# CURRENT STATUS OF DEVELOPMENT OF GEOTHERMAL POWER GENERATION IN JAPAN

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**Key words: power generation. Japan**

## Abstract

The current status of geothermal pover plants, nev site development and R & D in nev technologies are presented. Installed capacity of geothermal power plants in Japan is 298,705kW as of July 1994. in the next tvo years, 230kW vill he added making the total installed capacity 52911 by 1996. The Japanese Government is providing various programs to support the development and grants to cover a part of plant construction costs. The goal is to achieve a total capacity of 600kW in the year 2000, and 2,800kW by the year 2010.

## 1. INTRODUCTION

The first experimental geothermal power generation in Japan vas carried out in 1925 in Beppu. Kyushu. The first utility size commercial power generation started in 1966 at Yatsukava. With the "Oil crisis" in 1973 as a turning point. the development of nev geothermal fields vas accelerated. As a first result. Eatchobaru Unit 2 vas completed in 1990 and several nev geothermal pover plants vere put on line or are near to completion. Compared to the pover generated by geothermal plants of 1,400GWh/yr during 1985 and 1989. it increased to 1,724GWh in 1990.

The Central Electric Pover Council expects geothermal poser generation be 4,000GWh in the year 2000, vhich vill be 0.4% of the projected national gross power demand. Table 1 shovs various types of power generation in Japan both at present and in the future. Figure 1 shovs locations of existing and planned power plants as well as sites of nev development. Figure 2 depicts the locations vhere the promotion survey by NEDO are being carried out. Tables 2 and 3 contain detailed information concerning the sites shovn in Figures 1 and 2. Table 4 shows the details of vells drilled from January 1990 to December 1994.

## 2. GEOTHERMAL POWER PLANTS

### 2.1 In Operation

Details of pover plants are shovn in Table 2. Data about reservoir and vells are shovn in Tables 3 and 4. Follovings are some topics ahout existing pover plants.

- Yatsukava -

Since the replacement of the steam turbine and the revinding of the generator stator in 1993. the plant output has increased from 22kW to 23.5kW.

- Uenotai -

This 27.5kW plant vas put on line in March 1994. It is the nevest geothermal pover plant in Japan at the time of writing this article. To reduce the height of the pover station in consideration of the impact on the surrounding landscape. special measures were taken including installation of the top exhaust steam turbine on the first floor and lower cooling tover with increased number of cells. Some of the production vells are steam dominated.

- Onikobe -
New technology to utilize highly acidic brine was developed. Brine of pH as low as 3.3 can he used for power generation. The plant is remotely supervised from Isogo thermal power station in Yokohama which is about 400km away.
- Eatchobaru -
Unit 2 was added in March 1990 making the plant total output 110MW. The plant is remotely supervised from Otake geothermal power plant which is 2km away. The plant output can he remotely controlled.

**2.2** UNDER CONSTRUCTION
Details of planned power plants are shovn in Table 2. Data about reservoirs and wells are shown in Tables 3 and 4.
- Sumikawa -
The area is one of heavy snowfall where the accumulation reaches 450cm. This plant will employ hybrid cooling tower to prevent the freezing of steam plume on tree branches.
- Yanaizu-Nishiyama -
This 65MW unit will be the biggest geothermal unit in Japan once completed.
- Ogiri -
The construction of this plant was the first permitted in a National Park area since 1972.
- Yamagawa -
This power plant is being built on flat land near the ocean while all other geothermal power plants in Japan are located in mountainous areas.

**2.3** Sites of New Development
- Hachijojima -
Tokyo Electric Power Co. bas been conducting exploratory work since 1993 as a continuation of promotional survey work by NEDO which was carried out for three years on this small volcanic island 200km south of Tokyo. The installation of a 3Y1 unit is being considered.
- Oguni -
Electric Power Development Co. has developed the field and a 20MW double flash power plant is planned.

## 3. PROMOTIONAL PROGRAMS BY GOVERNMENT

The Japanese government provides various programs to promote the development of geothermal energy. The Agency of Natural Resources and Energy (ANRE) and The Agency of Industrial Science and Technology (AIST), both organizations in YITI. are heavily involved in geothermal development. Table 6 shows YITI budget related to geothermal development for FY 1994.

