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NEW AND RENEWABLE SOURCES of ENERGY IN TURKEY

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0. BACKGROUND INFORMATION:

Turkey is located in the Eastern Mediterranean region between longitudes 25° and 40° East and latitudes 36° and 43° North, covering an area of 7.8×10^5 square kilometers. She is bordered by the Black Sea at the North; the USSR and Iran at the East; Iraq, Syria and the Mediterranean Sea at the South-East, the Aegean Sea at the West; and Greece and Bulgaria at the North-West.

Turkey is divided into seven geographical regions as illustrated in Fig. 1. The climate is mild and humid along the coastal regions, gradually becoming colder and drier towards the inland with extremely cold winters in Eastern Anatolia. The rate of precipitation is about 300 mm/year at central plateau regions, 700-800 mm/year along the coastal regions, reaching its maximum (2000 mm/year) at the Eastern Black Sea Coast.

The population is 45 millions concentrated mainly at the West, particularly on the Northern Aegean and Marmara regions. At a rate of growth of 2.07 % per annum, it is forecast to reach to 55 and 68 millions in 1990 and 2000, respectively.

1. INTRODUCTION

Turkey, being in the throes of a major industrialization effort, is eminently in need of secure and reliable energy supply and of adequate energy technology in establishing her industry, improving the economic status and living standards of the country.

The total primary energy consumption is estimated to be 1410 PJ in 1980, representing a per capita energy consumption of 31 GJ which is well below the world average of 60-65 GJ per capita. Energy requirements are increasing at a far greater rate than production and importing is the only way to cover the growing shortfall. At present, nearly half of the national energy requirements is being imported in the form of oil.

The overall objective of the National Energy Policy is therefore aimed at reducing dependence on imported oil and avoiding its impact on any further increases in the balance of payments deficit. In this regard, the Turkish Government is focusing its efforts on accelerated development of alternative energy sources and on promotion of energy conservation without hampering the process of economic development.

To ensure these policy objectives the Five-Year Development Plan calls for a strategy consisting of the following means:

i) to expand the indigenous oil production through enhanced recovery techniques while exploring for new resources in the promising fields

ii) to promote the development of the coal resources possessing high potential utilization

iii) optimum utilization of hydraulic resources

iv) deliberate energy conservation through increased efficiencies and rational use of energy in all sectors of the national energy economy

v) development of new and renewable sources of energy.

In this context, much relative importance has been assigned upon all pertinent forms of new and renewable sources of energy with a view to determine the potential they could represent in meeting the present and future domestic energy needs.

Hydraulic, solar, geothermal and biomass are the most substantial new and renewable sources of energy in Turkey with a potential adequate to supply a considerable portion of the energy requirements in the coming years.

Hydropower is already being exploited. Research and development programmes referring to solar, geothermal and biogas are in operation.

2. INSTITUTIONAL STRUCTURE IN THE AREA OF NEW AND RENEWABLE SOURCES OF ENERGY

Energy management and supply is carried out by the State through development plans of five-year periods while the energy demand is controlled by means of price and tax regulations and industrial investment incentives.

State Planning Organization plays the key role in decision making in energy as well as in other sectors of the national economy.

A simplified diagram of the present energy management infrastructure for establishment and implementation of the national energy policies in the field of new and renewable sources of energy is illustrated in Fig. 2.

The corresponding responsibilities of the related governmental organizations concerning the evolvement and monitoring of the strategies and national research, development and demonstration (R, D + D) programmes are summarized in Annex I.

3. SOURCES OF ENERGY PRESENTLY USED AND THE POTENTIAL ROLE OF NEW AND RENEWABLE SOURCES OF ENERGY:

a) Conventional Energy Sources:

i) Primary Energy Reserves and Resources:

Practically all conventional sources of energy exist in Turkey. Estimates of primary energy reserves and resources are presented in Table I.

The general outlook is that Turkey is endowed with sufficient quantity of fuels. Nevertheless, the present fossil fuel resources base do not seem to be encouraging to ensure the intensive industrial and socio-economic development in the long-run mainly due to their low grade nature in addition to the formidable obstacles encountered in the extraction of these resources.

Petroleum is extracted with great difficulty owing to the depth of the wells and its viscous nature. The sulphur content of Turkish petroleum is also considerably high.

Similarly coal mines are at great depths and the layers are quite thin. The lignite reserves are rather abundant, particularly in the eastern part of the country, but consists mostly (about 85 %) of low grade (below 3000 kcal/kg) and high sulphur deposits.

It is however worth to empasize that great uncertainties exist in coal, particularly in lignite reserve estimates and exploration for additional reserves has been foreseen.

ii) Energy Supply and Consumption Patterns:

Turkey's main indigenous energy resource base has been solid fuels (lignite, coal and non-commercial energy sources) and hydropower.

Primary energy production and consumption patterns over the period 1960-1990 are presented in Tables 2 and 3, respectively.

Of the 57 % of total primary energy (TPE) consumption, produced domestically in 1980, 72 % was from solid fuels, 15 % from hydroelectricity and 13 % from oil.

In pace with the growth of the national economy, TPE consumption rises much higher than the TPE production which in turn increasing the gap between the national energy demand and supply.

The energy consumption structure for the period of 1950-1990 is plotted in Fig. 3. The figure shows three distinct characteristics:

a) the fastest rate and quantity of increase is in petroleum use

b) utilization of lignite and hydraulic resources is growing at a slow pace

c) the increase in coal, wood and animal wastes in terms of quantity has almost remained the same.

Fig. 4 gives the breakdown of energy consumption in 1980 on sectoral and fuel basis together with domestic and imported energy ratio.

As regards future projections, it should be noted that Turkey plans in the ongoing decade a quick increase in domestic energy production from 797 PJ in 1980 to 1562 PJ in 1985 and to 2111 PJ in 1990. Nevertheless, in the same period oil imports are projected to rise by 2.7 times to 1555 PJ (37.1 Mtoe).

b) Potential Role of New and Renewable Sources of Energy:

The new and renewable sources of energy with existing and potential use and which are expected to have significant contributions to the national energy balance are outlined hereunder:

i) hydraulic energy
ii) solar energy
iii) geothermal energy
iv) biomass energy
v) wind energy

Amongst them only solar energy and biomass are available at the national level.

Although Turkey is surrounded by water on the three sides, the plausible contribution from tidal and wave energy is envisaged to be minimal and consequently are not taken into consideration.

i) Hydraulic Energy:

As it is evident from the mountainous character of the Eastern Anatolia and the Central Plateau regions (Fig. 1), Turkey possesses a tremendous hydraulic potential. Of the total of 430 Twh gross theoretical hydro-electric potential nearly 100 Twh is estimated to be economically feasible.

Continuous efforts are underway for the purpose of considerable expansion of the national hydroelectric potential of which only 10 % has been developed to date.

It is estimated that this potential, in case fully exploited, could suffice in meeting half of Turkey's electricity demand well into 2000.

At present, the installed capacity of the main 44 hydroelectric power stations in operation amounts to 2131 MW and approximately 11325 Gwh electricity is generated annually. Through realization of the big and medium-seized hydroelectric power plant projects with a total of 23885 MW installed capacity to be commissioned in the period 1980-97, it is planned to utilize 65 % of the existing economically exploitable potential by 1997.

The utilization of small - scale hydroelectric capacity has been minimal to date and much relative importance has been assigned to the full appraisal of large-scale projects. Nevertheless, the related studies with regard to optimum assessment of small-scale hydro power plants have gained momentum in parallel with the national objectives so as to attain increased contribution from the indigeneous small scale hydroelectric potential amounting nearly to 20-30 Twh per annum.

