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Energy Analysis Division

THE ICELANDIC ELECTRIC POWER SECTOR
AN OVERVIEW

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**Prepared by the Icelandic members of NORDEL
and their organizations in May 1989**

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THE ICELANDIC ELECTRIC POWER SECTOR
AN OVERVIEW

1. INTRODUCTION

1.1 A Short Survey of Energy Production and Consumption in Iceland

Throughout the last 50 years, the population of Iceland has expanded from about 120,000 up to the present level of 250,000 inhabitants (Fig 1). At the same time, industrialization and urbanization have continued at a rapid pace, with public welfare and wealth rapidly increasing. One indication of this development is the steeply rising number of cars in the country (Fig. 2). It has to be noted, however, that there are no railways in Iceland.

As a result of these social changes, Iceland is now among the countries in the world with the highest per capita consumption of energy. Total primary energy consumption is about 105 petajoules (PJ) per year in terms of oil equivalents. Although quite modest in absolute figures, it corresponds to approximately 417 gigajoules/year (GJ/y) per capita (Fig. 3). Only Canada exceeds this per capita figure.

Hydroelectricity is now the most important source of energy, and geothermal energy is of growing importance, contributing more to the primary energy supply than oil (Fig 4). In 1988, over two thirds of total primary energy was supplied from indigeneous resources. From this figure it can be seen that the goal formulated during the first oil crisis, to reduce the importance of imported energy as far as feasible, has been achieved.

The largest single consumption sector is space heating (Fig. 5), accounting for almost one third of the total and reflecting the cool climate and geographical location of the country in the North Atlantic Ocean.

Looking at the evolution of the energy consumption during the last 50 years (Fig 6), it can be seen that use of domestic resources, especially geothermal energy, increased rapidly in the wake of the energy crises of 1973/74 and 1978/79. This was the result of a sustained effort to reduce the "oil bill" by replacing oil by domestic sources, hydro and geothermal. This endeavour was most fruitful in the space heating sector. The relative contribution of oil (Fig. 7) declined sharply in this sector in favour of geothermal energy, which now supplies about 86% of space heating energy. Large-scale utilization of geothermal energy started in Reykjavík half a century ago, and soon it proved to be the most economical source of energy for space heating. As of now, geothermal space heating is predominant not only in the Reykjavík metropolitan area, but also in the whole of the southern and southwestern part of the country, as well as in most of the towns in the north.

Coal was widely used for space heating before World War II and immediately thereafter (Fig. 8). Its use was then gradually abandoned in favour of the more easily handled oil. At present, coal is used only for industrial purposes, i.e. for ferrosilicon and cement production.

The use of oil continued to grow rapidly until the first oil crisis (Fig. 9), but has since remained almost static. The main reason for this development is, of course, the increased use of indigenous resources, but more efficient use of fuel for both motive power and heating is also an important factor.

It is anticipated that the role of geothermal energy will increase in the future (Fig. 10), while fossil fuels are expected to remain almost static in absolute terms. The energy use of possible new energy-intensive industries depends on the outcome of efforts to attract industrial investments and is excluded from forecasts, which therefore in all probability will err to the low side, especially as regards hydroelectricity.

1.2 Electrification

Harnessing of hydropower started around the turn of the last century. A major step was taken with the first of the three power plants on the Sog River, the Ljósafoss Station, a little more than 50 years ago, and shortly after World War II the huge task of electrifying the rural areas began. Landsvirkjun (The National Power Company) was founded in 1965, marking the beginning of large-scale utilization of the vast hydro resources of the country for the purpose of intensifying industrial development. In the 1970's the interconnection of all supply areas was undertaken and realized by the construction of a 132-kV grid around the country (Fig. 11). This was concluded in 1984, by closing the transmission line circle in the southeast.

Iceland is now a highly electrified country. More than 99.9% of the population has access to electric power from the national grid and the remaining people, living on 20 or so remote farms, have their own generators. In 1988, total electricity consumption was 17,500 kWh per capita (Fig. 12), enough to rank Icelanders among the largest electricity consumers in the world, second only to the Norwegians.

1.3 Use of Geothermal Energy

The use of geothermal energy for space heating started at the beginning of this century. Hot water was piped from hot springs to farms, schools, etc. Drilling for geothermal water dates back to 1928.

Since that time the use of geothermal energy has expanded (Fig. 13) and it is now utilized for many purposes. The consumption of geothermal energy classified by sectors is shown in Fig.14 (electricity generation is excluded). The most important use of geothermal energy is, as already stated, in space heating. There are 29 public district heating companies in the country. By far the largest is the Reykjavík District Heating Service (HR) serving over 50% of the population of Iceland. Most of the companies use low-temperature geothermal water, which is used directly without heat exchangers. The temperature of the water is usually 60°-90°C. In one utility, high-temperature geothermal water (240°C) is used for the production of hot water, and HR is harnessing a field with water at similar and even hotter temperatures.

Electricity production using geothermal energy is limited. Only 5.6% of the total electricity generated in 1988 was based on geothermal energy. There are three power plants for electricity production, all in high-temperature geothermal areas. The first one, at Bjarnarflag, in the northeast, a 3-MW atmospheric back-pressure turbine using saturated steam at 12 bars (abs), dates back to 1967. The others are at Krafla, also in the northeast, a 30-MW double-flash condensing unit of conventional design using saturated steam at 7 bars (abs), and at Svartsengi in the southwest, where 8 MW are produced in combination with hot water production. The steam is saturated and the pressure is 6 bars (abs).

1.4 The Energy Potential in Iceland

Iceland is situated in the North Atlantic Ocean, just south of the Arctic circle (Fig. 15). It is located right in the path of continuously recurring low-pressure areas moving from the east coast of America up into the polar region to the north of Norway. As the depressions pass over Iceland, the high mountains give rise to high precipitation on the mountainous island.

Much of Iceland was formed by lava, flowing out from the most active volcanic section of the North Atlantic Ridge. Here two adjacent plates of the earth's crust are moving gradually apart and the gap fills with molten basalt material pushing from underneath.

These geological features, the abundant moisture and the young, scarcely eroded landscape of porous volcanic rock, provide the basis for the geothermal and hydroelectric resources with which Iceland is so richly endowed. On the other hand, the country is devoid of fossil fuels (coal, petroleum, natural gas) and nuclear fuels.

The technically exploitable hydro potential of Iceland is estimated at 64 TWh/year, of which between 40 and 50 TWh/year is expected to be environmentally acceptable and harnessable at a cost lower than or equal to that of power from conventional steam power plants. Some 30 TWh/year are estimated as sufficiently economical to be of interest in connection with power-intensive industries. The power developed to date amounts to 4.4 TWh/year. The figures all refer to firm power, but in addition to this there are available variable amounts of non-guaranteed power, dependent on current hydrologic conditions.

The geothermal energy base is very large. It is mostly stored as heat energy, accumulated at a depth of a few kilometres below the surface in the form of intrusions of molten and semi-molten rock (magma) which heats the surrounding solid rock (Fig. 16). The stored energy is concentrated in so called geothermal fields, "heat mines" with, in principle, a limited "lifetime", which, however, is very difficult to estimate. There is also some perennial flow of heat from the interior of the earth, but it is of much smaller significance.

With present technology, geothermal energy production is by and large limited to the uppermost 3 km of the earth's crust. It has been estimated that the energy which would be technically producible from these 3 km in geothermal fields in Iceland amounts to 10,000 TWh/year of thermal energy if spread over a "lifetime" of 100 years. Of this, some 3,000 TWh thermal a year would be of sufficiently high enthalpy to be utilizable for the generation of electric power. Due to a low conversion efficiency in geothermal power plants, the above figure would yield only 190 TWh a year of electric power.

The proportion of the geothermal potential that may be utilized economically is at present indeterminate, since it depends to a very high degree on the available market for thermal energy, which is unknown today. In the case of geothermal power production, the economic constraints will be determined primarily by the cost of hydropower, with which this mode of generation has to compete. As long as cheap hydropower is readily available, the role of geothermal power in electrical generation is expected to remain low and be more or less confined to CHP (Combined Heat and Power) plants, the aggregate size of which in turn depends on the market for geothermal hot water. Such electric power is probably the most economical power available.

As a more or less reasonable guess, it is sometimes stated that some 20 TWh/year of electricity could be produced from geothermal sources as economically as from the hydro potential.

Considering how this potential compares with present utilization, it is not surprising that in Iceland not much thought has been given to alternative forms of energy such as tidal-, wind- and wave-power potentials, which are considerable but less economical.

2. THE ELECTRIC POWER SECTOR

2.1 Organization

The owners of the power production, transmission and distribution companies are the Icelandic State and the municipalities (Fig.17). The State is represented by the Althing (Parliament) and the Minister of Industry.

Landsvirkjun, the dominating power producer, is owned 50% by the State, about 45% by the City of Reykjavík and about 5% by the Town of Akureyri. Landsvirkjun is also responsible for the main transmission system and its substations, where energy is sold wholesale to distributing companies (utilities) and to large industrial final consumers. Building and operating a new electric power plant in excess of 2 MW requires separate legislation by the Althing and the permission of the Minister of Industry.

At present there are sixteen distributing companies, of which six buy directly from Landsvirkjun, as described in section 2.3. Landsvirkjun's principal industrial customers are the Icelandic Aluminium Company (ISAL) and Icelandic Alloys Ltd, a ferrosilicon producer.

The National Energy Authority carries out basic research in all matters of energy, as well as a general survey of indigenous resources, and acts as advisor to the Government.

Electric safety matters are handled by the State Electrical Inspection.

2.2 Production and Transmission

Production units of the electric power system in Iceland consist of 26 hydropower stations, 3 geothermal stations and 50 fossil-fired stations. Total installed capacity is 892 MW (Fig. 18) and breaks down into plant types as follows:

Hydropower plants 81%
Geothermal plants 5%
Oil-fired plants 14%

The existing hydropower is mostly in the southwest region, where almost 90% of the capacity is installed, in accordance with the geographical distribution of population and industry. Of the total of 892 MW, Landsvirkjun is in possession of 782 MW.

This system is capable of delivering 4,370 GWh/year of firm energy, without using the fossil-fuel stations for anything but emergency service. Average availability of energy from hydro and geothermal plants is about 5,000 GWh/year.

In 1988, the peak load in Iceland was 659 MW and power production 4,417 GWh, of which Landsvirkjun produced 4,134 GWh, or 93.6%. The electricity was generated mainly in the hydro stations, while the oil-fired stations were used mostly for standby and to a limited extent for peaking. The breakdown of production was as follows:

Hydropower	4,165	GWh	94.3%
Geothermal power	246	"	5.6%
Oil-fired power	6	"	0.1%

In Landsvirkjun's transmission system there are 470 km of 220-kV transmission lines, linking the largest power stations in the south with the industrial and residential load centres in the Reykjavík area. For maximum security, an 895-km-long closed loop of 132-kV transmission lines, with a 191-km radial link to the Westfjords peninsula, was constructed to serve the rest of the country. In this system there are 16 substations where the six distributing companies buy power. There are also sales outlets at all Landsvirkjun's power stations.

Landsvirkjun sells most of its power at 220 kV or 132 kV, but in some cases at lower levels, even as low as 11 kV.

During the past few decades, electricity demand in Iceland has increased rapidly. In the late 1960's and the 1970's this was mainly due to the development of power-intensive industries (Fig. 19), but later on, the replacement of oil for space heating purposes accounted for a considerable share of the demand. In the 1970's and 1980's, the ordinary market demand increased by an average of 4%-5% annually. It is not foreseen, however, that similar growth rates will be sustained in the future (Fig. 20), so it is forecast that the growth in the ordinary market will decrease from the present level down to 1.5% per year after the next decade. In 1988, power-intensive industries used more than half of the total electric power consumed. (Fig. 21). Future efforts to attract power-intensive industries will determine the growth in this category.

2.3 Distribution

The distribution of electricity in Iceland is carried out by 16 distribution companies or utilities, of which 6 buy power wholesale from Landsvirkjun.

One of them is the State Electric Power Works (RARIK), a 100% State-owned company, whose main task is electricity distribution in rural areas and small towns and villages in Iceland. In addition the company owns and operates a few small power plants and regional transmission systems and sells power wholesale to 10 small municipal distribution companies (Fig. 22).

Two are regional energy companies, i.e. covering both electricity supply and district heating, jointly owned by the State and municipalities in the respective regions. One of them, the Westfjords Energy Company, operates some small hydro stations of its own; the other, Sudurnes Regional Heating, operates the Svartsengi geothermal CHP plant mentioned above, which supplies district heating to the Sudurnes region and a considerable portion of its power requirements.

The three remaining wholesale customers are municipal distribution companies in Reykjavík, Akureyri and Hafnarfjordur (Fig. 23).

By way of example, a brief description of the two largest companies follows below. These two companies account for over 70% of the total sales for general use.

RARIK was founded in 1947. The operation of the company is divided into 5 regions with headquarters in Reykjavík (Fig. 24).

RARIK owns 8 small hydropower plants with a total capacity of 14 MW, and 30 diesel plants (39 MW), mostly used as a reserve. The company's own generation of electricity (94 GWh), accounted for 11% of its requirements for the year 1988, the remaining 89% being purchased from Landsvirkjun.

The aggregate length of RARIK's transmission system (132, 66, 33 kV) is 1,400 km of overhead lines and 40 km of submarine cables, and that of the distribution system (19 and 11 kV) is 6,500 km.

Retail energy sales stood at 562 GWh in 1988, breaking down into categories as shown in Fig. 25. Wholesale supplies in 1988 amounted to 175 GWh.

Reykjavík Municipal Electric Works (RR) began operations in 1921 when the hydroelectric station at Ellidaár was built. The Ellidaár station has an output of 3.2 MW and is still running. RR purchases most of its electricity (607 GWh in 1988) from Landsvirkjun. Today RR serves a population of about 126,000 within the Reykjavík metropolitan area.

There are 11 substations in the distribution system, with a total transformer capacity of 259 MVA. The total length of the high-voltage distribution system is 589 km, and there are 621 transformer stations with installed capacity of 315 MVA. The total length of the low-voltage (220/380 kV) distribution system is 1,641 km, of which 81% consists of underground cables.

The breakdown of RR sales in 1988 (Fig. 26) shows quite a different pattern from that of RARIK (Fig. 25) especially as regards space heating. In Reykjavík, where space heating is geothermal and heating costs are low, there are very limited sales of electric power for that purpose. In areas where there is no geothermal heat available, space heating is to a large extent based on electricity.

2.4 Electricity Prices.

In Landsvirkjun's wholesale tariff in May 1989, the average price of primary energy varies as follows according to utilization of peak demand of the year at 132 kV, measured as a 30-minute average demand at the point of delivery:

Utilization time (hrs)	Price (USD/kWh)	(kr/kWh)
4,000	0.0502	2.68
5,000	0.0417	2.23
6,000	0.0363	1.94
7,000	0.0322	1.72

The wholesale tariff is higher than the long-term marginal cost of power, which for ordinary use is estimated about 0.025 USD/kWh, mainly due to the fast buildup of the national transmission grid during the last few years. The tariff for non-guaranteed power is 0.0063 USD/kWh or 0.338 kr/kWh.

As mentioned above, Landsvirkjun delivers power to three power- intensive industries according to special contracts. The price to the aluminium smelter is now (May 1989) 0.0185 USD/kWh, to the ferrosilicon plant 0.0096 USD/kWh, and to a fertilizer plant 0.0125 USD/kWh.

The tariffs for retail sale of electricity varies between companies and also according to use. The tariffs can be divided into two types, namely a pure energy tariff and a mixed-demand energy tariff. The latter type is mainly used by industries and in agriculture. The prices for electricity for households (3,500 kWh/year) and industries (using 500 kW with 4,000 hours' utilization of the peak load) from RR and RARIK in May 1989 are as follows:

	RR		RARIK	
	(USD/kWh)	(kr/kWh)	(USD/kWh)	(kr/kWh)
Households	0.108	5.78	0.146	7.82
Industries	0.064	3.39	0.087	4.64

In Figures 27 and 28 the price of electricity from RR is compared to the prices in the capitals of the other UNIPEDE countries. As shown, there is a 25% sales tax on electricity. Some of the industrial firms, especially export industries, have the sales tax refunded according to special rules. Electricity prices in real terms have been declining during the last few years (Fig. 29).

