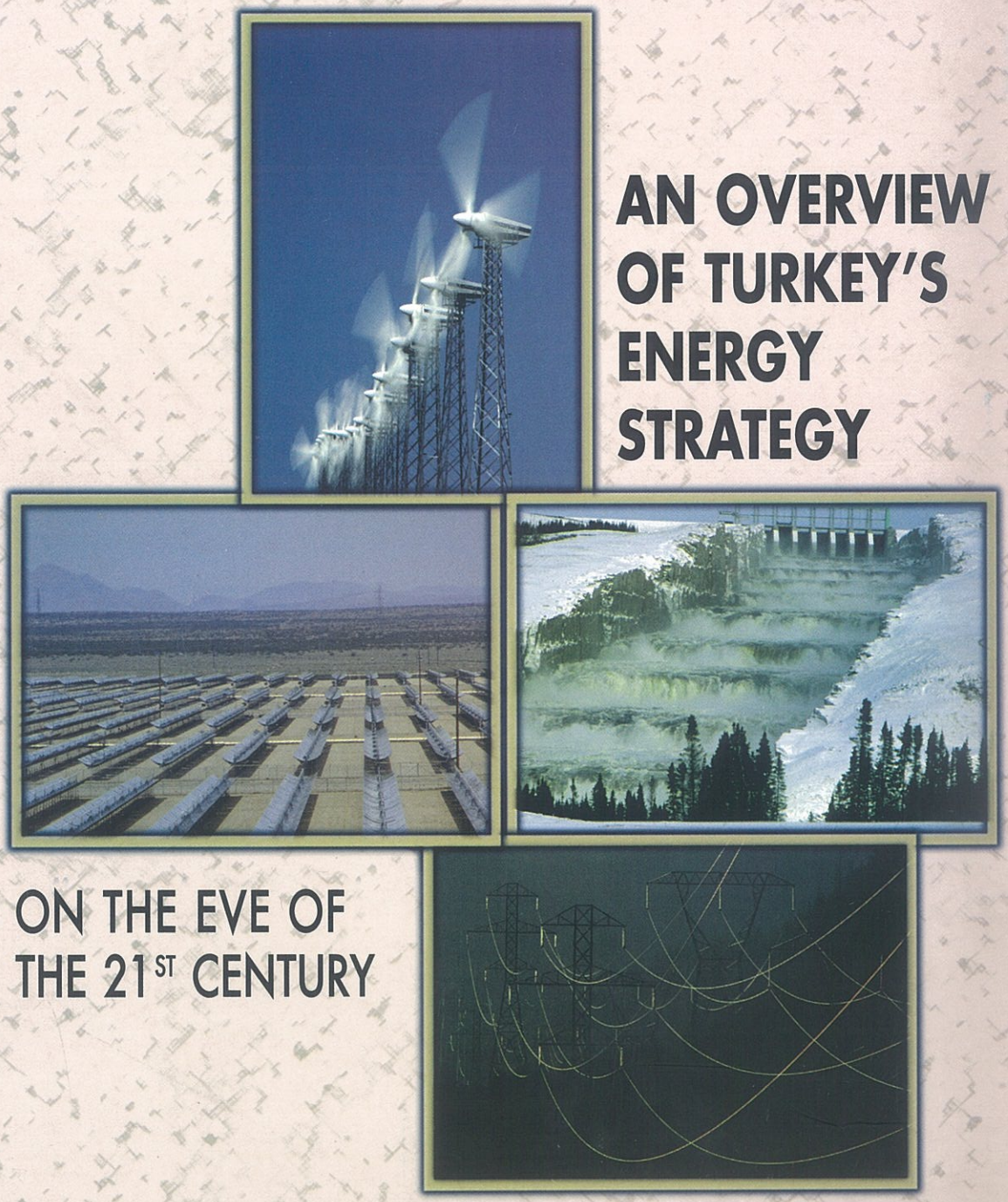
TÜSİAD

TURKISH INDUSTRIALISTS' AND BUSINESSMEN'S ASSOCIATION



# AN OVERVIEW OF TURKEY'S ENERGY STRATEGY

## ON THE EVE OF THE 21ST CENTURY

Executive Summary

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**(Executive Summary)**

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# FOREWORD

*TÜSİAD (Turkish Industrialists' and Businessmen's Association), which was founded in 1971, according to the rules laid by the Constitution and in the Associations Act, is a non-governmental organisation working for the public interest. Committed to the universal principals of democracy and human rights, together with the freedoms of enterprise, belief and opinion, TÜSİAD tries to foster the development of a social structure which confirms to Atatürk's principals and reforms, and strives to fortify the concept of a democratic civil society and a secular state of law in Turkey, where the government primarily attends to its main functional duties.*

*TÜSİAD aims at establishing the legal and institutional framework of the market economy and ensuring the application of inter nationally accepted business ethics. TÜSİAD believes in and works for the idea of integration within the international economic system, by increasing the competitiveness of the Turkish industrial and services sectors, thereby assuring itself of a well-defined and permanent place in the economic arena.*

*TÜSİAD supports all the policies aimed at the establishment of a liberal economic system which uses human and natural resources more efficiently by means of latest technological innovations and which tries to create the proper conditions of for a permanent increase in productivity and quality, thus enhancing competitiveness.*

*TÜSİAD, in accordance with its mission and in the context of its activities, initiates public debate by communicating its position supported by scientific research on current issues.*

*This publication is the executive summary of the report entitled "An Overview of Turkey's Energy Strategy on the eve of the 21st Century", which was prepared by Prof. Mustafa Özcan Ültanır in Turkish.*

**Prof. Mustafa Özcan Ültanır**

He studied both mechanical engineering and economics at graduate level. The areas of scientific research he has been involved in, throughout his 33-year academic career, include general energy technologies, renewable energy systems, the planning of alternative energy resources, energy economics, thermodynamics and heat techniques.

He has been a member of the 10th World Energy Conference Organisation Group. He has also been a member of the 3rd Five Year Development Plan Special Energy Specialisation Commission, the 5th and the 7th Five Year Development Plan General Energy Specialisation Commission and was employed a co-ordinator of the Renewable Energy Resources Working Group. He was the Head of the Commission which prepared the Turkish Energy Institute Draft Law, Productivity of Energy Draft Law and Wind Energy Power Station Draft Law. He was appointed as a member of the Energy Council Committee for a period of four years in 1998, by the Ministry of Energy and Natural Resources.

He is the Head of the Energy Working Group at the University of Ankara. He is also a member of the Board of Directors of the Turkish National Committee in the World Energy Council, on behalf of the Rectorate of the University of Ankara. He has been holding the position of Vice-President of the High Advisory Council of the National Committee since 1995, for his studies in the field of energy. He is the President of the Editorial Board of the Journal, World of Energy, a publication of the Turkish National Committee at the World Energy Council and a member of the Editorial Board of the Journal, "Energy", published by Uzman Publishing.

