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Social Acceptance of Geothermal Power Generation in Japan

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ABSTRACT

In Japan, development of geothermal power plant has failed occasionally because of a lack of local acceptance by some stakeholders such as hot spring inn managers and local governments. In our previous study, we identified the local risk and benefit structure to facilitate the resolution of the problem by conducting stakeholder interviews and analyzing the fundamental causes of opposition for hot spring inn managers. The objective of this study was to analyze local government and public attitudes regarding geothermal energy and to clarify the essential provisions for risk communication for mutual understanding and co-prosperity related to geothermal power generation. We conducted a mail-in questionnaire survey of local governments to clarify the concerns and opinions about geothermal energy in February 2012. An internet questionnaire survey was also conducted in February 2013 to examine public attitudes toward geothermal energy.

It was clarified that value and risk-benefit perception of geothermal energy differed between local governments. Thus, high geothermal potential areas did not always correlate well with high acceptance by local governments. They distinguish between large-scale geothermal power plants and small-scale geothermal facilities using hot springs. The acceptance of the latter has been relatively high. On the other hand, the public might, in fact, be willing to consider the introduction of geothermal energy technologies. However, it must be noted that the public may burden geothermal power technology with excessive expectations like for solar and wind power technology. Thus developers and local governments must inform the public regarding the risk-benefit and technical characteristics of geothermal energy in an understandable way. These results suggest that it is essential to provide appropriate information depending on stakeholders and to support their understanding.

1. INTRODUCTION

Japan has limited reserves of fossil fuels and other non-renewable energy resources. Despite the fact that there is availability of some potentially resource-rich geothermal locations and that Japanese companies hold an approximately 70% share of the global geothermal turbine market, the capacity of installed geothermal power plants has remained about the same since 1999. The installed capacity and the energy production of geothermal power generation were about 515 MWe and 2,764 GWh/year in 2012. It is estimated that about 81.9% of all potential geothermal energy sources in Japan are located in national parks, which are under development restrictions as special protected areas. In recent years, especially after the Great East Japan Earthquake on March 11, 2011, Ministry of Economy, Trade and Industry (METI) and Ministry of the Environment (MOE) have resumed economic assistance to developers and support in terms of relaxation of regulations, such as issuing permits for development in national parks. These policy supports can have an impact on the economic and financial viability of developers. The number of development plans and surface surveys for new geothermal power plants has been increasing rapidly.

On the other hand, the direct use of geothermal energy is one of the oldest, most versatile, and common form of utilization of geothermal energy (Dickson and Fanelli, 2003). Many hotels and Japanese-style inns utilize hot spring water for baths (onsen), and Japanese onsen culture has a long history. An onsen is a spa that uses hot spring mineral water, which is recommended as a cure for ailments and said to have healing and health-promoting properties. Japan's many volcanoes provide an abundance of hot spring areas, many of which have become health resorts.

Some managers of these hotels and inns, as well as some local governments and nature conservation groups, have been concerned about potential adverse effects of geothermal power generation on hot springs, landscape and natural environment in general. Since the very beginning of geothermal power development, these stakeholders have therefore expressed strong opposition to the development of geothermal power plants and geothermal development has been inhibited by the high barriers imposed by such vested interests (Jupesta, et al., 2013). Local governments expect substantial revenue from tourism related to onsen and tend to protect vested interests such as hot springs. Thus, stakeholders such as hot spring inn managers strongly influence the decisions of local governments regarding the issuance of drilling permits. In our previous study, we identified the local risk and benefit structure to facilitate the resolution of the problem by conducting stakeholder interviews (Kubota et al., 2013). The fundamental causes of opposition for hot spring inn managers were as follows; conservative values and beliefs, a particular risk perception of the reversibility and predictability of underground structures, and a variety of frameworks for geothermal energy utilization. There is also controversy regarding the benefits of geothermal energy, which is related to the conditions and locations of hot spring wells as well as the business scale and structure of hot springs.

