TÜSİAD

TURKISH INDUSTRIALISTS' AND BUSINESSMEN'S ASSOCIATION

LOOKING AT THE FUTURE OF THE ENERGY SECTOR

(Executive Summary)

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FOREWORD

Since its establishment in 1971, TÜSİAD (The Turkish Industrialists' and Businessmen's Association) has been continuously following up the developments which take place in the Turkish economy and preparing social and economic publications on special and important subjects.

TÜSİAD, which officially recognized by the government as a body of "national importance and interest", is entirely voluntary. The Association aims at being scientific and remaining impartial in its publications. Therefore, the evaluations which take place in the report, are under no circumstances directly related to official opinions or the views of the members.

This Executive Summary is a summary of the Report entitled "Looking at the Future of the Energy Sector", prepared by Dr. Vedat Şahin, the Energy Sector Expert of the State Planning Organization, and published by TÜSİAD in December 1994.

INTRODUCTION

Energy is an input the use of which is inevitable for increasing industrial production and improving the wealth of communities and individuals. Energy consumption continues to increase rapidly in parallel with technological developments and the increased use of modern equipment and devices in daily life.

Basically, the use of energy is a means rather than an aim. A certain service necessitates a certain amount of energy. There exist many alternative technologies and energy sources which can meet this demand. The attempts to determine the demand for energy sources separately rather than the total amount of energy, lead to erroneous projections in the medium and long term, since this approach overlooks the possibilities of substitution of the sources with each other. Therefore, the healthier approach would be to determine the total energy demand directly and then study the shares and roles of alternative sources within total supply.

At the present time, the term energy is generally conceived as electrical energy. However, electricity is a secondary source of energy. It is produced at the power plants from primary sources such as coal, petroleum, natural gas, or hydraulic and nuclear energy. Therefore, there exists a direct relationship between the demand for electricity and the demand for primary energy.

Energy projects need very long preparation and investment periods and are very costly. It is, therefore, essential for the planning and investment activities for facilities such as power plants, refineries, coal mines and natural gas pipelines, to start years before the actual demand arises. That is why planning is considered as an inevitable and extremely useful tool in the energy sector.

Delays in planning and implementation of the investment projects always lead to emergency solutions, which are not optimal and are very expensive. These increase the cost of energy, and adversely effect economic activities as well as the wealth level of the community.

In this study, the sectoral electricity and primary energy demand modeling approach and energy supply and demand projections, which were started as part of the doctorate thesis named "Turkey: Energy Planning and Policy Options" prepared in 1985, are revised and the appropriate energy supply system and the energy policies that should be applied while approaching the 2000s are analyzed.

In the original study, demand models were prepared by using data sets for the years between 1950 and 1981 and the electricity and primary energy demand forecasts

were made by major consumer groups within the framework of scenarios consisting of population, value added and other economic and social indicators. A comparison of these demand projections and the actual consumption figures realized between 1982 and 1992 have revealed that the study has produced considerably consistent results.

Therefore, it was decided to revise the model by preparing a healthier data set and increasing the number of consumer groups to be analyzed. With this purpose, the data set was improved until 1991, models were set up for a larger number of consumer groups and the projections were revised according to new economic growth and population scenarios.

In the first section, the importance of energy in the progress of a country is explained and the developments which have taken place in the sector during the recent years are summarized. This is followed by modeling of the demand and the formation of the demand models for electricity and primary energy.

The next section covers the projection work carried out within the framework of the new population and economic growth assumptions. In addition to the total sectoral demand values, the changing world and country conditions and policies, the probable supply structure of the energy system are analyzed within the framework of energy production and import possibilities, where the development of demand on the source basis is also explained.

The development of energy imports and the foreign exchange requirements of such imports are taken into consideration.

Similarly, within the framework of alternative scenarios, the environmental impacts of energy consumption are evaluated and the probable trend of air polluted gas emissions is analyzed.

A sensitivity analysis is carried out on the basis of the assumptions for energy saving and increase in efficiency. This analysis tries to determine the extent to which energy demand and import requirements can be pulled down in terms of quantity and foreign exchange and the levels to which harmful emissions can be reduced through energy saving.

In the final part, the energy consumption and supply structures are analyzed, the possible future structure of the supply system is explained and new policies are recommended within the framework of these evaluations.

LOOKING AT THE FUTURE OF THE ENERGY SECTOR

Energy is one of the foundation stones of economic and social development, in that it is an essential input used in production and it is necessary for improving the communities' level of wealth. Therefore, providing an adequate quantity of reliable energy to the economy at the right time and place and with the minimum cost, has great importance.

At a time when the conventional sources of energy are gradually becoming exhausted, the energy prices are expected to rise and the environmental problems stemming from the use of energy are growing, energy planning is considered as necessary and essential instrument especially for countries which have inadequate energy resources, are dependent upon imported energy and faced with foreign exchange shortages.

Another reason why planned action is necessary is that energy projects need very long preparation and investment periods and have high capital cost such as mines, refineries, pipelines and electricity power plants. Therefore, it is of great importance to plan the demand for energy well in advance with healthy analyses and studies, to find the appropriate solutions to meet this demand, to define the relevant projects and financing packages to be used and to commence the work for the necessary investments just on time.

Planning for the energy sector should be integrated with the economic and social activities and targets of the country. Energy is an essential input for economic development and modern living. It can, on the other hand, also become a factor which hinders development because of the difficulties involved in its procurement, the natural and financial sources it requires and the environmental problems it creates. That is why, when the activities are being planned and the policies are being set for the sector, the most appropriate energy production and consumption structure for the country, with due consideration to its positive and negative aspects, should be taken into consideration.

The energy sector comprises all sources of energy such as coal, petroleum, natural gas, fire wood, as well as animal and plant residues, not only electrical energy as generally conceived. At the present time the share of the electrical energy in our country in the final energy consumption stands at a low level of around 10%.

All the feasible domestic and foreign energy sources in the sector have to be utilized, with due emphasis to meeting the primary and secondary energy demands within the framework of a reliable supply structure and in the most economic way possible.

The production and consumption values in the electricity sector have increased significantly and improvements have been observed in the energy indicators since 1980, in parallel with the economic and social developments. The bottlenecks confronted with in energy imports because of foreign exchange shortages have been eliminated. The need to import electricity has come to an end. The energy demands of the consumers can be met without any curtailments, presently.

However, despite all these positive developments, per capita primary energy and electrical energy consumptions are considerably lower than those that prevail in developed countries.

There have been some structural problems in the sector. The inability of the relevant institutions concerned to coordinate their activities, the insufficient developments related to the production of primary energy resources, the infrastructure investments in the electricity sector which are inadequate at certain periods and excessive at others, ongoing investments in lignite plants without the existence of any related coal projects, imbalances between generation and transmission, low availability values and over-idle generation capacities, indicate that the sector is suffering from a lack of coordination and inadequate planning.