He is the President of the Turkish Department of the International Solar Energy Society (ISES) and the Director for Turkey at the ISES Board, a member of the Board of Directors and of the High Assembly of the Clean Energy Resources Foundation. He is a founding member of the Turkey branch of the European Wind Energy Association, of the Wind Energy Power Stations Industrialists' and Businessmen's Association, and an honorary member of the International Hydrogen Energy Association.

He has written 8 scientific books, 75 articles on science and technology in Turkey and 20 articles abroad. He has presented 35 scientific papers in Turkey and 12 abroad. He has 85 articles on energy published in newspapers. He has presented 5 reports on energy to various authorities. He has participated in 23 radio and television programmes and 9 conferences. 10 of his publications have been included in the International Science Citation Index. He has prepared a report on The Problem of Energy Resources in the Production of Electricity in the Private Sector and Solutions, for the Electric Industry and Businessmen's Association.

## EXECUTIVE SUMMARY

This report aims to define energy strategies of Turkey for the next quarter of a century which will mark the period between the 75th anniversary and the Centennial of the foundation of the Republic of Turkey. The study assesses the ways in which Turkey - a country still undergoing a period of rapid development and growth – can use her energy resources in a way that could raise her to the level of developed countries by the Centennial of the promulgation of the Republic.

## World Energy Resources and Turkey's Position

The world average of annual per capita primary energy consumption is 1.45 tonnes of oil equivalent toe/person.annum. The OECD average is 4.56 toe/ person.annum, the European Union figures being slightly lower at 3.69 toe/ person.annum and Turkey being at 1.10 toe /person.annum. The figures of electricity consumption are similar. Turkey's per capita net consumption after leakages and losses amounts to 1,281 kWh/person.annum, far below the global average of 2,376 kWh/person.annum.

Today, the world does not yet suffer from an insufficiency of energy resources, which certainly would fail to meet ever-growing demand. According to the findings of the 17th World Energy Summit in 1998, an energy bottleneck does not loom in the near future up until the year 2050. Energy prices are still at a relatively low level due to the abundance of supplies, although the greater share of global demand rests on hydrocarbon fossil fuels.

Furthermore, the slump in oil prices has driven the economic growth. Globalization of the world economy encourages international investment, technology transfer and an overall boost in energy trade, influencing exploration, production and resource development efforts. Worldwide energy markets have become more and more susceptible to market dynamics rather than state interventions, as the public sector's role continues to devolve in the industry. In spite of these favourable conditions, Turkey seems to have failed in benefiting from the opportunities.

Projections indicate that the world will continue to use fossil fuels to meet the expected surge in demand for oil and natural gas until the year 2025. Nevertheless, parallel to the rise in overall awareness of global warming and environmental concerns, the need to discover and utilize non-fossil energy sources will gain momentum in the coming years. An increasing share of energy expenditures will be appropriated to nuclear energy due to its interminable potential as the use of new and renewable resources and novel technologies become more familiar.

The past two decades have witnessed an increasing importance of the concept of sustainable development. Sustainable development necessitates an efficient use of energy and due respect to the environment. Scenarios pertaining to global energy consumption until the second half of 2000 have been devised in accordance with growth rates and the obvious interdependency between energy reserves and the surrounding environment.

Demand for coal, oil and natural gas is expected to maintain its upsurging pace until 2020 as the world continues to meet its energy needs through these sources. However, as the portion of the production of nuclear energy is increased to meet consumption needs, new safety measures shall be taken. A more efficient use of hydraulic energy resources is also needed. To keep in mind, new and renewable energies will replace fossil fuels in the long run.

## Turkey's Present Situation

Turkey's primary energy consumption increased 3.8 times during 1970-1997, from 18,849 Ktoe (thousand tonnes of oil equivalent) to 71,367 Ktoe. Concurrently, domestic production of primary energy resources also jumped 1.9 fold to reach 27,687 Ktoe from 14,493 Ktoe. Turkey's recent history records a rapid rise in the demand for natural gas. Figure 1 shows the progress of domestic supply and consumption of primary energy resources in Turkey.

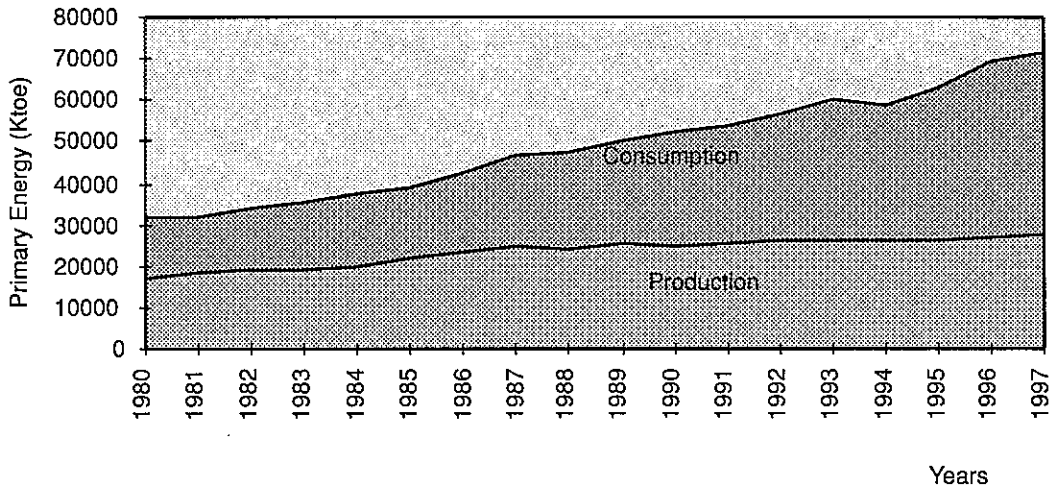


**Figure 1. Production and consumption of primary energy resources in Turkey**

Back in the 1970's domestic supply used to meet 75% of local consumption. Due to the fact that demand grows twice as fast as local production, only 38% of Turkey's local demand can be met domestically today. By the year 2000, the share of domestic production in meeting local demand for primary energy resources will further slip to 35%. 90% of oil, which corresponds to over half of the country's energy consumption and almost the whole of natural gas which makes up 15% of Turkey's demand for energy, are imported today. Figure 2 shows the rising trend in the consumption of primary energy resources.