At present, 150 small hydro plants are in operation, representing a total installed capacity of 25 MW.

On the other hand,relevant studies are in the planning stage concerning design, construction and operation of mini-hydro plants within the range of 50 kW - 1 MW for harnessing the exploitable potential of mini-hydro power in meeting the electricity needs of the remote rural areas.

ii) Solar Energy:

Amongst the new and renewable sources of energy currently under investigation, solar energy seems one of the most promising field, and activities on means in promoting the utilization of practical applications of solar energy has become a matter of growing national concern due to the attractive geographic climatology of the country.

Turkey has on the average 2500 hours of sunshine per annum while the yearly average solar flux exceeds 1800 kwh. In this regard, the average yearly solar energy potential which could be assessed as low-temperoture heat is estimated at about 36.10^6 tonnes of hard-coal equivalent and the duration of solar radiation intensity over the country is highly appropriate for all kinds of applications.

Fig. 5 shows the annual average total radiation on horizontal surface in Turkey.

In the Fourth Five-Year Plan, the total solar energy utilization was predicted to be 0.06 % of the total energy production in 1980. However, this figure excludes the natural solar drying of various agricultural products which is widely used throughout the country and a realistic assesment of the extent to its plausible contribution is difficult to estimate. Table 3 presents the 1979 production of certain sun-dried fruits and vegatables.

iii) Geothermal Energy:

Turkey can be regarded as having considerable geothermal energy potential due to its appropriate geographic structure for formation of rich geothermal reservoirs. She is located on the Mediterranean volcanic belt where relatively recent volcanic and tectonic activities are frequently observed.

The most promising geothermal fields are mainly concentrated in the Western Anatolia. Fig. 6 shows the distribution of reservoir temperatures of the existing hot springs in Turkey.

A variety of surveys through exploration and drilling activities are being conducted throughout the country for drawing up an inventory of the total geothermal potential. Although a realistic assesment can not be made of the extent of its contribution, tentative estimates indicate that merely a potential of 4500 MWe could be utilized for electricity generation.

On the other hand, it is anticipated that the total potential of low-enthalpy geothermal fields, not suitable for electricity generation but could profitably utilized for heating purposes, was much more substantial, amounting nearly to 31500 MW_{th}.

iv) Biomass Energy:

Wood, animal dung and plant wastes, still constituting the staple and non-commercial energy sources of most of the rural areas in Turkey, are mainly used for heating and cooking purposes.

The total area of domestic woodlands amounts approximately ta 20.10^6 hectares and according to the latest figures the rate of useful and renewable product per hectare is about 1.5 m^3 which is well below the 5 m^3/hectare realized in Western countries.

The amount of firewood consumption in 1980 reached to 14.10^6 tons constituting nearly 12.5 % of the total energy consumption.

Utilization of wood as fuel leads to deforestation and abolishing of forestry areas in the country due to the excessive fire-wood consuption, and in this respect, harnessing of wood for industrial purposes would be considered from economic viewpoint.

If the useful product output is to be increased to 5 m^3/hectare level, then wood energy can contribute significantly to Turkish energy demand.

According to 1980 statistics the cattle population is about 15.10^6 yielding 75.10^6 tons of manure per year.

Animal wastes constitute very rich input from agricultural viewpoint and therefore, the basic policy of the Turkish Government is focussed on multi-purpose utilization of agricultural wastes, namely as biogas and organic fertilizer.

A theoretical estimate of the bio-gas potential in Turkey reveals that an equivalent of 9.9 Twh energy (2.5×10^6 tons of petroleum equivalent) could be provided if the total production of cattle manure in 1980 were exclusively used in biogas production.

With agricultural wastes included, the total biomass energy potential is estimated to be 3.4×10^5 TJ/year. (8.10^6 tons of petroleum equivalent).

v) Wind Energy

As regards wind energy, Turkish conditions are considered to be scarcely profitable in comparison with those countries already utilizing wind power.

Most of the wind energy utilization potential is at the North, along the Black Sea Coastland and in the Aegean region where the yearly average wind velocities are assumed to be 5 m/sec, very rarely exceeding the economic utilization limit. However, there is still possible scope for use in irrigation and small-scale electricity production.

4. PRESENT STATUS OF THE R, D+D ACTIVITIES AND COOPERATIVE PROGRAMMES IN THE FIELD OF NEW AND RENEWABLE SOURCES OF ENERGY

The economic crisis and the bleak future in energy situation have aroused a nationwide continuous interest in new and renewable energy sources, with particular reference to solar energy, in complementary with energy conservation.

Fig. 7 shows the world energy consumption per unit of GNP against GNP per capita as of 1972. As apparent from the figure, the efficiency of the present energy utilization pattern in the main sectors of the national economy is considerably poor in Turkey. Consequently, research on national use of energy is an eminent necessity in the industrial and domestic sectors - comprising almost 79 % of the final energy consumption - In view of the above, R+D work with refer to energy conservation has enjoyed a nationwide attention and currently being pursued by various research groups.

As regards solar energy, present R+D activities are primarily concentrated on flat plate collectors and solar architecture.

Geothermal, biomass and wind energy are also receiving considerable attention. Several prototypes were built and related demonstration projects have been completed in respect of several applications of geothermal energy and bio-gas.

Major government energy R+D programmes regarding the promotion of the practical utilization of new and renewable sources of energy are currently centered on:

- solar heating and other various low-temperature applications;

- utilization of geothermal energy in electricity generation, space heating and heating of greenhouses;

- utilization of mini hydropower;

- biomass (biogas production from organic agricultural residues) as on alternate fuel;

- assessmentof wind energy for small-scale electricity generation within the scope of combined utilization of renewable energy sources (such as solar and biogas), particularly in remote rural areas.

Research and development work on solar, geothermal energy and biogas are already in operation while programmes with refer to wind energy and mini-hydro power are in the planning phase.

a) Solar Energy:

Activities aimed at making more effective contribution of the solar energy to the national energy balance are pursued under the coordinative responsibility and supervision of the Ministry of Energy and Natural Resources and in order to reach the planned targets Marmaris Solar Energy Research Centre was established in 1977.

In this respect, the Mineral Research and Exploration Institute was entrusted with the task of formulating a national solar energy working programme, to be organized on the basis of establishing and maintaining a close collaboration with all the interested universities in order to conduct the proposed activities in a co-operative manner.

On the other hand, The Scientific and Technical Research Council of Turkey and various universities particularly Ege University, are also engaged in active research work in the field of solar energy.

At the present stage of development, the main features of the activities, comprising merely low-temperature applications, in progress at the above-mentioned institutions cover the following areas:

- solarimetry studies and development of solar map of Turkey

- design, construction and performance testing of various solar collectors

- water heating

- house heating (passive and active methods)

- drying of various agricultural and industrial products

- heating of greenhouses

- solar distillation of sea-water

- architectural aspects of solar energy use for energy conservation in buildings.

In addition to the activities described above, the following R+D programmes are planned to be put forward in the near future:

- determination of the feasibility of combined utilization of solar, biogas and wind energy in meeting the various specific needs of isolated rural areas which are not yet connected to the national grid

- development of concentrating collectors for process heat production in the industry

- solar distillation of brackish water for sodium sulphate and magnesium sulphate production

- energy storage

- solar absorption cooling

- solar ponds.

Moreover, several commercial firms in the private sector are engaged in the manufacturing and marketing of various domestic designed solar water heaters and have been doing so for over the last three years.

They are installed in residential and commercial buildings and touristic places generally in locations where insolation is high and fairly uniform throughout the year.

b) Geothermal Energy

The activities regarding the assessment of geothermal energy potential have been going on systhematically under the administration and sponsorship of the Mineral Research and Exploration Institute since 1961.

