Especially for countries like Mongolia where the energy system consists of a small number of coal-fired power plants with low total installed capacity, connecting many high capacity wind parks will destabilize the system. In order to reduce or overcome these technical difficulties, Mongolia needs to improve the energy generation mix. The government needs to increase the share of manageable or flexible sources for generation in the energy system. Especially if large hydropower plants are added to the current energy system, the system stability will increase, which will make it technically feasible for more wind parks to be connected to the system.

Network	Weak connectivity between actors favoring the new technology	The main assignment for the high level decision makers are to organizeaknowledge base by compiling information regarding renewable energy projects, including lessons learned. This could assist the Government in developing a strategy and prioritising of Wind Park projects.
	Lack of involvement of stakeholders in decision-making	Another assignment of the high level decision makers is to clearly define the responsibilities and roles of different ministries and other stakeholders regarding the selection and implementation of renewable energy projects. Cooperation between the Ministry for Energy and other relevant Governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should alsobe improved.
Policy, legal and regulatory	Policy intermittency and uncertainty	In order to encourage the development of wind parks in Mongolia, the government needs to have long term political commitment. It is important to have clear government policies to reduce political risks for investors. The government needs to more effectively control the enforcement and implementation of laws and regulations.
	Highly controlled energy sector Measure:	In order to develop market competition and remove utility monopoly in the energy sector, the government should continue to support the liberalization of the energy market, at the same time supporting private investment in the energy sector
	Lack of professional institutions	The government should establish an energy research institute under the Ministry of Energy for research and development activities to support the policy makers for making long-term sustainable energy development policies

1.3.4 Proposed action plans for wind park technology

Table 67: Proposed action plans for wind park technology

Measures	*Actions*	*Why the actions need*	*Responsible organization*	*Time frame*	*Expected budget, 1000USD*	*How can be fund*
Economic and financial measures						
To get financial source for investment of WPs from Development Bank of Mongolia.	To approve by the Parliament the construction of WP and include in list of projects to be financed by Development Bank of Mongolia	According to the Development Bank Law, the Development Bank shall provide loans to finance large scale development projects and programs approved by the Parliament	The government and the Ministry of Energy	(5-10) years	450000 (Sainshand WP) 219000 (Choir WP)	Development Bank of Mongolia
Introduction of PPP model for implementation of HPP projects	In accordance with the Law on Concessions, implement the biggest HPP project, using public and private partnership (PPP)	Wind park projects require big initial investment	The government and the Ministry of Energy	(5-10) years	313600 (Egiin HPP)	Private investment
Exemption of import duty of machinery, and goods and materials for wind parks.	To make law on exemption of import duty of machinery, and goods and materials for WPs.	In order to decrease the initial investment of wind parks, import tax exemption or softening should be applied	The government and the Ministry of Energy	(5-10) years	No need	-
Prepare skilled local experts who could develop project development study including Feasibility Studies	Strengthen national capacities ensuring available specialists trained from national and foreign universities and train highly qualified technicians and engineers in developed countries	Due to the lack of specialists who will implement a project of wind parkproject, the national specialists should be educated and trained in developed countries	The Government, theMinistry of Education, Culture and Sports, and the Ministry of Energy	5-10 years	20000	State budget
Policy, legal and regulatory						
Long term political commitment.	Design and adopt long-term policy documents of energy sector development up to 2030	There are two major documents: the Central Energy System and National Program of Renewable Energy. However these two documents have very weak consistency and offer no strong background for the development. Based on UpdatedMaster Plan for the Energy Sector, an ADB-funded project, these documents shall be designed and adopted by the Parliament and the Government.	The Ministry of Energy is in charge with relevant ministries and agencies.	1 year	100.0	State budget

Clear government policies with no political risks for investors.	During the election period, The Parliament should issue a decree to develop the Government manifesto by synchronizing it with long-term objectives of developing the energy sector until 2030	The Government is obliged to implement long-term policies that were adopted by the Government and the Parliament.	The Government and the Ministry of Energy	1 year	No need	-
Establish renewable energy fund according to the Renewable energy law which was adopted in 2007	Establish the foundation of renewable energy	It is stated in the Law on Renewable Energy, which was approved by January 2007, the Law on special foundation of the Government shall regulate the establishment of the renewable energyfoundation and its expenditure, and performance reporting. The Law on special foundation of the Government includes regulation of legal framework of establishing renewable energy foundation. However, the Ministry of Energy, who is in charge of this matter, is not performing.	The Ministry of Energy	1 year	10	State budget
Support the liberalization of the energy market and private energy investment.	Implement policy to support private sector investment in energy sector	There is good practice for implementation of 50 MW WP by private sector investment	The Ministry of Energy	1 year		
Networkw						
Clearly definethe responsibilities and roles for different ministries and other stakeholdersregarding selection and implementation of large-scale HPP projects.	It should be applied that issuing the Government decree that distinguishes duties and responsibilities of stakeholders that implements large-scale HPP project	In order to implement a large-scale HPP project, many stakeholders such as many professional ministries, agencies, private companies, NGOs and international organizations should be involved	The Government and the Ministry of Energy	1-2 year	-	-

1.4 Action Plan for Pulverized coal combustion technologies (Super–critical)

1.4.1 Description of the technology

Pulverized coal power plants account for around 97% of the world's coal-fired electricity generation capacity. The conventional types of this technology have an efficiency of around 35%. For a higher efficiency supercritical and ultra-supercritical coal-fired technologies have been developed. These technologies can combust pulverized coal and produce steam at higher temperatures and under a higher pressure, so that an efficiency level of 45% can be achieved (ultra-supercritical plants). Supercritical and ultra-supercritical plants are more expensive because of the higher requirements to the steel forwithstanding the higher pressure and temperature, but the higher efficiency results in cost savings during the technical lifetime of the plants.

The emissions of CO_2 per MWh delivered to the grid could be reduced from 830 kg to 730 kg. Pulverized coal power plants can have a size of up to 1000 MW and are commercially available worldwide.The capital costs assumed range from 800 US$/kW to 1350 US$/kW from the largest 1000 MW USC plant to the smallest to unit of 150 MW CFBC plant. The plant's own use of electricity has been estimated to range from 6% to 9% and the plant efficiencies is in the range from 45% to 34%, respectively from largest unit to the smallest.

In coming years several Thermal Electric Power Stations will be built with significant capacity near coal mines in Mongolia. For all the Coal fired power plants to be constructed in Mongolia should be implemented supercritical (SC) and ultra-super critical USC) technologies.

An efficiency improvement from 30 to 45% would bring about a 33% decrease in CO_2 emissions. As two-thirds of all coal-fired plants are over 20 years old with an average efficiency rate below 30%, replacing this capacity with supercritical and ultra-supercritical plants could contribute significantly to global GHG emission reductions

Supercritical power plants are highly efficient plants with the best available pollution control technology; they reduce pollution levels by burning less coal per megawatt-hour produced and capturing the vast majority of the pollutants. Introduction of the Pulverized coal power plants has the potential to reduce fuel consumption of existing thermal power plants by 25-30 %.

Because of the above techno-economic benefits, along with its environmentally-friendly cleaner technology, more and new power plants are being developed with this state-of-the-art technology. As environmental legislation is becoming more stringent, adopting this cleaner technology has led to benefits in all respect. As LHV (lower heating value) is improved (from 40% to more than 45%); a one percent increase in efficiency reduces specific emissions such as CO_2, NO_X, SO_X and particulate matter by two percent.

1.4.2 Target for technology transfer and diffusion

Coal is the primary energy source in Mongolia. The share of coal and coal products in total primary energy supply is about 70%. Coal is expected to remain the most important primary energy source in the foreseeable future because of the large coal reserves in Mongolia and the much smaller reserves of oil and gas. Mongolia's total geological coal reserves are estimated at approximately 150 billion metric tons, including about 24 billion metric tons explored. Over 70 percent of the total domestic coal consumption happens at thermal power stations with the remainder taking place at heating plants, industry, households and the service sector.

The energy consumption of Mongolia will continue to increase rapidly due to population growth and economic development. In particular, energy consumption in the industrial sector has beenincreasing rapidly due to the development of the mining and quarrying industry.

In order to meet this growing energy demand, new energy sources are needed. Currently, a 600MW Combined Heat and Power Plant (CHP) in Ulaanbaatar is planned to be constructed in the coming years. In the long term, the construction of more coal-fired thermal power plants under consideration. The future coal fired thermal power plants should be modern, energy efficient and environment friendly, such as pulverized coal thermal supercritical (or ultra-critical) power plants. These technologies can combust pulverized coal and produce steam at higher temperatures and under higher pressure, so that the efficiency is much higher than traditional coal-fired thermal power plants and the environmental pollution is much less.

The target for technology transfer and diffusion of super critical and ultra-super critical thermal power plants is to construct thermal power plants with a totalcapacity of 1200 MW in 2020 and 3200 MWin 2030 in order to meet thegrowing energy demand, which is expected to reach 7800 million kWh annually in 2020 and 13200 million kWh annually in 2030.

1.4.3 Barriers to the technology's diffusion

Table 68: Barriers to the technology's diffusion

Key barriers identified		**Enabling measures**
Category	Barriers	
Economic and financial	The country does not have sufficient financial resources for the construction of power objects of high power	The country's export has increased with intensive development of the mining sector in the last few years. At the same time, the political parties distribute cash to the population so they can fulfill election campaign promises. The cash distribution shall be stopped and instead a fund support development of the country shall be established to pool and more effectively use the fund.
	High cost of capital	In near future, over USD 1.8 billion will be required to construct large-scale, high-efficiency TPPs. In order to raise the capital, attracting foreign investment or applying for international soft loans are essential for implementing the TPP projects
	High transaction cost	The Ministry of Energy is a policy-making authority; howeverinvolvement of some specialists of the Ministry in project activities implemented by Implementing Authorities tends to increase barriers.This shall be limited and discouraged. To build a team of national experts and professionals able to study national demand, review and select technologies appropriate for country's characteristics, and to design project and provide recommendations. Introduce practice that supports active involvement of national expert team in design of large-scale projects, and applies responsibility mechanisms
	Inappropriate financial incentives	The Government of Mongolia shall include improving fuel efficiency of energy production as a major activity of the Ministry of Energy, and shall focus on building a performance-based evaluation system. In this way, the interests to produce energy from less possible fuel will increase country-wide.
Policy, legal and regulatory	Policy intermittency and uncertainty	Intensify the Energy Ministry's activities to introduce new advanced technology, and increase energy efficiency; and improve overall implementation. A practice to follow and enforce action plans stated in the government's action plan and an accountability mechanism, furthermore, shall be established.

