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A TYPICAL EXAMPLE OF DIRECT USE OF GEOTHERMAL ENERGY IN A SMALL VILLAGE IN JAPAN

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1. Introduction

Japan is blessed with a lot of thermal springs which are possible sources for direct use of geothermal energy, because their wellhead temperature is too low to generate elecmc power. In fact. in Japan, in addition to power generation of 269.6 MWe, geothermal energy is used directly for various applications at a number of sites. But. embarrassingly, as the Japanese has enjoyed unbelievably the pleasures of bathing, thermal spring water is easily supplied to hotels and inns in spas for bathing. The total number of annual guests in spas is 131 million, which is larger than the population of Japan of 123 million, although the guests are almost not for balneotherapy. Then, direct use of geothermal energy in Japan is required to coexist with bathing.

A typical example of coexistence of active direct use with bathing is found in Kamitakara, Gifu prefecture, in central Japan. Kamitakara is located in the northeast part of Gifu prefecture (Fig. 1). The area is 472 km^2 and the population is 4800. The eastern part of Kamitakara, known as Oku Hida spa, on a mountainside of Yakedake volcano has many thermal springs. and the total number of annual guest is 1.2 million.

In the present report. it is attempted to illustrate briefly the various kinds of direct use in Kamitakara and to estimate the total installed thermal power and the total thermal energy used.

2. Direct use applications

2.1. Space heating

In the four subregions of Hirayu, Fukuji, Tochio and Shinhotakae of eastern Kamitakara shown in Fig.1, space heating is in practice coexisting with bathing. Residences and resort hotels and inns use thennal spring water of 60 to 98°C for bathing after lowering its temperature down to about 50°C by means of simple heat exchangers. The heat exchanger consists of a tank filled with flowing thermal spring water and some coiling tubes fixed in the tank. Fresh water is heated up to 65°C during its flowing through the coiling tubes to deliver into fan coil type radiators for space heating. The total flow rate of thermal spring water is approximately 13,600 Vmin for space heating in the 40 hotels and inns and 76 residences. The operating period of space heating is usually from mid October to mid April or early in May.

2.2. Fish breeding

There are three aquabusiness's in Kamitakara. Nagase snapping turtle breeding farm in Hirayu subregion having 17 ponds of 100 m^2 each and 10 ponds of 10 m^2 each uses 540 l/min of thermal spring water at 35.5°C to raise 20 thousands snapping turtles. This farm breeds also tilapia in the three ponds of 100 m^2 each.