3.1 Grant for Exploratory Wells
ANRE grants 50% of the drilling cost of exploratory vells intended for power generation.

**3.2** Grant for Power Plant Construction
ANBE grants 20% of tangible costs such as drilling of production and reinjection vells. construction of steam and hot water pipelines. the steam turbine and the

Tablel. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY

| | Geothermal | | Fossil Fuels*1 | | Hydro | | Nuclear | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Capacity MWe | Gross Prod. GWh/yr | Capacity MWe | Gross Prod. GWh/yr | Capacity MWe | Gross Prod. GWh/yr | Capacity MWe | Gross Prod. GWh/yr | Capacity MWe | Gross Prod. GWh/yr |
| In Operation in January 1995 | 299 | 1,722 | 113,160 | 550,257 | 38,592 | 105,674 | 38,376 | 249,256 | 190,427 | 906,909 |
| Under construction in January 1995 | 230 | - | 16.590 | - | 5,320 | - | 6,710 | - | 28,850 | - |
| Total projected use by 2000 | 600 | 4,000 | 148,100 | 538.000 | 45,500 | 96,000 | 45,100 | 308,000 | 239,300 | 946,000 |

generator. This program was applied at 13 power plants and for 69 wells during 1990 and 1993.

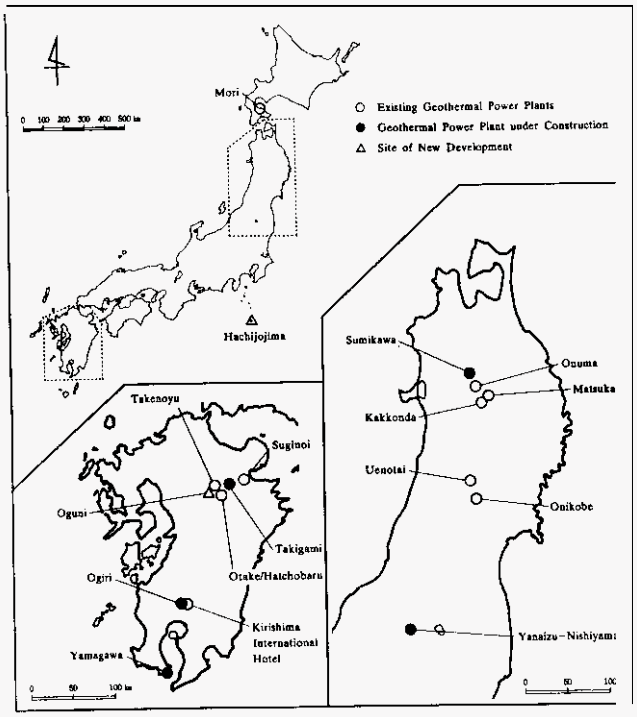


Fig.1 Geothermal areas for Power Generation

### 3.3 NEDO Projects

NEDO was established in 1980 as a central body to conduct the development of new types of energy to save petroleum. ANBE and AIST execute their policies through NEDO.

Highlights among the activities of NEDO are:

a)Geothermal Development Promotion Survey Project

The aim of this project is to promote development by the private sector by taking risks inevitable to early stage of geothermal development. There are three categories rhickh range from wide area survey work to pre-feasibility studies.

Category A: 100 - 300km$^2$
B: 50 - 70km$^2$
C: 5 - 10km$^2$

Category C is carried out in selected areas considered to he most promising based on collected information. The work

TABLE2. UTILIZATION OF GEOTHERMAL ENERGY FOR ELECTRICAL GENERATION IN DECEMBER 1994

1)Type of Unit DS:Dry Steam,DF:Double Flash SF:Singl Flash
2)Data fur 1994 if abailable,otherwise for 1993