The manufacturing industry comprises the largest share in Turkey's energy consumption (36.4%), while manufacturing industries, construction and services have an equal share. In primary energy consumption, The development of manufacturing industries in Turkey has resulted in an apparent interaction between GDP and total energy consumption figures. *The continuation of industrialization at this pace is dependent upon an incessant supply of energy, which should be provided in the right terms and conditions.*

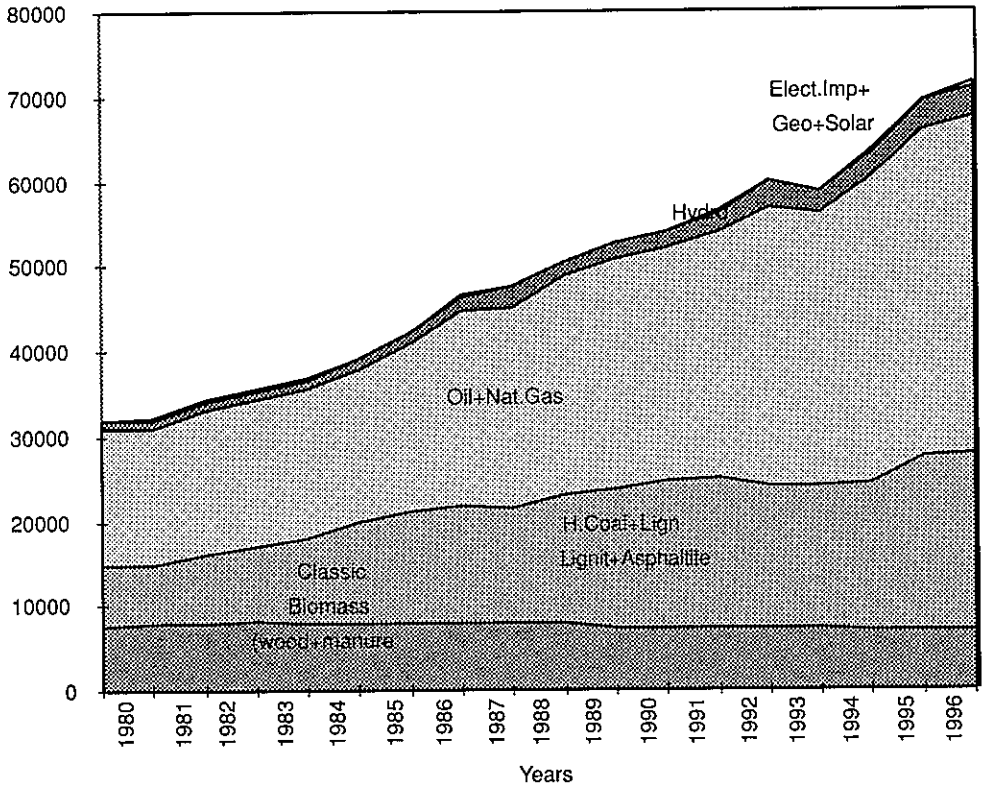


**Figure 2. Consumption of primary energy in Turkey**

The demand for electricity grew at an average rate of 9.9% annually in Turkey during the period of 1970-1997. The rise in annual demand exceeded 5% for 19 years and reached 10% for a decade. The annual rate of increase in electricity consumption fell below 5% for 4 years before 1990, and for 5 years after 1990; fell to 2.6% in 1994, 0.5% in 1995, 1.4% in 1996 and 0.3% in 1997. The growth in the production of established power plants can be seen in Figure 3.

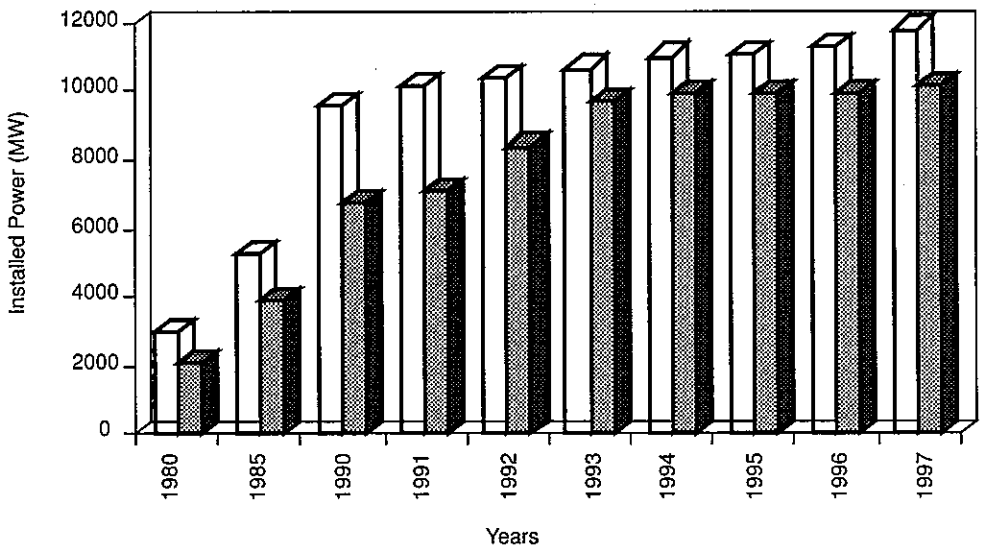


**Figure 3. Thermal and hydraulic power generation in Turkey**

The established power generation capacity rose to 21,889.4 MW in 1997 from 2,234.9 MW in 1970, but still fails to fulfil the demand. The private sector generates 1986 MW of the present capacity, with 940 MW yielded by private auto-producers. The total power generated in 1997 reached 10,4285.1 GWh, imported power energy reached 2,492.3 GWh, while exported energy remained at a mere 271 GWh, and the total consumption reached 106,506.4 GWh.

## Turkey's Energy Resources

Turkey does not possess ample fossil fuel reserves. Excluding lignite; coal, oil and natural gas reserves in Turkey are quite scant and are far from meeting domestic demand. From a long-term perspective, lignite deposits do not seem to be sufficient either. Turkey's total extractable reserves of coal, oil, natural gas, asphaltite and bitumen amount to 2,454 Mtoe (million tonnes of oil equivalent). All bitumen, thorium and uranium deposits are potential reserves. *Coal, lignite, oil, natural gas and uranium deposits must be improved through new explorations. There are areas where the above mentioned fossil fuel reserves could be developed.*

Contrary to the paucity of Turkey's conventional fossil fuel reserves, Turkey possesses a potentially rich reserves of inexhaustible natural resources. Turkey accommodates 124.5 TWh/year worth of hydraulic, 1.8 Mtep/year worth of geothermal, 25 Mtep/year worth of solar, 50 TWh/year worth of wind and 32 Mtep/year worth of biomass energies. *Hence, Turkey must give impetus to the use of renewable energy.*

Classical biomass and hydraulic energy are the most frequently used types of renewable resources in Turkey. At the moment, only 29% of the attainable hydraulic energy potential has been utilized, but it is expected to reach 38% by the time the power plants under construction begin to operate. The use of geothermal energy is restrictive in spite of its overriding potential. Although advanced technology provides multifarious areas of use, solar energy too is utilized only in restricted areas. The use of wind energy has started very recently, whereas generating energy from sea waves or the water currents at straits and utilizing the modern biomass energy can even be ommitted.