DEVELOPMENTS IN ENERGY PRODUCTION AND CONSUMPTION

Turkey's energy sources are negligible in terms of quality and quantity within the total energy reserves of the world. Nevertheless, hydraulic energy and lignite have a certain usable potential. The lignite is geographically dispersed, is of low quality and expensive and is harmful to the environment. Our hydraulic sources, on the other hand, are expensive to develop and unreliable because of their dependence on weather conditions.

Despite the disadvantages mentioned above within the framework of the policy to develop and make the best use of domestic sources, most of the activities and investments have been concentrated on lignite and hydraulic energy so far. Currently three fourths of commercial energy production is being met from these sources.

During the past forty years, the primary energy consumption has increased by an annual average rate of 5.3 % and reached 52.9 million tons of petroleum equivalent (tep) in 1990. During the same period, energy production has reached 28.8

tep in 1990, with an annual increase of 3.8 %.

Electricity consumption which was at the level of around 0.8 billion kWh in 1950, has increased to 56.8 billion kWh in 1990. This corresponds to a very high average annual growth of around 11 %.

It has not been possible to meet the entire primary energy demand of the country with domestic production and the portion met through imports has further increased in time. Currently this ratio stands at around 46%.

At the present time, electrical power system has a very high level of reserve margin on the capacity wise. However, the generation system cannot fully satisfy the requirements because of its structure. On the other hand, the inadequacy of the transmission and distribution lines have been continued.

Developments in Energy Production and Consumption

	1960	1970	1980	1990
PRIMARY ENERGY				
Production (MTEP)	9.5	14.9	18.9	28.7
Consumption (MTEP)	11.0	18.6	32.4	52.9
ELECTRICITY				
Production (TWh)	2.8	8.6	23.3	57.5
Consumption (TWh)	2.8	8.6	24.6	56.8

Very serious problems have been generally seen with respect to planning the investments in the electricity sector. The over investments made in power plants until 1985 because of the electricity shortage faced during the second half of the 1970s, resulted in a significant over-capacity in the sector. As a response to excess capacity, investments in power plants were substantially reduced during the subsequent years and the investments made during 1990 - 1993 fell to 50% of those made during 1979 - 1986 in terms of annual values. As a result of this, the opportunity to introduce optimal, low cost solutions to the risk of insufficient supply of electricity, in the near future was lost.

ENERGY DEMAND STUDY

The demand for electrical and non-electrical energy have been exercised separately in the energy demand study. Consumers have been divided into sub-groups according to the availability of data, and econometric demand models have been prepared.

As the demand models were being formulated, variables that were known or could be estimated, as well as indicators set as targets during the planning work were preferred, so as to ensure that healthy models that are projectable towards the future could be set up.

During the electricity demand study, consumers were analyzed in nine categories, namely agriculture, industry, urban houses, villages, commercial enterprises, services, public institutions, transportation and street lightning.

Demand for non-electrical fuel energy was studied under six categories consisting of agriculture, industry, houses, transportation, conversion and power plants.

Development Scenarios

The projection work is based on scenarios made up by using economic and social indicators. Electricity and primary energy demand structure is studied in a wide range of assumptions for economic growth, population and energy prices.

Low, normal and high growth scenarios, corresponding to annual economic growth rates of 5 %, 6 % and 7 % respectively, were studied on the basis of alternative GDP figures and the sectoral value added targets and expectations. Other variables such as population, energy prices and system losses were kept fixed in all three scenarios, for the purpose of simplification.

Within twenty years, national income increased two and a half times in the low growth and three and a half times in the high growth scenario.

The population is expected to increase from 56.4 million in 1990, to 69.4 million in 2000 and 83.1 million in 2010. The share of cities in population will rise from 60% to 70% in twenty years.

Within the framework of these expectations, the per capita national income is expected to rise from US$ 1.964 in 1990, to US$ 2.500 - 2.900 in 2000, and US$ 3400 - 4800 in 2010.

Currently, the average per capita national income on the basis of 1990 prices, stands at around US$ 20.000 in OECD countries and US$ 4.200 in the world. As can be seen, the highest level of per capita income Turkey can reach in 2010, is one fourth of today's OECD average and just about the current world average.

It is expected that during the coming years the local energy prices will better reflect the real costs and show parallel developments with the world prices and will be taxed as to force the consumers to save.

Electricity Demand Projections

The three different growth scenarios indicate that the demand for electricity which was 57 billion kWh in 1990, will reach 120 - 130 billion kWh and 237 - 293 billion kWh in 2000 and 2010 respectively. In order to meet the demand, a system with a 10 % reserve generation capacity should be established.

The annual average rate of increase in electricity demand has been forecast as 7.5 % in the low growth, 8.0% in the normal growth and 8.5% in the high growth scenario.

There is a considerably close relationship between the rate of increase in the GDP and the demand for electricity. However, the calculations reveal that there exists no fixed elasticity coefficient between these two values and that in the three different scenario projections the elasticities are changing between 1.2 and 1.5 during 1993-2010 period.

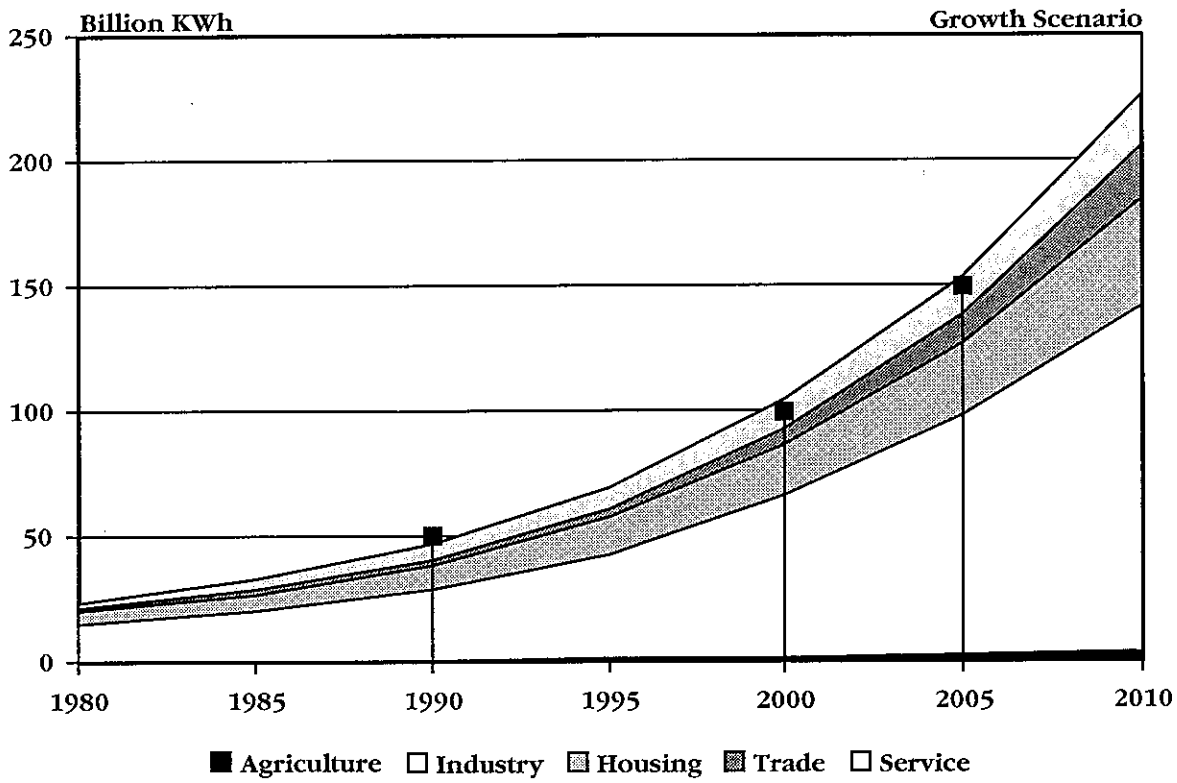
Developments in the Gross Electricity Demand (Billion kWh)