| Region | Power Plant name | Year Commissioned | No.of Units | Status | Type of Unit 1) | Unit Rating MW. | Total Installed Capacity MW. | Annual Energy Prod.2 MWh/yr | Total under Const.or Planed MW. |
|---|---|---|---|---|---|---|---|---|---|
| Hokkaido | Mori | 1982 | 1 | Operats | DF | 50.0 | 50.0 | 176 | - |
| Tohoku | Mastukawa | 1966 | 1 | operational | DS | 23.0 | 23.5 | 165 | - |
| | Onuma | 1974 | 1 | Operational | SF | 10.0 | 9.5 | 70 | - |
| | Onikobe | 1975 | 1 | Operational | SF | 25.0 | 12.5 | 93 | - |
| | Kakkonda | 1978 | 1 | Operational | SF | 50.0 | 50.0 | 375 | |
| | Kakkonda | 1996 | 1 | Under Const | SF | - | | - | 30.0 |
| | Uenotai | 1994 | 1 | Operational | SF | 27.5 | 27.5 | 42 | - |
| | Sumikawa | 1995 | 1 | Under Canst | SF | | | - | 50.0 |
| | Yanaizu-nishiyas | 1995 | 1 | under Const | SF | | | - | 65.0 |
| Kyushu | Otake | 1967 | 1 | Operational | SF | 12.5 | 13.5 | 100 | |
| | Hatchobaru | 1977 | 1 | Operational | DF | 55.0 | 55.0 | 328 | |
| | Hatchobaru | 1990 | 1 | Operational | DF | 55.0 | 55.0 | 363 | |
| | Suginoi | 1981 | 1 | Operational | SF | 3.0 | 3.0 | 10 | |
| | Kirishima Intr.Hote | 1984 | 1 | Operational | SF | 0.1 | 0.1 | 0 | |
| | Takenoyu | 1991 | 1 | Operational | SF | 0.2 | 0.105 | 0 | - |
| | Yamagawa | 1995 | 1 | under Canst | SF | - | | - | 30.0 |
| | Ogiri | 1996 | 1 | under Canst | SF | - | | - | 30.0 |
| | Takigami | 1996 | 1 | Under Canst | SF | - | - | - | 25.0 |
| Total | - | - | - | - | - | - | - | 1.722, | - |

includes drilling of production wells and estimates of reservoir characteristics. A total of 15 sites (Category A:2, B:11, C: 2) were surveyed under this project from 1990 to 1993 as shown in Figure 2.

b)Small Geothermal Power Generation Unit

NEDO sponsored the design, manufacture and demonstration testing of a 200kW condensing unit and a 300kW back pressure unit. The purpose was the popularization of small scale power generation using bot spa steam abundant in Japan.

c)Small Binary Geothermal Power Generation Systems

These systems will be suitable for brine temperature of 80 - 150deg.C. A 100kW system will be tested at the Otake area in FY 1994 and 95, and a 500kW system will be tested at the Takigami area in FY 1996 and 97.

d)Development of Reservoir Evaluation Technology

A computor simulation method for wellfields vas developed during FY 1984 and 92. Ogiri. Suaikawa. Mori and Oguni were selected as model fields for the simulation study.

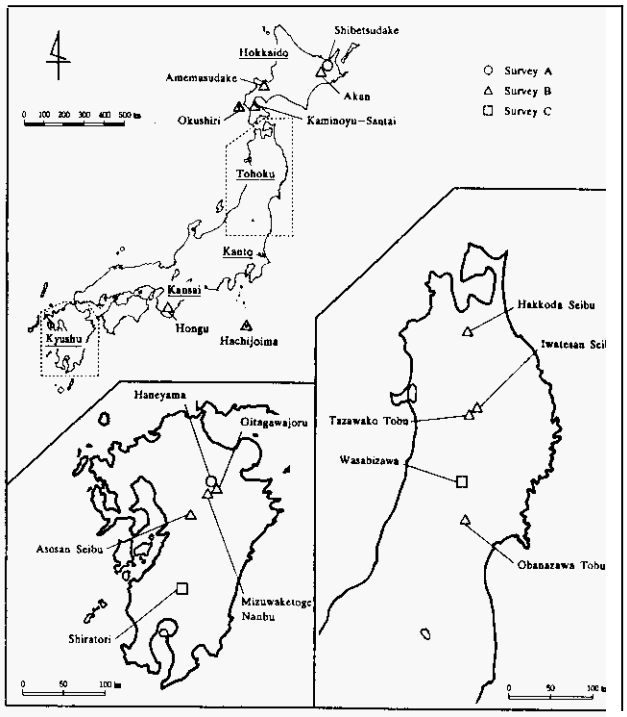


Fig.2 Location of Geothermal Development Promotion Survey Area

TABLE 3. INFORMATION ABOUT GEOTHERMAL LOCALITIES

1)Main type of rock
2)Total dissolved solids(TDS) in water befor flashing."v" is the symbol of vaper dominated
3)N=Identified geothermal locality. but no assessment information availabl
F-Feasahility studios
U=Commercial utilization