As a consequence of detailed surveys in certain regions having suitable reservoir and hydro-chemical conditions, energy generation possibilities have been determined especially in the western and central parts of Anatolia. At present 13 promising fields are considered to be primarily important and planned projects regarding the assessment of exploited geothermal potential are focussed on electricity generation and heating.

In Denizli-Kızıldere geothermal field which is the most progressive one at present, an experimental pilot plant of 0.5 MW installed capacity, established in 1975, has been operated succcessfully. Implementation of a power plant of 20 MW installed capacity (120 Gwh per year) has been planned and commercial operation was foreseen in 1982.

In addition to the electricity generation, waste geothermal fluid will be harnessed for the purpose of greenhouses heating. At present, a pilot project is in operation for heating greenhouses, 3000 m^2 in area. Favourable results have been obtained and possibility of further heating of greenhouses, of 500.000 m^2 in area, has been identified. Heating of the nearby towns offers another possibility.

Upon realization of the commercial operation of the power plant to be implemented in the Denizli-Kızıldere field, relevant studies for power production from other promising geothermal fields would be accelerated. In this connection, a large-scale demonstration project is underway aiming at construction of a domestic-designed turbine-generator of 5 MW capacity.

On the other hand, preparatory activities for appraisal of low-enthalpy geothermal fields were commenced.

c) Bio-Gas

R+D activities on the promotion and utilization of biogas in Turkey are being conducted by the Mineral Research and Exploration Institute under the coordination and sponsorship of the Ministry of Energy and Natural Resources.

The work programme has been put forward in three phases and in the light of the results achieved from the laboratory and pilot stages research work, a joint R+D project has been implemented with UNICEF in regard to the demonstration and propagation of biogas technology in Turkey on a national scale under cold climatic conditions. In this respect, a large-scale biogas plant, of 35 m^3 in capacity, was designed and constructed in one of the eastern provinces of the country, where biogas is definitely deemed as an important source of energy and agricultural/economic input.

The project is in progress under the coordinative responsibility of the State Planning Organization in co-operation with the Ministry of Energy and Natural Resources and the Ministry of Agriculture and Forestry.

Testing activities are underway for determination of the necessary economic and operational criteria. In the future course of activities, propagation of the prototype digestors throughout the country will be taken into consideration subject to economic reliability of the first stage of demonstration work.

5. MAIN CONSTRAINTS ON THE UTILIZATION OF NEW AND RENEWABLE SOURCES OF ENERGY

The national energy budget for the fiscal year 1980 amounted nearly to 63.8 10^9 $ US (1), comprising about 1.6 % of the GNP. Heavy reliance

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1 $ US = 80 TL.

on petroleum has severely affected the Turkish economy as can be deduced from Fig. 8, representing the amount of total petroleum imports against the percentage of GNP.

The heavy burden inflicted on the national economy by the petroleum imports bill has prolonged several major energy projects which in turn has forced a national blackout programme and even importation of electrical energy.

It is also worth to emphasize that industry, the largest energy consumer, is presently based mostly on inefficient technologies due mainly to the transfer of outdated and least expensive technologies and know-hows from developed countries, with minimum energy conservation considerations.

On the other hand, Turkey does foresee certain problems for the expansion of its basic national programmes as far as industrial capabilities and technical experience are concerned for certain large-scale applications. In this connection, process heat production, seasonal energy storage, small-scale electricity generation in the field of solar energy could be cited.

There is a considerable imbalance between the locations of resources and consumption centres. The major deposits of petroleum, lignite and peat as well as the main hydraulic sites are located in the South-Eastern part of the country while most of the industrial and agricultural activities and the population are concentrated in the Western and Northern regions.

It can therefore be concluded that an optimum balance between regional energy production and consumption patterns should be eminently established and, in this regard, effective assessment and beneficial utilization of the new and renewable sources of energy potential, as dispersed energy forms for local use, deserve adequate attention.

6. MEANS AT FACILITATING DEVELOPMENT AND USE OF NEW AND RENEWABLE SOURCES OF ENERGY IN TURKEY

In order to overcome the impediments encountered in further expanding the utilization of new and renewable sources of energy, the main lines of action concentrate on the following issues:

a) promotion of the supporting of R+D activities

b) allocating adequate financial resources to the related projects in the public sector

c) establishment of incentives for commercial applications

Many research groups in governmental and/or private and academic institutions have been intensively engaged in concerted research activities in the field of energy with due consideration to energy conservation, process optimization, new and renewable sources of energy and technology development.

Although the contribution of domestic industry to energy sector is limited to production of small-scale mechanical equipment and construction work, development of a national energy industry is expected and envisaged in the present National Development Plan. On the other hand, the technical infrastructure and industrial capability (know-how, engineering services and labour force) are quite sufficient for building and constructing energy producing plants subject to importation of the major equipment.

In the field of new and renewable sources of energy, programme for local manufacture of equipment is aimed at developing appropriate prototypes within the framework of economical, technical and social patterns prevailing in the country.

At the present stage of development, main industrial attention is focussed on solar energy equipment manufacturing, particularly flat-plate solar collectors and/or complete systems for water and space heating. Solar water heating is clearly the most promising application at present and the technological capability of the country is good enough to allow the development of such technology on a national basis.

On the other hand, special sub-committees have been formed within the Ministry of Energy and Natural Resources for purposes of handling and coordinating the development of ongoing national activities in the field of new and renewable energy sources in an effective manner. To this end, the preparatory activities are underway for further assessment of the economical, administrative and technical aspects of the relevant R+D activities.

Furthermore, close co-operation with international organizations (mainly with the United Nations) and/or foreign countries are being carried out in conformity with the programmatic goals of the related national activities in order to overcome those constraints encountered in the execution of the present R+D projects in the field of new and renewable sources of energy, stemming particularly from lack of foreign financing and equipment.

7. CONCLUSION AND RECOMMENDATIONS

The prospects for potential use of new and renewable sources of energy is highly promising in Turkey. Substantial attention is now being assigned to harnessing of their beneficial utilization in national energy planning and in this respect investments are encouraged with the aim to realize the planned targets on the practical applications of pertinent forms of new and renewable sources of energy.

The immediate fields of application comprise such domestic and agricultural uses in rural areas as heating, cooking, greenhouses heating, drying and irrigation.

Amongst the new and renewable sources of energy presently under investigation, solar energy plays the most prominent role. The passive utilization of solar energy in the residential sector seems very promising. The existing building codes offer scope

for meeting a considerable fraction of the heating requirements of dwellings and industrial plants by solar energy. Moreover, the temperature level of energy use by industry is very encouraging for solar process heat production.

Development of new and renewable sources of energy evidently receive greater importance for such oil importing developing countries like Turkey who are subject to ensure reliable and adequate energy supply in order to realize their economic developments and to improve their living standards especially that of rural populations.

It should however be emphasized that for most of the developing countries lack of national capabilities with refer to manufacturing major equipment and technological know-how, constitute major deterrents for widespread utilization of new and renewable energy sources.

In this respect, the ideal strategy may be to establish a national energy technology. It is doubtful, however, if any of the developing countries could indeed be self sufficient in energy technology in the foreseable future.

As can be concluded from Fig. 9, developing countries although supplying most of the energy in the world consume only a tiny fraction of it. In the figure, those countries lying above the self-reliance line are in more favourable position in contrast to the ones situated below the line.

Fortunately, Turkey as well as many other developing countries are close to achieving energy self-sufficiency and as a consequence major advantages for increased utilization of new and renewable sources of energy become evident. On the other hand, the fast depletion of petroleum and other fossil fuels eminently justifies the fact that renewable energy sources in reaching the energy self-sufficiency could play a significant role.

