MINING SECTOR, BACKGROUND INVESTIGATION – PROJECT STUDY –

FINAL REPORT

December 2014

Japan International Cooperation Agency (JICA)

Mitsubishi Materials Techno Corporation

IL
JR
14-127

CONTENTS

FIGURES & TABLES

List of Abbreviations

Abbreviation	Official name
ADF	African Development Fund
AFD	Agence Française de Développement
AfDB	African Development Bank
APRI	Aboitiz Power Renewables (Philippine)
ARGeo	African Rift Geothermal Development Program
ATI	African Trade Insurance Agency
BGS	British Geological Survey
BOO	Build, Operate and Transfer
CERD	Centre de Recherché Scientifique de Djibouti
CFE	Comission Federal de Electrisidada (Mexico)
CGPHI	Vhevron Geothermal Philippines Holding Inc.
CGR	Center for Geological Resources (Indonesia)
China Exim Bank	The Export- Import Bank of China
CIF	Climate Investment Fund
CONELEC	National Council for Electricity (Ecuador)
CORFO	Chilean Development Corporation (Chile)
CREGEN	Centro Regional de Energia Geotermica del Neuquen
CTF	Clean Technology Fund
DGMCG	Dirctorate General of Minerals, Coal and Geothermal (Indonesia)
DGSM	Department of Geological Survey and Mineral Development (Uganda)
DoE	Philippin Department of Energy
EAGP	East Africa Geothermal Partnership
EdD	Electricite de Djibouti
EDC	Energy Development Corp. (Philippine)
EEPCo	Ethiopian Electric Power Corporation
EIB	European Investment Bank
ENAP	National Oil Company
ENDE	Empresa Nacional de Electricidad (Bolivia)
EPEN	Ente Provincial de Energia del Neuquen
ESMAP	Energy Sector Management Assistance Program
EWASA	Energy, Water Supply Agency (Rwanda)
GDC	Geothermal Development Coorporation（Kenya）
GEAP	Geothermal Experts Advisory Pool

GEF	Global Environmental Facility
GSE	Geological Survey Ethiopia
GST	Geological Survey Tanzania
IBRD	International Bank for Reconstruction and Development
ICEIDA	Icelandic International Development Agency
IDA	International Development Agency
IDB	Inter-American Development Bank
IFC	International Finance Agency
INDE	Institute Nacional de Electrificacion (Guatemala)
INE	Institito Nicaraguense De Energia
INGEMMET	Instituto Geologic Minero Metalurgico (Peru)
ISOR	Islensker Orkurannsoknir
JBIC	Japan Bank for International Coorporation
JICA	Japan International Cooperation Agency
JOGMEC	Japan Oil, Gas and Metals national Corp.
KenGen	Kenya Electric generation Company
KfW	Kreditanstalt fur Wiederaufbau
MEER	Ministry of Electricity and renewable Energy (Ecuador)
MEM	Ministerio de Energia Mines (Peru)
MEM	Ministry of Energy and Minerals (Tanzania)
MENR	Ministry of Energy and Natural Resources (Djibouti)
MEMR	Ministry of Energy and Mineral Resources (Indonesia)
MIGA	Multilateral Investment Gurantee Agency
MOE	Ministry of Energy (Kenya)
NAFIN	Nacional Financiera (Mexico)
NDF	Nordic Development Fund
NTF	Nigeria Trust Fund
O&M	Operation & Maintenance
OPIC	Overseas Private Investment Corporation
PERTAMINA	PT.PERTAMINA (Persero) (Indonesia)
PGE	Pertamina Geothermal Energy (Indonesia)
PLN	PT. Perusahaan Listrik Negara (Persero) (Indonesia)
PPA	Power Purchase Agreement
Propaco	Promotion et Participacion pour la Coorperation economique
RE	Reykjavik Energy
RMF	Risk Mitigation Fund

SCF	Strategic Climate Fund
SERNA- GEOMIN	National Geological survey of Chile
SEGEMAR	Servicio Geologico Minero Argentino
TAF	Technical Assistance Facility
TANESCO	Tanzania Electric Supply Company (Tanzania)
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNU-GTP	United Nations University-Geothermal Training Program
USA Exim Bank	The Export-Import Bank of USA
USTDA	U.S. Trade and Development Agency
USAID	U.S. Agency for International Development
USEA	U.S. Energy Association
WB	World Bank
WBG	World Bank Group

Chapter 1 INTRODUCTION

1.1 Project Name

Background Study of the Mmining Sector – Project Study -

1.2 Implementation Period

from 24th March 2014
to 28th December 2014

1.3 Background and Outline of the Project

It reportedly started the end of the resource boom which had continued from around 2004 years, because the resource price indicates a decline trend after autumn in 2012, throughout European economic recession, USA's aggravation of financial condition, then the slowing of economic expansion of China. On the other hand, some forecast potentially to increase the resource demand in the long term. Therefore, it is necessary to seize the fast-changing and latest trend of market, exploration and development and to have knowledge of the future trend. Especially, it is important to effectively utilize the private sector vitality for advancing countries and to make a contribution on the construction of bilateral win-win relationship, after comprehending the trend of domestic companies.

There were twice oil-shock and the decline in international competitiveness by high yen closed numerous domestic mines after 1970's. As a result, the mining sector and the institution of the related advanced education were consolidated and reduced, and its resources are eventually limited now. So, it is necessary to select the adequate project and to aspire for the effective use after the correct comprehension for this resource constraint. It is also important to arrange and understand the existed JICA projects per a scheme, a sub-area and a country for the consideration of the future effective project development. In addition, it is necessary to arrange the trainee OB data and to plan the effective utilization of its network into the activities related with securing of resources for JAPAN.

The large scale developments of the geothermal resource have been still gone on in Asia, Africa and Latin America as a background for the continued high level of crude oil price, the clean energy-oriented and so on. Japan leads in the manufacturing domain for the geothermal power generation infrastructure like as a turbine and a generator. Therefore, it is crucial strategically to implement ODA projects including human resource development, development planning support and financial cooperation with keeping close attention to the movement in advancing countries.

With a background like the above, this project aims to investigate and identify for the recent trends of mining sector and oversea geothermal resource development around JICA, then to arrange fundamental documents for the preparation of sector strategy and individual projects by JICA based on the survey result.

1.4 Investigation Items of the Project

Investigation items of this project are mainly follows.

(1) Investigation items related with the mining sector

1) Trends of foreign mining sector
2) Trends of domestic companies
3) Trends of donors
4) Profile of foreign principal universities and graduated schools for mining – USA, UK, France, Canada, Australia and etc.
5) Identification of domestic resource
6) Collection of the related information with the government-sponsored foreign students by MEXT
7) Data arrangement for the previous JICA projects
8) Mining sector of advancing countries – 26 countries focused by JICA

(2) Data base construction composed of the mining sector investigation results

(3) Investigations related with foreign geothermal resource development

1.5 Basic Policy of the Project

(1) Identification of the specific related organizations for the major trends investigation of mining sector

It is basic policy of the project to go forward effective and efficient complement by selection and investigation of the related organizations for each item of “investigation items” in Capture 1.4.

Organizations to investigate corresponding to each investigation item are shown in Table 1.5.1. The selection of organizations to investigate is conducted mainly to access HP-web, documentations of JICA, JOGMEC and etc. and lists of society members. Specific name will be decided over discussing with JICA and related organizations.

Table 1.5.1 Organizations to investigate corresponding to each investigation item

Investigation Items	Organizations to investigate
1) Trends of foreign mining sector	JICA、JOGMEC and etc.
2) Trends of domestic companies	Trading company-resource division, Steel company, mining related company JOGMEC and etc.
3) Trends of donors	World bank, bilateral major donors, NGO, Extractive Industries Transparency Initiative (EITI) etc
4) Profile of foreign principal universities and graduated schools for mining	Principal universities and graduated schools for mining in USA, UK, France, Germany, Russia, Canada, Australia and other countries
5) Identification of domestic resource	1. University, Graduated school, Institute and etc. 2. Consultants for resource development 3. Domestic mines
6) Collection of the related information with the government-sponsored foreign students by MEXT	Focused countries for mining, Destination to study abroad
7) Data arrangement for the previous JICA projects	JICA etc.
8) Mining sector of advancing countries – 26 countries focused by JICA	JICA etc.

(2) Arrangement of investigation items to identify the major trends of mining sector

It will be identified research matters for each investigation items, shown in Table 1.5.2

Table 1.5.2 Research Matters for each Investigation Items

Investigation items	Research contents
1) Trends of foreign mining sector	- Production, consumption, consumer countries, price trend for 30 mineral resources which Japanese government decided at resource securement strategy, Trends of major natural resource companies, exploration and development situation in the world. - Background and history related with present resource nationalism, Cases in each countries and Risk which companies will face.
2) Trends of domestic companies	- Trends before some 5 years related with exploration, development and securing interests by trading company-resource division, Steel company, mining related company JOGMEC and etc.
3) Trends of donors	- Trends of assistance by WB, bilateral major donors, NGO, international organization. - Trend of Extractive Industries Transparency Initiative (EITI) and measure for conflict minerals
4) Profile of foreign principal universities and graduated schools for mining	- Selection of Universities and graduated school and arrangement of the details. - Assistant situation for human resource development in advancing countries.

5) Identification of domestic resource	- Universities, graduated schools, Institutions – study and education area, number of staff and student, acceptance situation of foreign students, laboratory instruments, oversea field survey activities, foreign partner university, detail information on acceptance matching for long-term trainee. - Consultants for resource development –- company name, specialization field, number of staff, age distribution, company scale. - Domestic mining engineering companies - company, specialization field, number of staff, age distribution, company scale.
6) Collection of the related information with the government-sponsored foreign students by MEXT	- Past record of foreign student from mining countries – country, fiscal year, mother university or organization, destination to study abroad (university, faculty, study period etc.) - Information of present foreign student – c0mtry name, mother university or organization, destination to study abroad (university, faculty, study period etc.)
7) Data arrangement for the previous JICA projects	- Data arrangement for the previous projects of mining sector – country name, sub-field, scheme, fiscal year, project profile of cooperation period, object, results, contractor company, C/P, granted equipment and amounts - Trainee – country, fiscal year, name training course, personnel name, sub-organ and job title, present job title and contact address. - Lesson and challenge from previous cooperation
8) Mining sector of advancing countries – 26 countries focused by JICA	- Administration organization chart, Policy of major mineral resource, development trends etc. - Major mines, management system (government-manage, private-manage, foreign investment JV)

(3) Construction of simple data-base and Considering for the effective and successive utilization

The results of terms 5) to 7) in investigation items (1) and other results which can be qualified will be used to construct simple data-base with Excel® application.

(4) Identification of specific countries and organizations to investigate major trends of geothermal development

Fundamental policy of the project is to aim effective and efficient implement with the collection and the arrangement of the existed information by domestic research and the oversea site inspection after decision of countries and organizations to investigate. The countries and organizations to investigate are shown in Table 1.5.3

Table 1.5.3 Countries and organizations to investigate

Investigation Items	Countries and organization to investigate
1. Domestic research for collecting information	− Another donors and University like as Geothermal Training Program (UN university, Iceland), Geothermal institute (Auckland university, NZ) − WB, Africa DB, IDB, KfW etc. − Related donors in countries (Africa, Asia, geothermal potential countries)
2. Oversea site inspection	− Geothermal Training Program (UN university, Iceland), Donor organizations (UNEP, Kenya), WB(Washington), IDB (Washington)

(5) Identification of specific countries and organizations to investigate major trends of geothermal development

Contents shown in Table 1.5.4 will be researched for each investigation items.

Table 1.5.4 Research contents for each investigation items

Investigation items	Research contents
1. Domestic research for collecting information	− To confirm the profile of human resource development related to geothermal resource development, performed by ex. UN university (Iceland), Donors or another university. − To confirm the outline of funds on geothermal resource development by WB, Africa DB, IDB, KfW etc. − To clarify the demarcation between the government and private sector at each geothermal development stages as field survey, drilling, evaluation, plant construction in different geothermal potential countries (Africa, Asia, Latin Americas) and to confirm the interrelationships with development situation. − To plan the oversea site inspection
2. Oversea site inspection	− To interview at UN university in Iceland, the related donors in Kenya, WB in Washington, IDB in Washington. − To arrange and analysis the interview results.

1.6 Project implementation

The investigation items will be conducted under the work flow, shown in Figure 1.6.1, based on JICA's work direction.

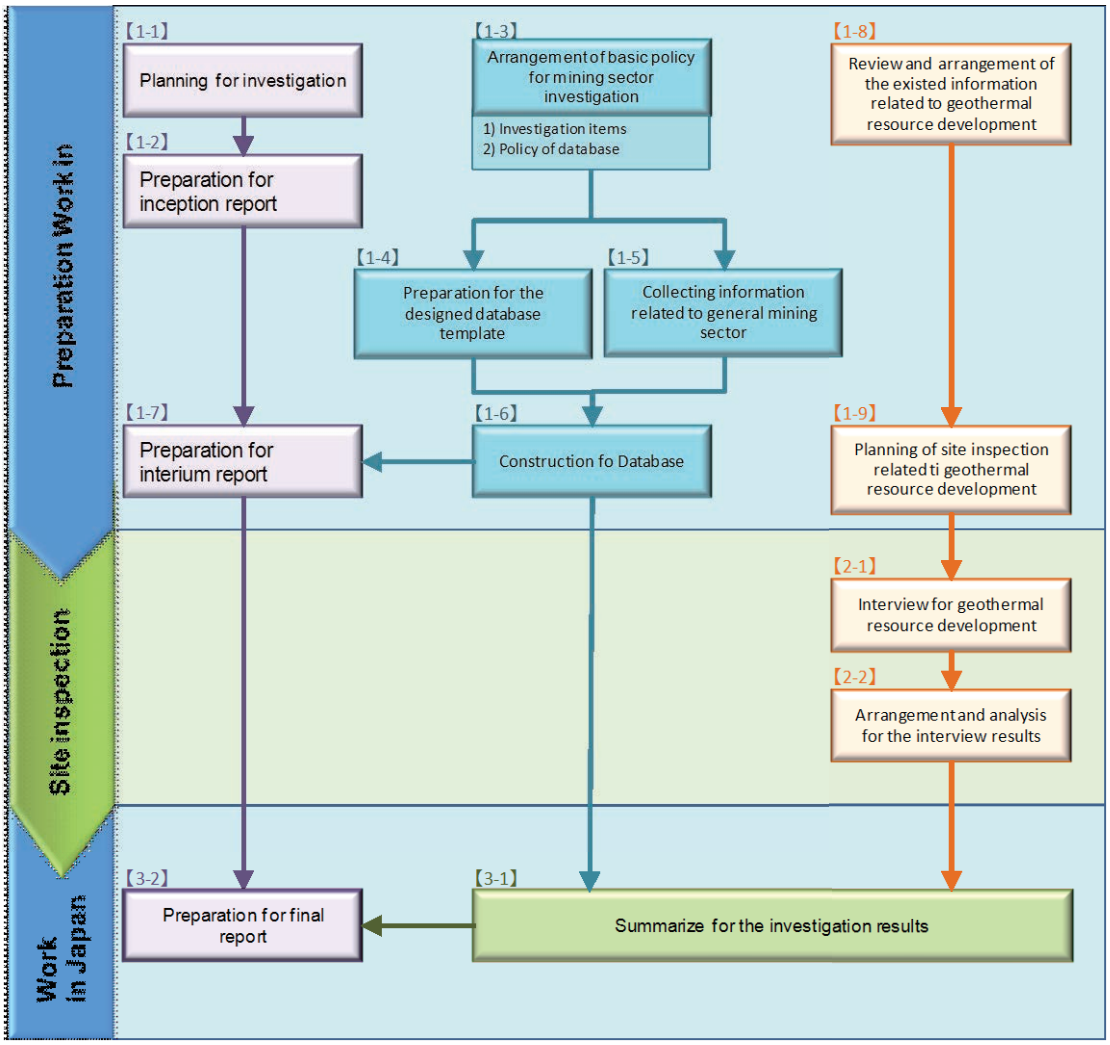


Figure 1.6.1 Work flow of project implementation

1.7 Staffs of the project

Staffs of the project are shown in Table 1.7.1

Table 1.7.1 Staffs of the project

Staff	Work in charge	Organization
Norio Ikeda	Management/ analysis of mining sector/ Oversea geothermal resource development	Natural resource survey
Tetsuo Noda	Oversea geothermal resource development	Nittetsu Consultant
Takehiro Koseki	Oversea geothermal resource development	Natural resource survey
Katsuhiko Maeda	Domestic resource research	Natural resource survey
Hiroshi Hyodo	Data processing	Natural resource survey

Chapter 2 Investigation results of domestic and foreign trends and domestic resources related to mining sector

2.1 Clarification of domestic resources

Six universities specified by JICA are as follows.

- ✓ Akita University
- ✓ Kyushu University
- ✓ Hokkaido University
- ✓ Waseda University
- ✓ Kyoto University
- ✓ Tohoku University

The organization, the contents and the number of foreign students, etc. of these universities and the graduate schools are described, and the individual list for every researcher is prepared on appendix.

The summary of university and graduated school is shown in Table 2.1.1.

Table 2.1.1 List of the summary of university and graduated school

Graduate school and the related laboratories		Akita Univ. Faculty of International Resource Sciences/ Graduate School of Engineering and Resource Science 11 Laboratories+6 domains	Kyushu Univ. Graduate School of Enginnering Department of Earth System Engineering 7 Laboratories	Hokkaido Univ. Cource of Sustainable Resources Engineering 6 Laboratories	Waseda Univ. School of Creative Science and Engineering Department of Resources and Environmental Engineering 11 Laboratories	Kyoto Univ. Graduate school of Engineering Department of Civil and Earth Resources Engineering 5 Laboratoris	Tohoku Univ. Graduate school of Environmental Studies 14 Laboratories
Existence or non-existence of English Program in Master Course		non, It's possible to partisipate into the reading program	Exist, the detail is unk.nown	Exist, (E-cube, English Engineering Education Program)	non	non, Only civil engineering	Exist, Grobal30 sustainable international environmental study
Category I- Large	Category II- Small	Laboratory, Professor, (Expatized field)	Laboratory, Professor, Expatized field	Laboratory, Professor, Expatized field	Laboratory, Professor, Expatized field	Laboratory, Professor, Expatized field	Laboratory, Professor, Expatized field
Resource geology	Economic geology	Economic Geology Research Group Prof. Imai, R.: Economic Geology, Resource Geology	Laboratory of Economic Geology Prof. Wananabe, K.: Geochronology, Economic geology, Environmental geology Associate Prof. Yonedu, K.: Geochemistry, Resources and Environmental Geology		Laboratory of Geochemistry of Mineral Resources Prof. Uchida, E.: Petrology, Mineralogy, Economic Geology, Cultural Heritage Science		Laboratory of GeoMaterials and Energy Prof. Tsuchiya, Y.: Geology, Geochemistry Associate Prof. Okamoto, A.: Lithology, Economic Geology
		Mineral Resources and Tectonics Group Prof. Watanabe, Y.: Ore deposit, Resource geology					
	Minelalogy				Laboratory of Applied Mineralogy Prof. Yamazaki, J.: Petrology, Mineralogy, Economic Geology, Inorganic Material and Physical Properties		
	Petroleum geology	Geohistorical and Paleoenvironmental Analyses Group Prof. Sato, T.: Petroleum geology, Palaeoceanography Associate Prof. Yamasaki, M.: Micropaleontology, Palaeoceanography					
		Petroleum Geology Group Prof. Arato, Y.: Petroleum Geology, Sedimentology Associate Prof. Chiyonobu, S.: Petroleum geology					
	Volcanology, Petrology	Petrology Group Prof. Oba, T.: Petrology, Volcanic Geology Associate Prof. Yamamoto, M.: Petrology, Volcanic Geology					
Environmental geology	Resource geology, environmental geology, grand and grandwater pollution	Circulation of Resource Environment Substance Laboratory Prof. Ishiyama, D.: Environmental Resource Geology, Petrology, Mineralogy Asscociate Prof. Ogawa, Y.: Earth-Resource System Engineering		Laboratory of Ground Water and Mass Transport Prof. Igarashi, T.: Foundation Engineering, Civil Engineering Environment Associate Prof. Harada, S.: Process Engineering, Fluid Engineering	Laboratory of Geo-Environmental Science Prof. Kamura. K.: Environmental Geology, Waste Treatment Engineering, Underground Environment Monitoring		
				Laboratory of Environmental Geology Prof. Sato, T.: Environmental Mineralogy, Clay Mineralogy Associate Prof. Otake, T.: Geochemistry, Economic Geology			
Resource exploration	Physical exploration, Remote sensing, Modeling	Geophysics Laboratory Prof. Nishiya, T.: Geophysics, Paleomagne Associate Prof. Tsutsui, T.: Geophysics	Laboratory of Exploration Geophysics Associate Prof. Mizunaga, H.: Exploration Geophysics, Environmental Geophysics Associate Prof. Saibi, H.: Exploration Geophysics		Exploration Geophysics Laboratory Prof. Saito, A.: Exploration Geophysics, Geophysical Logging	Laboratory of Geophysics Prof. Mikada, H.: Exploration Geophysics, Volcanology, Seismology Associate Prof. Goto, T.: Exploration Geoghysics, Submarine Physics	Information Science for Environment Laboratory Prof. Sato, G.: Underground Electromagnetism Measurement, SAR Associate Prof. Takahashi, K.: Applied Electromagnetism
		Energy Resources Engineering Laboratory Associate Prof. Onishi, K.: Oil Development Engineering, Physical Exploration				Laboratory of Environment and Resource System Engineering Prof. Matsuoka, T.: Exploration Geophysics, Statistics Science, CCS Associate Prof. Yamada, Y.: Geological Structure Modeling, Geophysical Logging	Surface and Subsurface Instrumentation Laboratory Associate Prof. Moriya, H.: Underground Information Measurement, Geophysics
						Laboratory of Environmental Geosphere Engineering Prof. Koike, K.: Remote Sensing, Geothermal and Crust Environment Modeling Associate Prof. Mito, Y.: Rock Engineering	Earth System Monitoring and Instrumentation Laboratory Associate Prof. Murata, I.: Physics of the Upper Atmosphere, Meteorology, Physical Oceanography
	Geochemistry					Laboratory of Environmental Geosphere Engineering Assistant Prof. Kashiwaya, K.: Hydrology, Environmental Tracer, Applied Geology	Geo-environmental Measurement and Analysis Laboratory Associate Prof. Hirano, N.: Petrology, Mineralogy, Environmental Technology, Geochemical Analysis
Development of Oil/ Geothermal	Oil reservoir engineering	Energy Resources Engineering Laboratory Prof. Fujii, H.: Geothermal and Oil Development	Laboratory of Energy Resources Engineering Prof. Itoi, R.: Geothermal Reservoir Engineering, Geochemical Prospecting		Rock Mechanics and Oil Production Laboratory Prof. Morita, N.: Numerical Rock Engineering, Oil Production Engineering		
					Petroleum Engineering Laboratory Prof. Kurihara, M.: Petroleum Engineering, Reservoir Simulation		
	Hydrothermal reservoir engineering		Laboratory of Energy Resources Engineering Prof. Itoi, R.: Geothermal Reservoir Engineering, Geochemical Prospecting				Crustal Complex Systems Design Laboratory Prof. Hashida, T.: Energy Conversion Material Engineering Associate Prof. Sato, K.: Material Strength
			Laboratory of Geothermics Prof. Fujimitsu, Y.: Geothermics, Geothermal Engineering, Hydrology				Extraction of Crustal Energy Laboratory Prof. Ito, T.: Solid Geophysics, CCS, Hydrothermal Reservoir
Mining	Rock Engineering (Mining Engineering)	Rock Engineering Laboratory Prof. Sugimoto, F.: Applied Rock Engineering Prof. Imai, T.: Rock Engineering Associate Prof. Kizaki, A.: Rock Engineering, Environmental Science	Rock Engineering and Mining Machinery Prof. Mataui, K.: Rock Engineering, Rehabilitation Engineering Associate Prof. Shimada, H.: Rock Engineering, Underground System Utility Engineering	Laboratory of Rock Mechanics Prof. Fujii, Y.: Rock Mechanics Associate Prof. Kodama, J.: Rock Mechanics		Labortory of Earth Crust Engineering Prof. Ishida, T.: Rock Engineering, Waste Storage Associate Prof. Murata, S.: Rock Engineering, Petroleum Reservoir Engineering	Earth Exploration Environmental Laboratory Prof. Takahashi, H.: Resources Development Engineering, Recycling Engineering Associate Prof. Sakaguchi, K.: Environmental Crust Dynamics, Geo-Mechanics
	Industrial engineering/ Mine Safty		Laboratory of Resources Production and Safety Engineering Prof. Sasaki, K.: Mineral Resources Production Engineering Associate Prof. Inoue, M.: Mining Engineering, Safety Engineering			Laboratory of Neasurement and Evluation Technology Prof. Asakura, T.: Rock Engineering, Tunnel Engineering, Foundation Engineering Associate Prof. Tsukada, K.: Non-destructive Inspection	
Metallurgeny/ Recycle	Metallurgeny/ Recycle	Mineral processing Labolatory Prof. Shibayama, A.: Mineral processing, Recycle Engineering	Laboratory of Mineral Processing, Recycling and Environmental Remediation Prof. Hirashima, T.: Mineral Processing, Resources Recycling Prof. Sasaki, K.: Mineral Processing, Remediation of Environments Associate Prof. Okiba, N.: Mineral Processing, Remediation of Environments, Biohydrometallurgy	Laboratory of Mineral Processing and Resources Recycling Prof. Hiroyoshi, N.: Mineral processing engineering, Resource Recycling Engineering Associate Prof. Ito, M.: Resource Engineering, Recycling Engineering, Specific Gravity Sorting, Jig	Laboratory of Resources Recycling Engineering Prof. Owada, S.: Recycle Engineering, Resource Separation Engineering, Ore Floatation		Recycling Chemistry Laboratory Prof. Yoshioka, T.: Recycling Engineering, Environmental Chemistry Associate Prof. Kameda, T.: Environmental Technology, Environmennal Materials
					Laboratory of Powder Processing for Resources and Environmental Treatment Associate Prof. Tokoro, C.: Resource Processing Engineering, Environmental Treament Engineering		
Refining	Refining	Refining Process Engineering Laboratory Prof. Inoue, R.: Refining, Metal Chemistry Associate Prof. Takasaki, Y.: Non-iron Refinement Engineering			Materials Processing Engineering Laboratory Prof. Fuwa, A.: Materials Processing Engineering, Refining		Environmental Green Process Laboratory Prof. Richard, L.S.: Chemical reaction Engineering, Process System Associate Prof. Watanabe, K.: Catalyst and Resource Chemical Process
							Material Process for Circulatory Society Laboratory Prof. Komarov, S.: Aluminum, Nanostructural Material Associate Prof. Yoshikawa, N.: Metal Production Engineering
							Process Engineering for Advanced Resourcs Utilization Laboratory Prof. Kasai, E.: Metal Production Engineering Associate Prof. Murata, T.: Metal Production Engineering
Environment	Environmental chemistry			Laboratory of Chemical Resources Associate Prof. Fukushima, M.: Environmental Chemistry, Catalyst Chemistry	Laboratory of Atmospheric and Aquatic Environmental Chemistry Prof. Okochi, H.: Environmental Kinetic Analysis, Environmental Impact Assessment		
	Environmental biology			Laboratory of Biotechnology for Resources Engineering Prof. Kawasaki, R.: Environmental Geotechnical Engineering, Microbe, Bio Grouting			Geoenvironmental Remediation Laboratory Prof. Inoue, C.: Environmental Reclamation, Bioleaching Associate Prof. Sudo, K.: Environmental Reclamation, Bioleaching
	Dust/ Environmental risk				Laboratory of Environment and Safety Engineering Prof. Nagoya, T.: Environmental Safety Engineering, Dust Pollution		Resource and Energy Security Laboratory Prof. Komai, T.: Fuel Resources Engineering, Environmental Risk Assessment Associate Prof. Watanabe, N.: Crustal Fluid, Environmental Technology
	Sustainable environmental engineering			Laboratory of Eco-materials and Resources Prof. Nawa, T.: Cement Chemistry, Eco-concrete Associate Prof. Kurumisawa, K.: Architecture, Building Construction and Materials			Designing of Nano-Ecomaterial Laboratory Prof. Tohji, K.: Material Function Engineering, Material Engineering Associate Prof. Takahashi, H.: Inorganic Chemicals, Catalyst and Resource Chemical Process
Scoial science/ Policy study	Micro resource economics	Prof. Adachi, T.: Mineral Resource Economics, Mineral Resource Development					
	Macro resource economics						
	Mining law						
	Mining Management						
	Anthropology, linguistics,local study and etc.	Prof. Miyamoto: Linguistics, Cultural Anthropology Prof. Miyake: Sodolinguistics, Linguistic Anthropology Prof. Nawata:Ergonomics, Cultural Anthropology Prof. Aizawa: International Sociology Associate Prof. Morrison: International Relations Associate Prof. Tadokoro: Cultural Anthropology Prof. Uchida: Sedimentology, Petroleum Geology					

Chapter 3 Research on Overseas Geothermal Resource Development

3.1 Survey Overview and Objectives

This study consists of review of publications and internet information in Japan, and interviews to the donor in overseas.

The purpose of the survey is as follows.

