

# Chapter 1

## Introduction and Project Scheme

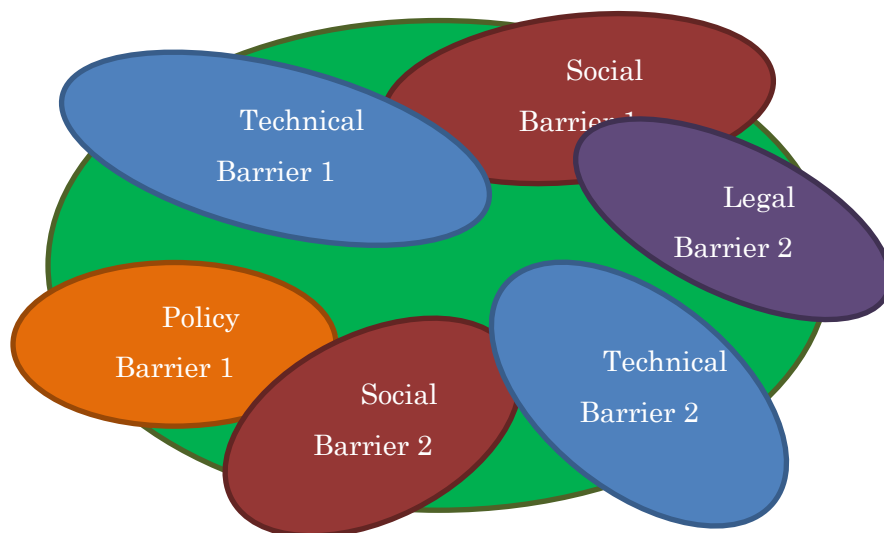
### 1. Introduction

Many Asian countries have been utilising geothermal resources and attempting to increase their capacity although the types of these resources vary from country to country, from the conventional steam power generation and direct use to the more advanced enhanced/engineered geothermal system (EGS) or ground source heat pump (GSHP).

In our previous research project 'Sustainability Assessment of Utilizing Conventional and New-Type Geothermal Resources in East Asia', several technical aspects, such as reservoir management and base (groundwater) data collection, were found to be extremely important for sustainable use of geothermal resources. Technical and social (including policy, legal, and environmental) barriers that discourage expansion of geothermal utilisation were also studied.

This research aims to extract necessary innovations for sustainable use of geothermal resources in Asian countries. Here, innovation includes both social and technical aspects. The benefits of geothermal utilisation, such as power and heat generation, energy saving, reduction of carbon dioxide (CO<sub>2</sub>) emission, and generation of new industries and employment (food, minerals, tourism, healthcare, etc.) will be studied as well to encourage policymakers and business people to invest more in development and utilisation of geothermal energy.

**Figure 1.1. Barriers to Geothermal Energy Use**



Source: The study team.

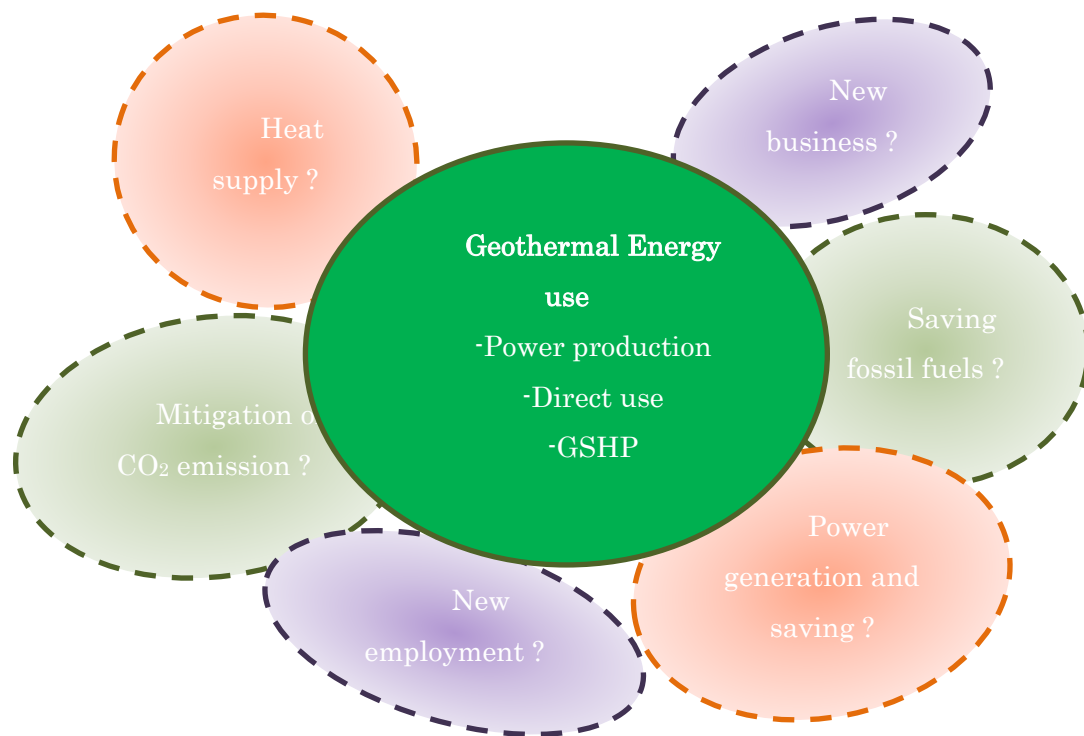
Various barriers are hiding real values of geothermal resources. Removal of these barriers often needs innovations, which can be done only by high-level decisions.