To this end, ways and means of establishing an international administration for energy, within the framework of the United Nations System, with the aim of promoting an effective technical and economic co-operation among developing and industrialized countries could be considered.

The ultimate goal of such a scheme should primarily focus on establishment of several international energy technology centres, with full scale research and development facilities, functioning mainly in the field of new and renewable sources of energy.

As an initial course of action, prior consideration might be given to assessment of potentials with respect to energy sources, technologies, manpower and financing while establishment of individual national centres and determination of the fields of specialization relevant to each research centre constituting the next further stages.

Turkey, being fully aware of the importance of energy-related issues and of the major role which new and renewable energy sources could play in the

solution of energy predicaments of developing countries, stands ready to participate in and play a leading role for establishing a United Nations Energy Technology Administration (UNETA) in order to aim at achieving the ultimate goal in the energy world, i.e., attainment of self-reliance in energy for all nations.

ANNEX I

Organizational Structure in the Area of New and Renewable Sources of Energy

a) Government Agencies Responsible for Evolving Strategies

i) State Planning Organization, established in 1960, has comprehensive authority over the preparation of national development plans, programmes and investment programmes as well as approval of related decisions with respect to implementation of above-mentioned plans and programmes.

In this connection, it has the statutory responsibility for determination of main energy policies, annual and long-term targets and for evaluation of the investment programmes within the perspectives of national economic strategies adopted in Five-Year National Development Plans.

ii) The Ministry of Energy and Natural Resources, set up in 1964, is responsible for implementing and coordinating national energy policies for the exploration, development, production, supply, distribution and use of energy and the total natural energy resources of Turkey.

It is, in this respect, in charge of preparing investment proposals and of their implementation so as to ensure the realization of the planned strategies and programme targets in conformity with the envisaged national policies adopted in the development plans.

iii) The Scientific and Technical Research Council of Turkey was formed in 1963, in order to develop , carry out, promote and encourage the basic and applied research in accordance with the objectives stated in the national development plans and programmes.

In the framework of above-mentioned objectives, it assists in facilitating adaptation and implementation of new technologies by means of technical and financial support to relevant organizations.

b) Government Institutions Responsible for the Execution of National Programmes

Within the Prime Ministry;

i) Under-Secretary for Environmental Affairs is responsible for overall coordination of the activities with regard to environmental protection issues on the basis of the national environmental policies.

ii) the Ministry of Finance is responsible from the standpoint of financing the investment projects.

iii) the Ministry of Industry and Technology is responsible for technology transfer within the energy R, D+D programmes as well as for guiding the private sector in commercial applications.

iv) the Ministry of Agriculture and Forestry is responsible for policy and implementation of the energy R, D+D programmes dealing with biomass.

v) State Meteorological Institution is in charge of meteorological forecasts and provides advice and/or background information to relevant organizations for promoting meteorological and heliometric data in the field of new and renewable sources of energy.

Under the auspices of the Ministry of Energy and Natural Resources;

i) the Mineral Research and Exploration Institute (MTA) is in charge of conducting the national R, D+D programmes dealing with solar, geothermal, biomass and wind energy.

ii) State Hydraulic Works (DSİ) is responsible for assessment and utilization of hydraulic resources.

iii) Electric Power Survey Administration (EİEİ) is in charge of preparing surveys on hydraulic resources in order to supplement the above-mentioned activities pursued by DSİ as well as of investigations in the field of energy conservation.

In addition of the afore-mentioned government agencies;

i) Ege University is responsible for executing part of the R+D activities concerning solar energy.

ii) Private Firms are engaged in commercial applications mainly in the field of solar energy and energy conservation.

TABLE: I

PRIMARY ENERGY RESERVES AND RESOURCES (10^6 tons)

	Proven	Proven + Probable	Probable	Possible	TOTAL
Hard Coal	187.2	71.4	287.2	906.2	1452.0
Lignite	4140.0	1016.8	1724.0	461.7	7342.0
Crude Petroleum	57.0	-	-	-	57.0
Asphaltites	-	36.0	-	16.0	52.0
Bituminous Schists	340.0	-	-	4856.0	5196.0
Natural Uranium	4.0	-	-	0.6	4.6
Thorium	380.0	-	-	-	380.0

TABLE: 2

PRIMARY ENERGY PRODUCTION IN THE PERIOD 1960-90
(10^{15}J)

Years	Hardcoal	Lignite[1]	Petroleum	Hydro	Geothermal	Nuclear	Wood	Animal and Plant Wastes	TOTAL
1960	93	36	16	10	-	-	163	87	405
1965	112	56	67	23	-	-	162	91	511
1970	117	75	156	32	-	-	161	97	638
1975	123	130	136	62	-	-	183	103	737
1980	92	210	102	118	-	-	176	99	797
1985	117	701	140	227	0.96	-	216	159	1561
1990	132	922	140	491	0.96	38	236	153	2113

PRIMARY ENERGY PRODUCTION STRUCTURE (%)

1960	23.0	8.9	4.0	2.5	-	-	40.2	21.4
1965	21.9	11.0	13.1	4.5	-	-	31.7	17.8
1970	18.3	11.8	24.5	5.0	-	-	25.2	15.2
1975	16.7	17.6	18.5	8.4	-	-	24.8	14.0
1980	11.6	26.3	12.8	14.8	-	-	22.1	12.4
1985	7.5	44.9	9.0	14.5	0.06	-	13.8	10.3
1990	6.3	43.6	6.6	23.3	0.04	1.8	11.2	7.2

(1) including asphaltities

TABLE: 3

PRIMARY ENERGY CONSUMPTION IN THE PERIOD 1960-90
(10^{15}J)

Years	Hardcoal	Lignite (1)	Petroleum	Hydro	Geothermal	Nuclear	Wood	Animal and Plant Wastes	TOTAL (2)
1960	99	34	85	11	-	-	163	87	479
1965	115	55	174	23	-	-	162	91	620
1970	119	73	337	32	-	-	161	97	819
1975	121	130	613	62	-	-	183	103	1213
1980	107	210	684	119	-	-	176	99	1409
1985	375	772	1177	227	0.96	-	216	159	2927
1990	656	1114	1695	491	0.96	38	236	152	4383
			PRIMARY ENERGY CONSUMTION STRUCTURE (%)						
1960	20.7	7.1	17.7	2.3	-	-	34.0	18.2	
1965	18.5	8.9	28.1	3.7	-	-	26.1	14.7	
1970	14.5	8.9	41.1	3.9	-	-	19.7	11.9	
1975	10.0	10.7	50.6	5.1	-	-	15.1	8.5	
1980	7.6	14.9	48.6	8.4	-	-	12.5	7.0	
1985	12.8	26.4	40.2	7.8	0.03	-	7.4	5.4	
1990	15.0	25.4	38.7	11.2	0.02	0.9	5.4	3.4	

(1) including asphaltites
(2) includes electricity imports

TABLE: 4

PRODUCTION OF DRIED FOOD PRODUCTS AND TOBACCO IN 1979

Product	Quantity (tons)
Dried Figs	40,000
Dried Grapes	130,000
Dried Apricots	3,500
Tobacco	230,000
Tomato Paste	18,000
Ready Food	5,000

