International Journal of Economics, Politics, Humanities & Social Sciences
Vol: 6 Issue: 3 e-ISSN: 2636-8137 Summer 2023

# TÜRKIYE'S ENERGY SECTOR ANALYSIS SINCE 1980 FROM AN ECOLOGICAL ECONOMICS PERSPECTIVE – INSTITUTION, DEVELOPMENTAL POLICIES, RESOURCES, MARKET, AND LABOUR*

Armağan CANAN[1]

***Makale İlk Gönderim Tarihi / Recieved (First):*** *25.06.2023* ***Makale Kabul Tarihi / Accepted:*** *14.07.2023*

***DOI:*** *10.59445/ijephss.1319996*

***Makale Türü:*** Araştırma Makalesi / ***Article Info*****:** Research Article

***Atıf / Cite:*** Canan, A. (2023). Türkiye's energy sector analysis since 1980 from an ecological economics perspective – Institution, developmental policies, resources, market, and labour, *International Journal of Economics, Politics, Humanities & Social Sciences*, 6(3), 187-215.

## Abstract

This research discusses the energy production and ecological sustainability in Türkiye. Türkiye's energy production per capita has increased since 1980, however, the country is considered ecologically indebted. Carbon emissions have led to environmental pollution, and reducing CO2 emissions has become a priority for achieving economic development sustainably worldwide. The research examines the developments in the energy sector in Türkiye after 1980 through an ecological economics approach. It observes the relationship between energy, development, and nature. First, the study discusses the relationship between the ecological economics approach and the Turkish economy. Then it covers a detailed analysis, where legal and institutional structures, development policies, resources, market design, and labour are evaluated to understand sustainability problems in the sector. Finally, it provides policy recommendations. The literature lacks in evaluating the development of the energy sector in Türkiye from an ecological macroeconomics view, and this research aims to fill that gap.

**Keywords:** Energy Sector Analysis, Ecological Economics, Developmental Policies, Ecological Macroeconomics.

**JEL:** N54, N74, Q43

* This article is derived from the PhD thesis Developmental Issues in Ecological Economics – A Study on Türkiye (2017) Marmara University Social Sciences Institute.

[1]Dr., Independent Researcher, armagancnn@gmail.com, ORCID: 0000-0003-1893-8681.

## 1. Introduction

The energy production per capita in Türkiye is increasing since 1980 from 0,71 tonnes of oil equivalent (TOE) per capita to 1,88 TOE per capita in 2021 (OECD, 2023). The same figures for OECD countries' average are 4,02 TOE per capita in 1980 and 3,81 TEO per capita in 2021. Türkiye is considered ecologically indebted, which is due to its development policies. Carbon emissions in Türkiye have not decreased and have led to environmental pollution. However, reducing $CO_2$ emissions has become a priority in achieving economic development sustainability worldwide.

Türkiye's Environmental Performance Index (EPI) score and ranking have improved in recent years, but there is still room for improvement. The literature lacks in evaluating the development of the energy sector from an ecological macroeconomics view. The relationship between energy, development, and nature needs to be examined to move towards ecological economics.

In this research, developments in this sector in Türkiye after 1980 are examined through an ecological economics approach. The energy sector in Türkiye is analysed in terms of sustainability. To analyse sustainability problems in the sector, legal and institutional structures, development policies, resources, market design, and labour need to be evaluated, and ecological solutions must be sought.

In the second section, I set the ground for the rest of the research by representing the relationship between the ecological economics approach the and Turkish economy. The third section covers the main analysis. The recommendations and conclusion are in the fourth section.

## 2. Ecological Economics Approach and Turkish Economy

Physiocrats and ecological economists share a common view on the physical aspects of economic processes. Their view is that natural resources and labour are reflections of energy (Hornborg, 2014:14). Therefore, energy occupies an important place in economic problems related to nature. On the other hand, the increasing energy demand of 21st-century economies and the pollution characteristics of energy-providing resources have become a contemporary economic problem.

Before the Turks encountered the effects of the industrial revolution, they had a culture that lived in harmony with and in connection with nature (Gündüz, 2012:17). With settlement policies after the Anatolian Seljuks (Freely, 2012:120) and the Ottoman Empire (Faroqhi, 2013), the nomadic culture began to decrease. Although this did not change their relationship with nature, encountering Western culture increased their knowledge of utilizing natural resources in more detailed ways and introduced private property (Godelier, 1974:84-85).

The development policies applied in Türkiye parallel the evolution of development policies imposed on the world and seem to have a neoliberal-based approach (Şengül, 2008:86). Both state intervention in the development problem and reducing the development problem to growth and hence capital accumulation seems to be in line with global development policies (Akbulut, 2015:14). The foundations of this understanding go back to the establishment years of the Turkish Republic, which fought against the frozen system in the Ottoman Empire (Koç, 1998:15-16). The revolutionists resisted imperialist expansion rather than a class struggle revolution within the country during their efforts to create a local bourgeoisie and shaped their policies accordingly (Özdemir, 1999:45-51). In this context, relations with the population, most of which were peasants, were also established through the intermediation of the gentry and religious figures who controlled the lands (Ahmad, 2014: 234-236). Therefore, the use of land and natural resources has been aimed not at any scientific production approach, but at increasing capital, creating local capitalists, and growth goals for them.

In Türkiye today, there is a dominant attitude of prejudice against environmental movements and the connection between environmental problems and capitalism. It is said that opponents of the

market economy want to stop economic growth, prepare for a ruthless authoritarian and totalitarian regime and that it is quite easy to put forward arguments against environmental problems (Şahin, 2004:21-25). Perhaps the reason for interpreting this way is that environmental problems in Türkiye have not been fully identified and perceived as a macro problem.

The answer to the question of what is the main factor to be developed for a country will largely determine the preparation and implementation of development policies. From an ecological economics view, labour, that is, the human resources of that country, has the property of being the most valuable resource that can be used for development as a factor that can produce more than itself ecologically, economically and socially (Acaroğlu, 1966:15). Using only natural resources will remain temporary and limited in terms of development. Examining the energy sector in Türkiye after 1980 without losing this perspective can provide substantial ideas for the selection and implementation of development policies.

## 3. Turkish Energy Sector

### 3.1. Legal and Institutional Structure in Energy Sector

Numerous Turkish regulations directly address environmental protection and the use of nature. However, these regulations often aim to mitigate or delay pollution and degradation resulting from growth-oriented decisions. Thus, practices that rapidly degrade the environment and nature are supported by laws enacted for development and growth.

Türkiye's Energy Efficiency Law, enacted in 2007, aims to prevent energy waste, reduce energy costs, and protect the environment. The Energy Efficiency Coordination Board, established under the law, meets quarterly to discuss energy efficiency. However, the development of energy efficiency inventories and projections required by the law has not been fully realized.

In his book "Enclosure," author Çağlar raises an important question: why have environmental debates in Türkiye lost their intensity and scope compared to the 1980s and 1990s, despite the worsening environmental issues in the 21st century (Çağlar, 2011:7)? One major reason is the legal and institutional structure that regulates the environment.