① Clarification for profiles of human resource development related to geothermal resource development provided by UN university, Iceland, another donors and universities of NZ etc.

② Clarification for profiles of geothermal funds by World Bank, Africa Development Bank, Inter-Americas development Bank, Kreditanstalt für Wiederaufbau (KfW), U.S. Department of State, U.S. Energy Association, U.S. Agency for International Development and Icelandic International Development Agency etc.

③ Clarification the demarcation between the government and private sector at each geothermal development stages as field survey, drilling, evaluation, plant construction in different geothermal potential countries (Africa, Asia, Latin Americas) and confirmation of the interrelationships with development situation.

3.2 Interviews Schedule

The schedule of interviews is shown in Table 3.2.1

Although it was due to interview 20 organizations at the beginning of a plan, the final interview place became 17 organizations. The main reasons were influences of impromptu political rallies in Nairobi, and it is raised that schedule adjustment became difficult.

Interviews with 4 organizations, USAID, ICEIDA, ARGeo, and GRMF should have been conducted as they are remarkable organizations in geothermal development. The interviews with the first 3 organizations were conducted as planned, however having an interview with GRMS was not carried out due to the difficulty of making an appointment. Instead of having an interview with GRMS, another interview with KfW which offers 100% of financial support to GRMS was organized so that necessary information about GRMF was acquired.

Table 3.2.1 Schedule of interviews

	Date		Contents
1	24-Jun	Tue	Tokyo (11:05) ⇒Washington (10:40)
			JICA USA Office (13:00)
			Inter-American Development Bank (IDB)(14:00)
2	25-Jun	Wed	International Finance Corporation (IFC)(10:00)
3	26-Jun	Thu	US Department of State (10:00)
			World Bank (WB/ESMAP)(16:00)
4	27-Jun	Fri	US Energy Association (USEA)(10:30)
			Washington (21:50) ⇒
5	28-Jun	Sat	⇒London (10:15, 13:00) ⇒Reykjavik (15:00)
6	29-Jun	Sun	Data compilation
7	30-Jun	Mon	Icelandic International Development Agency (ICEIDA)(10:00)
			Iceland Geosurvey (ISOR)(11:00)
			United Nations University -Geothermal trainning -program (UNU-GTP)(13:00)
8	1-Jul	Tue	Reikykjavik Enegy (RE)(10:00)
			Verkis (Verkis)(17:00)
9	2-Jul	Wed	Reykjavik (07:20) ⇒Munich (13:05)
			Munich Re(16:00)
10	3-Jul	Thu	Munich (07:45) ⇒Zurich (08:45,09:25) ⇒Nairobi (18:05)
11	4-Jul	Fri	JICA Kenya Office (8:00)
			UN Environment Programme(UNEP)-African Rift Geothermal Development Program (ARGeo)(10:00)
			African Trade Insurance Agency (ATI)(14:30)
12	5-Jul	Sat	Data compilation
13	6-Jul	Sun	Data compilation
14	7-Jul	Mon	Stop the interview due to strike
15	8-Jul	Tue	U.S. Agency for International Development (USAID)(9:30)
			JICA Kenya Office(11:00)
			Kreditanstalt für Wiederaufbau (KfW)(14:00)
			European Investment Bank (EIB)(16:00)
16	9-Jul	Wed	Nairobi (08:40) ⇒Istanbul (15:05, 17:10) ⇒
17	10-Jul	Thu	⇒Tokyo (10:25)

3.3 Memebers of Interviewers

① Mr. Norio Ikeda: Generalization and the overseas geothermal resources survey B
Field-survey period: June 24, 2014 to July 10

② Dr. Tetsuro Noda: Overseas geothermal resources survey A
Field-survey period: June 24, 2014 to July 3

3.4 Results of Interview

Interview organization and interview person are as in Table 3.4.1. Meeting minutes of interviews are attached to separate attachment data.

The data (see table 3.4.2) are acquired during the interview.

Table 3.4.1 List of Interview organization and interview person

	Donor etc.	Interviewees
1	Inter-American Development Bank (IDB)	Mr. Shohei Tada, Secondee
2	International Finance Corporation (IFC)	Mr. Shinji Yamamoto, Chief Investment Officer
3	U.S. Department of State	Mr.Tim Williamson, Deputy Director
4	World Bank (WB/ESMAP)	Mr. Pierre Audinet, Clean Energy Program Team Leader
5	U.S. Energy Association (USEA)-East Africa Geotyhermal Partnership (EAGP)	Mr. Andrew Palmateer, Acting Deputy Director
6	Icelandic International Development Agency (ICEIDA)	Dr. David Bjarnason, Programme Manager
7	Iceland Geosurvey (ISOR)	Dr. Fridriksson, Geochemist
8	United Nations University-Geothermal Training Programme (UNU-GTP)	Mr. Ingimar G. Haraldsson, Geputy Director
9	Reykjavik Energy (RE)	Mr. Einar Gunnlaugsson, Head of Natural Resources
10	Verkis (Verkis)	Mr. Gunnsr Ingi Gunnaron, Chairman/Senior Marketing Manager
11	Munich Re (Munich Re)	Mr. Stephan Jacob, Geologist
12	United Nations Environment Programme (UNEP)-Africa Rift Geothermal Development Program (ARGeo)	Dr. Meseret Teklemariam Zemedkun, Program Manager
13	African Trade Insurance Agency (ATI)	Mr. Jef Vincent, Chief Underwriting Officer
14	U.S. Agency for International Development (USAID)	Mr. Ira Frydman, Team Leader
15	Kreditanstalt für Wiederaufbau (KfW)	Ms. Oliver Muthoni
16	European Investment Bank (EIB)	Niko Miliantis, Senior Loan Officer

Table 3.4.2 List of acquisition data

	Donor etc.	Data	Print version	Digital file
1	Inter-American Development Bank (IDB)	La Geo: Programa Regional de Entrennamiento Geotermico	○	
2	International Finance Corporation (IFC)	Investment- IFC Track Record	○	
		IFC Investment in PNOC-EDC Supports Philippine	○	
		Private Financing of Geothermal Development IFC's Global Experience	○	
		Success of Geothermal Wells: A Global Study	○	
3	U.S. Department of State	2013.09.16 CTF Indonesia Geo program CONFIDENTIAL		○
		2013.09.16 CTF Indonesia Geo Proposal Cover sheet		○
		Chile MiRiG		○
		Mexico Geothermal Risk Mitigation Facility		○
4	World Bank (WB/ESMAP)	Global Geothermal Development Plan	○	
		ARGeo_Djibouti_Grant_Technical_Note_Jannuary 28		○
5	U.S. Energy Association (USEA)-East Africa Geotyhermal Partnership (EAGP)	Fact Sheet: U.S.-East Africa Geothermal Partnership (EAGP)	○	
6	Icelandic International Development Agency (ICEIDA)	Geothermal_Exploration_Brief May 2014		○
7	Iceland Geosurvey (ISOR)	-		
8	United Nations University-Geothermal Training Programme (UNU-GTP)	UNU GTP presentation May 2014		○
9	Reykjavik Energy (RE)	Geothermal Utilization Power Genaration and Hot water Supply in Iceland	○	
10	Verkis (Verkis)	GEOTHERMAL-ENERGY-CONSULTING-SERVICES		○
11	Munich Re (Munich Re)	Exploration Risk Insurance Geothermal	○	
12	United Nations Environment Programme (UNEP)-Africa Rift Geothermal Development Program (ARGeo)	-		
13	African Trade Insurance Agency (ATI)	Corporate Snapshot	○	
14	U.S. Agency for International Development (USAID)	Kenya Power Africa geothermal Program Overview	○	
15	Kreditanstalt für Wiederaufbau (KfW)	-		
16	European Investment Bank (EIB)	-		

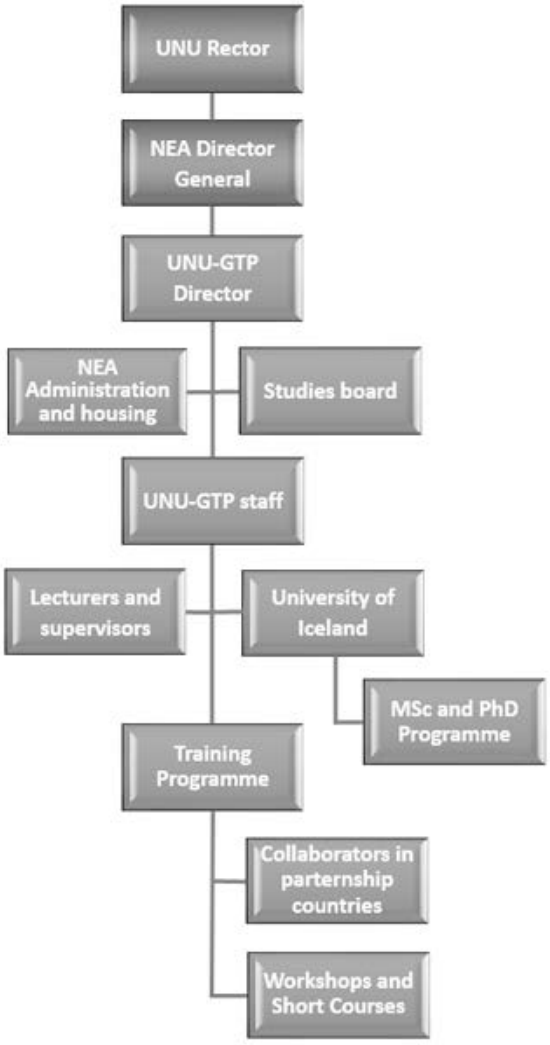
3.5 Overview of Capacity Building in Geothermal Resource Development

The United Nations University Geothermal Training Program (UNU-GTP) and the training program of institute of earth science and engineering of the University of Auckland are major training program for geothermal development.

(1) The United Nations University Geothermal Training Program (UNU-GTP)

1) Purpose and establishment of UNU-GTP

The Government of Iceland and the United Nations University (UNU) decided in 1978 to establish the UNU Geothermal Training Program (UNU-GTP), with Orkustofnun (NEA; the National Energy Authority of Iceland) as the host institution (Figure 3.5.1). The program hosted by the National Energy Authority (Orkustofnun) has been operated in Iceland since 1979.

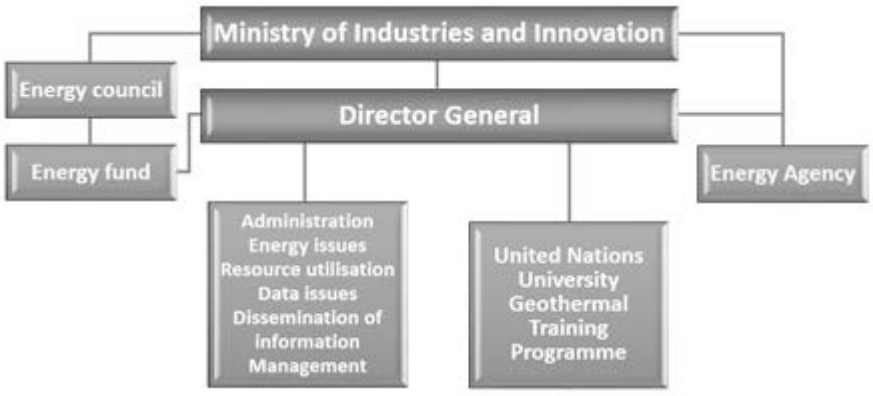


Source: UNU-GTP H.P.

Figure 3.5.1 Organization Chart of UNU-GTP

The aim of this program is to assist developing countries with significant geothermal potential to establish groups of specialists in geothermal exploration and development by offering six month specialized training, short course, Msc and PhD fellowship for professionals employed in geothermal research and/or development.

Orkustofnun is a government agency under the Ministry of Industry and Innovation. Its main responsibilities are to advise the Government of Iceland on energy issues and related topics, license and monitor the development and exploitation of energy and mineral resources, regulate the operation of the electrical transmission and distribution system and promote energy research (Figure 3.5.2). The Geoscience Division was separated from Orkustofnun, in 2003, and a new public company established of ISOR (Iceland GeoSurvey) with basically the same operations as the former Geoscience Division.



Source: UNU-GTP H.P.

Figure 3.5.2 Organization Chart of Orkustofnun

2) Organizations related to the UNU-GTP

The specialty of 90 staff members is at ISOR in 2008 as follows,

Table 3.5.1 Number of Specialist in ISOR

Category	Number of persons
PhD	20
Geologists	29
Geophysicists and reservoir physicists	18
Geochemists	9
Engineers	9
Geographers	3
Administrators	2
Technicians	10
Electricians	8

Source: Fridleifsson (2010)

The UNU-GTP also has a close cooperation with the University of Iceland (UI). Staff members of the Faculty of Science and the Faculty of Engineering have been key lecturers and supervisors of the UNU Fellows in some subjects since the establishment of the UNU-GTP. A co-operation agreement was signed in 2000 between the UNU-GTP and the UI on MSc studies in geothermal energy and PhD studies in 2008. A similar agreement was made with Reykjavík University in 2013.

3) Studies Board

The UNU-GTP has six full time staff members (employed by Orkustofnun), but lecturers and support staff are hired from ISOR, UI, Reykjavik University (RU), and other agencies/companies. Every year, about 50 staff members of these institutions render services to the UNU-GTP under contracts. This allows the flexibility required to provide highly specialized training in the nine fields of specialization offered. The UNU-GTP is academically governed by a Studies Board, which is composed of experts (from ISOR, UI and RU) responsible for each of the specialized courses. The UNU-GTP Director is the chairman of the Studies Board.

4) UNU-GTP program

UNU-GTP program is as follows,

i) UNU-GTP Six Month Training Program

ii) UNU-GTP Short Courses

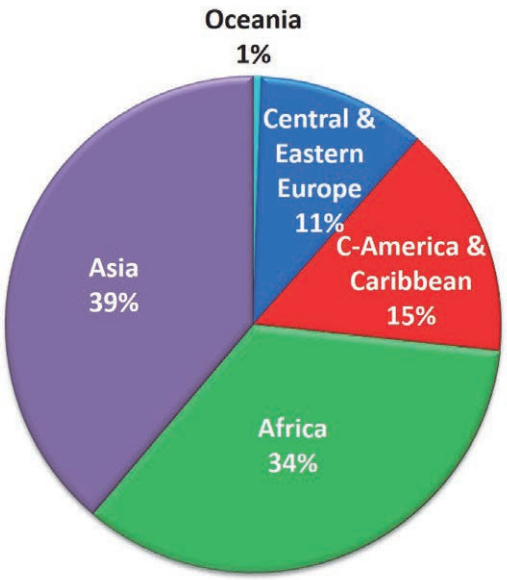
iii) MSc fellowship and PhD fellowship

5) UNU-GTP Six Month Training Program

a) Numbers of Participants and Countries

From 1979-2013, 554 scientists and engineers from 53 countries have completed the annual six month courses. They have come from countries in Asia (39%), Africa (34%), Central and Eastern Europe (11%), Latin America (15%), and Oceania (1%) (Figure 3.5.3). The largest groups of Fellows have come from Kenya (89), China (82), the Philippines (36), El Salvador (36), Ethiopia (32), and Indonesia (29) (Table 3.5.2, Figure 3.5.4).

The tendency of the participants in each year is shown in Figure 3.5.5.



1979-2013

- 554 scientists and engineers from 53 countries have completed the Six Month Training Programme
- Thereof 108 women (19%)
- 35 graduates from the MSc programme offered with University of Iceland since 2000 and Reykjavík University since 2013

Source: UNU-GTP H.P.

Figure 3.5.3 Participation region in UNU-GTP

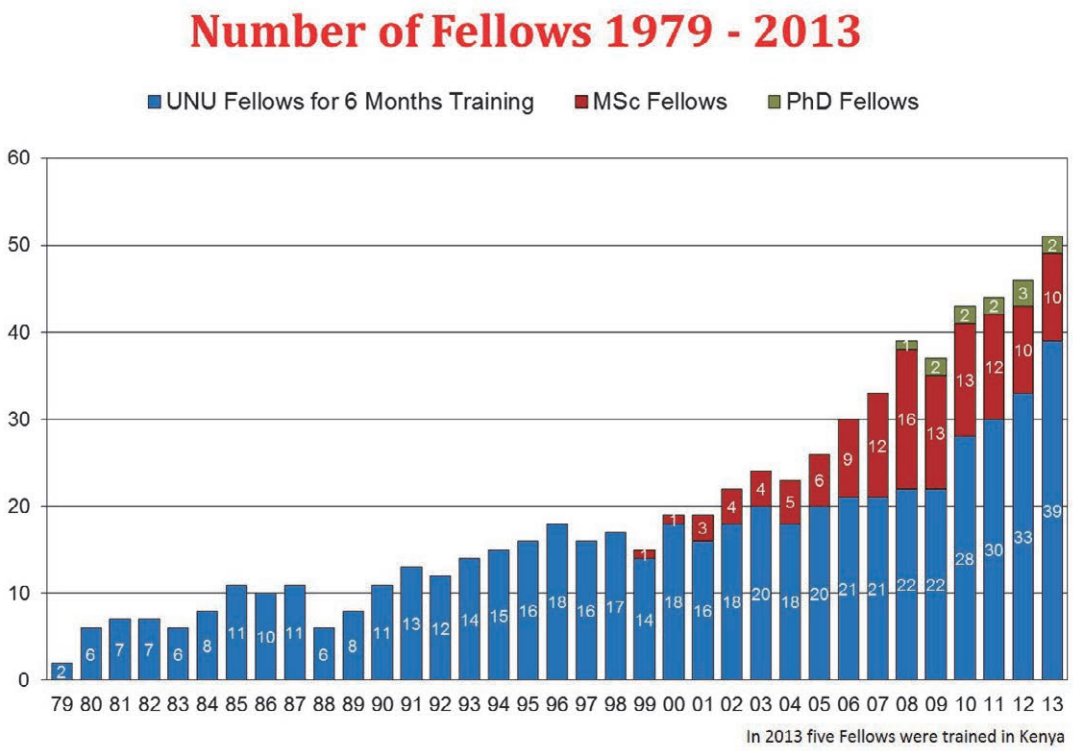
Table 3.5.2 Number of Participants in UNU-GTP Six Month Training Program

FELLOWS OF THE UNU GEOTHERMAL TRAINING PROGRAMME IN ICELAND 1979-2013										
Country	Geological exploration	Borehole geology	Geophysical exploration	Borehole geophysics	Reservoir engineering	Chemistry of therm. fluids	Environmen. Science	Geothermal utilization	Drilling technology	Total
Albania								2		2
Algeria	1		1			1		1		4
Azerbaijan							1			1
Bangladesh	1		1		2	1				5
Bulgaria					3	2				5
Burundi	1							1		2
China		2	1	2	35	17	10	13	2	82
Comoros			1							1
Costa Rica	2	2	3		2	5	2	2		18
Djibouti		2			2	1		4		9
Dominica						1				1
Egypt				1	1	1		1		4
El Salvador	2	1	2	2	5	7	4	9	4	36
Eritrea	2		2		1	2				7
Ethiopia		5	6		6	4	1	7	3	32
Georgia								1		1
Greece			1					2		3
Guatemala		1			1	1				3
Honduras		1	1					1		3
India								2		2
Indonesia		5	3		8	1	3	8	1	29
Iran		3	1	1	2	3	3	7	1	21
Jordan	1			1	2	1		1		6
Kenya	2	20	15	1	11	12	10	7	11	89
Latvia								1		1
Lithuania					1			1		2
Macedonia						1				1
Malawi	1							1		2
Mexico	1		1	1	4			1		8
Mongolia	1		1		1	2		5	1	11
Morocco			1							1
Nepal						1		1		2
Nicaragua		1		1	4	5	2			13
Pakistan	2	1				1				4
Papua New Guinea	1		1				1			3
Philippines	1	4	6	6	11	5		3		36
Poland				1	6	1		6		14
Romania						1		4		5
Russia	1				2	5	1			9
Rwanda	1	1	2		1	1	1	2		9
Serbia					2	1				3
Slovakia					2					2
Sri Lanka	1		1		1					3
St.Kitts & Nevis					1			1		2
Tanzania	3	1	1		1	1	1			8
Thailand		1		2		1		1		5
Tunisia					1			5		6
Turkey		1			1	4	1	3		10
Uganda	4	2	3		1	5	1			16
Ukraine					2					2
Vietnam	1		1		1	1			1	5
Yemen	2	1				1				4
Zambia								1		1
Total	32	55	56	19	124	97	42	105	24	554

Source: UNU-GTP H.P.

Source: UNU-GTP H.P.

Figure 3.5.4 Number of Participants in UNU-GTP Six Month Training Program



Source: UNU-GTP H.P.

Figure 3.5.5 Changes of Participants in UNU-GTP

b) The Six Month Training Program

The approximate time schedule of the six month specialized course is shown in Table 3.5.3. The program commences in April, and is divided into three phases: introductory lectures, specialised training and research project. Although the course content went into a new three-year plan from 2014, there is no particular change in the curriculum.

[Introductory lectures (5-6 weeks)]

Lectures, visits and excursions (2 weeks) to all the main geothermal fields under exploration and utilisation in Iceland. These are designed to provide background knowledge and appreciation for interrelationship between geothermal disciplines, from initial exploration to utilisation. Participants have to undertake two written tests during the introductory lecture course.

[Specialised training (5-6 weeks)]

Lectures, visits and excursions designed to provide practical training tailor made for

the individual Fellow.

Specialized training is offered in:

- ✓ Geological exploration
- ✓ Borehole geology
- ✓ Geophysical exploration
- ✓ Borehole geophysics
- ✓ Reservoir engineering
- ✓ Environmental science
- ✓ Chemistry of thermal fluids
- ✓ Geothermal utilization
- ✓ Drilling technology

Each trainee attends only one specialized course. The hallmark of the training is to give university graduates engaged in geothermal work intensive on-the-job training in their chosen fields of specialization.

[Research project (12 weeks)]

Independent work where Fellows focus and work on a project that has a direct relevance to their work at home.

Table 3.5.3 Schedule of UNU-GTP Six Month Training Program

WEEK	Geological Exploration	Borehole Geology	Geophysical Exploration	Borehole Geophysics	Reservoir Engineering	Chemistry of Thermal Fluids	Environmental Science	Geothermal Utilization	Drilling Technology
1	Introductory Lecture Course Main aspects of geothermal energy exploration and utilization Practicals and short field excursions								
2									
3									
4									
5									
6									
7	Field geology Lithological, tectonic & hydrothermal mapping Temperature surveying	Sample preparation Cutting analysis Petrography Lithological & alteration logs	Thermal methods Magnetics - Gravity Seismic methods Resistivity of rocks Resistivity methods: DC, TEM & MT	Well logging & testing - theory & practises Logging and testing demonstrations Reservoir physics & well/reservoir modelling Monitoring response to exploitation		Sampling of fluid & gas Wet steam wells Analytical methods Thermodynamics Data processing and interpretation	EIA project planning Chemistry - Physics Biology - Monitoring Revegetation - Safety	Thermal design of power plants & source systems - Direct use of geothermal heat Scientific modelling of utilization systems	Drilling equipment & procedures Well design Rig operations - Safety Management Cementing
8									
9									
10									
11	Excursion to some of the main geothermal fields of Iceland, geothermal power plants and direct use facilities								
12									
13	Gradient wells Remote sensing - GIS	XRD - Fluid inclusions Logging software	Processing & modelling resistivity data - GPS	Resource management & reinjection Data processing & software applications		Water-rock interaction Corrosion & scaling	Gas dispersion & abatement Corrosion & scaling	Power plant components Control systems Corrosion & scaling	Completion - Testing Problems Drilling software
14									
15	Project and report writing								
26									

Source: UNU-GTP H.P.

c) Selection of Participants and Site Visits

Candidates for participation in the specialized training must have a university degree in science or engineering, a minimum of one year practical experience in geothermal work, speak English fluently, be less than 40 years of age, and have a permanent position dealing with geothermal energy at an energy company/utility, research institution, or university in their home country.

Much care is taken in selecting the participants. Site visits are conducted by representatives of the UNU-GTP to the countries requesting training. The potential role of geothermal energy within the energy plans of the respective country is assessed, and based on this, the training needs of the country are assessed and recipient institutions selected.

The site visits have played a very significant part in the work and in the success of the UNU-GTP. Since 1979, a total of 173 site visits have been conducted to countries requesting training, or an average of 6 site visits per year. The visits have been made by the permanent staff of the UNU-GTP (70%), and members of the Studies Board and other geothermal specialists mostly from NEA/ISOR.

6) UNU-GTP Short Courses

The UNU-GTP organizes Workshops and Short Courses on geothermal development in Africa (started in 2005), Central America (started in 2006), and in Asia (started in 2008). The courses/workshops are set up in cooperation with energy and earth science institutions responsible for exploration, development and operation of geothermal energy utilities in the countries/regions. A part of the objective is to increase the cooperation between specialists in neighbouring countries in the field of sustainable use of geothermal resources. The courses may in the future develop into sustainable regional geothermal training centres. About 200 scientists and decision makers have participated in the workshops (1 week), and about 220 scientists have been trained at the short courses (1-3 weeks). Many former UNU Fellows are lecturers and co-organizers of the UNU-GTP Workshops and Short Courses. Superior students of a short-term training course are invited to 6 month training program mentioned above. A master and a doctoral acquisition support program are offered as shown in the following 7) to an applicant of a training program for 6 months.

A program of short-term training for about 20 days at Kenya Naivasha is indicated in table 3.5.4.

Table 3.5.4 Program of UNU-GTP Short Courses

Day		Schedule
from	to	
1		Arrival
2	7	Introduction & geothermal Field Work, Lake Bogoria
8		L.N. Country Club - Geothermal Energy & Geothermal Drilling
9		Geothermal and Geological Mapping- Field mapping in Olkaria
10	11	Geophysical Exploration & Mapping Resource
12		Geochemical Exploration
13		EIA, Legal Requim., Environmental Studies-Practical Sessions
14		Resource asses., Hydrology, Power Plants and Direct use
15		Visits to Geothermal Power Plants and Utilization Plants
16	17	Status of Geothermal Exploration in E-Africa
18		Planning and Costing Geothermal Projects-Case Examples
19	21	Project Work
22		Presentation of Project, Discussion, Course Review & Closing Ceremony
23		Departure for home

7) MSc Fellowship and PhD Fellowship

The UNU-GTP offers MSc Fellowships and PhD Fellowships former Fellows. Many UNU Fellows have already completed their MSc or PhD degrees when they come to Iceland, but several excellent students with BSc degrees have made requests to come back to Iceland for a higher academic degree. The MSc program and PhD program are intended to offer this opportunity to outstanding fellows. The MSc programme and PhD program are cooperation between the UNU-GTP and the University of Iceland and Reykjavík University. The MSc degree and PhD degree in Science and Engineering are granted by the University of Iceland or Reykjavík University.

8) Training site

Equipment and space that the trainees can strive to voluntary training on an individual basis are in training site of the UNU-GTP. Library stocked with technical books has also been enhanced. In the practice of the training course in Japan, plans for similar training environment is desirable.

(2) Institute of Earth Science and Engineering, the University of Auckland

1) Outline of the program

The Geothermal Institute of The University of Auckland has specialised in geothermal research and training for more than 30 years. The Geothermal Institute offers degree, certificate and professional development short courses on a range of geothermal topics. Study opportunities as follows,

- ✓ Short Courses
- ✓ Postgraduate Certificate in Geothermal Energy Technology
- ✓ Master of Energy
- ✓ Master of Engineering
- ✓ Master of Science
- ✓ PhD

a) Short Courses

The Institute of Earth Science and Engineering (IESE) coordinates short courses on various geothermal topics including: geothermal exploration, reservoir engineering and monitoring, power stations, steam-field layout and design, and environmental aspects.

In addition, IESE is experienced at designing individualised training programmes for the professional development requirements of companies and other institutions.

Examples of short courses include:

[One day introductory course]

This course covers introductory geothermal geoscience, geothermal engineering and environmental impacts of geothermal development. It is designed for those considering a geothermal career or for non-scientists with an interest in geothermal technology and development (it is usually offered alongside the New Zealand Geothermal Workshop in November each year)

[One - Four week professional development courses]

The Geothermal Programme team delivers Short Courses (from one to four weeks in duration), on demand, for various companies in New Zealand and internationally. Currently these courses comprise geothermal geoscience, geothermal engineering, reservoir modelling and exploration geophysics. The course content is designed for individuals already in the geothermal

workforce and is geared around resources, exploration, development and assessment.

[Specialist training]

Specialist training of small groups (2-3) is available at the University of Auckland. This involves working alongside one of the specialist teams (e.g. geothermal reservoir modelling, geophysics, geology, and geochemistry) for periods of 6-8 weeks.

[Customised courses for industry groups delivered internationally]

The Geothermal Programme delivers tailored Geothermal Short Courses for geothermal companies and organisations both locally and internationally. Recently courses have been run in Chile, Indonesia, New Zealand, Australia, the Caribbean and Singapore.

b) Postraduate Certificate of Geothermal Energy Technology

The programme is aimed a giving engineering and science graduates training in geothermal science and engineering. The programme is run over one semester (usually from July to November) and is followed by the New Zealand Geothermal Workshop. The programme consists compulsory courses and Elective courses (Table 3.5.5).