There are special tariffs for space heating, which are kept much lower. Thus the price of residential heating from RARIK is about 0.036 USD/kWh. The main reason for this is that the price of geothermal water for space heating is often very low. In the Reykjavík metropolitan area, for instance, it is only about 0.015 USD/kWh. Energy for space heating is not taxed in Iceland.

3. FUTURE DEVELOPMENTS

As mentioned above, Iceland's technically harnessable low-cost hydropower potential has been estimated about 60 TWh/year, of which 30 TWh/year appear to be economically harnessable taking environmental constraints into consideration. Likewise some 20 TWh/year of the geothermal resources can probably be developed at comparable costs. The total low-cost potential is therefore approximately 50 TWh/year. Of this figure, only about 8% has been harnessed so far, i.e. 14% of the hydropower and less than 1% of the geothermal potential.

As in many industrialized countries, recent growth rates in domestic electricity consumption in Iceland have been much slower than estimated some years ago. Growth is now estimated at 1.5%-2.5%/year for the next few decades. It is therefore evident that any substantial development in harnessing the hydro and geothermal resources for electricity generation depends on further industrialization, particularly in power-intensive industries such as aluminium, ferrosilicon, etc.

Owing to rapid progress in DC technology, both in DC submarine cables and converter stations, the possibility of exporting electricity via a DC submarine cable link from the east coast of Iceland to Scotland has become increasingly realistic. A study made by Landsvirkjun indicates that power prices from a converter station in Scotland would be competitive with prices from new coal-fired and nuclear stations in the UK. Such a project could be realized around the turn of the century.

The most immediate possibility for major power development in Iceland in the near future is to attract investments in new power-intensive industries in the country. Negotiations between the Icelandic Government and four European aluminium companies on the construction of a new 185,000-t/y aluminium smelter are under way. Landsvirkjun would be responsible for the power delivery to such a smelter, which would require the construction of several new power projects, both hydro and geothermal, in the next few years (Fig. 30).

FIG. 1

POPULATION OF ICELAND FROM 1940

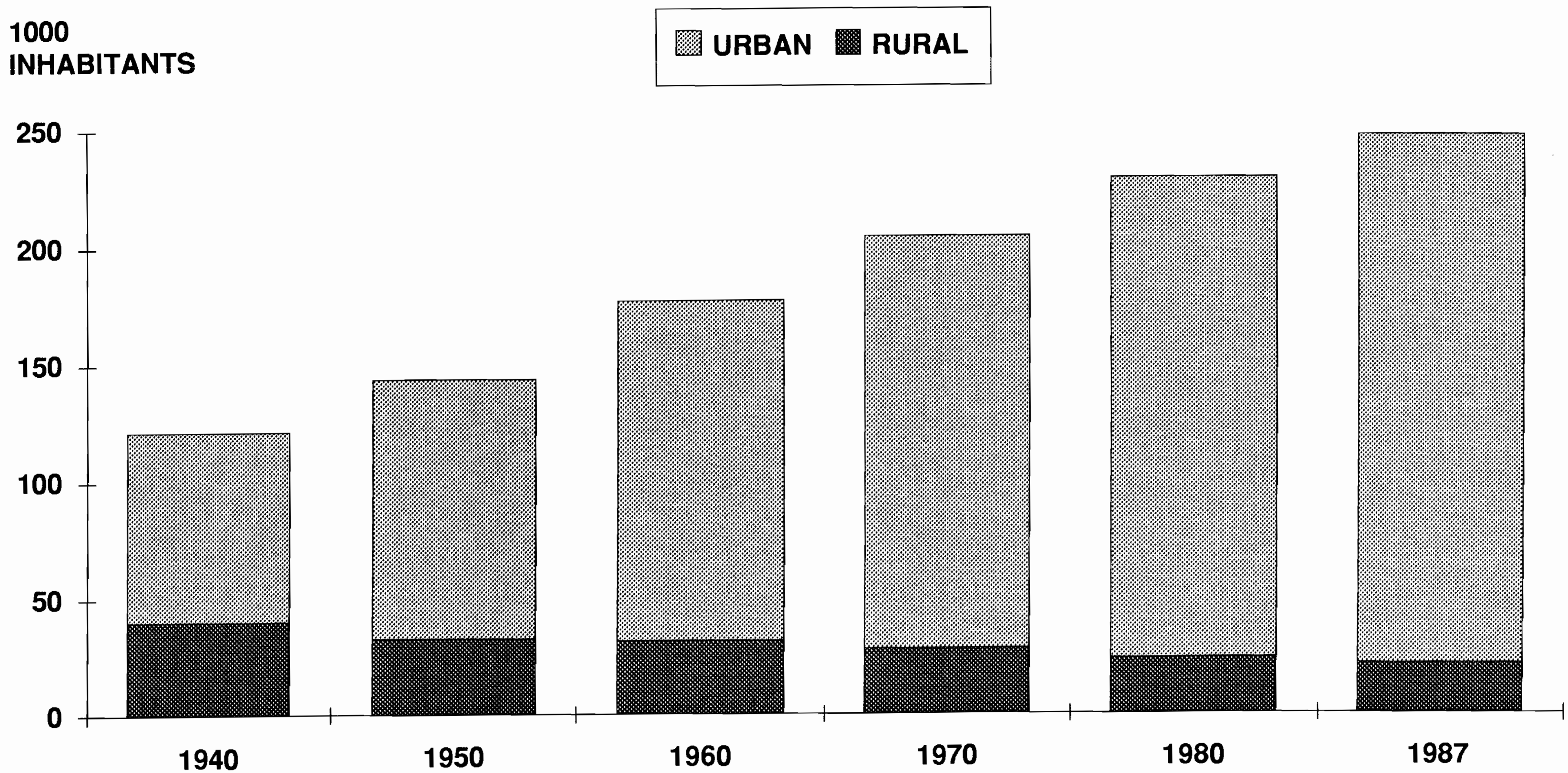


FIG 2

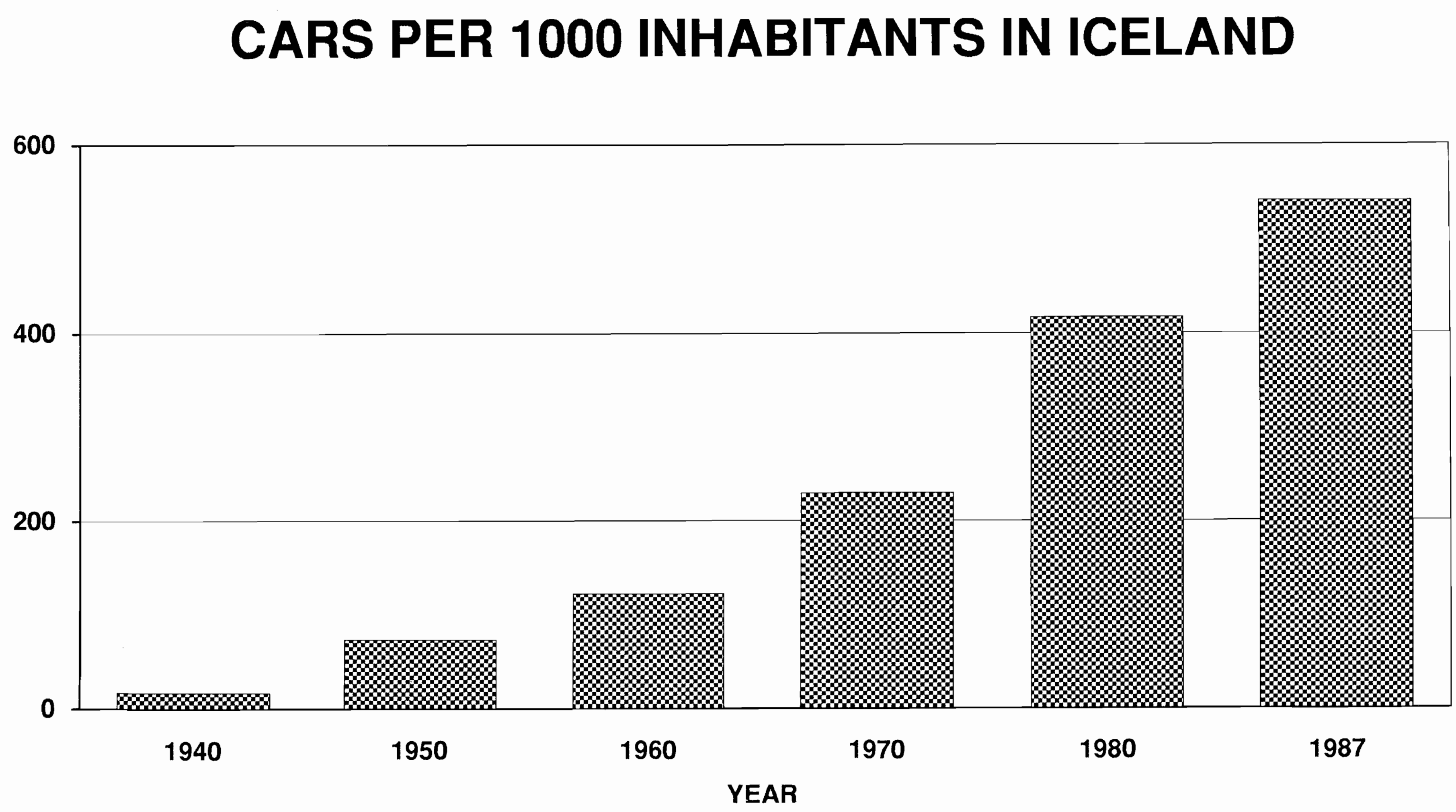

CARS PER 1000 INHABITANTS IN ICELAND
600
400
200
0
1940
1950
1960
1970
1980
1987
YEAR

FIG. 3

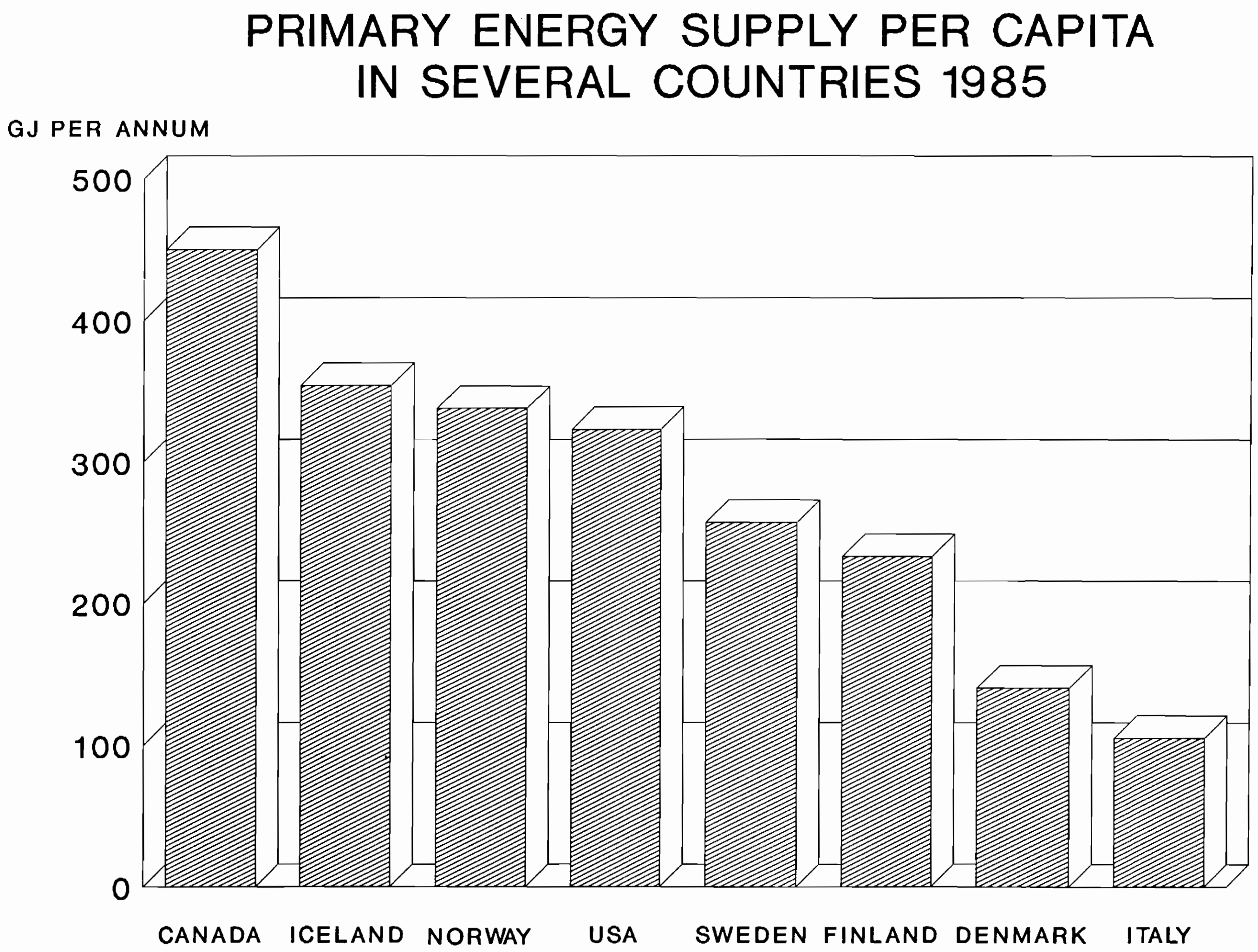

PRIMARY ENERGY SUPPLY PER CAPITA
IN SEVERAL COUNTRIES 1985
GJ PER ANNUM
500
400
300
200
100
0
CANADA
ICELAND
NORWAY
USA
SWEDEN
FINLAND
DENMARK
ITALY