Türkiye has several ministries responsible for enforcing laws related to nature, including the Ministry of Environment, Urbanism and Climate Change, Ministry of Energy and Natural Resources, Ministry of Culture and Tourism, Ministry of Agriculture and Forestry, and Ministry of Transport and Infrastructure. A complicated and disjointed institutionalisation is produced by the fragmentation of these ministries, each of which has distinct methods for interacting with nature, and by decision-making procedures without an ecological basis.

The approach to environmental protection in Türkiye, as stated in Article 56 of the Constitution, is anthropocentric, focusing only on environmental health and disregarding other living beings and natural-cultural values (Yılmaz, 2005:19). The Constitution assigns the responsibility of preserving natural resources to the state, emphasizing its role in Türkiye's development policies. This approach has led to natural resource monetization and their sale for development purposes, causing increasing environmental pollution.

The legal framework for environmental protection in Türkiye has not been conducive to effective private sector participation due to the government's reliance on command-and-control mechanisms. The lack of enforcement of environmental regulations has also led to noncompliance and pollution.

The Mining Law 3213, issued in 1985, was almost completely replaced by Amendment Law No. 5177 issued in 2004. This law has made changes not only to the Mining Law but also to many laws

related to the environment and nature. It has made it possible to mine in many protected natural areas, allowing land allocation for mining facilities and geothermal energy production plants in these areas. Regulations have also been made allowing for the use of pastures and agricultural lands for energy and mining purposes with laws and regulations issued in 2004 and 2005.

In 1983, National Parks Law No. 2873 allowed national parks to be leased for 49 years to individuals and legal entities, which could be extended up to 99 years if the management was deemed successful by the Ministry of Culture and Tourism. This marks a shift in the use of natural assets for private use since the 1980s.

The Special Environmental Protection (SEP) Institution was established by Decree Law No. 383 in 1989. The 8th article of the Decree Law requires the Institution's services to be carried out in accordance with development plans and annual programs. This contradicts the institution's aim of preserving ecological balance as stated in Article 10(a). In 2005, a change was made in the e-paragraph of Article 10, leaving the leasing, permission to use, operation, management, and other disposal rights of lands in SEP areas to the institution's presidency. This puts the land directly at risk of being used for private purposes without being transferred to state ownership.

These changes and the policy of transferring natural resources to private ownership were directed by international organizations such as the World Bank, GATT, and the EU, as well as domestic capital organizations and foreign capital support. For instance, the Foreign Capital Guide prepared by the Energy Market Regulatory Authority (EPDK) in 2012 repeatedly mentions market liberalization. This approach demonstrates that a technology and capital attraction method has been adopted within the framework of demands by organizations such as the IMF, World Bank, OECD, and others.

Türkiye's energy companies are primarily owned by the government. Eight of the 20 state economic enterprises at the end of 2015 were related to energy. The ratio of their capital to the total capital of state economic enterprises was 58%.

The construction of mega dams by the state in Türkiye, with the aim of development, is an important example of how environmental values are utilized to gain social consent for modernization ideals. Protecting natural values by the state also provides legitimacy to decide on the exploitation of these resources. Environmental policies aiming to be 'Western,' 'modern,' and 'civilized' have made the state the primary authority concerning environmental problems. Thus, society's economic and other relations with nature are determined by the state, which reserves the method, means, and right to make decisions regarding environmental values on behalf of society (Akbulut, Adaman & Arsel, 2014:284-286).

The 2017 Program associates environmental protection with sustainable development but allows for project and program-level work aimed at internalizing green growth approaches, renewing legislation, and institutional restructuring.

### 3.2. Energy Sector in Development Policies

#### 3.2.1. Five-Year Development Plans

The 5th plan, the first plan to be implemented after 1980, saw a shift from planning for development to a structural adjustment loan plan supported by the IMF and the World Bank. The 5th plan emphasized public investment in mining, transportation, and communication, while the private sector was encouraged to invest in other areas (Devlet Planlama Teşkilatı, 1984). However, the plan did not specify how the rationalization and saving principles would be implemented alongside the general framework of a free-market economy. In addition, the bureaucrat-politician balance in the High Planning Council has deteriorated in favour of the politician (Soyak, 2006:144-144).

The plans after the 5th plan lost their operational nature, causing uncertainty in the distribution of responsibility for environmental issues. The 6th plan, which was the first to use the concept of sustainable development, took note of the importance of the environment and ecological principles (Devlet Planlama Teşkilatı, 1993:10). The 7th plan's energy section was brief and only made references to the EU system and the need to comply with free-market principles (Devlet Planlama Teşkilatı, 1995). The 8th plan recommended modifying the Environmental Impact Assessment report to favour the mining industry (Devlet Planlama Teşkilatı, 2001a:116). However, after the 2000s, the Ministry of Environment and Urban Planning approved many mining and other sector investments without requiring an Environmental Impact Assessment report. The 8th plan's Electricity Energy Specialization Commission Report admitted that unplanned electricity production caused uncertainty in the volume of production, and as a result, no plans could be made for transmission lines and facilities (Devlet Planlama Teşkilatı, 2001b:13-24).

The 8th plan supported a free-market economy without a clear five-year macro plan. The report on the Electricity Energy Specialization Commission outlined the rules of competition in production, stating that for competition to exist, production must exceed demand, and producers whose products do not meet the quality and price criteria requested by the consumer should suffer losses. These lines highlighted the abandonment of macro-planning characteristics and showed that the plan relied on a capitalist production system.

According to the 9th five-year development plan (FYDP), the residential and service sectors have been identified as the determinants of increased energy demand since 2008. The share of the industrial sector in energy consumption decreased from 40% in 2006 to 35.5% in 2011, indicating a transformation within the sectors. While the use of solid fuels and oil decreased from 55.6% to 41.3% in the industrial sector, the share of natural gas and electricity increased from 40.9% to 54.2% (Devlet Planlama Teşkilatı, 2006). Given the increase in natural gas's share in electricity production and Türkiye's dependence on imports, primarily from Russia, it can be understood that the industrial sector is trying to produce energy using imported, expensive, and foreign currency-consuming energy.

The 10th FYDP's Energy Security and Efficiency Specialization Commissions report highlights that "public withdrawal from investment" has led to insufficient national savings, necessitating a sufficient level of foreign capital inflows to implement investments, for which safe energy markets need to be established. The plan analyzes energy sector problems from both the supply and demand sides. For example, the plan emphasizes the positive aspects of managing the demand side, taking into account energy efficiency practices, pointing out that Turkish energy projections have always been supply-oriented (Devlet Planlama Teşkilatı, 2014). As long as the growth target remains the primary goal, both energy supply and demand will tend to increase, ignoring ecological limits.

The plan predicts that "competition will increasingly intensify" in energy access. It is stated that Türkiye can't transition entirely to renewable energy, so an integrated system that prioritizes renewable energy sources is proposed. There is no explanation of how so many contradictions can be reconciled, but the report's general approach reveals how these contradictory situations and targets have emerged. The regulatory institutions, organizations, and individuals who prepared the report approached the energy sector within a supply-demand analysis framework that does not consider ecological limits. Growth and profitability-oriented analyses made for other sectors were also made for the energy sector. Therefore, references to Türkiye's energy and economic independence in certain parts of the 10th BYK report are inconsistent with the overall approach of the report.