| Locality | Location To Nearest 0.5Degree | | Reservor | | ratus in January 1995 | Reservor Temp. | |
|---|---|---|---|---|---|---|---|
| | Latitude | Longitude | Rock 1) | Disolved Solic mg/kg 2) | 3) | Estimated | Masured |
| Hokkaido | | | | | | | |
| Mori | 42.0N | 140.5E | Pre-Tertiary Lime stone | 10,000-16,00( | U | 250 | 240-280 |
| Tohoku | | | | | | | |
| Matsukawa | 40.0N | 141.0E | Tertiary tuff | V | U | - | 200-285 |
| Onuma | 40.0N | 141.0E | Teritiary Volcanics | 1,350 | U | 200-230 | 215 |
| Onikobe | 39.0N | 140.5E | Tertiary | 6,000-9,300 | U | - | 235-256 |
| Kakkonda | 40.0N | 141.0E | Tertiary tuff,gnite | 2,000 | U | - | 210-350 |
| Uenotai | 39.0N | 140.5E | Pretertiary metamorphic | 770 | U | 290-315 | 283-307 |
| Sumikawa | 40.0N | 141.0E | Tertiary Vol -canic rocks | 1,500 | U | 250-320 | Max 317 |
| Yanaizu-Nishiyama | 37.5N | 139.5E | Green tuff | 18,946-3,225 | U | 260-320 | Max 314 |
| Kyushu | | | | | | | |
| Otake | 33.0N | 131.0E | Andesite | 3,500 | U | - | 190-240 |
| Hatchobaru | 33.0N | 131.0E | Andesite and Tuff breccia | 4,200 | U | - | 220-280 |
| Suginoi | 33.5N | 131.5E | Andesite | - | U | | 190-240 |
| Kirishima Inte.Hotel | 32.0N | 131.0E | Andesite | - | U | 220 | - |
| Takenoyu | 33.0N | 131.0E | - | | U | - | - |
| Yamagawa | 31.0N | 130.5E | Deisaite | 30,000 | U | - | Max 374 |
| Ogiri | 32.0N | 131.0E | Pyroxene Andesite | 2,185 | U | - | Max 232 |
| Tkigami | 33.0N | 131.5E | Desite and Andesite | 2,100 | U | 200-260 | Max 252 |
| Oguni | 33.0N | 131.0E | Quaternary | | F | - | Max 248 |

e)Confirmation Study of Effectiveness of Prospecting Techniques for Deep Resources

From FY 1988 to 93 NEDO developed technologies to precisely deliniate deep fracture systems. They include the array type CSYT system and related analysis software. reflection method using seismic saves. VSP, seismic tomography and practical data processing system and analysis software using micro earthquakes.

f)Survey of Deep-seated Geothermal Resources

This is a part of the New Sunshine project sponsored by YITI. To harvest deep-seated geothermal resources efficiently and safely. the R & D of drilling technologies and production technologies are being carried out. The Kakkonda area has been selected as the survey site and one 4,000m well will be drilled to explore the conditions and the characteristics of deep terrestrial heat.

g)Hot Dry Rock Power Generation System

A test to extract heat from the fracture artificially made at the depth of 1800m at the experimental site in Yamagata Prefecture was carried out in 1991. A circulation-heat extraction test with 2200m deep artificial reservoir is being prepared.

h)Development of 10KW Binary Cycle Power Plant

Preparatory work for the demonstration test including the test of components. observation of the fluctuation of underground water level at the test site and the development of a real time well data aquisition system are being carried out.

### 3.4 AIST Projects

Followings are organizations under AIST and the major subjects related to geothermal energy currently being studied.