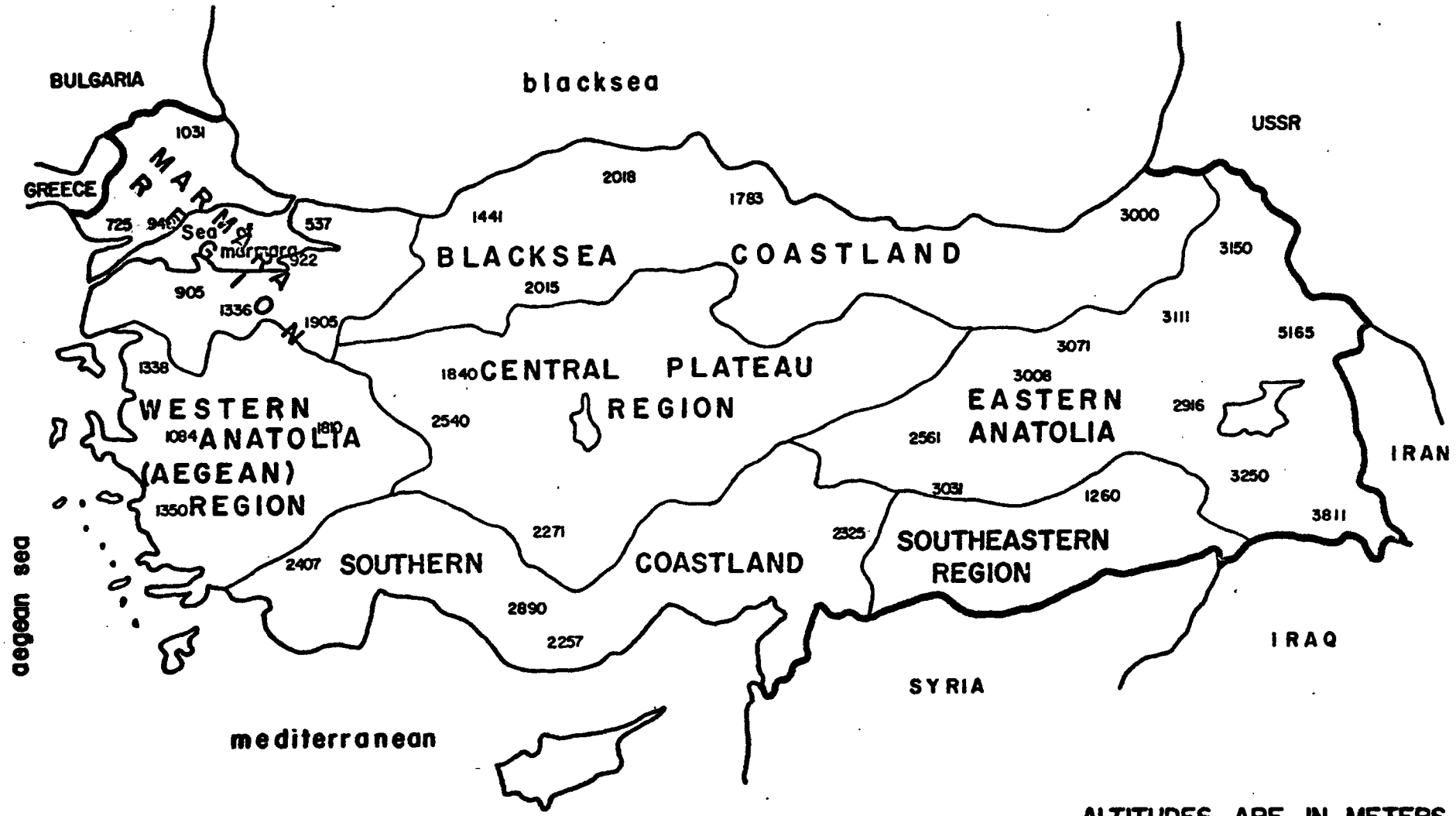

Fig: I - Geographical Map of TURKEY

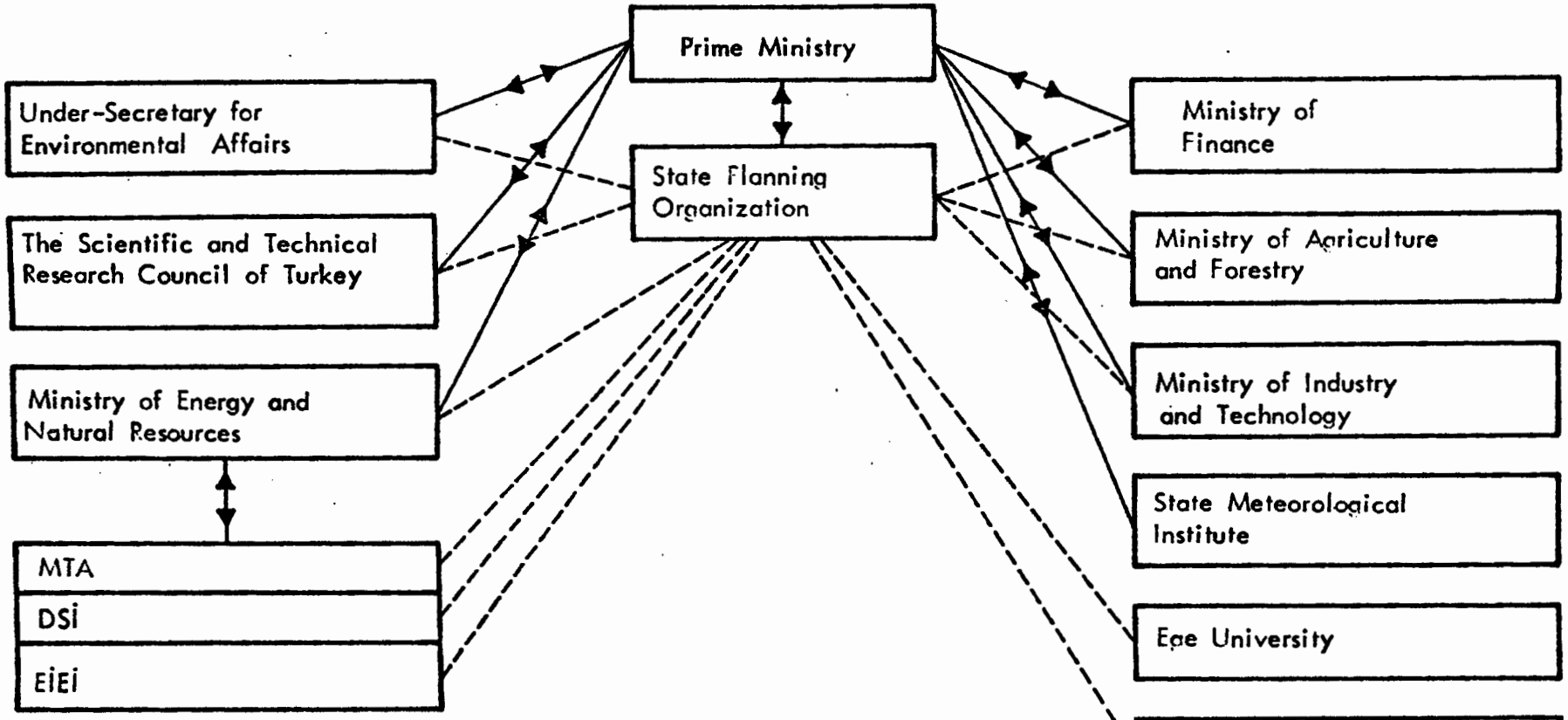

Fig. 2 Energy Management Infrastructure in the field of New and Renewable Sources of Energy