	Low	Normal	High
1990	56.8	56.8	56.8
2000	119.8	125.2	130.4
2010	237.3	263.4	292.5

The most determining factor of the electricity demand is the value added of the industrial sector, which is the largest consumer. Therefore, during periods when growth is largely based on industry, the national income elasticity of the

demand for electricity increases. The demand also rises in parallel with the increase in population as a direct positive effect, especially on the demand for houses, transportation and street lightning.

Sectoral Development of Net Electricity Demand



Within the scope of these developments, it is estimated that per capita net electricity consumption which is 835 kWh in 1990, will increase to 1.445 -1.575 kWh in 2000 and 2.465-3.040 kWh in 2010. Per capita consumption will be able to reach the level of world average in 2010, but will still remain well below the average of the developed countries.

Per capita net electricity consumption shows extensive variations among the countries. In 1990 this value was 22.130 kWh in Norway, 15.540 in Canada, 10.450 in USA, 6.020 in Germany, 4.790 in England, 3.710 in Italy and 3.210 in Spain. It is clearly seen that in addition to the level of development, geographical location also has an effect upon per capita consumption values. Consumption is higher in the northern countries which possess cheap hydraulic resources. While the per

capita net electricity consumption values in these countries are around 15.000 kWh, it varies between 2.700 and 3.700 kWh in developed Mediterranean countries which have the same geographical characteristics as Turkey.

In 1990, 905 kWh of electricity has been consumed in Turkey in order to create US$ 1000 value added in the industry. This value which is called the electricity intensity in industry, is at the level of 292 kWh in England, 312 in Italy, 310 in Germany, 352 in Spain, 541 in USA and 1.086 kWh in Canada. These comparisons reveal that the industry has a very intensive energy consumption structure in Turkey.

Comparison of Values on Use of Electrical Energy

(1990 Values)

	Per capita Net Electricity Consumption (*)		**Electricity Intensity (**)**	
	Total	Residences	Total	Industry
Canada	15540	4887	745	1086
Sweden	14050	4454	546	699
Norway	22833	7146	1118	1219
USA	10476	3676	477	541
Japan	6886	1497	287	350
England	4780	1634	294	292
Holland	4917	1104	263	384
W. Germany	6022	1575	253	310
France	5346	1718	253	332
Italy	3714	915	199	312
Spain	3229	775	258	352
Greece	2808	895	433	683
Portugal	2400	603	396	555
EC	5463	1333	300	
OECD Europe	5458	1322	326	
OECD	8073	2188	323	
TURKEY				
1990	835	163	425	905
Low	1446	279	578	1067
2000 Normal	1512	292	560	1004
High	1575	304	541	961
2010 Low	2465	456	724	1217
Normal	2737	513	678	1081
High	3040	575	635	978

(*) kWh/person (**) kWh/1000 USD Value Added

The average per capita electricity consumption in residences in Turkey was 163 kWh in 1990. This will increase to 280-305 kWh in 2000 and to 455-575 kWh in 2010.

While the average per capita electricity consumption in residences is currently between 600 and 920 kWh in Mediterranean countries such as Greece, Italy, Spain and Portugal, this value varies between 1.600 - 1.700 kWh in France and Germany and between 3.700 - 4.900 kWh in USA, Sweden and Canada. The per capita electricity consumption in houses is substantially influenced by the geographical location of a country in addition to its wealth and the type of own energy resources.

The per capita net electricity consumption in urban houses in our country was 210 kWh in 1990, while 98 kWh in the rural areas. The per capita net electricity consumption in houses will increase to 153 kWh in villages and to values between 590 and 760 kWh in cities by 2010. By the end of the period only the cities will have reached the current level of the Mediterranean countries.

It is very important for the electricity sector to be planned within the framework of realistic targets, since it needs very long planning and investments periods and the investments for the generation and the transmission systems are considerably expensive. It is observed that the estimations made during the past years for the electricity demand were rather optimistic. Over-estimation has a cost, just like under-estimation. The transfer of limited sources from more economic fields and projects to areas where they are not needed, causes an economic loss to the country in addition to creating an idle fixed capital stock in the electricity system, and this results in the formation of an irrational generation structure, with a high cost.

Primary Energy Demand Projections

The demand for primary energy will increase at an average rate of 5.1-6.5 % per annum between 1990 and 2010 according to all three scenarios and will reach 87-97 million tons of petroleum equivalent (tep) in 2000 and 144-186 tep in 2010.

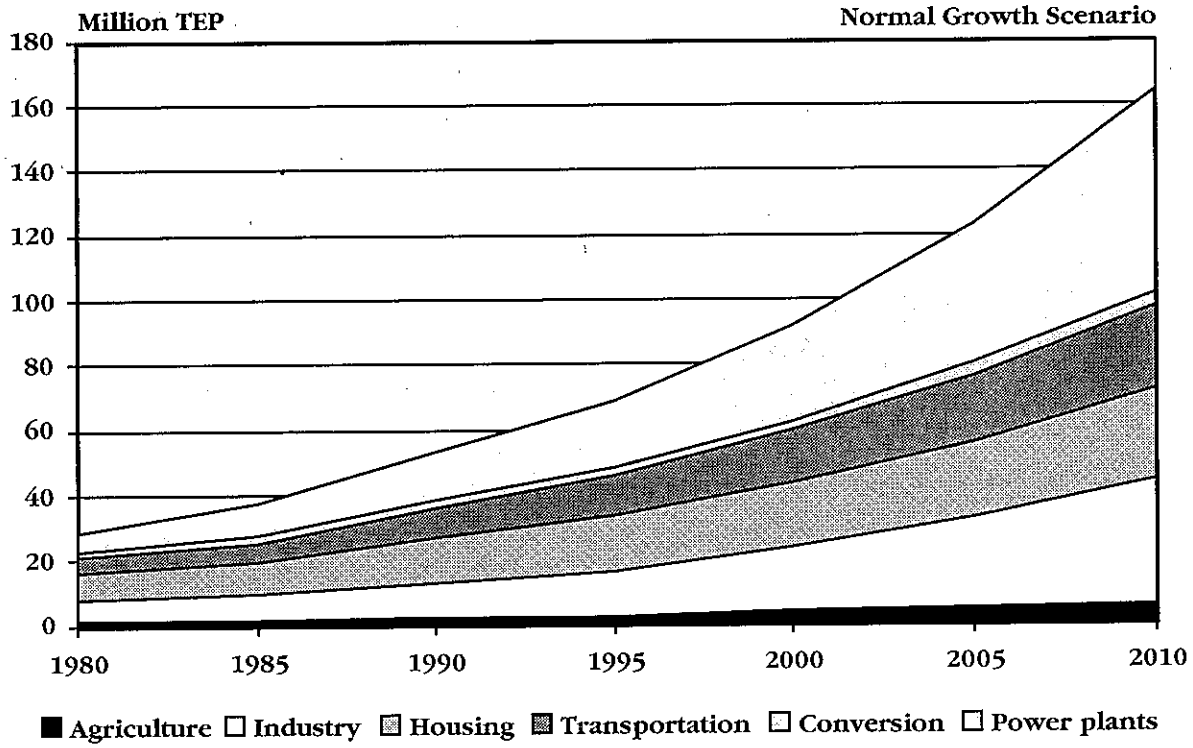
A very close relationship has been observed between the primary energy demand and national income. The income elasticity of energy demand varies between 0.95 and 1.05 amongst the different growth scenarios. When GDP rises by 1%, the demand for primary energy increases at around the same rate. When the growth rate increases, the elasticity value decreases.