## Prospects for the Demand and Production of Energy by the Centennial of the Republic

The Ministry of Energy and Natural Resources has drawn up a production plan based on an estimation of the demand for energy until the year 2020. The scope of the plan prepared for TÜSİAD has been extended to the year 2025, which will mark the centennial of the promulgation of the Republic. Besides the calculations by the Ministry, a separate demand estimation, which takes into account the basic indicators and a corresponding production plan, has also been made. The findings about demand in relation to Turkey's growth objectives are shown on Table 1.

The findings of the Ministry suggest that the primary energy demand in Turkey will be equivalent to 91,030 Ktoe in the year 2000, and 314,353 Ktoe in 2020. In line with this trend, in 2023, which marks the centennial of the Republic, Turkey's primary energy consumption will reach to 367,780 Ktoe and to 407,106 Ktoe in 2025. The report drafted for TÜSİAD estimates Turkey's primary energy demand for the year 2000 to be equivalent to 90,800 Ktoe and 397,655 Ktoe for 2025. There is a minor deviation of 2.3 % between the two demand curves. It is evident that Turkey's energy consumption will increase four times between 2000 and 2025. Turkey must

provide sufficient energy supply to meet this ever-increasing demand. In 2023, Turkey will take her place in the developed world with 4,252 kilograms of oil equivalent (kgoe)/person of primary energy consumption and per capita GDP of $15,047.

**Table 1- Primary energy demand in Turkey and basic economic indicators**

| Years | 2000 | 2005 | 2010 | 2015 | 2020 | ***2023*** | 2025 |
|---|---|---|---|---|---|---|---|
| Total primary energy demand (TPES) estimated by the Ministry (Ktoe) | 91030 | 124748 | 175074 | 233296 | 314353 | ***367780*** | 407106 |
| Total primary energy demand (TPES) estimated by TÜSİAD (Ktoe) | 90800 | 120905 | 167457 | 228682 | 307612 | ***359526*** | 397655 |
| GDP (current-$billion) | 238.11 | 321.56 | 458.32 | 666.85 | 994.82 | ***1272.27*** | 1499.01 |
| Energy intensity projected by the Ministry -TPES/GDP (Mtoe/$ billion) | 0.38 | 0.39 | 0.38 | 0.35 | 0.32 | ***0.29*** | 0.27 |
| Energy intensity projected by TÜSİAD-TPES/GDP (Mtoe/$ billion) | 0.38 | 0.38 | 0.37 | 0.34 | 0.31 | ***0.28*** | 0.27 |
| Population (thousands) | 65864 | 70271 | 74677 | 78633 | 82588 | ***84555*** | 85867 |
| Per capita energy consumption estimated by the Ministry (kgoe/person) | 1382 | 1775 | 2344 | 2967 | 3806 | ***4350*** | 4741 |
| Per capita energy consumption estimated by TÜSİAD (kgoe/person) | 1379 | 1721 | 2242 | 2908 | 3725 | ***4252*** | 4631 |
| Per capita GDP (current $) | 3615 | 4576 | 6137 | 8481 | 12046 | ***15047*** | 17457 |
| Per capita GDP (1992 PPP-$) | 7317 | 9975 | 13600 | 19299 | 27386 | ***33875*** | 38862 |

According to the Ministry's production forecasts, domestic production of primary energy will be 31,091 Ktoe in 2000 and 79,399 Ktoe in 2020. Projections indicate that domestic generation will reach 91408 Ktoe in 2023 and 95,946 Ktoe in 2025. The study conducted for TÜSİAD envisages a boost in local production of primary energy to 33,434 Ktoe in 2000 and 118,268 Ktoe in 2025 with the operation of renewable resources. Table 2 displays a comparative view of the findings related to the primary energy resources and their domestic production planning.

**Table 2- Domestic primary energy production targets of Turkey (Ktoe)**

| Years | 2000 | 2005 | 2010 | 2015 | 2020 | ***2023*** | 2025 |
|---|---|---|---|---|---|---|---|
| Coal projections of the Ministry (of Energy and Natural Resources.) (H.coal+Lig.+Asph.) | 16151 | 19066 | 28226 | 28580 | 36601 | ***38612*** | 40752 |
| Coal projections of TÜSİAD (H.coal+Lig.+Asph.) | 18253 | 23452 | 28819 | 35059 | 42169 | ***46852*** | 51136 |
| Oil + natural gas projections of the Ministry | 3408 | 2127 | 1314 | 877 | 628 | ***430*** | 330 |
| Oil + natural gas projections of TÜSİAD | 3408 | 2127 | 2155 | 2155 | 2580 | ***2580*** | 2580 |
| Central heating | 253 | 495 | 884 | 1336 | 2018 | ***2427*** | 2748 |
| Hydraulic energy projections of the Ministry | 3763 | 5422 | 7344 | 8526 | 8919 | ***9278*** | 9305 |
| Hydraulic energy projections of TÜSİAD | 3763 | 6268 | 7695 | 9219 | 9989 | ***10726*** | 11585 |
| Nuclear energy estimated by the Ministry and Choice 1 of TÜSİAD | 0 | 0 | 3657 | 9143 | 18286 | ***26988*** | 29200 |
| Nuclear energy according to Choice 2 TÜSİAD | 0 | 0 | 3657 | 10972 | 21943 | ***32386*** | 35040 |
| Geothermal energy estimations of the Ministry | 432 | 1380 | 3760 | 4860 | 4860 | ***5400*** | 5400 |
| Geothermal energy estimations of TÜSİAD | 432 | 1380 | 3760 | 5000 | 5250 | ***5400*** | 5400 |