The plan's emphasis on liberalized energy markets and private sector investment may not be appropriate for addressing the challenges of the energy transition, which requires a more coordinated

and collaborative approach between different stakeholders, including governments, civil society, and the private sector. The plan's neglect of environmental concerns and the need for a more sustainable energy future could also harm Türkiye's competitiveness in the global economy, as countries increasingly shift towards more sustainable energy systems.

### 3.2.2. Institutional Development Pathway

According to Çağlar, the transformation of public natural resources in Türkiye takes place in four ways: privatization, resource allocation, underutilization of public institutions, and decreased public effectiveness in resource transformation decisions (Çağlar, 2005:34-36). The same deterioration applies to the transformation of five-year development plans.

Sustainable growth, structural change in production and consumption patterns, technological advancement, social, political and institutional modernization, and widespread improvement in living standards are listed as requirements for economic development. In Türkiye, growth is considered the main issue in economic development policies. Legal regulations and institutional structures in Türkiye are developing accordingly.

To understand Türkiye's institutional development path, it is helpful to clarify the implications of the dual structure problem more prominently observed in developing countries. The dual structure in economics generally refers to different usage ratios of production factors such as capital and labour and intersectoral productivity differences. For example, the industrial sector in cities is capital-intensive, while the agricultural sector in rural areas is labour-intensive.

Manufacturing industries in Türkiye are interdependent. It is not difficult to demonstrate that all inputs used in manufacturing industries are connected to natural resources. The dual structure, which is based on the differences in input intensity between the industrial and agricultural sectors, can be understood more clearly through the following analysis.

Both the agricultural sector and industrial sectors fundamentally rely on natural resources as their main inputs. Therefore, the dual structure analysis based on the difference in input intensity between the industrial and agricultural sectors has a different meaning when viewed from an ecological economics perspective. The capital-intensive production in the industrial sector signifies a higher utilization of accumulated natural resource values as production inputs.

Creating new employment in the industrial sector requires more accumulated natural resources than in the agricultural sector. Therefore, the dual structure analysis based on capital-intensive and labour-intensive distinctions should be replaced by the distinction based on the use of natural resources necessary for employment.

In Türkiye, attempting to create employment through the industrial sector or "capital-intensive" investments seems unfavourable in the short term from an economic perspective and in the long term from an ecological perspective. A balanced development alternative involving increased employment in the agricultural sector, requiring less natural resource use and being more compatible with ecological values, is being abandoned. Unfortunately, Türkiye's development path is built on industrialization, which has taken on an assembly industry-dominated form due to various reasons, including the dual structure as the main cause.

In Türkiye, the first public organization dealing with the environment was established in 1978. The Ministry of Environment was founded in 1991 and merged with the Ministry of Forests in 2003 (Şengül, 2008:78). With the changes in various laws in 2005 and 2006, the privatization of existing public enterprises has begun. Development Agencies have become institutions that facilitate cooperation between the public sector, private sector, and NGOs (Şengül, 2008:81-83).

Türkiye's economic approach to energy-producing natural resources has been to build dams since the 1970s, establish hydroelectric power plants on all rivers in recent times, and extract domestic lignite very cheaply. These operations ignore the balance within nature (Orhan, 2011:40).

Türkiye Electricity Authority (TEK) was established with the TEK Law in 1970 to ensure the production, transmission, distribution, and trading of electricity from a single source. The reason for the state monopoly on electricity production and supply was to provide cheap energy to the industrial sector and accelerate development. The monopoly of TEK was maintained until 1994. After 1982, the public monopoly began to be legally abolished. In 1984, Decree No. 233 regulated the establishment of autonomous enterprises and the sale of public enterprises. In 1985, the Ministry of Energy and Natural Resources was established.

In the 1980s, the reason for TEK's continued growth with new investments was the encouragement of infrastructure investments in developing countries by organizations such as the World Bank. As the 1980s came to an end, organizations like the World Bank and IMF advocated for the privatization of large and monopolistic infrastructure institutions.

Until 1984, coal prices were determined by the Council of Ministers in Türkiye. In 1984, the authority was transferred to TTK with Decree Law No. 233, and coal prices began to be determined by the market during the privatizations of the 1990s. The Electricity Energy Fund, established in 1991, still appears at a 1% rate on electricity bills in 2017. The fund is used for various purposes such as research and development, providing loans to companies, and ensuring price stability.

The privatization tenders accelerated with an agreement made with the World Bank in 1995 (Resmi Gazete, 1995). In 1998, a new credit agreement led to the decision for the independent operation of transmission lines (Resmi Gazete, 1998). In 2001, Turkish Electricity Inc. (TEAŞ) was divided into three companies: Türkiye Electricity Transmission Inc. (TEİAŞ), Electricity Generation Company (EÜAŞ), and Türkiye Electricity Trade and Contracting Inc. (TETAŞ). TETAŞ undertakes long-term energy purchase commitments and sells electricity to regional distribution companies and other relevant institutions.

The Energy Market Regulatory Authority was established in 2001 to collect the energy-related powers of various governmental institutions and create a competitive energy market. As a result, the shares of the public and private sectors changed significantly. In 2008, distribution privatizations began, and production privatizations accelerated in 2013.

In 2003, the National Program aimed for harmonization with the European Union, and several laws were enacted to liberalize the energy market. All premises were performed by 2010.

Since 2015, all electricity distribution companies in Türkiye have been transferred to the private sector (TMMOB Makina Mühendisleri Odası, 2015:12). The policies in both electricity production and distribution have favoured the private sector. However, this has led to increased electricity prices due to long-term purchase guarantees from the state, reliance on foreign sources, and the easy entry of foreign investors. As the electricity distribution sector is privatized, loss and leakage rates have increased, with Türkiye's distribution system loss rate exceeding 11.38% in 2020, compared to the European average of 5%.

As a result of these privatization efforts and the transition to a 'commitment-based free market,' the energy sector has adopted a principle of non-planning. The Energy Market Regulatory Authority (EPDK) has been granting licenses for electricity production, transmission, distribution, and trading without considering the nature of electricity production. Sustainable energy demand is overlooked in these calculations.

Since the 1960s, public capital in the energy sector has been transferred to the private sector. This has deprived Türkiye of the ability to allocate resources between sectors through planning. Redirecting capital in the energy sector could provide significant advantages for a developing country like Türkiye. However, relinquishing this planning tool also implies giving up on development.

Table 1 compares the classical measurement of change in energy intensity with a cost-based efficiency using The Central Bank of the Republic of Türkiye (CBRT) energy sector data. While the change in final energy intensity (consumed energy amount/GDP) tends to decrease at an average of 2% per year for the 1980-2014 period, energy efficiency per capita (per capita income/energy consumption per capita) increases by an average of 2% per year for the same period. These data represent a consistent and slightly positive change. However, these calculations, which are used to measure energy efficiency, are based on income growth. When an evaluation is made according to the costs of the inputs used for the production of energy, the efficiency decreases by an average of 14% per year in the same period.