FIG. 4

GROSS ENERGY CONSUMPTION IN ICELAND
CONTRIBUTION OF PRIMARY SOURCES 1988

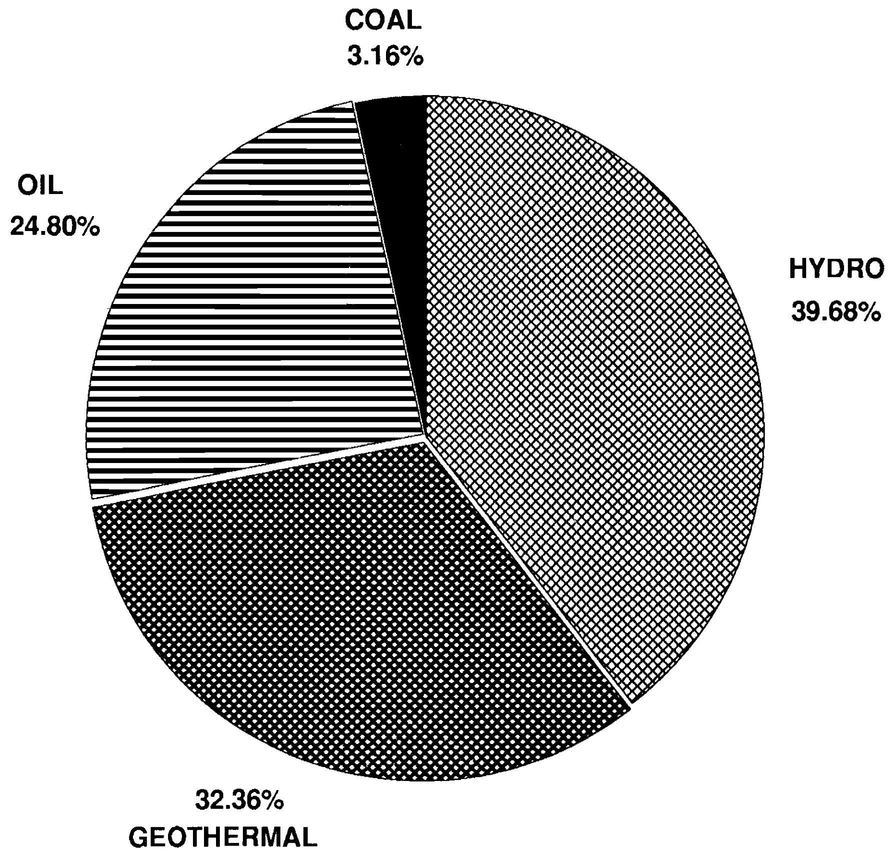


FIG. 5

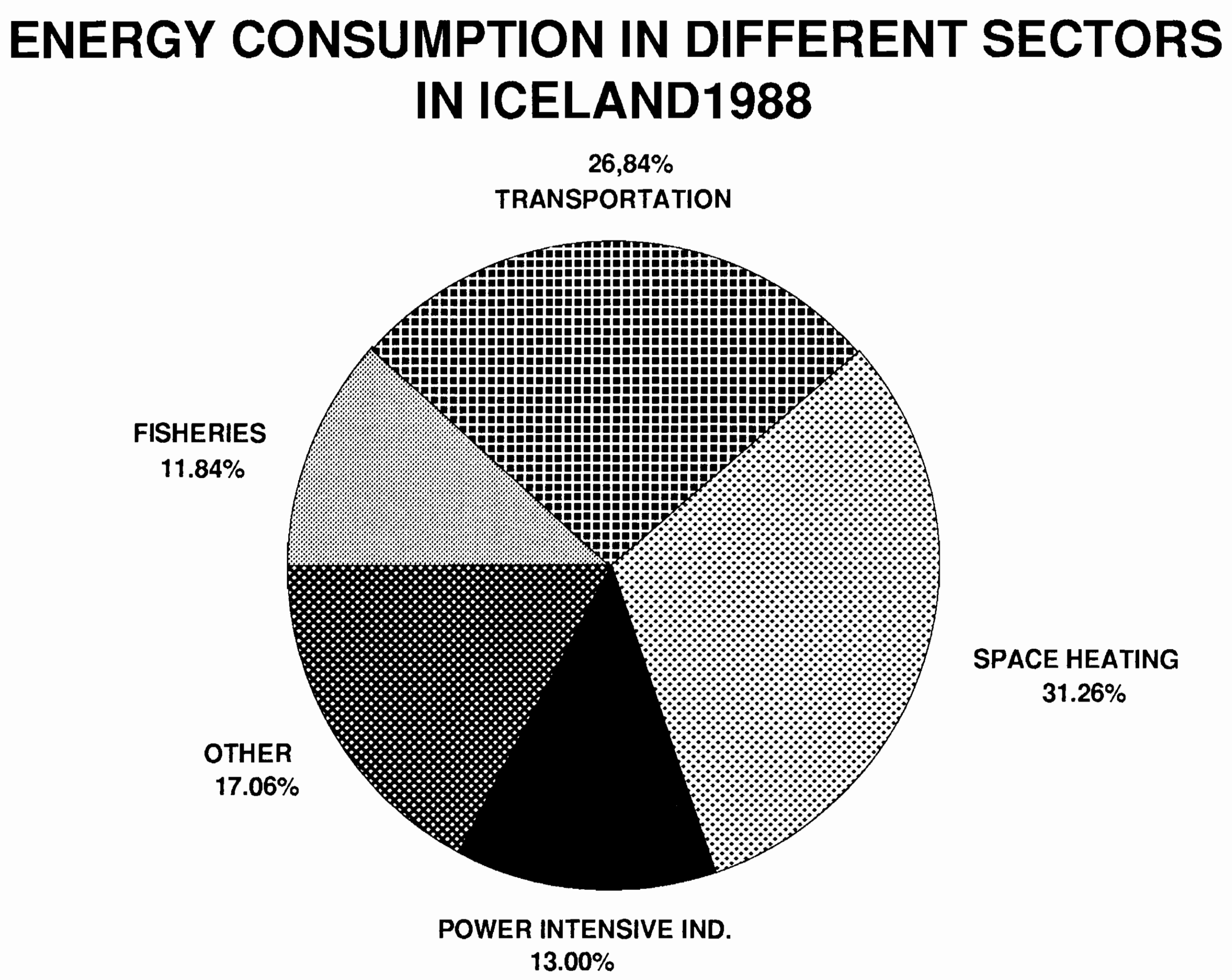
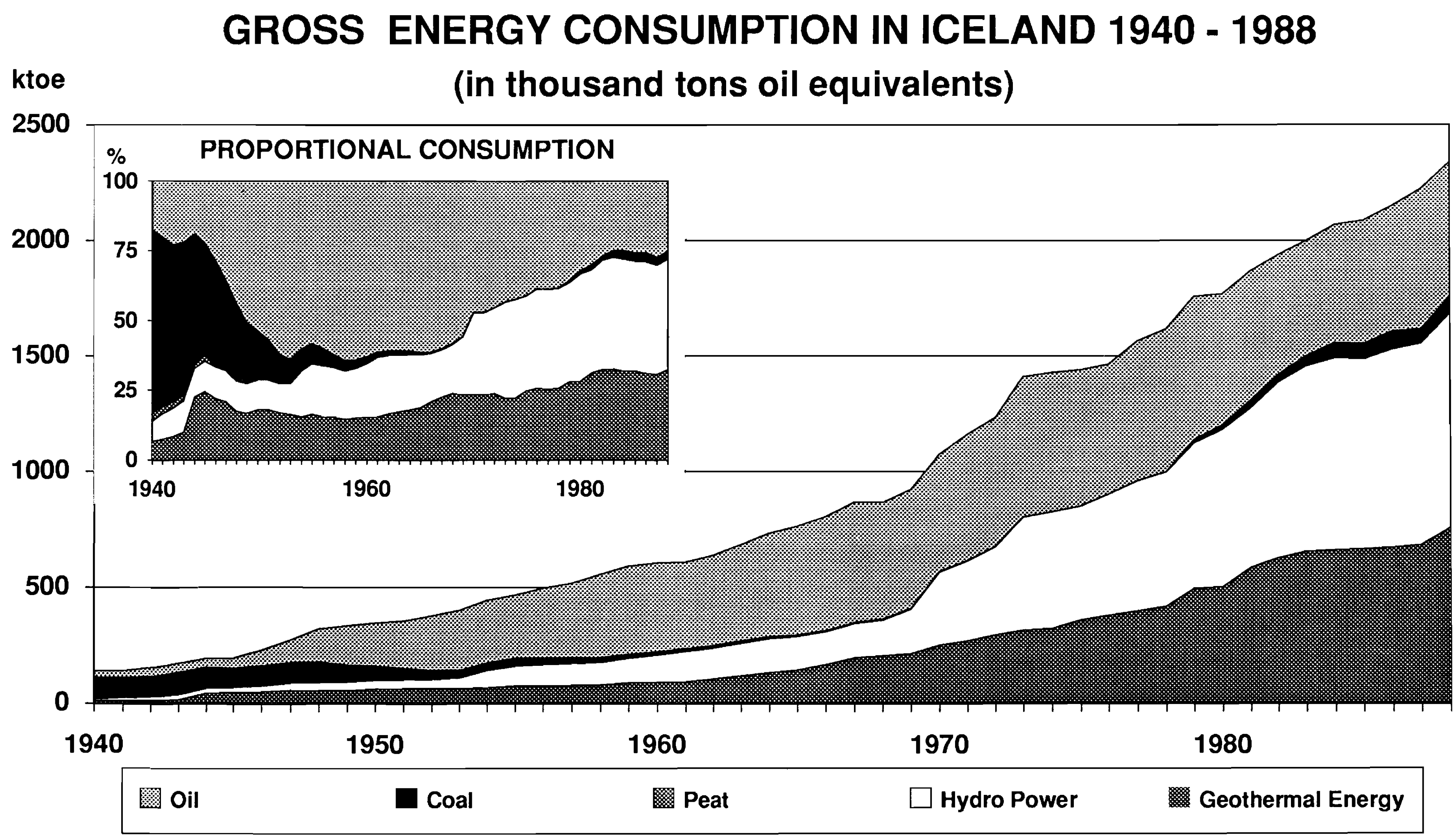

ENERGY CONSUMPTION IN DIFFERENT SECTORS
IN ICELAND1988
26,84%
TRANSPORTATION
FISHERIES
11.84%
SPACE HEATING
31.26%
OTHER
17.06%
POWER INTENSIVE IND.
13.00%

FIG. 6



GROSS ENERGY CONSUMPTION IN ICELAND 1940 - 1988
(in thousand tons oil equivalents)
ktoe
2500
2000
1500
1000
500
0
1940
1950
1960
1970
1980
PROPORTIONAL CONSUMPTION
%
100
75
50
25
0
1940
1960
1980
Oil
Coal
Peat
Hydro Power
Geothermal Energy