## Domestic primary energy production targets of Turkey (Ktoe)

| Years | 2000 | 2005 | 2010 | 2015 | 2020 | ***2023*** | 2025 |
|---|---|---|---|---|---|---|---|
| Solar energy estimated by the Ministry | 121 | 201 | 355 | 501 | 706 | | |
| Solar energy estimations of TÜSİAD | 287 | 716 | 1458 | 2514 | 3882 | ***4854*** | 5564 |
| Wind energy projections of the Ministry | 0 | 0 | 0 | 0 | 0 | | |
| Wind energy estimations of TÜSİAD | 58 | 263 | 629 | 995 | 1519 | ***1883*** | 2167 |
| Sea-wave energy forecasts of the Ministry | 0 | 0 | 0 | 0 | 0 | | |
| Sea-wave energy forecasts of TÜSİAD | 0 | 0 | 10 | 25 | 125 | ***175*** | 175 |
| Classical biomass estimations of the Ministry (wood+dry dung) | 6963 | 7057 | 7158 | 7268 | 7381 | | |
| Classical biomass estimations of TÜSİAD (wood+dry dung) | 6963 | 6461 | 5734 | 4789 | 3980 | ***3560*** | 3307 |
| Modern biomass projections of the Ministry | 0 | 0 | 0 | 0 | 0 | | |
| Modern biomass estimations of TÜSİAD | 17 | 765 | 1652 | 2500 | 3515 | ***4049*** | 4406 |
| Total estimated by the Ministry | 31091 | 35748 | 52698 | 61091 | 79399 | | |
| Total estimated by TÜSİAD | 33434 | 41957 | 56453 | 72735 | 93313 | ***109495*** | 118268 |

Production figures proposed by TÜSİAD report are 7.5% to 23.3% higher than those suggested by the Ministry. The plan of the Ministry estimates domestic production to meet demand by 25.3 % between 2000 and 2020. According to the local demand and production trends, locally produced energy can only meet 30.9 % of the corresponding demand, much lower than the figure of 38.1 % of the same period. The plan drafted by the Ministry projects 59,940 Ktoe and 234,953 Ktoe worth of energy imports in the years 2000 and 2020 respectively. Turkey's energy

imports will be in excess of 277 Mtoe by 2023. Figure 4 is a comparative table on Turkey's domestic primary energy supplies and demand.

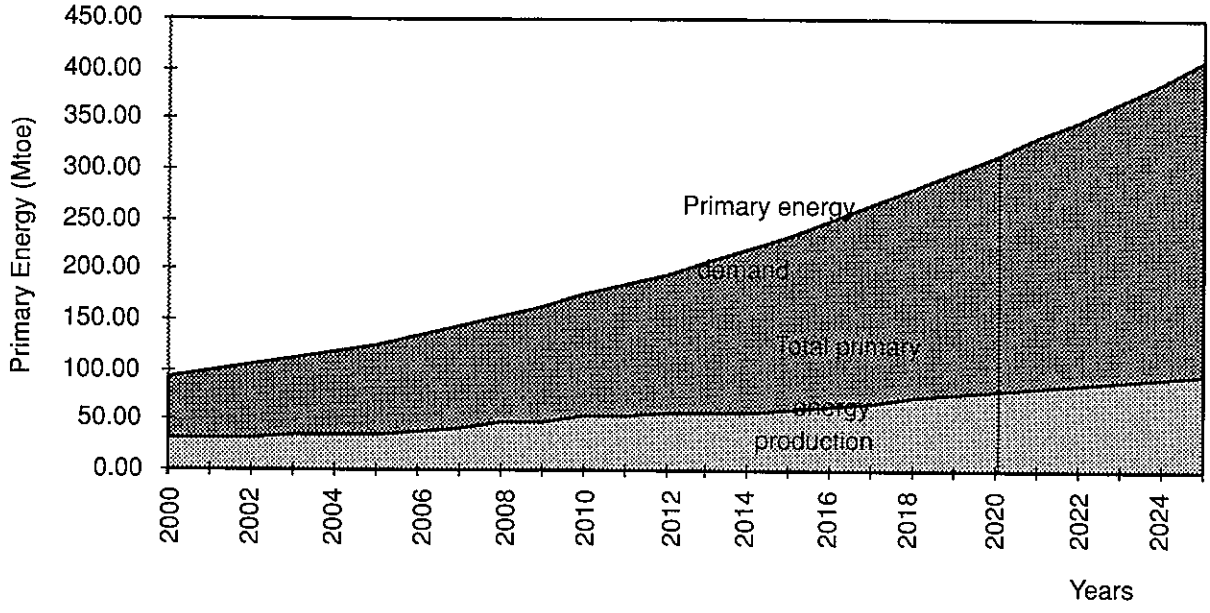


**Figure 4. Local primary energy production and total demand for primary energy according to the findings of the Ministry of Energy and Natural Resources**

Parallel to the forecasts of the Ministry of Energy and Natural Resources, Turkish Power Generation and Transmission Co. (TEAS) estimates that power generation capacity should be 30,395 MW to be able to meet a demand of 134,307 GWh in 2000; and 108,999 MW to meet a demand of 547,060 GWh in 2020. Exponentially, demand in 2023 will climb to 639,045 GWh, meaning that necessary capacity must reach 124,235 MW. Per capita electricity consumption will be 1,750 kWh in 2000 and 6,785 kWh in 2023. Imported natural gas, imported coal and lignite plants have a significant place in the projections of TEAS. *With due importance of the construction of the above mentioned power plants, the share of hydraulic and nuclear energy must be expanded and new and renewable resources for power generation must be used.*

## Hydraulic and Nuclear Energy

*On the centenary of the Republic, Turkey must be in a position to be able to fully benefit from her present hydroelectric potential. For Turkey to be able to entirely mobilize today's hydroelectric potential by the year 2023, established hydroelectric power must be raised to amount to 20,824 MW in 2005, 25,565 MW in 2010, 30,628 MW in 2015, 33,186 MW in 2020 and 35,635 MW in 2023. In this way, total production could be as high as 124,721 GWh by 2023.*

*Until 2023, Turkey must add a minimum of 1000 MW capacity per year to her current hydraulic production level by new projects. From the year 2023 on, projects should be initiated to increase the potential from 35,000 MW to 60,000 MW, so as to fully utilize the technical potential. Furthermore, pump storing hydroelectric power plants in the form of point plants should be built.*

Despite all the disputes, nuclear energy takes an important part in the production of energy in the developed and industrialized countries, and it is expected to keep this share in the future as well. Between 1990 to 1997, nuclear power generation in the OECD countries has significantly increased. In the next 25 years, the world's established nuclear power is expected to continue to grow. At the 17th World Energy Summit held between September 13-18, 1998, the importance of nuclear energy and the need to use it more extensively in the future was highlighted.

*Turkey should also follow this trend. Nuclear power plants are necessary both in order to meet the primary energy demand and to employ the existing technology.* Serious studies based on Turkey's primary resource reserves and potential, the advanced technology in the field of energy and anticipated deficits indicate that nuclear energy should be utilized in order to meet the vast demand for electrical power. The need for nuclear energy is partly due to the fact that they serve as base power plants in the system.

Strict safety measures are taken in nuclear power plants starting from the choice of their location and operations until their closing down. They are the outcome of a rigorously disciplined high technology applied under international inspection. Nuclear power plants are now becoming environment  enviranment-friendly, as well.