**Table 1. Energy Efficiency Comparison and Change in the Energy Sector**

| 1980-2014 | % Change In Final Energy Intensity (Kgoe/Gdp Thousand Tl) | % Change In Energy Efficiency (Income Per Capita / Energy Consumption Per Capita) | % Change In Energy Efficiency (Total Cost Of All Input / Total Energy Production) | % Change In Total Assets In The Energy Sector | % Change In Capital Exchange In The Energy Sector |
|---|---|---|---|---|---|
| **Averages** | -2% | 2% | -14% | 23% | 11% |

**Sources:** The data used in this study was obtained from the OECD, World Bank, TCMB Sector Data, and IEA Headline Energy Data 2016 sources. Results are calculated by the author of this research.

In 2005, Türkiye introduced the Renewable Energy Law, which established the Renewable Energy Support Mechanism (YEK) (Resmi Gazete, 2005). The mechanism guarantees fixed purchase prices in USD for renewable energy producers for 10 years, with the Council of Ministers determining the prices for organizations wishing to benefit from the mechanism after 2015. To obtain a renewable energy certificate, organizations must apply to the Energy Market Regulatory Authority (EPDK).

The law also incentivizes the use of domestically produced mechanical or electro-mechanical devices in renewable energy facilities by offering additional prices for five years. However, there are limitations to solar power plants' total installed capacity, such as a 600 MW limit for solar power plants connected to the transmission system before 2013.

The law prioritizes the use of geothermal and solar thermal resources for heating purposes in regions with geothermal sources, but natural gas consumption continues to dominate. The law also enables the direct transfer of public resources to the private sector for renewable energy projects.

Environmental NGOs in Türkiye are often established and controlled by the capital class. Groups that are not supported by capital are generally passive initiatives focused on raising awareness about pollution or reducing it (Orhan, 2011:42-43).

Türkiye is also implementing water resource management policies suggested by the World Bank, such as determining the economic value of water and adopting strategic decision-making methods for water sharing and pricing (The World Bank, 2016:9). In the 2000s, the mobilization of the private sector for dam and hydroelectric power plant construction has led to the emergence of many independent environmental movements in the Black Sea region.

Türkiye's Electricity Market and Supply Security Strategy aims to utilize all technically and economically viable hydroelectric potential by 2023. The strategy and the Renewable Energy Law also

allow renewable energy investments in areas protected by private and international regulations, with hydroelectric power plants expected to constitute a significant portion of the targeted 30% share of renewable energy.

Türkiye was initially reluctant to sign the Kyoto Protocol, but eventually did so in 2008, followed by passing Law No. 5836 in 2009. However, Türkiye's carbon limits were postponed to 2020 after the COP21 Paris meeting in 2015. Consequently, Türkiye participated in the carbon trade aspect of Kyoto but did not commit to reducing carbon usage (Serim, 2015:121). This could explain why Türkiye prioritizes the construction of hydropower plants (HES) through unlimited incentives, disregarding legal decisions. HESs, despite having a limited lifespan, emit high carbon emissions during construction but are presented as clean energy to the public.

In Türkiye, there is a dominant approach to removing natural resources from public spaces for economic purposes. There are no restrictions on how lands are used, and the law adapts to these actions. The closure of the Village Services General Directorate in 2005, an institution with undeniable contributions to environmental protection, exemplifies this new perspective on nature.

### 3.3. Natural Resource Structure and Energy Use

Türkiye relies on imported energy sources for trade, a vital part of the economic system. According to the Ministry of Transport, from 1990 to 2007, private vehicle traffic tripled while public transportation increased by only 8%, and railway transport decreased by 31%. Only 5% of freight transportation is done by rail, while the rest, causing air pollution and road degradation, is carried out by trucks (Atiyas, Çetin & Gülen, 2012:143).

The use of imported energy in the transport sector has also affected other sectors. This nationwide trend leads to exceeding the carrying capacity of nature in Türkiye's "industrialized" regions when examined locally. The increase in air, water, and soil pollution levels reflects this capacity exceeded. Table 2 shows the pollution levels in some major cities in Türkiye. It should be noted that these values represent long-term averages covering multiple years. Many days, especially during winter, experience pollution levels above the limits.

**Table 2. Air Pollution in Some Major Cities**

| City & Measurement Station | Measurement Date Range | Particle Type | Measurement Value Average (µg/M³) | Good Air Quality Reference Range (µg/M³) |
|---|---|---|---|---|
| Ankara - Cebeci | 01.2010-12.2016 | $NO_2$ | 62 | 0-100 |
| Ankara - Cebeci | 01.2010-12.2016 | $PM_{10}$ | **73** | 0-50 |
| Bursa - Beyazıt Caddesi | 01.2013-12.2016 | $NO_2$ | **69** | 0-100 |
| Bursa - Beyazıt Caddesi | 01.2013-12.2016 | $PM_{10}$ | **76** | 0-50 |
| İzmir - Bornova | 12.2013-12.2016 | $NO_2$ | **73** | 0-100 |
| İzmir - Bornova | 01.2008-12.2016 | $PM_{10}$ | **45** | 0-50 |

**Source:** Ministry of Environment and Urbanization, http://www.havaizleme.gov.tr.
**Note:** Measurement values close to or above the upper level of the good air quality reference range are highlighted in bold.

From 1990 to the end of 2013, Türkiye's total greenhouse gas emissions increased by 110%, aligning with these statistics (WWF and Sabancı Üniversitesi İstanbul Politikalar Merkezi, 2015:20).

The carrying capacity of a region is historically dependent on the characteristics of its production tools and the social functioning of resource distribution, whether it lacks trade routes, is close to vital

resources, or is distant from strategic areas (York and Marcus, 2009:138). Conversely, large cities constantly rely on external areas for food, water, and goods, expanding into larger territories (Barlas, 2013:56). The capitalist system leads to the exploitation of urban space for its social relationships, as well as in energy production-distribution-use systems (Kaygalak, 2009:44-45).

Türkiye is a country with high intermediate goods imports, with a significant portion being energy-related. Analyzing all intermediate goods imports, three main sectors stand out: energy and energy raw materials, scrap and steel metals (requiring intensive energy consumption in production), and chemical products (generally relying on fossil fuel sources for production). Detailed import rates for these sectors are given in Table 3.

**Table 3. Selected Intermediate Goods Imports and Their Share in Total Imports Related to Energy and Related Resources (2014)**

| **Intermediate Goods** | **Amount (Million USD)** | **Share in Total Intermediate Goods Imports (%)** |
|---|---|---|
| Crude Oil and Natural Gas Extraction | 34,766 | 19.7 |
| Refining of Petroleum Products | 17,640 | 10.0 |
| Primary Form Plastic Raw Materials | 11,019 | 6.2 |
| Manufacture of Basic Iron and Steel and Ferro Alloys | 9,799 | 5.5 |
| Precious Metal Production | 7,287 | 4.1 |
| Manufacture of Other Organic Basic Chemicals | 5,740 | 3.2 |
| Manufacture of Electric Distribution and Control Apparatus | 1,585 | 0.9 |
| Manufacture of Communication Equipment | 1,573 | 0.9 |
| Manufacture of Plastic Sheets, Plates, Tubes, and Profiles | 1,541 | 0.9 |
| Hard Coal Mining | 826 | 0.5 |
| **Total** | 91,776 | 51.9 |

