Research Report
Social Acceptance of Geothermal Energy: A Case Study in Oita Prefecture, Japan

by

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Social acceptance of geothermal energy: A case study in Oita prefecture, Japan

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I. Abstract

In the past decade, there has been significant growth of the global renewable energy sector. As the renewable energy utilisation rate increases, there is also a corresponding rise in society's interactions with renewable technologies in daily life. However, during the expansion of the renewable sector, the level of acceptance in society towards the different types of renewable energy technology varies. Addressing the public's attitudes towards renewable energy technology is a vital topic in changing the widespread implementation of such technologies. In Oita prefecture, power sourced from geothermal energy technology (GET) accounts for a relatively large portion of the region's energy mix and there are increasing investments towards the expansion of the geothermal energy sector. In the recent years, small-scale geothermal generation system, specifically 'Hot spring Geothermal Power Systems (HGPS)' have been constructed in urban areas, despite facing resistance from local residents.

This study will analyse the social acceptance on three levels in society, national level, regional level and local level. (1) National level - Japan faces international, domestic and economic pressure to diversify its energy mix away from fossil fuels and nuclear energy. (2) Regional level - Oita prefecture and its city government will be required to developed geothermal expansion strategies with adherence to the national policy and approval from local residents. (3) - Local level: by seeking the cooperation of local society through understanding of psychological and contextual factors is vital to intermediate the shift towards greater geothermal utilisation. This study will be analysing the three levels of social dimension using a mixed-methods analytical approach. These sources include quantitative survey data, qualitative semi-structured

interview data and the analyses of relevant secondary sources. Surveys were conducted on residents in Oita prefecture from 2016 on resisdents from four cites, Oita, Beppu, Hita, Kuju. There were 61 responses collected during the survey phase. In addition, six semi-structured interviews were conducted with government official, members of the industry and private business owners from 2016 to 2017.

The results collected were triangulated with the author's research data, government reports, policy reviews and media responses. The findings of the data show that there is continued growth of investment in the GET sector among private energy enterprises. Local citizens in Oita prefecture are divided in their opinions on the view of using GETs in their local residents. On the national level, there are constant reviews and revision of government policies with regards to geothermal development continues to support Japan's renewable energy while a creating more transparent and comprehensive developmental procedures. The findings in the paper can be utilised to understand the dynamics between the three social structures, to allow for better polices and measures for more successful implementations of GETs with greater social acceptance. This study has shown that consistent progress in Japan's policies for geothermal develoment regulations helps to improve the social acceptance amongst its citizens.

II. Acknowledgement

I would like to sincerely express my gratitude all the people who have help me with this research paper

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This paper would not have been possible without the support from local residents around Oita prefecture, as well as the groups and individuals from the government, energy utility and private enterprises. Thank you for your time in contributing to this project

Most importantly, I would like to thank my parents for giving me this opportunity to embark in this journey of wonderful learning experiences in Japan.

Finally, I would like to thank Pham Thanh Ha for the guidance and constant moral support which has helped tremendously while the writing of this research paper

III. Certification Page

I, Andrew Chee Tong Li (Student ID 512126005) hereby declare that the contents of this Master's Thesis are original and true, and have not been submitted at any other university or educational institution for the award of degree or diploma.

All the information derived from other published or unpublished sources has been cited and acknowledged appropriately.

Andrew Chee Tong Li
2017/12/18

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V. List of Abbreviation

ANRE	**Agency for National Resource and Energy**
CO_2	**Carbon dioxide**
FIT	**Feed-In-Tariff**
GET	**Geothermal energy technology**
HGPS	**Hot spring geothermal system**
KEPCO	**Kyushu Power electric company**
ISEP	**Institute for Sustainable Energy Policies**
JOGMEC	**Japan, Oil, Gas, Metal National Corporation**
kW	**Kilowatt**
kWh	**Kilowatt hour**
METI	**Ministry of Economy, Trade and Industry**
MOE	**Ministry of Environment**
MW	**Megawatt**
MWe	**Megawatt electricity**
NGO	**Non-Governmental Organisation**
TWh	**Terawatt hour**

VI. Table of Contents

Chapter 1:
Introduction of Oita prefecture and geothermal energy

1.1 Introduction to geothermal energy

Geothermal energy is defined as heat energy from the Earth's core. At the base of the continental crust, temperatures range from 200°C to 1000°C, with temperatures increasing at about 25 to 30°C per km into the Earth's crust (Fridleifsson *et al*., 2008, p 62). There are two common areas that are plentiful in geothermal resources.

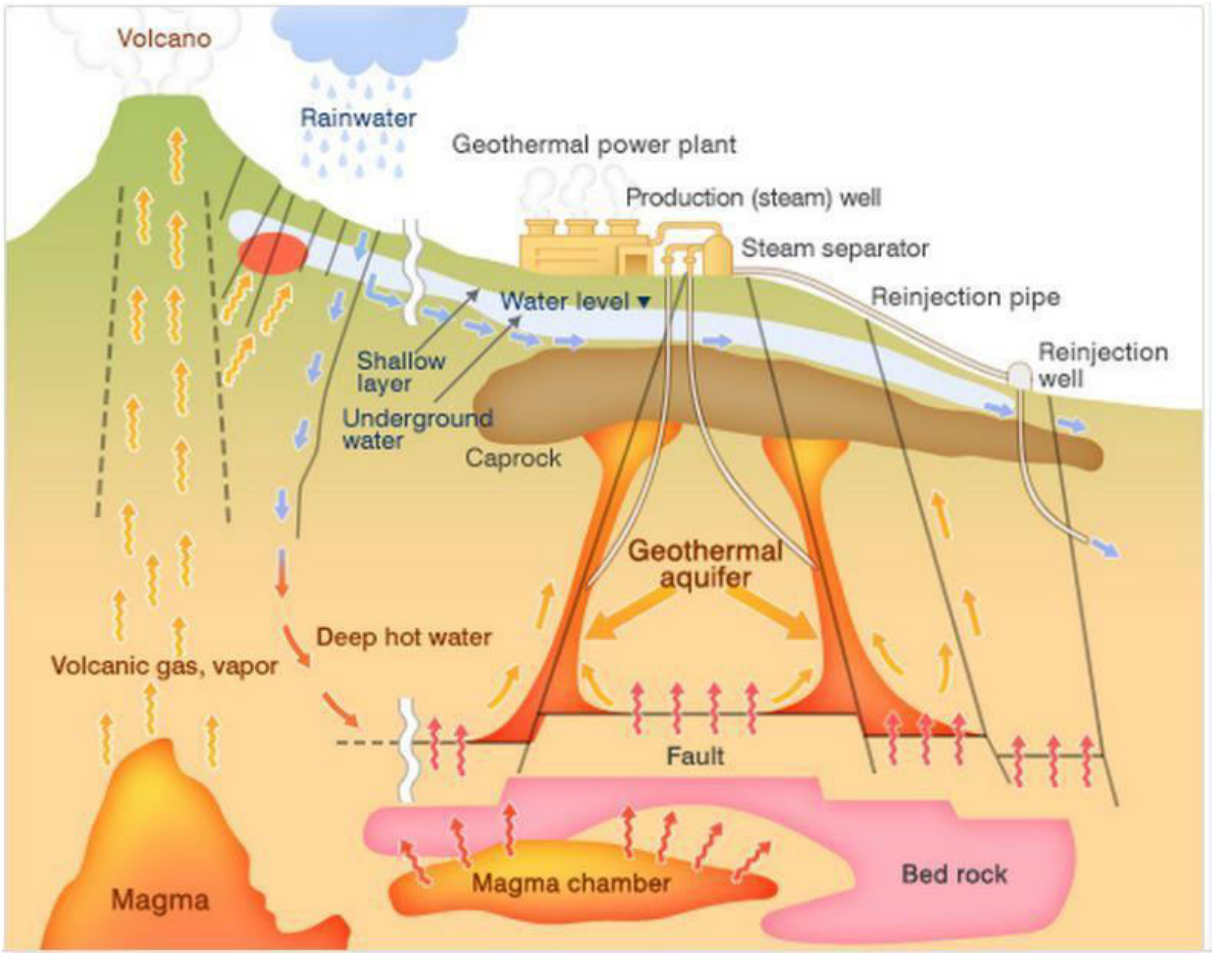


Figure 1: Underground model showing the origins of geothermal energy.
Source: Fukuda, Ishiguro and Saito (2008)

The first type of region is located away from volcanoes, and found around fault lines in areas known as low-temperature fields. The temperature of the geothermal

fields is less than 180°C (Fridleifsson *et al*., 2008, p 63). Due to the faults and high permeability rocks in the Earth's crust, underground water seeps through the cracks and gets heated up by the bed rock. The hot water then rises through the geothermal aquifer where it can be extracted for usage in the surface.

The second region is located in areas with volcanic activity and heavy seismic activity known as high-temperature fields. The temperature in these areas exceeds 180°C, are situated a few kilometres under the surface (Fridleifsson *et al*., 2008, p 62). This allows the groundwater nearer to the surface than the geothermal aquifers to be heated up and extracted without much drilling. The fields located around the Oita region are high-temperature fields with consistent geothermal output.

Geothermal technologies are renewable energy technologies that uses exchanging of heat between geological formations from the earth to the surface through a medium, like water (**Fig.1**) (Devine-Wright, 2007). Some examples includes the use of space heating, greenhouse heating, hot spring spas, industrial heat provisioning and electrical power generation (Lund *et al.,* 2005). In urban areas, electricity generated from fossil fuels is the main source of greenhouse gas emissions, however they are still one of the most common and widely used energy source in daily industries and residential sectors (International Energy Agency [IEA], 2009). One of the advantages is that geothermal energy has the potential to be established as base load power systems, by developing it as a mix of small and large scale facilities. The opens up opportunities for exploring the potential benefits of geothermal enegy and discovering more efficient power generation systems that can rival fossil fuel power. Gupta and Roy (2006) also

notes disadvantages that may arise through the usage of geothermal system including noise pollution, air pollution from chemicals, vibration and possible depletion of groundwater sources.

Unlike renewable energy such as solar or wind power, which are intermittent generating technologies, geothermal energy production has a capacity factor similar to base load coal and nuclear power (Buckheit, 2015). This allows a constant power generation, similar to hydroelectric, and it is not influence by the weather changes in the region. The reliable and consistent power produced from geothermal plants makes it a good source of renewable energy in a geothermal rich region like Japan.

1.2 Oita Prefecture and Japan

Japan has the third highest geothermal energy resources in the world. The estimated resources amount to about 33,000MW including thermal energy (ISEP,2016). In the thirty year period from 1966 to 1996, 520 MW of geothermal generation was installed in Japan, but then development ceased in favour of other renewable source like solar power (ISEP,2016). Furthermore, most areas of Japan does not have a readily accessible geothermal resource that requires little or no drilling for utilisation, which makes geothermal resource extraction difficult. However, unlike solar and wind power, geothermal power has a constant base load power, making it similar in terms of consistency of a conventional fossil fuel or nuclear power plant.

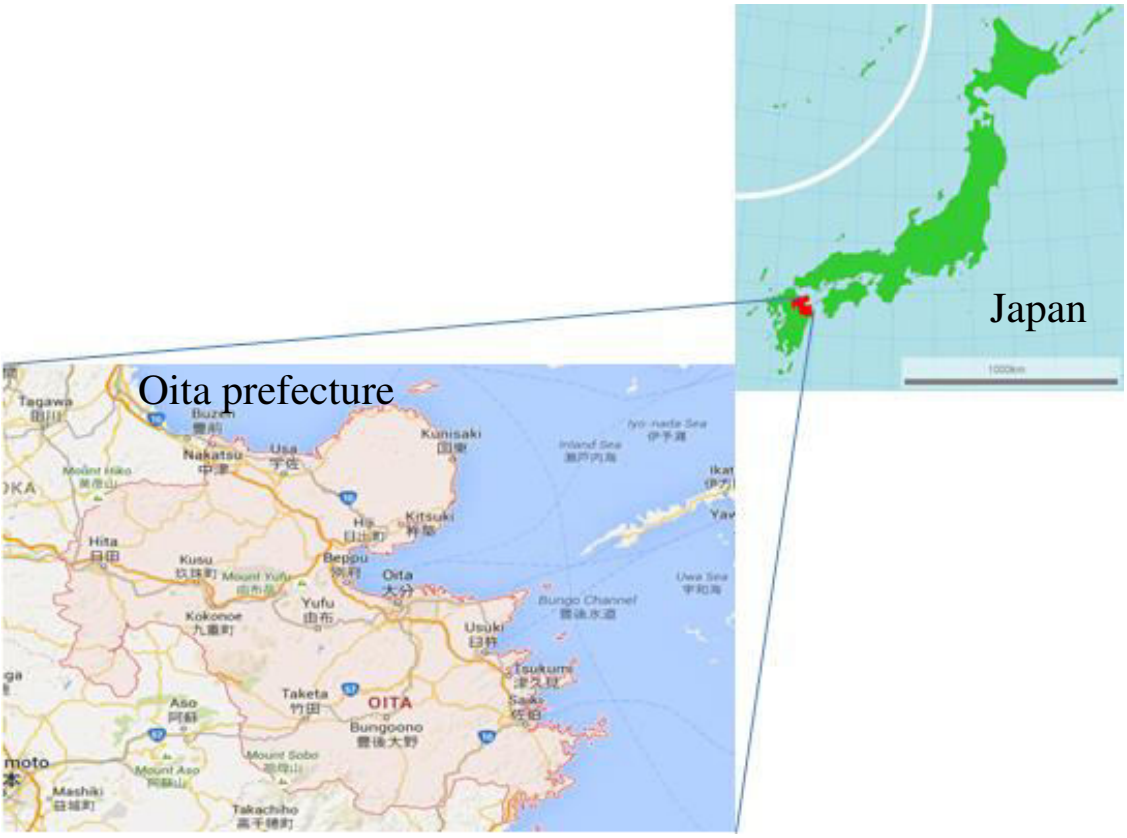


Figure 2: Map of Oita prefecture and Japan.
Source: Google Maps (2017)

Figure 2 shows the location of Oita prefecture in Japan, and its the capital Oita city. In Oita prefecture, about 70% of the land area is covered in forest (Oita city, n.d). The landscape includes the tallest mountain in the Kyushu region, Mount Kuju at the height of 1791 meters, and the largest active volcano, Mount Aso in the neighbouring prefecture of Kumamoto (Oita city, n.d). Oita prefecture is located over a fault line called the Median tectonic line, and it is also in the region of the Ryokyu arc, which resulted in the formation of the north eastern coast of the Kyushu island. Due to the surrounding geology, the region has a rich natural geothermal resource stemming from the fractures in the earth crust and rich ground water sources.

Oita prefecture is situated in the north-eastern region of the Kyushu Island in Japan. With the total land area of 6339km^2 encompassing 18 municipals cities, with the total population of 479,340. The capital city of Oita prefecture is Oita city, located near the central eastern coast of Oita prefecture, with almost 45%, or 214,361, of the prefecture's population living in that area (Oita city, 2015) The inland part of Oita region is covered with mountain ranges and water sources of rivers rich in minerals (Oita City, n.d.).

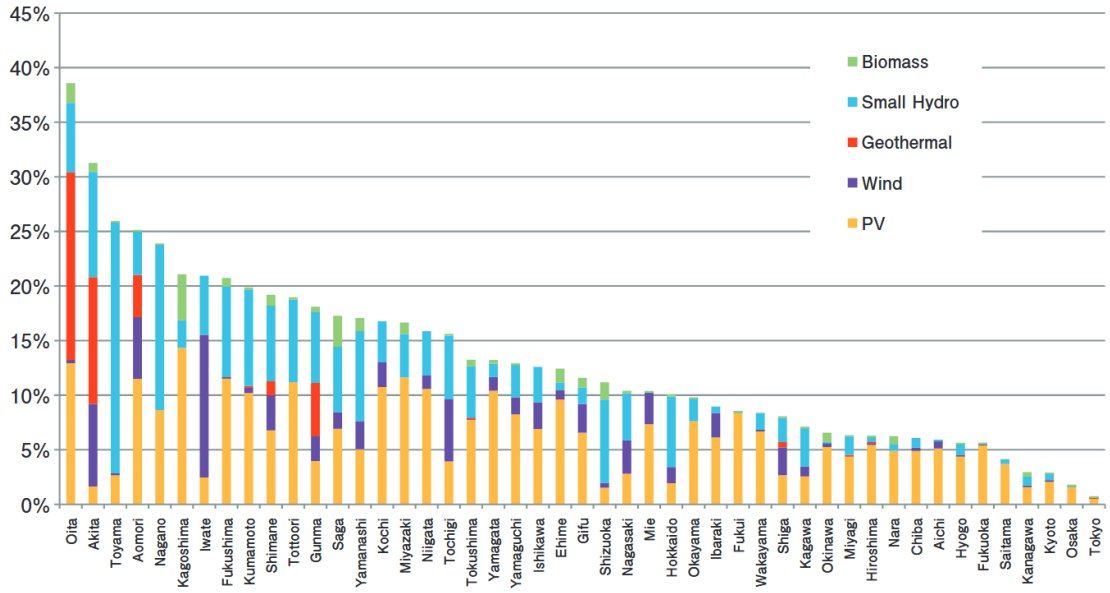


Figure 3: Share of renewable energy power generation in each prefecture of Japan as of 2014.
Source: Institute for Sustainable Energy Polices (ISEP) (2016)

Figure 3 shows the percentage of energy from renewable sources of each prefecture in Japan. Oita prefecture has the highest percentage of energy derived from renewable sources at about 39%, with geothermal accounting for approximately 17% of its total energy source, out of 47 prefectures in Japan (ISEP, 2014). The Geothermal Research Society of Japan [GRSJ] (2014) estimated that Japan is capable of a total geothermal generating capacity of 20,000MWe, or 140TWh in a year, to a depth of 3km. If fully utilised, this amounts to about 17% of the country's total energy needs, out of 1000TWh in a year, reducing the country's dependence on fossil fuels and nuclear energy. As part of the national goal to imrpove energy self sufficiency and security, regions like Oita prefecture seek to maximise the potential of their geothermal resource.