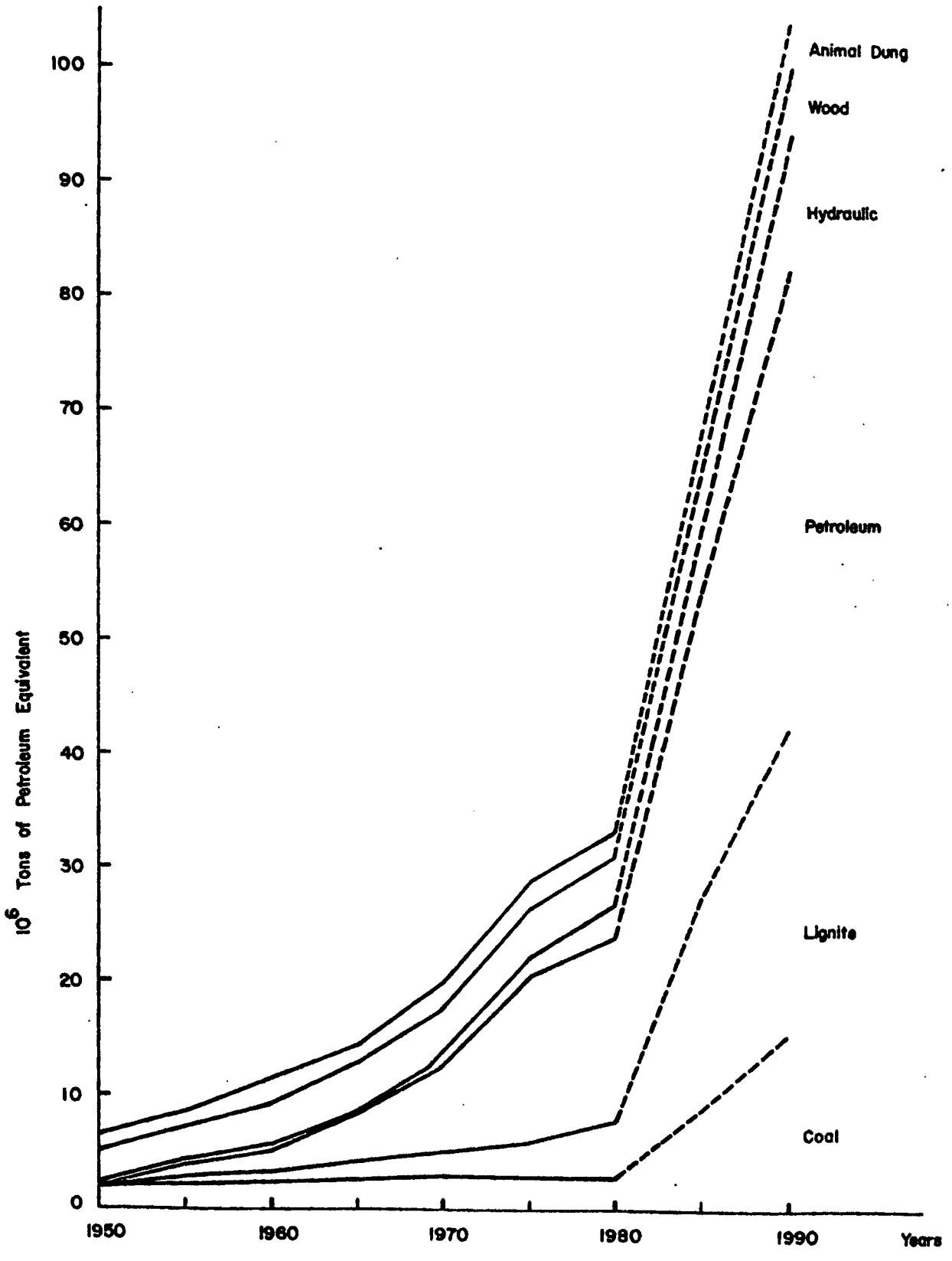

Fig 3 — Energy Consumption by Primary Energy Sources

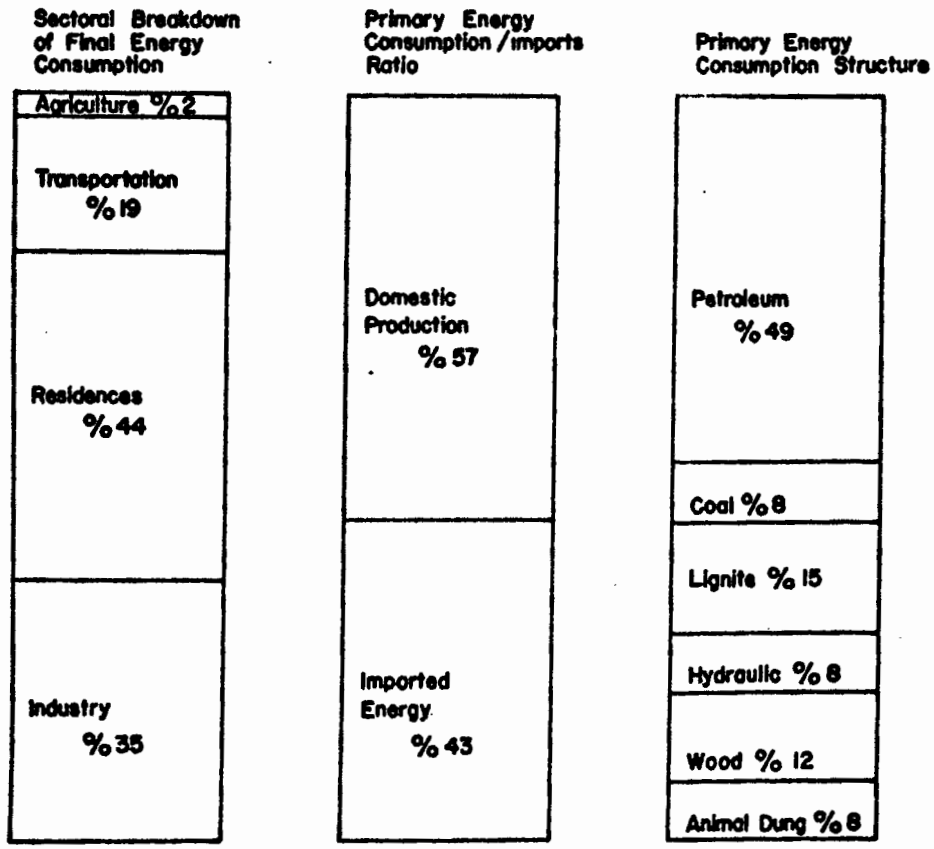

Fig 4 _ The Distribution of Energy Consumption in 1980

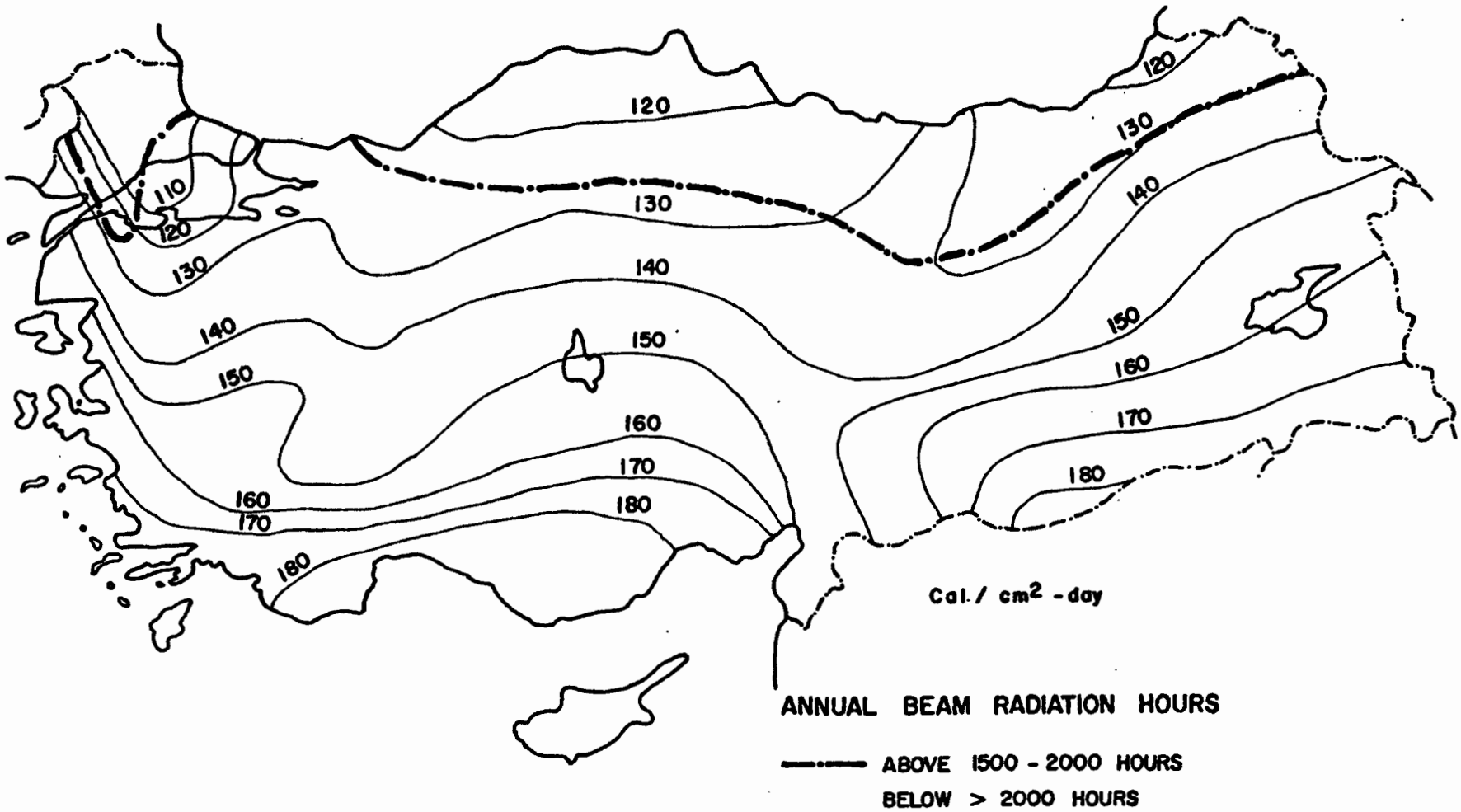

Fig 5 _ Solar Map of Turkey (Annual Total Solar Radiation on Horizontal Surface)