In Japan, the procedure of drilling geothermal wells follows the Hot Spring Law. For this reason, developers must obtain approval from the nearby hot spring managers in order to obtain a permit to drill the geothermal wells. The key decision makers for issuing drilling permits for geothermal wells and hot spring wells are prefectural governors, although the utilization of geothermal energy is a national energy policy issue. This policy complicates the process of reaching a decision and affects the lead-time and financial risks for developers. Moreover, if developers cannot reach consensus with stakeholders such as the local government, hot spring or land owners when obtaining a drilling permit, the lead-time will be prolonged and costs will increase. Therefore, the process of

reaching consensus between developers and stakeholders affects almost all other barriers of development. Local government attitudes and the details of risk communication strategy have not been clarified.

The most important visitors for hot spring inn managers and the local governments is the general public. Although acceptance of the public who are aware of geothermal power is as high as that for wind power, their awareness of geothermal energy is lower than for solar and wind power (Kubota et al., 2012). Most residents of Japan have been to an onsen, which is a well-known, familiar form of geothermal energy utilization, whereas few people know about geothermal power generation, and fewer have seen a geothermal power plant. However, public awareness and acceptance of geothermal energy has not been clarified after the Great East Japan Earthquake.

Thus, the objective of this study was to analyze the current local government and public attitudes towards geothermal energy and to clarify the essential provisions for risk communication for mutual understanding and co-prosperity related to geothermal power generation.

2. OUTLINE OF THE SURVEY

2.1 Mail-in Questionnaire Survey for Local Governments

A mail-in questionnaire survey was conducted between 12th January to 20th February 2012 with 69 local governments sampled from the 86 cities which were the members of the association of hot-spring areas and where geothermal power stations are located and with 22 prefectures sampled from 29 prefectures, excluding prefectures impacted by the earthquake disaster. The questionnaire covered hot spring utilization and management, utilization of geothermal energy in local areas, risk-benefit perception, attitude toward geothermal power technology and issues related to dialogue and risk communication with stakeholders.

2.2 Website Questionnaire Survey for the Public

A website questionnaire survey was conducted with 8,003 respondents aged 20 years and above, sampled from 15,961 monitors of a survey company between 26th February to 4th March 2013. There was approximately the same proportion of respondents by age and by sex (51.6% male, 48.4% female). The questionnaire covered three main areas. The first section sought to determine the perceived risk of climate change and assess the knowledge. The second section assessed risk-benefit perception, attitude toward each power technology, such as fossil fuel, nuclear, hydropower, and renewable (solar, wind, geothermal, and biomass) power. The third section assessed the information needs, the acceptance of and attitude toward the decision-making process in the case of geothermal or carbon capture and storage (CCS) technologies. The basic information for each technology was shown to the respondents before they answered the third section.

3. RESULTS AND DISCUSSION

3.1 Local government Attitudes toward Geothermal Energy

3.1.1 Attitudes toward Hot Spring and Geothermal Energy Utilization

Local governments thought that hot springs were important tourism resources and contributed economic ripple effects to the community (Figure 1). Figure 2 shows the results for local government relative attitudes toward various geothermal energy utilizations. Overall they supported energy saving technologies and the effective utilization of hot springs such as development of small-scale geothermal power plants. However, attitudes regarding development of large-scale geothermal power plants outside of national parks were divided and the acceptance of development in national parks was low. National parks are also an important tourism resource for local governments. These results showed that local governments distinguish between large-scale geothermal power plants and small-scale binary cycle geothermal facilities using hot springs. The acceptance of the latter has been relatively high.