*The energy modelling formulated for this report indicated that nuclear power should be increased to 17,700 MW by the year 2023.* If this level can be attained, electric generation from nuclear and hydraulic energy will become equivalent to 124 billion kWh, in 2023. *Turkey's policy regarding nuclear energy should be directed towards attaining a level of nuclear electric generation equivalent to that of hydroelectric generation by 2023.* Figure 5 shows the amount of power that can be generated by hydraulic, nuclear and renewable resources between the years 2000-2025.

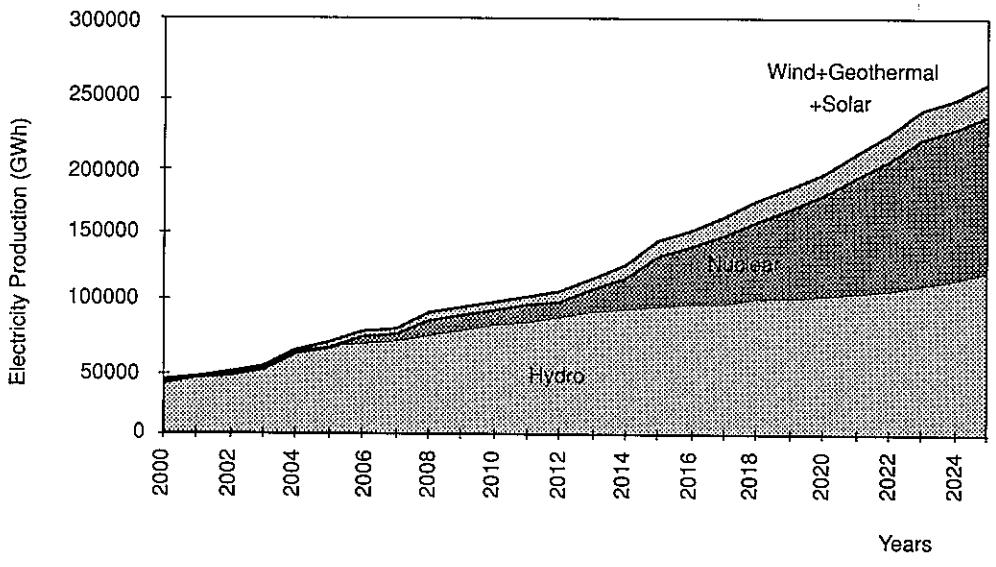


**Figure 5. The shares of hydraulic and nuclear energies in power generation**

## New and Renewable Energy Resources

*In order to alleviate the increasing export burden in energy and adopt a sustainable approach towards energy and environmental issues, the mobilization of new and renewable resources is necessary. Use of geothermal, solar, wind and modern biomass energy should be encouraged.* The plan drafted by the Ministry of Energy and Natural Resources, however, does not attach due importance to these

alternative resources. Figure 6 displays the possible overall energy generation using new and renewable resources. Introducing new and renewable resources together with advanced technology will provide new fields of employment, subsequently easing unemployment and increasing national income. *However, still, new and renewable energy resources should not be regarded as an alternative to nuclear energy.*

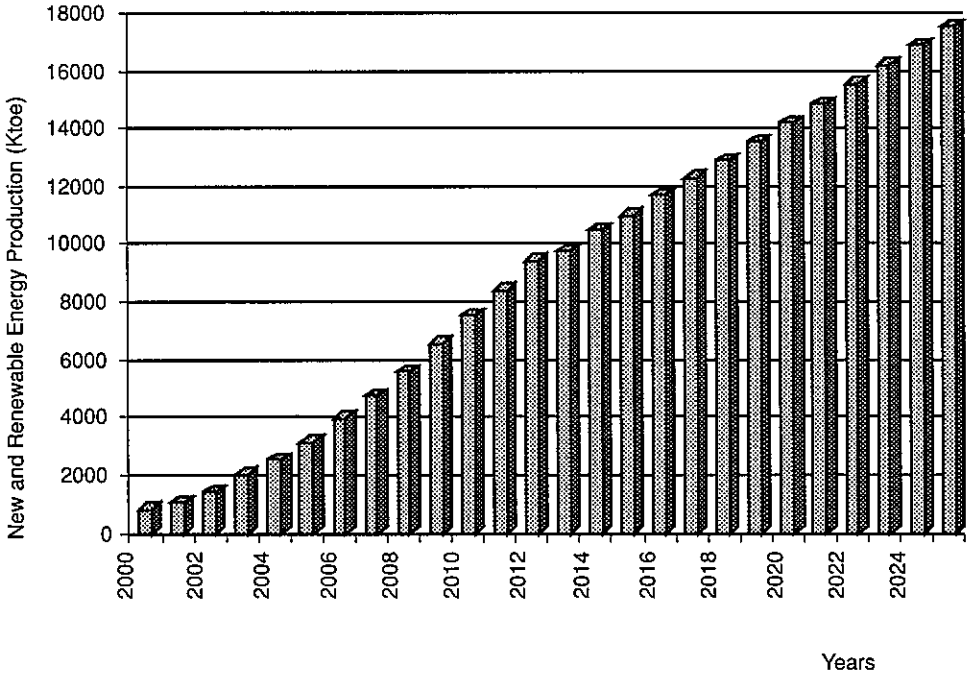


**Figure 6. Overall energy generated via new and renewable resources (geothermal - solar- wind - modern biomass)**

Geothermal energy is especially important for heating purposes in Turkey. Heating capacity in Turkey runs at 350 MWt, equivalent to 50,000 households. These numbers can be increased by some seven fold, to 2,250 MWt equivalent to 350,000 households through a proven and exhaustible potential. *Turkey must target 1,200,000 households, equivalent of 7,500 MWt. Geothermal central heating, which is less costly than natural gas, could be feasible for many regions. In spite of the fact that Turkey's potential for geothermal electricity is viewed to be sparse, there are resources that are yet to be exploited. Geothermal power plants must be built and*

*started to operate in the nearest future. The potential for geothermal electricity could be further bolstered by the use of low enthalpy fluids.*

Solar energy constitutes Turkey's most resplendent source of energy. The use of heat applications and solar energy in production could reach an equivalent of 121 Ktoe in 2000 and 745 Ktoe in 2020 according to the projections of the Ministry of Energy and Natural Resources. Furthermore, the use of advanced technology, non-water passive and active heating methods and solar energy in manufacturing processes could produce 287 Ktoe in 2000, 1,458 Ktoe in 2010, 3,882 Ktoe in 2020 and 4,854 Ktoe in 2023. *Turkey's plans for the upcoming decade must also incorporate solar-natural gas hybrid thermal power plants.*

