Executive Summary

Background, objectives, and scope

The importance of geothermal energy has been emphasised in the context of energy security and for global environmental issues since geothermal energy supplies stable heat and electricity sources with low, almost zero, carbon dioxide (CO_2) emissions.

Many eastern and south-eastern Asian countries have been attempting to deploy geothermal resources in their territories although the types of utilisation vary from country to country, from power generation to ground-source heat pump (GSHP), depending on the type of resources and energy needs. Countries with rich high-temperature resources have been utilising their geothermal resources for steam power generation. Other countries attempt to extract heat from deeper underground by enhanced/engineered geothermal system (EGS) technologies, or utilise shallow underground for conventional direct heat use or GSHP systems. However, geothermal deployment in these countries has not been progressing, largely due to lack of information on the latest technology of sustainable resource development.

The ERIA geothermal project 'Sustainability Assessment of Utilising Conventional and New-Type Geothermal Resources in East Asia' began in September 2013 to extract common and field-depending problems in terms of sustainability, finding solutions, and sharing information to improve technology for sustainable geothermal deployment in Asian countries. Geothermal experts from seven countries—China, Indonesia, Japan, the Republic of Korea (henceforth Korea), Philippines, Thailand, and Viet Nam—joined this project. At first, in order to extract common and individual problems related to maintaining sustainability of geothermal deployment, a census on the current status of geothermal deployment in member countries was made. It includes legal and political frameworks, technical and social barriers, among others. Then the most serious common technical barriers for sustainable use were extracted to intensively investigate finding solutions based on case studies. The final output of this study is a procedure guideline of sustainable development and utilisation of geothermal resources. This guideline should help engineers and managers who begin geothermal business. It may also be referred by related researchers. Beside the guideline, based on the result of the census on the current

status, this report provides 'Recommendations to Policymakers' for more rapid, intensive, and appropriate use of geothermal energy.

Major findings

As results of the census on the current status (Chapters 2 to 4), recommendations to policymakers for more intensive utilisation of geothermal energy are provided as follows:

Energy policy

- National programmes and development plans should be provided explicitly for geothermal power generation.
- Long-term programmes for geothermal power generation are necessary because geothermal development takes five to seven years.
- All counties should issue CO_2 tax law for renewable energy (RE) development for the preservation of the environment.

Technology management

- Among geothermal power–generating countries, sharing production history and strategies for reservoir management and control of reinjection problems is recommended for sustainability of steam production.
- Anti-erosion, corrosion to acidic fluid, and mineral scaling are also common problems for reservoir management for sustainability of steam production. Collaborative research studies with steel companies and chemical companies for finding solutions for acidity, corrosion, and mineral scaling problem are recommended.
- Support from research institutions may be necessary for installation and sustainable use of GSHP systems to avoid overspecification, which can cause high installation cost, and underspecification, which can cause unsustainable use.

Technical barriers

- To promote geothermal power generation, governments should support research activities. International collaborative cooperation in research and development (R&D) on solving those problems above should also be supported.
- For direct use, governments should put incentives to use thermal use of geothermal energy (for example, in Korea, a renewable heat obligation [RHO] law is planned to be enacted in the near future).
- For promotion and sustainable use of GSHP, governments should support R&D on hydrogeological studies, case studies, and long-term monitoring. Also governments

should encourage international research collaboration on these topics.

Environmental constrains

- Enactment of laws inside national parks to isolate certain areas for geothermal development (energy zone) and to balance energy development with national forest conservation is recommended to keep the balance between geothermal development and environmental protection.
- All countries should issue CO_2 tax laws for promotion of RE development to preserve the global environment.

Social and political matters

- Governments should provide supportive systems for involvement of the local population in geothermal development projects.

Legal matters

- One-stop-shop type of legislation including environmental permission is desirable to promote geothermal utilisation.

Financial capacities

- Governments should subsidise the cost of exploration drilling and create laws for cost recovery of geothermal development to encourage private investment.
- Countries that do not have enough expertise, equipment, or personnel should be supported by countries with experts through bilateral agreements.
- Governments should support R&D through agencies, not by bank loans.
- For development, low interest loans from the Asian Development Bank, the Japan International Cooperation Agency, or the World Bank are available in most countries. Governments should promote these systems to local developers and/or investors.