Developments in the Demand for Primary Energy (Million TEP)

	Low	Normal	High
1990	52.9	52.9	52.9
2000	86.9	91.9	96.7
2010	143.9	163.8	186.3

The per capita demand for primary energy, which was 943 kilograms of petroleum equivalent (kep) in 1990, rises to 1.260 - 1.400 kep in 2000 and 1.740 - 2.260 kep in 2010. Even in the high growth scenario, the per capita energy consumption values which will be reached in 2010 still remain significantly below the current average level of the OECD countries which stands at 4.750 kep.

Sectoral Demand for Primary Energy



Just like the value of the electricity, the per capita primary energy consumption varies extensively from country to country and according to the countries' development level, energy sources and geographical locations. While the per capita commercial energy supply stands at 7.900 kilograms of petroleum equivalent in Canada, 7.580 in USA and 5.550 in Sweden, 4.400 kep in Germany, 3.910 in France, 3.660 in England and 3.470 in Japan. This value stands at 2.680 kep in Italy, 2.260 in Spain, 2.180 in Greece and 1.670 in Portugal, which are Mediterranean countries located on the same latitude as Turkey. The per capita energy consumption in our country will reach the current level of the Mediterranean countries in 2010.

The per capita energy consumption in residential and commercial buildings in Turkey, which was 260 kep in 1990, will rise to 300 - 380 kep in 2010. This value is currently around 794 kep in EC and 1.010 kep in OECD countries. However, it is close to Turkey's values in countries such as Spain, Greece and Portugal.

In 1990, while an average of 190 kep primary energy was consumed in the EC and OECD countries to create a value added of US$ 1000, this figure in our country stood at a very high level of 480 kep.

Similarly, around 330 kep energy was consumed in the country in 1990 in order to create a value added of US$ 1000 in the industry. This industrial energy intensity is 130 kep in EC countries on average, 114 in Germany, 118 in England and 112 kep in Japan. The industrial energy intensity in our country, which is approximately three times higher than that of developed countries, indicates that there exists a substantial energy saving potential in industry of Turkey.

Comparison of Values on Use of Primary Energy

(1990 Values)

			Per Capita Consumption		Energy Intensity (**)	
			Total	Residences	Total	Industry
Canada			7901	1918	379	379
Sweden			5551	1251	216	169
Norway			5087	1241	249	197
USA			7581	1571	345	260
Japan			3466	588	145	112
England			3658	951	225	118
Holland			4443	1082	238	237
W. Germany			4399	1096	185	114
France			3913	875	185	126
Italy			2684	608	144	121
Spain			2259	271	181	125
Greece			2184	352	337	224
Portugal			1672	219	276	266
EC			3471	794	190	
OECD Europe			3206	757	192	
OECD			4747	1010	190	
TURKEY						
	1990		943	261	480	331
		Low	1260	275	503	312
	2000	Normal	1332	288	493	308
		High	1402	300	481	308
	2010	Low	1742	297	512	297
		Normal	1984	335	491	297
		High	2256	379	472	300

(*) kep/person (**) kep/1000 USD Value Added

ENERGY SUPPLY SYSTEM AND ENERGY RESOURCES

46% of Turkey's energy demand is currently being met through foreign sources. This percentage will further increase in the coming years. Due to the dependence on foreign sources and the obligation to import energy: in the energy planning studies the current situation in the world and the country, the general econo-

mic and environmental targets, the expectations related to population and energy prices, as well as the global and regional policies and strategies should be taken into consideration: The country's energy supply and consumption structure should be planned so as to comply with these general expectations and policies.

The energy sector necessitates substantial natural and financial sources. It has significant adverse effects upon the economy when it cannot be provided sufficiently. While the development of the sector is absolutely necessary for the general progress of the country, the continuous efforts exerted for achieving such development also impose a great burden upon the economy.

Therefore, the investment and import burden which the future energy demands, new policies and supply systems will impose upon the economy, should be correctly forecast. This is the only way to prevent the potential risks and the possible adverse effects on the economy.

Energy Balance in the World

The total reserve of fossil energy resources in the world is approximately 900 billion tons of petroleum equivalent. Coals constitute 75% of this reserve, while the remainder is shared between petroleum and natural gas. The energy reserves of our country are negligible among the world's reserves.

In 1991 the world's commercial energy supply is 7.9 billion tons of petroleum equivalent. The largest share in the supply is that of petroleum with 39 %, followed by coal with 29 %, natural gas with 22 %, nuclear energy with 7 % and hydraulic energy with 3 %.

At the present time, 52 % of the world's commercial energy is consumed by developed OECD countries. USA, with 5% of the total world population, consumes one quarter of the world's energy supply.

It is estimated that if the production and consumption levels of the current resources remain the same, petroleum, natural gas and coal resources will last for another 40, 60 and 240 years respectively. However, it is also a fact that the demand for energy increases rapidly, especially in developing countries. It is possible for these sources to become exhausted much earlier if alternatives cannot be found.

According to the projections, an average annual economic growth rate of 3 % will be achieved in the world within the twenty-year period ahead of us. The calculations reveal that the world's population will increase by 1.5 % per annum

during the same period.

The energy demand projections which is prepared within the framework of these general expectations indicate that the world's demand for primary energy will rise at the annual average rate of 2 % until the year 2010. The rate of increase is expected to be 1.3 % in OECD countries and 2.6 % in others.

Increase in demand for fossil energy will be headed by that for natural gas, at the rate of 2.5 % per annum. The coal will be the main energy source as far as reserves are concerned although it has some environmental problems. Therefore the demand for coal will inevitably continue to rise at the rate of 1.8 %.