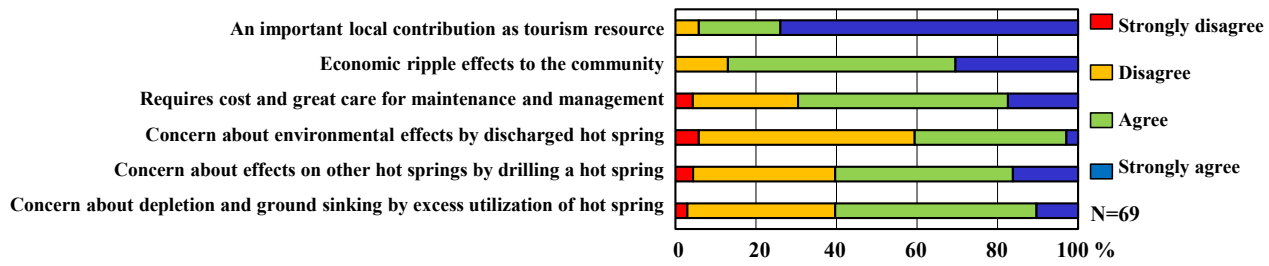

Figure 1: Local government attitudes toward hot springs.

3.1.2 Attitudes toward Geothermal Power Plants

The results for attitude toward geothermal power plants by local governments are shown in Figure 3. These attitudes were compared between proponents (N=31) and opponents (N=33) of development of geothermal power outside of national parks. Proponents evaluated the characteristics of geothermal power more highly than wind and solar. On the other hand, geothermal power plants received a poor evaluation by opponents. Opponents only wanted to utilize hot springs and energy efficiency. Both thought that consensus building with stakeholders was difficult. Thus, it was indicated that high geothermal potential areas did not always correlate well with high acceptance by local governments.

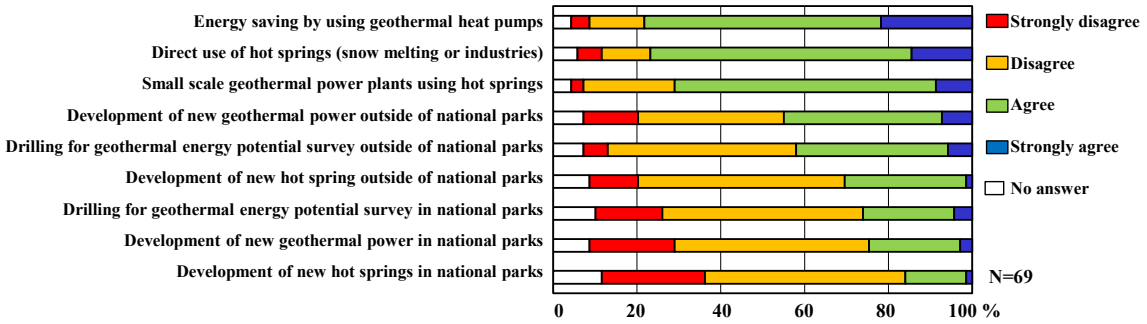

Figure 2: Local government preference behavior about introducing each geothermal energy technology in future.

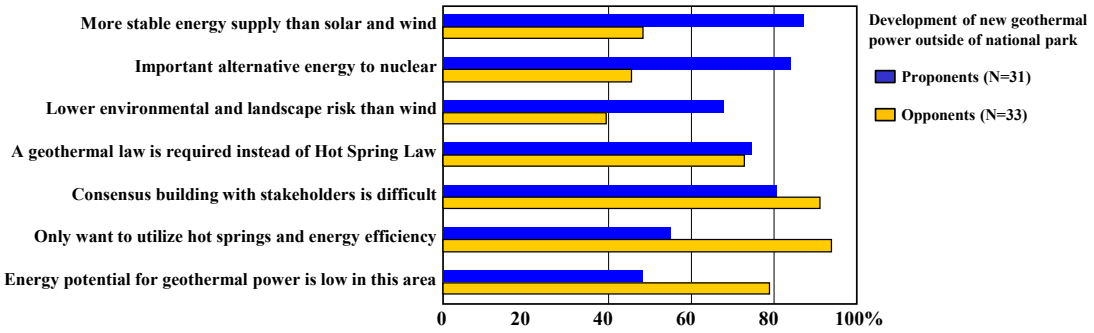

Figure 3: Local government attitudes toward geothermal power plants.