Table 3.5.5 Course List of Postgraduate Certificate in Geothermal Energy Technology

Compulsory courses	
GEOTHERM 601 - Geothermal Resources and Their Use	15
Worldwide occurrence of geothermal systems, introductory geology, volcanoes and volcanic rocks, New Zealand geothermal systems, hydrothermal alteration, permeability and porosity, introduction to geochemistry of geothermal systems, geothermal surface manifest compositions, geothermometry, silica geochemistry, overview of geophysics for geothermal exploration, geothermal resource assessm	
GEOTHERM 602 -Geothermal Energy Technology	15
Worldwide geothermal development, types of geothermal systems, thermodynamics, properties of water and steam tables, heat trans steam-field equipment, geothermal power stations, geothermal drilling, wellbore processes, completion tests, downhole measurement corrosion, stored heat, Darcy's law, cold groundwater, geothermal reservoirs, direct use, reservoir modelling, reservoir monitoring anc management.	
GEOTHERM 689 - Geothermal Project	15
Based on a study using field, lab or theoretical methods, students are required to submit a report on some aspect of geothermal explo or exploitation.	
Elective courses	
GEOTHERM 603 - Geothermal Exploration	15
Hydrothermal alteration, clays, fluid inclusions, direct use, subsidence, scaling and corrosion in geothermal wells, production geochem aspects of geothermal development, feasibility study, physical properties of rocks and self-potential (SP), magnetics, thermal methods methods, electrical methods, magneto-tellurics (MT).	
GEOTHERM 620 - Geothermal Engineering	15
Completion tests, wellbore flow, two-phase flow, geothermal power cycles, flow measurements, direct use of geothermal energy, envi scaling and corrosion in geothermal wells, drilling engineering, flow measurements, steam-field operation and maintenance, subsidenc rejection, heat exchangers, geothermal well-test analysis, stimulation, pipeline design, feasibility study, reservoir modelling theory, TC modelling process, case study (data and conceptual model, natural state modelling), Wairakei model.	

Source: IESE H.P.

c) Master of Energy

The programme is aimed at attracting good students from Engineering, Science, Business and Economics into a specialist postgraduate study of energy. The programme duration is 1 year.

d) Master of Engineering

Topics available in many branches of geothermal engineering. Duration is 1 year.

e) Master of Science

The MSc provides students an opportunity to undertake advanced study and independent research in an area of interest (applied geology, geophysics), and to further develop research skills. Duration is 1-2 years.

f) Doctor of Philosophy (PhD)

A wide range of topics available in geothermal science technology from supervisors in the Faculty of Engineering, Faculty of Science, and the Institute of Earth Science and Engineering. Duration is 3-4 years.

3.6 Overview of Geothermal Resource Development Funds

The following donors' was created by interview investigation and the information gathering publications and the internet data (Table 3.6.1 ~ Table 3.6.16).

Donors	Table No.
(1) Inter-American Development Bank (IDB)	Table 3.6.1
(2) World Bank Group（WBG）	Table 3.6.2, Table 3.6.3
(3) US Department of State	Table 3.6.4
(4) US Energy Association- East Africa Geothermal Partnership (USEA-EAGP)	Table 3.6.5
(5) Icelandic International Development Agency (ICEIDA)/Islensker orkurannsoknir (ISOR)/ Reykjavik Energy (RE)/ Verkis Consulting Engineers (Verkis)	Table 3.6.6, Table 3.6.7
(6) Munich Re (Munich Re)	Table 3.6.8
(7) UN Environment Programme (UNEP)- African Rift Geothermal Development Program (ARGeo)	Table 3.6.9, Table 3.6.10
(8) African Trade Insurance Agency (ATI)	Table 3.6.11
(9) African Development Bank Group (AfDB)	Table 3.6.12
(10) Agence Française de Développement (AFD)	Table 3.6.13
(11) U.S. Agency for International Development (USAID)	Table 3.6.14
(12) Kreditanstalt fur Wiederaufbau (KfW)	Table 3.6.15
(13) European Investment Bank (EIB)	Table 3.6.16

The mutual relation among the World Bank Group, other donors, and a candidate country is shown in Figure 3.6.1.

The relation between the organization of the World Bank Group and a project is shown in Figure 3.6.2, the relation between Inter-American Development Bank, a candidate country, etc. is shown in Figure 3.6.3, and the relation between the organization of the African Development Bank group and a project is shown in Figure 3.6.4, respectively.

Table 3.6.1 List of donor (IDB)

Agency : Inter-American Development Bank(IDB)

Introduction

● Inter-American Development Bank is a multilateral development finance institution responsible for the economic and social development of Latin America and Caribbean countries.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● JICA:Policy to continue to implement the plant construction from production wells drilled through the co-financing. (Costa Rica)
● GEF:In support implementation to ISAGEN(Power Corporation)(Colombia)
● NDF:The 5-month training course was opened in ES National University. Operation was carried out since 2013.(El Salvador)

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Costa Rica	IDB/JICA				Loan:Co-financing scheme				Power generation, power transmission, and power distribution are total management by public corporations. Own rig is used.
Colombia	IDB/GEF	TA							IDB is carrying out support to ISAGEN.
Nicaragua	IDB				Loan:San Jacino geothermal plant construction implementation from production well drilling region				The use of private financing of IDB.
	NDF	TA							
Mexico	CTF		TA/Loan		Guarantee/ Loan	Loan			
Mexico	TDB/NAFIN								Financing is reviewing to Power Corporation (CFE) and the private sector through the National Development Bank (NAFIN) from IDB.
El Salvador	IDB/NDF								The 5-month training course was opened in ES National University.
El Salvador and around	NDF,UNU-GTP,KfW	TA							Investment is still being adjusted between the Italian power company and the government of El Salvador in La Geo.
Guatemala	JICA	TA							
Dominica	EU	TA?							Small-scale geothermal power development plan

Remarks

(Reference:JICA(2013) Preparatory survey on Guanacaste geothermal power development in Costa Rica. Las Pailas Ⅱ,IDB-HP, Interview and Data obtained)

Table 3.6.2 List of donor (WBG) (1/2)

Agency : World Bank Group(WBG)
Introduction
● The World Bank Group (WBG) is a group organizations including the following group. - International Bank for Reconstruction and Development / International Development Association (IBRD / IDA) - Global Environment Fund (GEF): As the main institutions of providing Co-financing to the World Bank project, GEF provides $ 145 million of Co-financing to the projects conducted by the World Bank (2008). - Carbon finance (Carbon Finance) - International Finance Corporation (IFC) : IFC is an organization that plays the role of investing in the private sector of the WBG. Financing of the Philippines, Guatemala, Nicaragua, Chile, Indonesia, Kenya, Ethiopia, to Dominica. - Multilateral Investment Guarantee Facility (MIGA) : Kenya Olkariall project - International Centre for Settlement of Investment Disputes(ICSID) ● WBG provides funds to the following programs. ● WBG plans The Sustainable Infrastructure Action Plan (SIAP) and the Energy Sector Manegement Assistance Program (ESMAP) etc, and provides the funds to renewable energy-related project including geothermal projects. ● ESMAP is a technical assistance program that is managed by the World Bank, and aid the contract for research and drilling of test drilling stage. Subject countries are 11 countries in Africa, 13 countries in Latin America , Indonesia and Turkey. ● Scaling up Renewable Energy in Low Income Countries Program (SREP) is a program of the SCF of the CTF, which was established as one of the SIAP project of WB. Through the geothermal development study is implemented. SREP is granted to get the donation of $ 292 million from the donors of Japan, Netherlands, Norway, Switzerland, the United Kingdom and United States. ● CIF-SCF-SREP aims to improve energy access rate through the use of renewable energy in developing countries. Implementation of geothermal development study using the SREP is possible. Future, it is possibility that the request from the Eastern African countries such as Kenya and Ethiopia is issued. ● WB has become a leading donor of the energy sector recovery project in Kenya. The policy, legal and institutional framework is strengthened to promote private investements, and the efficient power expansion plan is assisted. Geothermal development is also included in this framework. ● WB has established and managed the Technical Assistance Program Trust Fund, ESMAP, collaborated with United Nations Development Programme (UNDP). In October 2012, ESMAP published the Geothermal Handbook: Planning and Financing Power Generation. ESMAP launched the Global Geothermal Development Plan (GGDP) in March 2013 and the $5 million is supported to test-drilling projects.The objects areas are 36 districts in 16 countries where surface exploration has been completed.
Doner
Cooperation contents of each institution and cooperation institutions are as follows. ● ICEIDA: Atorangano in Ethiopia drilling and geothermal resource evaluation: $ 3.5 million ● KfW ● JICA: Support of power plant construction of 70MW(30MW x 2) in Atorangano is scheduled. ● AFD ● EIB ● AfDB ● IDB ● CTF-Clean Technology Fund (US Department of State Promotion Project):Target countries in clude five countries and the funding amount is $ 115 million.

Table 3.6.3 List of donor (WBG) (2/2)

The trends for the countries

Area, Country	Project	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya	Renewable energy projects: Olkariall project	(MIGA)	Loan							One renewable energy projects: Olkariall project (Loan)
Kenya	Olkaria Ⅰ / Ⅳ	EIB,UNDP	TA?	Grant			Loan			Olkaria Ⅰ / Ⅳ: 280MW WB: $ 120 million, EIB: $ 168 million
Kenya	Menengai Ⅰ	AfDB,AFD, EIB,JICA,		Loan						Menengai Ⅰ:400MW WB: $ 102 million, EIB: $ 36 million
Djibouti	Renewable energy projects: Asal project	(IFC,GEF, CF)	Loan?							One renewable energy projects: Asal project
Djibouti	GGDP	(ESMAP/ GGDP)		TA?						GGDP: The $ 500 million project for geothermal test well drilling. Aid in Fiale caldera of Assal lake is approved from the World Bank.
Djibouti		(ESMAP/ GGDP)		Guarantee ?						Fiale caldera is implemented the $ 31 million project to evaluate the economic geothermal development potential. And Fiale caldera is approved International Development Association credit of $ 6 million.
Indonesia	New renewable energy project	(IFC, GEF, CF)								Three new renewable energy projects
Poland	New renewable energy project	(CF)								One new renewable energy project
Ethiopia	Atorangano geothermal resource evaluation	(WBG)				Loan				Atorangano geothermal resource evaluation: $ 218.5 million
Africa	Geothermal project in the initial stage	(ESMAP/ GGDP)								Aid for geothermal project in the initial stage
Central America, Caribbean	Exploration drilling project	(ESMAP/ GGDP)								A few exploration drilling project is aid the $ 1.6 million becouse of reduction and specification about geothermal development risk and development.
Dominica	Wotten Waven geothermal development	(ESMAP/ GGDP)								The government is supporting to make analysis report for recognizing the additional tasks required in order to advance the Wotten Waven geothermal development.

Remarks

・In 2008, 34 projects in relation to renewable energy project were accepted. Among them, 6 geothermal projects were included.
・IFC's financing countries are the following : the Philippines, Guatemala, Nicaragua, Chile, Indonesia, Kenya, Ethiopia, Dominican.
・Ministry of Foreign Affairs of Japan conducted the "Ethiopian Atorangano Geothermal Development Survey" from 2010 (grant aid of about 1 billion yen in engineering services and equipment procurement). After this project, WBG has provided the funds for drilling. Utilizing these information and the well, JICA is considering plant construction.
・Djibouti: funding to the four well drilling, but not raised achievement.
・Luanda: spent the funding of $ 300 million to the two wells, but failed.
・Funding $ 115 million is being prepared to the CTF target countries (Chile, Mexico, Colombia, Indonesia and Turkey).

(Reference:JICA (2010) Situation Analysis Study on Geothermal development in Africa, JICA (2013) Detailed Planning Survey for Capacity Strengthening for Geothermal Development in Kenya, WBG-HP, Interview and Data obtained)

Table 3.6.4 List of donor (US Department of State)

Agency : U.S.Department of State

Introduction

● The US Department of State promotes the clean technology fund (CTF) project / program (Climate Investmenet Funds) in geothermal development of Mexico, Chile and Indonesia.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● CTF: US Department of State are promoted the clean technology fund (CTF) project / program in geothermal development of Chile and Indonesia, Mexico.

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Chile					Loan/Grant				Risk mitigation program Loan $ 27.7 million, Grant $ 1.048 million. For private sector.
Indonesia					Loan/Grant				ADB private geothermal energy program Loan $ 31.5 million, without Grant. For private sector.
Mexico					Loan/Grant				Geothermal financing and risk transfer equipment Loan $ 31.5 million, Grant $ 2.8 million. For private sector.

The U.S. Department of State plants to use the electric power of MW class in Kyushu and to delivered to the US embassy or consulate in Japan.
The plan is to be proposed to Japan government.
The plan content：Japan domestic constraints including the power distribution are taken down and encouraged
the liberalization of power (In particular, power generation from renewable energy).
To encourage renewable energy development on a global scale.
The US Department of State want to work on development and cooperation with Japan .

Remarks

(Reference: Interview and Data obtained)

Table 3.6.5 List of donor (USEA-EAGP)

Agency : US Energy Association (USEA) - East Africa Geothermal Partnership (EAGP)

Introduction

● USEA is an American State member committee of the World Energy Council, which consists of government agencies and the private sectors associated with energy.
● In September 2012, US-East Africa Geothermal Partnership (EAGP) was established for the partnership program between US Agency for International Development (USAID) and the Geothermal Energy Association (GEA) in order to develop the geothermal resource in Easten Affica and promote the US geothermal industry. EAGP is carried out in part of the power-Africa Initiative, six countries concered with geothermal were selected as object contries. (refer to table).
● The activities of major partnership are as follows.
● The support for the enterprise and geothermal business between US and Eastern Africa.
● The adjustment of short-term technical advice of US industry.
● The implementation of capacity development seminars and workshops by the US geothermal industry and research institutions in Eastern Africa.
● Information collection about geothermal resources, projects, and events etc. in Eastern Africa.
● Technical assistance and cooperation areas are as follows.
● Ground investigation, advice and capacity technology development for drilling, reservoir evaluation and modeling, well field development, power station design and installation, framework for legislation, risk management, project financing, database management, equipment and facilities are supplied.
● As a short-term support program, decision makers of the East African countries are invited to geothermal-related events to be held in the United States.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● United States Agency for International Development (USAID):
● Geothermal Energy Association (GEA):Commercial union composed of US companies to promote support geothermal resources and geothermal energy development.
● Concerning with geothermal US companies and professionals, developers, equipment supply company, capacity development institutions.
● NDF
● ESMAP:UNDP and WB jointly established technical assistance program trust fund, ESMAP.

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Ethiopia	GEA/USAID	TA							・In East Africa, there is a potential geothermal resource of 15,000MW. ・EAGP is a part of President Obama's Power Africa Initiative. ・The goal is to double the energy supply in Sub Saharan-Africa. ・Power Africa is carried out coordinated support. Because It will help African partners to expand and supply the energy production.
Kenya	GEA/USAID	TA							
Rwanda	GEA/USAID	TA							
Tanzania	GEA/USAID	TA							
Uganda	GEA/USAID	TA							
Djibouti	GEA/USAID	TA							

● Following training has been carried out in Nakuru, Kenya. (Drilling training was one month course, while other courses were one week courses).
● Geothermal energy utilization, Geothermal geology and geochemistry, Geothermal geo-physics, Environmental policy, climate change and regulatory issues, Drilling engineering, Geothermal project management, Reservoir engineering and field operations, Power plant design, construction, management and transmission considerations, Geothermal development business and finance principals related to public vs. private sector structures and public-private partnership.

Remarks

Target countries of USEA-EAGP consist of six countries in Eastern Africa and six countries of power Africa . Because Kenya, Ethiopia, Tanzania are doubled, the target countries are actually nine countries.
Among these, the six countries in Eastern Africa are prior.

(Reference: Interview and Data obtained)

Table 3.6.6 List of donor (ICEIDA/ISOR/RE/Verkis) (1/2)

Agency : Icelandic Assistance Agency (ICEIDA)/Iceland Geosurvey (ISOR)/Reykjavik Energy(RE)/Verkis(Verkis)
Introduction
● Icelandic Assistance Agency(ICEIDA) started the project in 2013, supporting the geothermal development in Eastern Africa with the co-funded by Nordic Development Fund (NDF). ➢ The main target countries of the project is the countries belonging to the East African Rift Valley (refer to table). The purpose is to promote capacity related to geothermal utilization and policy. This project is funded based on a request from the countries. It helped the nine countries in Africa. Target areas of cooperation are as follows: ➢ Assisted country: Rwanda, Ethiopia, Kenya, Burundi, Uganda, Tanzania, Zambia, Djibouti, Comoros. ➢ Preliminary Investigation and geothermal research to develop the exploration well drilling. ➢ Strengthening technical assistance and capacity (training, organizational capacity building, framework of policy and the legal system against geothermal utilization). ➢ Contents to be expected at the end of the project : Specific evaluation of promising areas, further development plan of promising region, capacity improvement to propose exploration well drilling plan that takes into account the plumbing. ➢ Business fund is $ 13 million per year (five years).
Doner
Cooperation contents of each institution and cooperation institutions are as follows. ● UNU-GTP based in Iceland, the training of geothermal development has been carried out from 1979. It is mainly six months training course. The condidates must have one year work experience and under the 40 years. Addition to the course of the geothermal resource development for so far, a course of excavation and Bankable geothermal business planning and management is scheduled to be carried out as new training from 2015. Until now 583 people from 58 countries were accepted. Masters course was opened from 2000 and 39 people graduated. Doctoral course was opened from 2000 and 3 people graduated. One-month short course is offered cooperated with KenGen (after GDC) from 2005, targetting the African regin. Short course that targeting Latin America region was co-hosted by the LaGeo of El Salvador from 2006. The best of the short course is invited to 6 months course. As the course of system, applicants of 6 months courses are admitted to advance Masters course and even doctoral course. After the course, preparation to participate in Kenya's Center of Excellence has been gone forward. ● Iceland Geosurvey (ISOR) is a state-run NPO and a centre organization of geothermal research in Iceland. ➢ ISOR is carrying out cooperation concerning geothermal investigation, development and utilizaion not only to the Iceland government but also to the governments and companies around the world. ➢ Concrete cooperation content：Geothermal exploration, consulting related to drilling, boring survey, geothermal resource assessment, geothermal resource management, environmental impact assessment, geothermal exploration training ● Reykjavik Energy is a public corporation which supplies electric power, geothermal water for heating and cold water for water supply and fire fighting. - Reykjavik Energy was a plan to enter the geothermal development in Africa by national policy. But the plan was canceled by the economic crisis of Iceland. Later Reykjavik Energy has been dedicated to domestic business. For the training of the UNU-GTP, providing a field of on-site training. - Nesjavellir and Hellisheiði geothermal power plant generates electric power by using a high-pressure geothermal steam, provides the heated ground water to local heating, cold water from groundwater aquifers. Its supply area extends to 20 regions and covers the 67% of the population of Iceland. - Hellisheiði Power Station has been operating smoothly as per rating in the double flash system that consists of the high-pressure turbine made by the MHI and the low pressure turbine made by the Toshiba. The entire power station has become a tour course, photography is also free. Guidance and description of the power plant are scientific and taken into account to social contribution, and have been utilized effectively as a teaching materials of region as well as visitors. This guidance and description will be also helpful as a guide PR museums which are annexed to Japanese geothermal power stations. - The facility is unmanned, including district heating system. ● Verkis sells equipments of the geothermal and hydro power stations to the following countries or regions: ① Kenya and eastern Africa, ② Latin American countries such as Nicaragua, El Salvador, the Caribbean, Chile etc. and ③ Indonesia, China and Turkey etc.. - The sales activities are implemented within the direct trading of the power station equipments becouse of the high risk of drilling. - ISOR plays a consultant of the underground environment evaluation. - Verkis was founded in 1932 and continues to design and produce the equipments of geothermal and hydroelectric power stations in the world by total 250 employees (technical and administrative staffs). ● NDF：Joint investment in the project (2013 started) to support geothermal development in Eastern Africa ● WB_ESMAP：In the first phase of geothermal agreement partnership, Iceland Ministry of Foreign Affairs has started program in collaboration with the World Bank. ● GEG: Norwegian wellhead plant manufacturer ● IDB: ● ARGeo: Launch of AGID ● GDC: Under preparation of Curriculum of Center of Axcellence in Kenya with KenGen, AUC and UNU-GTP.

Table 3.6.7 List of donor (ICEIDA/ISOR/RE/Verkis) (2/2)

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Burundi	NDF/ESMAP	TA							Surface Survey: the conduct of promising point survey.
Comoro	NDF/ESMAP	TA							
Djibouti	NDF/ESMAP	TA							
Djibouti	?	TA							Classroom lecture
Democratic Republic of the Congo	NDF/ESMAP	TA							
Eritrea	NDF/ESMAP	TA							
Eritrea	ARGeo	TA							Surface survey is being examined whether conducted.
Ethiopia	NDF/ESMAP	TA							The drilling of 22 is scheduled @Aluto Langano. The driling of 4 is scheduled @ Tendaho.
Ethiopia	WB	?							schedule
Kenya	NDF/ESMAP	TA							The conduct of human resource development of GDC.
Malawi	NDF/ESMAP	TA							Total aid: $ 3.2 million
Mozambique	NDF/ESMAP	TA							
Rwanda	NDF/ESMAP	TA							
Rwanda	EU	TA							
Tanzania	NDF/ESMAP	TA							
Uganda	NDF/ESMAP	TA							Total aid: $ 3 million
Zambia	NDF/ESMAP	TA							Surface Survey: the conduct of promising point survey.
Nicaragua									Iceland and El Salvador dispatche the lecturers and implement technical cooperation for Nicaragua.

● The conduct of funding in Kenya and Tanzania, Uganda.

Remarks

・Target countries of ICEIDA are the following 13 countries which locate in Eastern African Rift Valley (Burundi, Comoros Islands, Djibouti, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia)
・ICEIDA supports TA of short course of UNU-GTP in Kenya . The task is to secure OJT in drilling site and of aid funds by IDB.

(Reference：JICA(2010) Situation Analysis Study on Geothermal development in Africa, JICA(2014) Data Collection Survey on Geothermal Energy Development in East Africa, ICEIDA-HP, Interview and Data obtained)

Table 3.6.8 List of donor (Munich Re)

Agency :Munich Re

Introduction

● Munich Re is a reinsurance company on geothermal exploration risks and drilling risk. Munich Re guarantee the exploration risk of the steam production, but doesn't guarantee the drilling risk due to the technical difficulties.
● At most eight drilling wells are possible to be signed inssurance. However, in case of the low and insufficient steam product, the policy of insurance contract proceeding in stages will be followed. Initially two drilling wells are carried out to sign the insurance contracts, if fails. The third well doesn't continue to contract the insurance.
● There is implementation experience of insurance contract in Turkey and Mexico. A reinsurance contract will be considered in the following country:Kenya, Djibouti, Ethiopia, Tanzania and Uganda.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● IFC:Cooperation with Turkey in the project
● IDB/IADB:Mexico project

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Turkey	IFC		Reinsurance						During the contract implementation
Mexico	IDB		Reinsurance						Two drilling contract already concluded (June)
Mexico	Mexican government		Reinsurance						During negotiations
Kenya			Reinsurance						Negotiations start
Djibouti									Under review
Ethiopia									Under review
Tanzania									Under review
Uganda									Under review

Remarks

(Reference:Munich Re HP, Interview and Data obtained)

Table 3.6.9 List of donor (UNEP-ARGeo) (1/2)

Agency : African Rift Geothermal Development Program (ARGeo)

Introduction

● United Nations Environment Programme (UNEP) is the core institution of the United Nations to address global environmental issues. The ARGeo was initially launched with the leadership of UNEP and KfW. Implementing agency of ARGeo is UNEP and the World Bank.
● UNEP: The following program was carried out, in cooperation between countries, and regional networking and technical cooperation.
● The ARGeo Program was estabsished for the purpose of promoting the development and utilization of geothermal energy in the Eastern African Rift Valley, reduction of the amount of greenhouse-gases discharge of the area and diversification of the energy supply of the area. It is a framework for partnership among international donor organizations and the countries in the region. Concepting was set up in April 2003, and 5 years later it was approved.
● Funds of ARGeo establishment were invested from ICEIDA and the Italian government, BGR (Germany). Current funding source is the GEF fund. Headquarters is in Nairobi.
● The GEF funds is a trust fund which established by World Bank. Funded by WB, UNDP, UNEP, etc. projects are carried out. Funds scale of GEF5 is $ 4.34 billion (July 2010 to June 2014). Next to the United States $ 575 million (16.2%) Japan contributes $ 505 million (14.3%) and is in the second place. The current Secretary General is Naoko Ishii (former Deputy Finance Officer).
● Resources of technical advisor department for the ARGeo is from Iceland.
● The activity contents include cooperation and adjustment among donors in addition to the support of policy and implementation system surface investigation and training. The regular proceedings is that the test drilling and resourse assessment are implemented once the funds of GRMF are obtained after the surface investigation in all contries study areas is carried out by ARgeo or GRMF. But the phase of steam development has not reached.
● Four components of ARGeo are as follows. Participating countries have 13 countries.
➢ Risk reduction facility (RMF) survey and drilling stage
➢ As technical assistance accompany with the RMF, Technical Assistance Facility related to capacity reinforcement of counterpart countries and institutions.
➢ As technical assistance accompany with the RMF, technical cooperation related to the surface investigation.
➢ Regional network construction for strengthening the technical capabilities and organizational force by the regional network.
● AGID has been launched and was started operating on Web. Development status and raw data of each country and each promising point has been published. The purpose is to promote private investment. System development are involved by ICEIDA.
● ARGeo manage the follows: the Risk Mitigation Facility component,the Technical Assistance Facility component for project-related TA support,the technical cooperation and regional networking.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● ICEIDA: The amounts provided by Iceland were $ 249,052.
● Italy government: The amounts provided were $ 120,388.
● BGR/KfW: The amounts provided were $ 2,940,000.
● GEF: The amounts provided were $ 17.75 million in grants.
● RMF: grant with attached condition of $ 25 million(risk mitigation of $ 10 million, technical assistance of $ 7 million, $ 8 million in the form of a grant).
● WB: The program was implemented in cooperation with national government agencies, Risk Reduction Facility (RMF) and Technical Assistance Facility (TAF).
● IGA: Under supervision of the World Bank, monitoring of TAF was performed.

Table 3.6.10 List of donor (UNEP-ARGeo) (2/2)

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya	ICEIDA	TA							Project Management Unit (PMU) of the implementation is installed in UNEP office in Kenya. Counterpart agencies of government level: Ministry of Energy、KenGen、GDC
Ethiopia	ICEIDA	TA							Counterpart agencies of government level: Ministry of Energy and Mineral, Geological Survey
Djibouti	GEF/RMF								Asal Project(During the interruption) Counterpart agencies of government level: Ministry of Energy and Natural Resources, CERD
Eritrea									Under review. Counterpart agencies of government level:Ministry of Mines, Ministry of Energy
Tanzania									Counterpart agencies of government level: Ministry of Energy and Mineral
Uganda	ICEIDA,WB			Loan?					kibiro. Counterpart agencies of government level:Ministry of Energy and Mineral Resources, Geological Survey
Rwanda	ICEIDA	TA							

Remarks

- Comoros, Rwanda and Zambia shows the interest.
- Re-evaluation of Luanda Kinig and Karisimbi regions is in operating by ICEIDA and ARGoe.
- ARGeo receives the support of KfW in an order from exploration stage.

(Reference:JICA(2010) Situation Analysis Study on Geothermal development in Africa, ARGeo-HP, Interview and Data obtained)

Table 3.6.11 List of donor (ATI)

Agency : African Trade Insurance Agency (ATI)

Introduction

● ATI is an African export credit agency, which was established in 2001 by the World Bank funding and technical assistance and seven African countries.
● ATI provides insurance products for political risk and trade credit risk, and supports the investment towards the bidirectional expansion of trade in the member nation in Africa and the world.
● ATI facilitate the investment and insurance contracts by ensuring the political and economic risk. For example, it is insurance on political risk when the IPP is to transmitted to KPLC.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.
● Munich Re : Evaluate the information connecting the reinsurance contract of exploratory wells.

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya									The insurance is provided on political risk relates to a steam supply to the KPLC.

Remarks

(Reference：ATI-HP, Interview and Data obtained)

Table 3.6.12 List of donor (AfDB)

Agency : African Development Bank Group (AfDB)

Introduction

● African Development Bank Group consists of the following organizations: African Development Bank (ADB), the African Development Fund (ADF), the Nigeria Trust Fund (NTF).
● AfDB advances the social and economic development of the region by schemes such as public-private lending, investment, technical cooperation and emergency assistance.
● In 2008, AfDB produced the "Clean Energy Investment Framework(CEIF) for Africa: Role of the AfDB".
● Geothermal development of Africa is supported with the funds aid of the SREP.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

●JICA：Capacity building
●ICEIDA, WB：Funding

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Tanzania	JICA,MEM	TA							plans
Tanzania	GST		Loan?						plans
Tanzania									In September 2013, $ 25M is expected to be financed in the implementation system strengthening of Tanzania (TGDC installation) and geothermal resource prediction, etc..
Uganda	ICEIDA,WB	Grant?	Loan?						
Uganda									Under review
Kenya	WBG		Loan?		Loan				
Kenya					Loan				$ 146M was financed from 2011 to the development of MENENGAI. Until the end of the 2016 steam development aims to 400MW, currently, the well of 24 and 115MW steam have been developed. Totally 105MW steam supply contract has been signed with IPP3 companies (Sosian, Quantum, Ormat). Part insurance is decided to apply in case that PPA and steam supply contract is difficult to perform. Development of the private sector are supported in the future.
Djibouti	UNDP								The support of $ 7.5 million to Lake Asal region
Djibouti			Loan	Loan					The participate in the financing (some free) of test drilling and geothermal evaluated in Assal.
Ethiopia									The participate in the financing of private development in Corbetti (1000MW). Development by the private sector are supported in the future.
Rwanda									Under review

Remarks

・SREP is one of the sub-programs of CIF which was established by World Bank in order to support the climate change measures in developing countries.
・In the 2008-2012 medium-term strategy, AfDB has invested 57.2% in power generation business, including geothermal among the areas of focus infrastructure ($ 3.91 billion).