Within the framework of these developments, the world's per capita energy consumption which was 1.550 kep in 1990, increases to 1.560 kep in 2000 and 1.710 kep in 2010. In the year 2010, this value reaches 5.750 kep for OECD countries, while it remains at 830 kep for developing countries.

On the other hand, it is estimated that the world's demand for electricity will rise at the rate of 2.8 % a year. The rate of increase will be around 2.2 % in OECD countries and 3.7 % in others. According to the projections, the world's electricity supply, which currently stands at 11.8 trillion kWh, will reach 15.3 trillion kWh in 2000 and 20.6 trillion kWh in 2010.

The share of natural gas used in electricity production is rapidly increasing, while that of power plants operated with petroleum and nuclear fuels is declining.

The per capita world electricity supply, which is currently around 2.360 kWh, will rise to 2.610 kWh in 2000 and to 3.070 kWh in 2010.

During the coming years the share of sources which are cleaner in use, more efficient and environmentally friendly, such as natural gas, renewable energy and electricity, is expected to increase in the world's energy supply.

With the decrease in the petroleum and gas sources, which currently meet a major portion of the world's consumption, followed by an increase in the demand for them, prices will start to rapidly rise, especially in the 2000s.

It may be speculated that when the prices of petroleum and gas will increase, demand will partly shift to solid fuels. This will entail an improvement in the technologies using solid fuels and therefore an increase in efficiency, and then the prices of solid fuels will also rise.

Energy Intensity and Efficiency

Each country's national income as well as the per capita primary energy and electricity consumption values, in other words, energy intensities varies in close relation to its industrial structure and geographical location.

Energy intensities can be pulled down by changing the energy consumption patterns, the technologies used and peoples' way of living, as well as by saving energy. Saving means using less energy for the production of the same goods and services. This will prolong the life of natural resources, alleviate the environmental problems arising during production and consumption, and reduce the volume of the financial sources needed. Due to these advantages, energy saving can also be considered as a clean and cheap source of energy in itself.

It is pointed out that 20 % saving of commercial energy can be achieved in developing countries with the existing level of technology and the current energy prices.

Comparisons with OECD countries show that the energy intensity can be reduced by 50 % in Turkey. The energy analyses carried out have revealed that a saving of around 20 % can be achieved by taking certain operational measures, without changing the technology or making any significant investments.

THE DEVELOPMENT OF ENERGY DEMAND ON THE SOURCE BASIS AND SUPPLY POLICIES

Selection of the energy resources and determining the supply system to be used for meeting the energy demand, is a complicated subject which has to be given serious consideration.

The aim is to set up the optimal structure for the energy supply system which can meet the requirements in the cheapest and most reliable manner. Therefore, when working on the optimization of the supply system, the availability of the sources, price projections, means and costs of transportation, as well as the world markets and the economic and political interrelations of the countries and regions have to be analyzed very well. Keeping the share of domestic sources at a high level and using different import sources are considered as necessary for safeguarding the system. However, there are also limits to using variable sources. The structure of consumption and technology changes from sector to sector and is not sufficiently

flexible to allow the use of all kinds of sources or to shift from one to the other.

On the other hand, even if the optimal supply system necessitates, it may not be possible to procure some of the imported sources. It may not always be possible to provide these sources to the relevant places on time, because of foreign exchange shortages, import difficulties, problems which prevail in foreign markets and inadequacies related to transportation and unloading.

Because of environmental problems, the use of certain low-quality fuels which create pollution is being restricted with the Environmental Law and international agreements. The cost of using certain energy sources is reaching excessive levels due to environmental sanctions and such sources are losing their market advantages.

These sort of externalities which limit the formation of the supply system, have to be taken into consideration when establishing energy policies and strategies.

The use of cleaner and more efficient energy sources will start to be preferred within the coming years. While electricity, a secondary type of energy, replaces the primary sources at the final consumption stage at a gradually increasing rate, the share of natural gas, steam coal and renewable energy in the primary energy sources will show an increase.

The use of natural gas in industry, houses and power plants is expected to increase substantially.

Natural gas import agreements are essential for meeting the requirements of the electricity system. The use of natural gas is also being preferred for meeting the additional energy requirements of the industry and the houses, because it is a more efficient source of energy which creates less pollution and emits lower levels of carbon, sulphur and nitrogen oxide. However, the transportation of natural gas is expensive and therefore the expansion of its use to places other than certain dense consumption areas and pipeline routes may not be economic or possible. The most appropriate approach would be to meet the energy demands in these fields with petroleum and imported steam coal.

The weight of petroleum products in the energy consumption of the transportation and agriculture sectors will inevitably remain the same. New technology and alternative energy sources are not expected to make a significant contribution to the energy supply for the transportation in the near future.

Although the country's lignite resources are considerable with respect to quantity, their quality is unsatisfactory. The only clean way of benefiting from low quality lignite would be using it at power stations equipped with flue gas desulfu-

rization facilities. The use of lignite in other consumption groups will not be considered above the current allocations unless it becomes absolutely necessary.

It is estimated that the contribution of renewable energy sources and especially solar energy utilization, will substantially increase during the 2000s. The use of geo-thermal energy is expected to start in houses and industry in addition to power plants.

The country's forest resources provide for the production of around 10 million tons of fire wood annually. However, according to the estimations, around 18 million tons of wood are currently being used as fuel, together with the illegal cuttings.

The demand for non-commercial sources is expected to drop in rural areas within the coming years, by way of decline in the population rate, the improvement of the income level, the construction of better-protected houses and the increased use of commercial fuels in the villages.

When establishing the energy supply system, more emphasis should be given to the energy sources which are more efficient and cleaner to use, easy to get from local origin. The most appropriate supply system should be chosen within the framework of these criteria.

In this study the development of the energy demand on the source basis is analyzed with two alternative approaches. The first one attempts at estimating the probable sectoral consumption shares of alternative energy sources within the framework of the findings and evaluations summarized above.

In the second approach, energy savings are considered as an alternative source of energy and the possibility of pulling down the primary energy demand with an increase in efficiency and savings is evaluated for different consumer groups.

In all the scenarios, the development of the energy imports have been reviewed by sources and values, and the levels of the carbon, sulphur and nitrogen gasses stemming from the use of energy have been determined.

The Study on the Probable Shares of the Energy Sources

During the period covered by the study, the largest demand increases on source basis are observed in renewable energy sources, natural gas and steam coal.

According to the low, normal and high growth scenarios, it is estimated that the demand for natural gas will reach 12 - 14 billion cubic meters in 2000 and 30 - 42 billion cubic meters in 2010.

The demand for steam coal is estimated as 6 - 7 million tons in 2000 and 22 - 30 million tons in 2010, and that for crude oil is expected to reach 38 - 43 and 56 - 73 million tons in 2000 and 2010 respectively.