Market	Poor market infrastructure	To build mechanism that supports activities and initiatives to increase production efficiency of the state-owned TPPs. Privatization is the solution of the problem. There are many successful experiences to operate state-owned TPPs in other countries. There shall be systems distinguishing the roles and responsibilities between sartorial organizations. Scientific approaches shall be applied for the selections of project technologies, so that there will be less hesitations and suspicions related projects and technologies
Network	Incumbent networks are favored by legislation	To support employment of edge-cutting, and experienced engineers and scientists at the Ministry of Energy. To prioritize improvement of their professional skills and sustainable employment with staff development programs and benefits and at the same time to increase responsibility mechanisms at higher levels
	Weak connectivity between actors favoring the new technology	It has been years since the adoption of the Law on Investment of Mongolia. Some articles of the law are inadequately enforced and shall be revised and amended. At project design level, the following shall be considered as a mandatory. • Public opinions, local community requests shall be solicited and taken into account; • Recommendations and requests of scientists and researchers of project-implementing sectors, especially involvement of relevant scientific and research institutes shall be reflected in. Establish a working group of national scientists and experts to conduct technical research on the energy sector, specifically on the thermal power plant technology and its efficiency. Regular discussions and meetings shall be organized for information exchange as well. Currently, a team of foreign expert teams are conducting technical baseline survey of a larger research project on the energy sector – these results often fails to cover the unique conditions of Mongolia.
Institutional and organizational capacity	Lack of professional institutions	A system that carries out regular research on determining solutions for the energy sector barriers, and development tendencies shall be introduced using existing capacity of scientists' team of the Mongolian University of Science and Technology (MUST). Final results of the new energy projects highly depend on implementing personnel; preparation of engineer and technical staff shall take place based on MUST capacity.

1.4.4 Proposed action plans for super-critical pulverized coal combustion technologies

Table 69: Proposed action plans for Pulverized coal combustion technologies (Super-critical)

Measures	***Actions***	***Why need to take these actions?***	***Responsible organization***	***Time frame***	***Expected budget, 1000USD***	***How can be fund***
		Policy, legal and regulatory				
Long term political commitment.	Development and approval of a long-term programfor the development ofenergy sectorof Mongolia	In the near future, electricity demands will continue to increase.To enable TTP to meet 85 percent of the demand for electricity, it is necessary to build large scale TTP near local deposits. This should be included in the program	Ministry of Environment andGreen Development; Ministry of Energy; Ministry of EconomicDevelopment	1 year	150.0	State budget
	Follow instructionson enhancing TPP in the National Climate Change Program	Currently, a master plan for energy sector development of Mongolia is the major policy document. Some revisions are needed	Ministry of Energy; Ministry of EconomicDevelopment	0.5 year	100.0	State budget
	For the energy sector, it is necessary to develop a special program forthe introduction of new technologies and more efficient energy production	These provisions are embedded in the National Program of Climate Change therefore, they should be coordinated and implemented	Ministry of Environment and Green Development; Ministry of Energy;	1 year	120.0	State budget
		Economic and financial measures				
Improve the financial capacity of the country	Create a financial fund for capital building area of major strategic targets	The country's export has been increasingwith intensive development of the mining sector in the last few years. At the same time, the political parties distribute cash to the population so they can fulfill election campaign promises. The cash distribution shall be stopped and instead a fund to develop the country shall be established to make better use of the funding.	Government, Parliament	1 year	No need	-
	Obtaining loans or issuing bonds	In the near future, over USD 1.8 billion will be required to construct large-scale, high-efficiency TPPs. In order to raise the capital, attracting foreign investment or applying for international soft loans are essential for implementing the TPP projects.	Ministry of EconomicDevelopment; Ministry of Finance	1 year	No need	-

Market						
Create and develop a system that increases the responsibility of employees to improve the efficiency of energy production	Development and adoption the law onenergy saving	Establish a working group to draft the Law of Energy Conservation	Energy Regulatory Committee of Mongolia	1.5 year	100.0	State budget
Create a market price systemfor the energy sector	development and approval ofguidelines ofthe energy price	Establish a workinggroup to develop guidelines on energy pricing /tariffing system	Government of Mongolia, Energy Regulatory Committee of Mongolia		No need	--
Train skilled local experts who could develop project development study including feasibility Studies	Training of specialistsin developed countries	The development of the project should be made highly knowledgeable	Ministry of Educationand Science; Ministry of Energy;	3 year	5000.0	State budget
Preparation of specialists on thermal power plants operate at super critical pressure of steam	Recruiting trainers and teachers from developed countries	Currently prepares a program for education and trainingTPP engineers. The Institute can train graduate engineersfor the new technology	Ministry of Educationand Science; Ministry of Energy;	5 year	10000.0	State budget

Network						
Improving the performance of any real decisions and programs on energy development	Establishing the principle of solutions of global importance necessarily based on the recommendation and findings of leading scientists and specialists	Newly establish an energyresearch instituteunder the Ministry of Energy Initiators of this project - the ministries and authorized agents – do not support involvements and requests of scientists, local authorities and community in the decision-making and this results in later on unexpected barriers during the implementation, in some cases even lead to cancellation of project implementation.	Government of Mongolia, Ministry of Energy	1 year	10000.0	State budget
Establishmentof the principle ofin the "Ministry work only highly qualified employees of the industry"	Continuous training of workers. To support employment of edge-cutting, and experienced engineers and scientists at the Ministry of Energy. To prioritize improvement of their professional skills and sustainable employment with staff development programs and benefits and at the same time to increase responsibility mechanisms to higher level	Administration of the Ministry of Energy is unsustainable; each time after the political elections, non-professional and political activists are appointed to major positions and who in turn build their own team consisted of non-professionals with little experiences. This inappropriate phenomenon is very common.	Government of Mongolia. Parliament	yearly	1000.0	State budget

2. Technology Action Plan for Residential and commercial subsector

2.1 Actions at sectoral level

2.1.1 Short sector description

GHG emissions from the residential and commercial subsector in 2006 accounted for 6.25% of total emissions and 11.55% of emissions from energy supply and use (Table 70).

Table 70: Trend of GHG emissions from the residential and commercial subsector

	Unit	*1990*	*1995*	*2000*	*2005*	*2006*
Total emissions (gross)	$GgCO_2$-eq	23,645	17,205	16,896	17,582	18,868
Energy supply and use	$GgCO_2$-eq	12,529	8,710	8,865	9,635	10,220
Residential and commercialsector	$GgCO_2$-eq	1,895	775	852	1,059	1,181
	% of total emissions	*8.03*	*4.53*	*5.03*	*6.03*	*6.25*
	% of energy sector emissions	*15.16*	*8.96*	*9.58*	*11.00*	*11.55*

Source: Mongolia's Second National Communication, Ulaanbaatar 2010.

The consumption of coal, electricity and heat by the residential and commercial subsector is shown in table 71. The table shows that the residential and commercial subsector in 2010 accounted for about 44.8% of total coal consumption, 24% of total electricity consumption and 43% of heat consumption by economic sectors.

Table 71: Energy consumption of coal, electricity and heat for the residential and commercial subsector

Type of energy	*Energy consumption*	*Unit*	*2007*	*2008*	*2009*	*2010*
Coal	Total consumption	1000 t	971	993.3	1348.3	1372.6
	Of which: Residential and commercial subsector	1000 t	454.8	580.6	598.2	614.9
		%	*46.8*	*58.5*	*44.4*	*44.8*
Electricity	Total consumption	million kWh	2829.1	3093.3	3034.1	3375.9
	Of which: Residential and commercial subsector	million kWh	694.6	742.3	727.6	809.7
		%	*24.6*	*24.0*	*24.0*	*24.0*
Heat	Total consumption	1000 Gcal	7165	7237.9	7828.5	7820.2
	Of which: Residential and commercial subsector	1000 Gcal	3372	3429.8	3573.9	3361.8
		%	*47.1*	*47.4*	*45.7*	*43.0*

The urban population of Mongolia is 1.6 million or over 60% of the national total. Nearly 72% of urban households in Mongolia live in private houses and gers[20] , and 28% live in

20. A ger is the traditional Mongolian tent used by herders; ger areasin Ulaanbaatar are sections of town where people have settled in theirgers.

apartment buildings, virtually all of which had been privatized.

The existing main policies and laws relevant to the residential and commercial subsector are shown in Table 72.

Table 72: Existing main policies and laws relevant to the residential and commercial subsector

Name of the policies/laws and date of enactment	***Contents/targets***
The Energy Law 2007	The purpose of this law is to regulate matters relating to energy generation, transmission, distribution, dispatching and supply activities, construction of energy facilities and energy consumption that involve utilization of energy resources.
The Government action plan (2012-2016) 2012	- Make the green development policy as one of the fundamental development policies of the country; - Housing loan system shall be reformed; - Construction materials shall be manufactured domestically; - Increase the amount of soft loans provided by the Developmental Bank for the purposes of supporting infrastructure and manufacturing industry; - Develop the construction materials industry, and pursue a policy to domestically supply such products as cement, metal structures for buildings, glass products and insulation materials; - Update the construction standards and align them with international standards, introduce the Canadian style standards in the construction sector, and include solutions that are economical in terms of power consumption and operations costs; - Introduce low heat loss building technology, and develop an industry to produce insulation materials using the Mongolian sheep wool; - Take measures to establish direct connections between the vocational training centers and the potential employers;
The National Action Program on Climate Change 2011	Strategic objective 3 - "Mitigate GHG emissions and establish a low-carbon economy through the introduction of environmentally friendly technologies andimprovement in energy effectiveness and efficiency": • limit incandescent light bulb usage • install insulation in buildings with high thermal losses in big cities and take other measures to reduce the rate of heat loss
The Building Code of Mongolia 2008	**Requirement to building design document :** To make favorable conditions for material, energy and water saving **Prohibit:** It is prohibited to use materials which do not meet the building standards

A profile of existing technologies for the residential and commercial subsector is provided in Table 73.