(Reference：JICA(2010) Situation Analysis Study on Geothermal development in Africa, JICA(2014) Data Collection Survey on Geothermal Energy Development in East Africa)

Table 3.6.13 List of donor (AFD)

Agency : Agence Française de Developpement (AFD)

Introduction

● AFD is a bilateral development finance institution of the French government and has scheem of the loans, technical assistance and grants.
● Support for GDC: € 50 million for rig procurement, € 6 million in technical cooperation for capacity building and making master plan of the energy sector.
● Sub-Saharan African countries are a priority for AFD.
● AFD has strengthened efforts to climate change mitigation. Most of AFD's assistance to geothermal development projects has been concentrated in Kenya, except for a feasibility study conducted in Dominica.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● EIB:Co-finance unit3 of Olkaria Ⅱ in Kenya with the World Bank.(AFD contributives € 20 million)
● JICA:Olkaria Ⅰ and Ⅳ are co-financing from the World Bank, EIB, KfW.(the amount of € 150 million)
● KfW:As noted above
● PROPARCO:PROPARCO In AFD implements the financing to private sector, which corresponds to IFC of the World Bank Group.

The trends for the countries

Area, Country	Project	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya	Olkaria Ⅱ	IDB,WB		Loan?						Co-financing: Olkaria Ⅱ ・ Unit 3 AFD: € 20 million
Kenya	Olkaria Ⅲ	AFD/PROPARCO		Loan?						Co-financing: Olkaria Ⅲ € 60 million
Kenya	Olkaria Ⅰ Ⅳ	JICA,WB,EIB,KfW		Loan?						Co-financing: Olkaria Ⅰ Ⅳ AFD: €150 million
Kenya		AFD/PROPARCO		Loan						€ 50 million to rig procurement € 6 million to technical cooperation for capacity building. Private loans € 60 one million.
Kenya	Menengai						TA			$ 170 million Rig purchase
Dominica										Investigation
Djibouti										Shown the interest
Ethiopia						L/G?				Drilling of production wells in the shallow wells is carried out in Tendaho.

Master Plan of the energy sector was conducted in early 2010. Among them, AFD has been loaned and financed to rig procurement (€ 50 million) and capacity development (€ 6 million) to GDC.

Remarks

・Technical cooperation on making plans about power generation and transmission will be carried out for Kenya Ministry of Energy in the next three years.

(Reference:JICA(2010) Situation Analysis Study on Geothermal development in Africa)

Table 3.6.14 List of donor (USAID)

Agency : United States Agency for International Development (USAID)

Introduction

● USAID implements geothermal program for the Kenya Power Africa .
● USAID is ODA implementing agency of the United States, also that of Power Africa. According to Obama gavament's initiative, POWER AFRICA aims to develop new 30,000MW power in sub-Sahara coorporated with private enterprises, WB and AfDB, etc. 6 government agencies (USAID and MCC, etc.) and about 40 private enterprises (GE, ORMAT, etc.) are joined.
● Private investment in environmental improvement: Support of policy and legislation, rate system, arbitration institutions, finance, risk mitigation in Ethiopia and Djibouti, etc.
● Coordination and reconciliation among donors are also be conducted.
● Geothermal program associated with Power Africa are as follows.
● Powering African Agriculture (PAA): Technical assistance is conducted for the purpose of accelerating the direct use of geothermy in GDC (potential assessment of geothermal direct use and support of the feasibility demonstration). Specifically, flower gardening by greenhouse, aquaculture, crop drying, dairy, the processing industry including the mining, etc.
● East Africa Geothermal partnership (EAGP): The technical coorperation is carried out for the purpose of development promotion support in Eastern African private sector geothermal development projects. Take GDC as the object. The contents include boring survey, construction planning, geophysical exploration, geochemical exploration, geological survey, reservoiring, data management evaluation, survey of project documents (eg steam supply agreement), etc. According to the plan to help the US geothermal industry trade mission, EAGP is ready for performing a technical and advisory support to GDC and KenGen directly.
● Africa Infrastructure Program Business Model: In August2013, The "Workshop on private investment in Kenya geothermal sector" was held at GDC's request. Human resourses in manager class of GDC are taken as objects in order to the enhance their understanding of geothermal development project finance and bussiness model. The covered topics are public-private partnerships, environment enabling legislation, competitive bidding, steam supply agreement and related supply issues, power purchase agreement and other agreements, business financing, tariff framework, development models, etc..
● United States Trade and Development Agency (USTDA): USTDA supports geothermal development through the capacity improvement and the reverse trade mission to the United States.
● U.S. Overseas Private Investment Corporation (OPIC):OPIC has provided a loan of $ 310 million to ORMAT in order to support the Olkaria III geothermal project (100MW Expansion Project).
● U.S.Export Import Bank (EXIM):In 2013, EXIM and GDC discussed the possibility of financing $ 300 million, but didn't come to an agreement.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● USAID/PAA:aim to promote application of the direct geothermal use, and supply technical assistance and training to Kenya GDC.
● USAID/OPIC:support the expansion of OlkariaⅢ geothermal project to 100MW, and finance $ 310 million for ORMAT.
● USAID/AIP:hold the"Workshop on private investment in Kenya's geothermal sector".
● USAID/EAGP:support the development and acceleration of East African private sector geothermal development project.

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya	GDC	TA							Baringo region
Kenya	(USAID/PAA)								TA for promoting of application of geothermal direct use
Kenya	(USAID/EAGP)		TA:Nine of geothermal training module						Steam supply agreement or Direct technical and advisory support to both of GDC and KenGen.
Kenya	(USAID/AIP)								"Workshop on private investment in Kenya's geothermal sector" (In August 2013) (Public-private partnership, Environment enabling legislation, Competitive bidding, Steam supply agreement, Related to supply problems, Power purchase agreement and other contract, Business financing, Tariff framework and Various development models etc.)
Kenya	(USAID/OPIC)								Olkaria Ⅲ project was offered a loan of $ 310 million.
Guatemala	IDB,JICA	TA							
Nicaragua	IDB	TA							

● Loans to the private sector development (including under review): Corbetti in Ethiopia, Bogoria-Silali in Kenya, Olkaria VI in Kenya, Fiale in Djibouti, Tanzania, Uganda, Rwanda.

Remarks

(Reference: Interview and Data obtained)

Table 3.6.15 List of donor (KfW)

Agency : Kreditanstalt für Wiederaufbau (KfW)

Introduction

● KfW Group provides medium- and long-term funds for the economic development of Germany and performs the bilateral financial assistance to developing countries. KfW Development Bank is responsible for support developing countries.
KfW support scheme is grant and loan (concessional loan and like market conditions loan) and the investment also possible.
● KfW took a leadership role for the early stages of the establishment of ARGeo, though at present KfW has decided to support geothermal projects independently of the ARGeo framework (2010).

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● IFC：Cooperation with Turkey in the project
● IDB/IADB： Mexico project
● EU-Africa Infrastructure Trust Fund : Among total EUR 50 million in risk reduction scheme, descrived above, EU-Africa financed EUR 30 million, and the remainder EUR 20 million was financed by KfW.

The trends for the countries

Area, Country	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya (Olkaria)	UNEP		Loan？						・Olkaria II, Olkaria IV is financed ・KfW and UNEP finances the € 8 million for two or three well drilling of GDC.
Kenya	?		Grant?						Assistance to ARGeo
Kenya	Single		Grant						・Risk reduction scheme is designed for exploratory well drilling. ・If successful, success fees are provided for proceed to the next stage of development. ・KWF supports the exploration well drillingd in each project.
Kenya (Balingo-Siliali)	UNEP,JICA, ICEIDA	TA	Loan？						GDC project is supported in Balingo-Siliali region.
El Salvador									Details of Support is unknown.

Remarks

・According to the characteristics of risk reduction scheme of KfW, the compensation is not performed if it fails to drilling, but to be paid if successful for proceed to the next stage of development.
・40% of funds for two exploration wells will be subsidized, and further 30% are to be added in case of success. The system is different from Risk Mitigation Fund of ARGeo which compensates the drilling cost in case of failure.
・Two ways are used to identify success according to drilling conditions:①the funds are availabe in order to proceed to the next stage of development, ②If the developer return the development rights to the country, the developer shows the future development prospects by creating a research report. And thereby, other developers is able to go into the country.
・The support subject discrived abobe is possible both government and the private sector. The country which has no cooperation agreement between the governments can be taken as turget country. Their countrys are follows: Djibouti, Eritrea and the countries in Eastern African except of Comoros.

(Reference：JICA(2010) Situation Analysis Study on Geothermal development in Africa, KfW-HP, Interview and Data obtained)

Table 3.6.16 List of donor (EIB)

Agency :European Investment Bank (EIB)

Introduction

● The EIB are of two large international financial institutions, along with WB.
● The EIB is policy-based financial institution to perform the following loan: To improve international competitiveness of industry within EU and small to medium enterprises, environmental protection, the stable supply of energy, infrastructure projects that contribute to the integration of Europe. EIB support scheme is possible both of investment and financing (for public and private sectors).
EIB performs the interest subsidy for project which is financially difficult and high economic benefit. Grant of up to 50% of the interest amount also possible. EIB is able to perform F/S and TA of a project on condition of furnishing funds and investing in a project by Grant. The principle of the EIB does not result in a distortion in the market.
● The EIB is also guided by external regional mandates to support European policies abroad and finance development projects in the developing countries.
● The EIB is the fund manager for the "EU-Africa Infrastructure Trust Fund", an instrument of the "EU-Africa Partnaership on Infrastructure". The Secretariat of the fund is housed at the EIB headquarters. The fund supports infrastructure projects with regional characteristics through four types of grant supports: interest rate subsidies, technical assistance, one-off grants for social environmental components of projects, and insurance premiums to cover country risks.

Doner

Cooperation contents of each institution and cooperation institutions are as follows.

● WB：Cooperation in financing in Kenya

The trends for the countries

Area, Country	Project	Partner	Exploration	Test Drilling	Resource Evaluation	Production Well Drilling	Plant Construction	Plant O & M	Reservoir O & M	Remarks
Kenya	Olkaria Ⅰ	WB,UNDP	TA?	L/G			Loan			・$ 168 million to the Olkaria Ⅰ and Ⅳ
Kenya	Olkaria Ⅱ	WB,UNDP	TA?	L/G			Loan			
Kenya	OlkariaⅣ	WB,UNDP	TA?	L/G			Loan			・$ 168 million to the Olkaria Ⅰ and Ⅳ (280MW). Among them, Olkaria Ⅳ is the loan of € 120 million. Among them free of charge: Drilling cost (€ 25-30 million) is free of charge.
Kenya	Ⅱ Expansion	WB,UNDP	TA?	L/G			Loan			
Kenya	?	WB,UNDP	TA?	L/G			Loan			・Power plant was constructed by commercial base finance to KenGen.
Kenya	Menengai Ⅰ	AfDB,AFD, WB,JICA,		Loan						$ 36 million was financed in Menengai Ⅰ (400MW)

Remarks

・In 2009, the amount of loan approved for Africa, the Caribbean, ACP and OCT including geothermal development was € 863 million.

(Reference：JICA (2010) Situation Analysis Study on Geothermal development in Africa, JICA (2013) Detailed Planning Survey for Capacity Strengthening for Geothermal Development in Kenya, EIB-HP, Interview and Data obtained)

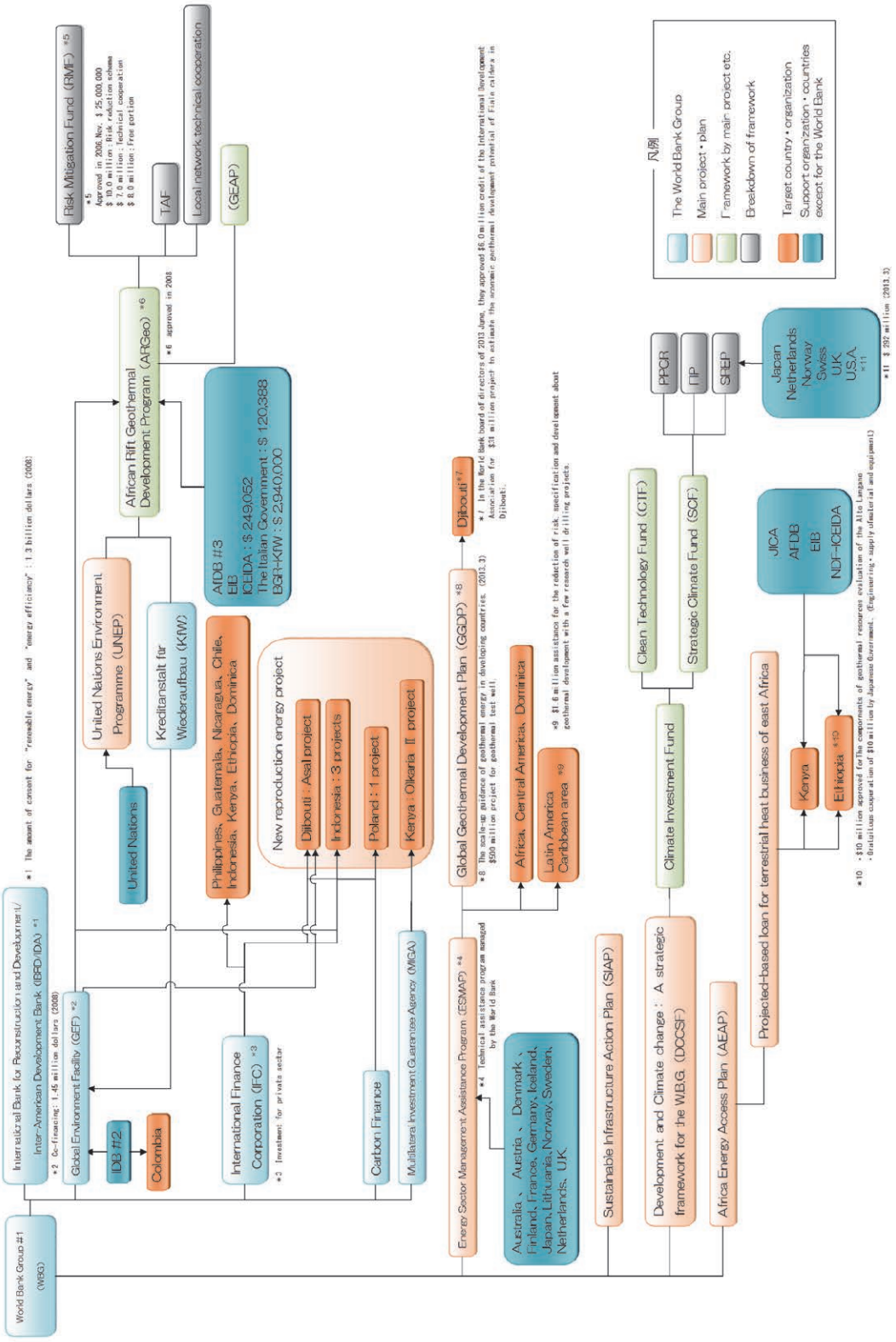


Figure 3.6.1 Relationship diagram of the overall of the World Bank Group , other donors and countries

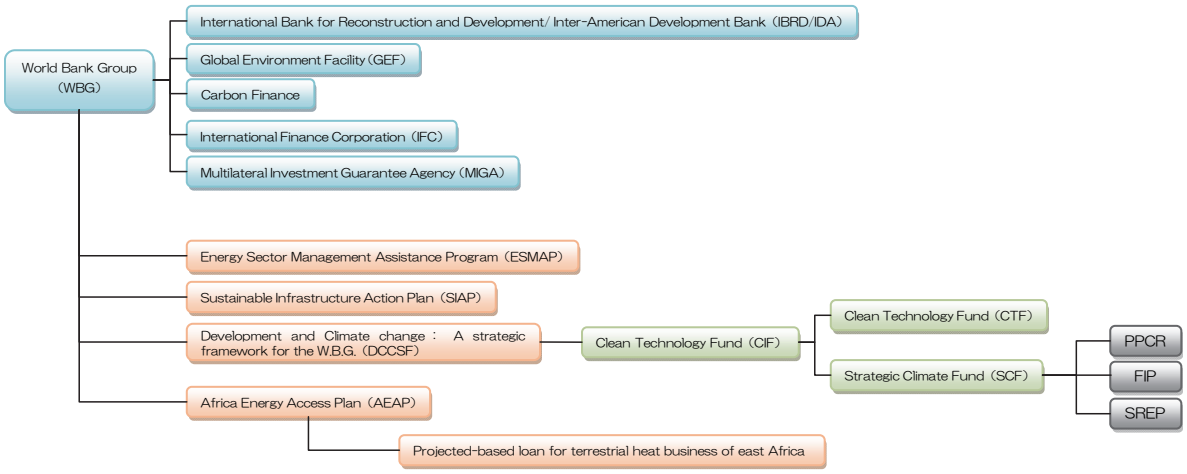


Figure 3.6.2 Relationship diagram of the organization and the project of the World Bank Group

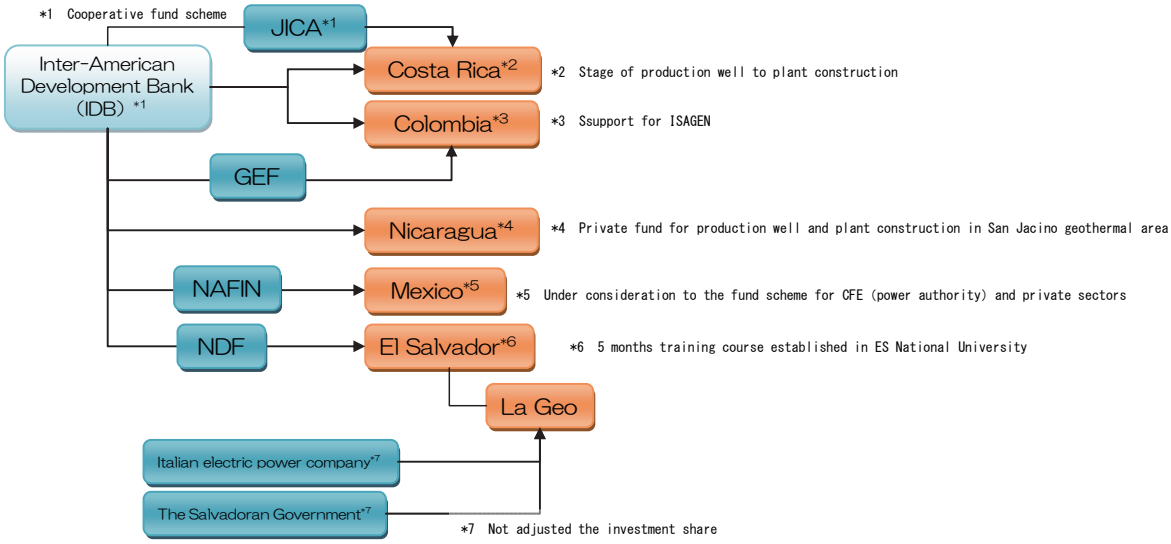


Figure 3.6.3 Relationship diagram of the Inter-American Development Bank and the target countries

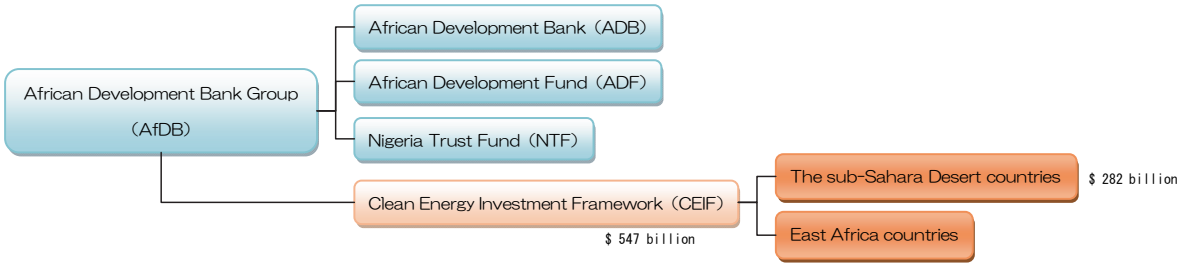


Figure 3.6.4 Relationship diagram of the organization and the project of the African Development Bank Group

3.7 Confirmation of the correlation between the development status and involvement demarcation of government or private sector

(1) Geothermal development status of each country

It was confirmed the correlation between the development status and involvement demarcation of government or private sector (field survey, test drilling and evaluation, plant construction and O & M) in each country (Figure 3.7.1). The status of each country is shown Table 3.7.1 - Table 3.7.30.

No.	Region	Country
1	Africa	Kenya
2		Ethiopia
3		Djibouti
4		Rwanda
5		Tanzania
6		Uganda
7	Central and South America	Guatemala
8		El Salvador
9		Nicaragua
10		Costa Rica
11		Ecuador
12		Peru
13		Bolivia
14		Chile
15		Argentine
16		Caribbean Island Nations
17	Developed Country	Mexico
18		Philippines
19		Indonesia
20		USA
21		Itaria
22		Iceland
23		New Zealand
24		Japan

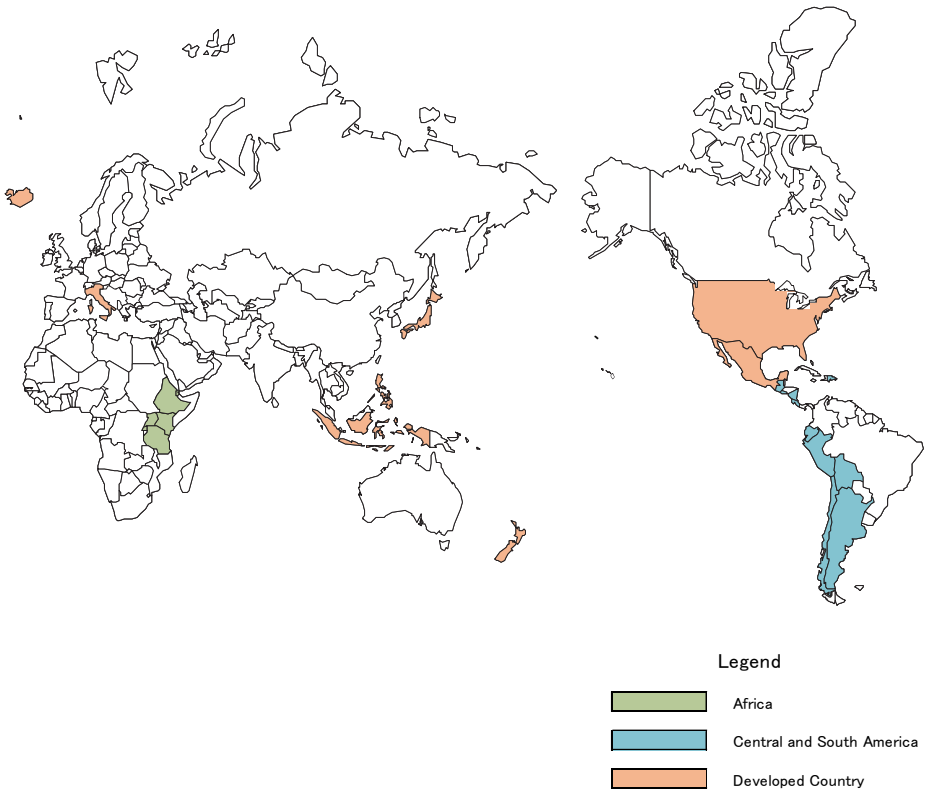


Figure 3.7.1 Location map of surveyed country

Table 3.7.1 The geothermal development status and involvement demarcation of government/private (Kenya) (1/3)

Country Name	Kenya 1
GGC/GRP	271 / 10,000 MW 2.7%
Implementing agency	Ministry of Energy (MOE) Kenya Electric Generation Company (KenGen) Geothermal Development Corporation (GDC)
Cooperation from Japan	JICA: Situation Analysis Study on Geothermal development in Africa (2010): Completed Project for Capacity Strengthening for Geothermal Development in Kenya(2013-2017) Project for Reviewing GDC's Geothermal Development Strategy in the Republic of kenya(2014-2016) Preparatory Survey on Second Olkaria Geothermal Power Project 2: On going Olkaria I Unit4/5 Power Plant Construction (Loan): On Going Olkaria I Unit6 Power Plant Construction (Loan): Preparating
Cooperation from other countries	World Bank through its various entities and the European Investment Bank (EIB) are the two multilateral development banks at the international arena. The International Development Agency (IDA) arm of the World Bank is aimed at financing credit to low income countries, International Bank for Reconstruction and Development (IBRD) serve the middle-income and creditworthy poorer countries market and International Finance Corporation (IFC) serve the private sector. World Bank and the EIB are active in the Kenya geothermal Sector. The Word Bank has supported the geothermal sector in Kenya for the last 35 years. With their support Kenya has installed the existing three geothermal plants, two public and one IPP. For the ongoing projects the World Banks has committed 120 million US$ towards the 280 MW Olkaria I & IV and 102 million US$ for the 400 MW Menengai Phase I project. On its part, EIB has committed US$ 168 million for the 280 MWe Olkaria I & IV project and a 36 million US$ grant to 400 MW Menengai Phase I project (Ngugi, 2012).

Geothermal Project Development Status

Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Olkaria Ⅰ(1-5)	Status								Olkaria Ⅰ : 45MW Olkaria Ⅱ : 105MW OlkariaⅣ : 70MW×2(Constructing) Olkaria Wellhead: 35MW
Olkaria Ⅱ(1-3)	Government/Private	Government	Government	Government	Government	Government	Government	Government	
OlkariaⅣ(1-2)	Donor	UNDP	UNDP			JICA(L)			
Olkaria Ⅰ-6	Status								KenGen : 70MW (Expansion) ODA loans remaining unused
	Government/Private	Gov (DM)	Gov (DM)	Gov (CON)	Gov (DM/CON)	Gov/Pri	Gov/Pri	Gov (DM/CON)	
	Donor					JICA(L)			
Olkaria Ⅲ(1-4)	Status								IPP GTP : 48MW+36MW OrpowerⅣ (Subsidiary of Ormat)
	Government/Private	Government	Government	Government	Government	Private	Private	Private	
	Donor	UNDP	UNDP						
Olkaria Ⅲ	Status								IPP GTP : 48MW+16MW OrpowerⅣ (Subsidiary of Ormat)
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Olkaria Ⅴ	Status								KenGen/IPP : 140MW
	Government/Private	Gov (DM)	Gov (DM)	Gov (CON)	Gov (DM/CON)	Gov (CON)	Gov (DM/CON)	Gov (DM/CON)	
	Donor					JICA(L)			
Olkaria Ⅵ	Status								KenGen : 140MW
	Government/Private	Gov (DM)	Gov (DM)	Gov (CON)	Gov (DM/CON)	Gov/Pri	Gov/Pri	Gov (DM/CON)	
	Donor					JICA(L)			
Menengai	Status								GDC : 107MW Start of operation is expected in may 2015. Expansion plans: 60MW, 100MW×3
	Government/Private	Gov (DM)	Gov (DM)	Gov (CON)	Gov (CON)	Pri(3社)	Private	Gov (DM)	
	Donor	JICA(T)	AfDB, SREP	JICA(T), WB(L)	AfDB(L), WB(L), AFD(L), EIB(L), JICA(T)	AfDB(PRG)			
Eburu	Status								KenGen : 2MW+30MW, expansion plan
	Government/Private	Gov (DM)	Gov (DM)	Gov (CON)	Gov (DM/CON)	Gov (CON)	Gov (DM/CON)	Gov (DM/CON)	
	Donor								
Baningo-Silili	Status								GDC : Expected to 400MW. Development plan of five promising ares has formulated.
	Government/Private	Gov (DM)	Gov (DM/CON)	Gov/Pri?	Gov (DM/CON)/Pri	Private	Private	Gov/Pri?	
	Donor	UNEP(T)、JICA(T)、ICEIDA(T)？	GRMF(G)、KfW(L)？	KfW(L)？	KfW(L)？				
Suswa	Status								GDC : Expected to 150MW. Funding stagnated. Environment, community issue
	Government/Private	Gov (DM)	Gov (DM/CON)	Gov/Pri?	Gov (DM/CON)/Pri	Private	Private	Gov/Pri?	
	Donor		India EXIM(L)		India EXIM(L)?				
Longonot	Status								IPP : 140MW AGIL owns the development license
	Government/Private	Private	Private	Government	Government	Private	Private	Private	
	Donor								

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.2 The geothermal development status and involvement demarcation of government/private (Kenya) (2/3)

Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Akira	Status								IPP : 140MW Marin Power owns the development license
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Finance								
Overview of geothermal Development	The most explored and developed field in Kenya is the Olkaria geothermal field, which is divided into seven areas. The Olkaria I area has a 45 MW power plant based on three 15 MW units commissioned in 1981, 82 and 85, and the Olkaria II area has a 105 MW power plant commissioned in 2003 and 2010. These two plants and areas are owned by KenGen. The Olkaria III area with a 50 MW plant is owned by ORMAT (an IPP). The Olkaria IV area (locally referred to as Domes) has ten exploration wells drilled with temperatures up to 350°C. The Kenyan Government, working through the newly formed utility GDC, has embarked on an ambitious generation expansion plan to install additional 2,746 MW by 2029 from geothermal sources. The planned geothermal developments require over 1,000 wells to be drilled and about 38 large power stations of about 70 MW each to be built at a total cost of over USD 8 billion, inclusive of wells and steam gathering systems. There are four geothermal power plants in the Olkaria area (Olkaria Ⅰ (6 Units), Olkaria Ⅱ (3 Units), Olkaria Ⅲ (4 Unit), Olkaria Ⅳ (2 Unit)). JICA is planning to support the geothermal power generation project in Olkaria V. In Menengai area, a detailed field survey was started in 2004. And the survey, supported by AfDB and WB, for construction of power plant (400 MW) has been carrying. The training programs of the reservoir evaluation, the target setting and drilling, have been initiated by JICA. Currently, the donor support is concentrated in Menengai project of GDC, but Baringo-Silali project and Suswa project are in trouble due to lack of funds. In addition, the government plans to adopt a new model of steam development with private sector.								
Future cooperation (Assumption)	Continue the technical cooperation project of engineer training and power station construction. And preparing a loan Olkaria I unit 6 and Olkaria V power plant construction.								