1.3 Beppu city and geothermal development

The location selected for the local study of geothermal developments and its social acceptance is Beppu city. Beppu city is the second largest city by population in Oita prefecture, it is home to a population of 118,988 residents in 2017 (Beppu city, 2017). The one of the geothermal related industry is the hot spring attractions and spas, with more than 80 spa locations within Beppu city area (Beppu city, 2017).. Geothermal energy is also used for study at research institutions, like the Institute for Geothermal Science of Kyoto University, and agricultural related activities, which includes the heating of greenhouse using geothermal energy. The hot springs spa facilities both directly serve the local population in their everyday usage and supply the local tourism facilities. In the city, where traditional homes do not have an individual bath and shower facility, most residents depend on the shared hot spring facilities for their hygiene, health and well-being. This cultural practice has allowed local residents to develop community bonds through the traditional ritualistic practice of communal bathing. Thus the preservation of the local ‘Onsen’ or hot spring spas is of importance for the residents as a community resource. Social acceptance study allows for clear understanging of the impacts of the introduction geothermal power in locals areas.

Table 1: List of installed geothermal power generation facilities in Beppu city

No	Named of facility	Installed location	Installed capcity (kW)	Type	Operational date
1	Kamenoi power plant	Osamu Tsurumi	11	TF	2014.11
2	Abe Department of Internal Medicine power plant	Honome	20	B	2015.01
3	Setouchi National Energy XLT power plant	Osamu Tsurumi	48	B	2013.01
4	KA Continue power plant	Osamu Tsurumi	48	B	2013.04
5	Minamitateshi power plant	Minamitateshi	49	B	2015.01
6	Tatara Daiichi power plant	Takenouchi	49	B	2014.07
7	Gotouen power plant	Minamitateshi	92	B	2014.01
8	Yuyama power plant	Yuyama	100	B	2014.10
9	Beppu Super Service power plant	Ogura	125	B	2014.09
10	Cosmotec Beppu power plant	Osamu Tsurumi	500	B	2014.11
11	Suginoi power plant	Kankaiji	1900	SF	2006.04

* SF - single flash system; TF - Triple flash system; B - Binary System
Source: Developed by author based on Ministry of Environment (2016)

The first geothermal power plant developed by Suginoi hotel group, Suginoi power plant, began operation on April 2006 in Beppu city. From **Table 1**, after the implementation of the Fit-In-Tariff system in Japan from 2012, there was an increase in the development of ten new geothermal facilities in the city. The installed generation capacity of the eleven facilities installed thus far, ranges from the 11kW Kamenoi power plant to 1.9MW Suginoi power plant (Beppu city, 2017). Based on the measurements from Google maps (2017), the facilities range from the surface land area of 250m² for the 11kW Kamenoi HGPS to 3200 m² for the 500kW Cosmotec HGPS.

There are two main types of geothermal power plants used in Beppu city area, the flash-type and binary-type. A flash-type plant utilises direct geothermal fluid extracted and 'flashed' in low pressure into geothermal steam to drive a turbine generator (Richardson, Addison and Lawson, 2014). During the 'flashing' process, fluid rapidly heats up and vapourises in to steam. In a single flash system like Suginoi power plant, the geothermal fluid is only flashed once and residual liquid is either reinjected into the ground water reservoir or used for direct purposes, e.g. hot spring spas. However, in a multi-flash system, similar to triple flash Kamenoi power plant, excess geothermal fluid from the first flash is then flash again at lower pressure to extract an even greater proportion of steam to drive the turbine (Richardson, Addison and Lawson, 2014). In Binary power plants, the system works on a heat transfer mechanism that uses a secondary separate fluid, of lower boiling point, to drive the turbine generator. In the binary system, the fluid is continuously recycled in a close loop system, while the external geothermal fluid is not use in the directly for driving the turbine (Richardson, Addison and Lawson, 2014). The advantages of the flash-type system over the binary system is there is no need for a secondary medium to drive the turbine. However, binary geothermal power plants are able to operate efficient at lower temperatures, <100°C, which makes it an attractive source of energy in low temperature geothermal wells.

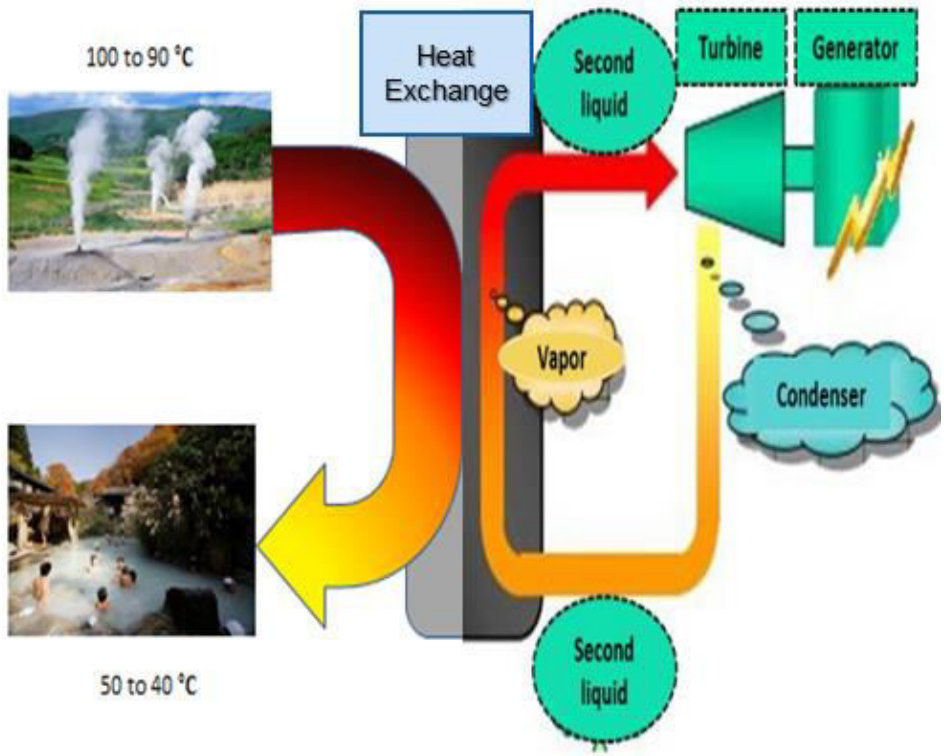


Image 1: Diagram of hot spring facilities with a conventional cooling system and binary hot spring geothermal systems used in Beppu city.
Source: developed by author based on reference by ISEP (2015).

The geothermal wells in beppu uses water extracted from underground to be use in hot springs facilities across the city. The nine of the eleven geothermal facilities in Beppu uses the modified binary plant system known as “Hotspring Geothermal Power Systems (HGPS)”. The facility utilises a small binary power generation that is connected to an existing source. **Image 1** shows the functions of the HGPS linked to a conventional system. Conventional hot spring facilities uses a cooling system to reduce the temperature of the water from around 100°C - 90°C to 50°C - 40°C so that it can safely be use for hot spring spas. The addition of the HGPS to the conventional cooling unit allows the otherwise unused or wasted heat from the cooling process to generate power, similar to geothermal binary power plants.

Table 2: Approved Hot spring geothermal power systems from 2017 August

No	Installation location	Developer
1	Beppu City Osamu Tsurumi	HTB Energy Co., Ltd.
2	Beppu City Osamu Tsurumi	Setouchi Natural Energy Co., Ltd.
3	Beppu City Osamu Tsurumi	Makino Shipping Co., Ltd.
4	Beppu City Osamu Tsurumi	(local individual owner)
5	Beppu City Osamu Tsurumi	GRACE CORPORATION
6	Beppu City Hall Sengyoishi	RUREVE CO., LTD.
7	Beppu City Osamu Tsurumi	PPSN Corporation
8	Beppu City Daikoku Iron Wheel	Tatsuida Construction Machinery
9	Beppu City Hall Sengyoishi	(local private group)
10	Beppu City Hall Sengyoishi	(local private group)
11	Beppu City Osamu Tsurumi	(local private group)

Source: developed by author based on Beppu city (2017)

In Beppu city there has been increasing investment into the power generation business for geothermal energy. From August 2017 there are 27 projects proposed by geothermal investors within the Beppu region. Eleven of those projects have been approved by the city government after preliminary consultation and surveillance with accordance to the city regulations of the development for geothermal energy generation. In order to accommodate the influx in the interest of HGPS in Beppu city, the local government introduced the “Ordinance of hot spring power generation for coexistence with the community of Beppu city”. Its main objective was to provide transparent and accessible information for local residents and potential HGPS investors. This includes the process of development, the type of projects, the locations of the projects and contact information. It provides monthly updates on the project approval status but it does not provide the information on the actual project developments.

Image 2: Conventional hot spring extraction, cooling and distribution facility without binary hot spring geothermal generation unit in Kanawa district, Beppu city
Source: Author

Image 3: Binary hot spring geothermal facility built alongside a conventional hot spring extraction, cooling and distribution unit at Miyamae onsen in Kanawa district of Beppu city
Source: Author

Image 2 is a geothermal well use for hot spring water extraction located in the Kanawa district in Beppu city. The ownership of the facility and its resources are broken down into 3 categories, (1) the ground water source, (2) the land owner and (3) the facility owner. The ground water source is under the national jurisdiction of water resource, where in this case the city, Beppu, has ownership to this resource. In order to use this resource, the interested parties bid for the rights for drilling and extraction of the hydrothermal resource (Beppu city, 2017). In most cases, the rights are bid by a group of local residents interested in using the resource, where they will pool their money and share the hydrothermal resource. In the case of land ownership, the site where the facility is located has to be owned by a private unit. In most cases, the site is on a location of an individual's property. The users sharing the drilling and extraction rights have to either pay for the rental of land for the facility or negotiate usage of hydrothermal extract with the land owner. Finally, the facility is owned, built and managed by local residents that also owned the drilling and extraction rights in the area.

Image 3 is the installation of a binary HGPS on a conventional hot spring extraction, cooling and distribution facility. This is system is gaining interest from investors in Beppu as there is no drilling required for extracting geothermal resource. Futhermore, Beppu city's abundance of geothermal wells provides investors the potential to negotiate with land and ground water rights user to develop geothermal power generation facilities. The increase of geothermal power installations within the city brings the issue of social acceptance of geothermal technologies among the people living there.

Chapter 2:

Research study of social acceptance for geothermal energy in Oita prefecture

2.1 Literature review

This section will provide the literature review on the current energy situation in Japan and its future plans, as well as the theory and frameworks used for the study of social acceptance

2.1.1 Current energy situation in Japan

Japan aims to increase its energy self-sufficiency to 24.3% in 2030 (METI, 2015). However, the country's energy self-sufficiency ratio has decline from 19.9% in 2010 to 6.0% in 2014 (METI, 2016). In order to satisfy the nation's energy demand, the country is looking to develop the three sectors in the energy industry, its renewable energy (RE) energy conservation/efficiency and conventional energy (ISEP, 2016). Growth in the renewable energy sector has been forecast at 14.4% in 2015, to grow to eventually 22.0%-24.0% for 2030 (METI, 2015). For energy conservation and efficiency sector, there is a greater focus on improving the efficiency of fossil fuel for power generation and power systems, rather than increase emphasis on renewable energy. Finally, despite the setbacks from the 2011 Great Eastern earthquake and Fukushima nuclear incident, there are plans to restore social trust for future development in nuclear energy (METI, 2015).

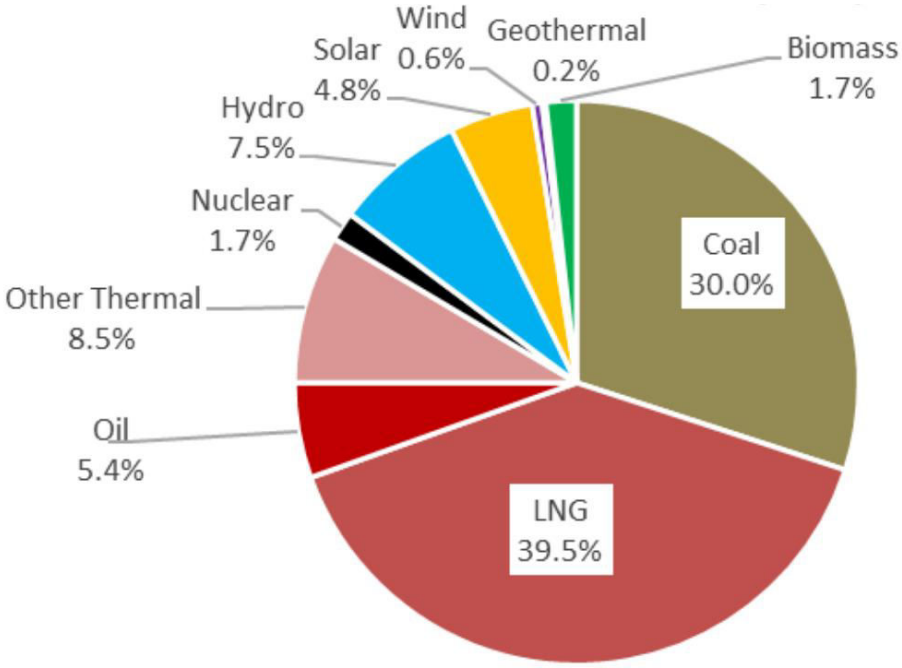


Figure 4: Japan's electricity energy mix for 2015
Source: Institute of Sustainable Policy (2016)

With increasing issues related to the use of conventional energy resources, and government policy aimed to restore the nuclear and fossil fuel energy sectors, the fate of Japan's renewable energy sector are at crossroads. Currently, Japan has to import around 88% of its energy in fossil fuels from other nations to meet its demand (METI, 2016). In the electric power sector, fossil fuels accounts for approximately 70% of the energy source (**Fig.4**). However, in the situation of scarcity of fossil fuels the increase in fossil fuels price may become an eventual economic burden on society, which will be negatively impact the nation as there are little or no alternatives to support the country's energy demand.

ISEP (2016) highlights that for renewable energy use (including geothermal energy) to become truly widespread, the current problems namely the ongoing environmental assessments, land-use zoning, obtaining social agreement and preparing

connections to the electrical system in the development of renewable energy projects has to be solved. Japan's current geothermal energy utilisation rate for electric power is at 0.2% (**Fig.**4). The country aims to increase this to 10% by 2030 (METI, 2016). ISEP (2016) states that for geothermal and mid-to small hydro power, getting consent from the local communities, land and water rights owners are vital issues and hurdle in order to further develop those energy sectors. Thus addressing the societal dynamics in renewable energy development is a vital factor for Japan's propagation of renewable energy.

Japan's renewable energy policies changed greatly after the March 11th Fukushima nuclear accident in 2011, but the renewable energy target for 2030 is only 24%, which is low compared to the targets of the European countries, from 30% to 40% (Huenteler et al, 2012). In the Basic Energy Plan decided in 2014, renewable energy was positioned as "a promising and diverse domestic energy source," and it was indicated that for three years after 2013, introductions would be accelerated to the largest extent possible. After that, from 2016 onwards, Japan will continue to actively promoted renewable energy sources. However, no mid-to long-term vision or targets were given. The overall policy was a basic coverage of the goal with no clear methods or measures to achieve this vision. The current nuclear power utilisation is almost zero (less than 1%), the energy mix in 2015 has achieved an overall lower national energy usage (8% reduction compared to 2010), renewable energy (increased to 14.4% from 10% in 2010) and fossil fuels (increased to 85% from 65% in 2010) (METI. 2015). Due to the decrease in nuclear energy usage, fossil fuels became the immediate substitute to meet the national energy demand. Geothermal energy may serve as a cleaner option that

has the potential as a better substitute for long term energy security with high and stable base loads.

Empirical studies on renewable energy technologies and GETs in Japan on the local level are increasingly being conducted in the aftermath of the 2011 Fukushima nuclear incident. These studies are focused on areas that can potentially develop their renewable energy and geothermal resource for electricity generation. Studies include the participatory role of community in energy use and development by Yamamoto (2016) which addresses the importance for identify the best organizational models for the proliferation renewable energy technology into society. The studies were conducted through social research methodologies like surveys and comparative sampling. Similarly, an area based study of Izu-Oshima Island in Japan by Shibata et.al. (2016) surveyed and interview the local lodging business owners on their perception of geothermal development for energy production on the off grid island. They observed that the lack of knowledge of GETs amongst the local hot spring spa business owners as the biggest barriers in the expansion of the geothermal energy sector. However, there are limited analyses into the theoretical framework from the local to regional to national level in terms of the relationship effects. As well as the deeper psychological factors such as their political beliefs, environmental awareness, place attachment and levels of trust between the social actors (Devine-Wright, 2007). This study illustrates that in order to achieve greater public beliefs and responses to specific technologies, users have to be continuously supported throughout the utilisation phase, rather than a one-off information session.

In the 2015 to 2016 Paris agreement (COP21) on climate change, Nations around the world have begun to set new goals on CO^2 emissions. This brings increasing pressure from the international community on developed nations to start shifting their energy mix towards, renewable sources of energy. Japan has no fossil fuel or nuclear energy sources, which results in the higher dependence on foreign for energy resources. Furthermore, Japan is an island lock country with no nearby nations to directly support its electrical energy sector for immediate demand. Unlike Japan, the European nations have trans-boundary grid dynamics which allows for electricity transmission across nations to ease or support other countries in need of energy. This furthers the need for Japan to ensure that it has a stable and secure energy mix to support the nation. Geothermal energy offers the advantage of clean and cheaper electricity production compared to conventional sources. One of the challenges faced in the implementation of geothermal power generation plants is from the societal aspect. Citizen's power within the nation can either create a shift towards expansion or abolishment of the renewable energy sector in Japan. This study aims to grasp the local consensus towards geothermal development, to better understand how the society, along with the economic, political and environmental factors, play out in the dynamics of energy security for Oita prefecture. Studies of other regions facing similar obstacles in introducing can apply similar methods in this thesis to developed their local resources and create opportunities for other renewable energy developments.