FIG. 7

RELATIVE CONSUMPTION OF ENERGY FOR SPACE HEATING

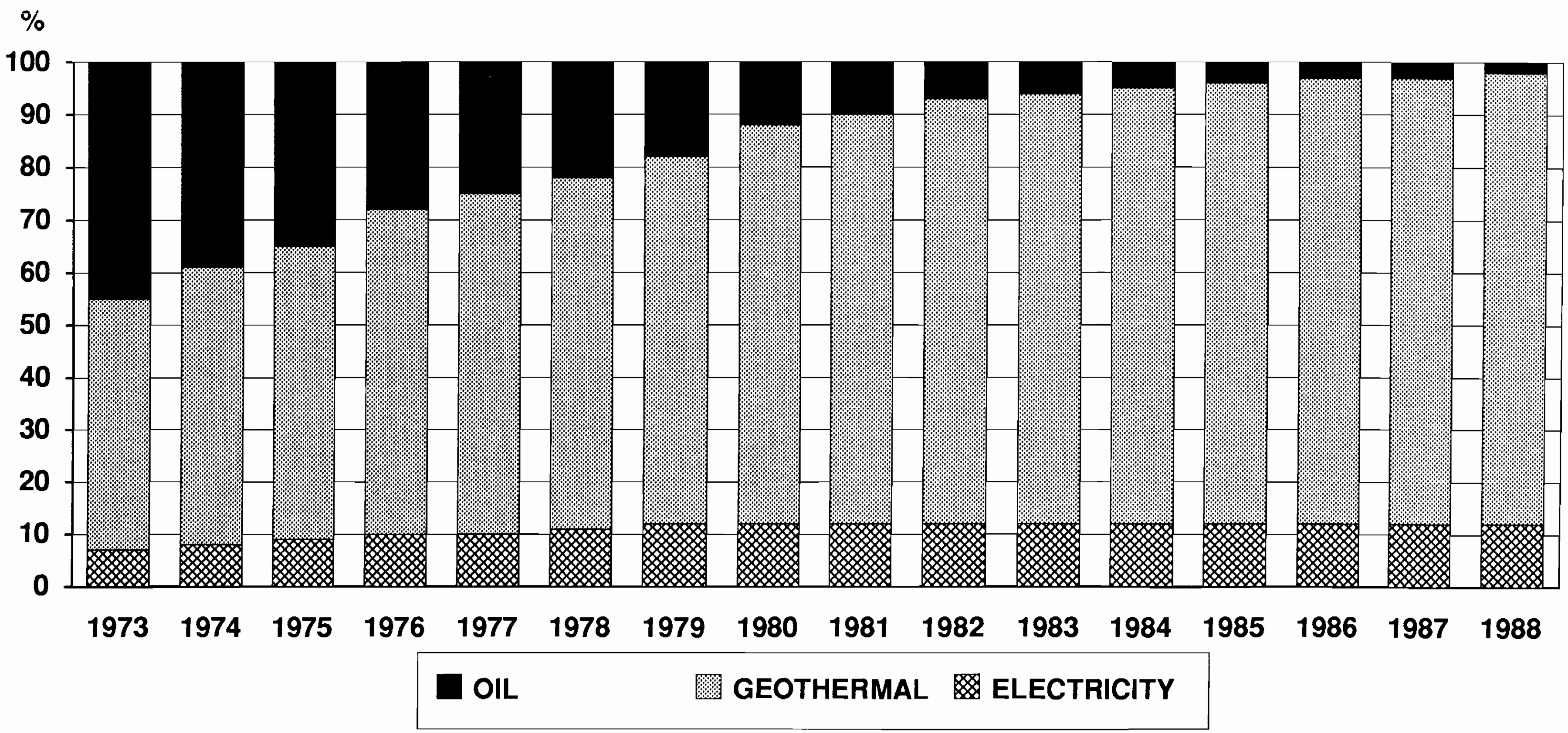


FIG. 8

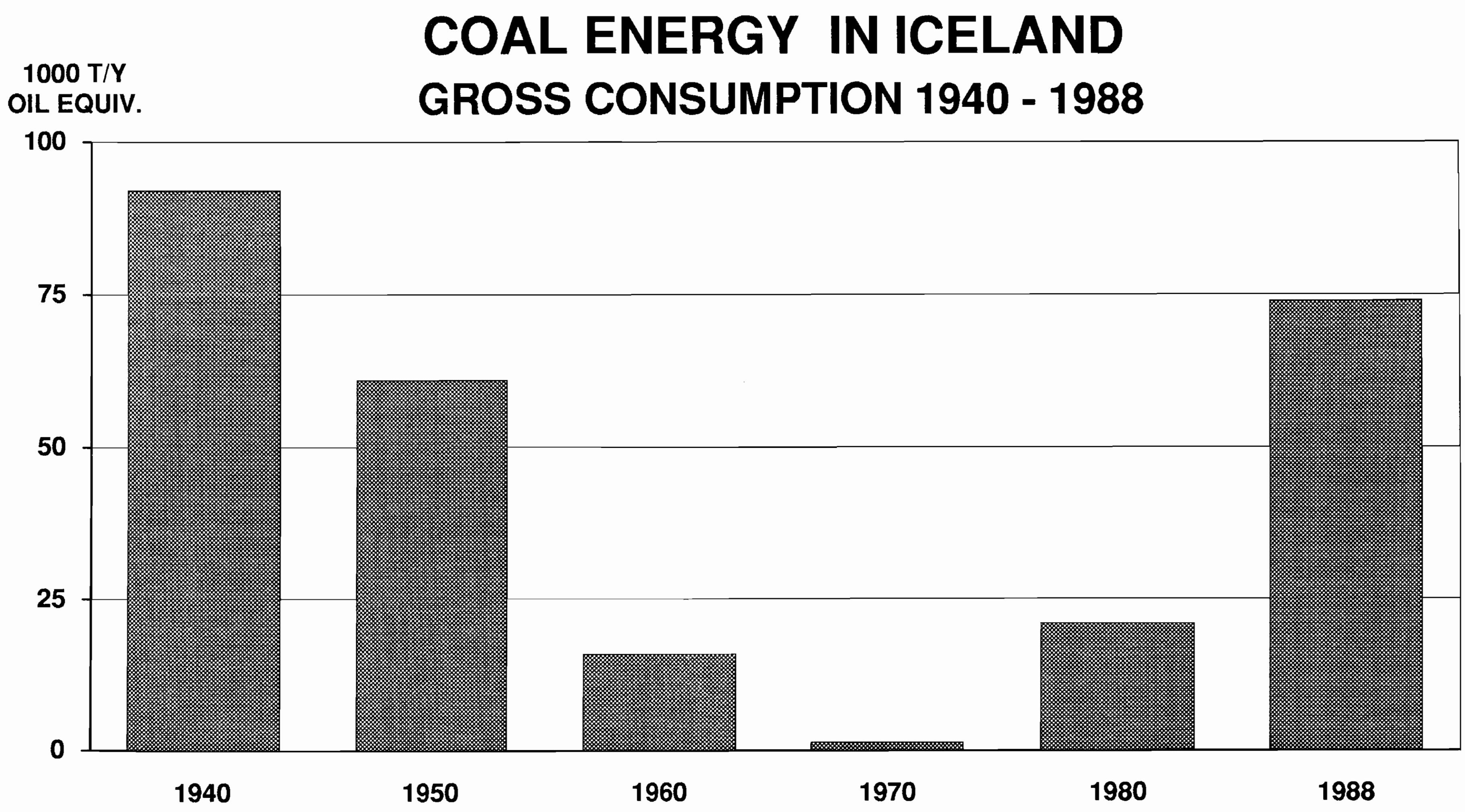

COAL ENERGY IN ICELAND
GROSS CONSUMPTION 1940 - 1988
1000 T/Y
OIL EQUIV.
100
75
50
25
0
1940
1950
1960
1970
1980
1988

FIG. 9

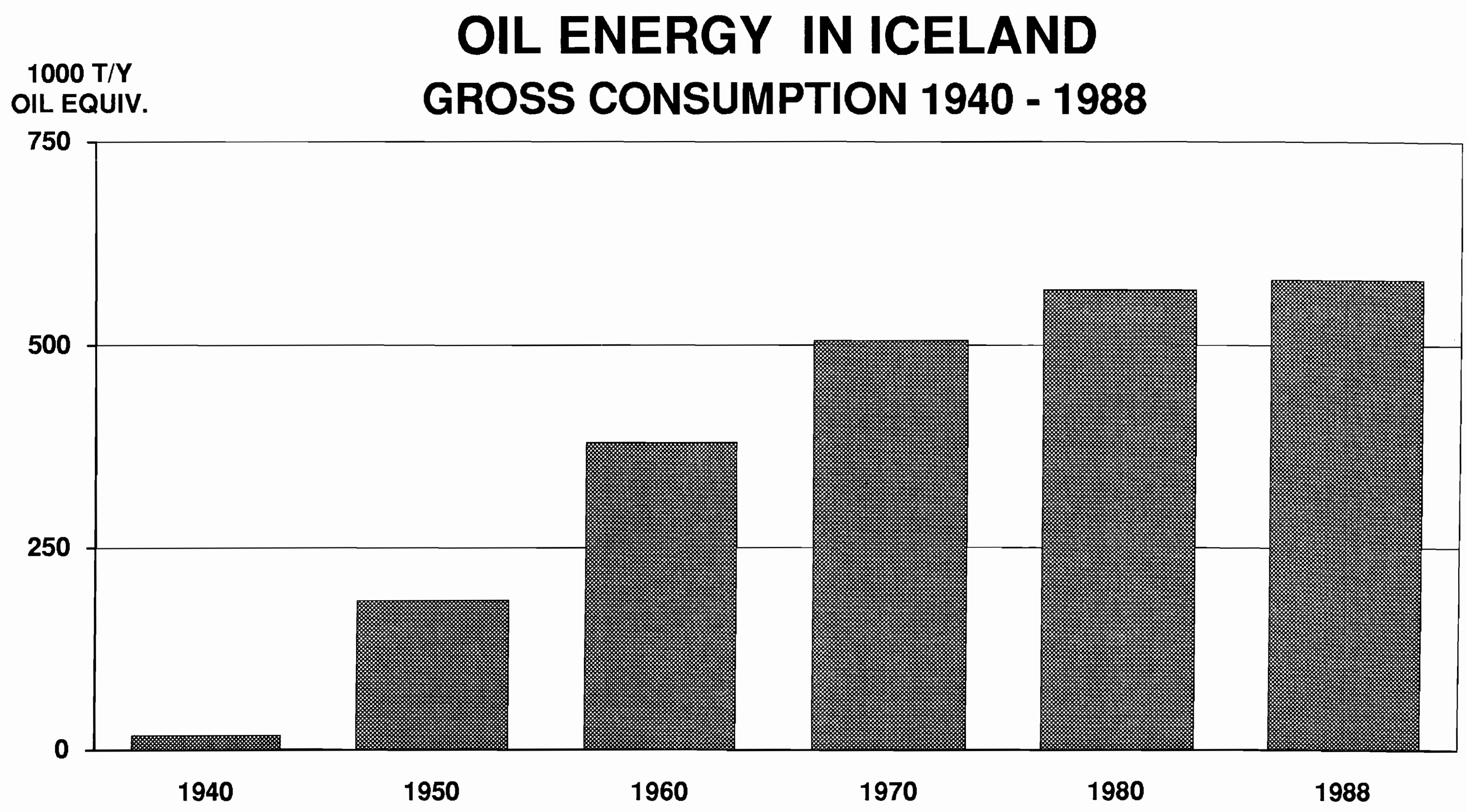
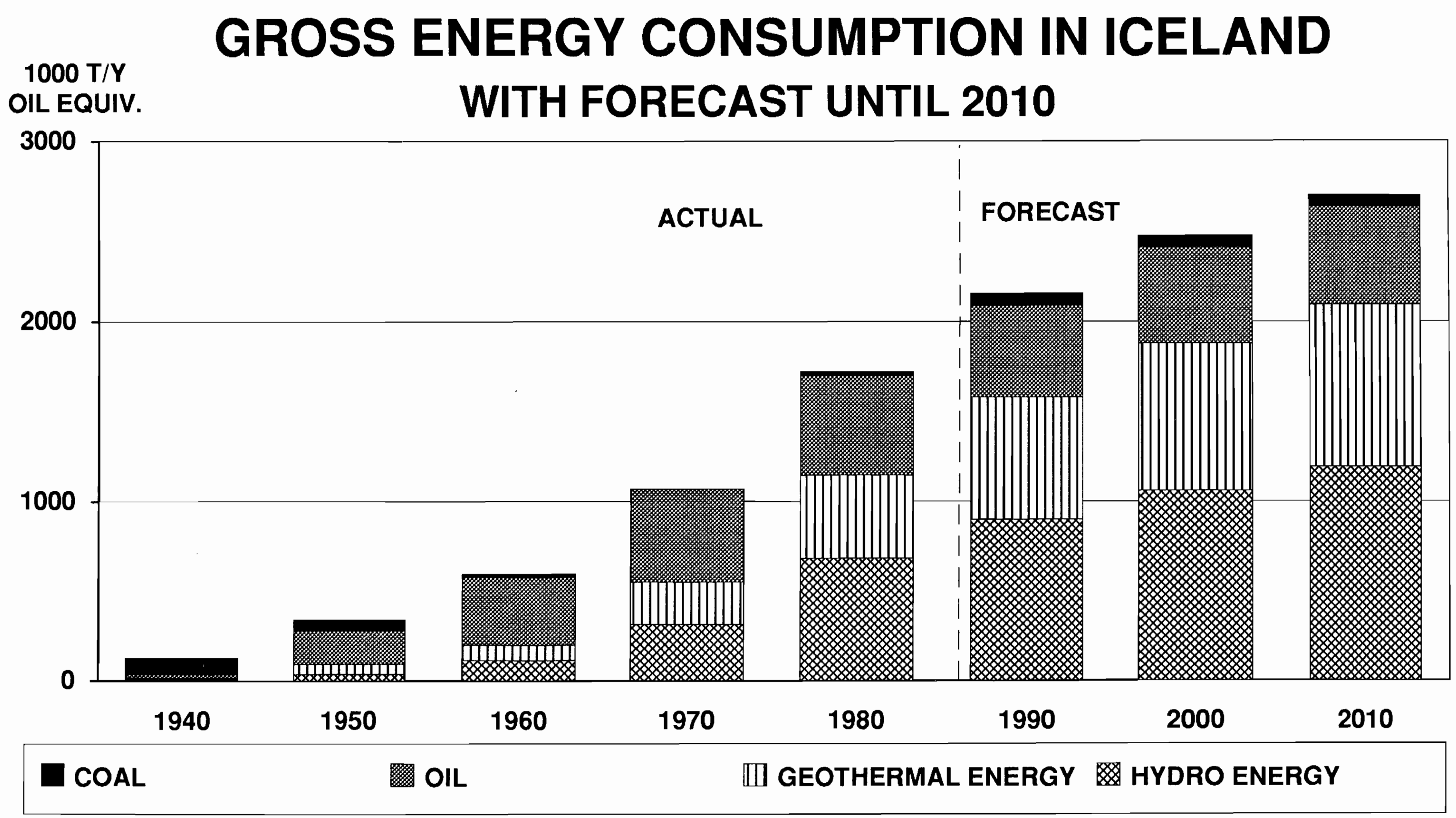

OIL ENERGY IN ICELAND
GROSS CONSUMPTION 1940 - 1988
1000 T/Y
OIL EQUIV.
750
500
250
0
1940
1950
1960
1970
1980
1988

FIG. 10


GROSS ENERGY CONSUMPTION IN ICELAND
WITH FORECAST UNTIL 2010
1000 T/Y
OIL EQUIV.
3000
2000
1000
0
ACTUAL
FORECAST
1940
1950
1960
1970
1980
1990
2000
2010
COAL
OIL
GEOTHERMAL ENERGY
HYDRO ENERGY

LANDSVIRKJUN'S POWER SYSTEM 1988

FIG. 11

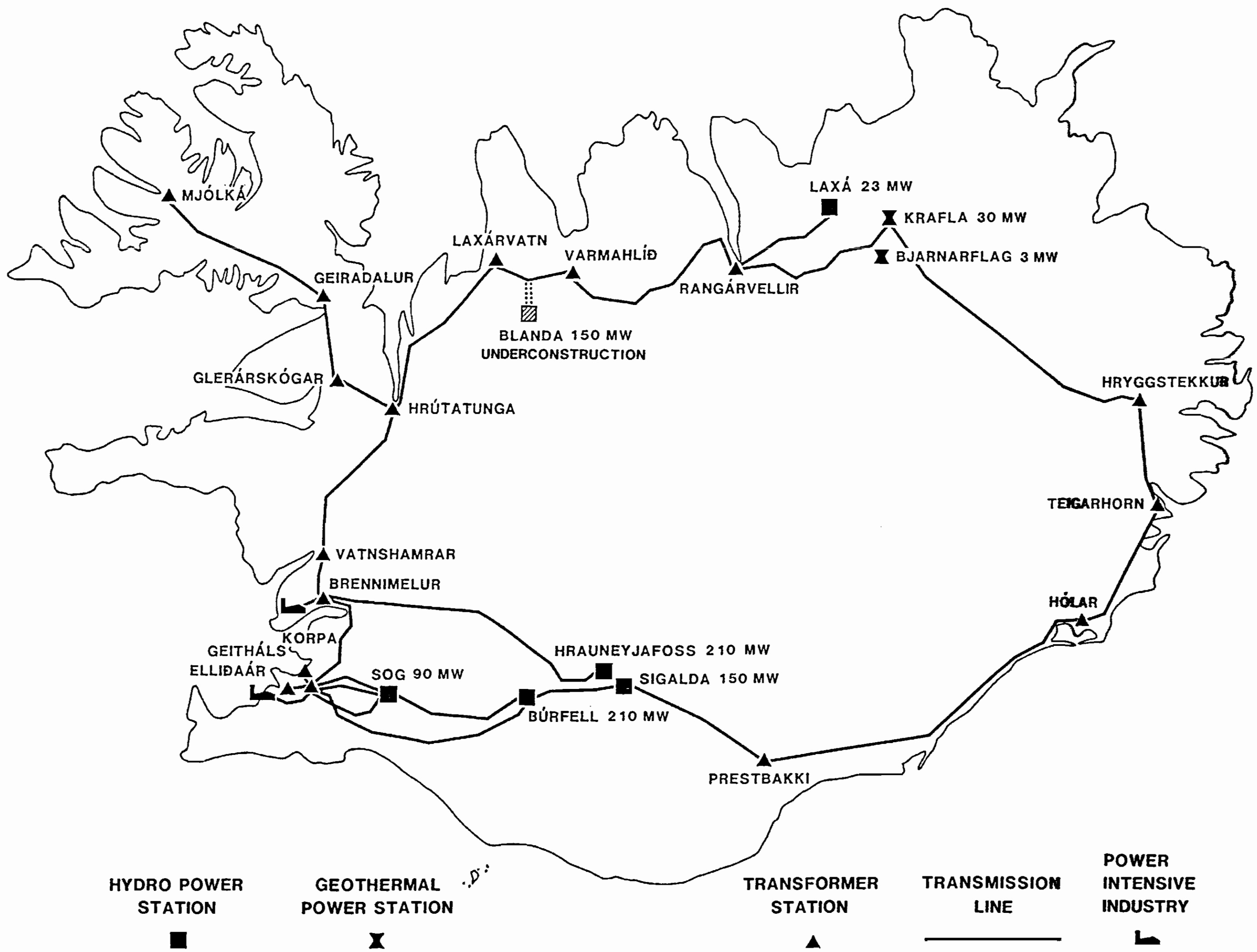


FIG. 12

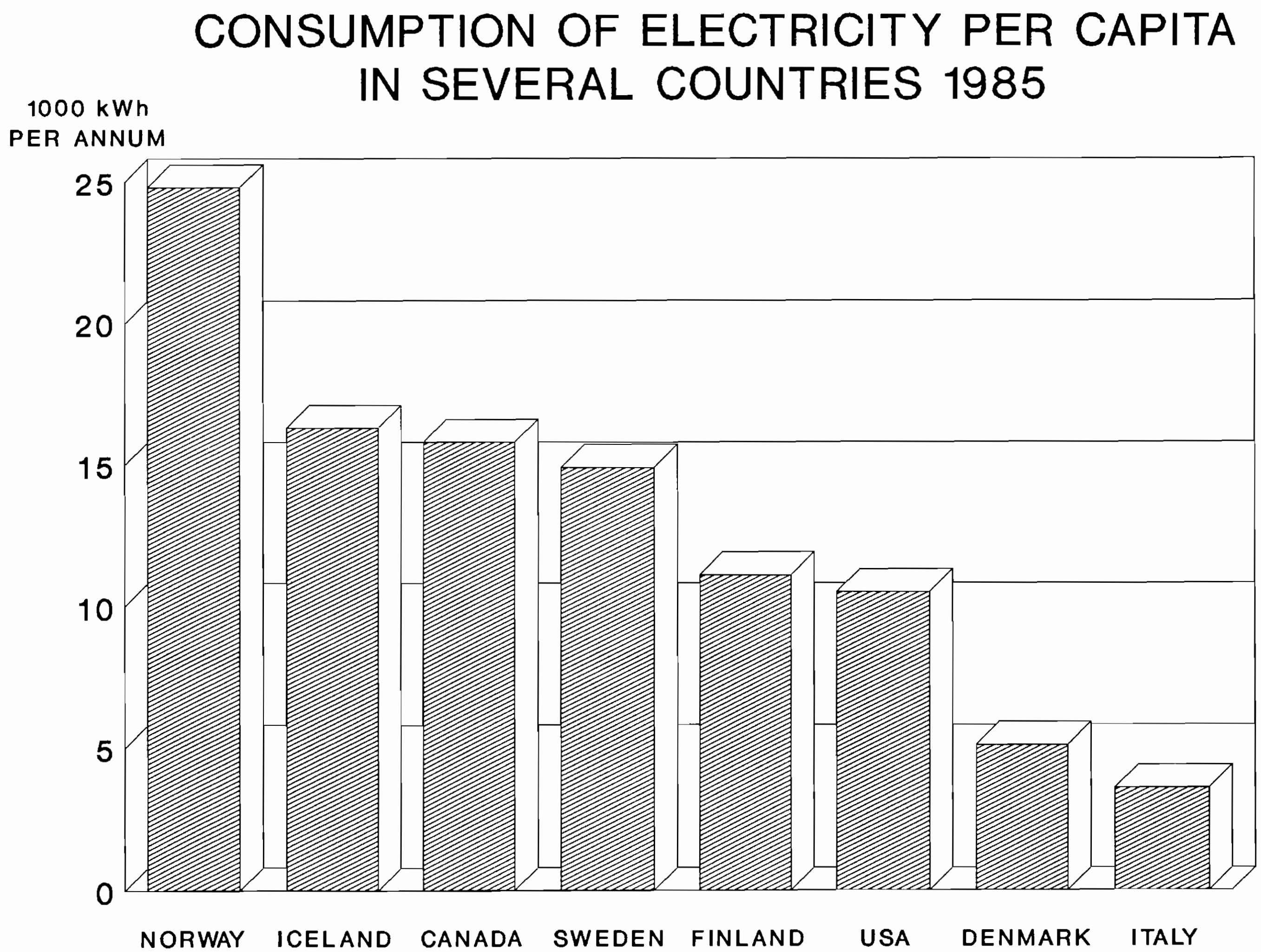

CONSUMPTION OF ELECTRICITY PER CAPITA
IN SEVERAL COUNTRIES 1985
1000 kWh
PER ANNUM
25
20
15
10
5
0
NORWAY
ICELAND
CANADA
SWEDEN
FINLAND
USA
DENMARK
ITALY