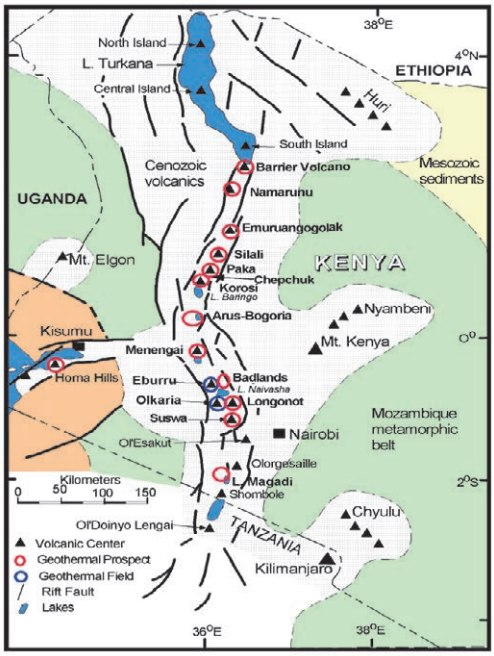
Table 1 Source of financing in Kenya

			Governments							Special purpose		
			Grants AID - Technical assistance			Concessional LOANS						
			Advisory services	Project preparation/ feasibility	Capacity building (Training)	Technical assistance	Credit (Very long-below market interest)	Loans (Long, market rate interest)	Private investment	Green funds	CDM	Insurance
Multilateral Development Banks	AfDB			♦	♦		♦	♦		♦		♦
	IDA		♦	♦	♦	♦	♦			♦	♦	
	IBRD							♦				
	EIB			♦	♦			♦			♦	
	IFC								♦			
	MIGA											♦
Bilateral Financing Institutions	France	AFD	♦	♦	♦	♦		♦				
		Proparco							♦			
	Germany	KfW									♦	
		DEG							♦			
	Japan	JICA	♦	♦	♦	♦	♦					
		JBIC					♦	♦	♦			♦
	China Exim Bank						♦					
	USA	Exim Bank						♦				
		USTDA	♦	♦	♦							
		USAID	♦	♦								
		OPIC										♦

Source : Ngugi(2012)

Table 3.7.3 The geothermal development status and involvement demarcation of government/private (Kenya) (3/3)

Fig. 1 Geothermal prospects in Kenya



Source : Simiyu (2010)

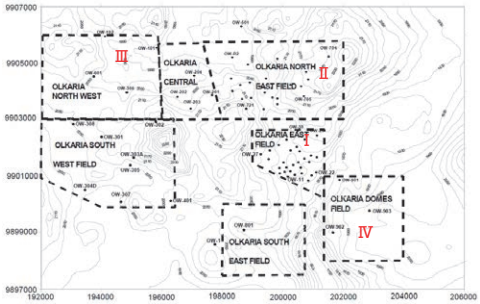
Fig. 2 Landsat image around Olkaria

Fig. 3 Location map of Olkaria geothermal field

Olkaria Ⅰ : East Field

Olkaria Ⅱ : North East Field

Olkaria Ⅲ : North West Field



Olkaria Ⅳ : Olkaria Domes Field

Oserian : Central

References

- AfDB (2011) Menengai Geothermal Development Project. Project Appraisal report, Nov. 2011.
- JICA (2010) Situation Analysis Study on Geothermal Development in Africa.
- JICA (2013) Detailed Planning Survey for Capacity Strengthening for Geothermal Development in Kenya
- Kinbara, K. (1984) Kenya, Olcaria Geothermal Field. Chisitu News, 63-72.
- Ngugi P. K. (2012) Financing the Kenya Geothermal Vision. United Nations University Geothermal programme.
- Simiyu, S. M. (2010) Status of Geothermal Exploration in Kenya and Future Plans for Its Development. Proceedings World Geothermal Congress 2010.

Table 3.7.4 The geothermal development status and involvement demarcation of government/private (Ethiopia) (1/2)

Country Name	Ethiopia								2
GGC/GRP	7.3 / 5,000 MW 0.1%								
Implementing agency	Geological Survey Ethiopia (GSE) Ethiopian Electric Power (EEP)								
Cooperation from Japan	JICA: Situation Analysis Study on Geothermal development in Africa (2010): Completed Project for Formulating Master Plan on Development of Geothermal Energy in Ethiopia(2013-2014)								
Cooperation from other countries	・World Bank: Considering to co-financing with JICA to Aluto Langano geothermal power plant. Planning to support a 35 MW geothermal power plant and drilling in Tendaho 2 (Ayro Bera) ・AFD: Plan to the power plant construction (100MW) and test drilling at Dubi (Tendaho 1). Loan of EUR 20 million for drilling. ・KfW: Grants of EUR 10 million for drilling. ・ARGeo: Ground survey of Dubi region. ・USAID: The planned reform of the institutional support for entering the IPP to geothermal power generation project.								
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Aluto Langano (Pilot plant)	Status								7.3MW pilot plant installed in 1998. O&M carried by EEP.
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor	UNDP, IAEA							
Aluto-1 (Aluto-Langano) (Unit1,2)	Status								
	Government/Private	Government	Government	Government	Government	Government			
	Donor	UNDP ICEIDA/NDF	ELC (Italian consultant)	GoJ	WB (150MUSD)	JICA (55MUSD)			
Aluto-2 (Aluto-Finkilo)	Status								
	Government/Private	Government	Government	Government	Government				
	Donor	UNDP ICEIDA/NDF	ICEIDA		WB (150MUSD)				
Aluto-2 (Aluto-Bobesa)	Status								
	Government/Private	Government	Government	Government	Government				
	Donor	UNDP ICEIDA/NDF			WB (150MUSD)				
Tendaho-1 (Tendaho-Dubti)	Status								3 Deep exploration well (Max 2,100m) . Max temperature 270℃.
	Government/Private	Government	Government	Government	Government				
	Donor	UNDP, BGR, ARGeo	ELC		AFD				
Tendaho-2 (Tendaho-Ayrobera)	Status								
	Government/Private	Government							
	Donor	UNDP, BGR, ARGeo							
Tendaho-3 (Tendaho-Allalobela)	Status								
	Government/Private	Government	Government	Government	Government	Government			
	Donor	UNDP ICEIDA/NDF	WB (25.8MUSD)		TBD (22.5MUSD)	TBD (27.5MUSD)			
Gedemsa	Status								
	Government/Private	Government							
	Donor	UNDP ICEIDA/NDF							
Tulu Moya	Status								IPP: RG (2008)
	Government/Private	Private							
	Donor	US Private							
Corbetti	Status								IPP: RG (2008)
	Government/Private	Private	Private	Private	Private	Private			
	Donor		GRMF, US Private		GRMF (8MUSD), US Private (40MUS)				
Abaya	Status								IPP: RG (2008)
	Government/Private	Private							
	Donor								
Dofan	Status								
	Government/Private	Government							
	Donor	GRMF (0.7-0.8MUSD)							
Fantale	Status								IPP: UK Private (2008)
	Government/Private	Private							
	Donor	GRMF							

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.5The geothermal development status and involvement demarcation of government/private (Ethiopia) (2/2)

Overview of geothermal Development	There are many geothermal promising area not only Tendho and Aluto langano in Ethiopia Rift Valley. Geothermal exploration has been carried out for the whole country of the last 40 years. GSE is responsible for geothermal investigation since UNDP project in 1969-1973 and EEP is responsible for construction management of the geothermal power plant development. The peak of exploration over the medium term from the beginning in 1980. A pilot plant of 7.3MW in Aluto Langano was installed in 1998.
Future cooperation	It is desirable to conduct detailed exploration in geothermal promising field.

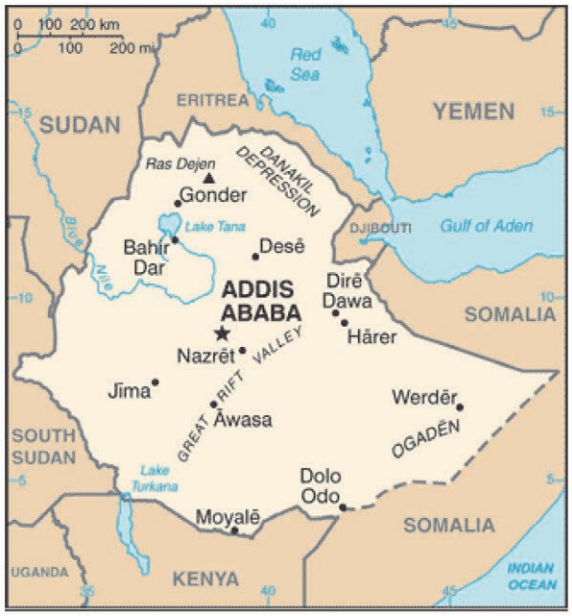


Fig. 1 Location map of Ethiopia

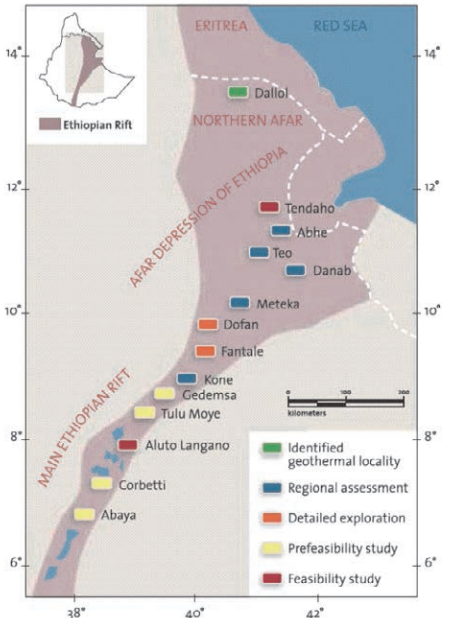


Fig. 2 Location map of geothermal promising srea

Table 1 Project Scope and Finance of Aluto Geothermal Development

Project Scope	Amount mUSD	Financed by
Drilling Consumable	24.5	SREP/IFC
Drilling Consumable	35.5	WB/IDA
Exploration, Well siting	—	Iceland
Steam Gathering System, Substation, Transmission	46.5	WB/IDA
Consultancy for Power Plant and Drilling	13	WB/IDA
Power Plant Unit Ⅰ, 35MW	55	JICA
Power Plant Unit Ⅱ, 35MW	55	TBD(To be Decided)

Source: JICA data

References	・JICA(2010) Situation Analysis Study on Geothermal Development in Africa. ・JICA(2013) Detailed Planning Survey for Project for Formulating Master Plan on Development of Geothermal Energy in Ethiopia. ・Teklemariam M. and Kebede S. (2010) Strategy for Geothermal Resource Exploration and Development in Ethiopia. Proceedings World geothermal Congress 2010.

Table 3.7.6 The geothermal development status and involvement demarcation of government/private (Djibouti)

Country Name	Djibouti								3
GGC/GRP	0 / 50-150 MW 0.0%								
Implementing agency	Ministry of Energy and Natural resources (MENR) Centre de Recherche Scientifique de Djibouti (CERD) Electricite de Djibouti (EdD) Djiboutian Office for Development of Geothermal Energy (ODDEG)								
Cooperation from Japan	JICA: Situation Analysis Study on Geothermal development in Africa (2010) Data Collection Survey on Geothermal Energy Development in Djibouti (2013-2014)								
Cooperation from other countries	・BRGM: Geothermal investigation from around 1970. ・UNDP: 4 wells in Lake Asal area, 2 wells in Hanle area in the late 1980s. High- temperature reservoir of over 260 has been confirmed in 1,000 to 1,300m depth in Lake Asal. ・REI: Acquired the mining rights of the Asal area for 50MW geothermal power plant construction in 2007, but it was destroyed in 2008 by the 2008 Icelandic financial crisis. ・AfDB: Agreed to be USD7.8 million to support geothermal development project of Lake Asal (2013.8).								
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Lake Assal	Status								Geothermal investigation was carried out from around 1970 by BRGM. 4 wells drilled by UNDP (Max. Temp; 260). AfDB: USD7.8 million
	Government/Private	Government	Government	Government	Government				
	Donor	BRGM, UNDP, REI	UNDP, AfDB						
Nord Goubet	Status								Development status expected to next of Assal
	Government/Private	Government							
	Donor	BRGM, UNDP							
Hanle	Status								124 ℃ was confirmed by deep exploration well (2,020m).
	Government/Private	Government	Government						
	Donor	BRGM, UNDP	UNDP						
Overview of geothermal Development	Geothermal investigation was carried out from around 1970 to 1990 by BRGM. Test well was drilled in Lake Asal and Hanle in the late 1980s by UNDP, the geothermal reservoir of high temperature was confirmed in Asal. REI was conducted various survey by obtaining the mining rights of the Asal area from 2007, but was destroyed by the financial crisis in Iceland. AfDB will provide assistance of USD 7.5 million in geothermal development of Lake Asal. The data collection survey including geological and geochemical surveys has been carried out by JICA.								
Future cooperation (Assumption)	It is desirable to conduct detailed exploration in geothermal promising field.								

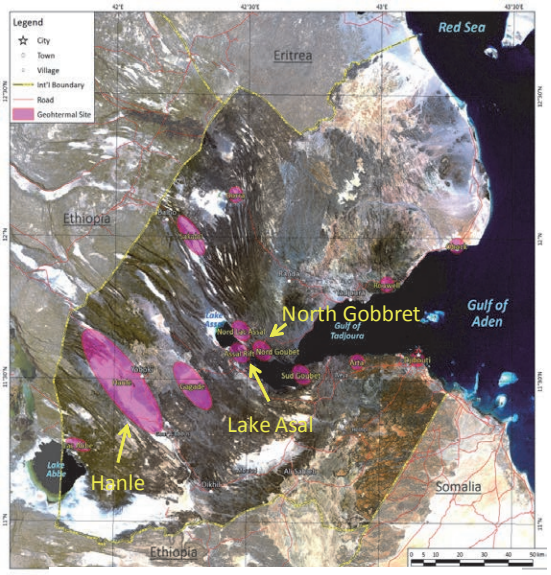


Fig. 1 Landsat image of geothermal promising area

Table 1 Geothermal promising area and exploration stage

Area	Exploration stage				Surface manifestations	
	Geology	Geo-chemistry	Geophysics	Exploration drilling	Hot springs	Fumaroles
Lake Asal	+++	++	+++	++	++	+
North Goubbet	++	++	++		+	+
Gaggade	++	++			+	+++
Hanle	++	++	++	+		++
Lake Abbe	++	++			++	++
Arta	++	++	++			+
Obock		++			+	+
Alol	+	+			++	+

Source: Houssein (2010)

References	・African Development Bank HP. ・Hjartarson G., Gisladottir V., Gislason G. and Olafsson K. (2010) Geothermal Development in the Assal Area, Djibouti. Proceedings World geothermal Congress 2010. ・Houssein D. E. (2010) Geothermal Resource Assessment of Asal Field, Republic of Djibouti. Proceedings World Geothermal Congress 2010. ・JICA(2010) Situation Analysis Study on Geothermal Development in Africa.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.7 The geothermal development status and involvement demarcation of government/private (Rwanda)

Country Name	Rwanda 4
GGC/GRP	0 / 100 MW 0.0%
Implementing agency	Energy, Water Supply Agency (EWASA), Geothermal Development Unit (GDU)
Cooperation from Japan	JICA: Data Collection Survey on Geothermal Nergy Development in Rwanda (2013) The Project for Preparation of Electricity development Plan Sustainable Geothermal Energy Development in Rwanda (2013-2014)
Cooperation from other countries	・ICEIDA: Geothermal training program was carried out to the GDU officials by entrusting to the UNU-GTP. Donating microscope, the fluid collection tool etc. ・Nordic Fund: Dispatch one drilling supervision from Reykjavk Geothermal Inc. for the well drilling by Chinese companies. ・BTC (Belgian Technical Cooperation): Cooperation in the implementation of environmental impact assessment. Provision of planned drilling cost of Kinigi region. ・EU/UNEP: MT survey and gravity survey in the northwest area. Electromagnetic survey in the south area.

Geothermal Project Development Status

Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Karisimbi	Status								Consignment type. Drilling engineer and wellsite geologist are dispatched in the drilling site, but drilling supervision engineer outsourcing. 1)Drilling surpervision engineer assistance
	Government/Private	Government	Government	Government	Government	Gov/Pri	Gov/Pri	Gov/Pri	
	Donor	JICA EU/UNEP	Nordic Fund[1)]						
Kinigi	Status								
	Government/Private	Government							
	Donor	JICA EU/UNEP							
Gisenyi	Status								
	Government/Private	Government							
	Donor	JICA EU/UNEP							
Bugarama	Status								
	Government/Private	Government							
	Donor	JICA							

Overview of geothermal Development	Geothermal investigation have been carried out by many agencies , based on these results, Bugarama (southwest) , Karisinbi, Kinigi and Gisenyi (northwest) have been extracted as geothermal promising area in Rwanda. Geochemical survey by BRGM (1982). Geochemical survey by Chevron (2006). Corporation survey by BRGM, KenGen and ISOR (2008). Investigation by KenGen (2009-2010). Potential evaluation by MININFRA (2011). Comprehensive investigation by IESE (2011-2012). Geothermal development potential has been estimated 700MW by potential evaluation survey in 2011. However, this potential evaluation, which is assumed to 4MW respectively, the production well capacity and one drilling production wells per unit area and was calculated by multiplying the area of development promising area evaluated from geophysical data, there is a problem about the validity of the calculated value. Validation Workshop with stakeholders was held in January 2013, exploration well drilling 3,000m has been determined in Karisimbi. Drilling was started in July 2013, and was completed to reach the depth 3,015m of October, but the temperature has been confirmed was 100 ℃ or less. Second well have been drilled in 2014, but was stopped in the middle because of the same situation as the first well. This exploration has been carried out by the self-financing of the Government of Rwanda, but it is determined that a promising geothermal signs not confirmed the accuracy of the drilling target selection is insufficient.
Future cooperation (Assumption)	It has supported the current power development plan, including geothermal development plan, to determine the support policy for the future based on the results. Challenges such as the following can be considered to geothermal development method of Rwanda from the drilling of this time, 1) Reliability of geophysical data, 2) Geothermal structure model, 3) Setting of the drilling target, 4) How to proceed with geothermal development studies. In the future cooperation, the training of capacity building for geothermal development is necessary. It is important to training and placement of human resources that can be adjusted donors.

Fig. 1 Geothermal promising area in Rwanda

References	・JICA(2010) Situation Analysis Study on Geothermal Development in Africa. ・JICA (2013) Republic of Rwanda, Data Collection Survey on Geothermal Development in Rwanda: Final Report.

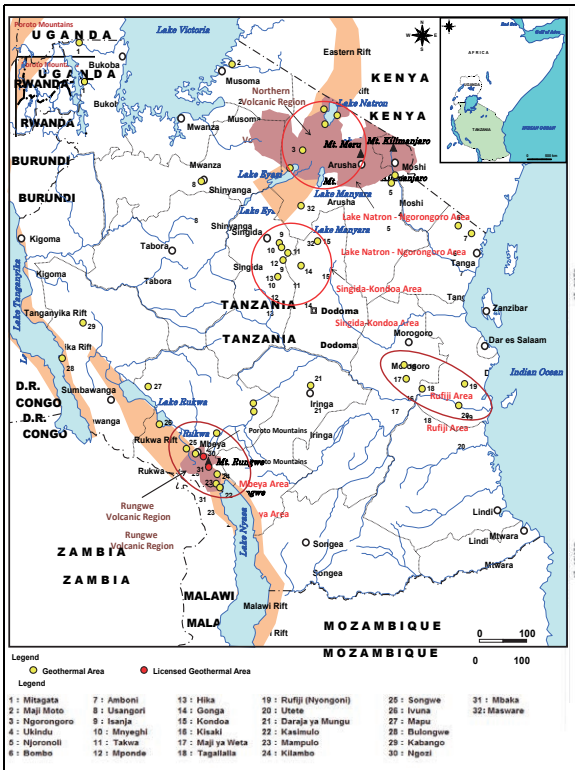
GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.8 The geothermal development status and involvement demarcation of government/private (Tanzania) (1/2)

Country Name	Tanzania								5
GGC/GRP	0 / 650 MW 0.0%								
Implementing agency	Ministry of Energy and Minerals (MEM) Geological Survey Tanzania (GST) Tanzania Electric Supply Company (TANESCO) Tanzania Geothermal development Company (TGDC)								
Cooperation from Japan	JICA: Situation Analysis Study on Geothermal development in Africa (2010) Data Collection Survey on Geothermal Energy Development in East Africa (2013-2014)								
Cooperation from other countries	・SIDA (Swedish International Development Corporation Agency): In Tanzania, prepared for energy donor partner group led by SIDA. Through the support to the geothermal sector with collaboration of some donors, this group aims to play a role in scaling up renewable energy program (SREP) in Tanzania. SREP plans funding for carrying out the advice to geothermal power generation detailed survey of geothermal sites, and exploration well drilling. ・BGR (Esderal Institute for Geosciences and Resources of Germany): 2006～2009 GEOTHERM project. Advice for geothermal expert training and the drilling site selection. ・DFID (Department for International Development) ・AfDB (Africa Development Bank): Workshops held in cooperation with DFID. ・ICEIDA: Human resource development for geothermal energy development. ※Economic Consultants Associated Ltd has published the "East Africa Geothermal Energy Review of Donor Initiatives and Current Regulatory Framework" in October 2012.								
Geothermal Project Developme									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Ngozi	Status								Geothermal exploration license was issued for GTP. A deep exploration well drilling was planned after three shallow wells drilling for 140 MW geothermal power plant.
	Government/Private	Gov/Pri	Private	Private	Private	Private	Private	Private	
	Donor								
Mbaka	Status								Geothermal exploration license was issued for GPT. Surface survey carried out in 2012. 600-800m depth of test wells
	Government/Private	Gov/Pri	Private						
	Donor								
Songwe/Rambo/ Ilaqtile	Status								Extracted by JICA(2014). Detailed survey planned by AfDB.
	Government/Private	Government							
	Donor	JICA/AfDB							
Overview of geothermal Development	Geothermal exploration in Tanzania has been conducted since 1949. Preliminary studies have yielded results in the areas of ground temperature measurement, chemical analysis of hot spring water and gas, flow rate measurement of hot spring water, etc. Most of the hot springs identified are in the Rift Valley. These hot spring areas are mostly distributed in the northern volcanic regions such as Kilimanjaro, Mel and Ngorongoro, near the border with Kenya, and in the Rungwe volcanic region in the southwestern part of Tanzania. SWECO conducted geothermal reconnaissance exploration in Tanzania from 1976 until 1978 funded by SIDA. As relatively high temperatures were identified around Lake Manyara, Lake Natron, Ngorongoro crater and Mbeya, these areas were therefore regarded as prospective areas for further studies. From 1997 to 2004, based on reconnaissance surveying conducted by FEC. In 2004 and 2005, with the funding from the AfDB, DECON conducted another survey for the purpose of rural electrification. Between 2006 and 2009 BGR conducted in collaboration with the staff from MEM, GST and TANESCO geological, geochemical and geophysical surveying (TEM, MT) in Mbeya region. The survey was conducted under the GEOTHERM project. Except the detailed studies made by BGR at Ngozi prospect, most of the geothermal exploration conducted in other areas of Tanzania are on a reconnaissance basis. FEC is a Tanzanian company was the first IPP to be issued with a geothermal license in Tanzania in 1997. As the company did not proceed this development and the license has since been cancelled. GPT was registered in Tanzania to explore and develop geothermal resources. GPT is 70% owned by Geothermal Power Limited (GPL registered in Mauritius), Interstate Mining & Minerals Ltd (Interstate, 25%) and National Development Corporation (NDC, 5%). GPT initially obtained six geothermal exploration licenses, but three licenses were rested. In 2012, GPT carried out surface investigations at Mbaka. Currently GPT is drilling three 600-800m exploration wells at Mbaka. They also planned to drill three other shallow wells at Ngozi before drilling a deep well exploration well and negotiating a 100MW PPA for the site.								
Future cooperation (Assumption)	As of July 2014, TGDC has submitted a request for test drilling and resource assessment of Mbeya to GRF. Based on the survey results,JICA will determine the policy of the future.								

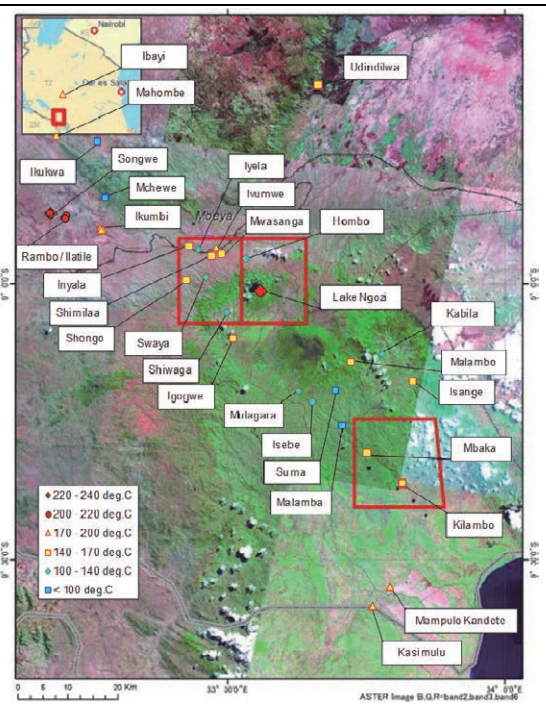
GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.9The geothermal development status and involvement demarcation of government/private (Tanzania) (2/2)



Source: JICA(2014)

Fig. 1 Geothermal promising area in Tanzania



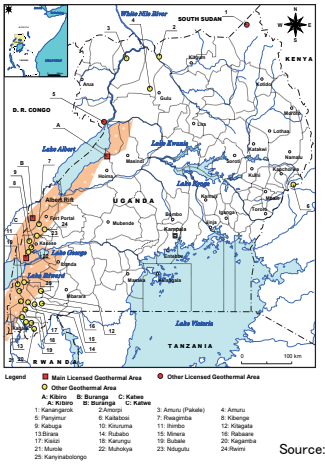
Source: JICA(2014)

Fig. 2 Distribution of Na-K-Ca geothermometers in Mbeya area

References	・JICA(2010) Situation Analysis Study on Geothermal Development in Africa. ・JICA(2014) Data Collection Survey on Geothermal Energy Development in East Africa Final Report (Tanzania).