Table 73: A profile of existing technologies for the residential and commercial subsector

Service	*Category*	*Brief descriptions of existing technologies*
Electricity consumption	Lighting	Most consumers use energy inefficient incandescent lamps.
		Very few consumers use energy efficient compact fluorescent lamps (CFL).
	Electric appliances	Consumers use very different kinds of refrigerators and TVs. There is no control on energy efficiency of electric appliances.
Heat consumption	District heating	Multi-story commercial and residential apartment buildings and a small number of private houses are connected to district heating networks for space heating and domestic hot water supply. Insulation of buildings is poor and leaves much room for improvement for reducing energy use for heat consumption in the residential and commercial subsector.
Fuel consumption	Fossil fuel	Small water heating boilers are used in provincial centers for providing heating for households, schools, hospitals, kindergartens and other public institutions. They are of very low efficiency (40-50%) due to outdated equipment.
		Individual heat stoves, which burn coal and/or wood to meet residential heating needs, are used in peri-urban areas of cities and in rural areas.
	Renewable energy	Some individual consumers, especially in rural areas, use biomass for heating and cooking.
		There are a few cases of experimental use of heat pumps for space heating and water heating of kindergartens.

Brief Description of the selected energy efficient technologies is shown in the following paragraphs.

Efficient lighting technology

The Compact Fluorescent Lamp (CFL) technology provides an energy efficiency lighting service through the use of a compact fluorescent light bulb that replaces the normal incandescent light bulb. Still, there are many different sorts of lamps from ordinary incandescent tungsten filament bulbs to Tungsten Halogen, Halogen infrared reflecting, Mercury vapor lamps, Compact fluorescent lamps, linear fluorescent, metal halide, compact metal halide, high pressure sodium (High Intensity Discharge HID lamp) and Light Emitting Diodes. CFLs contribute to security of energy supply as they can significantly reduce the energy use for lighting. The higher up-front cost could be a barrier for their implementation, but calculations show that the payback period of CFLs'initial investment within 900 hours of operation and also contribute to a reduction in the electricity bill over the lifetime of the bulb. The savings can be in the order of 10-20 times the initial cost over the life of the bulb.

Improved insulation technology of panel apartment buildings

Ulaanbaatar is the world's coldest national capital city with an eight-month heating season, and winter temperatures frequently falling to -30°C at night and -20°C in the daytime.

Around 500 panel apartment buildings house around 200,000 people or around 20% of the population of Ulaanbaatar.

The precast panel buildings have no added external wall insulation, their external doors and roofs arepoorly insulated, and most of them still have old double wooden framed windowswith high air ventilation heat loss.

The panel buildings' hot water radiator heating systems are not equipped with any heat output control. Apartments have no heat consumption metering fitted. Thus building managers and apartment owners lack both financial incentives and the technical means to reduce excessive heat losses or reduce overheating.

The proposed technologies are: (1) adding wall, roof, ground floor and basement insulation, fitting improved insulation level windows and reducing uncontrolled air infiltration; (2) installing thermostatic radiator valves to enable the apartment occupants to control their energy consumption for space heating; (3) providing new incentives for the apartment occupants to avoid overheating by adjusting their thermostatic radiator valves and (4) install heat consumption meters that measure eachapartment's actual space heating use which would then be used to calculateheat consumption and charges for each apartment.

2.1.2 General barriers and proposed measures

General barriers for existing technologies:

Barriers faced by efficient lighting and building insulation technologies in the residential and commercial sector appear to very similar.

The common economic and financial barriers are inappropriate financial incentives, lack of inadequate access to financial resources and uncertain macro-economic environment.

The common barriers regarding the policy, legal and regulatory aspects are mismanaged energy sector and lack of laws and regulations on energy efficiency.

The common barriers regarding the market and network aspects are insufficient coordination between relevant ministries and other stakeholders, lack of professional institutions, and lack of confidence in new climate technologies

The priorities of barriers are different in many cases for the specific selected technologies.

For the efficient lighting technology, the most priority barriersare low electricity tariff and lack of management for implementation of the technology

For the building insulation technology, the most priority technologies are high cost of capital and law, the households pay constant tariff which are not related to the actual heat consumption.

Proposed measures

The Government should finalise the Energy Conservation Law as soon as possible. Promulgating the Energy Conservation Law should send a strong signal to energy stakeholders and the wider public about the importance of energy efficiency. The Government should reinforce cooperation among all relevant Governmental institutions and other stakeholders in draftingthe Energy Conservation Law.

Upon the adoption of the Energy Conservation Law, the Government shouldensure thefurther development of secondary legislation and regulations indifferent sectors, in close cooperation with relevant actors.

The Energy Regulatory Committee (ERC) should increase energy tariffs as the current tariff doesnot allow the licensed energy companies to fully recovertheir costs and expenses. The tariff level should reach firstly at least the level of costcovering. After reaching cost covering tariffs, crosssubsidies currently existing between industry and residential tariffs should be removed.

The government should take actions to improve the enforcement and implementation of laws and regulations.

The Government should examine possibilities of introducing tax incentives forenergy efficiency projects.The government could support the insulation of apartment buildings and try to attract foreign aid and soft loan.

The government should establish formally mandated agencies in the country, delegate them to develop and implement the national and sectoral energy efficiency policies and programs.

The Government should make efforts to provide residents of un-insulated apartments to improveinsulation of their apartment using such policyinstruments as subsidies and micro credits.

The Government should consider consolidating the Green Credit Guarantee Fund and other similar funds in order to create revolving credit liquidity.

The Government should continue its efforts in attracting Clean Development Mechanism (CDM) financing for efficient lighting and building insulation projects.

The Government should put strong emphasis on the implementation andenforcement of building regulations.

2.2 Action Plan for Efficient lighting

2.2.1 Description of the technology

Compact Fluorescent Lamp (CFL) technology provides an energy efficient lighting service through using a compact fluorescent light bulb to replace the normal incandescent light bulb (ILB). Still, there is different sorts of CFLs, from ordinary incandescent tungsten filament bulbs to Tungsten Halogen, Halogen infrared reflecting, Mercury vapor lamps, Compact fluorescent lamps, linear fluorescent, metal halide, compact metal halide, high pressure sodium (High Intensity Discharge lamp) and Light Emitting Diodes.

The higher up-front cost could be a barrier for their implementation, but calculations show that CFLs pay back the initial investment within 900 hours of operation and also contribute to a reduction in the electricity bill over the lifetime of the bulb. The savings can be in the order of 10-20 times the initial cost over the life of the bulb (http://climatetechwiki.org/technology/cfl).

Significant energy savings will help to free up energy resources that can be spent on other national, social and human development goals.

The lighting service improvement technology can reduce electricity generation in power plants and save a significant amount of fossil fuels for electricity generation and for transport of coal from coal mines to power plants.

The lighting service improvement technology can reduce air pollution in big cities.

2.2.2 Target for technology transfer and diffusion

The efficiency of electricity use in the residential and commercial sector is still low. Oneprioritized technology for the residential and commercial sector is promoting the use of energy-efficient compact fluorescent lamps (CFL) to replace inefficient incandescent light bulbs (ILB). CFLs provide the same level of illumination as an incandescent lamp but use roughly 70% less electricity. Although CFLs are more expensive than ILBs, they are more economical on a life-cycle basis due to savings in electricity costs. Currently, most households and about 30% of service and commercial buildings use incandescent bulb lamps and the rest use fluorescent bulbs

The first phase implementation plan of the National Action Program on Climate Change approved by the government committed to limit incandescent light bulb usage during the period 2012-2016.

The Mongolia Nationally Appropriated Mitigation Actions (NAMA) to the UNFCCC secretariat also includes measures such as lighting efficiency in buildings.

After stakeholder consultation, it is assumed that by 2020, 60% of the households in Ulaanbaatar will be supplied by CFLs as the preliminary target of efficient lighting technology transfer and diffusion.

2.2.3 Barriers to the technology's diffusion

Table 74 : Barriers to the technology's diffusion

Key barriers identified		***Enabling measures***
Category	Barriers	
Economic and financial	Inappropriate financial incentives	It is important to increase electricity tariffs and implement measures to eliminate the outdated technology in the market. The Government should continue the planned energy pricing reform. The tariff level should be high enough to cover the electricity supply cost and the cross subsidies should be removed.
	High capital cost	The Government should examine the possibilities of introducing tax incentives for energy efficiency projects.The Government should continue its efforts in attracting Clean Development Mechanism (CDM) financing for energy efficiency projects including efficient lighting technology.
Policy, legal and regulatory	Insufficient legal and regulatory frameworke	Need legal environment for implementation of policieson energy efficiency.The Government should finalise the Energy Conservation Law as soon as possible. Enforcement of the Energy Conservation Law should send a strong signal to energy stakeholders and the wider public about the importance of energy efficiency. The Government should reinforce cooperation with all relevant Governmental institutions and other stakeholders in drafting the Energy Conservation Law. Upon the adoption of the Energy Conservation Law the Government should proceed with the development of secondary legislation and regulations in different sectors, in close cooperation with relevant actors
Technical	Product no reliable	Special attention should be given for importing energy efficient equipment which meets specific quality standard. Quality standards should be approved and strictly enforced
Institutional and organizational capacity	Lack of specialized ESCOs	It is important to establish the planning level and operational level Energy Service Companies (ESCOs). One of the assignments for the high level decision makers is to organise a knowledge base by compiling information regarding energy efficiency projects (including donor financed projects), including lessons learned. This could assist the Government in developing a strategy and prioritising future donor financing of energy efficiency projects.
Information and awareness	Lack of awareness about climate technologies	Cooperation between the Ministry for Energy and other relevant Governmental institutions should be enhanced. Cooperation withother actors such as NGOs, donor organisations, and private actors should also be improved.The Government should promote energy efficiency awareness raising andtraining for Government officials and the wider public at local, regional and national level.