2.1.2 Social acceptance of renewable technologies

The term social or public acceptance used in the context of energy technology is noted by Devine (2007) as a necessary condition for technology development, and a degree of diffusion relating to the psychological processes shaping public perceptions. Social acceptance portarys responses from the public's viewpoint, which are then addressed by key stakeholders, including government, industry and private organisations (Devine, 2007). This forms the basis for interactions between the relevant actors to help develop better policies and practices for those renewable technologies. Oltra, Boso and Prades (2014) defined social acceptance in energy technologies as "The favourable or positive reaction towards the implementation or adoption of a proposed technology by the members (individuals and collective actors) of a given society (country or region, community or town and household)". In narrowing the fields to specifically identify actors and drivers, there emerges a challenge to classify the various contexts into a comprehensive concept when identifying the different levels and drivers of social acceptance (Upham et al. 2015).

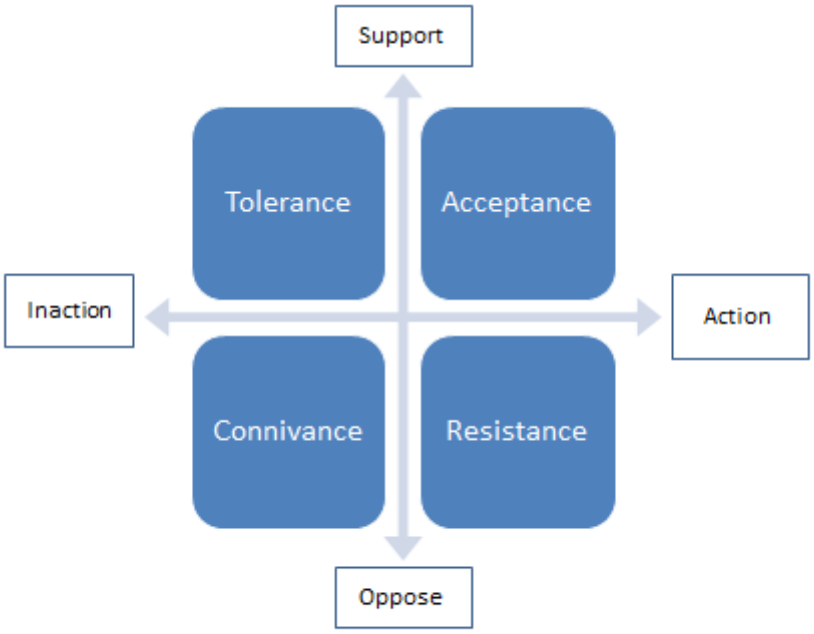


Figure 5: The four general types of behaviours towards new technology
Source: Developed by author based on Deathloff (2004)

In the field of psychology, *acceptance* is defined as the behaviour towards new technologies and attitude or responses towards these behaviours (Huijts, Molin and Steg, 2011). Huijts et.al (2011) notes that these behaviours are the reflections of acceptance that enables or promotes the use of technology, rather than showing resistance or inhibition towards its ultilisation. Behaviours of support can be noted in verbal proclamations of the benefits of the technology or investing in the technology. On the other hand, behaviours of resistance can be conveyed by protesting the usage and refusal to pay for the technology (Huijts et.al, 2011). Deathloff (2004) further defines the concept of people's behaviours in four different categories (**Fig.5**). *Acceptance* reflects behaviours that actively support the use of technology, while *resistance* indicates behaviours that actively oppose its implementation. In *Tolerance,* people exhibit behaviours that are in favour but they do not take any action to either support or

oppose it, whereas in *connivance* people opposes the technology and do not take any action against it.

Table 3: The cross-paradigmatic analysis of social acceptances

Actor Group		Level		
		General	Regional	End user
	Political	National acceptance	Local political acceptance	User acceptance
	Private	Stakeholder acceptance	Local stakeholder acceptance	Stakeholder acceptance
	Public	Public acceptance	Local public acceptance	Consumer acceptance

Source: Based on Upham et al, 2015

Due to the extensive nature of the social acceptance covering various areas, including economy, environment, political and technological, the challenge to conceptualise the full system is a hurdle to overcome (Painuly, 2001). Upham et al. (2015) devised an operational definition for social acceptance of energy related technologies. They are focused on three levels, (a) Macro level; national and general, (b) Meso level; regional and community, (c) Micro level; individual entity. This level are the objects of the RE applications. The three levels can be further differentiated into the (1) Public stakeholder (2) Non-political stakeholders and (3) Political stakeholders. This structure can be studied from the behavioural, cognitive and attitudinal acceptance

to allow applications into studies of infrastructure, technology application, willingness-to-pay and public-private sphere behaviour (Upham et al, 2015). With the application of an adaptive conceptual framework (**Table. 3**) different analytical perspectives can be integrated to develop a more focused perspective while engaging in an interdisciplinary approach towards the study of social acceptance phenomenon.

Using Upham's 'Cross-paradigmatic analysis of social acceptance' into geothermal energy in Oita prefecture, this paper is able to identify the relevant actor groups in the different levels. The framework is integrated into a pyramidal unit (**Fig. 6**) to analyse the different levels of the actor groups and their impacts towards geothermal utilisation in Oita prefecture

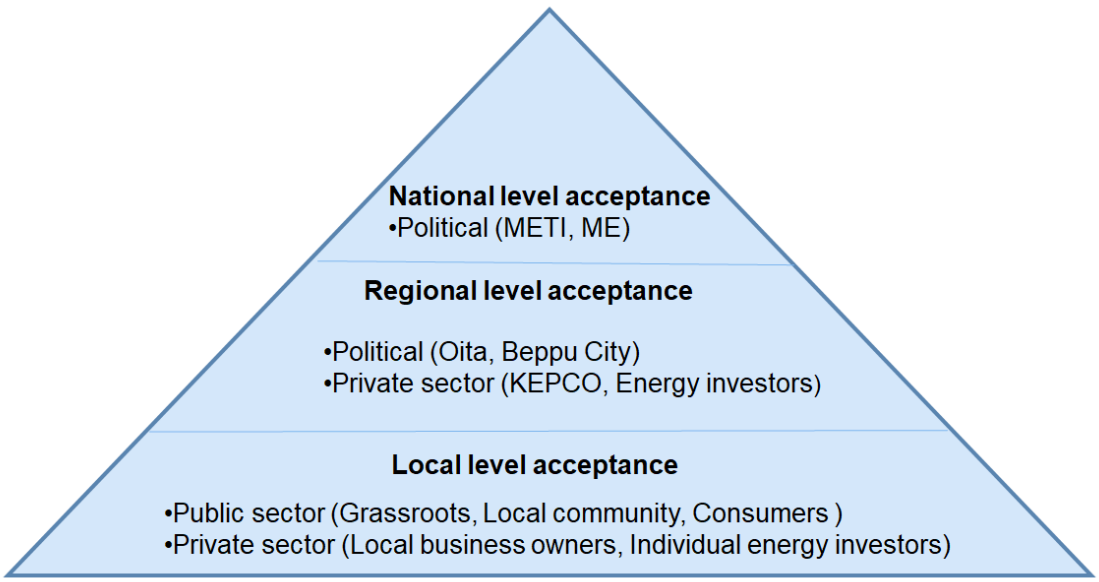


Figure 6: Cross-paradigmatic framework of Social Acceptance for Oita prefecture
Source: Developed by author based on Upham et al, 2015

Another academic literature used to analyse social acceptance of renewable energy as a multi-facet socio technical model is theorised by (Wüstenhagen, Wolsink and Bürer, 2007). This model is known as the 'triangle of social acceptance of renewable energy innovation'. It integrates three dimensions of social acceptance in society, (1) Community acceptance, (2) Market acceptance and (3) Socio-politcal acceptance.

Community acceptance focuses on the factor of fairness, and how community members perceived actions to be justifiable when developing renewable energy. Issues that are viewed as important by the general public are related to visual, health, safety and project decision making in the implementation of new technology (Devine-Wright, 2005). For renewable technologies to exist in communities there has to be support from the community in these aspects. The implication of the national energy policies and regional planning has direct impacts on community acceptance, which provides an opportunity for research into the current system, as well as the importance of having the right and transparent policies. This framework considers the three dimensions through a consistent link in society at the local level to analyse data of areas on a city and regional scale.

The Market acceptance dimension explores the business aspect of renewable energy development. The main influences of Market acceptance are more prominent in the early adopters of the technology (Rogers, 2003). Often new renewable energy enterprises faces the greatest hurdle when first introduced to the market. With lower

levels of understanding of the new technologies among the community, businesses may have a greater difficulty in bringing in new innovations. This aspect of studying new entrants to geothermal energy in Oita prefecture allows for the analyses of the trends and hurdles when developing new power generation in society.

The Socio-political acceptance dimension focuses on the level of social support along with the level of commitment among the political actors (Wüstenhagen, Wolsink and Bürer, 2007). A high socio-political acceptance emphasizes on the societal and political support of new renewable energy technologies. When introducing renewable technologies to society, the political sector either makes or breaks the technology's position in the community. For support among society, government actors are responsible in implementing effective policies and regular modifications of the old policies to establish a social institution that supports the growth of new renewable technologies. The Fit-In-Tariff system is one measure to incentivize the use of renewable energy. However, without constant regulation of policies on the societal, economic and environmental aspect of its development, there can be undesirable impacts on the region and the energy source.

Similar studies on the topic of social acceptance of geothermal energy includes a study in Indonesia focusing on regions with direct geothermal applications by Shoedarto et al. (2016). Shoedarto et al. (2016), also uses the 'triangle of social acceptance of renewable energy innovation' by Wüstenhagen, Wolsink and Bürer (2007) as the basis of developing the social acceptance study in locations within Indonesia with direct geothermal utilizations. The study concludes that the importance of raising public

acceptance is vital for the promotion of geothermal utilisation as an economically viable, sustainable and environmentally friendlyenergy source (Shoedarto et al. 2016). The Author also mentions that the importance of cultivating strong fondness for thermal water may help to reduce social conflicts when developing geothermal power plants in certain areas (Shoedarto et al. 2016).

2.2 Methodology

This section covers the research objectives, research questions, chapter overviews, data collection and analysis methods.

2.2.1 Research Objectives

The research is conducted to understand the following objectives and how they are related to the social aspect of geothermal development. It uses a mixed method approach to analyse Oita prefecture's direction in geothermal energy utilisation with the modified framework developed from (Wüstenhagen et al, 2007; Upham et al, 2015). The objectives of this research are:

- To examine the perceptions and attitudes of society towards geothermal power generation projects in Oita prefecture.
- To examine the role of the different level actor groups, national, regional and local on geothermal power generation in Japan.

2.2.2 Research Questions

The research questions developed are aimed at addressing the objectives of the research.

- How is/will the current/future of geothermal technologies contribute to Oita prefecture?
- What are the factors hindering the growth of the geothermal energy sector in Oita

prefecture?

- What are the negative impacts faced by the people with the implementation of geothermal technology?
- What are the levels of commitments of the people who are affected by the development?
- What is the level of public knowledge and understanding in their local geothermal development?
- How are the social relations/bonds dynamics between the various actor groups affecting geothermal energy development in Oita prefecture?
- What are the push and pull factors in society for geothermal energy development?
- What are the various social issues link to environment, economy and policy that are detrimental towards the sustainable development in Oita prefecture?
- How and what factors are relevant in developing a framework for geothermal expansion and development in Japan?
- How this can be apply for other regions seeking to develop towards an environmentally sustainable future

2.2.3 Chapter summary

This section covers the rationality of the methods utilised for this research, and the results obtained along with its applications. The data collected will initially be highlighted in this segment, with further reference and discussions to this material in subsequent segments of the thesis paper. This thesis will conclude with the limitations

and implications of the research process.

The thesis paper follows the structure of analysing the social acceptance based on the region of study. The importance of public acceptance is noted in the proliferation of renewable energy technologies and meeting the targets of energy policy (Devine-Wright, 2007). On the study of sustainable consumption, Spaargaren (2003) highlights the human interactions and actions are based on their past experience, situational context, future perceptions and place. This research develops its structure from the social science view to allow non-bias analyses of the interactions and responses from individual actor groups in the development of the geothermal energy sector, along with feedbacks between the various actor groups. Identifying and analysing the actual and potential situation within the selected social strata allows exploration for new routes to better innovation, while provisioning the community and ensuring a quality life for its consumers (Spaargaren, 2003). One of the aims is to find out potential development goals based on the data of the ongoing and past situations for a more sustainable utilisation of geothermal resource in the region.

This research will comprise of primary sources from interviews of the relevant individuals, institutions and organisations in geothermal as well as the energy sector. The analysis of the findings from the primary sources will be mainly constructed from quantitative methods that focus on the survey of social perceptions on the local level. Qualitative data methods are obtained from interviews of the relevant experts from political and private sectors in the local and regional level. Data from secondary sources include books, journal articles, conference papers, newspapers, government publication

and internet sources. This will make up for the bulk of reference for the national and international level, as well as parallel investigations for the primary sources. As the research thesis covers Japan countries, there are two main languages of sources, Japanese and English. All written text that is not in English will either be translated or provided with a transcribed translation.

Chapter one covers the induction of this paper and the area of study. It explains the basics of geothermal systems and its relevance in Japan. The other section introduces the area and region selected Beppu city and Oita prefecture, as well as the type of technology involved in the development of the geothermal sector in Japan.

In chapter two, the literature review and methodology of this thesis will be explained. First, it highlights the current energy situation in Japan and its plans for the future, as well as how geothermal energy can gain social acceptance for its technology and for it to be a solution to improve Japan's energy self-sufficiency. Lastly, it elaborates on the objectives and questions of this study, and identifies the research methods used for this thesis.

The third chapter focus on the data findings and presentation from the results of the survey and interviews the research. It will provide the rationality for the methods of surveying used as well as the in-depth analysis for each question and its development process. For the first portion of the survey analysis, the paper will follow the method conceived by Trochim et al (2016) using descriptive statistics in as a tool to provide the summary of the data and describing the immediate results.

Chapter four will focus on the analyzing of both the data from the survey and interview along with the literature review. The first step will be to directly interprete the data obtained from the research . The next step will be to infer from the sample data of the population consensus obtained from the survey results. This is done by analyzing the connections between the literature and descriptive statistics for conclusions. It will be followed by the analysis of the interviews; qualitative analysis in social science by Creswell (1998) will be use to find the relationship between theory and data. This is done by conceptualizing the data to explain the social phenomenon in the region.

The final (five) chapter serves as the conclusion for this paper by providing the final summary of results and limitations of the findings. Finally, concluding with the possible solutions to the research questions and the future of geothermal energy in Oita prefecture and other parts of Japan.

The area of study for thesis is focus on Oita prefecture and Beppu city. All Units and statistics are converted to the International system of units (S.I Units), and currency used will be converted to Japanese Yen for ease of reference as the place of origin of this paper.

2.2.4 Data collection

This paper derives its primary data from two sources, quantitative surveys and qualitative semi-structured interviews, as well as secondary sources of published materials. This section aims to provide the thought process for the methods used for the theses.

2.2.3.1 Surveys

Research investigating the social acceptance of geothermal energy uses survey data to analyse individual and society motivations based on their experiences in the use of geothermal energy (Kubota, 2015; Moula et al, 2013; Rogers et al. 2008 and Zoellner et al, 2008). Local level surveys are conducted aiming to provide a summary of the region, which will be analyses using methods of *descriptive statistics in social science* (Trochim et al 2016). This includes the direct description of the results of the survey. The second portion will involve *inferential statistics in social science*, which will provide the connections between the statistics to derive probable conclusions (Trochim et al 2016). Evaluating renewable energy technologies to identify the degree of suitability in the social context is dependent on a variety of criteria (Southerton, Mcmeekin and Evans, 2011). Southerton et al (2011) notes that even though some criteria used to study respondents may appear successful in some cases, it may be less effective among other situations giving different and less consistent results. This survey includes 17 questions to provide data for the research on social acceptance. This research data can be linked with the demographic and the individual perceptions of geothermal energy in Oita prefecture. Areas that are considered for quantitative analysis

in society include the community's knowledge, perceptions, awareness and commitment. This includes understanding the respondent's knowledge on geothermal energy systems in their region, perceptions of the various types of power sources, awareness of geothermal developments in their region, price perception and the knowledge of the stakeholders involved in geothermal developments. The surveys are conducted on a randomly selected individuals living in Oita prefecture. Printed questionaires were distributed at places frequent by local resisdents around Beppu city. The respondants are initially told of the purpose of the study relating to the issue of social acceptance of geothermal utilisation in Oita and the assurance of confidentiality, they are then given the choice to partake in the questionair survey. The statistics of the sample studied is intended to compare and represent the demographic region within Oita prefecture.

2.2.3.2 Interviews

To gain a greater degree and depth of perceptions, this research aims has interviewed relevant stakeholder groups involve or affected by the development of geothermal energy systems for power generation. Semi-structured interview of general and connected topics of geothermal development were used to explain the issues and perceptions with relation to their roles in the society (Rogers et al. 2008). The groups and representatives involved in the interview study are (1) the regional government, (2) the regional utility company, (3) a land rights owner, (4) a private geothermal investor, (5) a local water user and (6) a private business owner using geothermal energy. Qualitative analysis is used to identify the relationship between the established theories and data of the interviews (Creswell, 1998). The groups and individuals interviews are conducted on a face-to-face basis with semi-structure and open-ended questions

pertaining to the representative's field. This data is use to conceptualize and explain the phenomenon of the occurrences in geothermal developments.

2.2.4 Secondary data

Data collected from publish and external source are used in this these to support of the findings from the raw data. Triangulation with external documents and government reports is used to analyses the assertions of both the survey and interview data (Rogers et al, 2008). The data are collected from governmental reports, annual policy reviews and academic sources, including books and journals. Secondary sources are intended to fill in the gaps as well as linking the primary data of the surveys and interviews. It provides the information needed to support and developed the research thesis.