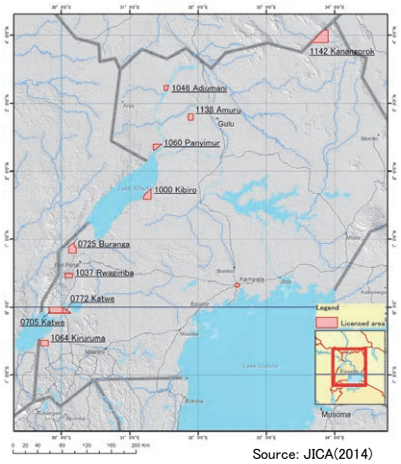
Table 3.7.10 The geothermal development status and involvement demarcation of government/private (Uganda)

Country Name	Uganda								6
GGC/GRP	0 / 450 MW 0.0%								
Implementing agency	Department of Geological Survey and Mineral Development (DGSM or GSU)								
Cooperation from Japan	JICA: Situation Analysis Study on Geothermal development in Africa (2010) Data Collection Survey on Geothermal Energy Development in East Africa (2013-2014)								
Cooperation from other countries	・AfDB: The DGSM submitted a request to AfDB in December 2012 for US$ 51.865m to fund geothermal exploration work, and is still waiting for a response. The funds were to cover detailed exploration work in the four priority sites of Katwe, Buranga, Kibiro and Panyimur, the drilling of three deep exploration wells in the most promising site. ・ICEIDA-WB: The possibility of providing a geothermal exploration grant of US$700,000 from its Compact project funds for extra work in Katwe on condition that the Katwe licenses already issued should be terminated. ・ARGeo-UNEP: Planning to carry out a geothermal exploration project in Kibiro geothermal prospect. ・GRMF: Uganda is expected to submit four surface exploration proposals for Katwe, Buranga, Kibiro and Panyimur and one drilling proposal for Kibiro. ・UNU-GTP, KenGen and GDC: UNUGTP offers a 6-month geothermal course in Iceland.								
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Kibiro	Status								After investigation of the donor countries, Moberge Finance Limited has exploration rights acquired in 2012.
	Government/Private	Gov/Pri	Government						
	Donor	UNDP, ICEIDA, OPEC, IAEA							
Katwe	Status								The geothermal survey by ICEDIA and UNDP. Six heat flow drilling by WB. Cozumel Energy Ltd acquired license in the west region in 2010, Katwe Geothermal Power Project Limited acquired in the eastern region in 2011.
	Government/Private	Gov/Pri	Government						
	Donor	ICEIDA, UNDP	WB						
Panyimur	Status								The geothermal survey carried out by DGSM. Pawakom International Ltd acquired license in 2012.
	Government/Private	Gov/Pri							
	Donor								
Buranga	Status								The geothermal survey carried out in GEOTHERM project by BGR. GIDS Consult Ltd acquired license in 2012.
	Government/Private	Gov/Pri							
	Donor	BGR							
Overview of geothermal Development	Most of the geothermal areas in Uganda are situated along the Rift Valley. Although a nationwide geothermal survey has not been conducted yet, a research agency of the United States estimated a geothermal potential of about 450 MW in a survey by UNDP in the 1980s. The following three areas are recommended as major potential areas: Kibiro, Buranga and Katwe. A high thermal gradient has also been identified in the course of oil exploration in the Panyimur area. Geothermal surface survey funded by ICEIDA was carried out in Kibiro, Katwe. And the surface survey assisted by BGR has been carried out in Buranga. The Government of Uganda started issuing geothermal Exploration Licenses under the Mining Act in 2010. However, it appears that no effective exploration work has been undertaken by these private companies, as required by the law. Due to the slow progress of development by these companies, DGSM intends to carry out exploration activity itself in these licensed fields after the expiry of the licenses. The Government has decided to form a department to handle geothermal development by forming a new Directorate of Minerals and Geothermal Resources.								
Future cooperation (Assumption)	Since geothermal license will be expired in three years, government support is important for exploration of geothermal area after that. However, coordinating with other donors are required. It is necessary to lead the geothermal development scenario making from a view point of overall.								



Source: JICA(2014)

Fig.1 Geothermal promising area in Uganda



Source: JICA(2014)

Fig.2 Location of the licensed geothermal area

References	・JICA(2010) Situation Analysis Study on Geothermal Development in Africa. ・JICA(2014) Data Collection Survey on Geothermal Energy Development in East Africa Final Report (Uganda).

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.11 The geothermal development status and involvement demarcation of government/private (Guatemala)

Country Name	Guatemala								7
GGC/GRP	49 / 3,320-4,000 MW 1.2-1.5%								
Implementing agency	Institute Nacional de Electrificacion (INDE)								
Cooperation from Japan	JICA								
Cooperation from other countries	JICA, IDB, OPEC, OLADE, ROCP/USAID, EC, IEA								
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Zunil Ⅰ	Status								GGC: 24MW
	Government/Private	Government	Government	Government	Government	Private	Private	Government	Power Generation Facility: BOO with ORMAT
	Donor	JICA							
Zunil Ⅱ	Status								
	Government/Private	Government	Government	Government	Government				Pre F/S
	Donor								
Amatitlan	Status								GGC: 25MW
	Government/Private	Government	Government	Government	Gov/Pri	Private	Private	Private	BOO with ORMAT
	Donor	(JICA)			(JICA)				
Tecuamburro	Status								USA Los Alamos (Pre F/S)
	Government/Private	Government	Government	Government					JETRO (Detailed survey)
	Donor			JETRO					
San Marcos	Status								F/S from surface survey
	Government/Private	Government							
	Donor	EC							
Moyuta	Status								
	Government/Private	Government							
	Donor								
Totonicapan	Status								
	Government/Private	Government							
	Donor	IAEA							
Overview of geothermal development	Power configuration of Guatemala in 2013 is 51% hydro, 35% thermal power, biomass 11%, 3% geothermal. The total geothermal potential of the country has been estimated about 1,000MW, but geothermal power plants in operation are only two plants: Sunil Ⅰ (24 MW) and Amatitran (25 MW). For Sunil Ⅱ, Guatemala Power Corporation (INDE) owns land ownership and the geothermal resource development license already, as a project of the public sector.								
Future cooperation (Assumption)	Guatemala government's policy is to promote as one of the priority projects geothermal development in Sunil Ⅱ by INDE, to achieve a reduction in the cost of power generation and enhancement of the required power generation capacity. Guatemala government requested the data collection survey on geothermal energy development to implement the geothermal drilling and the environmental and social considerations and evaluations in the future.								

Source: Bertani (2010)

Fig. 1 Geothermal promising area in Guatemala

[Power operational structure of Guatemala]
Due to the low quality of technologies and services and loss of power transmission and distribution, since 1986, capital investment in the power sector by the state fiscal stagnation, massive power outage has occurred in 1991 in Guatemala.
Structural reform of the domestic electricity business, with a focus on the introduction of the free market and the elimination of the monopoly of the power industry has been started.
1992: Power generation business investment by private sector initiative was started.
1996: General Electricity Act 1996 was enacted. Its outline is as follows,
Installation of the power regulatory agency
Installation of market management mechanism and the introduction of the holesale electricity market in the power sector
Power generation of Power Corporation of INDE, etc., power transmission, power distribution division of business
1997: National Electricity Commission was established as a power regulatory agency.
1998: Wholesale electricity market is introduced, wholesale power mechanism has been established as a market operating agency. Then, entry of private capital in the power transmission and distribution sector was observed.
(INDE is divided into power generation, power transmission, distribution companies by the General Electricity Act of 1996. Power distribution sector has been divided privatized in 1998)

References
JICA Analysis Support Report on Geothermal Development in Guatemala.
Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010.
Asturias F. and Grajeda E. C. (2010) Geothermal Resources and Development in Guatemala Country Update. Proceedings World Geothermal Congress 2010.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.12 The geothermal development status and involvement demarcation of government/private (El Salvador)

Country Name	El Salvador							8
GGC/GRP	204 / 500 MW 40.8%							
Implementing agency	LaGeo: owned by INE(Government Electric Utility) and Enel Green Power (Italy) Universidad de El Salvador							
Cooperation from Japan	JICA: Geothermal environment expert (short-term) (1998)							
Cooperation from other countries	IDB, UNDP, KfW, NDF							

Geothermal Project Development Status

Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Ahuachapán	Status								95MW: 30MW×2, 35MW
	Government/Private	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	
	Donor								
Berlin	Status								109.4MW: 28MW×2, 9.4MW, 44MW
	Government/Private	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	
	Donor								
Chinameca	Status								50MW (F/S has done) 240℃ (1,900m)
	Government/Private								
	Donor								

Overview of geothermal Development	There two geothermal field in El Salvador that have operating power plants: Ahuachapán and Berlin, both owned and operated by LaGeo which is owned by INE (Government Electric Utility) and Enel Green from Italy. Their combined installed Capacity is around 200MW. The geothermal power plant was started operation in 30 MW by WB support in Ahuachapan geothermal field. Then, it has expanded to 95 MW in 1985. In Berlin geothermal field, the geothermal power plant (5 MW) was started operation in 1992. It started operation in 30MW by WB support in Ahuachapán geothermal field. Then, it has expanded to 95 MW in 1985. In Berlin geothermal field, the geothermal power plant (5 MW) was started to operate in 1992, now it has expanded to 109.4 MW. Power generation and supply system, except hydroelectric power, has been liberalized in 1996. Geothermal power plants are operated by LaoGeo which is the electric power company. LaGeo is the hydroelectric power corporation owned by CEL (62.8%) and ENEL (36.2%). Also LaGeo has concession of two other promising sites. El Salvador government is developing a geothermal training centre of Latin America, which is supported by IDB and NEF.
Future cooperation (Assumption)	El Salvador government has a policy of effective use of the experience of geothermal development, for geothermal development center of the region which has been supported by IDB and NDF. The course for geothermal parties operating in the El Salvador University has been function as geothermal development center. JICA will consider supporting the geothermal course of the University of El Salvador while performing the acquisition excellent candidate of "bonds of resources".

Source: Bertani (2010)

Fig.1 Geothermal promising area in El Salvador

References	Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. Herrera R. Montalvo F. and Herrera A. (2010) El Salvador Country Update. Proceedings World geothermal Congress 2010.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.13 The geothermal development status and involvement demarcation of government/private (Nicaragua) (1/2)

Country Name	Nicaragua							9
GGC/GRP	150 / 1,519 MW 9.9%							
Implementing agency	Instituto Nicaraguense De Energia (IND)							
Cooperation from Japan	JICA: Momotombo geothermal power plant project (1978.3, 7,500M Yen, Partially Untied)							
Cooperation from other countries	IDB: San Jacinto－Tizate Geothermal power plant project $40M Loan (2010) ICEIDA: : Capacity development assistance over five years IAEA: Isotope survey (2001-2004) USAID: Financial, Technical assistance							
Geothermal Project Developme :								
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
San Jacinto-Tizate	Status								72MW
	Government/Private	Government	Government	Government	Private	Private	Private	Private	License: San Jacinto Power⇒ Polaris Energy Nicaragua S.A. (PENSA)
	Donor	IDB？	IDB?	IDB?		IDB			IDB $40M Loan (2010) Private sector operating. Additional power plant 10MW binary (Fuji) in 2014.
Momotombo	Status								35MW (1983), 35MW (1989), 7.5MW (2002)
	Government/Private	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	Gov/Pri	License: Ormat International Inc, BOT contract (1999)
	Donor					JICA(1978)			Private sector operating until 2014.
Castina-San Cristobal	Status								Consortium by 10 companies.
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
El Hoyo-Monte Galan	Status								Private sector keep a license. Planed 3 wells drilling.
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Managua-Chiltepe	Status								Planed test drilling.
	Government/Private	民間	民間	民間	民間	民間	民間	民間	
	Donor								
Volcan Cosiguina	Status								Reservoir evaluation planed from 2014 to 2015. Far from power transmission line.
	Government/Private	Government	Government	Government					
	Donor	IDB	IDB	IDB					
Caldera de Apoyo	Status								
	Government/Private	Government	Government	Government					
	Donor	IDB	IDB	IDB					
Volcan Mombacho	Status								
	Government/Private	Government	Government	Government					
	Donor	IDB	IDB	IDB					
Isla de Ometepe	Status								Large-scale development is difficult for island in Lake Nicaragua.
	Government/Private	Government	Government	Government					
	Donor								
Overview of geothermal Development	Geothermal exploration began in Nicaragua at the end of 1960s, focusing on the Momotombo and San Jacinto geothermal field. In 1983 35 MW geothermal plant was placed online. A second identical unit was installed in 1989, bringing installed capacity to 70 MW. In 1999, Ormat International, Inc won a 15 years Build-Operate- Transfer (BOT) contract. A geothermal master plan for Nicaragua was completed in 2001. In 2002, the country's geothermal law was approved. The inter national atomic energy agency conducted isotope studies. In 2003, the government of Nicaragua granted an exploitation geothermal concession to San Jacinto power to develop the San Jacinto geothermal field to achieve 66 MW. IN 2010, IDB approved $40M loan to finance the San Jacunto geothermal power project. Tripitapa and Caldera de Masaya have been developed by the government, but resources are not enough to development.								
Future cooperation (Assumption)	For technical corporation of ICEIDA has been completed in 2012, support from JICA has been requested from the Nicaragua government.								

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.14 The geothermal development status and involvement demarcation of government/private (Nicaragua) (2/2)

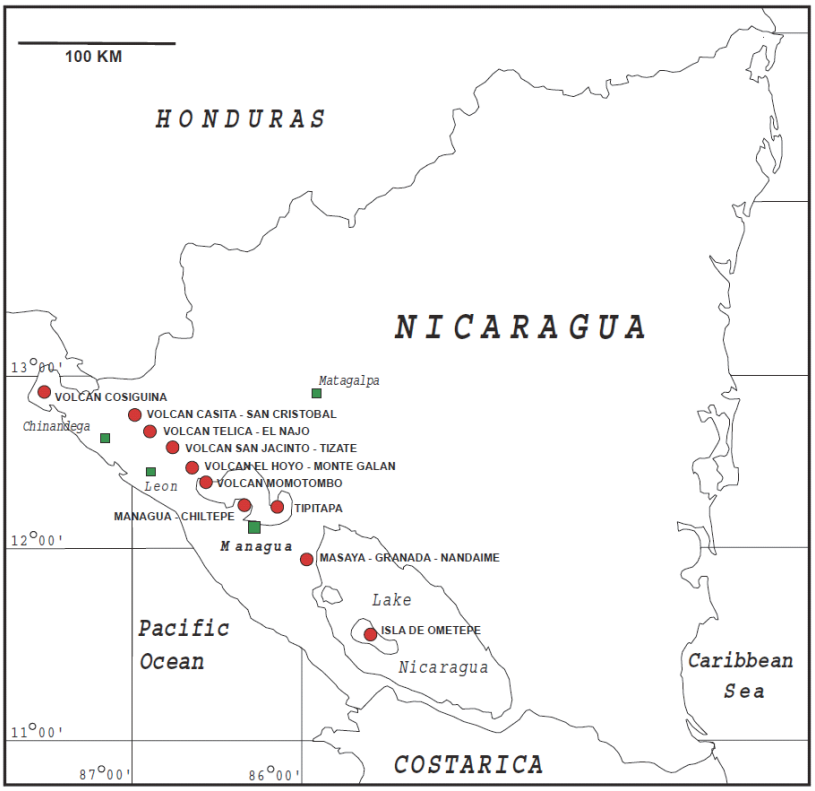
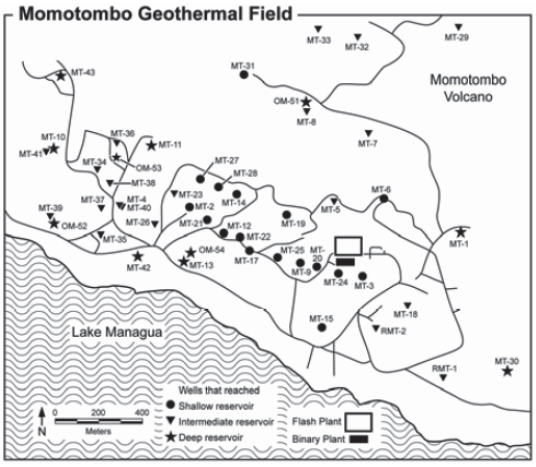


Fig. 1 Geothermal promising area in Nicaragua Source: Sanyal et.al (2000)



Source : Mayorga (2005)

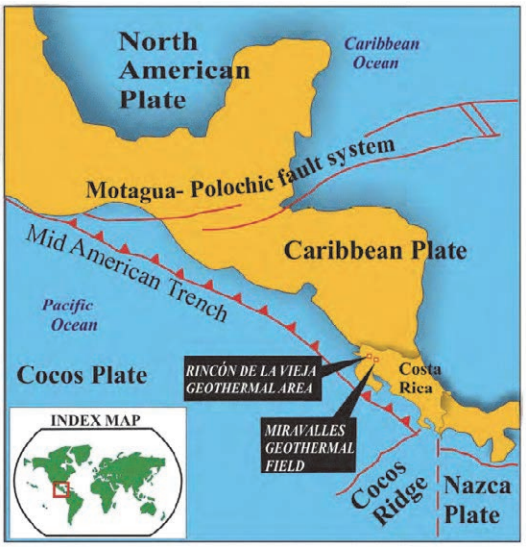
Fig.2 Location map of geothermal power plant in Momotombo

References

Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010.
Fridriksson T. and Guevara G. (2010) Geothermal Capacity Building in Nicaragua. Proceedings World geothermal Congress 2010.
Mayorga Z. A. (2005) Nicaragua Country Update. Proceedings World Geothermal Congress 2005.
Sanyal S. K., Granados E. E., Henneberger R. C., Klein C. W., Velasquez L. and Zuniga A. (2000) Development of a Geothermal Master Plan for Nicaragua. Proceedings of World Geothermal Congress 2000.
IDB homepage

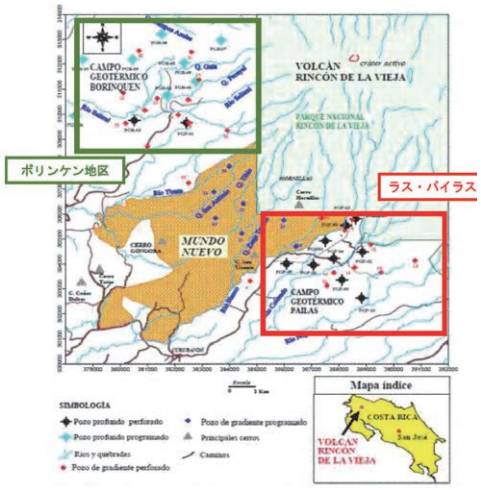
Table 3.7.15 The geothermal development status and involvement demarcation of government/private (Costa Rica)

Country Name		Costa Rica							10
GGC/GRP		205 / 865 MW 23.7%							
Implementing agency		Instituto Costarricense de Electricidad (ICE)							
Cooperation from Japan		JBIC: F/S of Las Pailas geothermal field JICA: Miravalles geothermal project (1985) Las Pailas Ⅱgeothermal project, Borinquen Ⅰ, Ⅱgeothermal project. JICA: Costa Rica Guanacaste geothermal power development preparatory survey.							
Cooperation from other countries		IDB							
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
MiraValles	Status								163MW (2003)
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor		IDB		IDB	OECF	OECF		
Las Pailas Ⅰ Las Pailas Ⅱ	Status								Ⅰ:42MW (2011) Ⅱ:JICA
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor			JICA	JICA	JICA/IDB			
Borinquen Ⅰ Borinquen Ⅱ	Status								JICA
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor			JICA	JICA	JICA/IDB			
Overview of geothermal Development		In Costa Rica, ICE has been continued to geothermal resources exploration from 1970's, from the results based on this survey, Mira Valles Ⅰ geothermal power plant was installed and operated five unite of generation facilities in that area. In Las Pailas area, Geothermal power plant of 42 MW (Las Pailas Ⅰ) was installed in July 2011. JICA is supporting Costa Rica's geothermal development by implementing the yen loan to Mira Valles power plant construction since the 1980s. The preparatory survey, to support the enhancement of the power supply by geothermal energy of Cost Rica, was carried out in 2011-2014 by JICA. As a result, "Guanacaste Geothermal development sector loan" is formed for Las Pailas Ⅱ, Boriken Ⅰ and Ⅱ. Therefore, Promoting study for Guanacaste geothermal development sector loan in Costa Rica will be carried from 2014. Costa Rica has become to implement the geothermal development vertically integrated so that has not been implemented privatization of Power Corporation. In Costa Rica, survey and drilling capacity is sufficient, it is a situation that requires an external consultant for geothermal reservoir evaluation.							
Future cooperation (Assumption)		Guanacaste geothermal development sector loan (ODA loan limits about 56.1 billion yen, E / N already concluded), including Las Pailas Ⅱ(55MW), Boriken Ⅰ, Ⅱ(55MW × 2). LA planed for Las Pailas Ⅱand Boriken Ⅰand Ⅱ							



DSource: Protti (2010)

Fig. 1 Geothermal promising area in Costa Rica



Source: JICA (2013)

Fig. 2 Location map of Boriquen and Las Pailas

References	JICA(2013) Preparatory Survey on Guanacaste Geothermal Power Development in Costa Rica. Las Pailas Ⅱ Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. Protti A. M. (2010) Costa Rica Country Update Report. Proceedings World Geothermal Congress 2010.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.16 The geothermal development status and involvement demarcation of government/private (Ecuador)

Country Name	Ecuador								11
GGC/GRP	0 / 500 MW 0.0%								
Implementing agency	Ministry of Electricity and Renewable Energy (MEER) National Council for Electricity (CONELEC)								
Cooperation from Japan									
Cooperation from other countries	AQUATER(Italy) BRGM(France) ICEL:Instituto Colombia de Electrificacion(Colombia)								
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Tufino-Chiles	Status								Group A(High Temperature) Slim hole drilled by public financing to 554m. Temperature 50℃
	Government/Private	Government	Government						
	Donor	BRGM AQUATER							
Chachimbiro	Status								Group A(High Temperature) Geopysical survey carried out by public financing.
	Government/Private	Government							
	Donor	BRGM AQUATER							
Chalupas	Status								Group A(High Temperature)
	Government/Private	Government							
	Donor	BRGM AQUATER							
Overview of geothermal Development	Earlier geothermal exploration, carried out from the mid 1970's to the earlier 1990's by government institutions with the aid of foreign technical assistance programs, defined a combined theoretical potential of about 500 MWe for the three most promising geothermal prospects, namely: Tufino-Chiles, Chalupas and Chachimbiro, located in the highlands of central-north Ecuador. INECEL (Instituto Ecuatoriano de Electrificacion, now defunct) and OLADE (Organizacion Latinoamericana de Energia), together with AQUATER (Italy) and BRGM (France), summarized the areas of interest in two main groups. In 2008, the Ecuadorian government through the MEER, re-starts geothermal exploration, aiming to develop one or more of the former INECEL geothermal prospects for power generation. A geothermal drilling program, small-diameter gradient holes in Tufino-Chiles Prospect and just completed borehole PGT-1 to a total depth of 554 meters this is the first geothermal exploration borehole drilled in Ecuador. Chachimbiro Geothermal Prospect received 1 MUSD of state funding for geophysical exploration to site deep exploration holes. October 29, 2013, Ecuador signed a bilateral agreement with Russia. Russia will support hydropower and geothermal power generation project. 195MUSD investment in the construction of the El Oro Termogas Machala geothermal power plant (187MW).								
Future cooperation (Assumption)	In Ecuador, promising areas has been extracted, but has not progressed geothermal investigation. Therefore, it is desired to implement of basic survey/data collection survey to understand the status of the geothermal development and geothermal resources.								
References	Beate B. and Salgado R. (2010) Geothermal Country Update for Ecuador, 2005-2010. Proceedings World Geothermal Congress 2010. Latin American Association Homepage.								

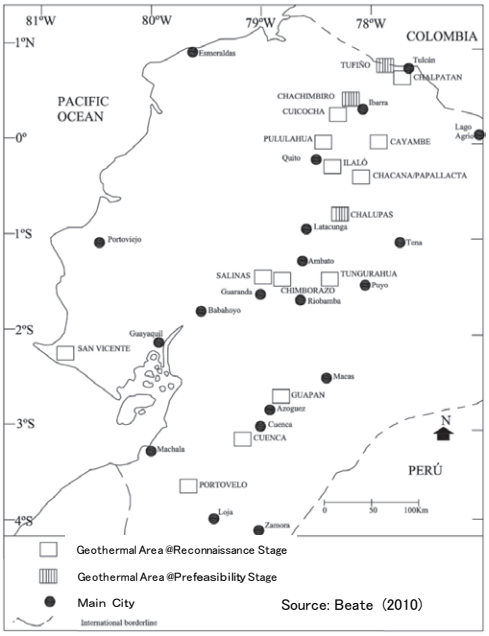
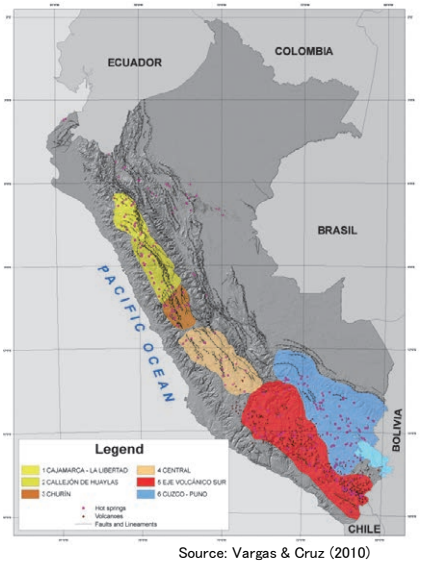


Fig.1 Geothermal promising area in Ecuador

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

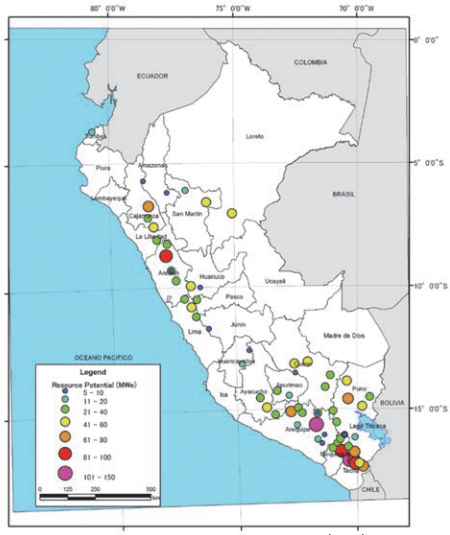
Table 3.7.17 The geothermal development status and involvement demarcation of government/private (Peru)

Country Name		Peru							12
GGC/GRP		0 / 3,000 MW 0.0%							
Implementing agency		Ministerio de Energia Mines (MEM) Instituto Geologico Minero Metalurgico (INGEMMET)							
Cooperation from Japan		JICA: Geothermal energy development master plan study in Peru							
Cooperation from other countries									
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Tutupaca, Crucero, Calacoa-Putina, Pinaya, Puqiou	Status								JICA Master plan, Priority Rank A, Exploration rights has granted
	Government/Private	Gov/Pri							
	Donor	JICA							
Overview of geothermal Development		The first geothermal studies began in the 1970's with first inventory of mineral and thermal springs. However, it is not working for geothermal energy development in Peru, the organization of geothermal development has not been equipped and geothermal resources have not been used. For this reason, Peru government has requested the cooperation survey of geothermal power development master plan created in the Japanese government. Currently six important geothermic region have been identified; Cajamarca-La Libertad, Callejon de Huaylas, Churin, Central, Eje Volcanico Sur and Cuzco-Puno. The development priority area is divided into rank A to D in geothermal development master plan, It can be expected that total of 640MW power generation would be achieved from the categorized in relatively high priorities (Rank A and B). Especially geothermal resources are abundant in the southern region. Exploration rights and development rights are set by the geological resources law. At the priority rank A, among the promising fields chosen, five where the authorization of exploration right has been already granted are categorized in this class. Among the 98 project application documents have been received, it is only 20 project exploration rights was granted. Exploration rights are beginning to be applied from February 2011, but there is no project that has acquired of development rights.							
Future cooperation (Assumption)		Geothermal development master plan study was carried out by JICA. The detailed survey for promising area is desired to implemented based on the result of master plan survey.							



Source: Vargas & Cruz (2010)

Fig.1 Geothermal promising area in Peru



Source: JICA (2012)

Fig. 2 Geothermal power potential in Peru

Table 1 Result of development priority evaluation

Source: JICA (2012)

Rank of Priority	Description	Geothermal Field	Possible Power Output(MW)	Total Possible Power
Rank A	Earlist development is expected. (The development would be done even without any support from the government)	Tutupaca	105	340
		Crucero	70	
		Calacoa-Putina	100	
		Pinaya	35	
		Puquio	30	
Rank B	Followie the Rank A (The authorization for wxploration is to be waited for)	Chivay-Pinchollo	150	300
		Ancocollo	90	
		Ccollo/Titire	35	
		Ulucan	25	
Rank C	Relatively early development is expected, but the resource potential is to be confirmed	Callioma	5	(60)
		Huancarhuas	(30)	
		Paila del Diablo	(15)	
		Paratca	(10)	
Rank D-1	The resource potential is to be confirmed. (Based on the existing data, high potential resource can be expected	17 fields (including Chancos and Jesus Maria)	-	Unknown
Rank D-2	The resource potential is to be confirmed. (Based on the existing data, the existence of high potential resource cannot be expected)	24 fields	-	Unknown

References	JICA(2008) Preparatory Survey Report for Geothermal Power Development Master Plan in Peru. JICA(2012) The Master Plan for Development of Geothermal Energy in Peru. Vargas V. and Cruz V. (2010) Geothermal Map of Peru. Proceedings World Geothermal Congress 2010.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.18 The geothermal development status and involvement demarcation of government/private (Bolivia)

Country Name		Bolivia							13
GGC/GRP		0 / – MW 0.0%							
Implementing agency		Empresa Nacional de Electricidad(ENDE)							
Cooperation from Japan		JICA: Preparatory survey on geothermal power plant construction of the Laguna Colorada in Bolivia (2010) Promotion project on geothermal power plant construction of the Laguna Colorada in Bolivia (2013) "Laguna Colorada geothermal power plant construction project (first stage)" (General Untide) 2,495M yen. METI/JETRO:F/S of geothermal resources development (2007)							
Cooperation from other countries		IDB							
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Laguna Colorada	Status								F/S geothermal resources development by METI/JETRO (2007)
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor		Italy	METI/JETRO, JICA	JICA	JICA/IDB			
	Status								
	Government/Private								
	Donor								
Overview of geothermal development		In southwest Potosi Sol de Manyana area, the deep drilling project was carried out from late 1980's to early 1990's, was drilled six wells and confirmed high temperature exceeding 250 ℃. The new geothermal power generation project is estimated to be up to 100MW, and is positioned as a priority project for the whole power sector. Cooperation by technology and funding of our country with the experience over more than 40 years of geothermal power generation is requested. In response to this JICA was preparing for yen loan projects through from 2009 to 2010 "Laguna Colorada Geothermal Power Plant Project". In addition, the project for the purpose of implementation system strengthening of data acquisition and ENDE necessary to power plant design was carried out. ODA Loan Agreement for the production well drilling and consulting services for the construction of geothermal power plant of 50MW between the Bolivian governments was signed in July 2014. IDB is planning to support for connection from the planned construction site to the backbone transmission line (230 kV,172 km). It is concerned that construction of geothermal power plant in high place and low level of implementation capacity of ENDE.							
Future cooperation (Assumption)		It is necessary to consider that the contents of assistance to assess the trend of Laguna Colorada geothermal development project. Note: Laguna Colorada geothermal development project has been promoted strongly in conjunction with lithium secured interest of Salar de Uyuni, but there is also a decrease of interest in lithium of Japanese interested parties. On the other hand, it is concerned that a capacity of implementing organization is shortage, but it is assumed the needs of more support.							