TABLE 4. WELLS DRILLED FOR ELECTRICAL AND COMBIND USE OF GEOTHERMAL RESOURCES FROM JANUARY 1,1990 TO DECEMBER 31,1994

1)type or purpose of well
E-Exploration
P-Production
I=Injection
2)Total flow rate at given wellhead pressure(WHP)

| Locality | Year Drilled | Well Numbe | ype of Well | Total Depth m | Max Temp. | Fluid Enthalp kJ/kg | Well Ou ow Rate kg/s | ut WHP bar |
|---|---|---|---|---|---|---|---|---|
| okkaido | | | | | | | | |
| Mori | 1991-1994 | 2 | P | 6,226 | 270-285 | 2,791 | 80 | 13 |
| | 1992 | 1 | I | - | - | - | - | - |
| ohoku | | | | | | | | |
| Matsukawa | 1990 | 1 | P | 1,130 | 200 | 2,757 | 40 | 4 |
| Onuma | - | - | - | - | - | - | - | - |
| Onikobe | 1990-1994 | 3 | P | 4,015 | 180-214 | 2,786 | 100 | 9-2( |
| | 1991 | 1 | I | 800 | - | - | - | - |
| Kakkonda | 1990-1993 | 3 | P | 7,186 | over300 | 2,770 -2,78 | 230 | 1-7 |
| Uenotai | 1991 | 2 | P | 4,141 | 197 | 2,795 | 56 | 15 |
| | 1990-1992 | 6 | I | 7,352 | - | - | - | - |
| | 1990-1992 | 1 | E | 1,493 | - | - | - | - |
| Sumikawa | 1990 | 1 | P | 2,512 | 274 | 2,757 | 35 | 6 |
| | 1990-1994 | 5 | I | 8,605 | - | - | - | - |
| Yanaizu-Nishiyama | 1990-1993 | 7 | ',I | 13,458 | 181-319 | 2,543' -2,14 | 47-131 | 7-1 |
| yushu | | | | | | | | |
| Otake | 1990-1994 | 6 | I | 3,568 | - | - | - | - |
| Hatchobaru | 1990-1994 | 4 | P | 7,670 | 244 | 1,793 | 140 | 6-9 |
| | | 5 | I | 6,298 | - | - | - | - |
| Hatchobaru | 1990-1994 | 2 | P | 3,625 | 270 | 1,483 | 78 | 6-8 |
| | | 1 | I | 1,500 | - | - | | - |
| Suginoi | - | - | - | - | - | - | | - |
| Kirishima Inte.Hotel | 1994 | 1 | P | 300 | 140 | 2,736 | 5 | 3 |
| Takenoyu | - | - | - | - | - | - | - | - |
| Yamagawa | 1994 | 2 | P | 3,910 | - | 1,844 | 56 | 10 |
| | 1994 | 1 | I | 1,245 | - | - | - | - |
| Ogiri | 1990-1991 | 7 | P | 9,135 | 232 | 2,726 | 252 | 4 |
| | 1990-1991 | 7 | I | 8,096 | - | - | - | - |
| Takigami | 1993 | 1 | P | 2,151 | 240 | - | 15 | 2 |
| | 1990-1994 | 2 | I | 3,402 | - | - | - | - |
| Oguni | 1990-1994 | 7 | E | 7,810 | 159-164 | 2,749 | 80 | 5-6 |

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1)type or purpose of well
E=Exploration
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I=Injection
2)Total flow rate at given wellhead pressure(WHP)