Chapter 3:

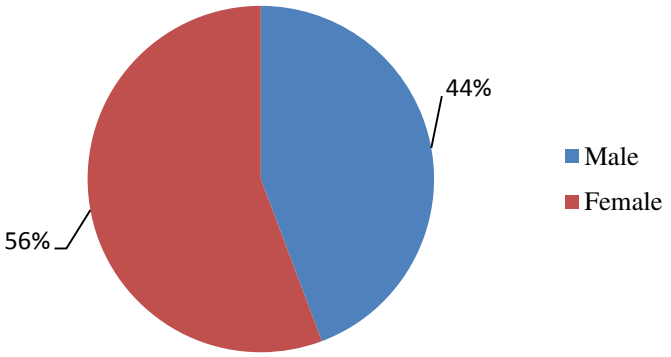
Findings and analysis of geothermal energy in Oita prefecture

3.1 Survey results

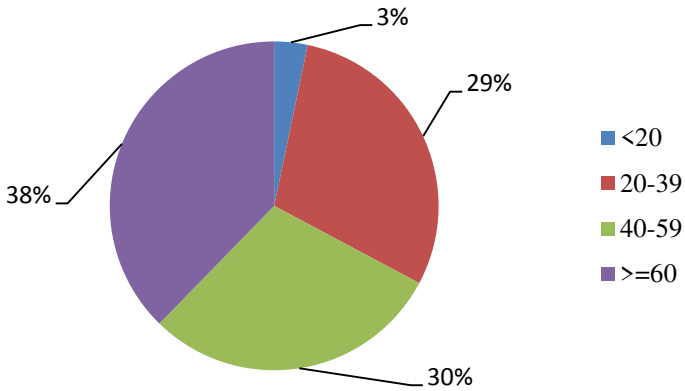
This section covers the results of the survey conducted on 61 respondents in Oita prefecture. It aims to provide insight into the local level public perceptions on geothermal energy in the region. The areas covered will include the 'Background information of the interviewees' which includes their age group, gender and city of resisdence. The second section will be on the 'Knowledge on climate change and geothermal energy' which asked about their thoughts on climate change, knowledge of geothermal energy for power generation and hot spring geothermal power generation. The third section will be on the 'Perceptions of local energy sources' which focuses on respondant's perception on their stance on geothermal energy compared to other sources of power, solar and fossil fuels. It also finds out about their concerns related to geothermal power generation. The fourth section addresses the 'Awareness of local geothermal power generation' by finding out whether respondants know about the existence of geothermal plants in their cities. The fifth section finds out the 'public peception of stakeholders', by understanding who they percieved should be responsible for the development of geothermal power plants. The last section focuses on the 'price perception and willingness-to-pay' for geothermal power and their image of geothermal sourced power compared with fossil fuel power.

3.1.1 Background information of interviewees

1. The gender of the interviewees



2. The age group of the interviewees



3. The location of the interviewees

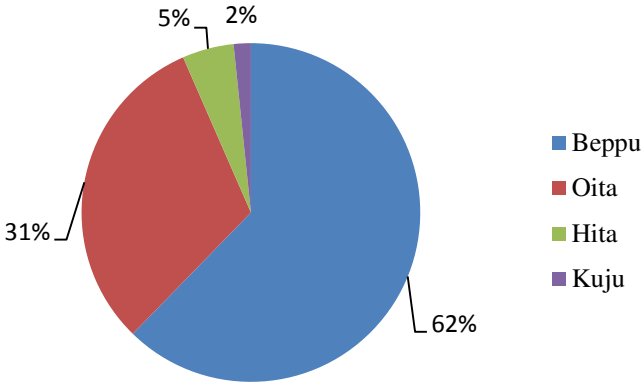


Figure 7: Information of interviewees.
Source: Author

The information from the first part of the survey in **Figure 7** identifies the general demography of participants selected in this study. These background information intents to illustrate the respondents gender, age group and area of residence. There are 44% male to 56% female respondents. The age breakdown of the respondents are 3%, from 20 years old and below, 30%, between the age of 20 to 39 years old, 30%, between the age of 40 to 59 years old, and 38% more than 60 years old. The respondents are from four cities in Oita prefecture, Beppu city, 62%; Oita city, 31%; Hita city, 5%; Kuju, 2%.

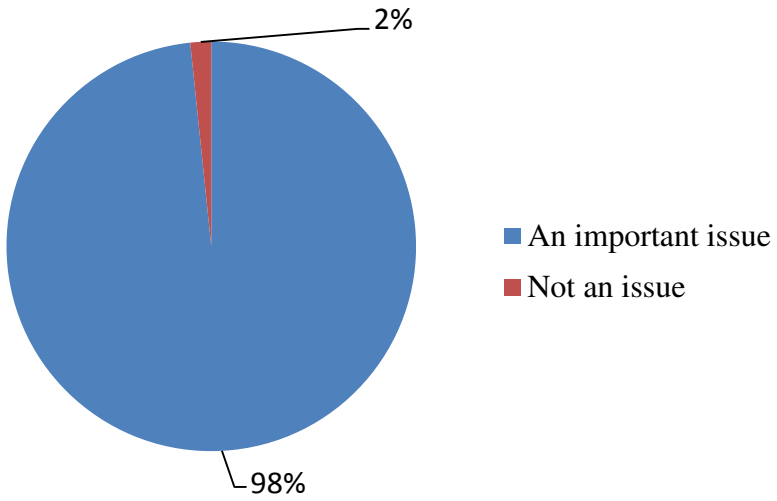
3.1.2 Knowledge on climate change and geothermal energy

This section provides data on questions relating to the general awareness to towards the concept of climate change and global warming. This set of questions provides the opportunity to introduce the concepts and geothermal power generation to the respondents. It helps to understand the respondent's level of knowledge in these areas. When asked about their impression of climate change and global warming (**Fig.8**), 98% of the respondents think that it is an important issue, while 2% thinks it is not an important issue. This suggest that people are generally aware of the issue. Thus, this provides an avenue for stakeholder parties, investors and government organizations, to integrate climate change and global warming alleviation information to geothermal development, for the promotion of geothermal energy.

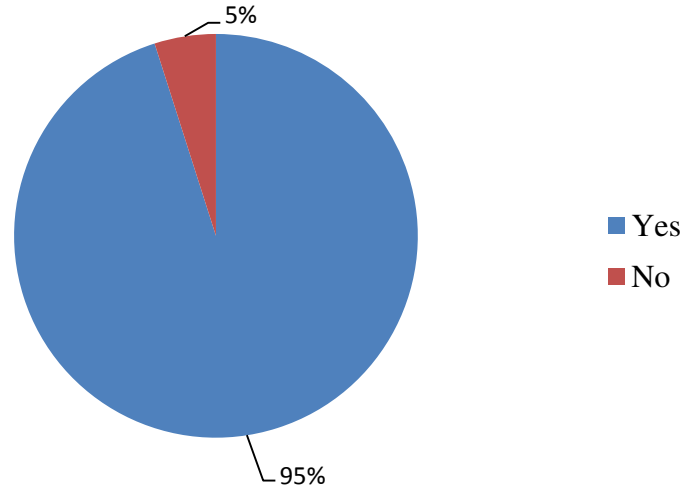
The second and third question from **Figure 8** focuses on the respondent's knowledge related to geothermal power generations. The second question focuses on the

general use for geothermal energy for thermal and electric generation. 95% of the respondents are aware of these technologies in one form or another, while 5% of the respondents are unaware of such uses. The third question takes a step further to find out the respondents knowledge on the recent development, noted in section 3.1, of the hot spring geothermal power systems (HGPS). This time the number of respondents that are aware of the technology is 36%. On the other hand 64%, of the respondents are unaware of this technology. The comparison of knowledge between conventional use of geothermal energy, from question two at 95%, and HGPS, 36%, highlights the gaps in common knowledge of the local power generation system. This provides opportunities for both investors and regional government to promote HGPS.

1. What do you think about climate change and global warming?



2. Do you know about geothermal energy for thermal and electric generation?



3. Do you know about hot spring geothermal energy for thermal and electric generation?

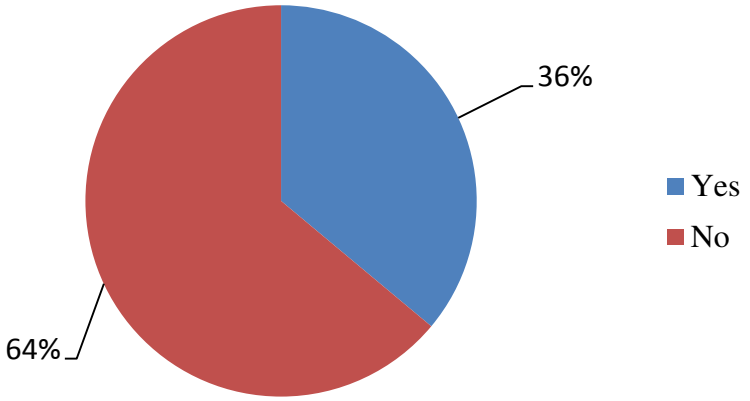


Figure 8: Knowledge on climate change and geothermal energy.
Source: Author

3.1.3 Perceptions of local energy source

This section tackle questions framed to better understand the respondents perception towards 'geothermal energy' as a source of power, and their stance for the proximity of their residences. Question one provides insight on the respondent's perception of geothermal energy being a 'reliable' source of renewable energy in the region (**Fig.9**). 84% of the respondents agreed that geothermal energy is a reliable source of energy. On the other hand, 2% of the respondents do not agree with the statement on its reliability, while 15% took a neutral stance, neither agreeing nor disagreeing with that statement. With geothermal energy supplying 17% of the prefecture's electricity needs, Oita prefecture has the highest geothermal energy utilisation rate in Japan (ISEP, 2014). It may be an attributing factor towards the trust in geothermal energy as a reliable energy source.

Question 2 aims to draw the respondent's attention towards the possibility of a geothermal energy source within their district, city or town (**Fig. 9**). This is finds out the respondent's stance of having a geothermal generation facility as part of their neighbourhood installation. The majority of respondents are undecided, 51% in this situation, with 36% answering 'yes' and 13% answering 'no'.

The third, fourth and fifth question aims to compare the respondent's stance between three different source of power, geothermal, solar and conventional fossil fuel power generation (**Fig. 9**). Geothermal energy has the highest percentage of supporters

at 56%, followed by solar with 49%, and conventional fossil fuel with the lowest at 10%. In terms of percentage of respondents against the type of power source, conventional fossil fuel is the highest at 51%, followed by solar at 18% and geothermal at 7%. The percentage of undecided respondents are generally the close with the highest for conventional fossil fuels at 39%, and closely followed by geothermal at 38% and solar at 33%.

Question 2 and 3 from **Figure 9**, is the position the respondents are in. In Question 2, respondents are in a theoretical situation where there has no plans to build a geothermal plants. While in Question 3, respondents are placed in a theoretical situation where they have to make a decision on whether to support, oppose or remain neutral towards a construction of a power plant. The number of respondents supporting increases from 36% to 56% when placed in a situation where the construction is decided. There is no definite reason for its increase; however it could be link to the higher trust levels the people have for the regional government who are the authorities for approving geothermal construction. This helps to provide a clearer comparison of the difference in respondent's position between the planned utilisation of a geothermal plant and the possibility of actually having one in their 'backyard'.

Question six focuses on respondent's perceptions of issues pertaining to their concerns of having a geothermal facility (**Fig. 9**). Safety is the highest concern amongst residents with 29 respondents, followed by noise pollution at 26 respondents, and the impact of environment and local hot springs with 17 respondents each. This information can provide both business investors and regional government to look into measures to

assure residents by promoting safety and methods to reduce noise emissions.

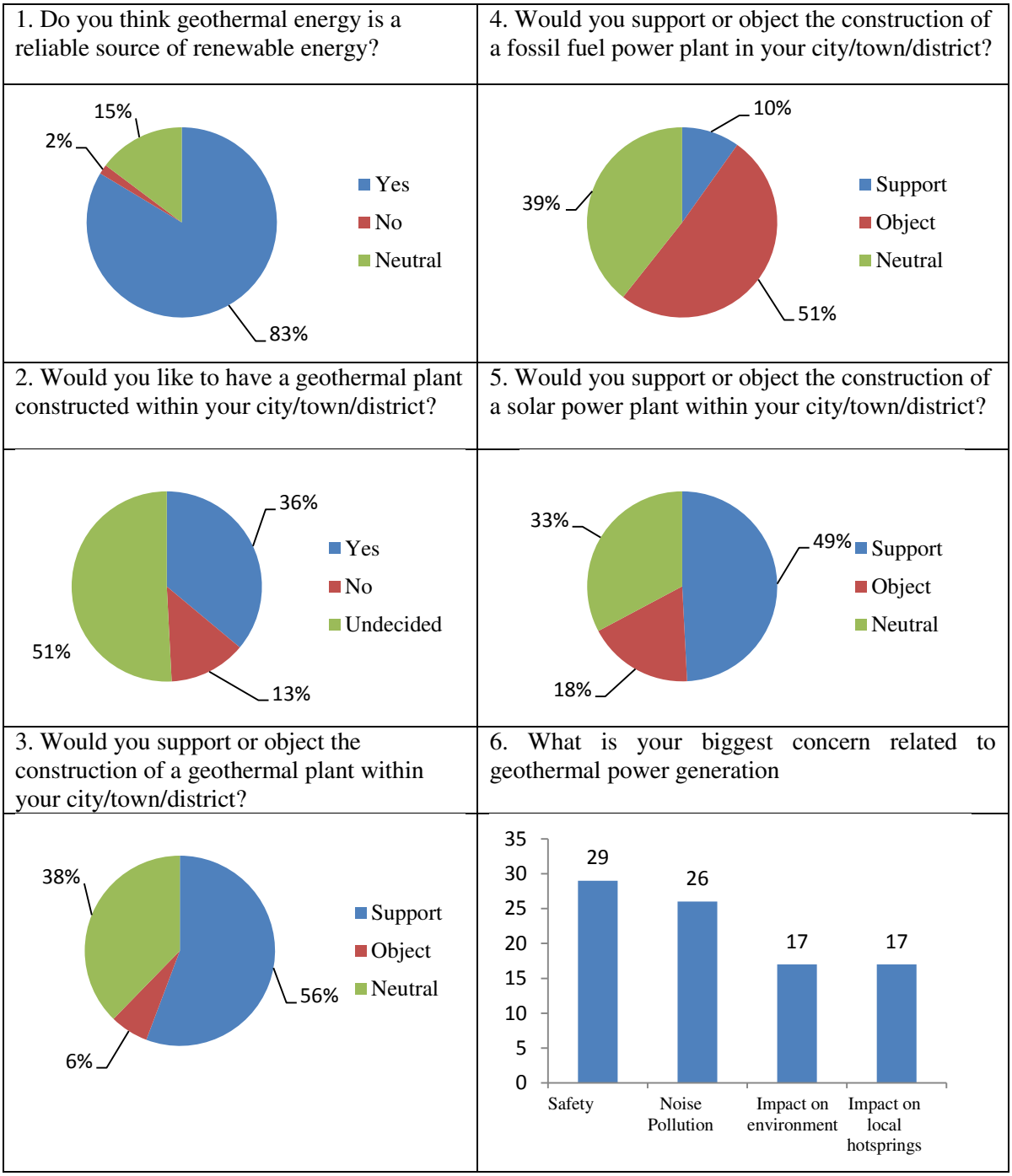


Figure 9: Perceptions of local energy source.
Source: Author

3.1.4 Awareness of local geothermal energy utilisation

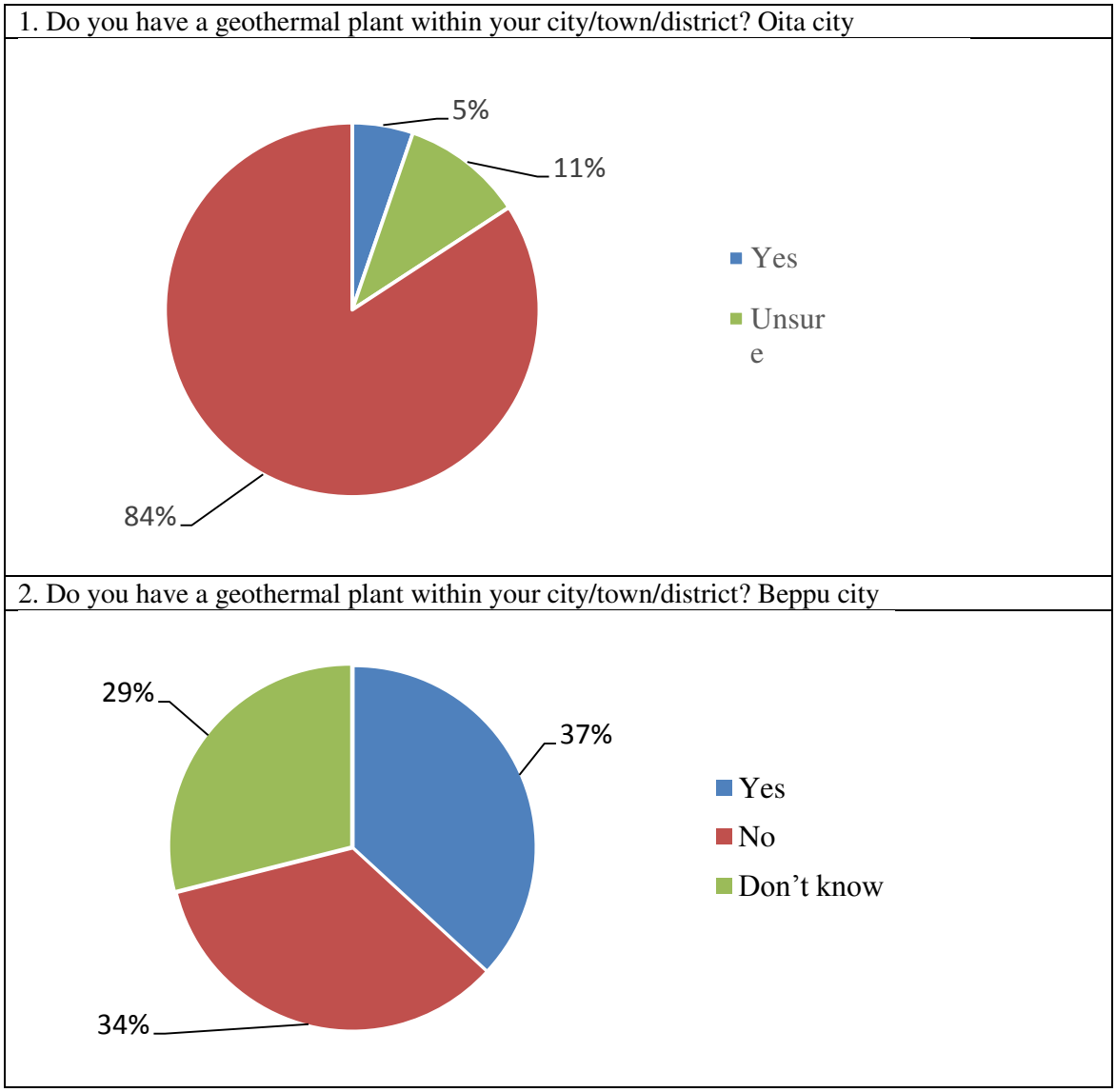


Figure 10: Awareness of local geothermal energy utilisation.
Source: Author

Question one and two address the respondent's awareness of their city's geothermal infrastructure (**Fig. 10**). This question is use to test whether the respondents know if that there is a geothermal plant in their city. Within the city of Oita there are no geothermal power plants, whereas in Beppu city there are 11 geothermal power plants

(Beppu city, 2017).