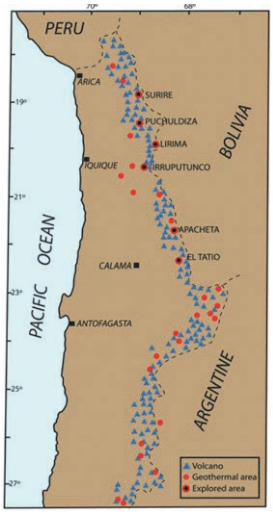
Fig.1 Geothermal promising area in Bolivia

References	JICA(2013) Final Report of Promotion Project on Geothermal Power Plant Construction of the Laguna Colorada in Bolivia. JICA homepage

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

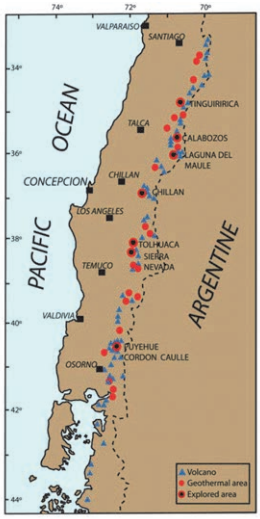
Table 3.7.19 The geothermal development status and involvement demarcation of government/private (Chile)

Country Name	Chile								14
GGC/GRP	0 / 16,000 MW 0.0%								
Implementing agency	Chilean Development Corporation (CORFO) National Geological Survey of Chile (SERNAGEOMIN) National Oil Company (ENAP) ENG(ENEL51%、ENAP49%)								
Cooperation from Japan	JICA: Geothermal power development project in Pchuldiza area (1978-1981)								
Cooperation from other countries	UNDP								
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
EL Tatio	Status								40MW
	Government/Private	Gov/Pri	Private	Private	Private				
	Donor	UNDP							
Puchuldiza	Status								
	Government/Private	Gov/Pri	Gov/Pri	Private					
	Donor	UNDP, JICA	JICA						
Calabosos	Status								Power plant construction; ENG(total 200MW) Operation; 2011-2017
	Government/Private	Gov/Pri	Private	Private	Private				
	Donor	UNDP							
Chillan	Status								Power plant construction; ENG(total 160MW) Operation; 2011-2017
	Government/Private	Gov/Pri	Private	Private	Private				
	Donor	UNDP							
Overview of geothermal development	Systematic geothermal exploration in Chile started in the northernmost part of the country towards the end of 1968, through a collaborative project between the CORFO and UNDP. In this project, reconnaissance survey was done in many geothermal areas, while detailed geological, geochemical and geophysical surveys in selected areas (1968-1976). Field survey and test drilling were carried out by JICA, the well was drilled to depth 1157m and encountered temperature of 201℃. They were followed by drilling of exploratory wells and feasibility studies for power generation at El Tatio and Puchuldiza. Since then, basic volcanological and geochemical studies in the geothermal areas have been occasionally conducted by the University of Chile, foreign institutions and the National Geological Survey of Chile In 2000, the Chilean government enacted a Geothermal Law. SERNAGEOMIN is doing detailed geological studies in the geothermal areas, for which geological maps are not available. CORFO is contributing with funds for pre-investment geothermal studies. At present, detailed exploration is being carried out by the state-owned oil company (ENAP), as well as private companies. In total, about 20 geothermal areas are currently under exploration by several private companies. It is expected that the first 40 MWe geothermal power plants will be installed at the El Tatio. In the northern areas, 6 geothermal prospects are under exploration by ENG, NGC, a joint venture between ENAP and Antofagasta and by other mining companies. The areas where exploration programs are being carried out are Puchuldiza, El Tatio and others. In the central- southern area, 7 geothermal prospects (Calabozos, Chillan, etc.) are under exploration by ENG, University of Chile and some private companies.								
Future cooperation (Assumption)	Geothermal promising areas are distributed along the volcanic belt. It is desired to implementation of the data collection survey for promoting geothermal development.								



Source: Lahsen et al.(2010)

Fig.1 Geothermal area in northern Chile



Source: Lahsen et al.(2010)

Fig.2 geothermal area in southern Chile

【Geothermal Law】
In January 2000, the Chilean government enacted Geothermal Law providing the framework for the exploration and development of geothermal energy in Chile. The law provides the regulations for exploration and exploitation concessions, which are granted by the Ministry of Mines.
Project area:
Exploration (100,000ha) , Exploitation (20,000ha)
project period:
Exploration (2 years, add. 2 years),
Exploitation (Indefinite, revoked by unexecuted)

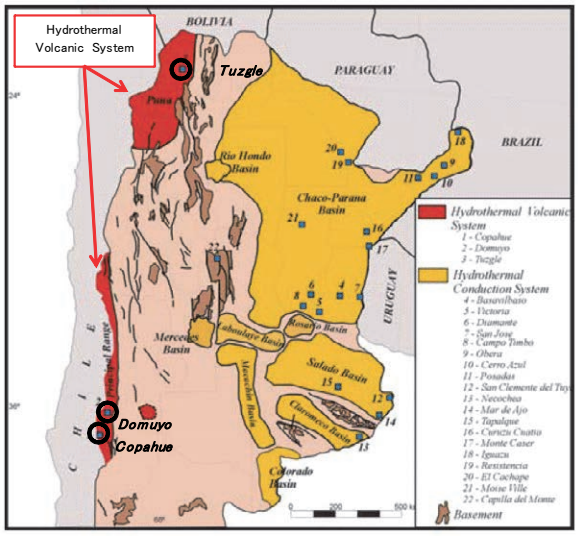
References

Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010.
Lahsen A., Munoz N. and Parada M. A. (2010) Geothermal Development in Chile. Proceedings World Geothermal Congress 2010.
Sakai Y. and Yoneda K. (1982) geothermal exploration in Puchuldiza geothermal field, Republic of Chile. Chinetsu, 19, 2, 79-90.
JETRO (2007) Activation geothermal power development. 12 December 2007, 6-8.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.20 The geothermal development status and involvement demarcation of government/private (Argentina)

Country Name		Argentina							15
GGC/GRP		0 / - MW 0.0%							
Implementing agency		SEGEMAR (Ente Provincial de Energia del Neuquen (EPEN)) (Centro regional de Energia geotermica del Neuquen(CREGEN))							
Cooperation from Japan		JICA: Argentine Republic, Northern Neuauen geothermal development project (1982-1984) The feasibility study on the northern Neuquen geothermal development project (1987-1992)							
Cooperation from other countries									
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Copahue	Status								COP-3 (Slim hole), 240℃ (Depth:1010m). Steam flow rate: 9.4t/h, 30MW (Volumetric method)
	Government/Private	Government	Government	Government					
	Donor		JICA	JICA					
Domuyo	Status								
	Government/Private	Government							
	Donor								
Tocomar	Status								
	Government/Private	Government							
	Donor								
	Status								
	Government/Private								
	Donor								
Overview of geothermal development		In Argentina, geothermal promising areas have been extracted into not only high-enthalpy geothermal area but also low-enthalpy geothermal area. Geothermal promising areas in high-enthalpy area are Copahu, Domuyo and Tuzgle. Geothermal investigation was carried out in the middle of 1970's, field survey and test drilling of 17 wells have been carried out by public sector in Copahu. After 1979, test wells of COP-1 and COP-2 were drilled and encountered temperature of above 200 ℃. Test well of COP-3 was drilled and comprehensive survey carried out by JICA from 1987 to 1992. The binary pilot plant of 0.67MW was operated using geothermal fluid from COP-1 in 1988.							
Future cooperation (Assumption)		It is desired to implementation of the data collection survey for promoting geothermal development in Argentina							



Source: Pesce (2010)

Fig.1 Geothermal promising area in Argentina

ADVANCE GRADE		PROVINCE	PROYECT NAME	
High Entalpia	Production	Neuquen	Copahue	
	Development	Neuquen	Domuyo	
		Jujuy	Tuzgle	
Low Entalpia	Exploitation	Entre Rios	Basavilbaso	Chaco-Parana Basin
			Victoria	
			Diamante	
			San José	
		Santa Fe	Campo Timbó	
		Misiones	Obera	
			Cerro Azul	
			Posadas	
		Buenos Aires	San Clemente del Tuyu	Salado Basin
			Necochea	
			Mar de Ajo	
	Development	Buenos Aires	Tapalqué	Chaco-Parana Basin
		Corrientes	Curuzú Cuatiá	
			Monte Caseo	
	Pre-feasibility	Misiones	Iguazu	
		Chaco	El Cachape	
		Santa Fe	Moises Ville	

Source: Pesce (2010)

Table.1 Geothermal project in Argentina

References	Pesce A. H. (2010) Argentina Country Update. Proceedings World Geothermal Congress 2010. Fujita T., Abe S., Ymada M., Nakanishi S. and Todaka N. (1996) Feasibility Study of Copahue Geothermal Development Project, Argentina. Chinetsu, 33, 1,39-55.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.21 The geothermal development status and involvement demarcation of government/private (Caribbean Island Nations)

Country Name	Caribbean Island Nations (Dominica, Grenada, St. Vincent, St. Lucia)				16
GGC/GRP	Dominica	0	/	300 MW	0.0%
	Grenada	0	/	– MW	0.0%
	St. Vincent	0	/	100 MW	0.0%
	St. Lucia	0	/	170 MW	0.0%
Implementing agency	Dominica: Miniatry of Public Works, Energy and Ports Granada: Minirtry of Finance, Planning, Economic Development, Trade, Energy & Coorporatives St. Vincent: Energy Unite in the office of the Prime Minister St Lucia: Ministry of Sustainable Development, Energy, Science and Technology				
Cooperation from Japan					
Cooperation from other countries	IDB：SEEC（Sustainable Energy for Eastern Caribbean）				

Geothermal Project Development Status

Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Roseau Valley (Dominica)	Status								Plant of 10-15MW scheduled operation in 2017
	Government/Private	Gov.(CON)	Gov.(CON)	Gov.(CON)	Gov.(CON)				
	Donor	IDB、EU Espaces Caraibes	IDB Espaces Caraibes	IDB Espaces Caraibes					
La Soufriere (St. Vincent)	Status								Detailed survey by Reykjabik Geothermal. Dicision scheduled of drilling in 2014 second half.
	Government/Private	Gov.(CON)	Gov.(CON)	Gov.(CON)					
	Donor	UNDP							
Sulfur Springs (St. Lucia)	Status								ORMAT owns concession.
	Government/Private	Private							
	Donor								

Overview of geothermal development	Four countries common: the diesel power generation is superior to the economy than small-scale geothermal power generation (about 5MW), because of the power demand is not high in the island country. Dominica: In addition Soufriere Area, Morne au Diable, Champagne, there are Glion any development plan, both research potential in the non-implementation undecided. Dominican government, exploration each "geothermal exploration contract" and resource use, "geothermal exploration contract", plans to contract with aggregated consultant to "geothermal resources section contract". In the future, we have established a large-scale geothermal plant, close to French territory Guadeloupe, etc., there is planning to export in the submarine cable and the like. There are geothermal development plan in Soufriere Area, Morne au Diable, Champagne and Glion, but each geothermal potential cannot be determined because geothermal survey is not carried out St. Vincent: The government is aggressive in geothermal development, but research on geothermal resource potential has been performed multiple times, there is no drilling data, the distribution of the geothermal reservoir has not been identified. Saint Lucia: The government is assumed geothermal development by the private sector, companies embark on development is less, and geothermal development is not progressing.
Future cooperation (Assumption)	Cooperation in the investigation of the geothermal potential. Because of the power generation capacity is small (5-20MW), the Japanese plant corporations are reluctant to advance for geothermal power generation business.

Source: Huttrer (2010)

Fig.1 Location map of Caribbian island nations

References	Huttrer G. H. (2010) 2010 Country Update for Eastern Caribbean Island Nations. Proceedings World Geothermal Congress 2010.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.22 The geothermal development status and involvement demarcation of government/private (Mexico)

Country Name	Mexico							17
GGC/GRP	983 / 6,000 MW 16.4%							
Implementing agency	Comision Federal de Electricidad (CFE)							
Cooperation from Japan	JICA: La Primavera geothermal development project in United Mexican States (1985-1989)							
Cooperation from other countries								
Geothermal Project Development Status								
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Cerro Prieto	Status								720MW、1973-
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor								
Las Azufres	Status								188MW、1982-
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor								
Los Humeros	Status								40MW、1990-
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor								
Las Tres Virgenes	Status								10MW、2002-
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor								
Overview of geothermal development	In Mexico, geothermal investigation has been carried out from 1960's. Geothermal power plant are operating into fore geothermal field namely; Cerro Prieto (720MW), Los Azufres (188MW), Los Humeros (40MW) and Las Tres Virgenes (10MW). All of the geothermal fields and power plant are owned and operated by the government agency CFE. Cerro Prieto is the oldest and largest Mexican geothermal field in operation. Its first power units were commissioned in 1973. There are currently 13 operating units and total generating capacity is 720MW. Las Tres Virgenes is the most recent field in operation in Mexico. There are two condensing 5MW power units in operation. Geothermal investigation was carried out in La primavera (current name is Cerritos Colorados) from 1985 to 1989 by JICA. The Cerritos Colorados project has been progressing in generating capacity of 75MW (25MWx3).							
Future cooperation								

Source: Bertani (2010)

Fig.1 Geothermal promising area in Mexico

References

Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010.

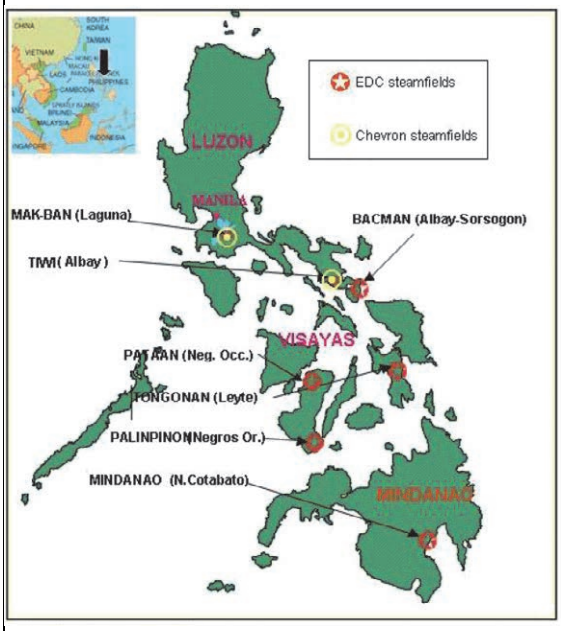
Gutierrez-Negrin L. C.A., Maya-Gonzalez R. and Quijano-Leon J. L. (2010) Current Status of Geothermics in Mexico. Proceedings World geothermal Congress 2010.

Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.23 The geothermal development status and involvement demarcation of government/private (Philippine)

Country Name		Philippine							18
GGC/GRP		1,904 / 6,000 MW 31.7%							
Implementing agency		Philippine Department of Energy (DoE) Energy Development Corp. (EDC) Chevron Geothermal Philippines Holding Inc. (CGPHI) Aboitiz Power Renewables (APRI)							
Cooperation from Japan		JICA: Buguias geothermal development (1980-1982)、Acupan-Itogon geothermal development (1982-1985)							
Cooperation from other countries									
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Makiling-Banahaw, Tiwi	Status								・Operater: CGPHI/APRI ・Plant; O&M is NPC sold to APRI, CGPHI is transferred by Unocal 【Generation Capacity】 ・Makiling-Banahaw (Mak-Ban) : 457.7MW ・Tiwi: 334MW
	Government/Private	Private (CGPHI)	Private (CGPHI)	Private (CGPHI)	Private (CGPHI)	Gov⇒Pri (APRI)	Gov⇒Pri (APRI)	Gov⇒Pri (APRI)	
	Donor								
Tongonan、Palinpinon、Mindanao、Pataan	Status								・Operater: EDC 【Generation Capacity】 ・Tongonan: 715.89MW ・Palinpinon: 192.5MW ・Mindanao: 103.23MW ・Pataan: 41.37MW
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Bacon-Manito	Status								・Operater: EDC 【generation Capacity】 ・Bacan-Manito: 150MW
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Overview of geothermal development		The installed geothermal capacity of the Philippine stands at about 1.9MW. Major developments and activities have taken place in Philippine industry after 2005. DOE remains as the main overseer of geothermal operations in the country. PNOC-EDC has changed to EDC by full privatization in 2007. EDC has become a fully vertically-integrated geothermal operator. The most recent development is the sale of power plant assets of NPC. As a result of industry-wide privatization efforts, three major players emerge in the redefined Philippine geothermal landscape. These are CGPHI, EDC and APRI.							
Future cooperation									



Source: Ogena et al. (2010)

Fig. 1 Location map of producting geothermal areas in the Philippines

Source: Ogena et al. (2010)

Fig.2 Identified geothermal prospects for advance exploration

References	Bertani, R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. Ogena, M.S., Sta. Maria, R.B., Stark, M.A., Oca, R. A. V., Reyes, A. N., Fronda, A. D. and Bayon, F. E. B. (2010) Philippine Country Update: 2005-2010 Geothermal Energy Development. Proceedings World geothermal Congress 2010. Ogena, M. S. (2011) Philippine Geothermal Industry Update 2011. Proceedings of the 9th Asian Geothermal Symposium 2011. Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

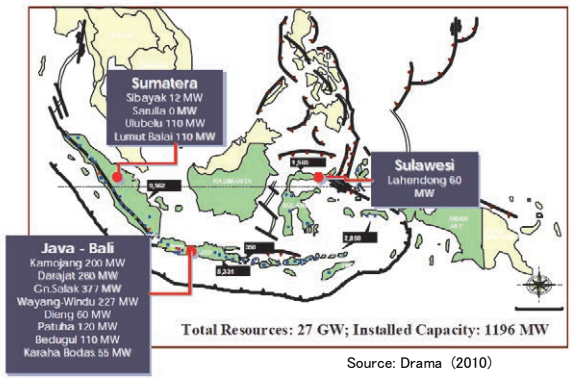
GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.24 The geothermal development status and involvement demarcation of government/private (Indonesia) (1/2)

Country Name	Indonesia							19
GGC/GRP	1341 / 28,635 MW 4.7%							
Implementing agency	Center for Geological Resources (CGR) Directorate general of Minerals, Coal and Geothermal(DGMCG) Ministry of Energy and Mineral Resources PT. Pertamina (Persero) Pertamina Geothermal Energy (PGE) PT. PLN(Persero)							
Cooperation from Japan	JICA: Mater plan study for geothermal power development (2005-2007) Study on fisical and non-fisical incentive to accelerate private sector geothermal energy development (2008-2009) Study on promotion policies for geothermal power development by independent power producers (2010-2011) JICA(Yen Loan): 2004 Lahendong geothermal power plant expansion project (5,866M Yen, Tide, PLN) 2005 Ulu Belu geothermal power plant construction project (20,288M Yen, General Tide, PLN) 2006 Kamojang geothermal power plant expansion project (995M Yen, Untied, PLN・PERTAMINA) 2011 Lumut Balai geothermal power plant ptoject (26,966M yen, Untied, PERTAMINA) 2011 Geothermal promotion program (5,104M Yen, General Tide, PLN)							
Cooperation from other countries	WB							
Geothermal Project Development Status								
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Kamojang	Status								Total: 200MW 250kW(1978), 30MW(1982), 110MW(1987): WB(US$61M)
	Government/Private	Gov(PGE)	Gov(PGE)	Gov(PGE)	Gov(PGE)	Gov(PLN)	Gov(PLN)	Gov(PLN)	
	Donor					WB, JICA			
Sibayak	Status								12MW、1996～
	Government/Private	Gov(PGE)	Gov(PGE)	Gov(PGE)	Gov(PGE)	Gov(PGE)	Gov(PGE)	Gov(PGE)	
	Donor								
Darajat Phase Ⅰ	Status								Total: 260MW Phase Ⅰ: 55MW(1994) JOC: Amoseas Indonesia Inc. (subsidiary of Chevron) and Pertamina
	Government/Private	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	Gov(PLN)	Gov(PLN)	Gov(PLN)	
	Donor								
Darajat Phase Ⅱ, Ⅲ	Status								Total: 260MW Phase Ⅱ: 95MW(1999) Phase Ⅲ: 110MW(2008) JOC: PGE and Chevron
	Government/Private	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	Gov/Pri JV	
	Donor								
Dieng	Status								Total: 60MW HCE (Himpurna California International) ⇒ Geo Dipa Energy
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Gunung Salak	Status								Total: 377MW Unocal ⇒ Chevron
	Government/Private	Private	Private	Private	Private	Government	Government	Government	
	Donor								
Lahendong	Status								Total: 60MW Unit I: 20MW (2002) Unit II: 40MW (2009) PGE/PLN
	Government/Private	Government	Government	Government	Government	Government	Government	Government	
	Donor					JICA			
Wayang Windu	Status								Total: 227MW Mandala Magma Nusantara BV
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
New WKP	Status								
	Government/Private								
	Donor								
Overview of geothermal development	In Indonesia, Pertamina started exploration activities in Kamojang in 1974 and installed a 250kW geothermal power plant. PLN built on this initial success with the construction of Indonesia's first commercial geothermal electric power plant in 1982. The current geothermal fields operated from 7 locations with total capacity of as a minimum of 1,196MW consists of Darajat 260MW), Dieng(60MW), Kamojang(200MW), Gumung Salak(377MW), Sibayak(12MW), Lahendong(60MW), Wayang Windu(227MW). Since 2000, various policy objectives as the effective use of the country's geothermal resources in Indonesia, legal framework has been established. In 2003, geothermal Act was enacted. In 2004 enacted geothermal development roadmap, in 2005 goal of 2025 has been set as the 9,500MW. In addition, the proportion of geothermal power generation in the power development crash program Ⅱ (2010-2014) is about 40% of 4,000MW.							
Future cooperation								

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.25 The geothermal development status and involvement demarcation of government/private (Indonesia) (2/2)



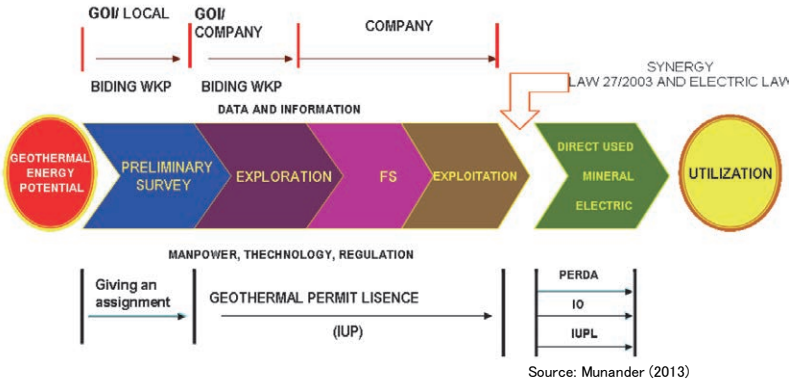
Source: Drama (2010)

Fig. 1 Location map of Indonesian geothermal resources and its installed capacity

Table 1 Geothermal potential of Indonesian islands

Source: Munander (2013)

No	ISLAND	NUMBER OF LOCATION	POTENCY OF GEOTHERMAL ENERGY (MWe)					Total Potency	Installed (MWe)
			Resources		Reserves				
			Speculative (MWe)	Hyphotetic (MWe)	Possible (MWe)	Probable (MWe)	Proven (MWe)		
1	Sumatera	90	3089	2427	6867	15	380	12778	122
2	Jawa	71	1710	1826	3708	658	1815	9717	1134
3	Bali-Nusa Tenggara	28	360	417	1013	0	15	1805	5
4	Kalimantan	12	145	0	0	0	0	145	
5	Sulawesi	65	1323	119	1374	150	78	3044	80
6	Maluku	30	545	97	429	0	0	1071	
7	Papua	3	75	0	0	0	0	75	
	Total	299	7247	4886	13391	823	2288	28635	1,341
			12,133		16,502				
			28,635						



Source: Munander (2013)

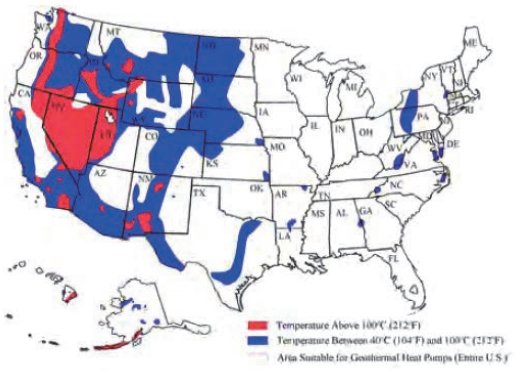
Fig. 2 Chart of geothermal development based on Law No. 27/2003

References

Bertani, R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010.
Darama S., Harasoprayitno S., Setiawan B., Hadyanro, Sukhyar R., SoedibjoA. W., Ganefianto N. and Stimac J. (2010) Geothermal Energy Update: Geothermal Energy development and Utilization in Indonesia. Proceedings World Geothermal Congress 2010.
Munandar A. and Widodo S. (2013) Geothermal Resources Development in Indonesia. Proceedings of the 10th Asian Geothermal Symposium 2013.
Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

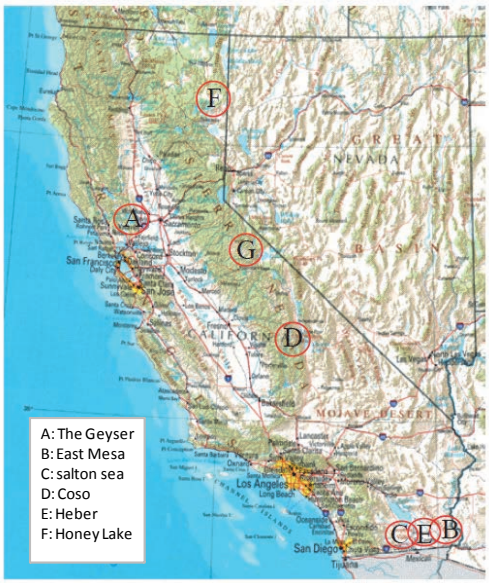
Table 3.7.26 The geothermal development status and involvement demarcation of government/private (USA)

Country Name	USA							20
GGC/GRP	3,129 / 30,000 MW 10.4%							
Implementing agency	Calpine Northern California Power Agency Ormat, CalEnergy Terra Gen, Magma, Nevada Geothermal Power							
Cooperation from Japan								
Cooperation from other countries								
Geothermal Project Development Status								
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
The Geysers (California)	Status								1,585MW Calpine and Northern California Power Agency
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Imperial Valley (California)	Status								Total: 654MW East-Mesa: 120MW Heber: 205MW Salton Sea: 329MW Ormat, CalEnergy
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Coso (California)	Status								270MW Terra gen
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Nevada	Status								442MW Enel Green Power Ormat, Terra Gen, Magma Nevada Geothermal Power
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Overview of geothermal development	Geothermal electric power plants are located in California (2553MW), Nevada (442MW), Utah (46MW), Hawaii (35MW) with recent installation in Alaska, Idaho, New Mexico, Oregon, Wyoming with 514MW being added. The two largest concentrations of plants are at The geysers in northern California and the Imperial Valley in southern California.								
Future cooperation									



Source: Lund et al. (2010)

Fig.1 Geothermal resources map of the United States



Source: Lund et al. (2010)

Fig.2 location map of geothermal power plant in California

References	Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. John W. Lund, Karl Gawell, Tonya L. Boyd and Dan jennejohn (2010) The United State of America Country Update 2010. Proceedings World Geothermal Congress 2010. Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.27 The geothermal development status and involvement demarcation of government/private (Italy)

Country Name		Italy							21
GGC/GRP		883 / 3,270 MW 27.0%							
Implementing agency		Enel Green Power (EGP)							
Cooperation from Japan									
Cooperation from other countries									
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Larderello	Status								594.5MW
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Travale/Radicondoli	Status								160MW
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Mt. Amiata	Status								88MW
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Overview of geothermal development		In Italy, there are two major geothermal areas located in Tuscany; Larderello-Travale and Mount Amiata. The first geothermal power plant of 250kW was built in 1913 in Larderello in the world. The explored area is about 250km2, where 200 wells produce temperature ranging from 150 to 270 ℃. The installed capacity is 594,5MW as of 2009 with 22 units in operation. In travale/Radicondoli area, the explored area covers approximately 50 km2; 27 wells produce temperature 190-250℃. The installed capacity is 160MW with 6 units in operation. Two additional 20MW units are planned. At the depth of about 3000m, the same temperature was found(300-350℃) both inside the field. The total installed capacity is 88MW, with 5 units on line in 2009. Although geothermal development has been carried out by Enel of state-owned power company, Enel Green Power was established in 2008 by the privatization. All the Italian geothermal fields are operated by EGP.							
Future cooperation									