Risk and benefit perception of geothermal power plants for proponents and opponents are shown in Figures 4 and 5. Proponents had high expectations for various local benefits such as contribution to climate change mitigation, stable energy supply, increased local employment and consumption related to developing geothermal power plants. On the other hand, most benefit evaluations by opponents were relatively low (Figure 4). However, proponents were highly concerned about the effects of geothermal power plants on hot springs, underground mechanics and groundwater, which was similar to opponents (Figure 5). The results suggest that it is important that opponents are provided quantitative data such as economic effects and information on best practices for geothermal power plants to support good decision-making in the local area.

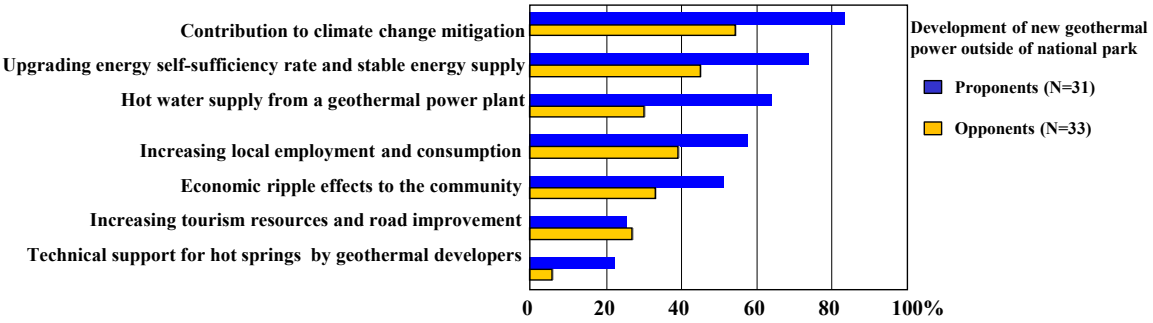

Figure 4: Expected local benefits by developing geothermal power plants.

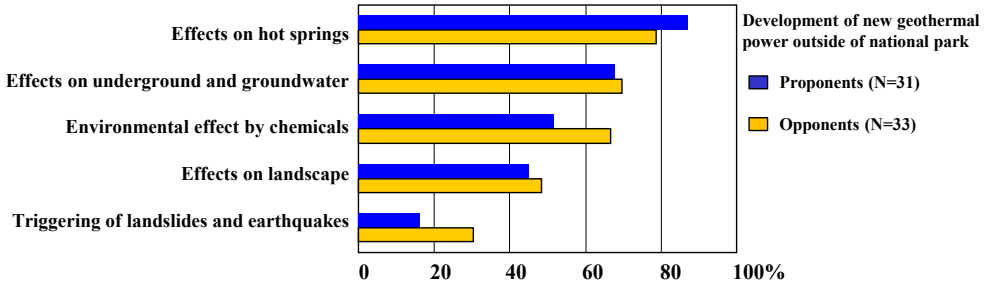

Figure 5: Risks and concerns by developing geothermal power plants.

3.1.3 Appropriate Institutions for Risk Communication

Appropriate institutions for risk communication to develop a geothermal power plant were examined. Local governments thought 'national or local institutions' and 'university professors' were the most appropriate neutral institutions for provision of scientific information (Figure 6).