2.2.4 Proposed action plas for efficient lighting

Table 75: Proposed action plans for efficient lighting

Measures	*Actions*	*Why need to take these actions?*	*Responsible organization*	*Time frame*	*Expected budget, 1000USD*	*How can be fund*
Policy, legal and regulatory, institutional measures						
ILaw on energy efficiency and energy conservation	To issue law on energy efficiency and energy conservation	There is no legal regulation on energy efficiency and conservation	Government, Ministry of Energy	1 year	30.0	State budget
R&D centers/ESCOs	EstablishR&D centers/ESCOs including hardware, personnel and programs	There is no ESCO for implementation of energy efficiency measures	Government, Ministry of Energy	2 years	10000	State budget/ donor support
Economic and financial measures						
Increase electricity tariff	to increase electricity tariffs for consumers	The tariff should cover the level of electricity prices and the cross subsidies should be removed	Energy regulatory committee	1 year	No need	-
Tax incentives	To exempt custom duties and taxes for efficient electric lighting devices	There is no tax exemption for energy efficient technologies. Recently, the custom tax is 5%, VAT- 10%.	Government Ministry of Economic Development; Ministry of Finance	2 year	No need	-
Technical						
Quality standard	To issue quality standard for electric lighting	To prevent the outdated electric lighting technology in the market	Mongolian Agency for Standardization and Metrology	1.5 year	50.0	State budget
Network						
Network vendors and NGOs with R&D for awareness raising and service quality improvement	Initiate free consulting service	Improve awareness and service quality of sellers and installers	State agencies and international financial organizations	2 year	100.0	State budget

2.3 Action Plan for Improved insulation of panel apartment buildings

2.3.1 Description of the technology

Buildings constructed during the socialist period are still in use in large numbers. In central city areas they may be replaced by private developers with newer/larger buildings, but elsewhere thesocialist period buildings are likely to remain in use for decades to come. These buildings have minimal levels of insulation and need to be retrofitted with extra (generally external) wall insulation and modern lower heat loss windows to replace old twin openable wooden windows. These existing buildings are not fitted with heat meters, nor do tenants have user-adjustable heat output controls on their radiators, nor can automatic temperature control thermostatic radiator valves (TRV) be fitted due to the single pipe vertical heating pipe layouts used. Therefore, for these existing socialist period buildings, a key barrier is that building owners and tenants have nomeans to control their heat use except by opening their windows and venting excessive heat to the outside, nor do they have any incentive to carry out expensive retrofitting insulation or modern insulating and air-tight windows.

Given the low income level of most occupants of existing apartment buildings, it is not realistic to expect any future building control system to be able to mandate, let alone enforce, the necessary costly retrofitting ofinsulation, re-piping of radiators, the fitting of heat meters, the use of consumption based heat tariffs, the fitting of controls such as TRV on radiators, and the installation of triple glazed or other equivalent performance insulating windows.

Benefits from the improved insulation of panel apartment buildings:

- Living conditions of the residents will be improved;
- Financial income of the people will be increased
- Heat energy costs of the apartments will be reduced.
- Reserve capacity for the city's heat sources will be set up and this reserve source can be used for heating of apartments planned to be built in future.

2.3.2 Target for technology transfer and diffusion

The majority of the apartment buildings in UlaanBaatar was constructed in the 1970s, 1980s and early 1990s and is in a poor state, without systematic professional maintenance and repairs. The energy efficiency in centrally and district heated buildings leaves room for technical and managerial improvement. Per square meter heat consumption of the buildings is about five times higher than the modern buildings in Europe. This to some extent is because of the very cold climate in Mongolia, but the main reason is poor technology and a lack of incentives to save energy.

A recent study (Mongolia: NAMA) on heat losses concluded that nearly 40% of the heat is lost in houses and buildings. The heat losses occur through windows, walls and doors: the design and construction of old apartment buildings in bigger cities are very similar to the buildings found in many places of the former Soviet Union.

A study onlocal building standards indicated that heat demand in multi-family buildings could be reduced by about 60%.(BEEP Report) There are around 500 panel apartment buildings which house around 200,000 people or around 20% of the population of Ulaanbaatar.

The first phase the implementation plan of the National Action Program on Climate Change approved by the government mentions the insulation of existing buildings with high heat losses during the period 2012-2016.

Mongolia's Nationally Appropriated Mitigation Actions (NAMAs) submitted to the UNFCCC secretariat also include building energy efficiency improvement measures such as the improvement of insulation in existing buildings.

After stakeholder consultation it is assumed that 300 existing panel apartment buildings will be insulated by 2020 as general target of building insulation technology transfer and diffusion.

2.3.3 Barriers to the technology's diffusion

Table 76: Barriers to the technology's diffusion

Key barriers identified		***Enabling measures***
Category	Barriers	
Economic and financial	Inappropriate financial incentives and disincentives	- Change the existing constant heat tariff and make heat charges depending on actual heat consumption. - The residents should have sufficient incentive to insulate their apartment. - Government should find adequate access to financial sources and establish financial mechanisms, such as making soft loans and government support available to residents.
	Lack of adequate access to financial resources	- The Government should continue its efforts in attracting Clean Development Mechanism (CDM) financing for energy efficiency projects, including efficient lighting technology. - The Government should consider consolidating the Green Credit Guarantee Fund and other similar funds in order to create revolving credit liquidity
	High cost of capital	- The Government should make efforts to provide resident of un-insulated apartments with insulation of apartment using such instruments as subsidies and micro credits - The Government should take action to develop building insulation projects and organize the implementation
Market	Poor market infrastructure	The government policy should focus on energy efficiency in energy production and energy saving among consumers. The energy producers and distributers should be motivated to support energy saving among consumers, including energy saving in buildings. The Government should put strong emphasis on the implementation andenforcement of adopted building regulations. The Government should introduce individual heat metering in apartment building where this istechnically possible.
	Under-developed competition	It is necessary to motivate the property developers and rental market to invest in building insulation. The government should have strong and effective policy to implement building standards amongexisting un-insulated buildings. The government needs to supporttechnical and managerial improvement in buildings with district heating.
Policy, legal and regulatory	Insufficient legal and regulatory framework	The Government should finalise the Energy Conservation Law as soon as possible. The Energy Conserdation Law should send a strong signal to energy stakeholders and the wider public about the importance of energy efficiency. The Government should reinforce cooperation with all relevant Governmental institutions and other stakeholders in drafting the Energy Conservation Law. Upon the adoption of the Energy Conservation Law the Government should proceed with the development of secondary legislation and regulations in different sectors, in close cooperation with relevant actors

Institutional and organizational capacity	Lack of professional institutions	It is important to establish Energy Service Companies (ESCOs)specialized in energy efficiency planningand energy efficiency project implementation. One assignment for the high level decision makers is to organise a knowledge base by compiling information regarding energy efficiency projects (including donor financed projects), including lessons learned. This could assist the Government in developing a strategy and prioritising future donor financing of energy efficiency projects
Information and awareness	Lack of awareness about climate technologies	Cooperation between the Ministry for Energy and other relevant Governmental institutions should be enhanced. Cooperation with other actors such as NGOs, donor organisations, and private actors should alsobe improved. The Government should promote energy efficiency awareness raising and training for Government officials and the wider public at local, regional andnational level. One assignment for the high level decision makers is to organisea knowledge base by compiling information regarding energy efficiency projects (including donor financed projects), including lessons learned. This could assist the Government in developing a strategy and prioritising future donor financing of energy efficiency projects

2.3.4 Proposed action plans for insulation of panel apartment buildings

Table 77: Proposed action plans for insulation of panel apartment buildings

Measures	*Actions*	*Why the actions need*	*Responsible organization*	*Time frame*	*Expected budget, 1000USD*	*How can be fund*
Policy, legal and regulatory						
Establishment the legislation	Development and adoption of the law onenergy saving	Establish a working group to develop the law of energy conservation.Building heat loss shall be covered in the law	Energy Regulatory Authority of Mongolia	1-2 year	No need	State budget
	Decision making of the city mayor	The decision should specify an approach of how, when and what organization and with which funding insulation of older buildings will be improved	Ministry of Constructionand Urban Planning city administrations	2013 year	No need	
Economic and financial measures						
Creation of financial resources	Set up fund to improve building insulation	About 80 million dollars is required for additional insulation of about 500 panel buildings as counted by 2010. In case of successful insulation of each building, over 550 thousand tons of coal can be saved each year. This way, investment payback period is very short.	Ministry of Constructionand Urban Planning city administrations	1 year	80 000	-
Market						
Increase awareness for residents aboutthe concept of building insulation	Organize workshops and trainings	Ccurriculum on building insulation with affordable technologies and their economic and environmental benefits shall be developed for the relevant authorities	Ministry of Construction and Urban Planning city administrations	2 year	150.0	State budget
	Organize public awareness raising campaigns	Not every resident is aware of the importance of building 0insulation	Ministry of Construction and Urban Planning city administrations	3 year	50.0	State budget
Improvedratesof pricesof heat forheating buildings	Set up a working groupto develop a new pricing/tariffing system	Currently, residents pay heating charge based on a constantrate per square meter of floor area and the on area of their apartments; residents do not have interest to saveheat	Energy Regulatory Authority of Mongolia	2013-2014	No need	--
Creating incentives	Guidelines to provide financial incentive to residents who successfully improved the building insulation	Precast panel buildings are all privatized. Even though the residents have interest to insulate their buildings, they have no financial resources to pay for the investment cost.	Ministry of Environment and Green Development	yearly	100.0	State budget

3. Cross-cutting Issues

There are several cross cutting issues that constitute common barriers for all technologies prioritized under TNA process. These issues result in insufficient development of climate change mitigation technologies in Mongolia.

Policy and regulation

Common barriers regarding the policy, legal and regulatory aspects are a lack of long-term political commitment and uncertain government policies (political risks for investors); lack of government control for implementation of laws and regulations; government or utility monopoly of energy sector.

Absence of appropriate national legal and policy frameworks prohibits technology development and its implementation.