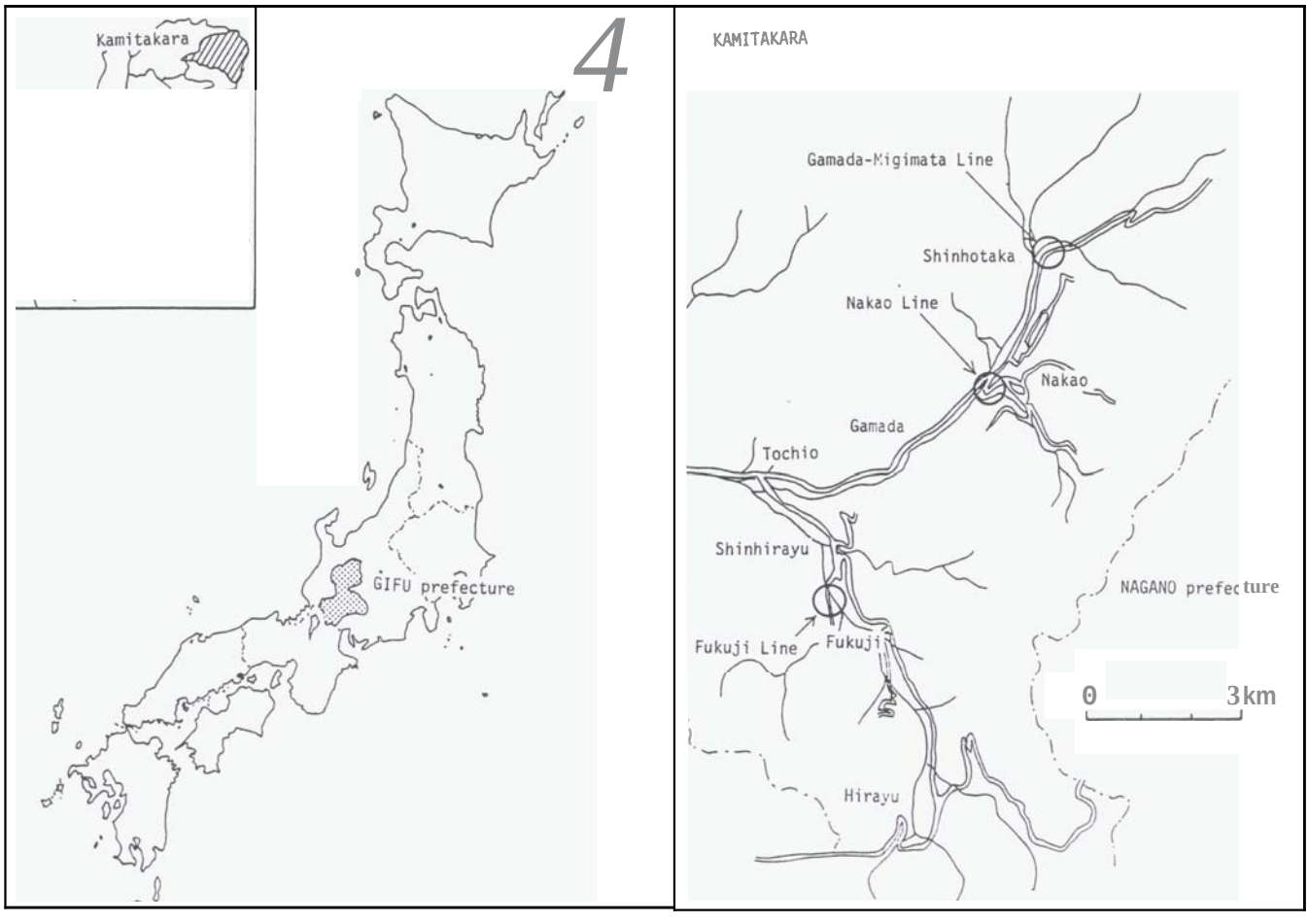

Table 1. The installed thermal power (ITP) and the thermal energy used (TEU) of direct use applications of geothermal energy in Kamitakara (Unit:MWt)

Sub-region	Space heating		Fish breeding		Snow melting		Pool		Greenhouse		Total	
	ITP	TEU	ITP	TEU	ITP	TEU	ITP	TEU	ITP	TEU	ITP	TEU
Hirayu	13.06	6.53	0.39	0.31							13.45	6.84
Fukuji	0.70	0.35			0.13	0.04					0.83	0.39
Shin-hirayu			0.64	0.64			0.21	0.07			0.85	0.71
Tochio	2.51	1.26							0.05	0.03	2.56	1.29
Gamada			0.38	0.28							0.38	0.28
Nakao					0.17	0.05					0.17	0.05
Shin-hotaka	0.10	0.05			0.22	0.07					0.32	0.12
Total	16.37	8.19	1.41	1.23	0.52	0.16	0.21	0.07	0.05	0.03	18.56	9.68

Uetani-hotaka ayu breeding farm in Gamada subregion mixes water of 450 Vmin at 32°C from an owned thermal spring well with water of 60°C piped about 5 km distance from another well and fresh water to produce fresh heated water of 20°C for supplying to breeding ponds.

Mori eel breeding farm in Shinhirnyu subregion uses water from three thermai spring wells of 400 l/min at 34°C, 320 l/min at 50°C and 300 l/min at 34°C to raise eel in 27 ponds.

2.3. Snow melting

Since Kamitakara is located on a sloping mountainside of Yakedake volcano and belongs to cold and snowy climate, Kamitakara has so far constructed three roads equipped with snow melting system, for topographical and climatical demand to maintain roads safety.

Nakao line is the first road, where the snow melting system was built in 1980 and since then operated successfully in Kamitakara. The length of the road is 1080 m and the width is 5 to 6 m (the area of 5940 m^2). Thermal spring water of 90 l/min at 35°C passes through four embedded polybuthene pipes with the outlet temperature of 15°C. A diverged road of 120 m long and 7 m wide from the main road has been also completed in 1988, with the snow melting system consisting of six embedded polybuthene pipes. The flow rate is 40 l/min and the inlet and outlet temperatures are 35°C and 20°C, respectively

Gamada-Migimata line of 340 m long and 6 m wide (the area of 2040 m2) freezes frequently in winter. Thermal spring water of 60 Vmin at 75 to 80°C is pumped up to the uppermost part of the road to flow down gravitationally through six 20 mm polybuthene pipes embedded within the pavement at the depth of 12 cm. The water temperature drops to 32°C at the outlet after passing through the system. This snow melting system opened in December 1984.

Fukuji line of 440 m long and 7 m wide (the area of 3080 m^2) has a snow melting system consisting of ten 25 mm pipes embedded within the pavement. This was constructed in 1988. The inlet and outlet temperatures of the system are 69°C and 34°C, respectively, and the flow rate is 90 l/min.

2.4. Pool

An indoor pool is operated during the period from April to November. A heat exchanger processes thermal spring water of 100 Vmin at 60°C to supply fresh heated water for maintaining the water temperature of pool at 30°C. The number of visitor is 15,000 per year.

2.5. Greenhouses

In two greenhouses (212.6m^2 each) soil is warmed by use of 30 l/min of thermal spring water at 57°C passing through embedded pipes. Heating period is usually from October to May.

3. Conclusion

As was mentioned above, though small, Kamitakara has carried out almost all kinds of direct use which are found in Japan and all over the world. The data of the inlet and outlet temperatures and the flow rate make it possible to estimate installed thermal power and moreover thermal energy used by multiplying the load factor. Unfortunately those data, in particular the outlet temperature, are frequently not available. If some assumptions are permitted and estimates from similar facilities are carried out the installed thermal power and the thermal energy used can be computed. The results are shown in Table 1.

The installed thermal power is totally 18.56 MWt and space heating of 16.37 MWt, which coexists with bathing, ranks the top occupying 87%. On the other hand, the thermal energy used is found to be 9.68 MWt, in which space heating covers also 85% of the totals. Dividing 9.68 MWt of the thermal energy used by 18.56 MWt of the installed thermal power, the average load factor of 52% is obtained.

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