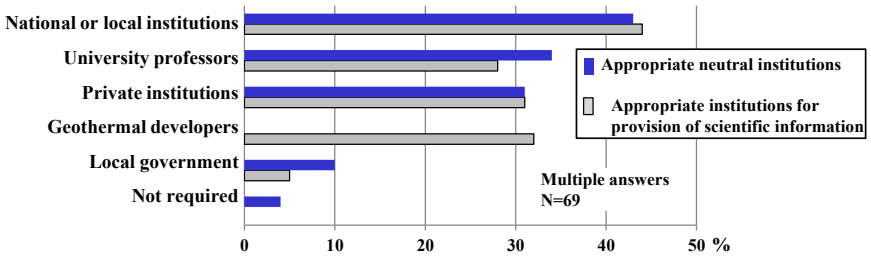

Figure 6: Appropriate institutions for risk communication for developing geothermal power plants.

Local governments are faced with various policy conflicts in terms of the trade-offs between the reduction of greenhouse gases, regional energy strategy, tourism policy, and protection of hot springs. The increased use of electricity generated by geothermal power plants is expected to contribute to decreasing greenhouse gas emissions and its usability for base load power makes it a worthy renewable option. On the other hand, some local governments may not necessarily accept development even if they understand that the careful development of geothermal power plants based on scientific monitoring data from past to present might prevent adverse effects on nearby hot springs because they think that nobody can predict what will happen in the future. It is important for policy makers and developers involved in geothermal energy to overcome associated obstacles and to discuss the various risks and benefits of introducing geothermal power plants with all concerned stakeholders, because local governments are key persons for developing geothermal energy utilization.

This issue can affect the development of low-emission energy technology, despite permissive policies and economic support. Improvements in legislation might also be necessary as the decisions regarding geothermal energy policies are not made by the central government but rather by local governments since prefectural governors have the legal authority to permit drilling of wells.

Also suggested is that a strategy for local utilization of geothermal energy should consider a wide variety of available options, including off-grid and smart-grid power sources. Developers should pursue appropriate risk management strategies for coexistence and shared prosperity with local stakeholders.

3.2 Public Attitudes toward Geothermal Energy

3.2.1 Knowledge and Preference Behavior

Over 80% of respondents thought that they 'know' or 'know well and can explain in detail' about each of the various power technologies, including fossil fuel, nuclear, hydropower, solar, and wind power (Figure 7). However, this dropped to 64.2% and 32.5% in the case of respondents' recognition of geothermal and biomass power, respectively. The percentages of respondents who knew about geothermal power were modestly increased compared to our survey results conducted before Fukushima disaster (Kubota et al., 2012). The ratio of males was higher than for females.

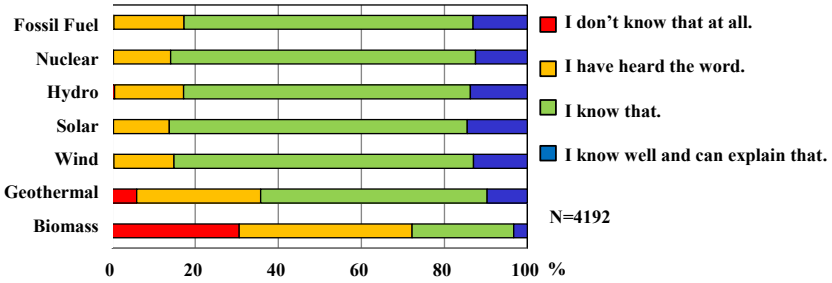

Figure 7: Public self-evaluation of knowledge about each power technology.

On the other hand, attitudes of respondents regarding use of each power technology in the future are shown in Figure 8. After the accident that occurred in 2011 at Fukushima, many people have begun to oppose the use of nuclear power due to concerns about nuclear accidents and raised expectations for introduction of renewable energy. However, most respondents thought that nuclear power provided a steady supply of electricity (Figure 9). Their attitudes toward fossil fuels, which are the major sources of energy supply in Japan, were relatively low (Figure 8). Of importance was the respondents' favorable attitude toward geothermal generation, which was similar to the results for solar and wind. However, they didn't know much about the characteristic of geothermal energy technology, which can provide a steady supply of electricity (Figure 9). Respondents who understood geothermal energy and its technological characteristic, and were favorable about hot springs, had higher preference for the introduction of geothermal power generation than those who didn't. For hot spring inn managers and local governments, the most

important source of revenue is tourism. Among those who are aware of geothermal power generation, its societal acceptance is relatively high. Therefore, raising awareness of geothermal energy is vital.