FIG. 13

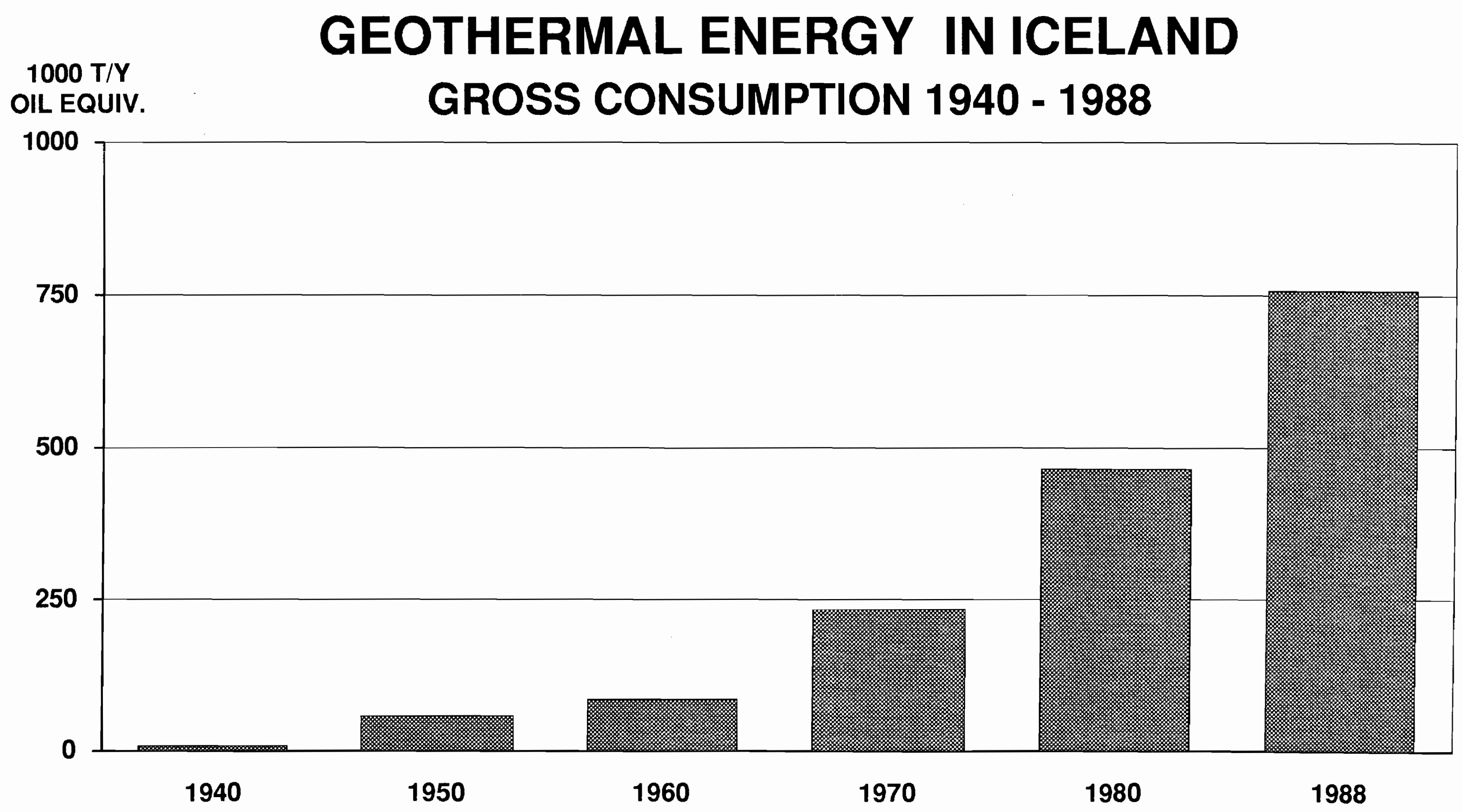

GEOTHERMAL ENERGY IN ICELAND
GROSS CONSUMPTION 1940 - 1988
1000 T/Y
OIL EQUIV.
1000
750
500
250
0
1940
1950
1960
1970
1980
1988

FIG.14

CONSUMPTION OF GEOTHERMAL ENERGY IN ICELAND 1988

Classified into groups, used energy (electricity generation excluded).