| Locality | Year Drilled | Well Number | Type of Well | Total Depth m | Max Temp. | Fluid Enthalpy kJ/kg | Well Output 2 Flow Rate kg/s | Well Output 2 WHP bar |
|---|---|---|---|---|---|---|---|---|
| Hokkaido | | | | | | | | |
| Mori | 1991-1994 | 2 | P | 6,226 | 270-285 | 2,791 | 80 | 13 |
| | 1992 | 1 | I | - | - | - | - | - |
| Tohoku | | | | | | | | |
| Matsukawa | 1990 | 1 | P | 1,130 | 200 | 2,757 | 40 | 4 |
| Onuma | - | - | - | - | - | - | - | - |
| Onikobe | 1990-1994 | 3 | P | 4,015 | 180-214 | 2,786 | 100 | 9-20 |
| | 1991 | 1 | I | 800 | - | - | - | - |
| Kakkonda | 1990-1993 | 3 | P | 7,186 | over300 | 2,770 -2,782 | 230 | 11-73 |
| Uenotai | 1991 | 2 | P | 4,141 | 197 | 2,795 | 56 | 15 |
| | 1990-1992 | 6 | I | 7,352 | - | - | - | - |
| | 1990-1992 | 1 | E | 1,493 | - | - | - | - |
| Sumikawa | 1990 | 1 | P | 2,512 | 274 | 2,757 | 35 | 6 |
| | 1990-1994 | 5 | I | 8,605 | - | - | - | - |
| Yanaizu-Nishiyama | 1990-1993 | 7 | P,I | 13,458 | 181-319 | 2,543 -2,145 | 47-131 | 7-11 |
| Kyushu | | | | | | | | |
| Otake | 1990-1994 | 6 | I | 3,568 | - | - | - | - |
| Hatchobaru | 1990-1994 | 4 | P | 7,670 | 244 | 1,793 | 140 | 6-9 |
| | | 5 | I | 6,298 | - | - | - | - |
| Hatchobaru | 1990-1994 | 2 | P | 3,625 | 270 | 1,483 | 78 | 6-8 |
| | | 1 | I | 1,500 | - | - | - | - |
| Suginoi | - | - | - | - | - | - | - | - |
| Kirishima Inte.Hotel | 1994 | 1 | P | 300 | 140 | 2,736 | 5 | 3 |
| Takenoyu | - | - | - | - | - | - | - | - |
| Yamagawa | 1994 | 2 | P | 3,910 | - | 1,844 | 56 | 10 |
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| Ogiri | 1990-1991 | 7 | P | 9,135 | 232 | 2,726 | 252 | 4 |
| | 1990-1991 | 7 | I | 8,096 | - | - | - | - |
| Takigami | 1993 | 1 | P | 2,151 | 240 | - | 15 | 2 |
| | 1990-1994 | 2 | I | 3,402 | - | - | - | - |
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- Geological Survey of Japan

a)Research on Exploration Technologies of Deep-seated Geothermal Resources

b)Analysis and Evaluation of Data Acquiredby the Confirmation Study of the Effectiveness of Prospecting Techniques for Deep-seated Geothermal Resources

- Institute for Resources and Environment

a)Extraction Technologies for Geothermal Energy

b)Hot Dry Rock Porer Generation System

c)Analysis and Evaluation of the Condition-Yonitoring System related to Well Drilling