Supportive measures

- Feed-in tariff (FiT) for geothermal power is recommended for countries where geothermal business has not matured.
- High credit in renewable portfolio standard (RPS) is recommended for geothermal power (cf. 10 percent in the Philippines).
- National programmes and development plans should be provided explicitly for geothermal power generation, with the provision of fiscal and non-fiscal incentives, such as tax exemptions, royalties, and subsidies (for example, in Korea, maximum 80 percent of GSHP installation cost for greenhouse; from local government, 30 percent; and central government, 50 percent).

- For risk management in the exploration stage, some government is desirable. Subsidies for exploration drilling (for example, in Japan, it is 50 percent) are recommended.
- Continuous R&D support from governments is important no matter how much geothermal power generation is materialised.
- As in Indonesia, governments should conduct basic resource surveys (for temperature distribution and geothermal model) based on geological, geochemical, and geophysical (3G) data.
- International cooperation is important not only from the R&D aspect but also for the business aspect.
- Only a few countries have national programmes for direct use and GSHP. National programmes for direct use and GSHP are recommended for ALL countries.
- RHO, like RPS for electricity, is recommended to promote renewable heat for district heating/cooling (for tropical countries).

Future concerns

- National programmes should be provided explicitly for geothermal power generation, direct use, and GSHP, with the provision of fiscal and non-fiscal incentives, for example, tax exemptions, royalties, and subsidies.
- It is important to enact laws inside national parks to isolate certain areas for geothermal development (energy zone) and to balance energy development with national forest conservation.
- Governments should support through agencies to reduce the long process of securing environmental permits for exploration.
- One-stop-shops for securing various permits and documentation for geothermal exploration and development are strongly recommended. (Not going to national and local, and environmental, and other government agencies).
- Small-scale geothermal development programmes for islands and remote rural areas (separated from the national grid) are recommended, with financial incentives and subsidies from government.
- International cooperation is recommended for the countries where geothermal power has not been intensively used and no technology developed.
- Geothermal laws should be provided explicitly for geothermal development, separate from mining laws or hot spring laws.
- Continuous R&D support from the government is important no matter how much geothermal power generation is materialised.
- Geothermal education courses should be provided at the university level.

- From a technological viewpoint, each country has different future concerns. Therefore, international collaboration not only in the Asian region but also through worldwide information channels should be provided in a practical manner, which is effective to increase human capacity.
- For countries with such specific problems, they should initiate collaborate research with countries having solutions to these problems.
- Geothermal education programmes and awareness of local people for public acceptance of geothermal development, emphasising advantage of geothermal power and heat is needed.

International cooperation

- Bilateral agreements between governments should be provided for countries without experience in geothermal installation such as Thailand and Viet Nam on pilot plant projects, identifying agencies to implement the project.

According to the results of the census on 'Technology and management of geothermal energy use' in Chapter 2, the highest technological interest related to sustainability of geothermal power generation and direct heat use are (in order of priority);

- monitoring and reservoir engineering,
- reinjection,
- anti-scaling, and
- anti-corrosion and anti-erosion.

For GSHP systems, no common interests on technology were found, but basic hydrogeological data collection and system monitoring were pointed out to be important for sustainable use.

Collection of case studies on these topics were conducted (Chapter 5) and guidelines for sustainable use of geothermal energy were made based on the compilation of these case studies (Chapters 6, 7). Case studies and guidelines were made separately for 'power generation and direct heat use' and GSHP since the necessary technologies are totally different for these two things.

Note that 'sustainability' in this report is mainly for the 'resource sustainability' and environmental sustainability is only partially discussed. Separate investigations are necessary to discuss environmental, economic, and/or social sustainability.

Although the solutions shown in the guideline may contribute to sustainable use of geothermal energy for some extent, continuous studies are needed for the future.

Recommendations to policymakers for more sustainable utilisation of geothermal energy are:

- For the present, the guidelines in this report (Chapter 7) should be distributed to geothermal developers, GHSP installation companies, and research institutes and be used as a result of review on the current best practices.
- Continuous study should be done for the sustainable use of geothermal energy in the future, especially for the topics listed above. Government support for such study is desired.