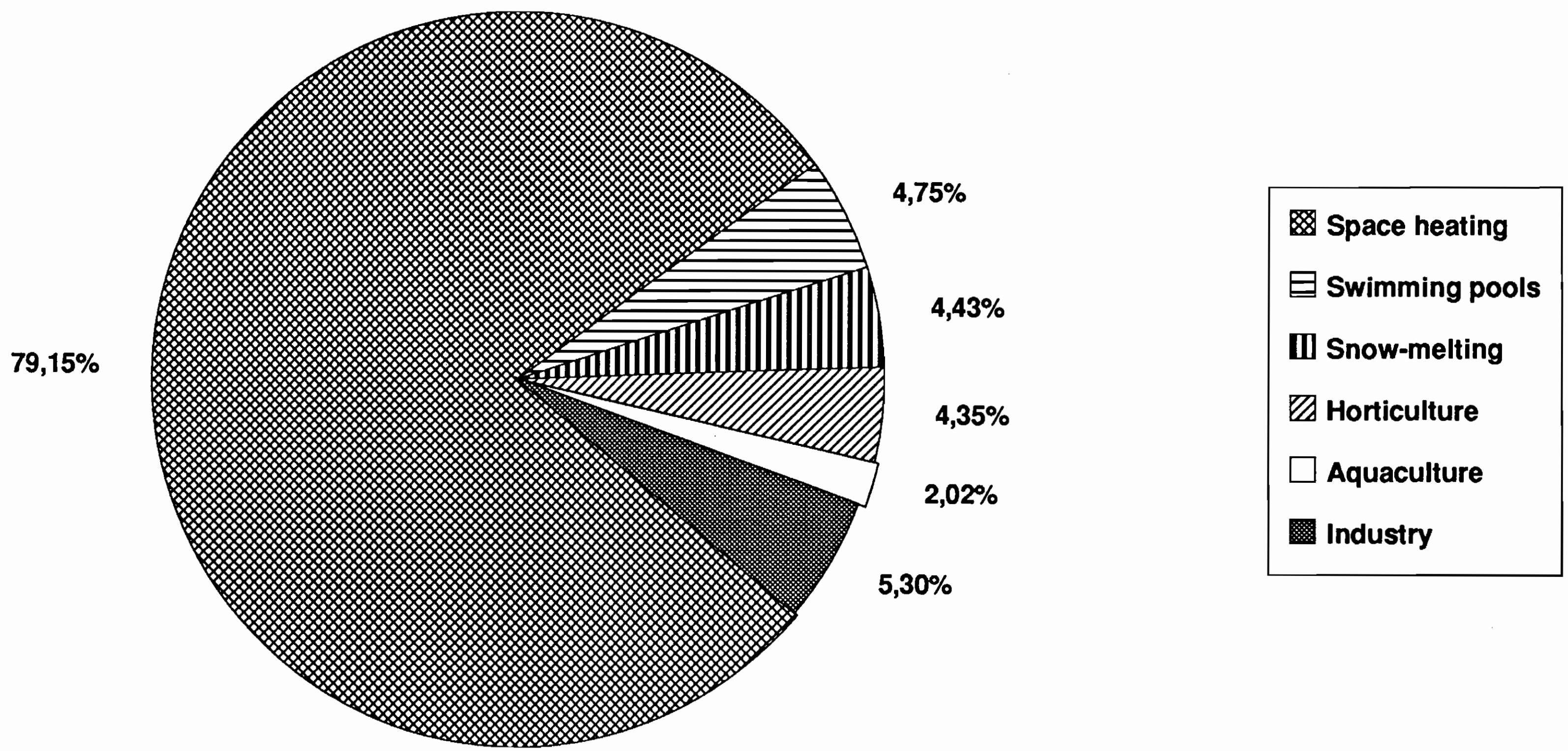


FIG. 15

LOCATION OF ICELAND

WITH DISTANCES OVER THE ATLANTIC OCEAN

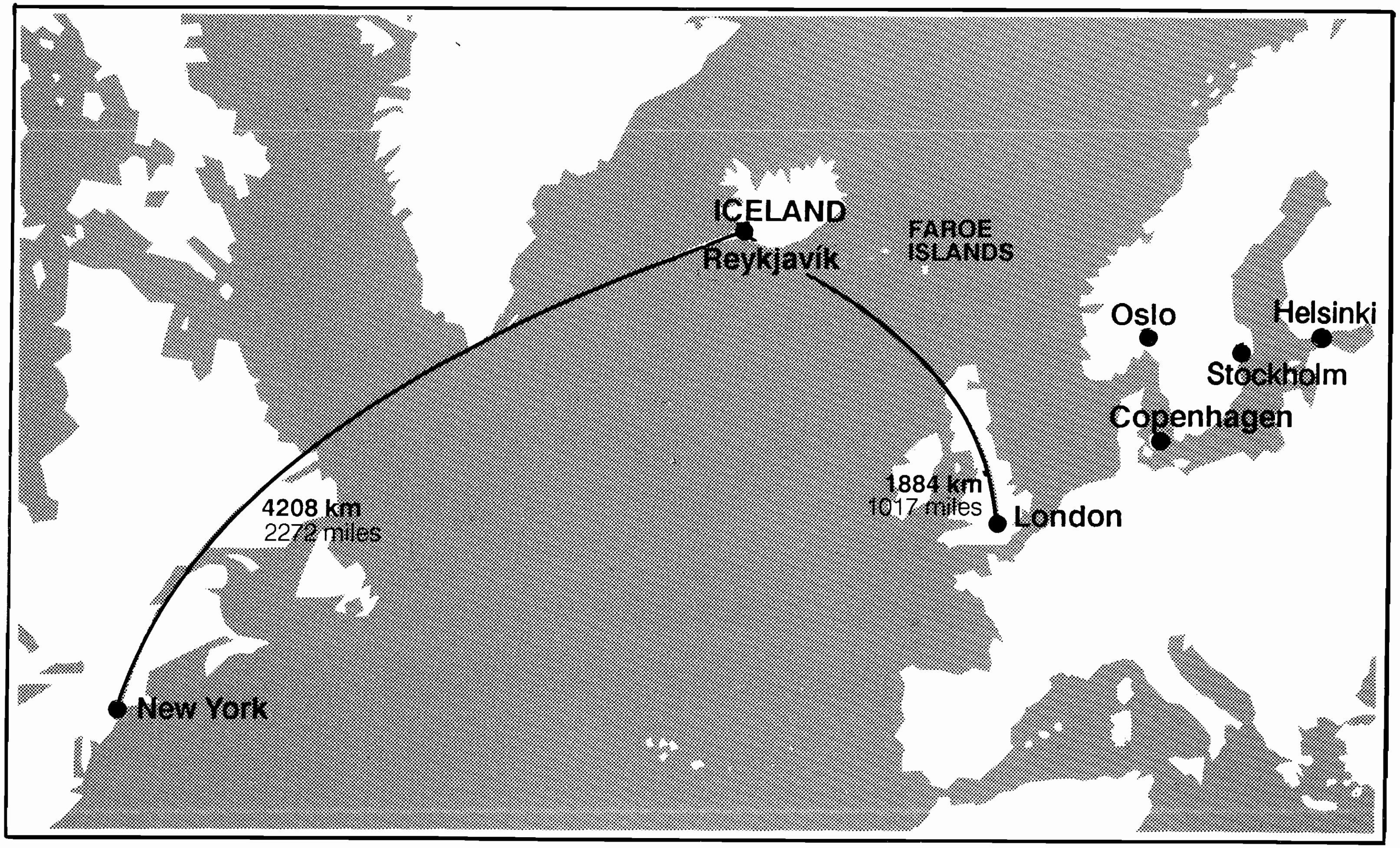


FIG. 16

KRAFLA GEOTHERMAL FIELD

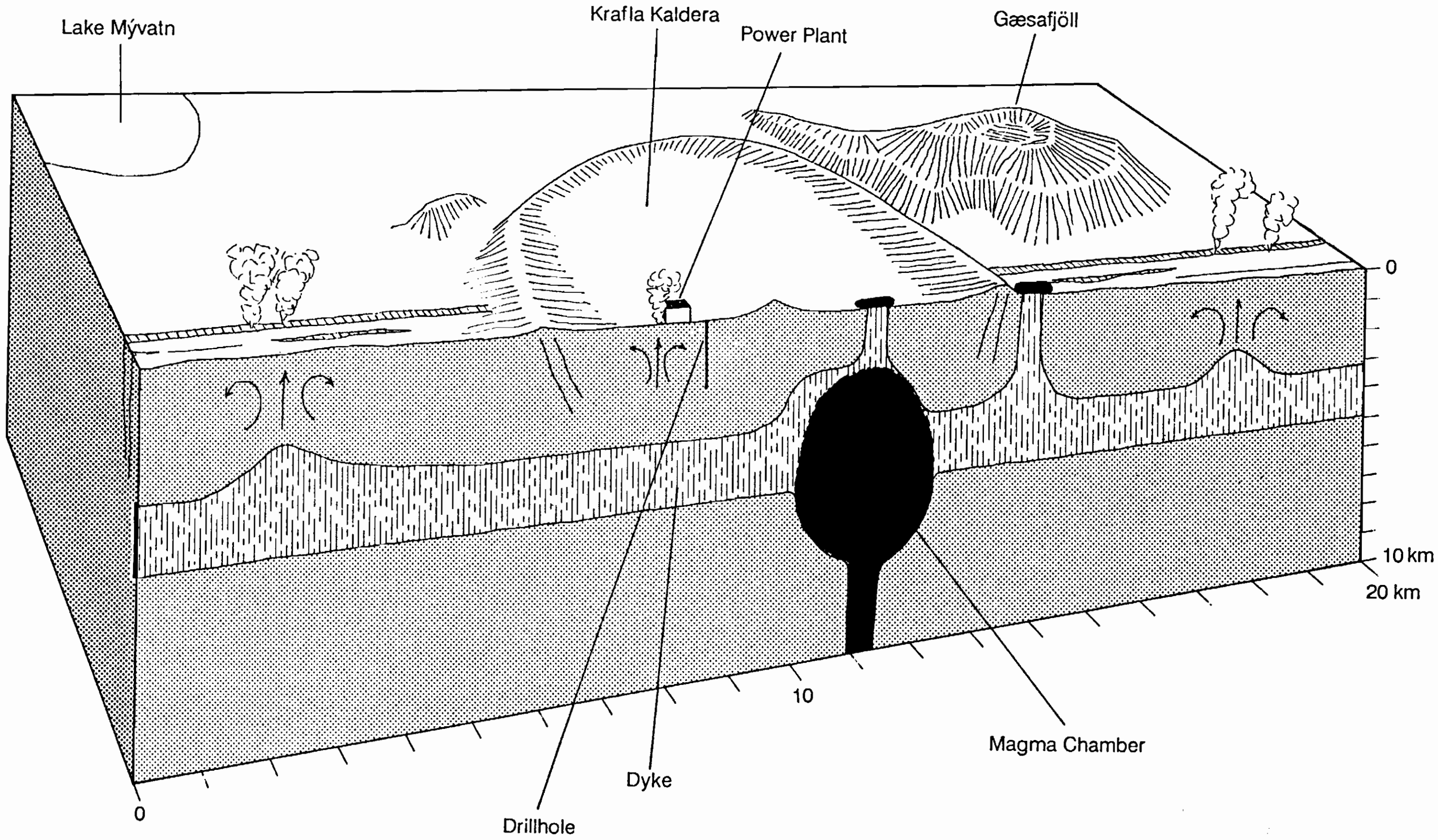
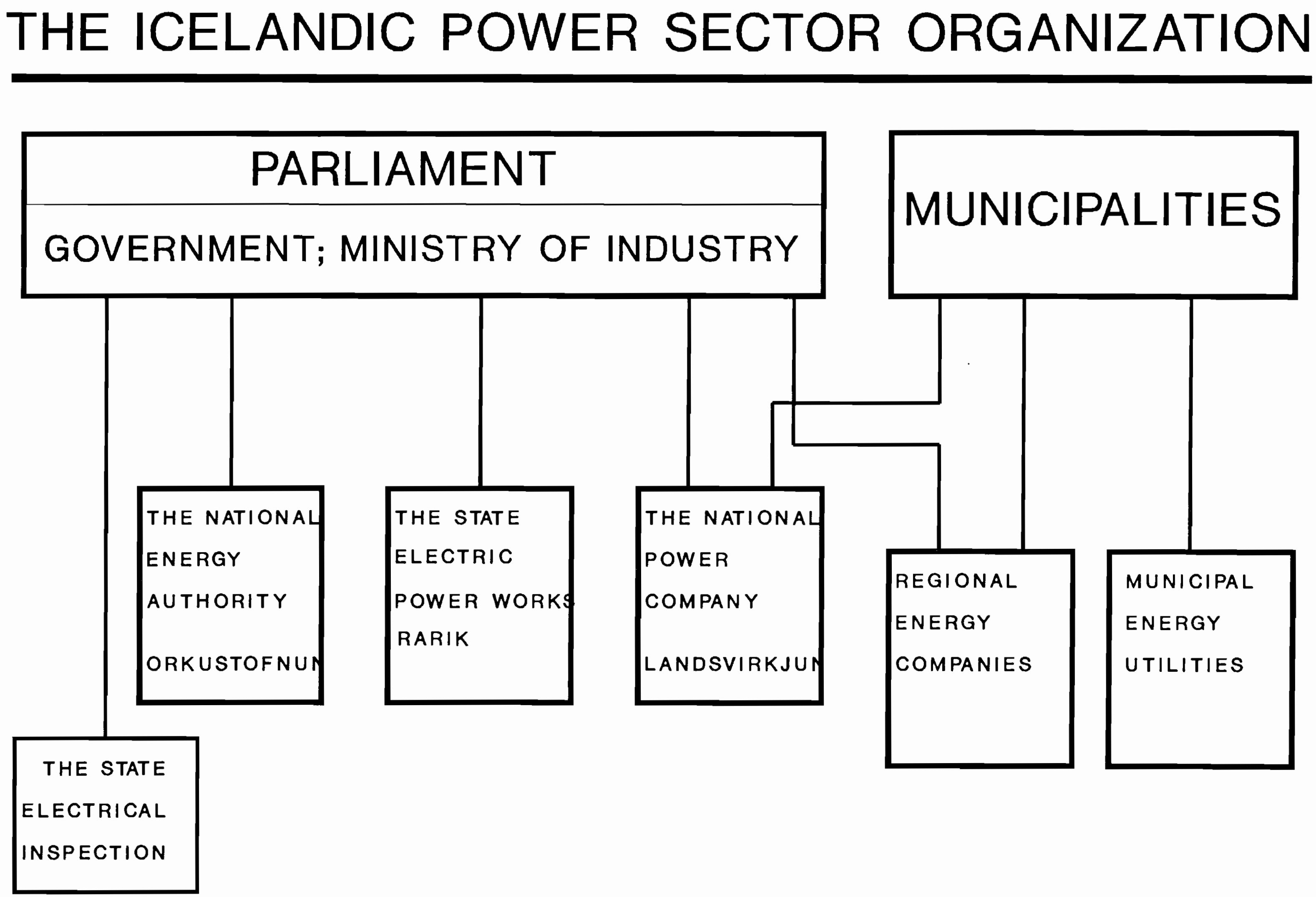


FIG. 17



THE ICELANDIC POWER SECTOR ORGANIZATION
PARLIAMENT
GOVERNMENT; MINISTRY OF INDUSTRY
MUNICIPALITIES
THE NATIONAL ENERGY AUTHORITY
ORKUSTOFNUN
THE STATE ELECTRIC POWER WORKS
RARIK
THE NATIONAL POWER COMPANY
LANDSVIRKJUN
REGIONAL ENERGY COMPANIES
MUNICIPAL ENERGY UTILITIES
THE STATE ELECTRICAL INSPECTION

FIG.18

1988

COMMISSIONED HYDRO, GEOTHERMAL AND OIL FIRED POWER PLANTS

		SIZE MW	FIRM CAPACITY GWh/YEAR
SOUTH AND SOUTHWEST:			
HYDRO		670	3820
GEOTHERMAL		8	50
OIL FIRED		61	
	TOTAL	**739**	**3870**
WEST, NORTH AND EAST:			
HYDRO		52	300
GEOTHERMAL		33	200
OIL FIRED		68	
	TOTAL	**153**	**500**
TOTAL IN ICELAND		**892 MW**	**4370 GWh/Y**

LANDSVIRKJUN

FIG. 19

ENERGY PRODUCTION AND SALES

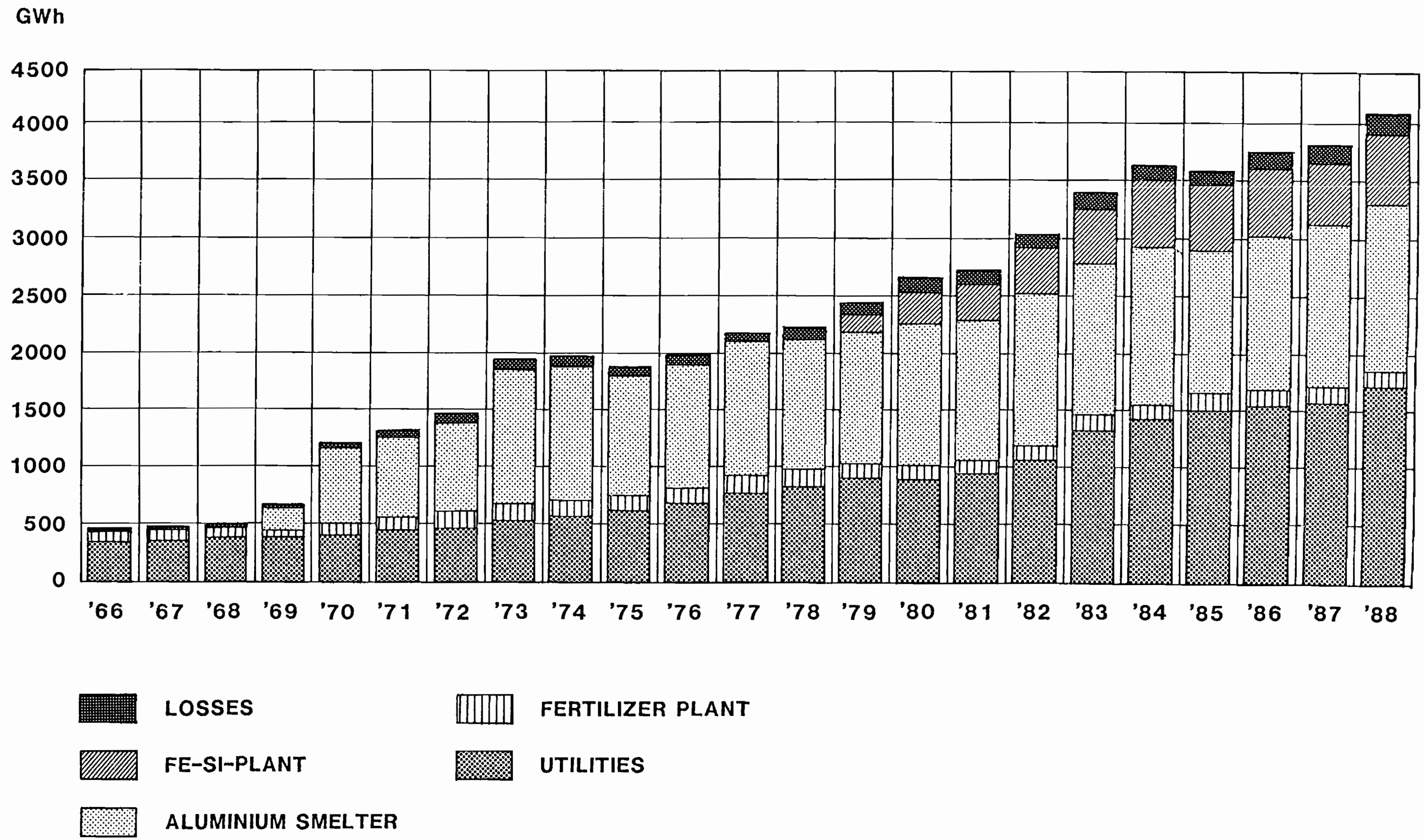


FIG. 20

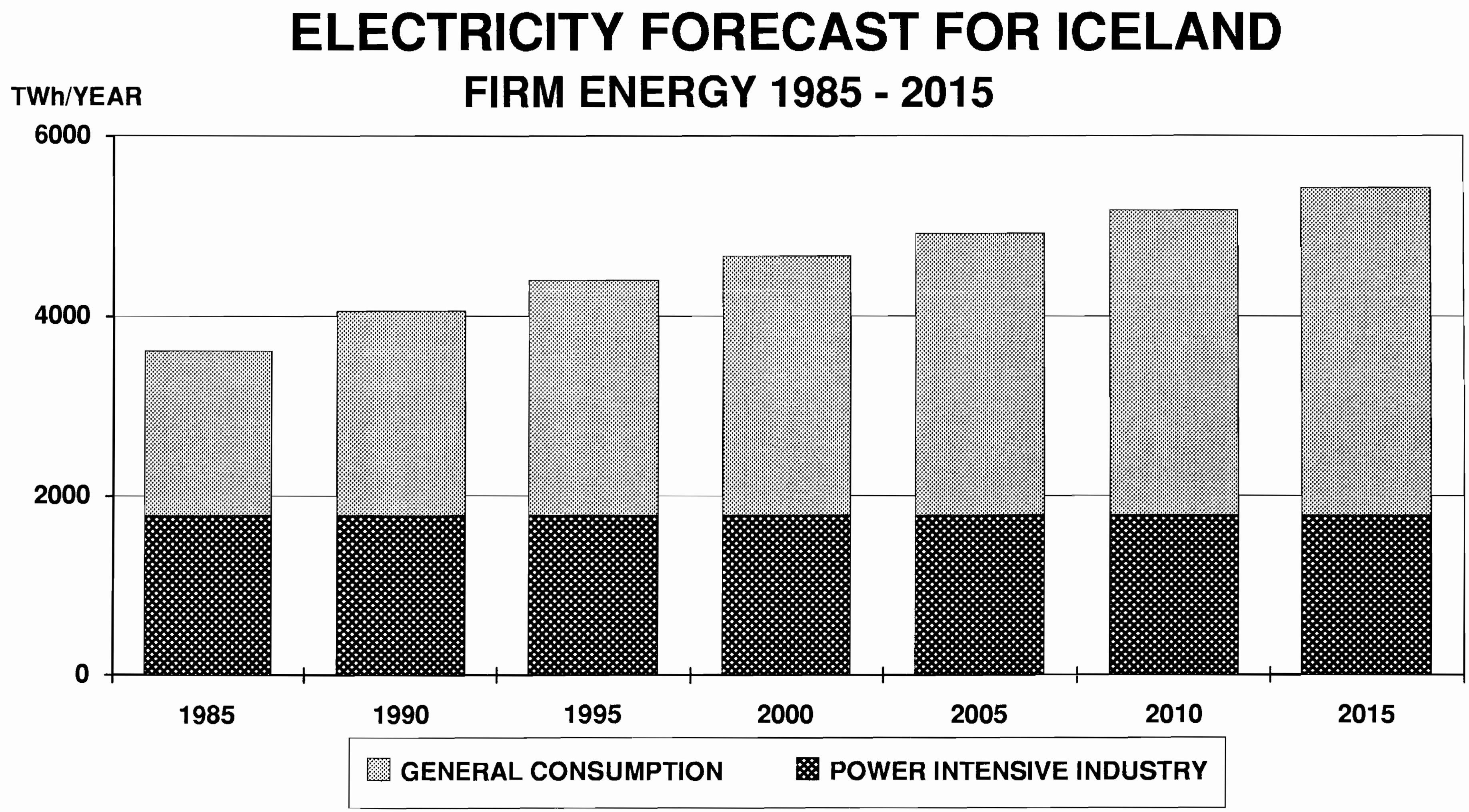
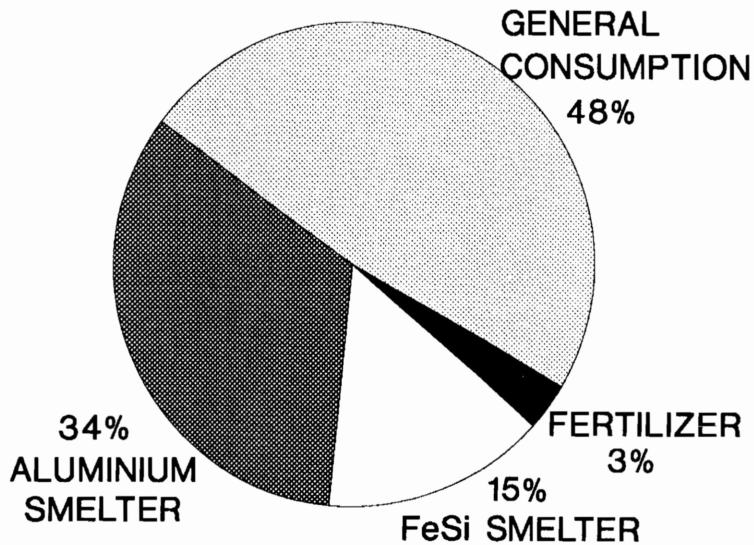

ELECTRICITY FORECAST FOR ICELAND
FIRM ENERGY 1985 - 2015
TWh/YEAR
6000
4000
2000
0
1985
1990
1995
2000
2005
2010
2015
GENERAL CONSUMPTION
POWER INTENSIVE INDUSTRY