**Source:** Türkiye Kalkınma Bankası, Türkiye Ara Malı Dış Ticareti, Ankara, January 2016, p.21.

**Table 4. Türkiye's Energy Mix (%)**

| **Energy Source** | **1990** | **1995** | **2000** | **2005** | **2010** | **2015** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| Natural gas | 6% | 9% | 17% | 27% | 30% | 31% | 27% | 31% |
| Oil | 45% | 47% | 40% | 34% | 30% | 30% | 28% | 27% |
| Coal | 30% | 26% | 30% | 27% | 30% | 27% | 27% | 25% |
| Wind, solar, etc. | 1% | 1% | 1% | 2% | 3% | 5% | 10% | 10% |
| Hydro | 4% | 5% | 3% | 4% | 4% | 4% | 5% | 3% |
| Biofuels and waste | 14% | 12% | 9% | 6% | 4% | 3% | 3% | 3% |

**Source:** IEA, 2023

The analysis conducted so far reveals that energy use in Türkiye is unplanned, beyond public control, excludes people from decision-making mechanisms, grants privileges to the private sector capital, shaped by international organizations' decisions, harmful to ecology, strains the balance of

payments, and dependent on external sources. Within this framework, examining the primary sources of energy provision may hold some clues for transforming this structure.

### 3.4. Unsustainable Energy Sources

Fossil fuel companies worldwide receive annual government subsidies of $400-650 billion USD, with Türkiye's subsidies reaching USD 476 million in 2014 (Sweeney, 2015:23). Coal, fuel oil, and natural gas emit 2.5, 2, and 1.45 units of CO2 per unit of energy obtained, respectively. Natural gas, despite being considered cleaner, still contributes significantly to CO2 emissions and is expensive due to limited availability. Coal, being more readily accessible, emits aerosols with a cooling effect (Gündüz, 2012:118). Türkiye's transition from domestic coal to imported natural gas improved air quality, but natural gas is not significantly different from coal in terms of atmospheric warming.

#### 3.4.1. Nuclear energy

Nuclear power plants have a life of 30-40 years and can be increased up to 60 years with renovation work. At the end of this period, they must be dismantled. Radioactive parts are kept for 30-50 years without being dismantled, and some fission products retain their radioactivity for up to hundreds of thousands of years (Yavuz, 2015:63-64). The nuclear power plant produces radioactive wastes in gaseous, liquid and solid form. Gaseous wastes such as xenon, krypton and iodine are subjected to the separation process and kept in the holding tanks until it loses their radioactivity. Liquid wastes are made solid by separating from the cooling water and stored in special containers (Akın, 2009:190). Solid wastes such as clothes, ventilation filters, floor coverings and other vehicles are kept in special containers at the power plant (Devlet Planlama Teşkilatı, 2001b:9). Conservation of wastes with high levels of radioactivity is costlier and risky, and there is no recycling of waste. Nuclear power plants are considered to be combined with sustainable energy sources, but they do not have a mechanism to balance seasonal and daily fluctuations of sustainable energy resources (Atiyas, Çetin & Gülen, 2012:129). Hydroelectric power plants that do not consume fossil fuels outside of the establishment phase offer a good support mechanism in terms of flexibility. Nuclear power plants are very expensive investments, and they may need to be protected by military forces in terms of security threats (Barlas, 2013:167).

Türkiye discovered 9,129 tons of uranium reserves in 5 different deposits until 1990, but with the change in nuclear power plant technology, high-grade uranium found in Canada and Australia must be used. Production of yellow cake from uranium, uranium dioxide used as fuel and fuel pellets can be carried out at the laboratory level in Türkiye, but there is a risk of polluting the environment with radium, which is water-soluble and is found with uranium (Devlet Planlama Teşkilatı, 2001c:1-2).

Law No. 5710 on the Establishment and Operation of Nuclear Power Plants and the Sale of Energy was enacted in 2007 to achieve the nuclear target. The Ministry of Environment and Urbanization approved the Environment Assessment Report for the Akkuyu power plant to be established by the Russian company Atomenergoproekt at the end of 2014 (EÜAŞ, 2015). The foundations of the power plant to be established in Sinop were laid in 2016 and investment has begun. If Akkuyu and Sinop nuclear power plants come into operation, they will meet around 10% of the country's electricity needs.

EÜA will hold 30% to 49% shares of this power plant. The Akkuyu project, with a 15-year purchase guarantee, has a weighted average price of 12.35 cents per 1 kWh and an additional provision that allows the investing company to increase the price to 15.33 cents per 1 kW/h (Atiyas, Çetin & Gülen, 2012:151). However, the law enacted in 2007 contains many uncertainties, such as the absence of details on issues such as the occurrence of a nuclear accident, the management of waste and the

protection of the environment by dismantling the power plant when it expires. Debates continue as to whether Akkuyu is a suitable site for the power plant, and the most important among the problems is the inadequate security regulations. Türkiye has not fully developed its institutional structure for the use of nuclear technology, and in 2017, all nuclear power plants are operated by utilizing the energy generated by fission.

### 3.4.2. Oil

Türkiye, which has few known oil resources, has been importing this type of energy for decades. Turkish Petroleum International Company (TPAO) carries out oil exploration and production activities in countries such as Kazakhstan, Azerbaijan, Turkmenistan, Algeria, Libya and Iraq jointly with international companies. Changes in its prices from year to year reveal that oil is an unstable cost element. Türkiye's production and reserves are not at a level to meet its energy needs, and there are no Turkish companies that can be effective in oil in the world market.

Petroleum is a product that needs to be processed in refineries after it is extracted, and the distribution of refined petroleum products is carried out by nearly 100 private sector establishments, mostly domestic ones. The oil industry in Türkiye is highly capital-intensive, with some job opportunities in the exploration and production sector but high capital-intensive production in the refining and distribution sector. Privatizations of TÜPRA and PETKM were carried out during the 9th FYDP period, and 4 billion m3 of BOTA was transferred to the private sector. In terms of the use of petroleum energy, Türkiye is foreign-dependent but has an integrated market and technology. Benefiting from ecologically highly polluting petroleum in the production of chemical products, in scientific studies and industry is of key importance for development, but using it as an energy source can lead to the problem of 'undevelopment'.

### 3.4.3. Lignite

Obtaining energy from mines requires minimizing environmental problems, and that lignite is a resource containing high levels of ash and sulfur (Bilgen et al., 2015:231). The quality of lignite resources in Türkiye is low, with 0.84% of the total reserve being higher than 4,000 Kcal/kg, 5.16% in the range of 3.001-4,000 Kcal/kg, 24.5% in the range of 2.001-3,000 Kcal/kg, 66.32% in the range of 1.000-2.000 Kcal / kg, and 3.18% of it giving less than 1.000 Kcal / kg of heat (Devlet Planlama Teşkilatı, 2009:41). In 2006, TK and EÜA produced 92% of the total lignite production, while the remaining lignite was produced by a large number of private mining companies, usually small-scale. In 2006, 21% of Türkiye's electricity production was realized with the lignite produced by TK alone (Devlet Planlama Teşkilatı, 2009:52-54). None of the electricity produced by the private sector with coal and lignite was based on domestic resources (Devlet Planlama Teşkilatı, 2009:122).