Primary Energy Demand on the Source Basis

	1990	2000	2010	
Bituminous Coal	7.1	7-9	11-15	Mn Tonnes
Steam Coal	1.6	6-7	23-30	Mn Tonnes
Lignite	46.2	74-84	108-139	Mn Tonnes
Crude Oil	22.9	38-43	56-73	Mn Tonnes
Natural Gas	3.5	12-14	31-42	Bn m^3
Renewable Energy	-	0.2	2-3	Mn Tep
Uranium	-	-	90-110	Tonnes
Hydraulic Energy	23.1	39-43	57-70	Bn kWh
Wood	17.9	16	12	Mn Tonnes
Animal and plant residues	11.0	10	8	Mn Tonnes
TOTAL	**52.9**	**87-97**	**144-186**	**Mn Tep**

According to the optimization plans for the electrical system, nuclear plants are programmed to start operating as of the first half of the 2000s. Projections indicate that 89 - 110 tons of uranium will be used in the year 2010.

It has been projected that the value of the primary energy production, which stands at 29 million tons of petroleum equivalent (tep) in 1990, will reach 38 - 41 million tep in 2000 and 50 - 60 million tep in 2010.

Demands for sources that cannot be met fully by domestic production, will be met through imports. According to the calculations, energy imports will rise at an average rate of 7 - 9 % annually during the study period and the value which stands at 24 million tons of petroleum equivalent in 1990, will reach 49 - 56 and 94 - 127 million tep in 2000 and 2010 respectively.

The ratio of imported sources within total energy consumption, which is 46 % in 1990, reaches considerably high values of 56 - 58 % in 2000 and 65 - 68 % in 2010.

The crude oil imports which are 18 million tons in 1990, will rise to 34 - 39 million tons in 2000 and 51- 68 million tons in 2010. Crude oil imports to be realized in the year 2010 may be three times higher than the current level.

On the other hand, natural gas imports which stand at 3.3 billion cubic meters in 1990, are expected to rise to 12 - 13 billion cubic meters in 2000 and to 28 - 40 billion cubic meters in 2010.

Steam coal imports will increase significantly during the 2000s and reach a value between 23 - 30 million tons in 2010.

If these projected energy sources cannot be imported on a regular basis, it will become impossible to meet the energy requirements of the economy, industrial production will slow down, the growth rate targets will not be achieved and the necessity for restricting or curtailing the use of energy may arise.

Shortage of energy should under no circumstances be a factor that hinders or delays economic development. Therefore, the policies and projects prepared in accordance with the energy demand, production and import forecasts, should start to be implemented without hesitation.

Work on the possibility of finding new natural gas sources should start immediately, because among all the imported energy sources, natural gas is the one that necessitates the longest period of preliminary work as well as special transportation investments.

Turkmenistan, Iraq and Qatar, among countries which are close to Turkey, possess expansive gas reserves that can be channeled into exports. Anatolia seems to be the most economic route for the transportation of this natural gas to the Western and Southern European countries, which will be the major gas customers of the 2000s. The large-capacity pipelines which will pass through our country under such projects, will provide us with the important opportunity of procuring cheap and reliable natural gas.

Similar projects have to be considered with respect to the imports of crude oil. Pipelines are the only means of ensuring continuous and reliable procurement of imported petroleum, which the volume will reach 50 million tons in the 2000s. Petroleum of Azerbaijan, Kazakhistan and Iraq are the important energy sources which we can benefit from. Long-term agreements should be made for the import of high-quality coal, which will first be needed for the power plants and then for replacing the lignite used in industry and houses. These projects should be integrated with specific transportation systems. Possibilities of setting up deep harbours

that will be needed for the import of steam coal, expected to reach an extremely high volume in the 2000s, should be looked into with due consideration to using such ports for other areas of the economy at the same time.

The Sensitivity Study on Savings

The sensitivity study on savings carried out in line with sectoral energy analyses and comparative energy intensity values, foresees savings amounting to 15 - 25 % in industry, 10 - 16 % in houses and 15 % in highways by the year 2010.

These values represent the savings that can be achieved with the measures taken in industrial enterprises and by increasing efficiency in houses and in transportation with technological developments, without making any special investments directly geared at providing savings. With the strict implementation of a serious savings policy, it will be possible to achieve much higher increases in efficiency and to pull down energy intensities by 40 % with structural changes.

The sensitivity study carried out within the framework of these saving and efficiency expectations, has revealed the following results when compared with the probable share projections :

The demand for primary energy under saving assumptions reaches to 80 - 90 tep in 2000 and to 122 - 157 tep in 2010. Hence, with these assumptions for savings, the demand for energy can be pulled down by 6 - 7 million tep by 2000 and by 21 - 30 million tep by 2010.

This means that the impact of the sectoral-based saving targets upon total primary energy demand stands at around 7.5 % in 2000 and 15.5 % in 2010. These are considerably lower than the saving values reached by comparing the energy intensity figures among the countries, which were calculated as 20 - 40 %. This shows that in the long term higher saving values can be achieved with the structural and technological changes to be made with respect to the use of energy.

The domestic production values as well as the need for production-geared investments also show a decline for some sources, in parallel with the decrease in demand. The domestic production falls by 5 - 8 million tep in 2010 as a result of the contraction in demands.

Imports will drop by 4 - 5 million tep in 2000 and by 15 - 22 million tep in 2010. 9 - 12 million tons of less petroleum , 5 - 8 billion cubic meters less natural gas and 3 - 5 million tons less steam coal will be imported in 2010.

Foreign Exchange Requirements for Energy Imports

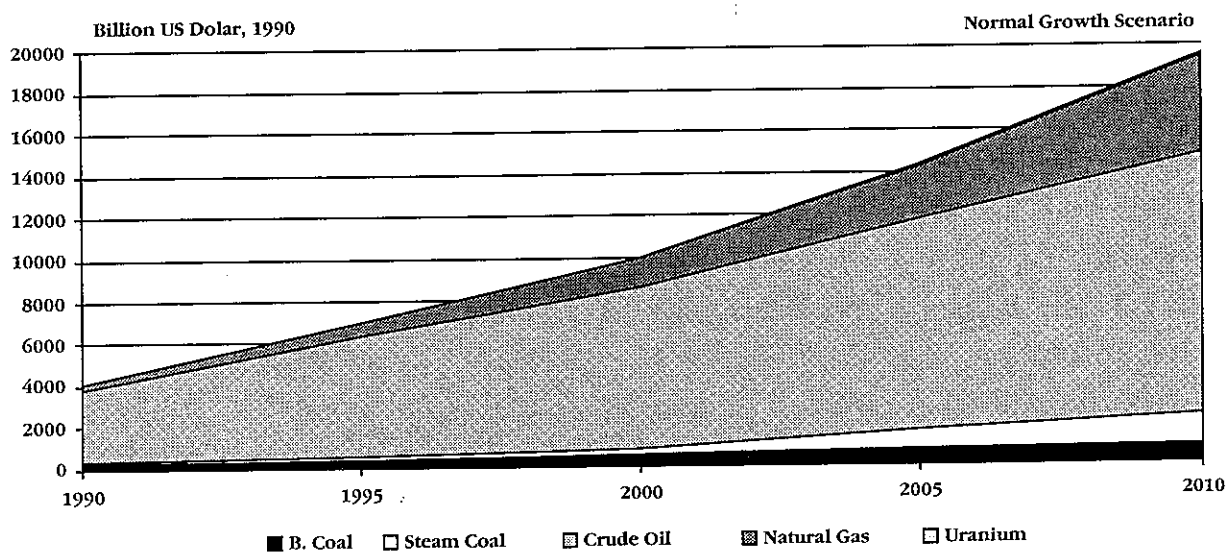
The foreign exchange necessary for the primary energy imports, calculated according to the probable shares approach, will increase from 4 billion dollars in 1990 to 9 - 11 billion dollars in 2000 and 17 - 23 billion dollars in 2010, with the fix price basis.