FIG. 21

ICELAND 1988

ELECTRICITY CONSUMPTION

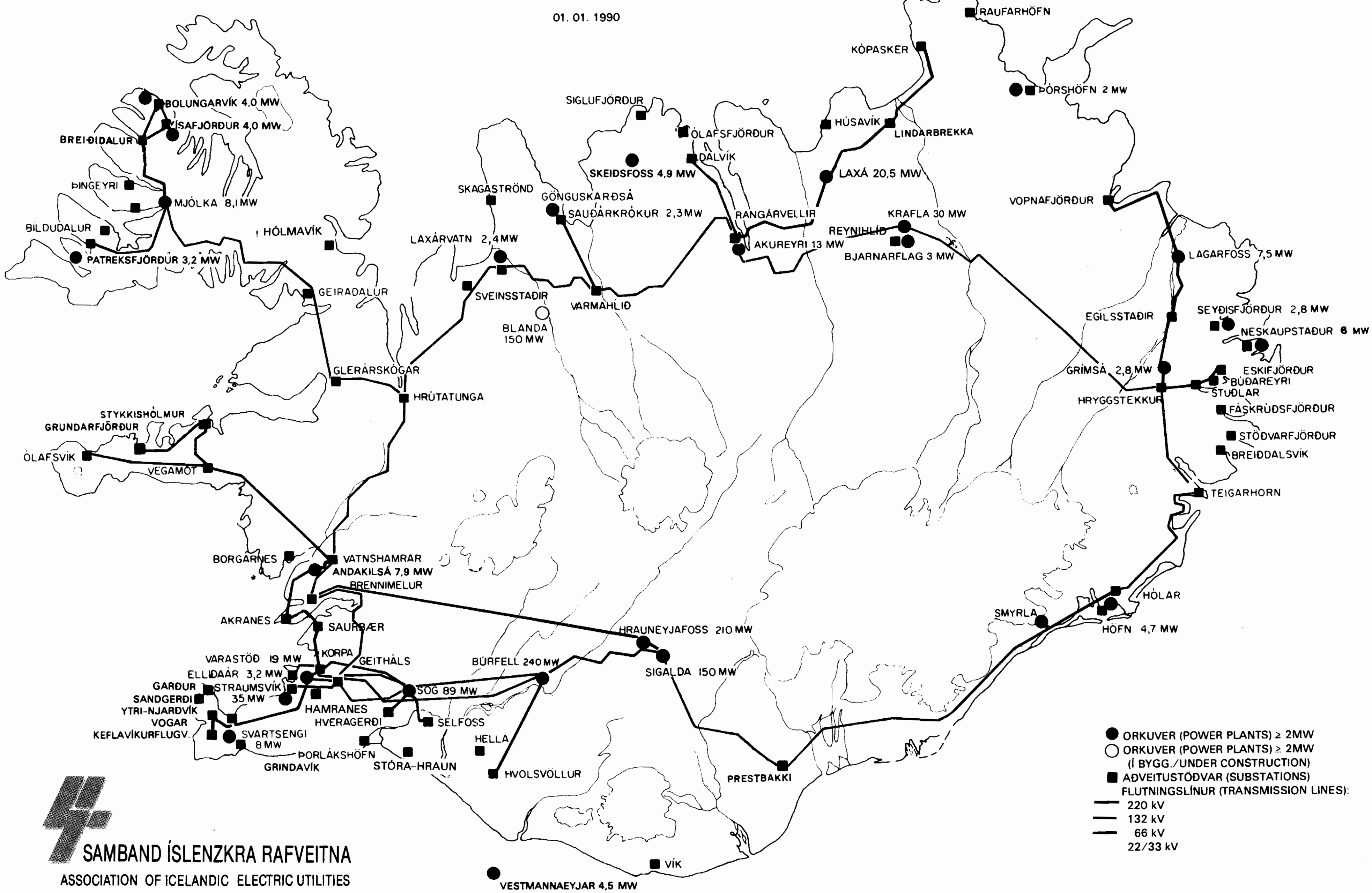
CATEGORY	GWH
GENERAL CONSUMPTION	2'133
FERTILIZER PLANT	142
ALUMINIUM SMELTER	1'485
FERROSILICON PLANT	657
TOTAL	4'417



