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# ENERGY IN ICELAND

A short survey
presented by the
Icelandic delegation.

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## INTRODUCTION

Iceland is an island republic in the North-Atlantic, with an area of 103 thousand square kilometres and a population of 229.187 (Dec. 1 1980). The economy is primarily based on fishing and fish-processing industries. Agriculture, which, for climatic reasons, is restricted to animal husbandry, is largely geared to the domestic market. Manufacturing industries are also still mainly based on that market, but export is expanding. Power-intensive industries, based on export, have been established in recent years, and may be expected to expand in the near future.

The per capita GNP in Iceland amounted to U.S. $12100 in 1980 and the country belongs to the group of developed countries. Its industries, agriculture and fishing are all highly mechanized, and the per capita consumption of primary energy, which in 1980 amounted to 309 GJ oil equivalent, is among the highest in the world.

## ENERGY RESOURCES AND USE

Iceland does not possess economic deposits of fossil or nuclear fuels. On the other hand, the country is richly endowed with renewable energy resources in the form of water power and geothermal energy, which up to now have been utilized to a minor degree only. Up to the beginning of the twentieth century, when the Icelandic economy was primarily agrarian, with most of the population living in rural areas, animal wastes, fuel-wood and hand-cut peat were the principal sources of energy. Through the ages, a combination of fuel-wood cutting, grazing and climatic fluctuations has, in the harsh climate of Iceland, had disastrous effects on the country's vegetative cover, giving rise to serious soil erosion. An extensive revegetation and reforestation programme has been established to counteract this deterioration of the vegetation.

The use of these energy resources has now been entirely discontinued. In the rural areas, hydro-generated electricity has replaced dung, fuel-wood and peat for household purposes, while to-day's mechanized agriculture is based on imported oil products and electricity. Practically the whole rural population has now access to electricity. In fishing, wind and muscle power has been replaced by oil. In the urban areas, geothermal energy and electricity supplies the bulk (89%) of space heating requirements, with oil taking care of the remainder. Industry uses electricity for motive power and oil as a source of process heat. Transportation is entirely oil-based.

TABLE 1

Sales of energy to final consumers in Iceland in 1980 (terajoules, TJ)

| Energy sources / Consumption sectors | Hydro power TJ | Geothermal energy TJ | Oil products TJ | Total TJ | Total % |
|---|---|---|---|---|---|
| Domestic consumption | 897 | 14 | 14 | 925 | 1,9 |
| Space heating | 1 357 | 17 111 | 2 646 | 21 114 | 42,3 |
| Industry | 6 919 | 2 048 | 5 371 | 14 338 | 28,8 |
| Fisheries | - | - | 7 207 | 7 207 | 14,4 |
| Trade and Services | 626 | 11 | 11 | 648 | 1,3 |
| Transport | - | - | 5 631 | 5 631 | 11,3 |
| TOTAL | 9 799 | 19 184 | 20 880 | 49 863 | 100,0 |
| % | 19,6 | 38,5 | 41,9 | 100,0 | |

Table 1 shows the energy sold to final customers in Iceland in 1980, by sources and consumption sectors. It is seen that space heating is the largest sector. The reason is the country's cool climate, which makes some heating necessary in all months of the year. The table shows that the renewable indigeneous sources, hydro-power and geothermal energy, account for 58,1% of the consumption. This proportion has been on a steady increase for a long time, but especially after the 1973 oil crisis. Particularily noteworthy is the role of geothermal energy. Its share in the total supply is greater in Iceland than in most, if not all other countries.

## OIL CONSERVATION EFFORTS

It has, for a long time, been a policy of Icelandic Governments to encourage in various ways, replacement of oil by hydro-generated electricity and geothermal heat, the country's indigeneous sources of energy. Prior to the 1973 energy crisis, the reason behind the Government's efforts in this field was not so much oil conservation per se, since oil in those years was a cheap commodity. Rather, the purpose was to bring electricity to the rural population, which by the end of World War II was largely without access to public utilities, and to encourage the development of geothermal heat for space heating purposes by municipalities and individuals by sharing with them the risk associated with drilling. The motivation for rural electrification was largely social, viz. to bring to the rural people the benefits of electricity which the urban population already enjoyed, thereby decreasing the urbanization pressure. For the geothermal effort, the reasons were mainly economical since, even in the days of cheap oil, geothermal heating could often be considerably cheaper than oil heating.

After the 1973 oil crisis, this endeavour was more deliberately aimed at conserving oil in order to ameliorate the impact of the increased oil bill on the national economy. This has now become known as the oil conservation programme. In the geothermal field, steps were taken to increase risk participation by the publicly financed Energy Fund to 60% from previously 40%, and by making more funds available to intensify geothermal development. At the same time the Energy Fund began to provide loans for construction of geothermal heating systems. On the electric side, efforts were undertaken to reinforce the electric distribution systems in rural areas so that they could carry the additional load of full electric heating in those areas. These reinforcements are being financed by Government subsidization via the Energy Fund.

Studies have been undertaken of the feasibility of replacing some of the oil presently consumed by industry, especially the fish-meal industry, by electricity. Also, Government-sponsored information campaigns aimed at oil conservation have been undertaken.

It is expected that the efforts of the oil conservation programme will have practically eliminated oil from the space heating sector by 1985. In industry, progress is expected to be considerably slower, and slower still in transportation and fishing.

Table 2 shows a forecast up to the turn of the century of production and import of primary energy in Iceland, in PJ/year oil equivalent.