In the MENR 2015-2019 Action Plan, it is envisaged that the lignite potential will be used for electricity generation and an annual increase in installed power between 25% and 35%. Public resources are being tried to be put into operation by making agreements with Qatar, South Korean and Chinese companies, but no agreement has been reached yet (TMMOB Makina Mühendisleri Odası, 2015:15). Lignite is much more polluting than natural gas and is not a viable option for sustainable development.

### 3.4.4. Hard Coal

The energy obtained from hard coal is used in electricity production, the iron and steel industry, the cement sector, heating areas, alumina refineries, paper, chemical and pharmaceutical factories (Devlet Planlama Teşkilatı, 2009:8). Hard coal and lignite power plants are plants that do not have high investment costs and can generally operate with domestic resources. However, they need control units and large transport systems for the transport of the extracted natural resource (Orta Karadeniz Kalkınma

Ajansı, 2011:42). Coal mines may need to be operated everywhere, from agricultural and forest lands to industrial and residential areas. Studies such as drilling, welling, splitting or geochemical sampling during exploration activities cause negligible damage to the environment (Devlet Planlama Teşkilatı, 2009:85).

**Table 5.** Coal Production and Dependency on Imports

| Years | Production (ton) | Export (ton) | Import (ton) | Total Amount | Dependency on Imports (%) |
|---|---|---|---|---|---|
| **1980** | 3,500,000 | 0 | 100,000 | 3,600,000 | 2.78 |
| **1985** | 3,500,000 | 0 | 3,000,000 | 6,500,000 | 46.15 |
| **1990** | 2,750,000 | 0 | 5,000,000 | 7,750,000 | 64.52 |
| **1995** | 2,250,000 | 0 | 6,000,000 | 8,250,000 | 72.73 |
| **2000** | 2,394,246 | 0 | 14,000,000 | 16,394,246 | 85.40 |
| **2005** | 2,177,201 | 0 | 17,000,000 | 19,177,201 | 88.65 |
| **2010** | 2,591,918 | 0 | 22,000,000 | 24,591,918 | 89.46 |
| **2012** | 2,292,255 | 0 | 29,195,000 | 31,487,255 | 92.72 |
| **2015** | 2,074,049 | 0 | 34,000,000 | 36,074,049 | 94.25 |

**Sources:** For production data from 1995 and before TKİ, Coal Sector Report (Linnite), from 2000 and later TTK, Hard Coal Sector Report, 2015 data from MENR's World and Our Country Energy and Natural Resources Outlook. TKİ's Coal Sector Report (Linyite) was used for import data, and TTK's Hard Coal Sector Report (2015) was used for 2012 and 2015 data.

If the mine is operated as an open pit, the fertile topsoil is lost, the surface waters are polluted, dust, noise and vibrations are dispersed to the residential areas, the natural structure of the land deteriorates, the productivity of nearby agricultural lands decreases, and sea pollution can be caused (Devlet Planlama Teşkilatı, 2009:86).

Türkiye subsidizes coking production for domestic coal and iron-steel industry, and coal is a cleaner and higher energy resource than lignite (Devlet Planlana Teşkilatı, 1991:55). However, there is a limited amount of hard coal resources in Türkiye, and industrial enterprises using this resource meet their needs through imports. Hard coal remains dirty and expensive and is not a preferable resource for ecological development.

### 3.4.5. Natural gas

The number of natural gas power plants in Türkiye has increased rapidly, with electricity generation with natural gas and LNG reaching 48% in 2014. These power plants have lower investment costs compared to other power plants, can be operated with an efficiency between 35% and 42% in a single-cycle system and between 52% and 60% in a combined-cycle system, and can be installed in a short time (Şevik, 2015:573-583). Additionally, natural gas causes fewer emissions compared to coal and oil, leading to its use more with the Jevons effect.

Similar to EU energy regulations, Türkiye has likewise liberalised the energy market, however, this hasn't made the issue of energy generation and distribution tolerable for the environment and society. Oil and natural gas exploration and production activities continue in Türkiye, but the discharge of brine separated in these activities poses a problem for the environment.

**Table 6. Natural Gas Production and Foreign Dependency in Türkiye**

| Year | Production (million m3) | Export (million m3) | Import (million m3) | Total Supply (million m3) | Dependency on Imports (%) |
|---|---|---|---|---|---|
| **1980** | 23 | 0 | 0 | 23 | 0 |
| **1990** | 212 | 0 | 3,356 | 3,568 | 94.06 |
| **2000** | 639 | 0 | 14,986 | 15,625 | 95.91 |
| **2010** | 726 | 649 | 38,036 | 38,113 | 99.80 |
| **2015** | 399 | - | 48,427 | 48,826 | 99.18 |

**Sources:** 1980 & 1990 data for production from 7th National Environment Action Plan, Air Pollution from the Energy Sector, 1995 data from World Energy Council Turkish National Committee, Primary Energy Sources Production (http://www.dektmk. org.tr/incele.php?id=MTQ3), 2000 data is from PIGM, Oil and Natural Gas Production by Years, 2010 data is from TPAO, 2012 Crude Oil and Natural Gas Sector Report, 2015 data is from Taken from MENR's World and Country Energy and Natural Resources Outlook. For export data, the World Energy Council Turkish National Committee for the years 1980-200, Türkiye Energy Balance Tables (http://www.dektmk.org.tr/incele.php?id=MTQ3), 2010 and later EMRA, Natural Gas Market Taken from the Industry Report. For the import data, the World Energy Council Turkish National Committee for the years 1980 & 2000, Türkiye Energy Balance Tables, 2010 and later EMRA, Natural Gas Market Sector Report.

Türkiye imports natural gas mainly from Russia, Algeria, Nigeria and Iran. Imported natural gas does not have a transformative effect on development in Türkiye, as it prevents capital accumulation and is not a clean source. It also contributes to increasing the CO2 emission levels.

### 3.4.6. Hydroelectricity

Hydroelectric capacity in Türkiye increased from 2.13 GW in 1980 (UCTE, 2006) to 31,49 GW in 2021 (Statista, 2023). Hydroelectric power plants (HEPPs) are used for sustainable energy production, but they are not always sustainable (Perelman, 1976:15). The life span of HEPPs varies between 50 and 500 years, and the investment amount, environmental impact and lifetime must be carefully calculated (Devlet Planlama Teşkilatı, 2001b:4-25). Integrated watershed management should be applied for HEPPs, and plants should not be handled individually. Unfortunately, current hydroelectricity plants and plans are not designed in this way (WWF, 2013:3-4). According to WWF, Türkiye should be handled with care due to its population of 100 million in 2030 and the possibility of 1,100 m3 of water per person per year (WWF, 2013:13-15). HEPPs do not cause greenhouse gas emissions, and the electrical energy they transfer to the system can be rapidly increased or decreased.

Controlling water also provides benefits in terms of irrigation and flood control. Unit electrical energy costs are low in well-planned power plants that can be operated close to their capacity. Hydroelectric power plants (HEPPs) are a type of power plant that can have negative side effects, such as disruption of the natural flow of water and the need to measure the flow rates for a long time. Additionally, the initial investment costs of these power plants are quite high (Orta Karadeniz Kalkınma Ajansı, 2011:40). Pumped hydroelectric power plants allow the establishment of a hybrid power plant with solar and wind energies. Unfortunately, they are not well-supported in Turkey, and the potential is as low as 0.8% at the maximum of the total energy needed (Melikoğlu, 2017:147-151).

