THE NATURAL HEAT RESOURCES OF ICELAND

Memorandum compiled by the Department for Natural Heat, State Electricity Authority, Reykjavik.

Introduction

The following memorandum is compiled in order to give a brief description of the natural heat resources of Iceland, the present status of exploitation and a brief discussion of future projects and prospects.

For a more detailed exposition of geological and physical aspects the reader is referred to the following paper: "Hot Springs and the Exploitation of Natural Heat Resources in Iceland" by Gunnar Bödvarsson.

The Natural Heat Resources

Two types of thermal areas may be distinguished in Iceland, i.e. the low-temperature areas characterized by hot-water springs, and the high-temperature areas characterized by natural steam holes in the ground.

The low-temperature areas are scattered over most parts of the country with the exception of the eastern parts where there are no hot springs. The number of low-temperature areas is around 250 and the number of the individual major springs is around 600. A considerable part of the activity is located in the South-West relatively near to Reykjavik, the capital. One area of major interest is located in the city as will be discussed below. The total natural heat output of the low-temperature areas is around 400 Gcal/hour.

The high-temperature areas are located in Neo-Volcanic zone in the central and southern parts of the country. These areas are closely related to the volcanism and are characterized by high temperatures and large areas of thermal metamorphism.

There are 13 high-temperature areas with a natural heat output of around 3,000 Gcal/hour. Two areas are located relatively near to the city of Reykjavik.

Exploration has revealed that the low-temperature areas have in most cases a subsurface temperature below 150° C whereas the high-temperature areas have temperatures up to 240° C at depths not more than 300 to 400 meters.

Exploitation by drilling

The first attempt to increase the natural output of a thermal area in Iceland was carried out in 1928. A number of wells were drilled in the thermal area in the city of Reykjavik. The work was successful and drilling has been carried out on an increasing scale since. In 1958 a modern oil-field rotary rig was put into operation in the region around Reykjavik.

As now the total integrated depth of hot-water and natural steam wells in Iceland amounts to around 70,000 meters. The deepest well is in the city of Reykjavik and is 2,200 meters deep.

The three major results of the drilling activities are given in the following table.

TABLE (1)

Results of drilling in three major areas

(1) Name of area		Reykir	Reykjavík	Hveragerði
(2) Location		16 km NE of Reykjavik	in the city	45 km E of Reykjavik
(3) Natural flow	l/sec	100	10	
(4) Temperature of (3)	°C	80	88	
(5) Natural heat output	Gcal/hour	40	6	100
(6) Number of wells		70	40	8
(7) Integrated depth	meters	24,000	18,000	6,000
(8) Maximum depth	meters	1,380	2,200	1,250
(9) Free flow of wells	l/sec	370	135	500
(10) Temperature of (9)	°C	80-93	80-147	180-225
(11) Heat output of wells	Gcal/hour	116	55	380
(12) Increase ratio (11)/(5)		2,9	9	3,8

In passing, it should be mentioned that results of a similar nature have been obtained in other thermal areas in the world. Drilling in thermal areas both in Tuscany, Italy, and in New Zealand has produced an output of heat which is substantially greater than the original natural output of the thermal areas.

Present utilization

Natural heat is at present utilized in three ways in Iceland, i.e. (1) for domestic heating, (2) green-house heating and (3) heating of swimming pools.

District heating systems have been installed in the capital, Reykjavik, and the following communities, Ólafsfjördur, Saudárkrókur, Selfoss and Hveragerdi. The system in Reykjavik was put into operation in 1943 and supplies now domestic

heating for about 40,000 people. The other much smaller systems were put into operation in the years 1943 to 1958 and serve a total of 5,000 people.

The floor area of all green-houses operated by natural heat in Iceland is now approximately 100,000 square meters. The number of heated swimming pools is about 80.

The total amount of fuel oil saved by the natural heat installations mentioned above can be estimated as follows:

	fuel savings
Domestic heating	40,000 tons (long) fuel oil/year
Green-houses	15,000 "
Swimming pools	5,000 "

The total annual savings are thus estimated at 60,000 tons, i.e. approximately 350 kg oil per year and inhabitant of Iceland.

Future projects

The total number of inhabitants in the Reykjavik area is now around 85,000, the communities of Kopavogur and Hafnarfjördur included. The annual population increase is around 2,000 giving approximately 105,000 inhabitants in 1970. The number of people not served by the Reykjavik District Heating Service is, therefore, at present 45,000 and will increase to 65,000 in 1970 if no new consumers are added to the system.

The natural heat sources in the area around Reykjavik are no doubt capable of delivering a much larger heat flow than will be consumed for domestic heating by a city of 100,000 inhabitants. This is apparent from the results of the drilling in the area at Hveragerdi mentioned in Table (1). Furthermore, there are no major problems or economical difficulties involved in the piping of hot water over distances as large as 50 km. The extension of the Reykjavik District Heating System to all possible consumers in the Reykjavik

area is, therefore, a sound project which will probably be realized in the coming decade.

The erection of a natural steam power plant at Hveragerdi is the second important project which can be expected to be realized in the coming years. A power plant of a capacity of 15,000 kW will probably be put into operation in 1964. An increased capacity to at least 25,000 kW in 1970 can be expected.

An increased utilization of natural heat for domestic heating outside the Reykjavik area can be expected. The number of people served may in the coming decade increase by at least 5,000.

Based on these figures the expected saving of fuel oil by natural heat in 1970 will be as follows

Domestic heating	100,000	tons (long)fuel oil/year
Green-houses and pools	25,000	"
Power generation	25,000	"

This gives a total of 150,000 tons per year, i.e. about 750 kg per year and inhabitant of Iceland in 1970.

Further possibilities and prospects

In addition to the more realistic projects listed above there are some further possible uses of natural heat which may become of importance in the coming years. These possibilities are now under investigation. The following possibilities can be mentioned:

(1) Production of heavy water
(2) Production of diatomite in northern Iceland
(3) Drying of grass, peat and seaweeds
(4) Production of salt and other materials from the sea
(5) Distribution of high-temperature water for industries in the Reykjavik area.

The production of heavy water is at present the most interesting prospect. There are no difficulties involved but the market for heavy water is uncertain at present. The demand may, however, increase quite suddenly.

An appraisal of the other prospects appears premature at present.

Economic importance of the natural heat resources

In order to give a certain measure of the economic importance of the natural heat resources in Iceland the above figures on the fuel savings can be compared to the per capita production of crude oil in the U.S.A. and West-Germany.

		Annual per capita production or saving of oil
Iceland 1961		350 kg
Iceland 1970	probably	750
U.S.A.		2,000
West-Germany		100

The estimate for Iceland for 1970 does not include any of the prospects (1) to (5) mentioned above.

The well-head cost of the unit heat in the major thermal areas mentioned above is 0.25 to 1.00 $/Gcal which is only 10% to 40% of the minimum price per unit heat from fuel in Western-Europe.

Capital requirements

In order to realize the heating and power generation projects mentioned above the following capital will be required.

Exploration	$ 1 million
Drilling	4 "
District heating systems for 70,000 people	17 "
Power plant 25,000 kw	8 "
Total	$30 million

The figures do not include the prospects mentioned under (1) to (5) above.

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