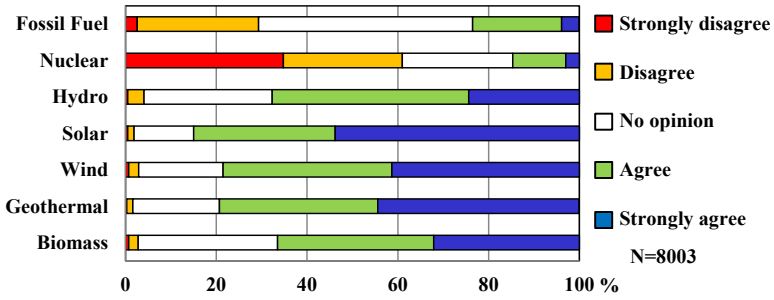

Figure 8: Public attitude toward introducing each power technology in future.

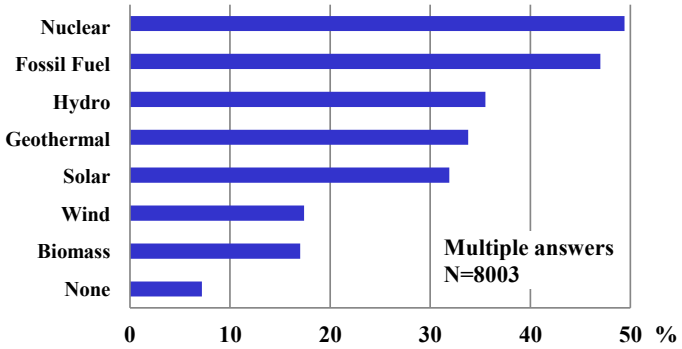

Figure 9: Which power technologies are providing a steady supply of electricity?

3.2.2 Attitude toward Geothermal Energy Utilization

The results for relative attitudes of respondents toward various geothermal energy utilizations are shown in Figure 10. Although overall they favored the effective utilization of hot springs, energy saving technologies, and development of geothermal power plants, the acceptance of development in national parks was relatively low.

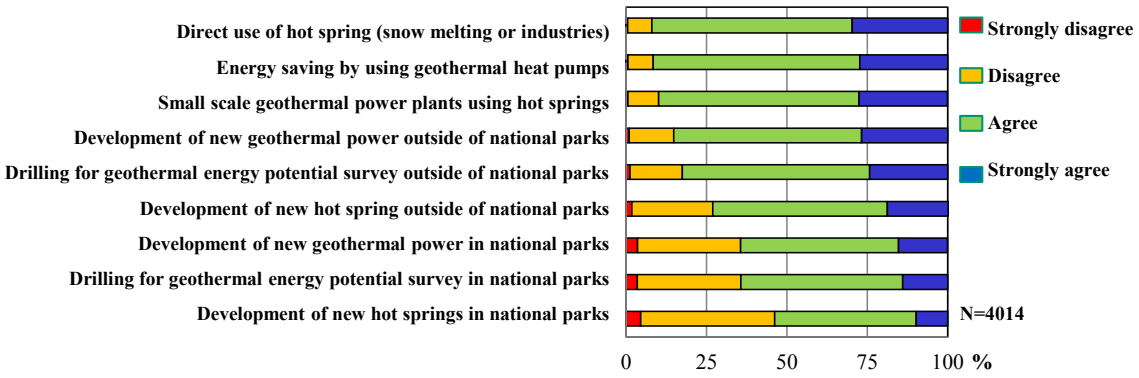

Figure 10: Public preference behavior about introducing each geothermal energy technology in the future.