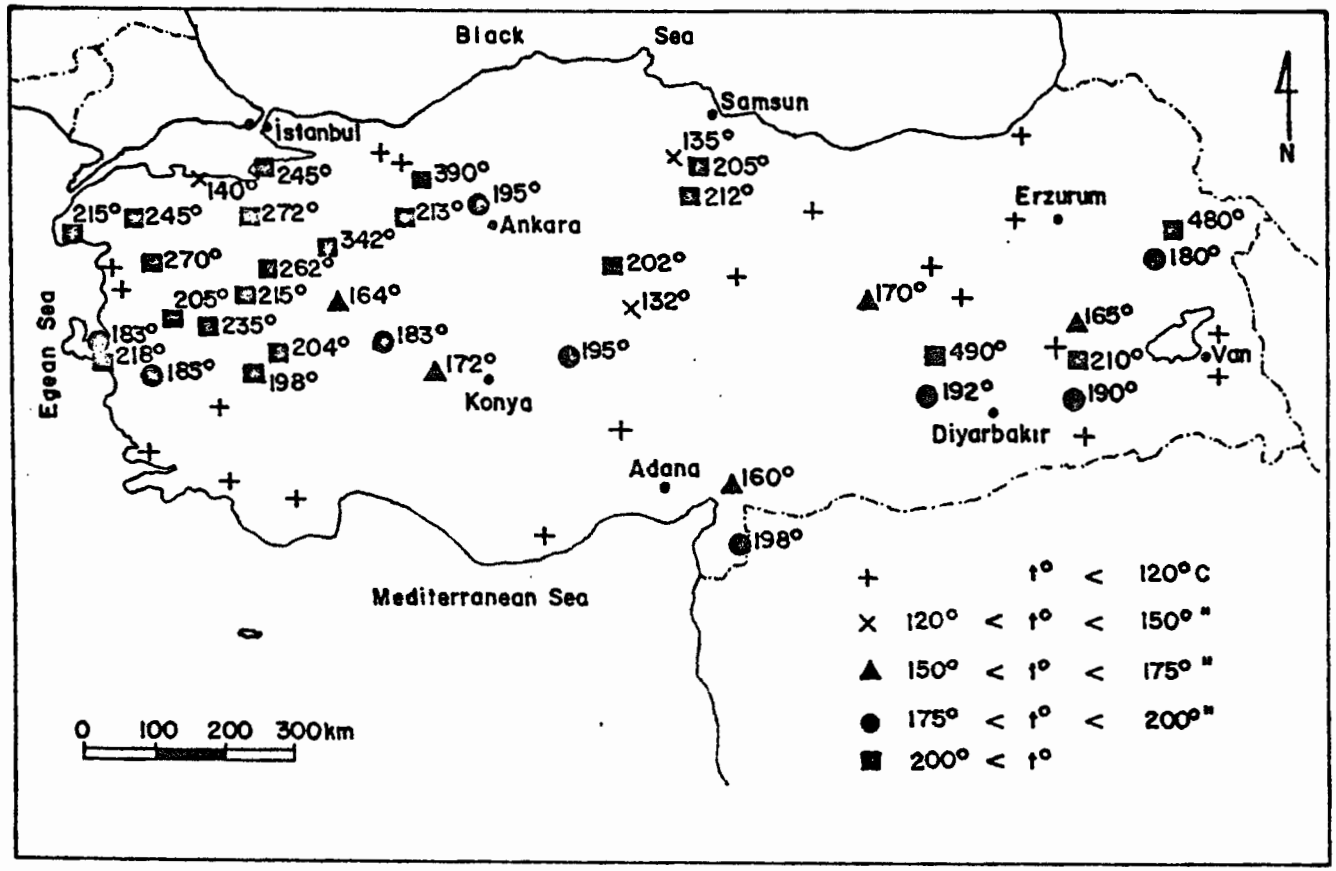

Fig 6 _ Reservoir Temperatures of Hot Springs in Turkey

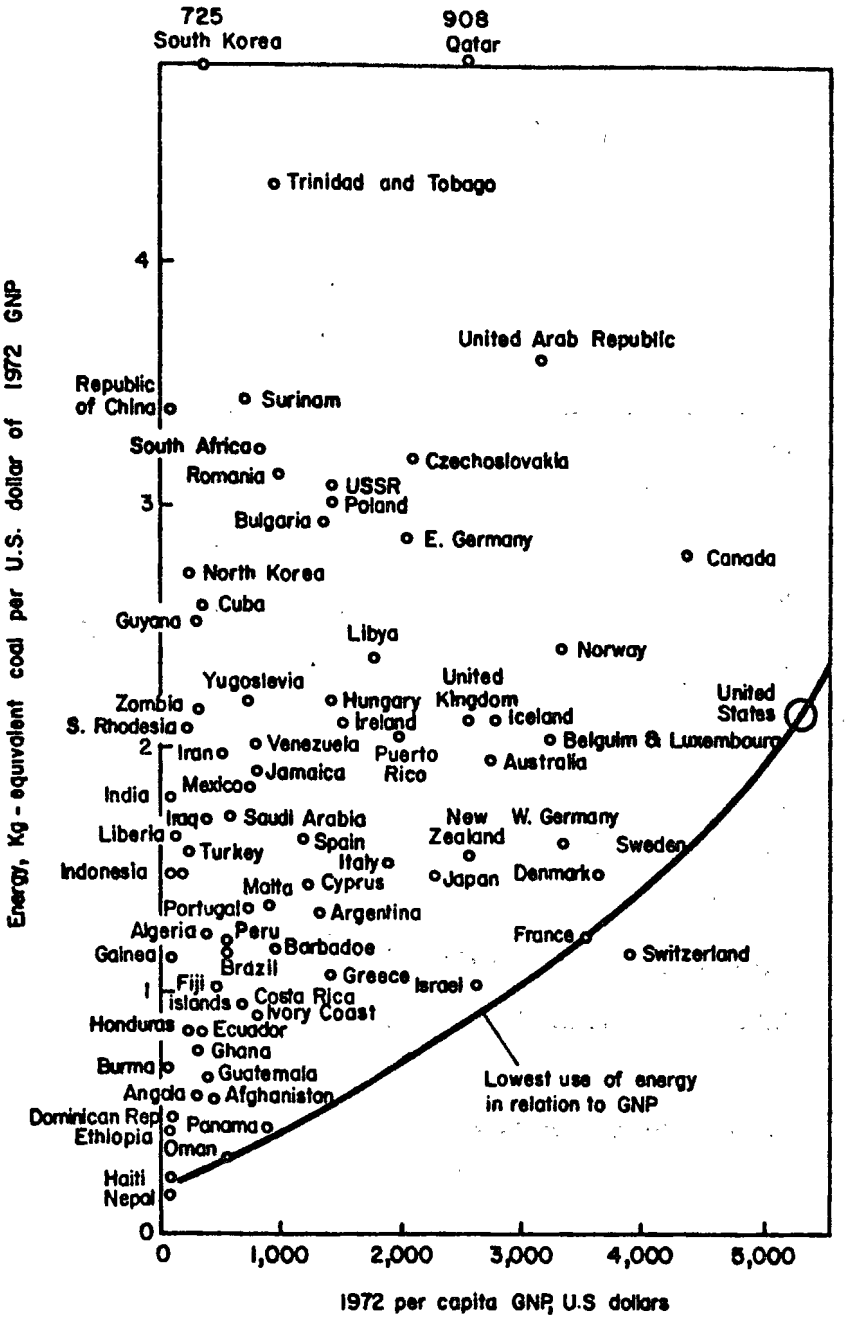

Fig 7 – Worldwide Energy Consumption per Unit of GNP Compared with the GNP per Capita