d)Analysis and Evaluation of Bot Dry Bock Heat,Extraction System

e)Analysis and Evaluation of Deep Geothermal Resources Extraction Technologies

-Tohoku Industrial Research Institute

a)Research on Geothermal Materials

b)Analysis and Assessment of Bydrothermal Systems

TABLE5 WELLS DRILLED FOR PROMOTING GEOTHERMAL DEVELOPMENT FROM JANUARY 1, 1990

*( ) : Plan of completation until March 31. 1994

| | Locality | Aria $km^2$ | Year Drilled | Location To Nearst 0.5 Degree Latitude | Location To Nearst 0.5 Degree Longitude | Well Thermal Gradient | Well Exploration | Well Max Temp. ℃ |
|---|---|---|---|---|---|---|---|---|
| Survey A | Shibetudake | 300 | 1994~Continue | 43.5N | 144.5E | 800m×3 | – | 92 |
| | Haneyama | 300 | 1993~Continue | 33.5N | 131.5E | 400m×3<br>600m×2<br>900m×1) | (1400m×1)<br>(1600m×1) | 57 |
| Survey B | Akan | 75 | 1988~1990 | 43.5N | 144.0E | 500m×2 | 1000m×2<br>1200m×2<br>1500m×2<br>1700m×1 | 292 |
| | Okushiri | 70 | 1990~1992 | 42.0N | 139.5E | 400m×2 | 1200m×5<br>1500m×1 | 181 |
| | Kaminoyu Santai | 70 | 1990~1992 | 42.0N | 140.5E | 400m×3 | 1000m×2<br>1200m×1<br>1500m×2<br>1800m×2 | 197 |
| | Amemasudake | 70 | 1991~Continue | 43.0N | 141.0E | 400m×6 | 1000m×1<br>1300m×2<br>1485m×1<br>1500m×1 | 205 |
| | Hakkoda Seibu | 55 | 1989~1991 | 40.5N | 141.0E | – | 1000m×4<br>1500m×3<br>1564m×1 | 219 |
| | Iwatesan Seibu | 60 | 1989~1991 | 40.0N | 141.0E | – | 1000m×3<br>1200m×3<br>1500m×1<br>1700m×1 | 316 |
| | Tazawako Tobu | 65 | 1988~1990 | 40.0N | 140.5E | – | 1000m×4<br>1500m×4 | 289 |
| | Obanazawa Tobu | 65 | 1988~1989 | 38.5N | 140.5E | 400m×7 | 1000m×1<br>1360m×1<br>1703m×1 | 142 |
| | Hachijyojima | 70 | 1989~1991 | 33.0N | 140.0E | – | 510m×1<br>1000m×3<br>1200m×1<br>1300m×1<br>1500m×2 | 316 |
| | Hongu | 70 | 1991~1992 | 34.0N | 135.5E | 200m×7<br>400m×3 | 1000m×2 | 105 |
| | Mizuwaketoge Nanbu | 80 | 1990~1992 | 33.0N | 131.5E | – | 1000m×3<br>1200m×1<br>1300m×1<br>1500m×2<br>1700m×1<br>2000m×1 | 243 |
| | Oitagawa Joryu | 70 | 1988~1989 | 33.0N | 131.0E | 400m×3 | 1000m×2<br>1500m×1<br>1700m×1 | 103 |
| | Asosan Seibu | 70 | 1991~1993 | 33.0N | 131.0E | 400m×3 | 1000m×1<br>1200m×3<br>1700m×2<br>1800m×1 | 216 |
| Survey C | Wasabizawa | 7.8 | 1993~Continue | 39.0N | 140.5E | – | 1400m×1<br>1500m×1<br>(1500m×1) | 286 |
| | Shiratori | 7.5 | 1992~Continue | 32.0N | 131.0E | – | (2000m×3) | |

### 3.5 Other Organizations

-New Energy Foundation (NEF)

The NEF is a privately funded organization that promotes utilization of new types of energy. and is vorking closely vith MITI and NEDO. The NEF GeothermaL Division, which has a staff of 25. does survey work both domestic and international. organizes several committees and publishes activity reports. The Geothermal Committee submits Recommendations regarding policy for geothermal energy development to the government. NEF publishes CEINETSU ENERGY magazine four times a year.

-Central Research Institute of Electric Pover Industry (CRIEPI)

CRIEPI is carrying out the research on Hot Dry Bock pover generation. It succeeded in forming multiple stage fractures in 1000m wells in 1991 at Ogachi. Akita.

The Japan Geothermal Energy Association (JGEA) and the Geothermal Research Society of Japan (GRSJ) also publish magazines and conduct tours. seminars and annual meetings. Table 7 shows memberships of both JGEA and GRSJ.

## 4. CONCLUSION

By the end of 1996. the installed capacity of geothermal power plants in Japan will reach 53011. Though this is still only 0.2% of the total pover generating capacity. geothermal is an important national energy resource for Japan. Efforts will be continued to increase the utilization of geothermal energy in both government and private sectors.

Table6. TOTAL INVESTMENT IN GEOTHERMAL IN (1994)US$ BY JAPANESE GOVERNMENT(MITI)

| Period | The Agency of Natural Resources and Energy, (ANRE) | Agency of Industrial Science and Technology (AIST) | Total |
|---|---|---|---|
| FY1975-FY1984 | 595 | 384 | 979 |
| FY1985-FY1994 | 1,113 | 519 | 1.632 |

| Year | JAPAN GEOTHERMAL ENERGY ASSOCIATION (JGEA) | | GEOTHERMAL RESEARCH SOCIETY OF JAPAN (GRSJ) | |
|---|---|---|---|---|
| | Corporate | Individuals | Corporate | Individuals |
| 1990 | 101 | 480 | 114 | 840 |
| 1991 | 105 | 493 | 117 | 842 |
| 1992 | 106 | 496 | 115 | 836 |
| 1993 | 108 | 482 | 117 | 823 |
| 1994 | 111 | 466 | 116 | 828 |