While the amount of foreign exchange required for the crude oil imports rises to 7 - 8 billion dollars in 2000 and 11 - 15 billion dollars in 2010, this amount for natural gas reaches 1.3 - 1.5 billion and 4 - 6 billion dollars in 2000 and 2010 respectively. The foreign exchange to be paid for steam coal which is currently imported at limited quantities, will be around 1.2 - 1.7 billion dollars in 2010.

The economy, with a growth rate of 5 to 7 %, will inevitably be confronted with problems in meeting its foreign exchange requirements for the import of energy which will grow at the rate of 7 to 10 %. This indicates that foreign trade revenues have to increase at a greater rate than the general economic development.

A comparison of the scenarios with and without savings, reveals that savings will lead to a decrease of 0.8 - 1 billion and 3 - 4 billion dollars in the payment for energy imports in the years 2000 and 2010 respectively. Thus, the amount saved in the year 2010 will be close to the current import bill. Even this difference shows that energy savings is an extremely profitable investment and that it should be given serious consideration.

Energy Imports



Energy Imports

	1990	2000	2010 Volume	2010 Bn US $	Share of Imported Energy in Consumption
Bituminous Coal (Mn Tonnes)	4.8	5-6	9-13	0.7-1.0	% 85
Steam Coal (Mn Tonnes)	1.7	6-7	23-30	1.2-1.7	% 100
Crude Oil (Mn Tonnes)	18.0	34-39	51-68	11-15	% 93
Natural Gas (Bn m^3)	3.3	12-14	28-40	4-6	% 94
Uranium (Tonnes)	-	-	90-110	0.1	% 100
TOTAL (Mn Tep)	24.2	49-56	94-127	17-23	
Share of imported energy in total consumption	% 46	% 57	% 67		

Sectoral Development of the Energy Demand by Fuel

40 % of the final energy was consumed in houses and other buildings in 1990. Industry was second with a share of 33 % and transportation ranks third with 22 %. The agricultural sector only consumed 5% of total energy.

At the present time, 43 % of the demand is met with petroleum products, 25 % with coal and 20 % with non-commercial sources. In the final energy consumption, electricity has a low share of 10 % on the basis of supplied energy.

Within the coming years, the share of the industry in final energy consumption reaches 37 % in 2000 and 43 % in 2010. In the same periods, the share of houses and other buildings drops to 34 and 30 % respectively. The share of the transporta-

tion sector, increases to 24 % in 2005 and falls back to 22 % in 2010.

The share of coals drops to 22 % in 2000 and 18 % in 2010. Meanwhile the share of natural gas increases to 3 % in 2000 and 16 % in 2010, while that of electricity rises to 13 and 17 % in 2000 and 2010 respectively. This represents an important step in switching from air polluted fuels to cleaner and more efficient sources. There is also a move towards cleaner types of coal.

On the other hand, the share of non-commercial fuels constantly decreases falling down to 5 % in 2010, the renewable energy sources are able to meet 2 % of the demand in 2010.

ENVIRONMENTAL EFFECTS OF ENERGY CONSUMPTION

As of 1990, the volume of carbon emission from fuels stands at around 54 million tons in our country. The carbon emission per square kilometer is 70 tons, while the amount per person is around 962 kilograms.

According to the probable fuel shares approach, carbon emission will reach to 83 - 93 million tons in 2000 and 128 - 166 million tons in 2010.

Turkey has a considerably unfavorable structure with respect to its indigenous energy resources, the types of energy consumed and their polluting effects. Therefore radical changes in the energy supply and consumption structure aimed at restricting the carbon emission, do not seem possible in the short and medium term.

Even if low economic growth scenario, energy saving assumtion and the use of clean sources are considered, it is seen that the level of carbon emission will be doubled in twenty years.

In the view of these values, it seems impossible for Turkey to limit carbon emissions or make international commitments in this direction even for the long term.

The amount of carbon emission in the country, which was 70 tons/sq.km in 1990, rises to 107 - 119 tons/sq.km in 2000 and 164 - 212 tons/sq.km in 2010 according to the development of probable fuel shares, while the carbon emission per person reaches 1.202 - 1.336 and 1.543 - 1.994 kilograms in 2000 and 2010 respectively.

The carbon emission according to area is currently 44 tons/sq.km. in the world and 235 tons/sq.km in OECD member European countries. The carbon emission per person stands at 1.170 kilograms in the world and the very high

level of 2.240 kilograms in the OECD member European countries.

The above carbon emission levels in our country, reach 50% of the average for OECD members and two thirds of that for OECD member European countries, even in the year 2010.

The value of energy-based sulphur-dioxide emission in our country was 1560 thousand tons in 1990.

It is expected that lignite-based units of the power stations will be partially and the new lignite plants will be fully equipped with sulphur refining facilities in the future. As a result of this, the sulphur dioxide emission will reach 2.3 - 2.7 million tons in 2000 and 2.3 - 3.2 million tons in 2010.

The emission of nitrogen dioxide stands at 772 thousand tons in the year 1990. This amount is considerably below the emission level and averages of other countries. At the present time, the nitrogen dioxide emission per person stands at about one third of the average for EC countries.

According to the economic growth scenarios, the nitrogen dioxide emission in Turkey will increase to 1.3 - 1.5 million tons in 2000 and 2.0 - 2.6 million tons in 2010.

In the view of the energy savings approach, the emission values increase at much lower quantities and rates. With the structural changes to be made among sources and the adaptation of new burning technologies, it will be possible to reduce these emissions to much lower levels than those projected.

Energy Based Carbon, Sulphur Dioxide and Nitrogen Dioxide Emissions in Turkey

Emissions Per Person in Turkey (kg/person)

	1990	2000	2010
Carbon	962	1270	1755
Sulphure dioxide	28	36	33
Nitrogen dioxide	14	20	27

Carbon Emissions Per Person in Other Countries (kg/person)

	1990	2000	2010
OECD	3310	3605	3911
OECD-Europe	2240	2438	2633
World	1173	1167	1282

TURKEY TOWARDS 2010

In the view of the economic development of the past forty years, it is estimated that the country's economic growth rate during the forthcoming periods could be between 4 and 7 %. It is considerably difficult to maintain a stable growth rate exceeding 7 % for a long time.