3.2.3 Risks and Benefits

Risk and benefit perception of geothermal power plants are shown in Figures 11 and 12. Respondents expected local benefits such as contribution to climate change mitigation and stable energy supply from development of a geothermal power plant (Figure 11). They were highly concerned about effects on underground mechanics and on groundwater by geothermal power plants (Figure 12). Concern regarding potential effects on hot springs and landscape were relatively low for respondents.

3.2.4 Information Needs for Decision Making

High public information needs for decision-making to develop geothermal power plants include the data on power supplying capability, countermeasures for safety management and effects on electricity price (Figure 13). The results suggest that it is

important that developers or local governments prepare the information required by the public including power supply capability, safety management and effects on electricity price.

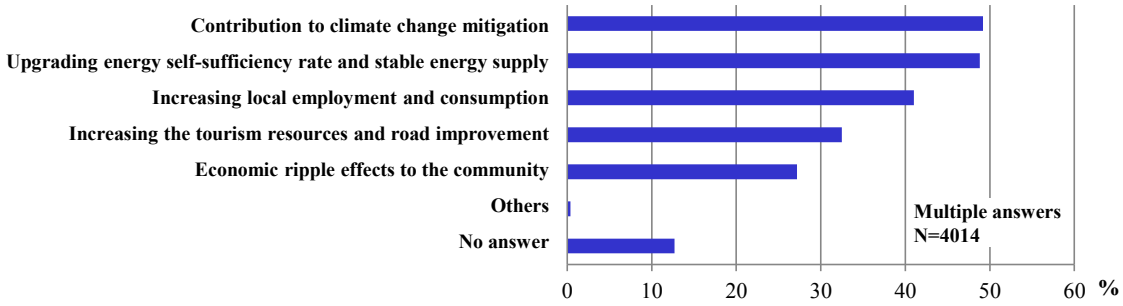

Figure 11: Expected local benefits by developing geothermal power plants.

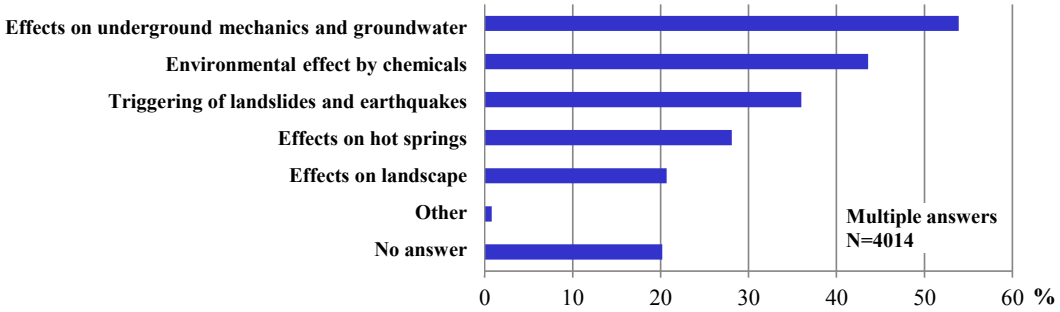

Figure 12: Risks and concerns for developing geothermal power plants.