The solutions of some cross-cutting barriers are only at policy level, for example, policy frameworks on enhancing fundamental research, policy framework on implementing technologies, and public perception and education on new technologies. Absence of appropriate national legal and policy frameworks on enhancing fundamental research prohibits technology development as well as its implementation.

Effective technology implementation requires a solid national plan, ensuring sufficient budgets, manpower, and resources. In addition, various activities to promote public awareness in science and regulation

Strengthening of research and development institutions

Energy research and development center with targeted programs and effective coordination is extremely important for successful deployment and dissemination of renewable energy, energy efficient and other high priority climate technologies in Mongolia. There is a plan for establishment of a new research institute of energy technology under the ministry of energy. However it may take some more time before these efforts will result in effective and functional institutions. Meanwhile the existing institutions need to be strengthened and developed to address the needs of measurement, testing, design adaptation, other innovation and expert support for climate technologies, including information provision, skills and education training.

Economic and financial issue

The common economic and financial barriers are inappropriate financial incentives; high cost of capital; high transaction cost; lack or inadequate access to financial resources and uncertain macro-economic environment.

The above barriers have resulted in a lack of state policies and action plans for climate technology development. As a consequence there are no effective fiscal mechanisms of taxs breaks, state subsidies organs involved to support the deployment and dissemination of climate change mitigation technologies. Introduction of such support mechanisms should be justified by understanding of environmental economic, social and political aspects related to continued use of traditional energy sources such as coal.

The existing legal framework permit foreign investors to invest in the climate technologies without significant risks. Access to credits in Mongolia is expensive and difficult, and long-term loans are scarce. This is a common barrier for all technologies implementation. Protection of foreign investments and improvement of local crediting conditions are crucial.

Common barriers regarding the market and network aspects are underdeveloped competition, insufficient coordination between relevant ministries and other stakeholders.

Stakeholder Coordination

A better coordination between the donor agencies, NGOs and specialists is needed around a common plan for renewable energy and energy efficiency development in Mongolia . This is an opportunity for improving the quality of the projects and achieving better joint results. In absence of the government strategy and action plans in renewable energy and energy efficient technologies there is an increased need for coordinating different donor agencies with NGOs and knowledge field experts in order to develop a coordinated tactics for promotion of those technologies.

The objective of information exchange and stakeholder collaboration is to formulate appropriate actions which would ensure greater mobilization of resources/data and further enhance the efforts from implementation agencies and stakeholders in fulfilling their support from the government and attracting international support.

List of references 3

TNA Guidebook 2012 - Overcoming Barriers to the Transfer and Diffusion to Climate Technologies, UNEP, January 2012.

MSNC 2010 - Mongolia Second National Communication under the United Nations Framework Convention on Climate Change, Ulaanbaatar, 2010.

NAPCC 2011 - National Action Program on Climate Change, Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2011

NAPCC 2000 - National Action Program on Climate Change, Ministry of Nature, Environment, Ulaanbaatar, 2000.

NRSD 2010 - National report on sustainable development, Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2010.

CCM Mongolia 2010 - Climate change mitigation: Needs and possibilities, 2010 (in Mongolian)

ES 2011 - Energy Statistics 2011, Energy Regulatory Committee (in Mongolian), Ulaanbaatar, 2011.

Energy Charter, 2011 - In-Depth Review of Energy Efficiency Policies and Programmes: Mongolia, Energy Charter Secretariat, 2011

GHG Mongolia, 2000 - Greenhouse Gas Mitigation Potentials in Mongolia, Ulaanbaatar, 2000.

Compendium, 2007 - Compendium of energy related laws (in Mongolian), Ulaanbaatar, 2007.

Mongolia: NAMA Mongolia: Nationally appropriate mitigation actions of developing country Parties

BEEP Report Energy Efficiency in New Construction in the Residential and Commercial Buildings Sector in Mongolia (in short Building Energy Efficiency Project), MON/09/301, Ulaanbaatar-2012.

Annex 7: List of stakeholders involved and their contacts

Stakeholders		Representatives		Approach of consultation	Contact
Organization	Departments	Name	Position		
Ministry of Mineral Resources and Energy	Energy Policy Department	Y. Enkhtuya	Officer	meeting discussion, questionnaire	enkhtuya_yo@yahoo.com
	Fuel Policy Department	N. Boldkhuu	Deputy director	meeting discussion, questionnaire	bube1458@yahoo.com 99111276
Energy authority	Renewable energy division	Ch.Batbayar	Chief	meeting discussion, questionnaire	batbayar@ea.energy.mn
	Energy department	S. Purevdash	Officer	meeting discussion, questionnaire	sosapu@yahoo.com 88110965
		P. Baatar	Consultant	meeting discussion, questionnaire	purev_baatar@yahoo.com 99158925
		B. Ochirjav	Consultant	meeting discussion, questionnaire	ochirjav_b@yahoo.com 99035965
Ministry of Nature, Environment and Tourism	Climate Change coordination office	D. Dagvadorj	Chairman	meeting discussion, questionnaire	dagvadorj@mne.gov.mn 99246722
	CDM National Bureau	B. Tsendsuren	Head	meeting discussion, questionnaire	tsendsurenb@gmail.com 88991184
	CDM National Bureau	Kh.Undarmaa	Officer	meeting discussion, questionnaire	cdm.bureau@gmail.com 99172807
National Development and Innovation Committee	Industrial Development Department	G. Misheelt	Fuel and Energy policy officer	meeting discussion, questionnaire	misheelt@ndic.gov.mn 99901885
UNDP in Mongolia	Building Energy Efficiency project (BEEP)	Munkhbayar	Project manager	meeting discussion, questionnaire	munkhbayar.b@beep.mn
Clean Energy	Co., Ltd	Ts. Sukhbaatar	Director	meeting discussion, questionnaire	sukhbaatar@newcom.mn 99114462
Mongolian Academy of Sciences	Energy corporation	M. Bum-Ayush	Director	meeting discussion, questionnaire	341757 91142305
Mongolian National University	Energy Institute	Y. Gantogoo	Consultant	meeting discussion, questionnaire	gantogooy@yahoo.com
The government office of Ulaanbaatar city the capital of Mongolia	The government office	Ch. Tsogtsaikhan	Officer	meeting discussion, questionnaire	tsog_1966@yahoo.com 99117893
	The government office	Ch. Seded	Officer	meeting discussion, questionnaire	sededchoijil@yahoo.com 95142819

Energy regulatory Committee	The government office	S. Tsetsgee	Officer	meeting discussion, questionnaire	tsetsgee@era.energy.mn 99854710
Mongolian Millennium Challenge Corporation	Project Implementation Office	N. Tsolmon	Project officer	meeting discussion, questionnaire	tsolmonn@gmail.com
Mongolian Energy Association	Non-governmental Organization	G. Purevdorj	General secretary	meeting discussion, questionnaire	gal.purevdorj@yahoo.com 99092150
Mon-Energy Co., Ltd	Co., Ltd	D. Sod	Energy expert	meeting discussion, questionnaire	sod@mon.energy.mn 99762407
		D. Landannorov	Senior consultant	meeting discussion, questionnaire	landa@mon.energy.mn 91183015
MCS Group	Energy resources Co., Ltd	T.Ganbold	Energy expert	meeting discussion, questionnaire	gtogooch@yahoo.com 99163103
	MCS International Co., Ltd	D. Samdan	Energy expert	meeting discussion, questionnaire	samdan.d@mcs.mn 91140649

Section IV.
Project ideas

EXECUTIVE SUMMARY

The project ideas described below are concrete actions for realization of the Technology Action Plans for Energy and Residential/commercial sectors.

The following project ideas have been prepared:

I. For the energy sector:

- To construct of a 220 KW hydropower plant on the Egiingol River in the Selenge aimag to regulate the Combined Heat and Power plant (CHP) regimes of central grid
- To construct the Wind Park project in Gobi region
- To build a super critical thermal power plant with an installed capacity of 600 MW at the Baganuur Coal mine, which is located 130 km from Ulaanbaatar.

II. For Residential/commercial sectors

- Improved insulation of 300 existing panel apartment buildings in Ulaanbaatar
- Replacement of 500000 incandescent light bulbsby energy-efficient compact fluorescent lamps in urban households

1. Project Ideas for the Energy Sector

1.1 Brief summary of the Project Ideas for Energy Sector

The project ideas described below are concrete actions for realization of the Technology Action Plans for Energy sector.

The following project ideas have been prepared for the energy sector:

- To construct of a 220 KW hydropower plant on the Egiingol River in the Selenge aimag to regulate the Combined Heat and Power plant (CHP) regimes of central grid
- To construct the Wind Park project in Govi region
- To build a super critical thermal power plant with an installed capacity of 600 MW at the Baganuur Coal mine, which is located 130 km from Ulaanbaatar.

Attracting investors' interest and supporting their motivation to progress with a project idea is essential for a successful project launch. It is therefore important that during the early stages of a project, investors are able to access relevant project-related information, including a brief description of the project's main economic and technical features, country legal and regulatory environment, existing barriers and activities planned. In this context, the project ideas presented below are developed in response to the needs identified above and as such provide a first step for the attraction of investor interest in the transfer, diffusion and deployment of energy mitigation technologies.

1.2 The construction of Hydropower Plant in Egiin River

1.2.1 Introduction/Background

The TNA/TAP process has identified largescale HPP technologies as a top priority technology for climate change mitigation, which is in line with the development priorities of Mongolia.

The proposed project activity will be a 220 MW hydroelectric power generation facility, which is to be constructed on the Egiin River.

The proposed project is located approximately 300 km north west of Ulaanbaatar. The Egiin River is the third largest river in Mongolia, and the project will be constructed near the confluence of this river and the Selenge River. The area within the projected reservoir inundation zone consists mainly of natural pastureland (used sparsely by nomadic locals) with small areas of forest and crop land

The proposed roller-compacted concrete (RCC) dam is composed of aggregates and cementious material (Portland cement, fly ash from power plants and milled natural pumice). The planned dam has a crest length of 710 m, width of 8 m and height above foundation of 95 m. The planned reservoir capacity is 4,000 million $m^3$and it would extend 50 km away from the dam and have a maximum surface area of 125 km^2 (Egiin HPP PDD 206)

The power station is planned to have four 55 MW Francis turbines with design head of 59 m and the discharge of 105 m^3/s. The foreseen annual electricity generation is 412 GWh. The turbines will be fed by embedded steel penstocks passing through the dam. The plant will be connected by a direct, double-circuit 220 KV line to a large sub-station in Erdenetat a distance of approximately 64 km.