Within the scope of the economic growth scenarios, the country's national income will reach by approximately three times of its current value in twenty years, while the industrial value added will rise more than four times. However, economic development is not reflected upon the wealth level of the community at the same ratio. Since population growth hinders this to a great extent, per capita incomes do not increase at the desired rates even when the best economic growth rates are achieved.

The country's population continues to increase at the very high rate of 2.2 %. The high population increase leads to excessive demographic investments which are not geared towards production such as housing, health and education and approximately one third of the capital which can be used for economic purposes goes to non-productive investments. This slows down the economic growth, the rate of increase in employment falls and unemployment increases.

At a population growth rate of 2 %, an economic growth rate of at least 8 % has to be maintained so as to be able to keep the number of the unemployed at the same level. An economic growth rate of 6 % can only meet the employment requirements of a population increasing at a 1.5 % per annum.

Unemployment, the uneven income distribution, regional population movements, faulty urbanization, inadequate infrastructures, and other social and economic issues, coupled with the inadequacies in the supply and import of energy and environmental problems, indicate that serious measures have to be taken to stop the population increase definitely.

The country 's demand for primary energy will increase three times of present value in twenty years. A move is expected towards energy sources which are efficient to use and not harmful to the environment. As a result of this, the shares of energy sources such as natural gas, steam coal, renewable energy and nuclear energy in consumption will show an increase.

Obtaining the financial sources needed for the imports and the necessary investments in the sector to meet the energy requirements of an industry where the

production increases at the average rate of 6 - 8.5 % and the population increase is around 2 % per year, should be expected to create certain economic bottlenecks.

The internal and external financing requirements for the power plant investments needed to meet the additional demand of 200 - 250 billion kWh in the next twenty years and the transmission, distribution and network projects to be set up in parallel with these, will reach extremely high levels.

The cost of production or import of the energy should be fully reflected upon the prices in real terms. An optimal production structure in industry is only possible with the full reflection of all the input costs onto the prices in real terms. Implementing a correct price policy for production inputs ranks first among the prerequisites for ensuring that the industry is structured correctly, the selection of production methods and technologies are healthy and the plants are operated efficiently.

The environmental issues should definitely be taken into consideration during the planning of the energy sector. However, comparisons of the per kilometer and per person emission values reveal that the carbon, sulphur and nitrogen emissions from energy sources are still at very low levels in Turkey. The emission projects prepared during this study have shown that these values will continue to remain below the averages prevailing in developed countries in the coming years too.

When making international commitments such as restricting the use of energy with the aim of protecting the environment, the long-term trends of the country's energy demand must definitely be taken into consideration.

The excessively high energy utilization values per unit of value added in almost all the consumer groups in the country, indicate that energy is being used very intensively and inefficiently and that there exists a substantial saving potential.

The return of energy saving is very high and variable. As a result of saving, the limited natural resources will be protected and the emission of harmful gasses to the nature and the environment will decrease since energy consumption will fall. While the energy input per unit of product declines in industry, the cost of production falls and the competitiveness of national industries in foreign markets increases. The demand for imported energy inputs and therefore the foreign exchange needed for imports declines.

It is possible to pull down the energy intensities with the policies implemented during the establishment of new industrial facilities in addition to saving measures taken for the existing industrial facilities. During the twenty year period ahead of us, production in industry and consequently the production capacity will

grow four times. With the facilities that will become inoperative during the same period, approximately 80 % portion of industry will be made up of completely new facilities. Therefore, it would not be correct to say that the opportunity for setting up a more efficient energy consumption structure in industry has been missed.

The world markets, the developments expected in production methods and technologies, and the costs of alternative production inputs must be taken into consideration during the establishment of new industrial policies. When determining the profitable industrial fields for the country and the input mixture within the framework of this approach, it should be remembered that energy will continue to be a scarce input that has to be imported at a high cost and the industry should be developed with an energy-sensitive structure.

Financing energy sector investments such as exploration, production, transportation, refinery, power plant, transportation and distribution facilities cannot be solely financed through public means. Therefore, the share and contribution of the private sector in energy investments and operations should be increased. However, during the privatization activities, it would be more appropriate to take up facilities which are not productive, which are faced with a financial bottleneck and which cannot be operated efficiently. Such facilities should be modernized and improved by the private companies and healthy operating conditions should be provided for them.

During the privatization of the electricity sector, deviation from the fundamental objectives and policies of the sector should be avoided. The search should continue for a low-cost optimal supply system, whereby public and private sector companies can function efficiently and in harmony, and demands can be met in an adequate and reliable manner. It should always be remembered that privatization is a means rather than an objective.

The state enterprises in the sector are operating inefficiently and with high costs due to reasons such as administrative and financial inadequacies, faults in the implementation of investments and operations, political pressures and overstaffed.

The state enterprises, which are currently financed through the General Budget, and the activities and investments of which cannot be summarized and evaluated in a financial table, create a more serious bottleneck on the budget and the economy than the SEEs.

A lot of state enterprises contract tenders to contract their projects to third parties despite the excessive number of personnel they employ. It would be more

appropriate for these enterprises to be re-structured so as to only prepare the projects and hold and control the tenders.

It would be extremely beneficial to set up an autonomous Supreme Energy Board equipped with the necessary authorities and responsibilities for the energy sector, to establish the general policies and strategies, to direct and coordinate the activities of the public and private sector companies with the aim of establishing an optimal system, to determine the energy price policies, and to take decisions for the implementation of savings policies.

RECOMMENDATIONS

Priority Policies in the Energy Sector

- The share of the energy sector in infrastructural investments has gradually decreased during the recent years. It would be possible to increase the investments in the sector to a satisfactory level with an increased private sector share, by recognizing appropriate incentives to investors.
- The state which has been losing its investment power in the energy sector during the recent years, should expedite privatization so as to be able to minimize investments and operation costs.
- A consistency should be maintained between "build-operate-transfer" and privatization implementations of the government.
- When making investments, the government should give priority to the development of primary energy sources.
- A simple permission system should be set up for private sector investors who apply for procuring fuel, establishing facilites, pricing and similar matters. The state should provide guidance to such investors.
- Projects which provide energy saving should be encouraged, regardless of whether or not the location of the investment is in a priority development region.
- Private sector industrial establishments, which are the largest consumers in the sector, should be effectively represented in the Supreme Energy Board to be made up of private sector representatives.

The Private Sector Should Play a More Active Role in the Energy Sector

- Along with the public sector, the private sector should also be sensitive towards an energy bottleneck which the country may be confronted with in the near future.
- In addition to the investments it makes in many fields, the private sector should also increase its investments in the energy sector. Institutions with a high level of energy consumption should give special priority to investing in energy plants.
- Bearing in mind that energy is a scarce and expensive source, the industrial sector as well as other sectors should attach great importance to saving energy with measures to be taken during the foundation stage. An energy saving campaign should be launched by the private sector to this end.
- While implementing projects aimed at energy saving on the one hand, the private sector companies should focus their attention on taking measures for the protection of the environment on the other.