In recent years, the world has witnessed a significant growth in the capacities of wind plants. No doubt, Turkey too was susceptible to the changes having submitted 30 applications for wind energy plants with a minimum capacity of 645 MW. However, neither the Ministry of Energy and Natural Resources nor TEAS (Turkish Power Generation and Transmission Co.) have included wind energy in their plans. *Estimations and future models show that the established capacities of wind energy plants could reach 300 MW in 2000 and reach as high as 2,979 MW in 2010, 7,849 MW in 2020 and 9,733 MW in 2023.* Electricity produced using wind power will be 675 GWh in 2000 and 21,900 GWh in 2023. *The total share of wind energy in the generation of electricity will increase to 3.5 % from the current level of 0.5 %.*

Biomass energy in the form of animal and plant fossils also holds a substantial share in Turkey's energy supply, although not commercially viable. According to the findings of 1997, classical biomass energy constitutes 25.5 % of total primary energy production. Classical biomass energy must be gradually replaced by modern biomass energy. *The share of modern biomass energy, which yields high quality fuels derived from wood, agriculture and wastes, will take over solar and wind energies.*

Classical biomass energy will yield 6,963 Ktoe in 2000 and 7,381 Ktoe in 2020, according to the estimations of the Ministry of Energy and Natural Resources. It is

likely that the contribution of classical biomass energy will be reduced to 3,980 Ktoe in 2020, to be compensated by an accelerated transition to modern biomass from 17 Ktoe in 2000 to 3,515 Ktoe in 2020 and 4,049 Ktoe in 2023.

## Turkey, an Energy Terminal

Turkey resides in juxtaposition to rich oil and natural gas producing countries, in vicinity to high energy consuming countries of the West, abridging Asia and Europe. As it had been with the historical Silk Road, energy routes could flow via Turkey today. Turkey obviously has great interests vested in the likelihood of becoming an energy terminal or hub connecting the two continents. International oil pipelines and natural gas routes play a central role in Turkey's policies of energy, economy and foreign affairs. Oil and natural gas pipelines have become a national policy for Turkey, which has been striving to harbour these points of connection. Apart from oil and gas routes, power connections via the neighbouring countries could help interconnect Europe, Middle East and the Caucuses.

Turkey presently avails from the Crude Oil Pipeline from Iraq and the Natural Gas Pipeline stretching from the Russian Federation to Europe via Turkey. The pipeline carrying crude oil from Iraq has an alternate operation enabling Turkey to import fuel and also function as a terminal for Iraqi exports to other destinations. The natural gas pipeline stretching from the Russian Federation into Europe was laid for Turkey's gas imports. Unfortunately, the Russian gas imported through the pipeline is inadequate to meet Turkey's ever-growing demand. There are plans to boost the pipeline capacity, as well as LNG imports, which are already ongoing.

The so-called Baku-Tiflis-Ceyhan crude oil pipeline whose itinerary covers the Caspian and the Mediterranean seas will carry 11.5 million tons/year at the outset and will reach 45 million tons of capacity in six years. Although both political and economic challenges continue to stifle the construction of the Baku-Ceyhan pipeline, the Turkish State will give utmost importance to the issue, making it a mandatory achievement.

There are a number of projects assuring a continuous supply of natural gas to and via Turkey to the European countries; namely the Russian Federation-Black

Sea-Turkey (Blue Stream); Turkmenistan-Turkey-Europe; Iran-Turkey; Iraq-Turkey; Trans-Balkans and Egypt-Turkey-Mediterranean Natural Gas Pipeline Projects. The Iran-Turkey Natural Gas Pipeline, which was to begin to operate in 1999, now faces a downturn.

Today, Turkey and the Russian Federation are parties to a natural gas agreement, providing Turkey with natural gas and the means to import LNG in addition to the Iran Agreement and the Russian Blue Stream. Nevertheless, the current sources of supply do not meet Turkey's demand. Turkey's natural gas shortage is expected to run at 963 million m3 in 1998, 3,406 million m3 in 1999, 957 million m3 in 2000, 4,671 million m3 in 2005, 9,151 million m3 in 2010, 20,400 million m3 in 2015 and 35,598 million m3 in 2020. The Turkmenistan natural gas project will be a bail out, helping to compensate the increasing rift between supplies and growing demand in Turkey.

## Advanced Energy Technologies

Progress in technology also provides improvement in the energy sector as evidenced by the increasing importance of coal combustion in fluidised beds, integrated power generation through coal gasification, combined conversion and cogeneration plants. *Future lignite plants in Turkey must be based on fluidised beds, coal plants with combine heat and power plants and industrial heat wastes must be reused in industries or for heating.*

Today, the number of combined conversion natural gas plants is increasing in the country. The established power of privately built plants already running on conversion amounts to 13,500 MW excluding autoproduction cogeneration units. Apart from the existing 825 MW of autoproduction congeneration plants, an additional 1,427 MW of new units has been planned.

*Turkey must employ newly designed energy conversion techniques, follow up the developments in technology, enhance the creation of local technologies and accelerate research and development studies.* Underground thermal energy storage and natural gas caverns, whose technologies are available today, are unfortunately overlooked in Turkey. Fuel cells and hydrogen energy, which are made available as a result of research-based technological advancements, are almost non-existent in Turkey.

## Hydrogen: Fuel of the 21st Century

Hydrogen is a technologically new viable fuel, whose use has been underpinned by the continuous deprivation of fossil fuels, and by the carbondioxide containing emissions of conventional fuels whose effects in global warming have been proven today. Hydrogen, a non-primary energy resource, is an energy carrier produced from primary resources, various raw materials and water in particular. Hydrogen, which is an efficient environment-friendly fuel of wide usage yields water vapour when burnt.

For the past 15 years different engines running on hydrogen have been designed and produced, and have been employed for testing and pilot purposes in vehicles. Power plants with fuel cells up to 11 MW in power running on hydrogen have been built. Catalytic incinerators have also enabled domestic usage of hydrogen as fuel. International standards have been designated regarding its widespread usage. Hydrogen is a competitive alternative to oil with regards to its effective cost and positive environmental effects. The outer cost of hydrogen is also almost on a par with that of petroleum products. Efforts have been underway for the intercontinental haulage of hydrogen. Today, the world is on the brink of a total conversion to the use of hydrogen, which will come into effect in the next 10-15 years.