The responses from Oita city shows that 84% of the respondents know that there is no geothermal facility in their city, while 5% wrongly stated 'Yes' and 11% were unsure. On the other hand, the responses from Beppu shows that 37% of the respondents know that there are geothermal facilities within their city, while 34% wrongly stated 'No' and 29% were unsure. The results shows that more people are unaware of whether there is an existence of a geothermal facility within their city in Beppu city compared with Oita City.

3.1.5 Stakeholders of geothermal power generation

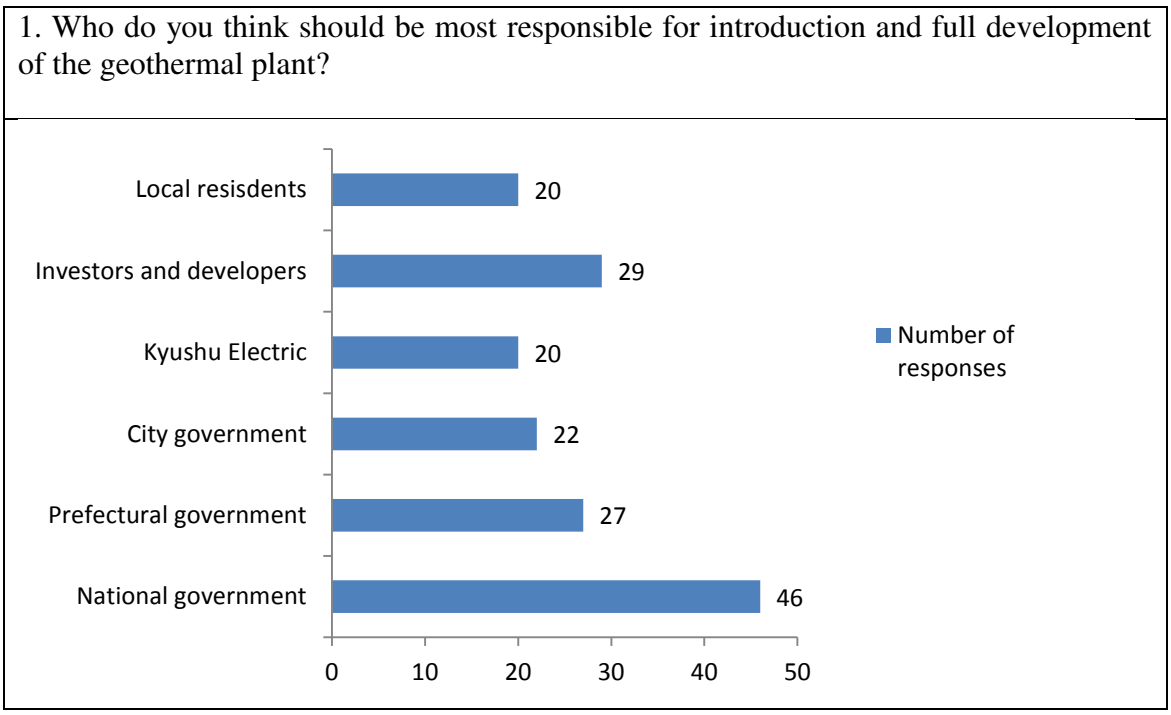


Figure 11: Stakeholders of geothermal power generation.
Source: Author

In this section, F**igure 11** shows the responses of the question about who the interviewees perceive to be the stakeholder most responsible for the full life cycle of the geothermal facility. The largest number of responses, 46, stated that the 'National government' should be responsible for the development of geothermal facilities. The National government refers to the Ministry of Economy, Trade and Industry, the Ministry of Environment and its division within the ministry, followed by the 'Investors and developers', 'Prefectural government' and 'City government' at 29, 27 and 22 respondents respectively. The Investors and developers refer to the private groups interested in building the geothermal facility. And the prefectural government is Oita prefecture's government. Local residents and Kyushu Electric are considered by the public as least responsible for the geothermal plant. By understanding the public's perception on the various stakeholder groups' responsibility, the relevant groups can develop more concrete materials to educate the public on their responsibility on stages of the project that they are involved. This information can also be helpful for the people to seek avenues to learn more about the geothermal developments within their city.

3.1.6 Price perception and willingness-to-pay

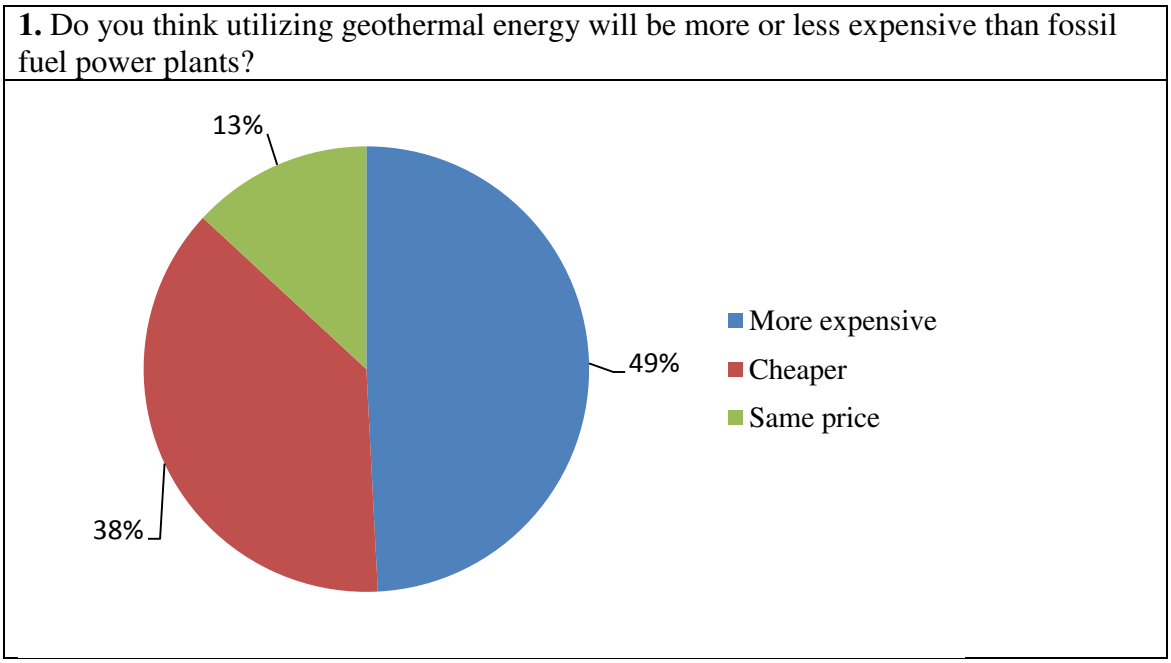


Figure 12: Price perception of geothermal energy.
Source: Author

Question one (**Fig.12**) focuses on understanding the respondent's price perception for generating electricity between two sources of energy geothermal and conventional fossil fuel power. In Japan, the cost of 1 kWh of energy generated from geothermal power is ranged from 9.2 yen/kWh to 11.6 yen/kWh, while fossil fuel power is priced at a static 9.5 yen/kWh (METI, 2014). Based on the responses, 49% of the respondents believe that geothermal energy is more expensive to use, while 38% thinks that it is cheaper and 13% thinking that the price is the same. This question provides a big picture on the public's perception on the price of geothermal power generation. As the technology for geothermal systems improves, the cost of geothermal systems may decrease below the cost of conventional fossil fuel power generation. Investors and government can use the information to provide the public with materials on the price for

electricity generated from different sources to help to promote geothermal energy.

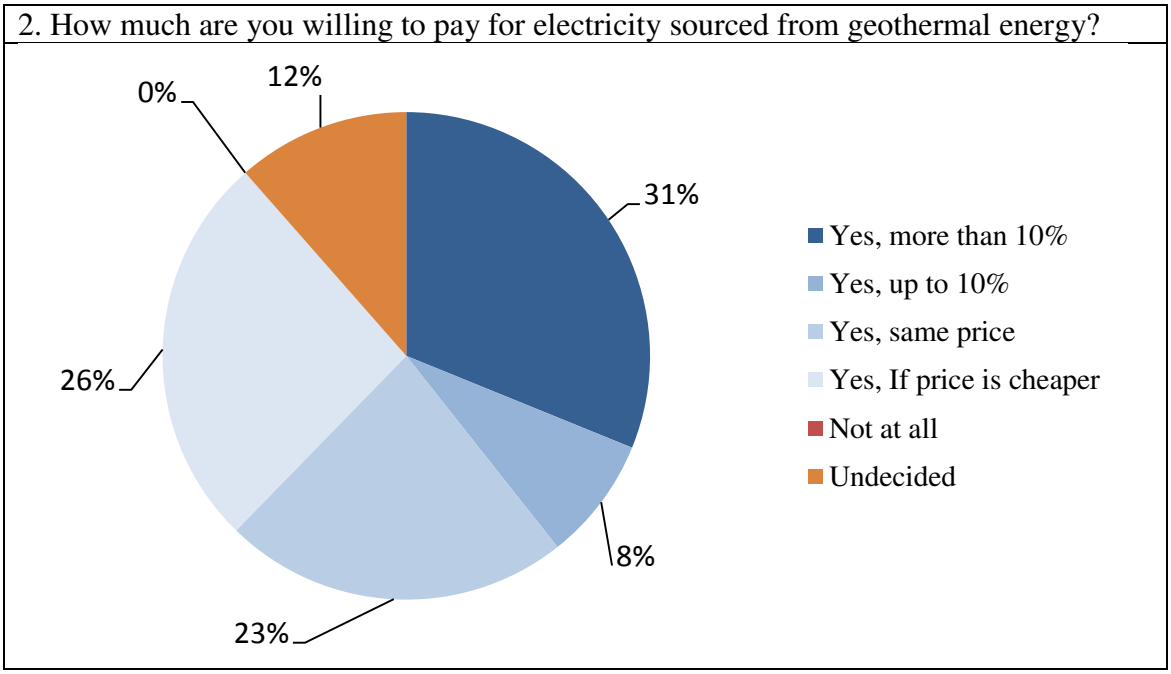


Figure 13: willingness-to-pay for geothermal energy.
Source: Author

Question 2 (**Fig. 13**) aims to find out the respondents willingness to pay for electricity sourced from geothermal facilities. 31% of the respondents indicated 'Yes' and they are willing to pay for more than 10% of the price they are paying for electricity now. Followed by 8% of the respondents willing to pay up to 10% more, 23% who will pay the same price, 26% willing to pay less, 12% undecided and '0%' not willing to pay at all. In terms of paying, consumers generally want to pay the lowest possible for the energy use. This results shows that there are groups of people willing to pay more for their energy sourced for geothermal to support is utilisation. While there are people who will pay for their geothermal energy as long as it is a cheap option. Government and energy retailers can work towards the development of business models to reduce or equal the cost of geothermal energy. By overcoming the hurdle of high cost, higher acceptance in terms of the public's willingness to pay can be achieved.

3.2 Interview and secondary results

This section is the summary of data from both secondary sources of governmental reports and primary data interviews with the relevant actor groups. This helps to provide insight into the social, political and economic interactions between from national level down to the local communities. The results explore the contributing and hindering factors of the social acceptance of geothermal power in Oita prefecture.

3.2.1 National government

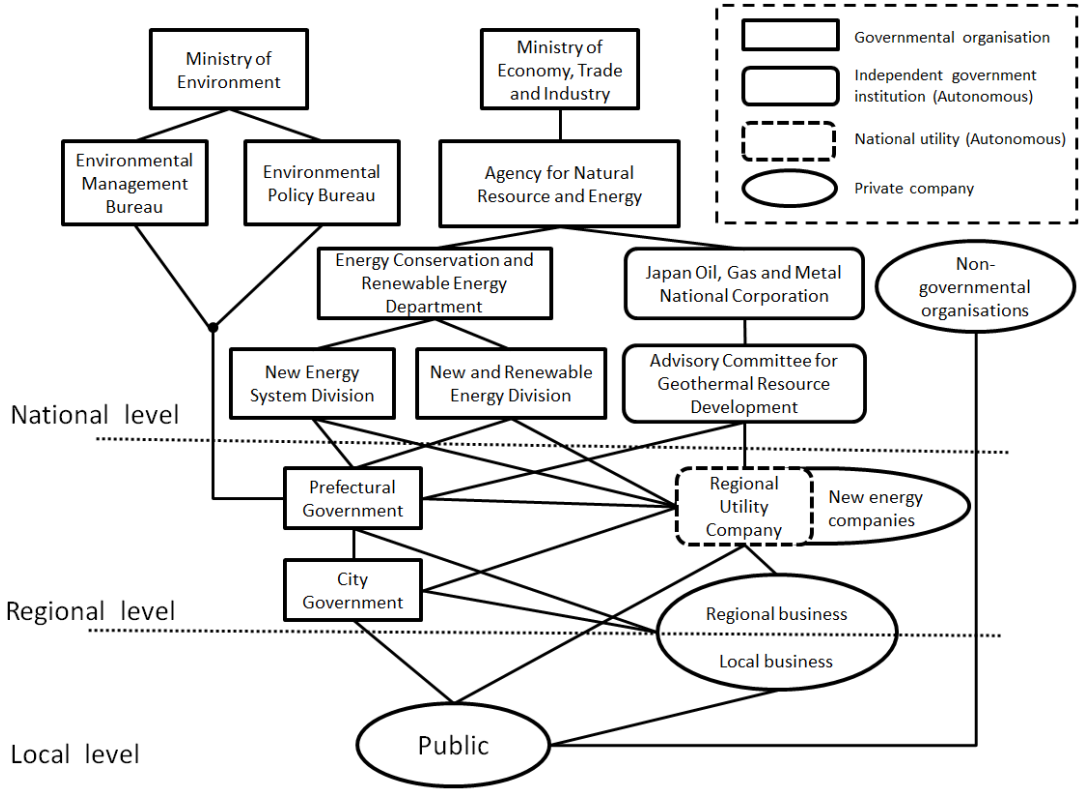


Figure 14: Institutional chart of the various actor groups for geothermal energy development in Japan.
Source: Developed by author based on METI (2017)

Figure 14 illustrates the connections of the various actor groups from the

national to the local level in Japan. From the top of the national level, *the Ministry of Economy, Trade and Industry* (METI) along with the *Ministry of Environment* (MOE) are the highest governing body responsible for policies and regulations attaining to geothermal developments.

The MOE focuses on the impacts of the geothermal systems on its environment and conservation policies to prevent degradation of the environment related to land use. Its role towards the development of geothermal systems tends to be related to the external settings as compared to the METI which has more emphasis on the technical infrastructure of the system. The MOE and its divisions, *Environmental Management Bureau* and *Environmental Policy Bureau*, are responsible for the enactment of environmental laws on the guidelines and procedures of businesses intending to operate geothermal facilities. These laws will be adopted by the Prefectural and City government, which will be aligned and utilised within the regions. As shown from **Table 4,** on the laws and divisions in Beppu and Oita prefecture, and F**igure 15**, on the local procedures for geothermal business development. This will consist of the application process for businesses interested in developing geothermal systems in the city.

Within the METI, the division in charge of any geothermal related issues comes under the *Agency for Natural Resource and Energy* (ANRE). It focuses on the geothermal facilities and technologies as well as the full life cycle of the systems in terms of the economic, social and political implications. The *Energy Conservation and Renewable Energy Department* and its division, the *New Energy Systems Division* and

the *New and Renewable Energy Division*, focus on the policies, regulations and laws regarding the development of geothermal energy. The *Japan Oil, Gas and Metal National Corporation* (JOGMEC) is an autonomous governmental institution created by ANRE as a private entity that connects the political sector with the major private energy companies in Japan. They provide the relevant information regarding energy economics as well as a collective data of technologies and geometrics for geothermal resource exploration, and other energy sources (JOGMEC, n.d.). From 2016, JOGMEC created a new division called the *Advisory Committee for Geothermal Resource Development*. It is an organisation that mediates the national government and major energy companies with Japan's utility companies and all the prefectures. They are tasked with providing high-level technical knowledge including, expert-based information, data analysis and the formulation of operational guidelines with the relevant criteria (METI, 2016).

Also on the national level, *Non-governmental organisations* (NPO) play a part in providing information for Japan. As a private entity, they are able to provide data and updates on policies with their own analysis to the public. In terms of social acceptance, it can help to put a technology in a good or bad light. Two of the NPOs related to geothermal development and renewable energy are the 'Geothermal Research Society of Japan' and 'Institute of Sustainable Energy Policies', Their members consist of geothermal academics and industry experts (GRSJ, 2017; ISEP, 2017). They act as a platform for experts to share their opinions and ideas, as well as organising events related to sustainability and geothermal developments. One of the attributes of NPOs is that they are recognised by the national government, thus they have access to governmental events related to policy changes on geothermal energy. In some occasions

they are able to participate in expert meetigns that will influenece the course of the policy changes in Japan. The role of NPOs in geothermal development helps to give the public a more direct access to information as an unbiased medium.