## 3.5. Sustainable Energy Sources

### 3.5.1. Geothermal

Geothermal energy is beneficial for the environment, emitting very low levels of CO2, NOx and SOx in electricity production. It can be used in the heating of buildings, providing hot water, integrated heating of residential areas, greenhouses, tropical plant fish farming, animal farms, soil, street, other ground and airport runways, swimming pools, thermal treatment centres and other touristic facilities. And also it can be used for drying, sterilizing, canning food, lumbering and wood coating, weaving and

dyeing, drying and processing of leather. fermentation and distillation industries, cooling facilities, the drying of concrete blocks, and laundries (Devlet Planlama Teşkilatı, 1996).

The cost distribution of a geothermal heating system is approximately as follows: 60% pipeline network (transmission and distribution), 15% production and reinjection wells, 15% building adaptation, 5% heat centre installation, 5% project and engineering (Devlet Planlama Teşkilatı, 2009:252). In the investments to be made to generate electricity from geothermal energy, 40% of the total expenditure is allocated to field research studies and production and reinjection wells Geothermal reservoirs are predominantly water-based or steam-dominated in nature (Devlet Planlama Teşkilatı, 2009:255).

Low enthalpy fluids with temperatures between 20°C and 70°C are referred to as low enthalpy, and medium enthalpy fluids with temperatures between 70°C and 150°C are referred to as medium enthalpy. Electricity can be produced from medium and high enthalpy fluids, and low and medium enthalpy fluids can be used for heating. Geothermal energy resources are very safe and economically efficient and can be used continuously, regardless of weather conditions (Devlet Planlama Teşkilatı, 1996:5-7).

However, the investment risk is high due to the long construction period, high initial investment cost and uncertainties in the geothermal reservoir (Şener and Uluca, 2009:326). The creation of insurance opportunities with favourable conditions for geothermal investments, as well as the options of conducting exploration by the public, should be brought to the agenda.

More than 200 geothermal reservoirs have been identified in Türkiye, and 95% of the fields are suitable for heating (Haklıdır, 2015:115). The cost of the geothermal heating facility in İzmir-Kızılcahamam is between 1/3 and 1/4 of the natural gas cost. The investment cost of a geothermal heating system per 100 m2 residence in Türkiye varies between 1,500 and 2,500 USD (Devlet Planlama Teşkilatı, 2001d:60). Following the enactment of the Geothermal and Natural Minerals Law in 2007, investments in this resource increased. Geothermal power plants in Türkiye are established by privately owned energy companies.

### 3.5.2. Wind

Wind farms are an important energy source due to their zero greenhouse gas emission and low fuel costs. However, they can be damaged in extremely windy weather, cause bird deaths, disrupt electromagnetic waves, and cause a decrease in the prices of real estate in the surrounding area (Coşkun and Türker, 2012:1269). There are some places where large wind power plants cannot be installed, such as regions with an altitude of more than 1,500 meters and a slope of more than 20%, residential areas, regions where roads, railways and airports are located, regions with wetlands and qualified forest areas, conservation areas (Orta Karadeniz Kalkınma Ajansı, 2011:59).

**Table 7. Installed Wind Power (GW) in Türkiye**

| Years | Capacity (GW) |
|---|---|
| 2010 | 1,320 |
| 2015 | 4,503 |
| 2020 | 8,832 |
| 2021 | 10,607 |

**Source:** Statista, https://www.statista.com/statistics/421847/wind-power-capacity-in-Türkiye/, Access date: 18.06.2023.

According to the relevant regulation issued in 2010, tendering mechanism is held for the installation of wind power plants in Türkiye. If the rapid production increase in wind energy could be

avoided from the effects of capitalist relations, public R&D studies could be organized for the recycling of turbines, and the transmission system is made suitable for wind energy; wind would be an important sustainable energy source for Türkiye.

### 3.5.3. Biomass

Biomass is the energy obtained from living or dead biological materials, such as plants and animal wastes. It is renewable, has a high calorific value, has close to zero carbon dioxide effect, can be found everywhere, has low sulfur, nitrogen and ash content, and its input is cheap. However, it is low in density, has a high moisture content, has high transportation costs, can lead to deforestation, and has a low thermal content. It is one of the costliest energy resources. Biomass energy production cost is decreasing globally (Bilgen et al., 2015:229).

The efficiency of furnaces, thermal gasification, and heat-power plants are all methods of obtaining bioenergy in Türkiye. The sources of biomass energy in Türkiye include wheat residues, woody materials, nutshell, grain dust, harvest residues, and fruit tree residues (Bilgen et al., 2015:231). Bioethanol is obtained by fermentation of sugar cane, sugar beet, corn, potatoes, and plants containing sugar starch or cellulose, while biodiesel is obtained from oily plants such as rapeseed, sunflower, soybean, safflower, flax, jatropha, and jojoba. 90-100 companies are operating in the sector, but some firms produce without a license, some offer products from expensive imported plants, and some do not pay taxes (Atiyas, Çetin & Gülen, 2012:133). The regulation need is obvious in the sector.

Biodiesel production from the soil is debatable in Türkiye, which has an increasing population and an agricultural structure dependent on imports for food. Energy forestry has many advantages over fossil fuels, such as being local and sustainable. It does not cause an increase in CO2 when operated at a sustainable level and does not cause environmental pollution as much as fossil fuels when burned. It also supports rural employment and can enable the creation of new forest areas. Studies for biogas production through energy forestry started in 1957, but government support was discontinued in 1987 (Çukurçayır and Sağır, 2008:272).

Biogas plants with a capacity of 1,200 kW/hr cost $3,500,000 and return on investment varies between 3-5 years. Facilities with a capacity of at least 500 kW/hour are recommended for farms with 1,000 cattle, 3,000 ovines, or 70,000 poultry (Orta Karadeniz Kalkınma Ajansı, 2011:113). Bioenergy can support energy security, climate change, and poverty problems, but it is not as practical as geothermal energy in terms of cost, technical difficulties, and awareness of its users. Additionally, soil impoverishment or death is a problem with biological energy sources, so integrated systems and ecology knowledge are needed.

### 3.5.4. Solar

The southern regions of Türkiye are suitable for generating electricity from solar power plants, while the northern regions are suitable for photovoltaic panels. A report shows the comparison of Antalya from the south, Samsun from the north, and Munich, in terms of photovoltaic solar panel usage, and the payback period is shorter in Türkiye than in Germany (Orta Karadeniz Kalkınma Ajansı, 2011.). This is due to the longer duration of sunshine in Türkiye, which has a high potential to generate electricity and heat from solar energy (Barlas, 2013:173).

Türkiye can direct its subsidies to fuels such as coal and lignite to solar energy. Because although it is a type of energy that gets cheaper day by day, its unit cost is still high when compared to other sustainable energies.