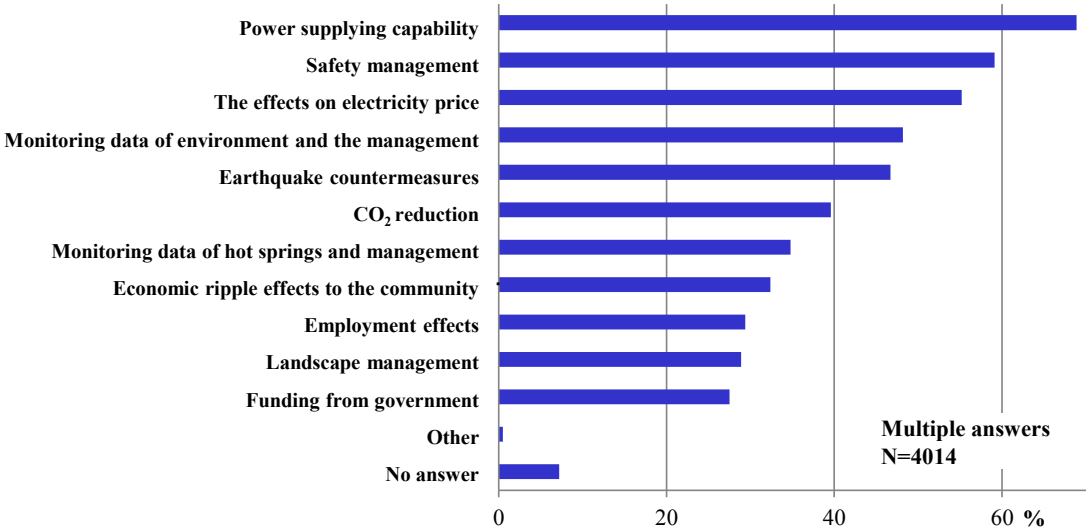

Figure 13: Public information needs for decision-making to develop a geothermal power plant in resident area.

3.2.5 Appropriate Institutions for Risk Communication

Appropriate institutions for risk communication regarding development of geothermal power plants were examined. Respondents thought that private institutions were the best appropriate neutral institutions and provider of scientific information (Figure 14). The results were different from the results of local governments (Figure 6). These findings suggest that there are cognitive gaps between the public and local governments. It was very difficult to ensure neutrality in risk communication. Local government should consider selection of appropriate members to meet local stakeholder needs.

4. CONCLUSIONS

This research analyzed current local government and public attitudes toward and acceptance of geothermal power technologies through questionnaire surveys. It is important to pay attention to ensuring fairness in local benefits. Through continuous dialogue

and consensus building, stakeholders should affirm a common recognition of the definition of effects on hot springs and formulate a mutual understanding regarding risk management options to meet their common goals and vision of the future.

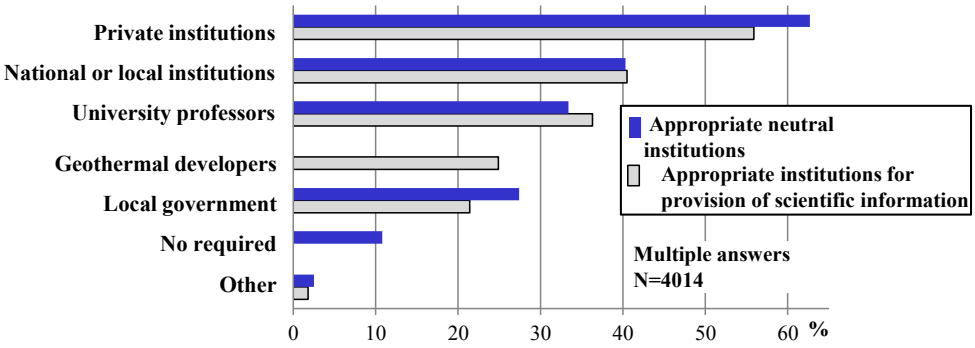

Figure 14: Appropriate institutions for risk communication for developing geothermal power plants.

It was clarified that value and risk-benefit perception for geothermal energy differed between local governments. Thus, high geothermal potential areas did not always correlate well with high acceptance by local governments. Local governments distinguish between large-scale geothermal power plants and small-scale geothermal facilities using hot springs. The acceptance of the latter has been relatively high. On the other hand, the public might, in fact, be willing to consider the introduction of geothermal energy technologies. However, it must be noted that the public may burden geothermal power technology with excessive expectations like for solar and wind power technology. Thus developers and local governments must provide accurate information on risk-benefits and technical characteristics of geothermal energy in an understandable way. These results suggest that it is essential to provide appropriate information depending on stakeholders and to support their understanding.

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