On the regional level, the *Prefectural government* and *City government* are the actor groups from the political sector. They are in charge of the regional policy and planning for geothermal energy within their city boundaries. They are also responsible for the regulation and ordinance of all the geothermal systems under their city or prefecture's jurisdiction. The private sectors relating to the retail, distribution, transmission and production of geothermal power are the R*egional utility companies*, *New energy companies* and *Regional businesses* involved in geothermal energy. The *Regional utility companies* are currently the largest actor group involved in the retail and production of energy, and the only group involved in the transmission and distribution of electricity. The *Regional utility company* for Oita prefecture is Kyushu Power Electric Company which also deals with the entire Kyushu region. With the deregulation of Japan's energy grid, *New energy companies* can now enter the market for both retail and production, and from 2018, they will also be allowed to transmit and distribute electricity (METI, 2017). *New energy companies* such as Softbank, a telecommunication company in Japan, have diversified their business into the electrical energy sector. *Regional Businesses* are mainly involved in the production of electric power. They are often middle to large size companies with other businesses seeking to expand into the renewable energy market. Their operations involve surveying potential local areas to develop renewable energy systems. One regional company, based in Tokyo, which has invested into the HGPS in Oita prefecture, is Cosmotec, which

specialises in the production of high-end mechanical components (Cosmotec, n.d.).

The local level consists of the largest actor group, the *Public*, and *Local business*. *Local business*es have similar business operations as *Regional business,* including other business operations and expanding to the renewable energy sector as part of their new business. They differ from the *Regional business* in terms of scale and location. *Local businesses* tend to be small in size, ranging from small to mid-size, and are situated in the city of the source of energy. An example of a *Local business* in the geothermal energy business is 'West Japan Geothermal Generation Company' based in Beppu city, in Oita prefecture. Their other business operations include electrical and plumbing solutions branching into the geothermal power generation business in 2014. Currently, they operate and run two HGPS in Beppu city. The *Public* is the largest actor group in the institutional chart. It comprises of the end-users of the system. In the case for Beppu city, the impact of geothermal development will affect the population of 122,138 residents (Beppu city, 2015). In Japan, chain of command and order is a strictly hierarchical process. Units or subcommittees wishing to enact new policies or measure have to follow the national bureaucratic system. Policies measures and works on a feedback system from the lowest and majority unit, residents, all the way to the final policy makers at the top.

3.2.2 Regional and local government

This section will explore the roles of the regional government, Oita prefectural government, and city government, Beppu city government, in developing and adopting

their region for geothermal projects. The interview with a representative from Beppu city's Environmental division provided an insight into the developmental stages and rationales behind the procedures for businesses developing geothermal projects. Beppu has historically been utilising geothermal energy for various uses, from heating of green houses, electricity generations and recreational purposes. However, since the introduction of the Feed-In-Tariff system in 2012, there has been changes in the power generations sector for geothermal energy. Beppu city saw its first investment in geothermal energy generation since 1981, by Suginoi hotel Geothermal plant. In 2013, Cosmotec HGPS was the first plant introduced since then (Cosmotec, 2014).

'Since we do not introduce city-owned hot spring power etc. as Beppu city, we will use the example of private business entities to explain the effects. For the initial case of Cosmotec company's HGPS, it was developed before the drafting of the rule where geothermal investors are required to inform the locals on the facilities construction. With no explanation to the residents, power plants are installed in the Ogura district of Beppu city.'

- Beppu city government representative

In 2014, Beppu city was working with a Tokyo-based company, Cosmotec, to build the Cosmotec HGPS. One of the objectives is to develope local power generation facilities within the city to provide energy for the local citizens. Along the way they have encountered challenges from the local residents, who were not part of the initial consideration during the establishment of the facility.

'As a result, the opinions of the residents at that time were unknown. Since the local environment are influenced by the development of HGPS. There were oppositions towards the project from the Ogura residential area'

- Beppu city government representative

After the incident, Beppu city government started working with new geothermal projects to improve the social acceptance levels of residents in proximity to the geothermal plants. From then on, they have adopted new measures to ascertain the viability of geothermal development within the city. This includes new steps to inform the local region about geothermal projects. **Figure 15** shows the procedures '*Geothermal investors and business operators'* have to follow in order to get approval from the city government before the construction of geothermal facilities.

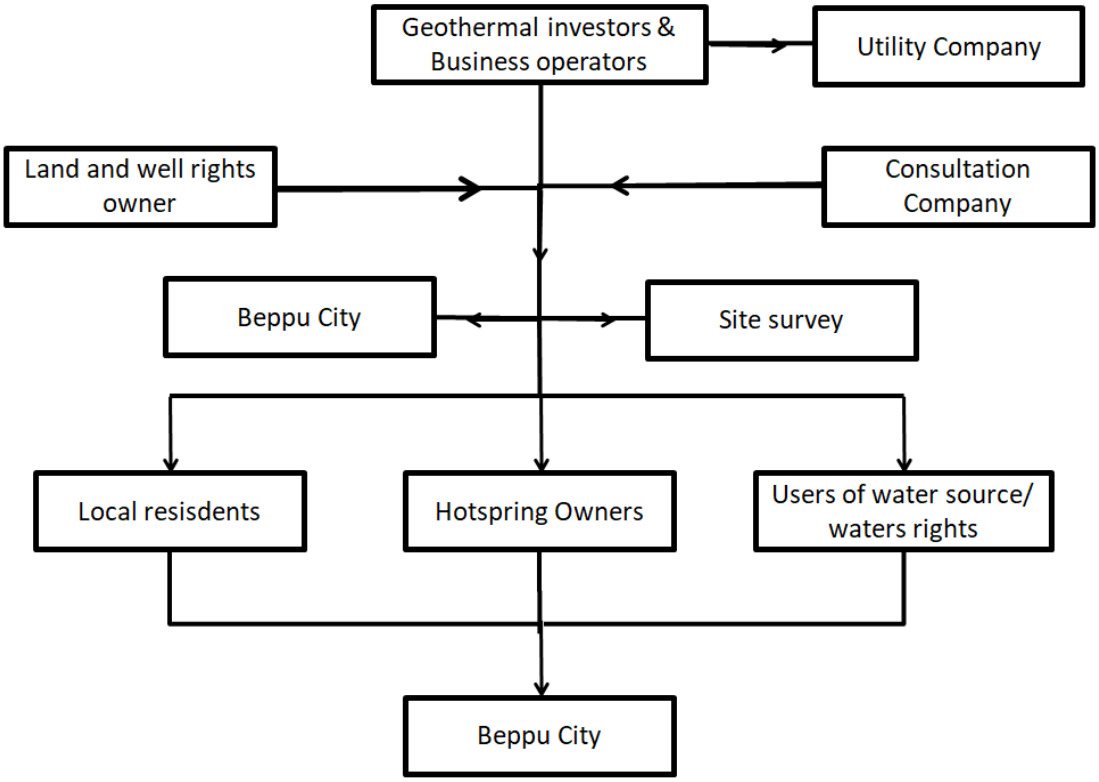


Figure 15: Procedural flow chart for geothermal business investors from 2016
Source: Developed by author based on information from Beppu city official

Before any new project is approved by the government, investors have to engage the *Utility Company, Land and well rights owner, Consultation Company* as well as conducting a site survey. The *Utility Company*'s approval will allow the geothermal power producers the ability to sell electricity to the grid. While the *Land and well rights owner* along with the *Consultation Company* will draft out contracts for the geothermal source usage and the agreed payments for the *Land and well rights owner.* The new steps included after the Cosmotec geothermal development in Ogura district of Beppu city includes informing three local groups, *Local residents, Hotspring owners and Users of water source*. This step ensures that the local people are informed of the development of geothermal projects within their residential areas.

Table 4: Procedures and regulations required from geothermal developers to gain permission to build geothermal facilities in Beppu city.

Sections	**Types of law** (**Number of policies under the same law*)		
1. Land transactions	• Land Use Planning Act • Forest Law • Agricultural land Law		
2. Land use	• Urban planning Law (5) • Building Standards Law • River law (2) • Environmental conservation ordinance (2) • Agricultural land law (2) • Forest law (4) • Urban park law • Regulation law on construction of residential land • Cultural property protection law • Cultural property protection Act (4)	• Road Act (2) • Ordinance on Management of Beppu City non-statutory public goods • Landscape law • Soil contamination counter measure law • Oita prefecture sediment loading regulation • Natural park law • Protection and management of wildlife law • Waste disposal and cleaning law • Hot spring Act (3) • Hot spring Law	• Thermal law • Oita prefecture hot spring law enforcement ordinance (5) • Landslide prevention law • Sabo law • Quarrying method • Promotion of sediment-related disaster law • Disaster prevention Act • Oita prefecture large scale land use
3.Environmental impact assessment	• Environmental Impact assessment law		
4.Construction of building	• Building standards law • Beppu environmental protection regulations		
5. Installation of equipment	• Fire service Act (2) • Fire prevention regulation (3) • High pressure gas safety law (3) • Industrial Safety and Health act - Boilers (2) Cranes (1)		
6.Environmental protection	• Noise regulation law • Beppu environmental protection regulation (3) • Vibration control Act • Electricity Business Act (3) • Water Pollution Control Law • Seto Inland Sea environmental conservation special measures law		
7.Electricity business Acts	• Electricity Business Act (7)		
8. Business authorization (Non-regional jurisdiction)	• Procurement of energy special measures law (2)		

Source: Developed and translated by author from Beppu city government (2017).

Table 5: Government and utility groups involved in the process application for the development of geothermal power plants in Beppu city.

Groups	**Division and department** (**Number of policies related to this division*)
National Government	• Agency for Natural Resources and Energy Electricity and Gas Division (2) • Kyushu Industrial Safety and Inspection unit power Safety Division (4) • Kyushu Bureau of Economy, Trade and Industry for Natural Resources and Energy Environment Department energy policy division (1) • Aso Kuju National Park Kuju Nature conservation officials (1)
Oita Prefectural Government (Regional Government)	• Prefecture River Division Planning Research Group (2) • Prefecture Environmental Conservation Division Water Environment Team (2) • Prefectural Eastern Health Department Hygiene Section Living Sanitation and Environment Team (3) • Prefecture Forest Symbiosis Promotion Office Forest Environment Protection Team (1) • Prefectural Eastern Health Department Hygiene Section Living Sanitation and Environment Team (1) • Prefectural Forestry Administration Division Forest and Forestry Planning Group (1) • Prefectural Forest Conservation Division Forest Location Conservation Team (1) • Prefectural Nature Conservation Promotion Office Hot Spring / Regional Resource Utilization Team (5) • Prefectural Eastern Health Center Health Safety Planning Division General Affairs Team (5) • Prefecture Sabo Section Management and Planning Study Group (2) • Prefectural Industry Promotion Division Management and Environment Team (1) • Prefecture cities and town planning department management land use squad (1) • Prefecture Environmental Conservation Division of Air Quality Group (1) • Oita River National Highway office Oita maintenance branch office (1) • Oita Labor Bureau Labor Standards section Health and Safety Division (2) • Prefecture Environmental Conservation Division of Air Quality Group (1) • Prefecture Eastern region public health centers for life, health and environment group (1) • Prefecture Environmental Protection Division, Water Environment group (1)
Kyushu Power Electric Company (Regional utility)	• Kyushu Electric Power Beppu sales office (1)
Beppu City Government (City Government)	• City Planning Division City Planning Division (1) • City Agriculture, Forestry and Fisheries Division (3) • City Agriculture Committee (3) • City Policy Division Landscape Designer (3) • Municipal policy department urban design staff (1) • City Road River Division Manager (4) • City Environment Section Division Environmental Sanitation Division (1) • City park green area Division of park maintenance (1) • City Board of Education Social Education Section (3) • Department Beppu Civil Engineering Office Administration Division (4) • Eastern Promotion Bureau Ministry of Agriculture and Fisheries Promotion Division Forest Management Team (4) • District Eastern Promotion Bureau Regional Promotion Division (1) • City Building Guidance Division Building Guidance engagement (1) • City firefighting headquarters Prevention Division leadership engagement (3) • County fire security room security team (2) • City Environment Division environmental hygiene engagement (3) • City Hot Springs Division Onsen policy engagement (2) • Registered Safety Management Examination Body (2)

Source: Developed and translated by author from Beppu city government (2017)

Since the local residents do not have the power to decide the construction of the geothermal projects in their areas, the city government compensate by implementing stringent regulations, applications and procedures for investors to follow. This ensures that new geothermal projects do not violate the comfort, safety and expense of the local residents. Table 4 is the list of 83 different laws and regulations that geothermal investors and developers have to gain approval before that are allowed to start any geothermal projects. Table 5 indicates the various groups involve in the application processes from the National governmental level to the City government, which developers have to gain approval before the construction of the geothermal facilities can start.

'Since the introduction of hot spring power generation will be promoted mainly by private enterprises, new measures such as the "Basic policy of facilities introduction", "Assurance of business operator's compliance with laws, regulations and procedures", "Understanding neighboring areas" "Utilising hot springs in a sustainable manner "as a pillar for future developments.

- Beppu city government representative

Along with the procedural requirements from Table 4 and 5, the new investors have to undertake projects to promote their geothermal facility to the local residents. This includes providing locals with the basic information of their facilities, conducting a business assurance on their facility to ensure constant compliance to the law, conducting studies to better understand the local district, as well as to promote their sustainability of their facility.

'At the city level, we have developed the "Beppu City Regional New Energy Vision" in FY2014. It is the "Outline of Preliminary Procedures for the introduction of new energy in Beppu City Region", and in FY2016, the "Beppu City Hot Spring Power Generation Regional Coexistence" as part of our commitment to establish and enforce regional energy for a more energy resilient and harmonious city.

- Beppu city government representative

The city serves as the governing body responsible for development of the geothermal power sector. It has to constantly strengthen social bonds between the private and public sector in energy projects.

'*The introduction of hot spring power generation or small binary power generation utilizing existing source (HPGS) by private enterprises based in Beppu City have increased greatly. In particular, after FY2015, the number of equipment certifications of the fixed price acquisition system has doubled.*'

- Beppu city government representative

After the update of the 2015 national energy policy for the 'Purchase Prices under the Fit-In-Tariff Scheme', purchase prices for energy producers of geothermal power is 40 yen/kWh for systems less than 15,000 kW in capacity, which includes HGPS (METI, 2016). These prices provided an incentive for the private enterprises to invest into Beppu city's extensive geothermal network. Furthermore, compared to conventional geothermal systems where expensive land survey and drilling is required,

HPGS is able to be installed into existing source which reduces the need for these additional expenses (JOGMEC, 2015). However with the increase of HGPS projects in Beppu, the city has adopted new procedures after the early setbacks of the initial construction of the Cosmotec HGPS.

'In view of the efficient use of hot spring water that has been discharged, the city has been using the surplus water for hot springs within the city. These surpluses are not excessive in a way which will be detrimental to the groundwater source and surrounding hot spring facilities. This can only be achieved through the use of small-scale binary power generation. For this reason, projects that require large-scale drilling of geothermal sources in order to use large-scale geothermal power are not permitted within the city.'

- Beppu city government representative

With regards to the long term plans to ensure the sustainability of the geothermal resources and ensuring greater social acceptance, Beppu city views large scale geothermal systems as an improbability.

3.2.3 Kyushu electric power company

This section will focus on the utility company of the region, Kyushu electric power company, also known as KEPCO; it is the Kyushu Island's sole electric utility company. It services the seven prefectures, Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Kagoshima and Miyazaki, with electric services. The company's operation includes partially energy production, full energy transmission and distribution and full market retail. They play an important role as an electric energy utility company and in increasing the level of social acceptance in geothermal energy development. The interview with the local representative of Kyushu Electric Power Company helps to understand the operations, connections and the role of the company in society and the development of geothermal energy.

On the issue of national policies affecting the growth of geothermal energy, KEPCO's role as the buyer, seller and producer of electricity is at the fore front of the impacts of any national changes in polices.

'The current Feed-In-Tariff (FIT) system will continue to promote geothermal development across the nation. So far there is a gradual increase in terms of renewable energy across the region, however much of it has been focused on the development of PV solar systems. Geothermal power development tends to take much longer time, with greater investment into land survey and planning. This demerit has deterred investors who would rather support more simple renewable systems such as solar energy.

Currently, with more information available for investors the development of geothermal plants becomes more appealing as they can develop business plans based on the fixed selling rates of the FIT system. They are now able to developed business plans with consideration of development period, development risk and cost making it easier to implement the projects.

- KEPCO official

This development allows geothermal energy investors to developed concrete business plans encouraging greater investments into the industry, thus boosting the market acceptance portion in terms of the overall social acceptance of geothermal energy. With more investors keen on geothermal development, greater emphasis on the local level acceptance has to be undertaken on the part of both city and private enterprises. In the long run, with the lessons learnt from the past and current geothermal projects, there is a constant mutual growth of all areas, national to local level, related to the development of geothermal energy sector.

KEPCO's part as the developer of geothermal energy can be seen through Hatcobaru Geothermal power plant, located in Kokonoe town in Oita prefecture. The development process has allowed KEPCO to experience improving the social acceptance of resident living in areas where there are geothermal facilities. The Hatchobaru geothermal power plant consists of 3 separate plants in the same area. The Hatchobaru plants 1 and 2 are flash type power plants that opened 1977, while the latest one is a zero emission binary plant that open in 2006. The whole facility has the highest power generation capacity for a geothermal plant in Japan at 112 MW (The Geothermal

Research Society of Japan, 2015)

'At the time of development of the geothermal power plant (Hatchobaru geothermal power plant) in 1977, people and businesses were worried of the influence on the hot springs associated with the geothermal development. While it seemed there had been a sense of uneasiness initially, KEPCO had continuously explained and held meetings to discuss issues. In addition, in Kokonoe Town, local spa operators and our company established a place for regular exchange of opinions. We provided information such as driving situation, construction.Questions on whether "the local hot springs will become exhausted" were at the utmost importance. However over the years, explanations and discussions conducted on a continuous basis have allowed local residents to understand and coexist with the geothermal facilities.'

- KEPCO official

Many local hot spring and lodging businesses, like traditional Japanese inns and hotels, heavily depend on the local hot spring resource for their business. As the direct utilisation for hydrothermal resource for geothermal power generation affects the amount of water source, many people were worried that the ground water source will deplete and their business maybe affected. KEPCO needed to work with local business to provide assurance that the geothermal plants would not jeopardise the local tourism industry. The promotion of Hatchobaru geothermal plant for free tours is one of the approaches used to improve local acceptance. By becoming a tourist site, Hatchobaru geothermal plant is able to attract visitors to visit Kokonoe town. Tourists then patronise the local businesses and contribute to the local tourism industry.