The reservoir will be flood 120 km^2 of marginal agricultural land, and displace rather less than 500 persons. Alternative arable land and resettlement locations exist at short distance from the affected area, and resettlement costs will be comparatively low.

1.2.2 Objectives

To construct a 220 kW Hydro Power Plant in Egiingol river of Selenge aimag[21] to regulate regimes of coal fired Combined Heat and Power plants (CHP) in central grid of Mongolia. All capacities in national grid are in form of base load stations such as coal fired CHPs and the grid at present has no special peaking, load adjusting capacity. Peak power has for many years been imported from Russia. In long term power imports will not be reliable or predictable source of supply for Mongolia.

1.2.3 Measurable outputs

It is expected to generate and supply approximately 500,000 MWh/year of electricity for the Mongolian national grid. It will achieve CO_2 emission reductions of just over 192,500 tCO_2/year (Egiin HPP PDD, 2006)by displacing electricity that would otherwise be generated by coal-fired power plants

1.2.4 Relationship to the country's sustainable development priorities

The large scale HPP is supported by many country policy instruments, including:

- The Law on Renewable Energy of Mongolia (LREM 2007);
- National Renewable Energy Program of Mongolia (2005-2020) (NREP 2005)
- Mongolia Second National Communication under the UNFCCC (MSNC 2010)
- Mongolia: Nationally appropriate mitigation actions of developing country (NAMA 2010)
- National Action Program on Climate Change (MAPCC 2011)
- Integrated Energy System (National Program) (IES 2007)

The National renewable energy program approved by parliament in 2005 indicates: "Gradually implement goal of increasing the share of renewable energy in the total energy production and reaching 3-5 percent in the national energy by the year 2010, 20-25 percent share by 2020". But the target for 2010 has not been achieved. As of 2011, the share of renewable energy in total electricity production is only 1.11%. In the future, the electricity generation will increase gradually and reach 7800 million kWh in 2020. In order to reach the 20% target, the electricity generation from renewable energy sources especially from HPPs should be increased gradually.

1.2.5 Project Deliverables

In addition to power generation and greenhouse gas (GHG) emission reduction, the project will contribute to sustainable development by:

- 500,000 MWh of annual electricity generation from the HPP will be involved in the country energy balance, improving regime of coal fired power plants and reducing electricity imported and thus increasing country energy security;
- displacing coal with a domestic renewable resources for power generation
- providing jobs and training for semi-skilled and skilled workers during after the construction and operation stages of the project;
- during the construction period, local villagers can earn additional income through selling their agricultural produce to workers;
- theincorporation of other productive water use projects such as water supply, irrigation, tourism and recreation.
- reduce import electricity

1.2.6 Project scope and possible implementation

The proposed Egiin hydro electric project will be built on the Egiin River in north central Mongolia in about 300km northwest of the capitalcity of Ulaanbaatar.

The Egiin is Mongolia's third largest river and at the proposed damsite has a catchment area of about 40,000km^2. The damsite is located about 4km upstream of the confluence of the Egiin and the Selenge ,the country's biggest river (Egiin HPP 2006).

There are good construction conditions for Egiin HPP, and no restricting factors exist in technology, society and environment. To build this hydropower station is economically attractive as it has remarkable economical

21. The aimagis a first level administrative subdivision of Mongolia. Mongolia is divided into 21 aimags

returns and social effect of developing the local economy.

The Project covers the area of utilization of renewable sources. The HPP will be connected to national grid. Public Private Partnership approach could be attracted in the project implementation.

1.2.7 Project activities

Concrete future investor's activities oriented to build Egiin HPP will start after the appropriate contract is signed. After the contract enters into force, the investor/company selected will proceed to:

- obtain all permits;
- contacting with all local authorities;
- make power purchase agreement with electricity transmission company ;dam excavation
- dam concrete placing
- power station

1.2.8 Project Timeline

4 years (2015-2019).

The following timeline for implementing the project is to be expected.

It is assumed that the work for concrete placing is carried only for the summer season (from April to October).

Diversion work - 2015 (June – October)

Dam excavation – August 2015 – October 2016

Dam Concrete Placing – April 2017 – October 2018

Power station –April 2018 – August 2019

1.2.9 Budget/Resource requirements

The following budget in USD for implementing the project is to be expected.

Civil engineering works
177600

Electro-mechanical equipment
83800

Contingencies
30400

Engineering and administration
22000

Total
313800

For implementing the project, it is need soft loan from international funding sources.

1.2.10 Measurement/Evaluation

The output as electricity distribution (500,000 MWh/year) to the central grid will be measured by electricity meter on in the power house of the HPP.

1.2.11 Possible Complications/ Challenges

The low electricity tariff is hindering foreign investment in hydro power plants. Even though in the renewable energy law, it is mentioned that higher feed-in tariff should be provided for electricity supplied by renewable energy resources, the electricity generated by HPPs with capacity more than 5MW is not eligible to receive high feed-in tariff (**RE Law 2007**). The low tariff hinders investment in hydro power plant project as the power purchase agreement doesn't reflect the feed-in tariff mentioned in the renewable energy law.

There lacks domestic technical capacity on the installation and operation of large scale HPP. Therefore selection of technology, equipment purchase, contracting will require study and time and high transaction cost.

Bureaucracy is high in energy sector as it is a public sector. The bureaucracy itself limits possibilities to implement projects and increases costs to conduct project baseline surveys.

Depending on climate condition of Mongolia the time in year for construction of HPP is only in the summer season from April to October.

1.2.12 Responsibilities and Coordination

Government/Ministry of Energy will be responsible in coordination with private companies and international financing organizations

1.3 The Wind Park project in Govi region

1.3.1 Introduction/Background

Renewable energy power plants are planned to be established in the Gobi and the Eastern aimags according to the Government Strategy.

- Energy demand of Sainshand is expected to grow due to planned construction of the industrial park in the area.
- Sainshand is a windy area in Mongolia. Wind assessment is being done by the National Renewable Energy Center

1.3.2 Objectives

To construct a wind park in Gobi region to operate inparallel with the national grid in order to meet increasing demand for energy in Sainshand.The project activity will also generate GHG emission reductions by avoiding CO_2 emissions from electricity generation by fossil fuel power plants, which dominate the power supply to the Central Grid of Mongolia.

1.3.3 What are the outputs and are they measurable?

The capacity of the proposed wind park will be 52 MW and the expected annual electricity generation is 170 million kWh/year.

The electricity produced by the wind park will be supplied to the Central Grid.

1.3.4 Relationship to the country's sustainable development priorities

- Improve electricity supply to users
- Reduce coal combustion and GHG emissions. The expected GHG emissionsare 174,000 tons CO_2/year
- The large scale HPP is supported by many country policy instruments, including:
- The Law on Renewable Energy of Mongolia (LREM 2007);
- National Renewable Energy Program of Mongolia (2005-2020) (NREP 2005)
- Mongolia Second National Communication under the UNFCCC (MSNC 2010)
- Mongolia: Nationally appropriate mitigation actions of developing country (NAMA 2010)
- National Action Program on Climate Change (MAPCC 2011)
- Integrated Energy System (National Program) (IES 2007)

The National renewable energy program approved by parliament in 2005 indicates: "Gradually implement goal of increasing the share of renewable energy in the total energy production and reaching 3-5 percent in the national energy by the year 2010, 20-25 percent share by 2020". But the target for 2010 has not been achieved. As of 2011, the share of renewable energy in total electricity production is only 1.11%. In the future, the electricity generation will increase gradually and reach 7800 million kWh in 2020. In order to reach the 20% target, the electricity generation from renewable energy sources especially from WPs should be increased gradually.

1.3.5 Project Deliverables

Construction of Wind Park in Gobi region capacity 52 MW and the expected annual electricity generation is 170 million kWh/year.

1.3.6 Project scope and possible implementation

The proposed project is located in the Southern Mongolia,providing a total of 52 MW. The project site has an excellent wind resource, which has been measured extensively. The proposed wind park will be constructed in area near to Sainshand of Dornogobi aimag. The wind farm will deliver its electricity to the proposed mining processing plants located in Dundgobi, Dornogobi and Umnugobi aimags as well as to the consumers in Central Grid of Mongolia.

The project will assist Mongolia in stimulating and accelerating the commercialization of grid connected renewable energy technologies and markets. It will therefore help reduce GHG emissions versus the high-growth, coal-dominated business-as-usual scenario. Furthermore the project will demonstrate the viability of larger grid connected wind farms, which can supportimproved air quality, alternative sustainable energy futures, improved local livelihoods andsustainable renewable industry development.

1.3.7 Project activities

The project activities for implementing this project are:

- Site survey
- Wind measurement
- Feasibility study
- Site selection
- Technicald esign
- Equipment ordering
- Concrete base
- Installation
- Monitoring

1.3.8 Project Timeline

The following timeline for implementing the project is to be expected.It is assumed that the work for concrete placing is carried only for the summer season (from April to October).

- Windmeasurement – 2014 -2015
- Feasibilitystudy - 2015
- Site selection - 2015
- Technicaldesign – 2015-2016
- Equipmentordering - 2016
- Concrete base– April 2017 – October 2017
- Installation – April 2018 – October 2018

1.3.9 Budget/Resource requirements

The total requested budget for implementing this project is 120 million USD.

The project can be implemented by private investments supported by feed-in tariff as indicated in the Renewable Energy Law

1.3.10 Measurement/Evaluation

The output as electricity distribution (500,000 MWh/year) to the central grid will be measured by electricity meter on in the power house of the HPP.

1.3.11 Possible Complications/ Challenges

Due to the wide land area and small population with low density, the transportationnetwork is not well developed in Mongolia.

Therefore, in some parts,wind farm equipment transportation is difficult which often requirestemporary road construction.

It is difficult for heavy trucks to travel over this unpaved roads and over soft and sandy land. Bigger trucks cannot use this kind of road. This constraint also affects the installed capacity per unit (turbine).