## 2 Key Objectives of the Research

Barriers against geothermal exploitation should be removed (Figure 1.1), but cost–benefit balance should first be clarified before any effort is done. Benefits derived from geothermal energy use have been commonly advocated (Figure 1.2), but have not been quantified specifically for each country.

The key objectives of this project, therefore, are to clarify the barriers and their contributions in each country and to quantify benefits obtained if each barrier is removed. The essential output of this project will be a table of these estimated numbers, which might be achieved through social and technical innovations in the region (Table 1.1).

**Figure 1.2. Benefits of Geothermal Use**



CO<sub>2</sub> = carbon dioxide, GSHP = ground source heat pump.

Source: Authors.

**Table 1.1. Image of Essential Output of this Project\* (Original of this report)**

	Innovation	Policy	Legal	Social	Fiscal	Technical	Total
<b>Benefit</b>							
<b>Power generation (kWh/year)</b>							
<b>Heat supply (MJ/year)</b>							
<b>CO<sub>2</sub> mitigation (tonnes/year)</b>							
<b>New employment</b>							
<b>New business</b>							

\*Items in the rows to be added in the final result.

CO<sub>2</sub> = carbon dioxide, kWh = kilowatt-hour, MJ = megajoule.

Source: Authors.

### **3. Study Method and Research Plan**

The research plan for this project is shown in Table 1.2.

#### **a) Identification of barriers and additional geothermal potential**

- Review current geothermal energy use and its problems in each of the countries covered by this study.
- Identify legal, social, technical, and other barriers that prevent increase and/or sustainable use of geothermal energy.
- Identify amount of additional geothermal energy, which can be utilised if barriers are removed.

#### **b) Identification of contributions of barriers**

- Establish a method to evaluate the contributions of each barrier.
- Identify contributions of specific barriers in each country.

#### **c) Identification of necessary innovations**

- Identify major common barriers and select barriers to be studied.
- Investigate necessary innovations to overcome these barriers.

#### **d) Estimation of benefits to be derived through the innovation**

- Identify possible benefits from additional geothermal energy use, such as additional power/heat supply, CO<sub>2</sub> reduction, new employment, new business, etc.

- Estimate quantitatively the benefits per additional power/heat capacity.
- Calculate benefits per innovation (per removal of each barrier).
- Fill in Table 1.1 with estimated values.

**Table 1.2. Research Plan**

	2015–2016	2016–2017	2017–2018
<b>a) Identification of barriers and additional geothermal potential</b>	Review current situation		Review situation
	Identify barriers (fill top line of Table 1.1)		Review barriers and specify country-specific matters
	Identify potential (fill end column 'TOTAL' of Table 1.1)		Review potential
<b>b) Identification of contributions of barriers</b>	Suggest methods	Establish a method	Improve method
		Identify contributions	Review contributions from survey of domestic experts especially for country-specific matters
<b>c) Identification of necessary innovations</b>	Identify major common barriers		
		Select barriers to be studied	
		Investigate necessary innovations	
<b>d) Estimation of benefits by the innovations</b>		Identify possible benefits (Fill the index column of Table 1.1)	
		Suggest methods to estimate benefits	Estimate benefits quantitatively
		Calculate CO <sub>2</sub> mitigation by additional geothermal use	Calculate benefits per each innovation (Fill whole matrix of Table 1.1)
<b>Reporting</b>	Write progress report	Write progress report	Write final report

Source: The study team.

#### 4. Expected Policy Recommendations

Another objective of the project is to provide policymakers with information on social and technical innovations necessary to increase geothermal power and heat supply in the region and on possible outcomes that could be provided by installation of additional geothermal power and heat supply systems.

The expected policy recommendations include the initiation of necessary research, development, and demonstration for technical innovation and social and legal innovative measures, based on the numbers of possible outcomes, such as increase of power and/or heat supply, energy saving (equivalent oil saving), reduction of CO<sub>2</sub> emission, possible new businesses and employment, etc.

The outcome table will help governments make decisions on innovations in laws or regulations and allocate budgets for related research, development, and demonstration.