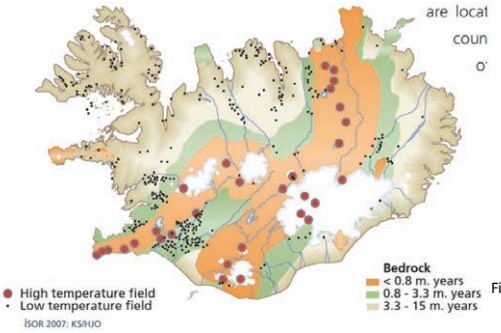
Fig.1 Location of the geothermal fields in Italy 出典：Cappetti et al. (2010)

References	
	Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. Cappetti G., Romagnoli P. and Sabatelli F. (2010) Geothermal Power Generation in Italy 2005-2009 Update Report. Proceedings World Geothermal Congress 2010. Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.28 The geothermal development status and involvement demarcation of government/private (Iceland)

Country Name		Iceland							22
GGC/GRP		660 / 5,800 MW 11.4%							
Implementing agency		Reykjavik Energy HS-Ora							
Cooperation from Japan									
Cooperation from other countries									
Geothermal Project Development Status									
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Hellisheiði	Status								90MW(2006)→123MW(2007)→213MW(2008)→303MW(2011) Reykjavik Energy
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Nesjavellir	Status								30MW×2(1998)→120MW(2005) Reykjavik Energy
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Svartsengi	Status								1MW×2(1977)→72MW HS-Orka
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Reykjanes	Status								2006(100MW) HS-Orka
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Krafla	Status								1977(8MW)→ 1982(30MW)→ 1997(60MW)
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Overview of geothermal development		Iceland has very favorable conditions for geothermal development. The geothermal resources are utilized both for electricity generation and direct heat application. The shear of geothermal energy supply is 69%. Space heating is the most important direct utilization of geothermal energy in Iceland, covering 90% of all houses in the country. Generation of electricity by geothermal energy has been increasing during the past 15 years. The total installed capacity is 660MW in 2012. The main geothermal power plants are Hellishei ð i (303MW), Nesjavellir (120MW), Svartsengi (72MW), Reykjanes (100Mw), Krafla (60MW). Geothermal development has been carried out by private companies such as Reykjavik Energy、HS-Orka. Reykjavik Energy has been owned by Reykjavik city and in 2009 the former Sudurnes Regional Heating was split into two companies HS-Orka and HS-Veitur. HS-Orka is privately owned.								
Future cooperation									



Source: Ragnarsson (2013)

Fig. 1 Volcanic zones and geothermal areas in Iceland

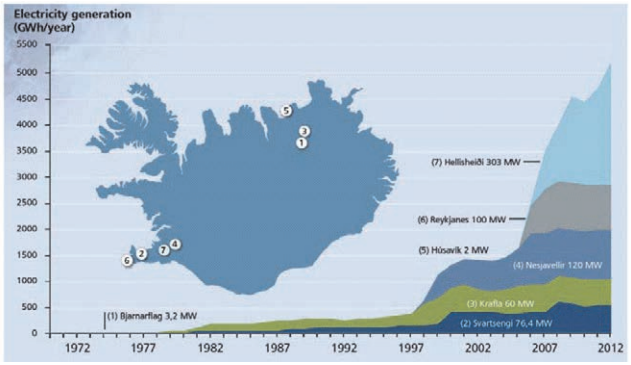


Fig.2 Electricity generation by geothermal energy in Iceland 1970-2012

Source: Ragnarsson (2013)

References	Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. Ragnarsson A. (2010) Geothermal Development in Iceland 2005-2009. Proceedings World Geothermal Congress 2010. Ragnarsson A. (2013) Geothermal Energy Use, Country Update for Iceland. European Geothermal Congress 2013. Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.29 The geothermal development status and involvement demarcation of government/private (New Zealand)

Country Name	New Zealand							23
GGC/GRP	762 / 3,650 MW 20.9%							
Implementing agency	Contact Energy Mighty River Power Tuaropaki Trust Tauhara North No.2 Trust							
Cooperation from Japan								
Cooperation from other countries								
Geothermal Project Development Status								
Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Wairakei Ohaaki	Status								232MW 103MW Contact Energy
	Government/Private	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	Gov→Pri	
	Donor								
Mokai	Status								111MW Tuaropaki Power Company (Tuaropaki Trust and Mighty River Power)
	Government/Private	Gov→Pri	Gov→Pri	Private	Private	Private	Private	Private	
	Donor								
Kawerau	Status								122MW NTGA (Ngati Tuwharetoa Geothermal Assets), Norske Skog Tasman, Mighty River Power
	Government/Private	Private	Private	Private	Private	Private	Private	Private	
	Donor								
Rotokawa	Status								31MW Tauhara North No.2 Trust, Mighty River Power
	Government/Private	Gov→Pri	Gov→Pri	Private	Private	Private	Private	Private	
	Donor								
Nga Awa Purua (Rotokawa)	Status								140MW Mighty River Power Tauhara North No.2 Trust
	Government/Private	Gov→Pri	Gov→Pri	Private	Private	Private	Private	Private	
	Donor								
Overview of geothermal development	New Zealand's geothermal power station capacity of over 700MW, and expansion plan for generation from known fields at standard depth are currently underway to increase this to perhaps 15% of total generation. The geothermal power plants are Kawerau(122MW), Moakai(111MW), Norathland(Ngawha)(25MW), Reporoa(Ohaak)(103MW), Wairakei(232MW). In addition, the Nga Awa Purua that is largest single unit (130MW) of geothermal power plant in the world has started operation in 2010. Wairakei geothermal power plant was started operation in 1958, and was the second oldest power plant in the world. And Ohaaki geothermal power plant was started operation in 1989. Geothermal development of New Zealand was carried out by the government, but was promoted by private company after privatization. Contact energy and Mighty River Power were established in 1996 and 1999, respectively.							
Future cooperation								

Source : NZGA homepage

Fig. 1 Geothermal area in New Zealand

出典：NZGAホームページ

Fig.2 Taupo geothermal area in New Zealand

References	Bertani R. (2010) Geothermal Power Generation in the World 2005-2010 Update Report. Proceedings World Geothermal Congress 2010. Harvey C. C., WhiteB. R., Lawless J. V. and Dunstall M. G. (2010) 2005-2010 New Zealand Country Update. Proceedings World Geothermal Congress 2010. McLoughlin K., Campbell A. and Ussher G. (2010) The Nga Awa Purua Geothermal Project, Rotokawa, New Zealand. Proceedings World Geothermal Congress 2010. Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

Table 3.7.30 The geothermal development status and involvement demarcation of government/private (Japan)

Country Name	Japan							24
GGC/GRP	526.6 / 23,470 MW 2.2%							
Implementing agency	METI, JOGMEC							
Cooperation from Japan								
Cooperation from other countries								

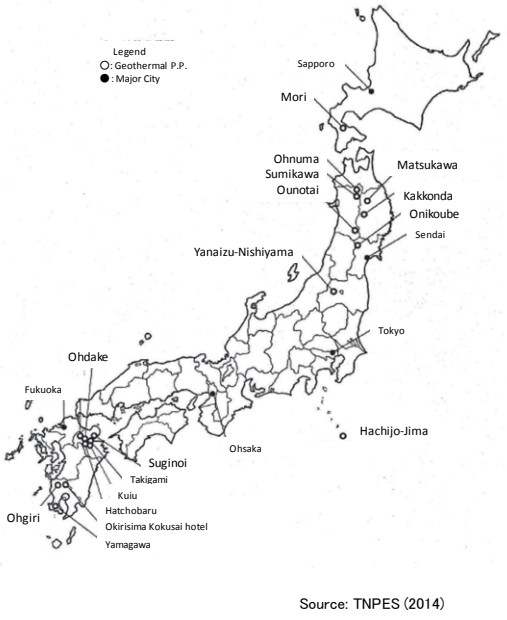
Geothermal Project Development Status

Site Name	Stage	Field investigation	Test Drilling	Reservoir Evaluation	Production Well	Power Plant	Plant O&M	Reservoir O&M	Remarks
Mori	Status								25MW
Onuma, Sumikawa	Government/Private	Gov/Pri	Gov/Pri	Private	Private	Private	Private	Private	10MW/50MW
Matsukawa, kakkonda	Donor								23.5MW/80MW
Uenotai	Status								28.8MW
Onikoube	Government/Private	Gov/Pri	Gov/Pri	Private	Private	Private	Private	Private	25MW
	Donor								
Hatijozima	Status								3.3MW
	Government/Private	Gov/Pri	Government	Private	Private	Private	Private	Private	Gov: Geothermal promotion survey
	Donor								
Otake, Hatyobaru	Status								12.5MW/112MW
Takigami	Government/Private	Private	Private	Private	Private	Private	Private	Private	27.5MW
Suginoi, kuzyu	Donor								1.9MW/2MW
Ogiri	Status								30MW
Yamagawa	Government/Private	Gov/Pri	Gov/Pri	Private	Private	Private	Private	Private	30MW
Yanaizu Nisiyama	Donor								65MW Gov; Geothermal promotion survey
New area	Status								National subsides; field survey, test drilling. Investment & debt guarantee; production well, plants
	Government/Private	Gov/Pri	Gov/Pri	Private	Private	Private	Private	Private	
	Donor								

Overview of geothermal development	Geothermal power plant installed capacity is 526.6MW in Japan. Geothermal power plants mainly are distributed in Tohoku, Hokkaido and Kyushu, and Hachijo as power plant of the island. Installed capacities are Mori(25MW), Sumikawa(50MW), Onuma(10MW), Matsukawa(23.5MW), Kakkonda(80MW), Uenotai (28.8MW), Onikoube(25MW), Yanaizu Nishiyama(65MW), Hachijo-jima(3.3MW), Odake(12.5MW), Hachobaru(112MW), Takigami (27.5MW), Ogiri(30MW), Yamagawa(30MW). National subsidies for field survey and drilling have been started, and investment and debt guarantee program have been started for production well drilling and installation of the plant. Geothermal exploration has been started in many geothermal fields by this system.
Future cooperation	

Name	Power generation Steam Supply	Unit	Installed Capacity	Permitted Output	Start of Operation
Mori	Hokkaido Electric Power Co.	1	25,000	25,000	1992
Sumikawa	Tohoku Electric power Co. Mitsubishi Materials Co.	1	50,000	50,000	1995
Matsukawa	Tohoku Hydropower & Geothermal Energy Co.	1	23,500	23,500	1966
Kakkonda	Tohoku Electric Power Co. Tohoku Hydropower & Geothermal Energy Co.	1 1	50,000 30,000	50,000 30,000	1978
Uenotai	Tohoku Electric Power Co. Tohoku Hydropower & Geothermal Energy Co.	1	28,800	28,800	1994
Onikoube	J-Power co.	1	25,000	15,000	1975
Yanaizu-Nishiyama	Tohoku Electric Power Co. Okuaizu geothermal Co.	1	65,000	65,000	1995
Hachijo-Jima	Tokyo Electric Power Co.	1	3,300	3,300	1999
Ohdake	Kyusyu Electric Power Co.	1	12,500	12,500	1967
Hatchobaru	Kyusyu Electric Power Co.	1 1 1(Binary)	55,000 55,000 2,000	55,000 55,000 2,000	1977 1990 2006
Takigami	Kyusyu Electric Power Co. Idemitsu Oita geothermal Co.	1	27,500	27,500	1996
Ohgiri	Kyusyu Electric Power Co. Nittetsu Kagoshima Co.	1	30,000	30,000	1996
Yamagawa	Kyusyu Electric Power Co.	1	30,000	30,000	1995
Total for Business		16	512,600	502,600	
Ohnuma	Mitsubishi Materials Co.	1	10,000	9,500	1974
Suginoi	Suginoi Hotel	1	1,900	1,900	2006
Kuju	Kuju Kanko Hotel	1	2,000	990	1998
Kirisima Kokusai Hotel	Daiwabo kanko Co.	1	100	100	2010
Total for Private		4	14,000	12,490	
Total		20	526,600	515,090	

Table 1 Geothermal power plant in Japan Source: TNPES (2014)



Source: TNPES (2014)

Fig.1 Location map of Geothermal power plant in Japan

References	Thermal and Nuclear Power Engineering Society (2014) Current status and trends of geothermal power generation Muraoka H. (2009) Present Status and Future Perspective of Geothermal Power Development in the World and Japan. The Journal of Fuel Cell Technology, 9, 1, 122-127.

GGC: Geothermal Generation Capacity, GRP: Geothermal Resources Potential, DM: Direct Management, CON: Consignment

(1) Characteristics of geothermal development

The system of geothermal development (for demarcation of government or private sector) is including government-led type, private sector-led type and an intermediate type. Summary of demarcation of government or private sector in geothermal development stage is shown in Table 3.7.31.

(a) Government-led type

Government-led type countries are Mexico, Costa Rica, Kenya, and Guatemala, Ethiopia, Tanzania, Uganda, Djibouti, Rwanda, Ecuador, Peru, Bolivia, Argentina, Caribbean countries.

1) Government-led type countries in geothermal development

Geothermal development countries which have been promoted primarily by the government are Mexico, Costa Rica, Kenya, and Guatemala. Geothermal power plant of Cerro Prieto and Las Azufres has been operated in Mexico, and has power generation capacity of 983 MW already. Geothermal development has been promoted by the government (CFE). Geothermal power plant of Mira Valles and Las Pailas has been operated in Costa Rica, and has generation capacity of 205MW. Government has implemented vertically integrated geothermal development, research capabilities, drilling capacity are sufficient but geothermal reservoir evaluation has been outsourced. Geothermal power plant of Olkaria has been operated in Kenya, and has power generation capacity of 271 MW. Geothermal survey and development has been promoted by the government (GDC) direct management. Because of vigorous activity of donors, geothermal development is advancing quickly. Geothermal power plant of Zunil and Amatitlan has been operated in Guatemala, and has power generation capacity of 49 MW. Geothermal development has commissioned by the government. In addition, Ormat has built of geothermal power plant in BOO (BOT) system.

2) Government-led type geothermal developing countries

Geothermal developing countries which have been promoted primarily in the government, are Ethiopia, Tanzania, Uganda, Djibouti and Rwanda in Africa, are Bolivia, the Caribbean, Argentina, Ecuador and Peru in Latin America.

a) Africa

Pilot plant of 7.3MW was placed on the Aluto Langano in Ethiopia. Geothermal investigation has been actively implemented with the donor supporting. A few test drilling has been carried out in Tanzania and Uganda, but the status of geothermal development is mainly first exploration survey in the geothermal area. Exploration activities such as prospecting surveys are being carried out by some private sector in Tanzania, exploration activity is not active. The

geothermal exploration license have been issued by the government in Uganda, but geothermal exploration activities in the private sector that has acquired the license has not progressed. Also, TGDC which is Tanzania version of GDC, is installed in December 2013, geothermal development research activities in the future is expected in Tanzania. Drilling survey was carried out in a few areas in Djibouti, but the status of geothermal development is mainly first exploration survey in the geothermal area. In Djibouti, high temperature of over 260 ℃ have been identified in test drilling at Lake Assal area, geothermal development is expected in the future from AfDB support. Surface survey was carried out the assistance of many donors in Rwanda, 3000m drilling survey conducted by the government, and it is interrupted the drilling , because of formation temperature is low. Currently, surface exploration and re-analysis study has been carried out by JICA, the results have been noted. It has determined that support for geothermal power plants of 50MW at the Grana-Colorada in Bolivia. Geothermal power plants 10-15 MW in Roseau Vally of Dominica is being planned in the Caribbean. It is aggressive geothermal development in the Dominican government and St. Vincent, but the investigation has not been progress. Geothermal development has not been progress in Argentina and Ecuador. Master plan for geothermal development study is being carried out by JICA in Peru.

(b) Private sector-led type

Geothermal development countries which have been promoted primarily by the private sector are Philippine, Italy, Iceland, New Zeland, USA, and Japan. Geothermal development has been advanced in these countries. In Philippines, As a result of industry wide privatization efforts, PNOC-EDC has changed to EDC and NPC has sold the power plant to private sector. In Italy, geothermal development was promoted by Enel. Enel Green Power was established by the privatization and to carrying out geothermal development. Furthermore Enel green Power is working to expand overseas geothermal development. In Iceland, Reykjavik Energy and HS-Orka have been carrying out until the geothermal power plant operation from primary exploration. Reykjavik City is a shareholder of Reykjavik Energy. In the United States, geothermal development has been promoted by the private sector, In Japan, geothermal development has been promoted the private, but initial exploration was carried out by government in some areas. National subsidies for field survey and drilling have been started, and investment and debt guarantee program have been started for production well drilling and installation of the plant. Geothermal exploration has been started in many geothermal fields by this system.

(c) Intermediate type

Geothermal development countries which have been promoted by both government and the private sector are Chile, Nicaragua, El Salvador and Indonesia. In Chile, primary field

investigation was conducted by government, and detailed investigation has been carried out by government or private. Geothermal Law was enacted in 2000; geothermal development by the private sector has been promoted. In Nicaragua, geothermal exploration has been carried out by government but has some exceptions. Geothermal facilities have been developed by the private sector. In El Salvador, geothermal development has been carried out by LaGeo (co-owned by the government and Italian companies). In geothermal development in Indonesia, there are various development forms of private sector and government. At the new geothermal development area, the government set the study area (WKP), and determines the development company by bidding.

(2) Challenges of geothermal development initial stage countries

The initial geothermal exploration including test drilling has been carried out by government in the countries of geothermal development initial stage. It can be mentioned that the challenges of their countries are insufficient of geothermal technical capacity and geothermal project management capacity. In addition, there are some countries that have given the exploration license to the private sector, but geothermal development activity has stagnated due to its exploration risk such as drilling investigation. In Italy, Indonesia, Philippines, although geothermal development has been promoted by the private sector by privatization in the current, there is a history that the geothermal development has been originally promoted by the government. In Kenya, Costa Rica and Guatemala, geothermal power plant has been operated and geothermal developments have been promoted, but have the challenges of insufficient of geothermal technical capacity and management capacity building. In Kenya, government agencies (GDC) is carried out geothermal development in the direct management, capacity building of engineers is achieved. Furthermore, TGDC was established by government as Tanzania version of GDC and started the activity in Tanzania. Although 3000 m class drilling survey was conducted by government in Rwanda, but the project was interrupted because of the low temperature. The main challenges are including 1) The targeting of the drilling, 2) Geothermal project management.

【The targeting of the drilling】

Although geothermal exploration actively and various exploration have been carried out by the donor in Rwanda, there are some challenges that are reliability of basic geophysical exploration data, a comprehensive analysis and constructing geothermal model, and it is possible to set a drilling target by performing these reliably. It is necessary the ability to evaluate the result of exploration data and is important to build up of geothermal engineering capacity.

【Geothermal project management】

Three wells drilling depth of 3000 m class has been promoted on the premise in the drilling plan. The problem of the drilling project first, the drilling plans of 3000 m has been determined. But it

is important to confirm of the shallow ground temperature by slim hall at the first stage. Furthermore, in spite of insufficient geothermal information from the first well, the second well began to drill without consideration of drilling result of the first well. It is necessary to reflect the first drilling results, and it is important to enhance the organizations and management capabilities for operation of the geothermal project.

Table 3.7.31 Summary of geothermal development status and involvement demarcation of each country

No.	Country name	GGC	Geothermal Development Field	Development Stage: Field survey	Test Drilling	Production drilling	Power Plant	Government /Private sector	Main donor	Development status	Framework and Challenges
1	Mexico	983	Cerro Prieto, Las Azufres					Government		Cerro Prieto: 720MW, Las Azufres: 188MW.	Geothermal development has been carried out by government (CEF).
			Los Humeros, Las Tres Virgenes					Government		Los Humeros: 40MW, Las Tres Virgenes: 10MW.	
2	Costa Rica	205	Mira Valles					Government	IDB, OECF, JICA	163MW	Government operate all development as vertical integration. Geothermal exploration and drilling capacity is sufficient. Reservoir engineering are outsourced.
			Las Pailas Ⅰ					Government		42MW	
			Las Pailas Ⅱ					Government	JICA	Planed capacity 55MW	
			Borinquen Ⅰ					Government	JICA	Planed capacity 55MW	
			Borinquen Ⅱ					Government	JICA/IDB	Planed capacity 55MW	
3	Kenya	271	Olkaria Ⅰ, Ⅱ, Ⅳ					Government	JICA	Olkaria Ⅰ:45MW, Olkaria Ⅱ:105MW, OlkariaⅣ:70MW×	Geothermal survey and development has been promoted by the government (GDC) direct management. Development is progressing by government and donor activity. The challenge is skill up of officials for geothermal development.
			Olkaria Ⅲ					Private		OlkariaⅢ:IPP48MW+36MW, Orpower	
			Olkaria Ⅴ					Government	JICA	KenGen/IPP:140MW, Plants construction is planed in new PPP	
			Menengai					Government	JICA, AfDB, WB, AFD, EIB	GDC:107MW, Start of operation is scheduled in 2015.	
			Eburu					Government		KenGen:30MW expansion.	
			others					Gov/Pri	GRMF, KfW	GDC:Baningo-Siliali, Suswa (150-400MW). IPP:Longonat, Akira (140MW).	
4	Guatemala	49	Zunil・Amatitlan Zunil Ⅰ, Amatitlan					Gov/Pri		Government: exploration, "ORMAT" constructed in BOO.	Government lead development (consignment). The challenge is skill up for geothermal development.
			Zunil Ⅱ					Government	JICA	"INDE" keep land ownership and development license.	
			Tecuamburro, San Marcoho, others					Government			
5	Ethiopia	7.3	Aluto Langano					Government	UNDP, IAEA	Pilot plant: 7.3MW. Operated and maintenanced by EEP.	Projects are operated mainly by government. The challenge is skill up of officials for geothermal development.
			Aluto-1,2,3					Government	UNDP, JICA, ICEDA/NDF, WB	WB supported in drilling survey. Planed capacity 35MW (WB/JICA).	
			Tendaho-1,2,3					Government	UNDP, BGR, ARGeo	Historic survey in 1990s recorded max 270℃ at 2,100m.	
			Tulu Moya, Corbetti, Abaya					Private	GRMF	Developed in IPP method.	
6	Tanzania	0	Ngozi, Mbaka, Songwe, Rambo, Ilaqtile					Gov/Pri	SIDA, BGR, AfDB, ICEDA, JICA	Field survey in operation. AfDB is scheduling detail survey in the area which was found in JICA project result.	Government operate field survey through GPT and provide exploration license to private sector. TGDC, similar sector to GDC in Kenya, was organized. Challenge is improvement of TGDC officials skill.
7	Uganda	0	Kibiro, Katwe					Gov/Pri		Katwe: WB planed heat hall survey. Private company acquired exploration license.	Government operate field survey and also provide exploration license to private sector. However, they have not progressed.
			Panyimur, Buranga					Government		Private company acquired exploration license.	
8	Djibouti	0	Lake Assel, Nord Goubet, Hanle others					Government	BRGM, UNDP, AfDB, JICA	Max 260℃ in Lake Assal area. AfDB supported7.5M US$.	Government lead development. Coordination among donors is important.
9	Rwanda	0	Karisimbi					Government	JICA, EU/UNEP,BTC	3000m class drilling project interrupted by the drilling result. JICA project results have been noticed.	Government lead development. Coordination among donors is important.
			Kinigi, Gisenyi, Bugarama					Government		Field survey in operation.	
10	Bolivia	0	Laguna Colorada					Government	JICA, IDB	Production well and consulting for 50MW class geothermal plant (Loan).	Public sector operate projects. There is need to assess the trend of geothermal development.
11	Caribbean Island Nations	0	Dominica Roseau Valley					Government	IDB, EU	Planed 10-15MW class geothermal plant.	There is some development projects. However, they have not progressed.
			St. Vincent La Soufriere					Government	UNDP	Reykjavik Geothermal operating detail survey.	Government have positive impression. However, their projects have not progressed.
			St. Lucia Sulfur Springs					Private		ORMAT acquired development license.	Public sector count on private sector works. However, geothermal development have not progressed.
12	Argentina	0	Copahue					Government	JICA	Historic drilling in JICA project reported 240℃ and estimated 30MW as generation capacity.	Government operated primarily exploration. However, there is no progress after that.
			Domuyo, tocomar					Government			
13	Ecuador	0	Tufino-Chiles, Chalupas					Government	BRGM, AQUATER	Slim hole drilling survey was carried out by public finance. It recorded 50℃ at 554m.	Public sector operated field exploration. It is necessary to detailed investigation
			Chachimbiro					Government	BRGM, AQUATER	Geophysical exploration was carried out by public finance.	
14	Peru	0	Tutupaca, Crucero, Calacoa-Putina, Pinaya, Puqiou					Government	JICA	JICA has developed geothermal development master plan. Priority Rank A Fields have been granted exploration right.	It is necessary to detailed investigation
15	Chile	0	EL Tatio					Gov/Pri	UNDP	Planed capacity 40MW.	Public sector operates primarily exploration at first. Detail exploration have been operated by private sector.
			Puchuldiza					Gov/Pri	UNDP, JICA	Historical survey drilling in 1981 supported by JICA.	
			Calabosos, Chilan					Gov/Pri	UNDP	Plant construction are operated by ENG (Calabaso: 200MW, Chilan: 160MW).	
16	Nicaragua	124	San Jacinto-Tizate, Momotombo					Gov/Pri		Public sector operated reservoir evaluation and production well drilling. Plant construction are operated by Private sector.	Public sector lead exploration and private sector assume facilities. Some part of public sector operate prospects. The challenge is skill up of officials.
			Castina-San Cristobal, others					Private		Private sector keep exploration license.	
			Volcano Cosiguina, others					Government		Government planed geothermal exploration.	
17	El Salvador	204	Ahuachapan					Gov/Pri		100MW, LaGeo(INE/Enel) keep ownership.	Public company, owned by government and Italian company, lead projects. Univ. of El Salvador provide a geothermal course which is supported by IDB etc.
			Berlin					Gov/Pri		109.4MW, LaGeo keep ownership.	
			Chinameca					Gov/Pri		F/S was carried out 50MW class power plant.	
18	Indonesia	1341	Kamojang, Sibayak, Lahendong					Government	WB, JICA	PGE/PLN operate this project, Kamojang: 200MW, Sibayak: 12MW.	Geothermal master plan studied by JICA. Their road map scheduled a capacity as 9,500MW in 2025. There are many kind of frameworks, public/private or private. The new study area (WKP) is set by government and the developer is determined by bidding.
			Daraja Ⅰ, Ⅱ, Ⅲ					Gov/Pri		JV of public and private sector. Public sector keep the ownership of Daraja Ⅰ, Total: 520MW.	
			Dieng, Wayang Windu					Private		Private sector operating, 60MW, 227MW.	
			Gunung Salak					Gov/Pri		Government keeps the ownership of generating facility, 377MW.	
			New development areas					Gov/Pri		Public sector plot out WKP. Development right is given by bidding.	
19	Philippines	1904	Makiling-Banahaw, Tiwi					Gov→Pri		Operator: CGPHI/APRI, NPC sell facility to APRI.	Corporatization of EDC and selling of NPC facility made progress of private sector led development.
			Tongonan, Palinpinon, Mindanao, others					Gov→Pri		Operator: EDC, PNOC-EDC was privated and change to EDC.	
20	Italy	883	Larderello, Travale, Mt. Amiata					Gov→Pri		Lardello: 594.5MW, Travale: 160MW, Mt. Amiata: 88MW.	Development was promoted by Enel. Enel Green Power was established from Enel by the privatization.
21	Iceland	660	Hellisheiði, Nesjavellir, others					Gov→Pri		Hellisheiði: 303MW, Nesjavellir: 120MW, Privatization.	Geothermal development has been promoted by private sector.
22	New Zealand	762	Wairakei, Ohaaki, Mokai, others					Gov→Pri		Wairakei: 232MW, Ohaaki: 103MW, Mokai: 111MW. First large area prospection was carried out by government.	Public sector operated initial exploration. By privatization, geothermal development has been carried out by private sector.
23	USA	3129	The Geysers, Imperial Valley, others					Private		Geysers: 1,585MW, Imperial Valley: 654MW.	Private sector operate development. California: 2,553MW, Nevada: 442MW.
24	Japan	527	Onuma・Sumikawa, Uenotai, Odake・Hacchoubaru, others					Gov/Pri		Sumikawa: 50MW, Uenotai: 28.8MW, Hacchoubaru: 112MW.	Geothermal development has been carried out by private sector with government exploration. Steam supply and power generation companies are separated often. The new project has funding of government.
			Hachijyojima, Yamakawa, Yanaizunishiyama, others					Gov/Pri		Hachijyoujima: 3MW, Yamakawa: 30MW, Yanaidunishiyama:65MW, Initial exploration were carried out by government.	
			New development areas					Gov/Pri		Initial exploration have done as the nation subsidized projects. Production well drilling and plant construction supported by capital injection and guarantee of liabilities from public sector.	

Government (developed) Government/Private sector

Government Private sector