Other issues to be considered include:

- Wind turbine specifications, type approvals etc.
- Analysis of wind turbine/site compatibility.
- Layout (micro-siting) of the wind farm.
- Installation and transportation.
- Grid connection.

Technology Barriers: The technology risks associated with wind power in Mongolia are high due to the transfer of advanced foreign made technology. This leads to an increased perception of risk from financiers and makes it more difficult to attract financing. The developer is also facing the barrier that this is one of the first projects for development of wind farms in Mongolia.

Transaction Costs: Wind parks in Mongolia faces the barrier of project development costs and transaction costs for financing that are disproportionately high, as is often the case for low-capacity

1.3.12 Responsibilities and Coordination

Government/Ministry of Energy will be responsible in coordination with private companies and international financing organizations

1.4 *Super critical thermal power plants (TPP) capacity 600 MW*

1.4.1 Introduction/Background

One of the challenges facing Mongolia, similar to other countries, is to reduce GHG emissions and manage the cost of energy generation by reducing fuel consumption.

Mongolia has been planning to construct Thermal Power Plants of a total capacity of 2800MW near Aduunchuluu, Tavantolgoi, ShiveeOvoo and Baganuur coal mines, with annual electricity generation of 14-16 billion kWh in the near future. These power plants are expected to combust about 12.0 million tonnes of coal every year. Coal-fired supercritical TPP technology is crucial and highly recommended for reducing the GHG emissions from these planned thermal power plants.

Supercritical and ultra-supercritical plants are more expensive because of the higher requirements for the steel which needs to stand higher pressure and temperature, but the higher efficiency can result in cost savings during the technical lifetime of the plants.

The emissions of CO_2 per MWh delivered to the grid could be reduced from 830 kg to 730 kg.

In Mongolia, coal fired Combined Heat and Power plants contribute 98 % of the total electricity supply.Among the total installed electricity capacity of turbines of CHPs currently under operation, 60% is 13 MPa, 22% is 3.5 MPa, and 18% is 9.0MPa.

1.4.2 Objectives

To build a super critical Thermal Power Plant with capacity 600 MW at the BaganuurCoalMine, which is 130 km from Ulaanbaatar.

1.4.3 Measureable output

Electricity generationis 3.3billion kWh/year.

1.4.4 Relationship to the country's sustainable development priorities

- Improving the efficiencyof electricity production in Mongolia;
- Increase reliability ofthe country's energy supply;
- Increase favorable conditions for the construction of large electricity projects
- Introduce advanced technologie sin the energy sector;
- Reduce the negative impact of energy on the environment;
- Reduce greenhouse gas emissionsfrom the energy sector;
- Gain access to advanced technologies.

1.4.5 Project Deliverables

Construction of coal fired supercritical power plants with installed capacity 600 MW for delivering electricity in amount of 3.3 billion kWh/year to national grid.

1.4.6 Project scope and possible implementation

The proposed supercritical coal fired TPP will be constructed in Baganuur coal mine.

The Baganuurcoal mine is one of the biggest open coal mines in Mongolia, which is supplied 50% of the Mongolia's total coal demand and 70% of the coal demand of the Central region. The Baganuur mine is located 139 km from Ulaanbaatar, contains 600 million tons of coal and has the capacity to extract 3 million tons of coal annually.

1.4.7 Project activities

I. Preparation Phase

- Organize studyon the technology of Super Critical TPP for the senior decision makers and specialists;
- Organize discussion about the technology of Super Critical TPP for the specialists and senior decision makers;
- Take the decision on the implementation of technology super critical TPP in thermal power

plants of high capacity;
- Conduct pre-feasibility study on the coal-fired super critical TPP at Baganuur Coal mine;
- Develop engineering design for the super critical TPP with a capacity of600 MW.

II. Implementation Phase

- Decide to invest in the super critical TPP;
- Change legislation, if necessary, for foreign investment in the construction of thermal power plants;
- Call for tenders for construct or for the super critical TPP;
- Contract a company that will build theTPP;
- Build the super critical TPP;
- Train specialists for Super critical TPP

III. Development oftechnology

- Establish an organization for the operation of super critical thermal power plants;
- Invite foreign experts for training workers;
- Develop guidelines for operation super critical thermal power plants;
- Set up and configure the super critical TPP;
- Commission for operation;
- Monitor and assess the economic and environmental efficiency of super critical TPP.

1.4.8 Project Timeline

The following timeline for implementing the project is to be expected. It is assumed that the work for concrete placing is carried only for the summer season (from April to October).

- Conduct feasibility study on the coal-fired super critical TPP at Baganuur Coal mine – 2003-2004
- Develop engineering design for the super critical TPP with a capacity of 600 MW 2004 - 2015
- Call for tenders for constructor for the super critical TPP - 2015;
- Contract a company that will build theTPP -2015;
- Build the super critical TPP –April 2016 - October 2016; April 2017- October 2016; April 2017 – October 2017

1.4.9 Budget/Resource requirements

The total requested budget for implementing this project is 900 million USD.

The project can be implemented by soft loan or through encouraging private investment in public-private partnerships according to Concession Law of Mongolia.

1.4.10 Measurement/Evaluation

The output as electricity distribution (3.3 billion kWh/year) to the central grid will be measured by electricity meter on in the power house of the super critical TPP.

1.4.11 Possible Complications/ Challenges

The main barriers to the deployment and dissemination of this technology are: 1. Lack of adequate access to financial resources; 2. Lack of public and specialist information about efficient super critical TPP and energy use, as well as lack of information for policy makers to develop adequate strategy in this direction. An important missing component of enabling environment for coal combustion technology is the long term strategy for energy sector – which is the most important indigenous energy source in Mongolia. This is largely because of the lack of sufficient information for policy making.

1.4.12 Responsibilities and Coordination

Government/Ministry of Energy will be responsible in coordination with private companies and international financing organizations.

2. Project Ideas for the residential and commercial sector

2.1 Brief summary of the Project Ideas for residential and commercial sector

The following project ideas have been identified for the residential and commercial sector:

- Improved insulation of panel apartment buildings project. This project will carry out additional insulation on 300 existing apartment buildings in Ulaanbaatar in order to ensure thermal comfort for the residents who live in old residential buildings and reduce coal consumptions for heat supply in power plants.
- Replacement of incandescent light bulbs with energy efficient lamps project: This proposed project aims to replace 500,000 incandescent bulbs with compact fluorescent lamps (CFL) in order to support efficient use of electricity and reduce electricity generation in power plants. The project can be implemented through promoting consumers to switch from incandescent bulbs to more energy efficient CFL lamps by providing them with some incentives originated fromthe Certified Emission Reductions (CERs) revenue as Clean Development Mechanism (CDM) Project. This project will qualify for CDM because it will reduce greenhouse gas emissions by avoiding CO_2 emissions from electricity generation by fossil fuel power plants that supply the Central Energy System of Mongolia.

2.2 Improved insulation of 300 existing panel apartment buildings in Ulaanbaatar

2.2.1 Introduction / Background

About 90 per cent of the overall thermal energy is used for the building heating purposes, which is a peculiarity of Mongolia. The introduction of technologies aimed at improving building insulation is critical for achieving increased energy efficiency. Most of the produced thermal energy have been used for heating buildings for the 8 months of cold winter.

Most of the residential buildings were built with poorly insulated concrete panels before 1990s. So, heat losses of buildings arevery high. However, the panel buildings will continue to be used for decades.

Research projects on building insulation have been implemented and funded by GTZ and etc. The research projects concluded that heat loss of buildings can be reduced by 50-60 % through additional insulation and rehabilitation of residential buildings.

2.2.2 Objectives

To offer additional insulation for 300 existing apartment buildings in Ulaanbaatar in order to ensure thermal comfort of residents who live in these residential old buildings

2.2.3 What are the outputs and are they measurable?

The main output of the project is the additional insulation for 300 existing apartment buildings in Ulaanbaatar and 50% of heat losses reduction in those buildings

2.2.4 Relationship to the country's sustainable development priorities

The project can help to:

- Improve the living conditions of residents;
- Increase reliability of the country's energy supply;
- Reduce coal consumption in power and heat plants;
- Introduce advanced technologies in the residential sector;
- Reduce the negative impact of energy on the environment.
- Reduce greenhouse gas emissions from the energy sector
- Reduce air pollutions in cities
- Increase the disposable income of the residents
- Reduce the heating costs of the state

2.2.5 Project Deliverables

The primary beneficiaries areresidents of 300 existing apartment buildings in Ulaanbaatar.

Apartment comfort will be improved.

GHG emission is expected to be reduced by 842,600 tCO_2/year

2.2.6 Project scope and possible implementation

There are around 500 panel apartment buildings which house around 200,000 people or around 20% of the population of Ulaanbaatar.The precast panel buildings have no added external wall insulation, have poorly insulated external doors and roofs, and most of them have old double wooden framed windows of high heat loss through ventilation.

As mentioned above, 300 panel apartment buildings will be insulated for this project.

The panel buildings' hot water radiator heating systems are not equipped with any heat use controlling device. The apartments are not fitted with any heat consumption metering equipment. Thus building managers and apartment owners lack both financial incentives and the technical means to reduce excessive heat losses or avoid overheating.

2.2.7 Project activities

The following technologies/measures will be deployed in the project:

- EPS (Expanded Polystyrene) wall insulation fitted to the outside of the external precast concrete walls, roofs, and windows changed. Uncontrolled ventilation reduced;
- The heating pipeline to the radiators changed;
- Balancing valves installed for all heating risers by balancing valves;
- A thermostat valve is installed to each radiator;
- Heat meters installed for each apartment heat meters;
- Apartment space heat billing changed from an square meter based heat tariff to a measured actual heat supply based heating tariff.

2.2.8 Project Timeline

The following timeline for implementing the project is to be expected. It is assumed that the construction work is carried only for the summer season (from April to October).

The time line for the additional insulation for 300 existing apartment buildings in Ulaanbaatar is 8 years starting from 2014. Each year from April to October will be insulated 60 existing apartment buildings.

2.2.9 Budget/Resource requirements

The total requested budget for implementing this project is 90 million USD.