'The future plans for Oita prefecture includes "Oita prefecture new energy vision", with regards to nature. Thus, we are promoting the introduction of harmonized eco-energy. The four main activities of the initiative are (1) Promotion of introduction of eco energy (2) Promotion of energy conservation (3) Eco-energy in harmony with the natural environment in a consumer society (4) Training energy industry to support efforts to promote the introduction of renewable energy (geothermal and small hydropower). This initiatives are supposed to support the development of sales channels for local enterprises, but they also encourages the expansion renewable energy utilisation (including geothermal power) in the prefecture'

- KEPCO official

Currently, KEPCO are involved in many aspect of improving social acceptance of various forms of new energy system. In order for the region to consistently improve energy resilience and security, KEPCO has to constantly find more efficient and new technologies to integrate to the community. In order to implement these technologies, public approval and cooperation is vital for the success. Thus, KEPCO works with the local and regional government to promote green energy, educate the public, as well as training and supporting locals in geothermal energy. This opens up more jobs and business that contributes to the development of a clean energy society for Oita prefecture.

3.2.4 Local level groups

This section consists of interviews with the private sector in Oita prefecture. They are actor groups that represent the private entities on the local level. The representative groups are (1) Local land and well rights owner, (2) President of local geothermal company for HGPS, (3) Local farmer and (4) President of a local business utilising geothermal water for their facility.

3.2.4.1 Local land and well rights owner

The local owner is from the Yuyama district of Beppu city, Oita prefecture. As a local resident, he first heard of the use of HGPS for power generation from a local exchange event.

" I have been living in this area for more than 40 years, a geothermal vent and well is located on my property that provides hot water for the nearby hot spring spa in the community center about 20 meters from here. In 2013, I met with a president of a local company telling me about the potential for power generation (HGPS) of my geothermal well. I never had any negative perceptions of (HGPS) initially (before the land owner met with the company), and further explanations by the company convinced me to work with them."

-Local land and well rights owner

In the initial interaction back in 2013, both parties were generally supportive of the idea of utilising the otherwise wasted heated for power generation. The local land owner had a good image of the HGPS and had no opposition towards the technology.

"We negotiated a rental fee for the usage of the geothermal heat as well as the development of the facility on my property. The company clearly explained the thorough process and procedures required for the development of the HGPS facility. The relationship we have to the company is very strong and we often meet up to talk about the latest information of the facility."

-Local land and well rights owner

Through close relations and constant interactions between the geothermal facility investor and the land owner has allowed both parties to develop a strong bond. The trust developed between the local owner and investors helps to improve the social acceptance of the local investor towards the use of geothermal energy.

"One the issues that I hope will change in future is the method of utilizing the power generated directly in my home. Currently, the electricity is sold back to the grid, and I have to buy back the electricity generated on my own property from the utility company. I would like be able to directly use the power generated in my own property."

-Local land and well rights owner

As the land owner has a contract with the regional utility company, KEPCO, to use electricity, they can directly use the energy from the facility. This situation has

the opportunity to change in future after the deregulation of the electricity utility sector, as the land owner is able to directly install his own connection from the facility to his house for direct use.

3.2.4.2 Local geothermal company

This section discusses the interview with the president of a local company invested into the geothermal power generation business in Beppu city. The company is based in Beppu city with operations in other parts of Japan. Initially, the company's business is focused on pipping and utility connection services.

"The Fit-In-Tariff scheme implemented in 2012 opened up a new avenue for investment to expand our company's operation into geothermal power generation. As we already had expertise in developing piping for geothermal fluids, geothermal power generation was a good direction for our company. As a new energy power investor, we also received financial support from Oita prefecture government to develop the facility. In 2014 January, we started operation of our first HGPS plant, a 92kW generation capacity HGPS known as Gotoen geothermal plant. Within the same year in October, we started operation of the second plant, a 100kW HGPS system in Yuyama."

-President of a local geothermal company

The incentive of the FIT system and financial support of the prefecture, the company is able to consecutively install two geothermal power plants within one year. As the installation of geothermal systems requires costly land surveillance and high

infrastructure cost, the geothermal industry were not given enough financial support to develop. However after the Fukushima nuclear incident in 2011 and the introduction of the FIT system in 2012, Japan is aiming to improve its energy resilience and expand its renewable energy sector. With financial incentives and support more geothermal developments are able to be constructed.

"One of the best ways to developed strong relationship with local residents is to directly interact and talk to the local residents in the potential area for development. We are able to hear their worries and directly address the issues of geothermal facility that affects the residents. Another measure we take is to survey the area and build our facilities in locations that have the least impact on the community and furthest away from residential homes."

-President of a local geothermal company

Being a local company, the business operates within the same city the residents live. This implication of a local company investing may be critical to have a higher acceptance rate among the residents living in the area. Furthermore, during the initial land survey of potential sites, the company specifically selects sites that are located as far away as possible from the residents that are not related to the development of the geothermal facility. This reduces the occurrence of noise and vibration disturbance from the power generation process to the surrounding areas.

3.2.4.3 Local water users

One of the groups affected by the development of geothermal power generation facilities is the local water users. They are involved in the utilization of water resource for agriculture purposes and they have to pay for the rights to use the water source. With the development of HGPS in Beppu city, local farmers are concerned of the effects on their agricultural business.

"One of the issue is that the water discharge from the facilities sometimes maybe too warm, thus affecting the growth of some of the crops. The other issue is related to the amount of groundwater used. Geothermal energy generation companies may extract more thermal water if the temperature of the well drops, thus reducing the groundwater reservoir."

-Local farmer

Issues faced by the local farmers' may affect the overall social acceptability of geothermal development projects in the local areas. The regional and local governments are responsible for the managing the resource utilization and ensuring that the geothermal facilities do not exploit the local resources. Energy companies and local government can collaborate to monitor the effects of the geothermal facilities on farms and downstream geothermal water users.

3.2.4.4 Local business owner

For many companies in Beppu city, their business often rely directly or indirectly thermal water from geothermal sources. One of the companies that use the thermal water is a retirement home located in Beppu city. The company pays for and shares the water rights and well rights with other nearby buildings. The system used for thermal water is a conventional Hotspring extraction, cooling and distribution facility.

"Our company pays for the partial rights for geothermal water usage and the land rental fee of the well. By sharing the cost of water and well rights with other nearby users we can save money as well as negate the need for drilling new wells."

-President of a company using geothermal water

The impact of developing wells for geothermal water utilisation poses two financial issues to private businesses. Firstly, surveying and drilling for new wells can be costly investments for new businesses, thus many seek out existing or old wells when developing a facility in need of geothermal springs. Secondly, the annual upkeep cost from maintaining the extraction, cooling and distribution system, as well as the yearly fee for the land and well rights can be an economic burden to any business in the area. One of the methods to alleviate this burden is for nearby interested users to share the usage for the system, wells and water rights. Since the amount of water permitted for extraction is determined by the 'Oita prefecture hot spring law enforcement ordinance' (Beppu city, 2017), the users of the well will have to ensure amongst themselves that the amount of water distributed is equivalent to their financial contribution.

"*As one of the water and well rights user, we have to pay for its usage for the thermal water. If possible, I would be interested in sharing with the other land and well rights users to lease, rent or invest in a HGPS. However, initial investment for such facilities are an upwards of 50 million yen. So unless there is are more individuals interested in the investing together it will be difficult for small private business to build their own HGPS."*

-President of a company using geothermal water

One of the points highlighted by the company, is that they understand the potential for developing their conventional geothermal extraction, distribution and cooling systems for electric power generation and even revenue generation. HPGS shares similar benefits to the installations of solar PV for power generation in private business for energy expense savings and income from the FIT. Unlike solar PV, the initial investment for HGPS is more costly. However, the advantage of HGPS over solar PV is that it is a base load power system. Private and local companies have the potential to incentivize in developing their own HGPS or simply leasing to energy investors to 'add-on' HGPS to their current conventional system.

3.3 Chapter conclusion

The relationships dynamics between the various actor groups, local, regional and national level, highlights the direction of geothermal utilisation in Oita prefecture The data collected from the survey provides a general coverage on the residents

awareness and and perceptions of the current state of geothermal utilisation. This aspect comprises of the study for the community and local level acceptance, which is the largest group and involving local residents who live in the areas where there will be geothermal developments. It has shown that there are concerns related towards the safety, noise, impact on the local environment and hot springs. Thus, for renewable technologies to exist in communities there has to be support from the community which becomes a determinant for the the national and regional level actor groups.

The move to create the *Advisory Committee for Geothermal Resource Development* in 2016 shows that there measures undertaken to create a more inclusive network and fluid communication bridge between the local, private and regional stakeholders with the national level policy makers. With a special geothermal division involved, it allows for greater communication, regulation and monitoring of geothermal utilisation across Japan. This move highlights the socio-political acceptance of geothermal energy geothermal energy on the national level. The consistent growth of geothermal projects in the region links the market acceptance amongst private stakeholders. Opportunities for local businesses to explore new revenue sources from their current geothermal unit with guaranteed returns is one of the factors attributing to the expansion of the geothermal energy sector in Oita prefecture. Their role involves promoting the national eneergy policies through the development and expansion of the geothermal power utilisation sector, as well as the provider of energy for the local level users. The advantages of having ownership among local stakeholders ensures that there is greater accountability and responsibility when developing new geothermal power generation facilities. The growth of the geothermal sector

Chapter 4:
Conclusion and future implications

4.1 Conclusions

In the coming years, the general trend for renewable energy has been steadily increasing; the Japan's METI has started taking policy measures to cope with this influx be initiating a new policy study groups to analyse the trends and impacts. Known as the "Study Group for Policy Issues in the Era of Large-volume Introduction of Renewable Energy", they are tasked to help the nation adapt to the changing energy landscape. Issues analysed by the group include the decreasing public burden of renewable tariffs, assisting regional cities and businesses in developing their geothermal resource, and providing detailed information regarding geothermal developments in Japan. The growth forecast for small scale geothermal facilities, such as binary hot spring geothermal plants, is expected to rise rapidly in the next few years, and with over 27 projects granted a go ahead within Beppu city in Oita prefecture. The economic balance between its growth rate and the utilisation has to be achieved. This is to avoid a scenario where there is an oversupply and the utility companies can refuse to buy or buying electricity at a low rate.

Furthermore, in the Japanese FIT legislation there are certain conditions under which Japanese power companies can choose not to accept the electricity produced by renewable energy from domestic and private sectors, including a lack of transmission capacity as a valid reason (Buckheit, 2015). This affects small scale privately owned geothermal plants as they are not able to sell off their excess power to the grid, due to the lack of transmission capacity. This means that excess power generated by private power plants, like the Suginoi and Kuju hotel power plants in Oita cannot be sold back

to the grid if the excess power they produce do not meet the minimum standard set by the government.

However, if they meet the standard amount, electricity generated from small-scale domestic and business from renewable sources, especially from solar, can be sold to the grid when the feed-in-tariff program was introduced, a spike of investment in renewable energies arose from private companies and residential households. This resulted in the electric power companies having to start paying producers that meet the requirements, and producers that were producing electricity before the FIT program, as well as the new and steadily increasing new renewable energy investors. This means that the government has to find new ways to pay the producers to support feed-in-tariffs program.

In order to reduce this financial strain of the FIT, all electricity users in the country are billed an additional tax called the renewable energy levy, this fund is use support the FIT to ensure and allow the future renewable energy sector to steadily expand. The positive side to renewable energy levy system is that in the long term it provisions the households and companies to move towards generating their own electricity

Figure 16: The areas for new energy business to enter after the deregulation of Japan's energy grid and utility services.

Source http://sparkyourpower.ca/electricity-101/deregulation/

In future, after the full deregulation of the national electric utility systems from 2020 in Japan (**Fig.16**), there will be market for new energy businesses focusing entirely on renewable energy. The ability for business to become a part of the community energy system will allow greater flexibility and choices for both providers and consumers of electricity. For instance, from **Figure 16**, energy enterprises may create an entire business producing their electricity from a mix of 100% renewable source, transmit and distribute electricity on their own grid lines and selling them to consumers . However, this also gives consumers the ability to choose to purchase their energy from companies based on which source of energy their power comes from. Hence, the role of social acceptance in geothermal energy is decisive in regions like Oita prefecture, where the potential for more extensive geothermal power utilization is available. With greater public acceptance towards geothermal energy, new energy companies interested in geothermal power investments are in a better position to promote their business towards consumers that support geothermal energy. This gives consumers the power to decide which energy source is best suited for their region, thus curbing the growth in

“unwanted” investment from energy sources that are not socially accepted.

This study has covered areas of social acceptance from the National level, Regional level and Local level. The National level acceptance is affected by the impacts of international drivers influencing Japan to change its energy mix for its national energy security and to meet greenhouse gas emissions targets. As Japan is dependent on other countries for most of its energy in the form of fossil fuels, the National level acceptance is also affected by the need to improve energy self-reliance for long term economic stability. Consistent measure and implementation towards national geothermal policies and development shows that the national government recognises that geothermal energy is potential source of energy to improve energy self-reliance. The Regional level acceptance is influence by both the National level and Local level. Regional government plays the role of adopting the policies implemented by the national government, and monitoring its effects on society. Thus their role of monitoring the feedback from the local level is vital in helping the national level develop appropriate measures and regulations for more effective geothermal propagation across the country. The Local level consists of all the citizens and consumers of geothermal power. Their collective attitudes and perceptions on geothermal energy is vital for the National and Regional level stakeholders to understand in order to move forward in the energy development. The local level in Oita prefecture are divided in their opinions of using geothermal energy, however there are evidence that there is potential for the citizens to continue and improve their image of geothermal energy. Thus, there are opportunities for the Regional level to identify and address issue for improvement on the Local level that are also consistent with the

National level goals. The overall connection between the various actor, level groups and public acceptance creates a vital mechanism for the development of Japan's geothermal sector.

4.2 Limitations of study

This paper covers the social aspect on geothermal energy adoption in the Oita region. This information could be used to find correlations between gender, age and area of residence with the level of acceptance. However, for a research on such correlations to be valid, an in-depth study with a larger sample size has to be undertaken to draw conclusive results. This paper could not address any conclusive results with the connections to the background information and social acceptance, but it provides an avenue for further studies to see if there are higher levels of social acceptance among certain groups in society. Further studies can be focus on the technical aspect to achieve greater social acceptability within the region. The in depth study of the geothermal technology use in the locality can contribute towards a more positive social acceptance. Areas that can be explored includes finding the optimal power output based on the resource available while keeping the noise and pollutant levels below the threshold accepted by the local community. The empirical data can be used to develop better geothermal systems, such as the binary hot spring geothermal plant that can be integrated to other regions without much disturbance to the society and to gain a greater support for geothermal energy generation industry.

4.3 Future implications

After the Fukushima incident, the general population has low general support towards the establishment of new energy systems. Due to the doubt and mistrust, implementation of new energy systems such as the binary hot spring geothermal generation is faced with hurdles to entering the energy market

With the bill my METI to revise the electricity business act in 2017, the Japanese government revise the identity of the PPS, known Power, Producer and Supplier. Formerly, Japan`s electricity market is almost totally controlled by the 10 regional Integrated power companies, EPCOs, which deals with the source, production, supply and sales of electric power (METI). However, after the Energy reform in 2016, privately owned new entrants (PPS) to the electricity market can own power source and produce electricity that can be sold to the national grid. While the regional EPCOs still control the supply, transmission and distribution sector, there are plans by the national government (**Fig.17**) to fully unbundle the supply chain and open it up to private investors by 2018 (METI, 2016). This will allow the possibility for areas in Japan to develop fully privatised and localised electric markets for the first time. Regions that have high public resistance towards their regional Electric power companies like Fukushima prefecture, after the Fukushima Nuclear incident in the aftermath of the great Eastern earthquake, can now develop their ideal energy system mix to power their grid.

This delocalisation of power generation helps to develop a higher quality of PPS, by allowing active competition in prices, technology, safety, comfort and efficiency in the

electricity market.

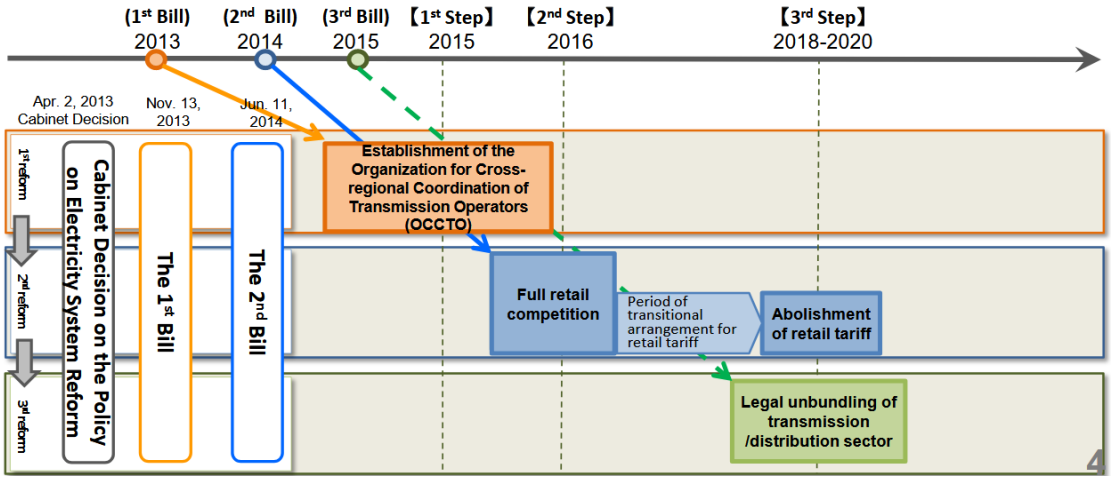


Figure 17: Deregulation process of Japan's energy market
Source: METI (2015)

In 2014, the METI (2014) held a council meeting on "Industrial construction for the safety electric power generation" with one of the agendas is to revise and ease the regulations for obtaining permits and license to build small-scale power plants without the need to first reduce the temperature to below 100degrees C. Previous policy requires that binary geothermal generation facilities require additional facilities to reduce the temperature of the steam below 100. However, the study done by the safety committee notes that the water/steam above 100 degrees can be safely utilise to generate electricity (METI, 2014). This brings two main benefits for investors; firstly this will help to reduce the overall cost for developing a binary geothermal facility as there is no need to build a cooling unit to reduce the steams temperature. Secondly, energy that would have been lost during the cooling process will now contribute to the power generation, thus improving the systems efficiency amount of power that can be potentially generated from the steam. Furthermore, direct utilisation of the higher temperature steam can still be used more efficiently to produce more power from the

geothermal facility. This development requires that geothermal investors put more caution to safety while giving them the opprtunity to develop more efficient systems. From now on; geothermal developers have adopted new measures to ascertain the viability of geothermal development within the city. This includes steps to inform the local region about geothermal projects.