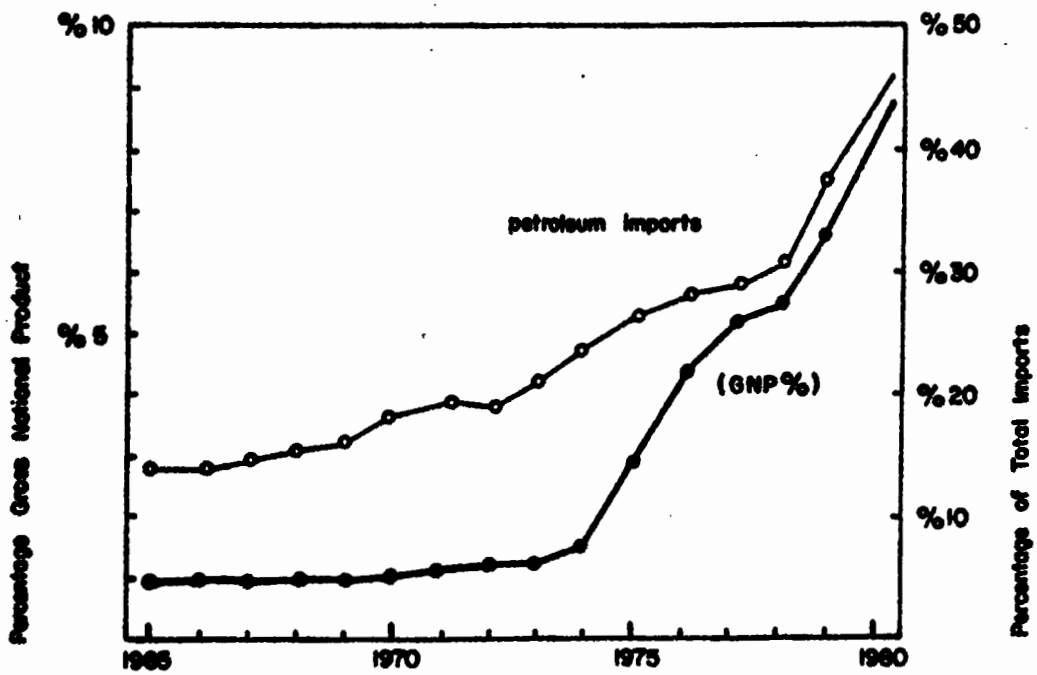

Fig 8 – The Ratio of Petroleum Imports to Total Imports and Gross National Product

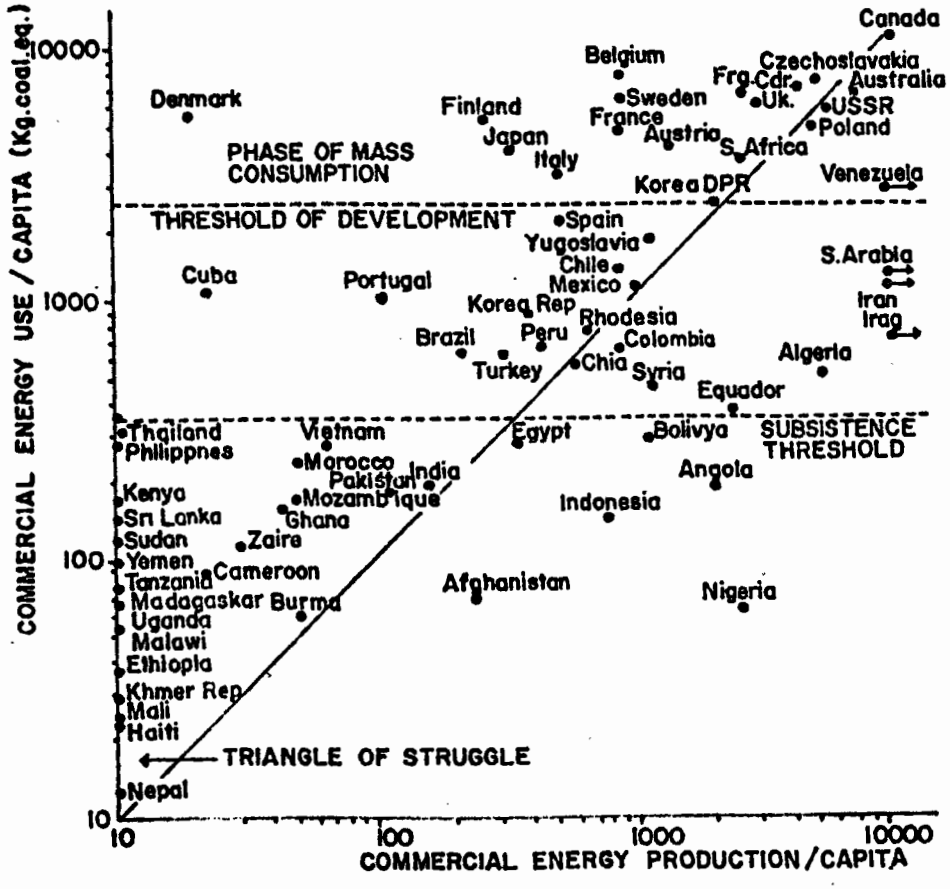

Fig. 9 – World Energy Production and Consumption