The project can be implemented by soft loan or from domestic funding sources or share of international and domestic funding sources

2.2.10 Measurement/Evaluation

The main output is the reduction of heat consumptionin panel apartment buildings. These outputs will be measured by the heat meters installed at this apartment buildings and reflected in the heat balance distributed from Ulaanbaatar District heating Company.

Heat losses reduction in panel apartment buildings, which will be calculated on the bases of measurement.

2.2.11 Possible Complications/ Challenges

Residents have limited interest in paying huge amounts of money for the insulation of heat meters in their buildings. When the heating expenditure is calculated based on the area of the apartment, heating costs will not decrease as a result of better insulation.

Precast panel buildings are all privatized. Even though the residents have interest in insulating their buildings, they do not have the financial resources to pay for the investment cost. Public financing is also difficult. Insulation of these old precast panel buildings is very expensive requiring huge amount of capital expenditures.

2.2.12 Responsibilities and Coordination

The city government could manage the implementation of the project coordinating with international financial organizations, government and private companies

2.3 Replacement of 500000 incandescent light bulbsby energy-efficient compact fluorescent lamps in urban households

2.3.1 Introduction / Background

The efficiency of electricity use in the residential and commercial sector is still low. One prioritized technology for the residential and commercial sector is promoting the use of energy-efficient compact fluorescent lamps (CFL) to replace inefficient incandescent light bulbs (ILB). CFLs provide the same level of illumination as an incandescent lamp but use roughly 70% less electricity. Although CFLs are more expensive than ILBs, they are more economical on a life-cycle basis due to savings in electricity costs. Currently, most households and about 30% of service and commercial buildings use incandescent bulb lamps and the rest use fluorescent bulbs

The first phase implementation plan of the National Action Program on Climate Change approved by the government committed to limit incandescent light bulb usage during the period 2012-2016.

The Mongolia Nationally Appropriated Mitigation Actions (NAMA) to the UNFCCC secretariat also includes measures such as lighting efficiency in buildings.

2.3.2 Objectives

The objective of this project is:

- To promote reduction of electricity consumption for lighting of by replacing incandescent light bulb by energy efficient CFL lamps.
- To reduce the peak demand of central grid.

2.3.3 What are the outputs and are they measurable?

- Changing 500000 incandescent light bulbs (ILB) by compact fluorescent lamp (CFL);
- Reduction of the peak demand for central grid by 40 MW;
- Reduction of CO2 emissions by 90,000 tons/year.

2.3.4 Relationship to the country's sustainable development priorities

- Reduce coal consumption in power and heat plants
- Increase reliability of the country's energy supply
- Introduce advanced technologiesin the residential sector
- Reducethe negative impactof energyon the environment.
- Reduce greenhouse gas emissionsfrom the energy sector
- Reduced air pollutions in cities
- Increase the disposable financial income of the residents

2.3.5 Project Deliverables

Main deliverables are replacing 500000 incandescent light bulbs(ILB) by compact fluorescent lamp (CFL) in urban households mostly in Ulaanbaatar.

2.3.6 Project scope and possible implementation

The project covers the area of rural households of Ulaanbaatar and Darkhan cities.

2.3.7 Project activities

- To conduct pre-feasibility study on the implementation of efficient lighting technology;
- To design implementation scheme for efficient lighting technology in urban household
- To prepare project design document for reduction of CO_2 emissions
- To call for tenders for implementation of efficient lighting technology;
- To contract an investor that will implement the efficient lighting technology;
- To implement the efficient lighting technology

2.3.8 Project Timeline

The time line for changing 500000 incandescent light bulbs (ILB) by compact fluorescent lamp (CFL)is 3 years starting from 2015.

- To change 100000 ILB by CFL in 2015
- To change 200000 ILB by CFL in 2016
- To change 200000 ILB by CFL in 2017

2.3.9 Budget/Resource requirements

The total requested budget for implementing this project is 2.5 million USD.

The project can be implemented by domestic or international funding sources.

2.3.10 Measurement/Evaluation

The main output is the reduction of electricity consumption in household sector. These outputs will be measured by the electricity meters installed in households and reflected in the electricity balance distributed from Ulaanbaatar electricity Distribution company.

The proposed project can reduce greenhouse gas emissions by avoiding CO_2 emissions from electricity generation by fossil fuel power plants that supply the Central Energy System of Mongolia. The CO_2 emission reductions will be determined, not measured, based on UNFCCC CDM Methodologies and available Grid Emission Factor developed already for central grid of Mongolia.

The reduction of peak demand will be measured at by power meter at the National Dispatching Center.

2.3.11 Possible Complications/ Challenges

The possible complications/challenges for implementation of the efficient lighting technology are:

- low electricity tariff;
- lack of management for implementation of the technology
- low quality of CFLs have entered the Mongolian market;
- lack of awareness of energy efficient lighting;
- lack of legal regulation to implement energy efficient technology.

2.3.12 Responsibilities and Coordination

The project can be implemented through encouraging consumers to switch from incandescent bulbs to more energy efficient CFL lamps by providing them with some incentives originated by the Certified Emission Reductions (CERs) revenue through registering the project as a Clean Development Mechanism Project.The proposed project can reduce greenhouse gas emissions by avoiding CO_2 emissions from electricity generation by fossil fuel power plants that supply the Central Energy System of Mongolia. Most of the CER revenue acquired by this project activity can be designed to be distributed to CFLs buyers in the form of economic incentive.

List of references 4

TNA Guidebook 2012. Overcoming Barriers to the Transfer and Diffusion to Climate Technologies, UNEP, January 2012.

MSNC 2010. Mongolia Second National Communication under the United Nations Framework Convention on Climate Change, Ulaanbaatar, 2010.

NAPCC 2011. National Action Program on Climate Change, Ministry of Nature, Environment and Tourism, Ulaanbaatar, 2011

ES 2011. Energy Statistics 2011, Energy Regulatory Committee (in Mongolian), Ulaanbaatar, 2011.

GHG Mongolia, 2000. Greenhouse Gas Mitigation Potentials in Mongolia, Ulaanbaatar, 2000.

Mongolia: NAMA. Mongolia: Nationally appropriate mitigation actions of developing country Parties.

BEEP Report. Energy Efficiency in New Construction in the Residential and Commercial Buildings Sector in Mongolia (in short Building Energy Efficiency Project), MON/09/301, Ulaanbaatar-2012.

Egiin HPP PDD. 2006 The 220 MW EgiinGol Hydroelectric power generation project in Mongolia (The Project or Project activity).

Egiin HPP, 2006 - 220 MW Egiin Hydropower Project, Ministry of Fuel and Energy, Mongolia.

LREM 2007 - The Law on Renewable Energy of Mongolia;

NREP 2005 - National Renewable Energy Program of Mongolia (2005-2020).

MSNC 2010 - Mongolia Second National Communication under the UNFCCC.

NAMA 2010 - Mongolia: Nationally appropriate mitigation actions of developing country

NAPCC 2011 - National Action Program on Climate Change.

IES 2007 - Integrated Energy System (National Program).

Annex 8: List of stakeholders involved and their contacts

Stakeholders		***Representatives***		***Contact***
Organization	***Departments***	***Name***	***Position***	
Ministry of Mineral Resources and Energy	Energy Policy Department	Y. Enkhtuya	Officer	enkhtuya_yo@yahoo.com
	Fuel Policy Department	N. Boldkhuu	Deputy director	bube1458@yahoo.com 99111276
Energy authority	Renewable energy division	Ch.Batbayar	Chief	batbayar@ea.energy.mn
	Energy department	S. Purevdash	Officer	sosapu@yahoo.com 88110965
		P. Baatar	Consultant	purev_baatar@yahoo.com 99158925
		B. Ochirjav	Consultant	ochirjav_b@yahoo.com 99035965
Ministry of Nature, Environment and Tourism	Climate Change coordination office	D. Dagvadorj	Chairman	dagvadorj@mne.gov.mn 99246722
	CDM National Bureau	B. Tsendsuren	Head	tsendsurenb@gmail.com 88991184
	CDM National Bureau	B. Bat-Ulzii	Officer	cdm.bureau@gmail.com 88406846
National Development and Innovation Committee	Industrial Development Department	G. Misheelt	Fuel and Energy policy officer	misheelt@ndic.gov.mn 99901885
UNDP in Mongolia	Building Energy Efficiency project (BEEP)	Munkhbayar	Project manager	munkhbayar.b@beep.mn
Clean Energy	Co., Ltd	Ts. Sukhbaatar	Director	sukhbaatar@newcom.mn 99114462
Mongolian Academy of Sciences	Energy corporation	M. Bum-Ayush	Director	341757 91142305
Mongolian National University	Energy Institute	Y. Gantogoo	Consultant	gantogooy@yahoo.com
The government office of Ulaanbaatar city the capital of Mongolia	The government office	Ch. Tsogtsaikhan	Officer	tsog_1966@yahoo.com 99117893
	The government office	Ch. Seded	Officer	sededchoijil@yahoo.com 95142819
Energy regulatory Committee	The government office	S. Tsetsgee	Officer	tsetsgee@era.energy.mn 99854710
Mongolian Millennium Challenge Corporation	Project Implementation Office	N. Tsolmon	Project officer	tsolmonn@gmail.com
Mongolian Energy Association	Non-governmental Organization	G. Purevdorj	General secretary	gal.purevdorj@yahoo.com 99092150

Mon-Energy Co., Ltd	Co., Ltd	D. Sod	Energy expert	sod@mon.energy.mn 99762407
		D. Landannorov	Senior consultant	landa@mon.energy.mn 91183015
MCS Group	Energy resources Co., Ltd	T.Ganbold	Energy expert	gtogooch@yahoo.com 99163103
	MCS International Co., Ltd	D. Samdan	Energy expert	samdan.d@mcs.mn 91140649

TNA. Volume 2 - Climate Change Mitigation in Mongolia

Ministry of Environment and Green Development, Mongolia
Address: Government Building -2, United Nations Street 5/2
Ulaanbaatar 15160, Mongolia
Tel: (+976)-11-311173
(+976)-11-320402
Fax: (+976)-51-264711