The geothermal power in Oita Prefecture has a direct impact on the tourism industry. As a region high influx of tourist of around 4,400,000 visitors in 2016 (Oita prefectural government, 2017), the importance of establishing harmony between the locals and tourists, both domestic and international, in terms of bearing the cost for implementation of geothermal energy within the region is vital. The study by Kostakis and Sardianou (2012) on the willingness of tourist to pay for renewable energy shows the importance of information dissemination and environmental awareness of the tourist in their willingness to pay for renewable energy. Furthermore, policies aimed at increasing consumer acceptance can contribute to the adoption sustainable lifestyles, which results in tourists becoming more sustainable consumers; hence the impact of tourism on the environment will reduce (Kostakis and Sardianou, 2012). Local government and the tourism industry have to develop cohesive policies that will allow people to support the geothermal energy sector while avoiding a scenario that inhibits the tourism and economic growth of the region. The local community may also have to compromise by bearing some of the environmental costs for energy utilisation from the influx tourist. This sacrifice pays off from the utilisation of geothermal energy in the form of long term economic gain, regional energy security, better local health and environment.

There is evidence that there is still room for improvement in terms of general public's level of energy literacy. It is important to develop the knowledge for decision making when it comes to the installation of geothermal facilities in their cities. This measure is vital to promote GHPS as a sustainable energy source for the region. A reliable and trusted actor group such as the city government can be the source of education and information for local residents. They can also provide opportunities for networking events between locals and businesses. The greater participation in local decision making by the public sector is vital. Thus, in order for the general public to develop a higher social acceptability towards geothermal energy systems, there has to be more emphasis on improving individual knowledge on the advantages of using renewable energy.

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Appendix

I. Survey form (Japanese)

Form in Japanese and English

大分県の住民への地熱発電調査　2017
立命館アジア太平洋大学院の二年生、アンドリュー・チと申します。
私自身の研究の目的で、大分県の地熱研究とそれについての情報を入手したいと考えています。
恐縮ですが、下の質問についてご回答いただけると大変助かります。
よろしくお願いいたします。

性別	□ 男性　　□ 女性
年齢	□ １０代　□ ２０代～３０代　□ ４０代～５０代　□ ６０歳以上
お住まいの地方	□別府市　□大分市　□湯布院市　□日出町　□九重町　□杵築市　□国東市　□宇佐 □豊後高田市　□竹田市　□豊後大野市　□玖珠/日田/中津市　□臼杵/佐伯/津久見市

1. 地球温暖化についてどう思いますか？
□　重要な問題　　□　重要ではない　　□　どちらでもない　　□　知らない

2. 発電するための地熱エネルギーはご存知ですか？
□　知ってる　　□　知らない

2a.発電するための温泉発電はご存知ですか？
□　知ってる　　□　知らない

3. 地熱エネルギーは良いエネルギー源と思いますか？
□　はい　　□　いいえ　　□　どちらでもない

4. 現在、あなたの地区内で地熱発電所がありますか？
□　はい　　□　いいえ　　□　知らない

5. 地区や市内に地熱発電所を作りさせたいですか？
□　はい　　□　いいえ　□　どちらでもない

6. もし、あなたの地区内で地熱発電所を作る予定があたら、どんな反応をしますか？
□　賛成します　　□　反対します　　□　どちらでもない

7. もし、あなたの地区内で火力発電所を作る予定があたら、どんな反応をしますか？
□　賛成します　　□　反対します　　□　どちらでもない

8. もし、あなたの地区内で太陽発電所を作る予定があたら、どんな反応をしますか？
□　賛成します　　□　反対します　　□　どちらでもない

9. 誰が地熱発電について責められるべきでしょうか？(1 から 6 までお書いてください)
(1 – 最も責任者)

□日本国政府　□大分県政　□市政　□九電力　□設置者　□住民

10. 地熱発電は火力発電より高価になると思いますか？
□ はい　□ いいえ　□ 同じ

11. 今の電気代に再生可能エネルギー代があるのはご存知ですか？
□ 知ってる　□ 知らない

12.もし使えば、地熱エネルギーの電気代金を払う気がありますか？
□ 払う　□ 少しだけ高たら払う　□ 同じなら払う　□ 今より安いなら払う
□ 払いたくない　□ 未決

13.もしあれば、小型地熱発電プロジェットの投資は興味がありますか？
□ はい　□ いいえ

14. 地熱発電について、あなたの最大の心配は何ですか?
□騒音　□地域温泉施設の影響　□環境の影響　□安全性　□その他:

15.ご意見がございましたら、ご記入をお願いします。

ご協力ありがとうございました。

II. Survey form (English)

Dear residents of Oita prefecture

My name is Andrew Chee, from Singapore.
Currently, I am a 2nd year graduate student from Ritsumeikan Asia Pacific University.
I would like to research on the social perceptions and attitudes towards geothermal energy in Oita prefecture. With your response, I hope understand how to better integrate renewable technologies into societies.
All answers you provide will be kept in strict confidentiality.
Thank you for taking part in this survey.

Gender	☐ Male ☐ Female
Age group	☐ Under 19 ☐ 21 to 39 ☐ 40 to 59 ☐ Above 60 years old
Area of residence	☐Beppu ☐Oita ☐Yufuin ☐Hiji ☐Kokonoe ☐Kitsuki ☐Kunisaki ☐Usa ☐Bungotakada ☐Takeda ☐Bungoono ☐Kusu/Hita/Nakatsu ☐Usuki/Saiki/Tsukumi

1. What do you think about climate change and global warming?

☐ An important issue ☐Not an important issue ☐Neither ☐Not sure about the issue

2. Do you know about geothermal energy for thermal and electric generation?

☐ Yes ☐ No

3. Do you think geothermal energy is a reliable source of renewable energy?

☐ Yes ☐ No ☐ Undecided

4. Do you have a geothermal plant within your city/town/district?

☐ Yes ☐ No ☐ Not sure

5. Would you like to have geothermal energy within your city/town/district?

☐ Yes ☐ No ☐ Undecided

6. Would you support or object the construction of a geothermal plant within your city/town/district?

☐ Support ☐ Object ☐ Undecided

7. Would you support or object the construction of a fossil fuel power plant in your city/town/district?

☐ Support ☐ Object ☐ Undecided

8. Would you support or object the construction of a solar plant within your

city/town/district?

☐ Support ☐ Object ☐ Undecided

9. Who do you think should be most responsible for introduction and full development of the geothermal plant? (Please indicate from 1 to 6, with 1 being the group most responsible for it)

☐National government ☐Prefecture government ☐City government ☐Energy utility company ☐Private energy investors/companies ☐Local residents

10. Do you think utilizing geothermal energy will be more or less expensive than fossil fuel power plants?

☐ More expensive ☐ Less expensive ☐ Same price

11. Do you know if you are currently paying for using renewable energy in Oita prefecture?

☐ Yes ☐ No ☐ Not sure

12. Are you willing to pay for electricity generated from geothermal energy?

☐ Yes ☐ Yes, if it is only little more expensive ☐Yes, if the price is the same

☐Yes if the price is cheaper ☐Not at all ☐Undecided

13. If possible, would you be interested in investing local small scale geothermal energy projects?

☐ Yes ☐ No

14. What is your biggest worry related to geothermal power generation

☐Noise pollution ☐Impacts on the local hot springs ☐Impacts on the environment

☐Safety issues ☐Others:_____

15. Feel free to share if you have any other comments?

Thank you for your cooperation.

II. Interview - Kyushu Power Electric Company

1 What are the Japanese policies related to geothermal power generation that affects KEPCO as a utility company?

ANS: With regard to questions about national policy, we are not in a position to answer, but I think whether it is easy to understand when referring to the following site as reference information. In addition to introducing the FIT system, we are promoting geothermal power generation by supporting private-sector geothermal development. Please visit the Ministry of Economy, Trade and Industry 's Agency for Natural Resources and Energy on the website for support system. (Keyword Search: Geothermal Development Understanding Heisei 29, etc.)

2 .What are the effects of the 2012 Fit-In-Tariff scheme on geothermal power generation?

The current Feed-In-Tariff (FIT) system will continue to promote geothermal development across the nation. So far there is a gradual increase in terms of renewable energy across the region, however much of it has been focused on the development of PV solar systems. Geothermal power development tends to take much longer time, with greater investment into land survey and planning. This demerit has deterred investors who would rather support simpler renewable systems such as solar energy. Currently, with more information available for investors the development of geothermal plants becomes more appealing as the can developed business plans based on the fixed selling rates of the FIT system. They are now able to developed business plans with consideration of development period, development risk and cost making it easier to implement the projects.

3 .Before the construction of the Hatchobaru geothermal power station, what were the reactions of the local citizens? What sort of positive and negative reactions were received?

At the time of development of the geothermal power plant (Hatchobaru geothermal power plant) in 1977, people and businesses are worried of the influence on the hot springs associated with the geothermal development. Questions on whether "the local hot springs will become exhausted" were at the utmost importance. However over the years, explanations and discussions conducted on a continuous basis have allowed local residents to understand and coexist with the geothermal facilities.

4 What sort of measures and actions were taken in order to improve the social acceptance of geothermal facilities for the local residents.

Although it seems there was a sense of uneasiness initially, KEPCO have continuously explained and discussed and gotten an understanding now. In addition, Kokonoe Town, spa operators, our company has established a place for regular exchange of opinions.

We are providing information such as driving situation, construction etc. and asking opinions from local people.

５　。Are there any future plans for the expansion of geothermal utilization in Oita? If not, what kind of obstacles does geothermal development face?

As a reference, in Oita prefecture, as "Oita prefecture new energy vision", with nature We are promoting the introduction of harmonized eco-energy. http://www.pref.oita.jp/soshiki/14200/vision28kaitei.html
As a reference, in Oita prefecture, as "Oita prefecture new energy vision", with nature We are promoting the introduction of harmonized eco-energy.

As the four main activities of the initiative
1 Promotion of introduction of eco energy
2 Promotion of energy conservation
3 Eco-energy in harmony with the natural environment Orientation of a disposable society
4 Training energy industry to support

Efforts to promote the introduction of eco energy in (1) (geothermal and small hydropower) are supposed to support the development of sales channels for local enterprises, but also to expand the use of renewable energy (including geothermal power) in the prefecture It will be understood that we will emphasize

II. Interview - Beppu city environmental divison

1. What are the national policies that supported geothermal development in Japan?

ANS: The basic policy of energy for the Japan is summarized in "basic energy plan". Please refer to http://www.enecho.meti.go.jp/category/others/basic_plan/#head.

2. What are the effects of the Feed-In-Tariff Programs from 2012 on geothermal development Beppu city?

ANS: The introduction of hot spring power generation or small binary power generation utilizing existing source (HPGS) by private enterprises based in Beppu City have increased greatly. In particular, after FY2015, the number of equipment certifications of the fixed price acquisition system has doubled.

1. What was the reaction of the locals during the initial proposal for development of the geothermal facility? What kind of reactions did the project faced from people supporting or against the idea? ）

ANS: Since we do not introduce city-owned hot spring power etc. as Beppu city, we will use the example of private business entities to explain the effects. For the initial case of Cosmotec company's HGPS, it was developed before the drafting of the rule where geothermal investors are required to inform the locals on the facilities construction. With no explanation to the residents, power plants are installed in the Ogura district of Beppu city

2. With relation to social acceptance of the local population, what kind of measures was taken to promote the development of geothermal in 別府市?

ANS:The introduction of hot spring power generation will be promoted mainly by private enterprises in the city,It includes "The basic policy of geothermal introduction", "Ensure business operators comply with laws and regulations and procedures", "Understand neighboring areas" "Utiliing hot springs sustainably". Specifically, we have conducted a questionnaire survey at the time of consideration in the "Beppu City Regional New Energy Vision" in FY2014, and also published the official website of the main city and the environmental newspaper produced by the Environment Division) And "Outline of Preliminary Procedures for the introduction of new energy in Beppu City Region", and in FY2016, the "Beppu City Hot Spring Power Generation Regional Coexistence etc." have been established and enforced under the 'Order of Ordinance'.

3. Are there any future plans for the expansion of geothermal utilization in Beppu city? If not, what kind of obstacles does geothermal development face?

ANS: 'In view of the efficient use of hot spring water that have been discharged, the city has been using the surplus water for hot springs within the city. These surpluses are not excessive in a way which will be detrimental to the groundwater source and surrounding hot spring facilities. This can only be achieved through the use of small-

scale binary power generation. For this reason, projects that require large-scale drilling of geothermal sources in order to use large-scale geothermal power are not permitted within the city.'

4. In 2013, Cosmotec Company opened a binary geothermal plant in Beppu city. Initially、I heard that there were some protests from the locals, regarding the plant. Eventually, how did Beppu city, Cosmotec and KEPCO work together with the people to positively resolve this issue?

ANS: For private enterprises, we are trying to cope with the introduction of hot spring power generation from the viewpoint of "compliance with related laws and regulations", "harmony with the natural environment and living environment" and "symbiosis with neighboring residents (neighboring parties etc.)" . Regarding questions of your question, listen to complaints from neighboring residents, encourage Cosmotec to have opportunities to talk with neighboring residents, and in collaboration with related organizations such as the Kyushu Bureau of Economy, Trade and Industry, the administration of laws and regulations We have taken corrective measures to solve difficult problems, such as providing guidance.

5. How you think the changes in public's attitude towards geothermal energy utilization have changed over the past few years?

ANS: As a resident's opinion, I think protecting hot spring resources and trying to make more efficient and sustainable use of spas on hot springs. I believe that the response of residents to projects of private business operators is also keeping this idea. However, when comparing the contents of hot spring resource protection and efficient and sustainable use of hot springs, there are increasing numbers of people who emphasize protection of hot spring resources, such as raising a voice to express a sense of crisis against hot spring resources, is the impression that I am receiving.

6. For the future, what kind of measures will be taken to ensure the support of the local residents?

ANS: In FY2016, we carried out the "Hot Spring Energy Project Possibility Study Project" utilizing the Ministry of the Environment's auxiliary projects and investigated the hot spring resource situation for the first time in 30 years. Based on the results of this survey, we are currently studying how to create a mechanism that enables sustainable utilization of hot spring resources.

II. Interview - Local land and well rights owner

1. How did you know about the opportunity to rent your land for HGPS development? And where did you hear about it?

I have been living in this area for more than 40 years, a geothermal vent and well is located on my property that provides hot water for the nearby hot spring spa in the community center about 20 meters from here. In 2013, I met with a president of a local company telling me about the potential for power generation (HGPS) of my geothermal well. I never had any negative perceptions of (HGPS) initially (before the land owner met with the company), and further explanations by the company convinced me to work with them.

2. How was the process of the agreement and your relation to the investor?

We negotiated a rental fee for the usage of the geothermal heat as well as the development of the facility on my property. The company clearly explained the thorough process and procedures required for the development of the HGPS facility. The relationship we have to the company is very strong and we often meet up to talk about the latest information of the facility.

3. What are the areas that you hope can improve on with relation to geothermal development and power?

One the issues that I hope will change in future is the method of utilizing the power generated directly in my home. Currently, the electricity is sold back to the grid, and I have to buy back the electricity generated on my own property from the utility company. I would like be able to directly use the power generated in my own property."

II. Interview - Local geothermal company

1. What made you decide to invest into geothermal energy developments in Beppu city?

The Fit-In-Tariff scheme implemented in 2012 opened up a new avenue for investment to expand our company's operation into geothermal power generation. As we already had expertise in developing piping for geothermal fluids, geothermal power generation was a good direction for our company. As a new energy power investor, we also received financial support from Oita prefecture government to develop the facility.

2. What are your projects and developments so far?

In 2014 January, we started operation of our first HGPS plant, a 92kW generation capacity HGPS known as Gotoen geothermal plant. Within the same year in October, we started operation of the second plant, a 100kW HGPS system in Yuyama.

3. How did you approach the local citizens to achieve greater public acceptance towards your geothermal developments?

One of the best ways to developed strong relationship with local residents is to directly interact and talk to the local residents in the potential area for development. We are able to hear their worries and directly address the issues of geothermal facility that affects the residents. Another measure we take is to survey the area and build our facilities in locations that have the least impact on the community and furthest away from residential homes."

II. Interview - Local water user

1. How does a geothermal development affect you and your livelihood?

As a local farmer, we have to apply and pay for the usage of the city water for our farms. When geothermal facilities develop upstream from my farm, they may affect downstream establishments and agriculture business like mine when they discharge thermal waters from the geothermal plant

2. How does the thermal water discharge affect your farm?

One of the issue is that the water discharge from the facilities sometimes maybe too warm, thus affecting the growth of some of the crops.

3. Are there other issues with geothermal developments to your farms?

One issue is related to the amount of groundwater used. Geothermal energy generation companies may extract more thermal water if the temperature of the well drops, thus reducing the groundwater reservoir."

II. Interview - Local business owner

1. What is your business relation to geothermal energy?

As an elderly care centre, we use geothermal energy for internal heating and hot spring spa facilities in the building. In order to use the geothermal water, our company pay for the partial rights for geothermal water usage and the land rental fee of the well. By sharing the cost water and well rights with other nearby users we can save money as well as negate the need for drilling new wells.

2. What are the areas that you hope can improve on with relation to geothermal development and power?

As one of the water and well rights user, we have to pay for its usage for the thermal water. If possible, I would be interested in sharing with the other land and well rights users to lease, rent or invest in a HGPS. However, initial investment for such facilities are an upwards of 50 million yen. So unless there is are more individuals interested in the investing together it will be difficult for small private business to build their own HGPS.