TABLE 2

Forecasted production and import of primary energy in Iceland 1980 - 2000 (petajoules, PJ, oil equivalent)

| | 1980 1) | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| Hydro | 30,2 | 41,9 | 52,3 | 82,1 | 92,9 |
| Geothermal | 17,3 | 23,8 | 30,2 | 41,0 | 57,9 |
| Oil products 2) | 23,4 | 23,4 | 23,4 | 23,8 | 24,1 |
| TOTAL | 70,9 | 89,1 | 105,9 | 146,9 | 174,9 |

1) Actual figures
2) Assuming that the oil products are imported, i.e. no domestic refining.

The important feature revealed by this forecast is that the total increase in the supply of primary energy in Iceland, from now up to the turn of the century will come from renewable energy sources, while the contribution from non-renewables will remain essentially at the present level. This means that the relative contribution of non-renewable energy in the supply picture will decline steadily, as shown in Fig. 1.

This is considered a very important achievement and fully in line with the necessary transition away from non-renewable towards renewable sources of energy which inevitably will have to carry the lion's share of man's energy requirements in a more distant future, say, towards the middle of the next century. In this connection it should be mentioned that there seems to be a technical possibility in Iceland to produce synthetic fuels based on electrolytic hydrogen which might be used to replace the import of oil, thus reducing the non-renewable energy supply below the present level. The hydrogen could be produced on the basis of the country's hydro-electric potential. In some cases exhausts from electro-metallurgical industries, which would otherwise constitute an environmental load, might be utilized as a source of carbon for these fuels. In others imported coal or domestic peat would be used to provide the carbon. With present-day technology and oil prices, however, such synfuels are not economically competitive with oil, and it is not known when they will become so. It has, therefore, not been considered prudent to allow for this possibility in the forecast outlined above, which only extends to the next twenty years. But such fuels constitute an interesting future possibility for Iceland, to reduce its oil imports, a possibility that will be vigorously pursued. Conciev ably, such electrolytically-based synfuels could have some impact towards the end of this century.

## INTERNATIONAL ENERGY COOPERATION

Iceland participates in international energy cooperation efforts in a number of ways. At Government level, the country, which belongs to the Nordic or Scandinavian group of countries, takes part in regular consultations among the Nordic Governments in the energy field. It is a member of the International Atomic Energy Agency, IAEA (mainly for reasons of non-energy applications of nuclear technology, since nuclear power is not expected to play a role in Iceland's energy picture in the foreseeable future), but not of IEA, the "oil club". At the technico-economical level, Iceland is a member of several regional, mainly Nordic, energy organizations as well as international ones.

Through its long and extensive use of geothermal energy Iceland has over the years acquired a considerable know-how in geothermal exploration and resource evaluation,production drilling, development and utilization, primarily for non-electric purposes like space heating, but in recent years for industrial applications and power generation as well. Icelandic geothermal experts have gained a world-wide reputation, and have often been hired, by United Nations special agencies, for geothermal projects in the developing countries. Also, they have, in cooperation with consulting firms abroad, been involved in design and construction of such projects in these countries.

In 1979 the Icelandic National Energy Authority (Orkustofnun), a Government organization responsible for geothermal research and exploration, entered into an agreement with the United Nations University in Tokyo to establish an International Geothermal Training Programme in Iceland where people from developing countries could be trained in geothermal research and exploration techniques, drilling and utilization. The Programme can accept 6 - 7 trainees at a time for a duration of about 6 months, from April to October. Training consists of lectures at a post-graduate level (applicants are expected to have a University degree), laboratory and field work. Iceland carries more than half of the cost of the training programme as a part of its development aid; the remainder is borne by the United Nations University.

It is the policy of the Icelandic Government to increase its development aid above the present level, subject to considerations of the country´s encomomic situation at any particular time. In addition to fishing, which has been the traditional field of activity in Iceland´s development aid, such an increase might very well be in the field of geothermal energy, and possibly also in exploration, assessment and design of hydro-electric developments, where Iceland has also gained considerable experience.

*Relative contribution of renewable and non-renewable energy sources in the primary energy supply of Iceland 1980-2000, according to forecast.*

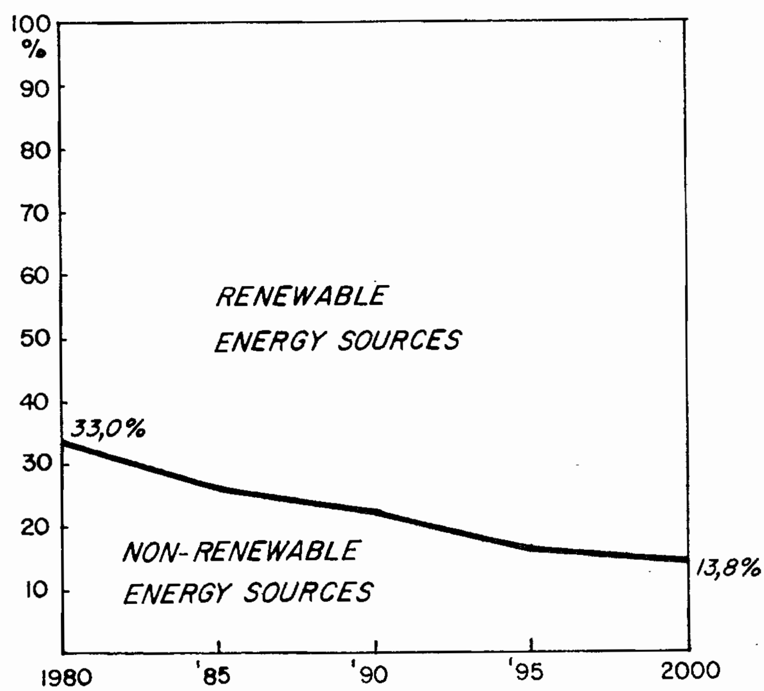


*Fig. 1*