*Turkey has failed to give due importance to hydrogen as an alternative source of energy. In fact, the Black Sea bed is a natural hydrogen reserve, which is a boon for Turkey's future. Turkey must give consistent and substantial impetus to all related areas of study that would make hydrogen a viable source of energy in the future.*

## Rational Use, Efficiency and Savings

*Energy produced from a variety of primary resources must be used productively and consumed reasonably. Technological advancements must be pursued for a more efficient use of energy. The overriding goal is to produce a larger quantity of goods and services with less energy consumption.*

Studies conducted in different industries in Turkey reveal that savings is possible in total energy consumption. Manufacturing industries could save upto 5.3 annually, while domestic consumption and services could be reduced by 5.1 Mtoe/year. Transportation, an area which consumes energy intensely, could also optimize energy use and save 2.8 Mtoe per year. Energy saving measures could yield some 13.2 Mtoe annually, corresponding to $2.6 billion in monetary terms. Additional savings could be achieved in the areas of energy conversion sector with 3.5 Mtoe and agriculture that could cut back waste by 0.4 Mtoe annually. Overall, Turkey's energy loss amounts to 63.1 % in input and 84.5 % in final output compared to the estimated productivity levels of 36.9 % and 15.5 %.

*Turkey's drive toward savings in energy consumption lack a sound scientific and technological groundwork. Efforts are appallingly negligent and merely pay lip service to aspirations. Figures reveal that Turkey could reduce its current energy consumption as far as 18%. Efficiency could be driven by technological measures based on incentives, rather than lowering demand through price-oriented manoeuvres, which will underscore abundant and economically priced energy.*

## Energy and the Environment

Although mankind continues to change the nature, energy is perhaps one of the most important areas of concern today. There are no pollutant types of energy, what makes it a contaminant is the technology used in production. Today clean practices have become a byword in production as environmental policies are intertwined with industrial ecology. Environmental action plans are designed on the basis of sustainability features, making energy one of the most prioritized industries to be sought after.

Today the most serious ecological issue inflicting the world is that of global warming. Global warming is a by-product of the excessive use of fossil fuels. Fossil fuel emissions contain greenhouse gases such as carbondioxide which perpetuate a process of global warming that could lead to climatic changes in the atmosphere. *Ways to curb global warming must be sought in nuclear and alternative new and renewable sources of energy. Needless to say, all forms of energy technologies neces-*

*sitate measures to protect the environment. Remedial measures that could help stave off environmental hazards must be strictly applied.*

Energy and the environment must not be viewed as conflicting areas of concern. Today transportation industry generates much higher levels of air pollution compared to the obvious culprit; the energy plants. Energy and the environment must be in congruity let alone face clashes. Unfortunately in Turkey, the environmental effects of thermal energy plants operating on fossil fuels reveal the bitter reality that most energy plants are in too much of a vicinity to one another, that they are in one another's territory, located in zones of high agricultural and touristic potential, indifferent to anti-pollutant measures and that they embody major design mishaps. Although further investments with a view to compensating the shortfalls are already underway, measures must be taken at the design and project phases for efficient results.

*Authorities must make the effort to make use of scrupulous, non-hazardous, environment-friendly, productive and equally cost-effective technologies in mining raw materials, primary and secondary phases of production, transportation, storage, transmission and consumption of energies so as to safeguard the ecological balance. The environmental impacts of power plants must be viewed in advance, no later than the project phase. An optimum equilibrium must be continuously maintained between energy, economics and ecology.*

Environmental and health related risk exposures are valid for all energy types. Nevertheless such risks or environmental effects can be mitigated through the use of advanced science and technological tools. Human beings de facto employ controllable forms of energy. *Measures that resolve environmental controversies must employ state of the art technology and not prohibit the construction or operation of any power plant.*

## Restructuring the Energy Sector and Privatization

Turkey's energy policies have been prone to a wide array of rules and regulations from statist measures, planned hybrid economy to a full-fledged liberal scheme. Lately, worldwide developments have accentuated liberalization and

privatization feats and the energy industry is included within this scope. *All related enterprises and associates of the Ministry of Energy and Natural Resources must be privatized. Although Turkey felt the urgent need to sell-off state-held energy operations much earlier than many countries, the privatization drive has long been marred by a sluggish pace. All administrative, legislative and supervisory measures and changes must be made to accelerate the process of privatization. The state must be stripped of all its duties in the energy sector apart from those of close supervision and guidance.*

The energy stalemate also stems from financial difficulties in Turkey. Most plans have proven unfruitful in the past, due to the shortage of funds. Challenges encountered in the provision of funds do not only delay operations but also pave the way for doldrums related to scant supply.

*In the next 25 years $300 billion must be invested in the energy sector to develop power, coal, oil, natural gas, hydraulic energy, nuclear, new and renewable sources, to boost efficiency and relieve energy-environment conflicts. Private sector funds of foreign or local capital must finance these investments. The energy sector must be developed through private investment and capital.* All forms of energy generation is in fact a production and only the private sector can finance the most productive means of production, transportation, transmission and distribution.

Bureaucratic challenges stemming from legislation tend to stifle local and foreign capital joint ventures. Such impediments can only deter the inflow of foreign capital that Turkey desperately needs. The influx of foreign capital, which is pre-conditional for economic prosperity, is either curbed due to the inadequacy of local conditions or hindered by the intricate and cumbersome legal framework. *To prevent any further loss of time, the inflow of local and foreign capital must be eased and challenges be removed.*

*Plants constructed on natural resources, the natural wealth of any country must be subject to private ownership during their operations. Contracts in the field of energy must be prone to private laws and international arbitration ought to be sought in the resolution of disputes.*

*The Oil Law and Mining Act for energy raw materials must be made more lenient and amended through a liberal understanding to introduce novel forms of incentives. Renewable energy resources and efficient use of energy must be endowed with newly enacted laws and regulations of specific incentives. The shortfalls of the Build-Operate-Transfer Law must be remedied, the scope of Build-Operate Law be expanded and both areas of legislation be harmonized with financing requirements.*

*Economic growth must not be stalled, and must be guaranteed by the timely, and low-cost provision of sufficient supplies of high quality and reliable energy, in order to be efficiently employed with progressive and environment-friendly technologies. Turkey's energy policies must be geared to those measures, which must be taken to preempt energy, and power bottlenecks, and which must accelerate the pace of privatization and private sector investments. Challenges that stifle private investments and state sell-offs must be eradicated to allow for a productive and lucrative playing field.*

**Reference**

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**Nomenclature**

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|---|---|
| toe | = tonne of oil equivalent = 10 500 kcal = GJ |
| kgoe | = kilogram of oil equivalent |
| Ktoe | = thousand tonnes of oil equivalent |
| Mtoe | = million tonnes of oil equivalent |
| TPES | = Total Primary Energy Demand (Supply or Consumption) |
| GDP | = Gross Domestic Product |
| MW | = megawatt = 1000 kW |
| kWh | = kilowatt-hour = 3.6 MJ |
| GWh | = gigawatt-hour = millions kWh |
| TWh | = terawatt-hour = billions kWh |