RAFORKUKERFI ÍSLANDS

THE MAIN ELECTRIC POWER SYSTEM IN ICELAND

01. 01. 1990

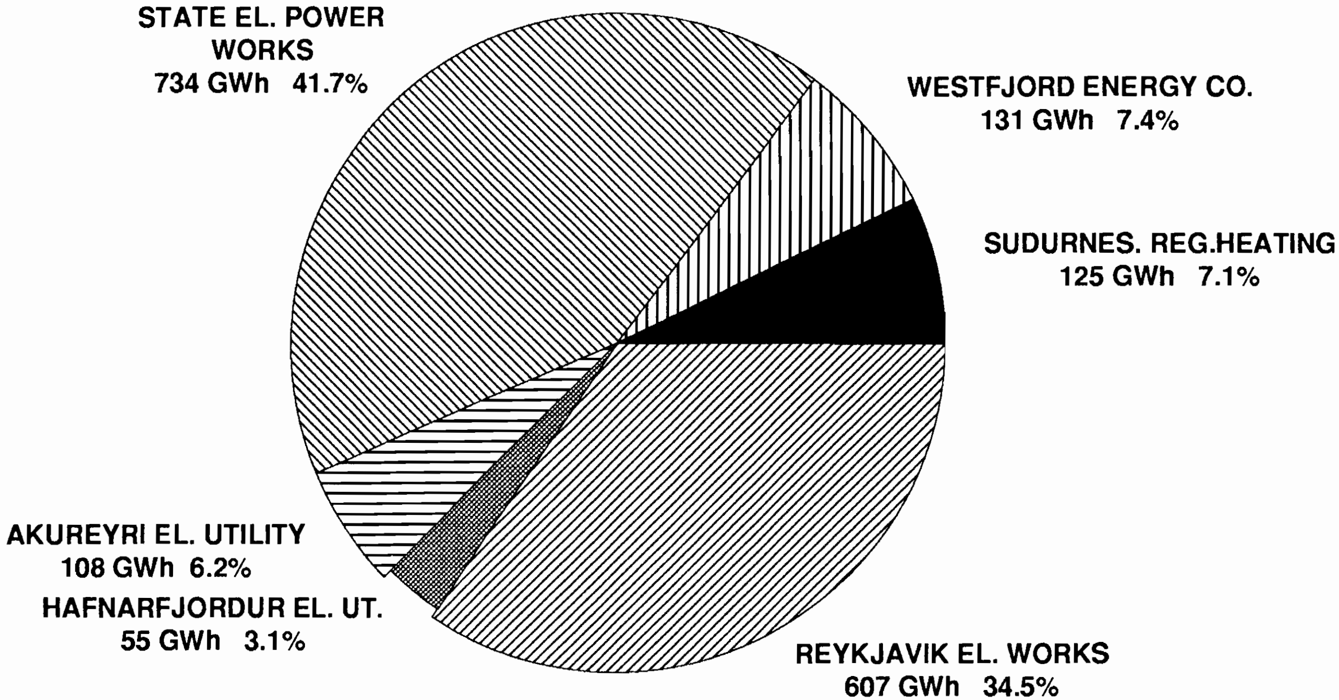


SAMBAND ÍSLENZKRA RAFVEITNA

ASSOCIATION OF ICELANDIC ELECTRIC UTILITIES

FIG. 23

LANDSVIRKJUN SALES TO UTILITIES IN 1988



DISTRIBUTING COMPANIES

01.01.1989

FIG. 24

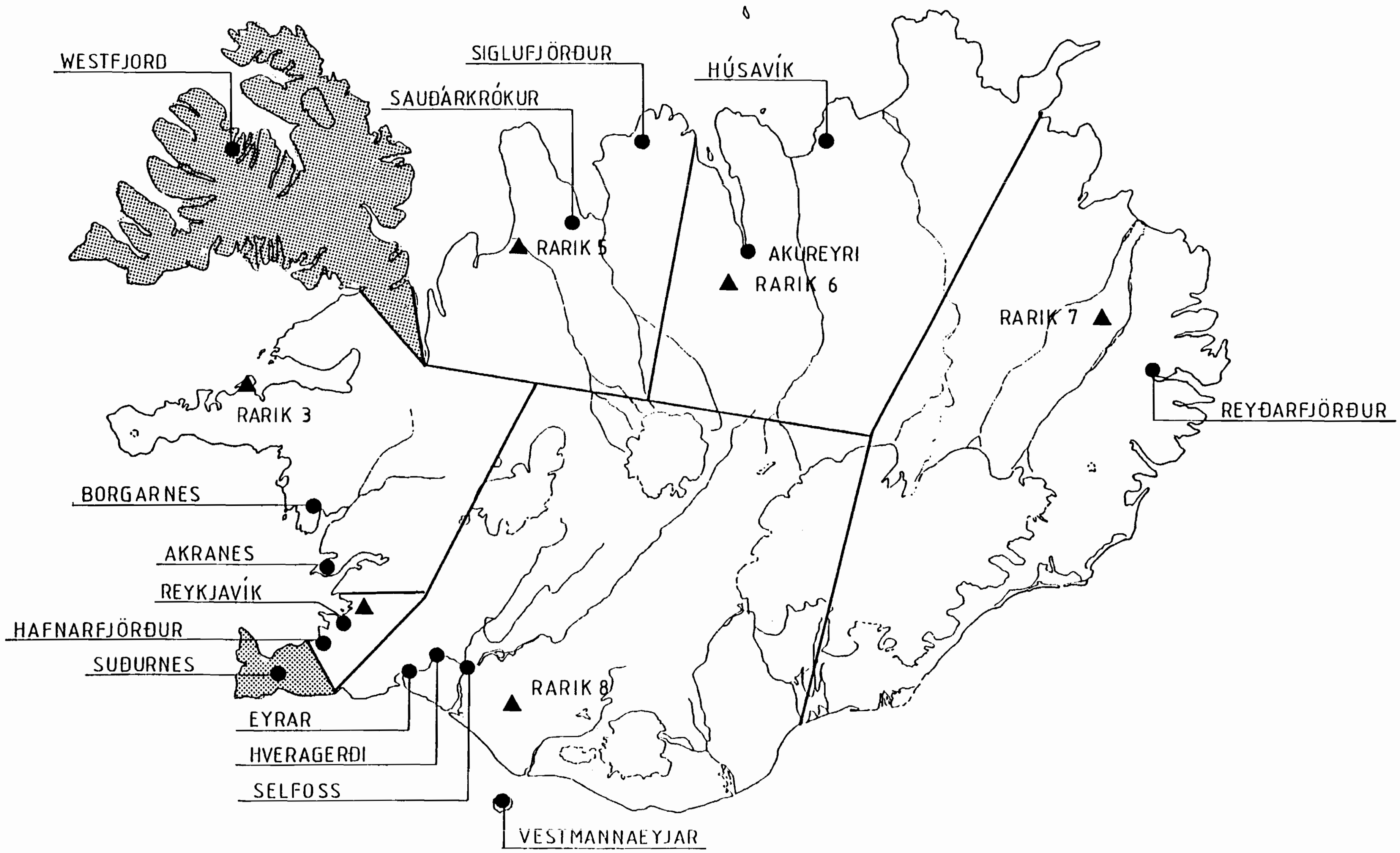


FIG. 25

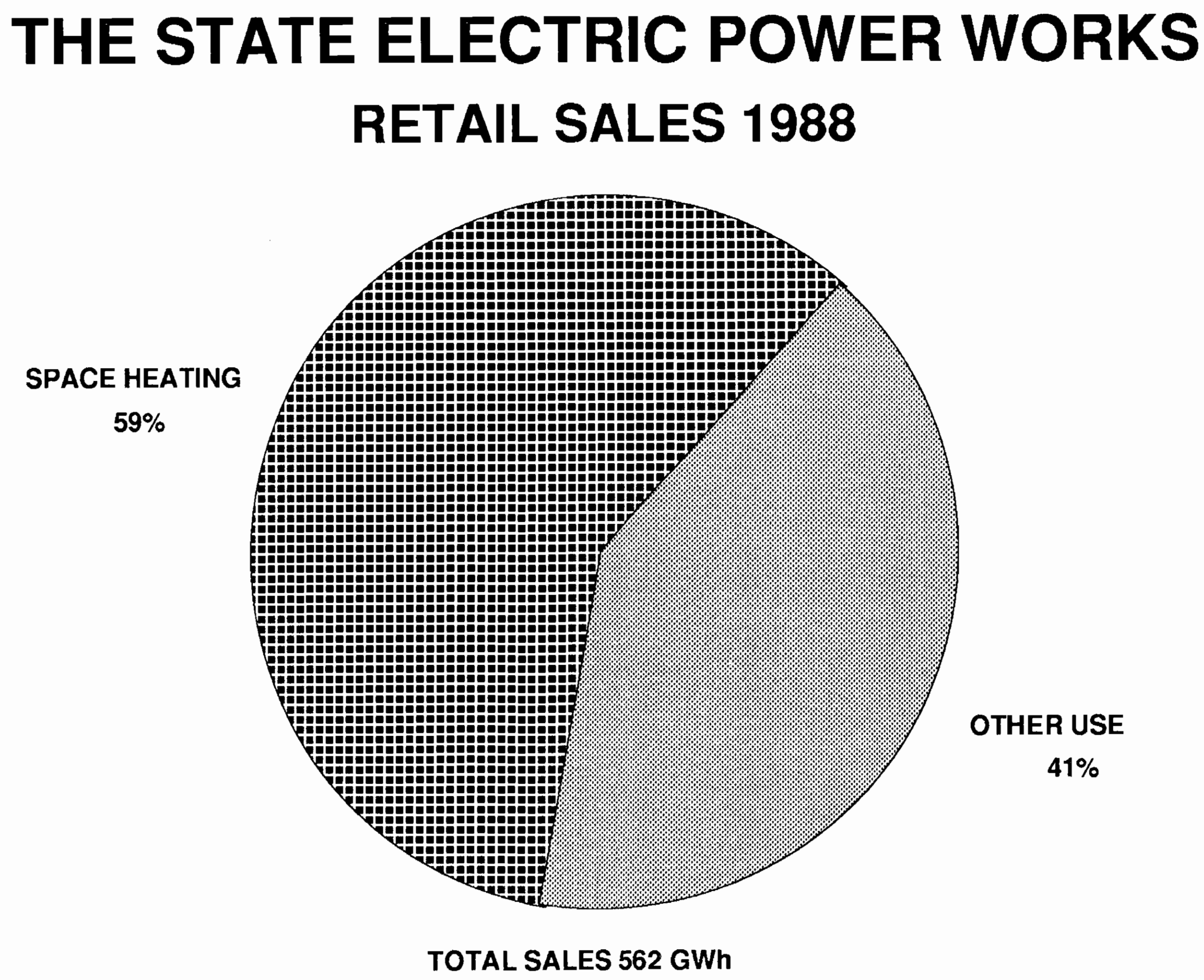

THE STATE ELECTRIC POWER WORKS
RETAIL SALES 1988
SPACE HEATING
59%
OTHER USE
41%
TOTAL SALES 562 GWh

FIG. 26

REYKJAVIK MUNICIPAL ELECTRIC WORKS

RETAIL SALES IN 1988

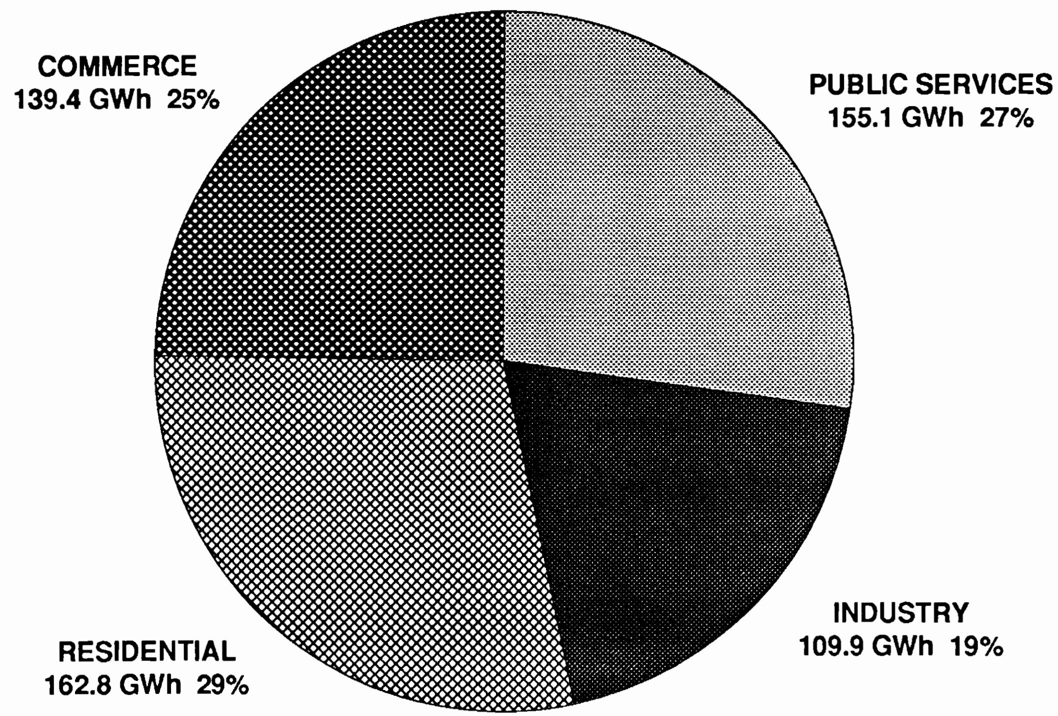
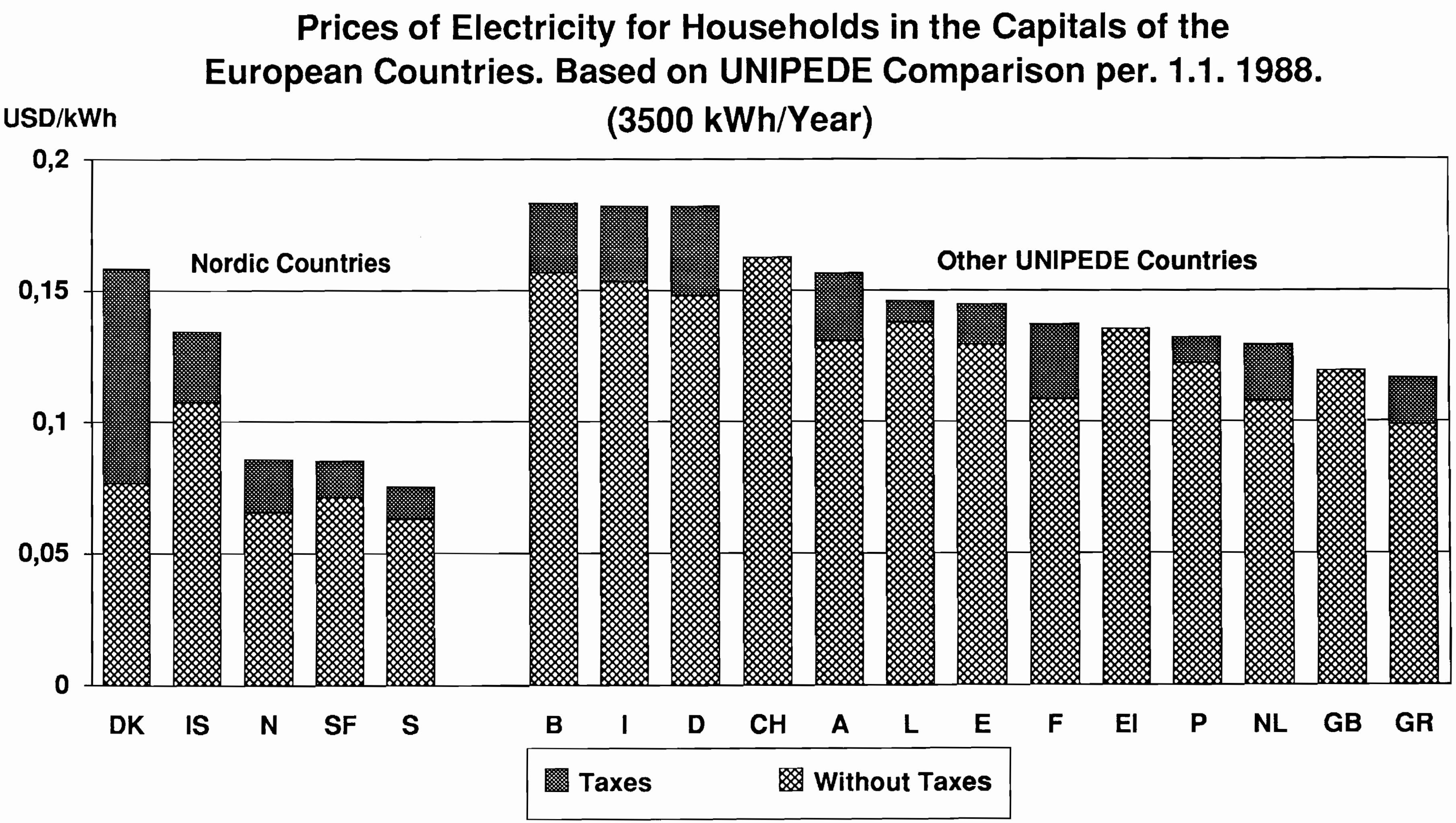


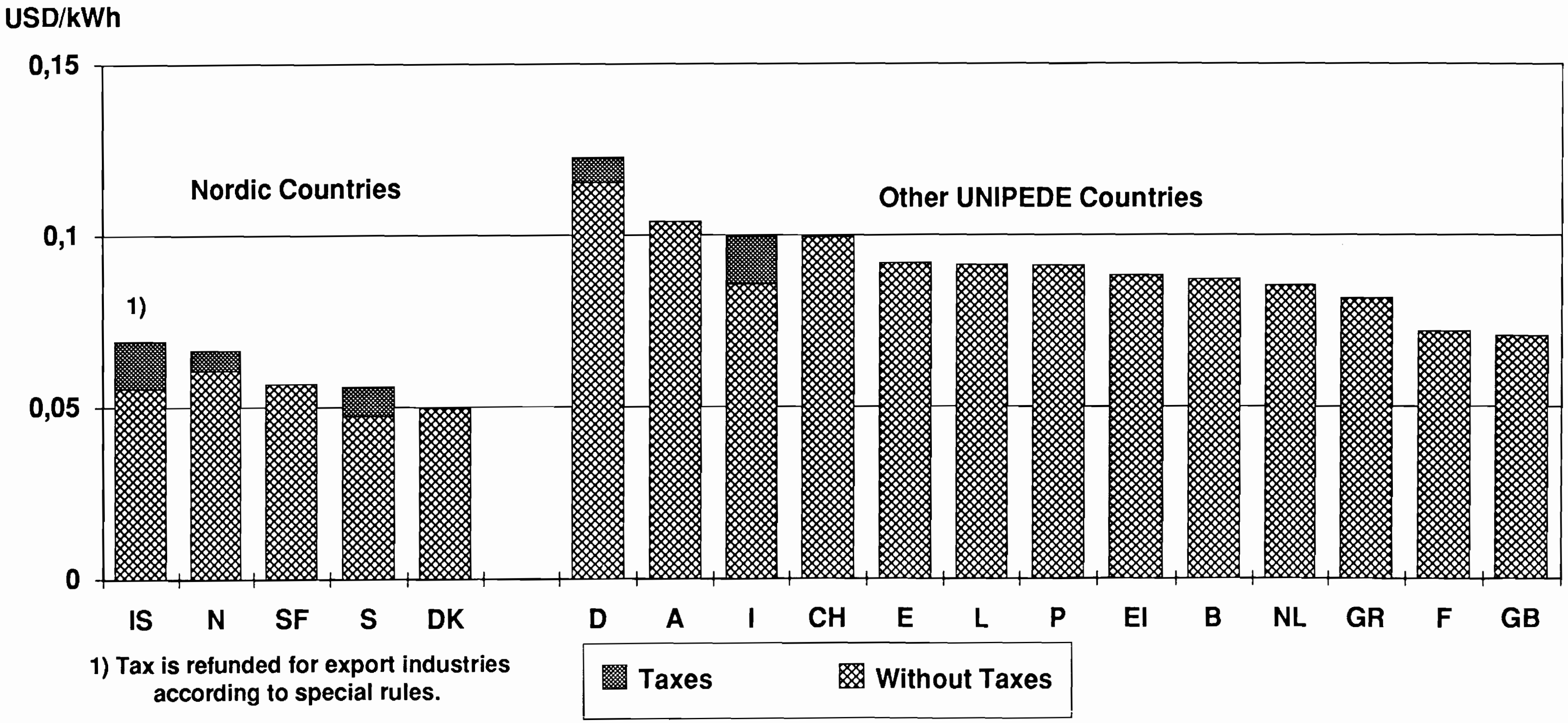
FIG. 27



Prices of Electricity for Households in the Capitals of the
European Countries. Based on UNIPEDE Comparison per. 1.1. 1988.
(3500 kWh/Year)
USD/kWh
0,2
0,15
0,1
0,05
0
Nordic Countries
Other UNIPEDE Countries
DK
IS
N
SF
S
B
I
D
CH
A
L
E
F
EI
P
NL
GB
GR
Taxes
Without Taxes

FIG. 28

Price of Electricity for Industries in the Capitals of the European Countries. Based on UNIPEDE Comparison per. 1.1. 1988. (500 kW and 2 GWh/Year)

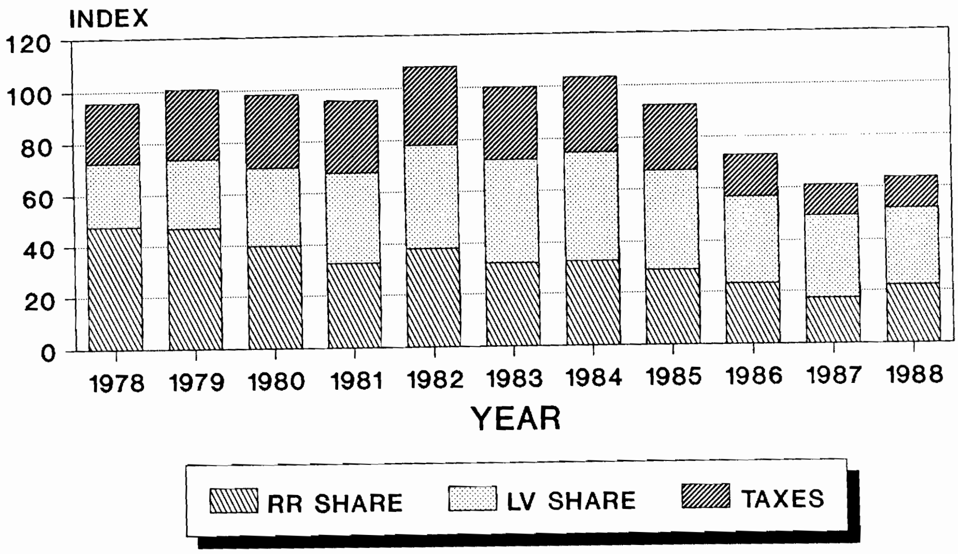


1) Tax is refunded for export industries according to special rules.

FIG. 29

REYKJAVIK MUNICIPAL ELECTRIC WORKS

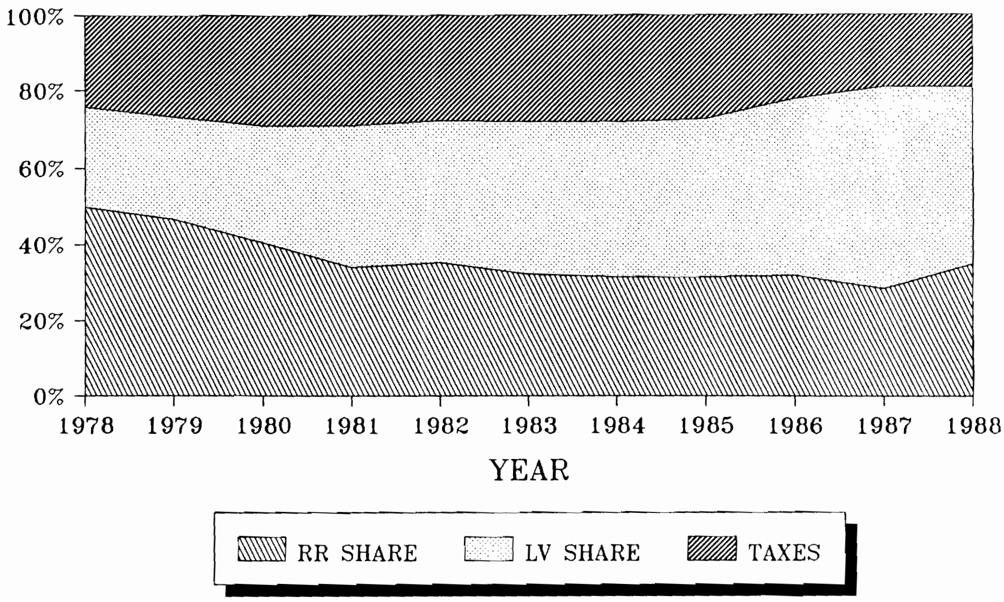
ELECTRICITY PRICES 1978 - 1988



Adjusted by building cost index

LV SHARE = PURCHASE OF ENERGY

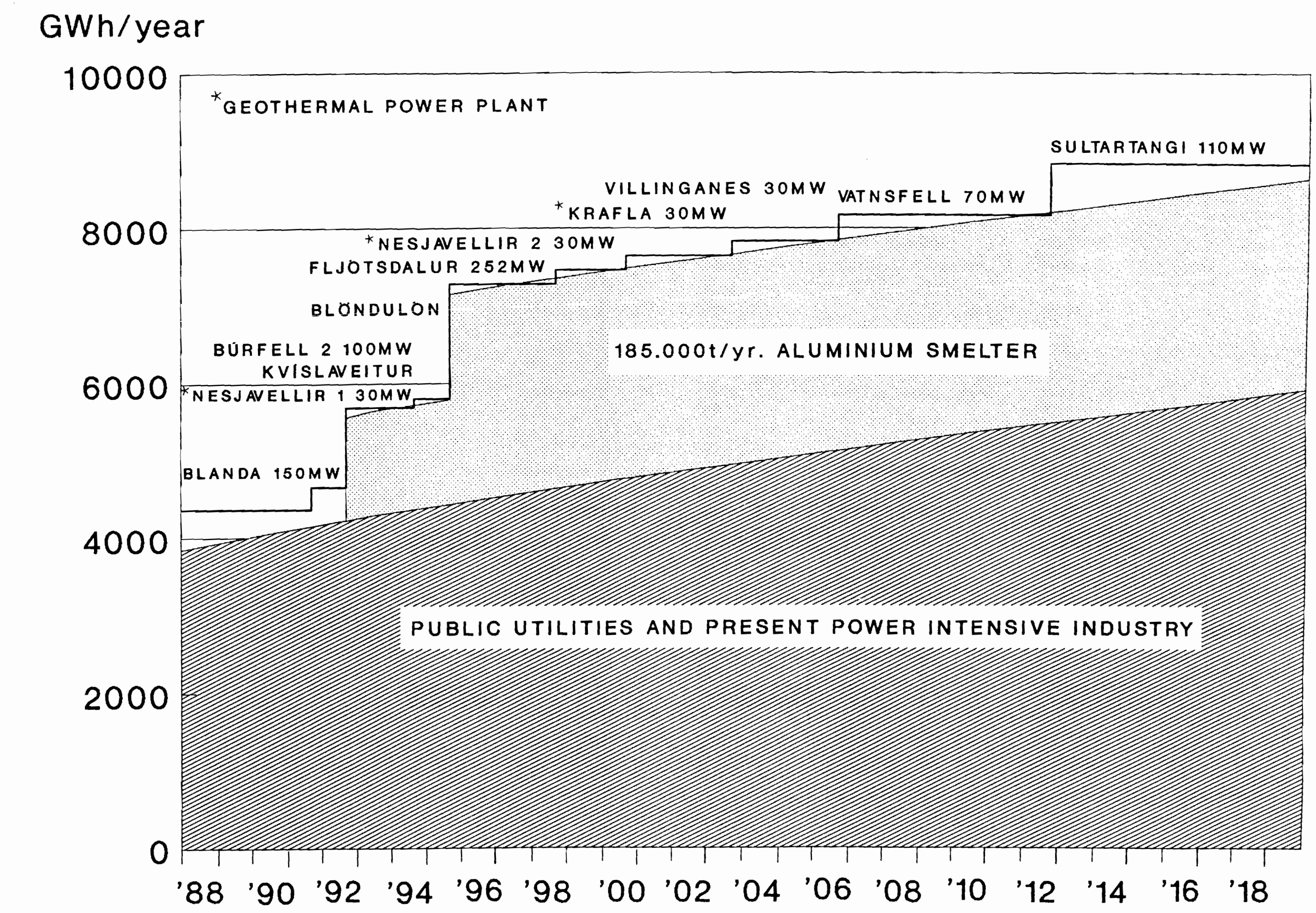
AVERAGE PRICES FOR ELECTRICITY



Proportional shares

ENERGY BALANCE
SCENARIO 185A5

FIG. 30



24.04.89