**Table 8. Solar Energy Production & Capacity in Türkiye (Thousand TOE)**

| Years | Production (Thousand TOE) | Photovoltaic | Thermal | Capacity (GW) |
|---|---|---|---|---|
| 1980 | 0 | 0 | 0 | - |
| 1990 | 21 | 0 | 21 | - |
| 2000 | 262 | 0 | 262 | - |
| 2005 | 384 | 0 | 384 | - |
| 2010 | 432 | 0 | 432 | 6 |
| 2015 | 844 | 16 | 827 | 250 |
| 2021 | - | - | - | 7,817 |

**Sources:** 1980 data from 5. FYDP, 1985-1995-2000 data from World Energy Council Turkish National Committee, Primary Energy Resources Production (http://www.dektmk.org.tr/incele.php?id=MTQ3), 1990 data from the 7th National Environmental Action Plan, Air Pollution from the Energy Sector, all remaining years from Eurostat. For capacity: https://www.statista.com/statistics/878791/solar-energy-capacity-in-Türkiye/, 18.06.2023.

### 3.5.5. Marine

The energy obtained from the sea is still quite foreign to Türkiye. Tidal energy is a type of energy that can be used in countries with a coast to the ocean. This energy uses the differences in sea temperature and also does not have the opportunity to be used in Türkiye. However, it seems possible to obtain energy from the currents in the Istanbul and Çanakkale Straits (Şen, 2017). Studies are showing that the wave energy potential is high, especially in the regions between İzmir and Antalya (Sağlam and Uyar, 2005).

### 3.5.6. Hydrogen

Hydrogen is a type of energy that can be used in many fields, is cheap to transport, does not leave any polluting gas and waste to the environment, and is only pure water when burned. It is mostly used to store energy from other sustainable or unsustainable forms of energy, either as a gas or liquid or as a hydrogen fuel cell. The first hydrogen energy production in Türkiye was established in Bozcaada in 2011 with a loan of 1,500,000 USD from the World Bank Industrial Development Organization (UNIDO) and a 55 KW fuel cell with the energy obtained from the wind and solar power plants on the island. However, it is expensive to store hydrogen in large tanks with special materials. From a developmental, ecological, and economic perspective, more research is needed to use hydrogen sources directly.

## 3.6. Market

Companies can have collaborations and partnerships with private companies and foreign state enterprises abroad. For example, ENKA Enerji A.Ş., the largest electricity producer after EÜAŞ, cooperates with General Electric on issues such as the infrastructure of its power plants and carbon reduction (Enkapower, 2016).

Ayen Energy invests in wind and hydroelectric power generation plants. For example, it has obtained a 49-year license from EMRA for the 31.5 MW RES in Aydın-Akbük. In 2007, it was able to obtain a EUR 36,337,490 exim loan with a maturity of 15 years and a commercial loan of EUR 5,104,500 with a maturity of 8 years from Commerzbank (Eti Menkul Kıymetler, 2008:48).

In the Turkish energy sector, there are generally French, German and Canadian companies as foreign capital. French EdF owns wind farms of over 500 MW in Türkiye and is a 45% shareholder of

Polat Enerji. The company mostly prefers Türkiye for HEPP and sustainable energy production (Balkan Energy, 2016). However, in 2011 it was interested in nuclear power plant investment in Türkiye. Due to Ankara's desire for the French government to change its EU membership stance on Türkiye, there was a political disagreement. As a result, the company abandoned this initiative (Sönmez, 2011).

Another French company in Türkiye, GDF SUEZ (ENGIE) owns Izgaz, Türkiye's 3rd largest gas distributor. The company is licensed to import and trade natural gas, has two natural gas power plants in Türkiye, and owns 95% of Baymina Energy, which produces turbines, generators etc. The company has been in Türkiye for nearly 40 years for energy investments except for sustainable energy. Together with Japanese ENGIE-Itochu, of which the company is a partner, Japanese Mitsubishi is constructing the 22 billion USD worth of Sinop Nuclear Power Plant (Gazete Vatan, 2016).

German company E.ON, which owns 50% of Enerjisa, Türkiye's 3rd largest electric power producer after EÜAŞ and ENKA, holds natural gas import and trade licenses. It aims to produce 10% of Türkiye's electricity in the medium term (Enerjisa, 2017).

Another German company, RWE, has licenses to import and trade natural gas. It operates a natural gas combined cycle power plant with a capacity of 775 MW in Denizli, in which it is a partner with Turcas. It also deals in energy wholesale and engineering works. The German company EnBW, which owns many power plants in Türkiye, mainly wind energy, also has a joint energy company with Borusan.

CEZ, 70% of which is owned by the Czech State, has investments in nuclear and coal energy in the world. In Türkiye, it has a total of 7 HEPPs in the Mediterranean and Southeastern Anatolia regions. It also owns 37.36% of Akenerji. In 2006, Akenerji started to sell off its enterprises, whose capacity was below 10 MW, because efficiency could not be achieved (Eti Menkul Kıymetler, 2008:46-47).

One of the Canadian companies, PSP Investment owns 45% of Polat Energy. This company is a government agency that provides financing to various industries. Although it is autonomous, it is a very transparent company that works by the law enacted for it.

MWH Global is a very old British company. However, it was acquired by the Canadian company Stantec in 2016. This company, which provides consultancy and financial services in the energy, finance and trade sectors, provides resources for financing projects related to environment and energy investments in Türkiye.

Another Canadian company, Valeura Energy, is engaged in the extraction of oil, shale gas and natural gas in Türkiye. It extracts shale gas and natural gas from the Thrace region, and oil from the Southeastern Anatolia Region.

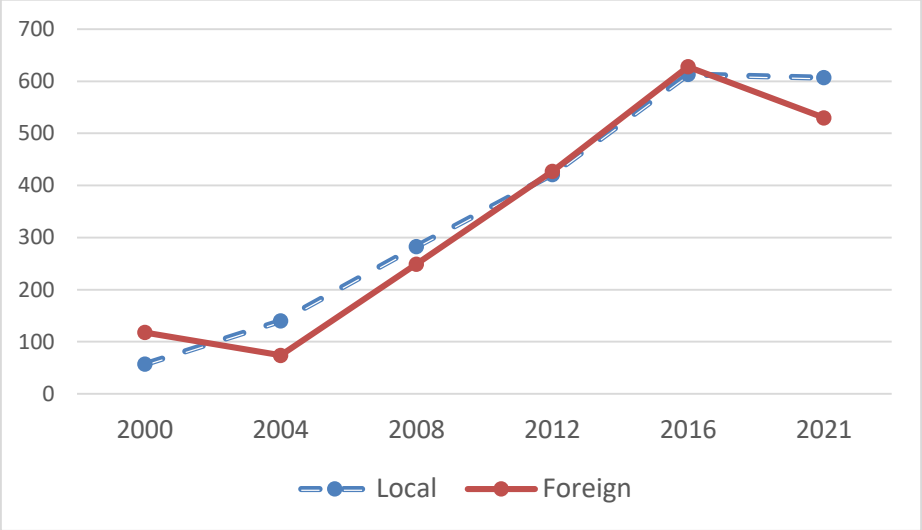
The energy sector in Türkiye is quite open to foreign influences as an extension of the general economic structure. Recently, a practice that reinforces its openness to this effect is that the Energy Union, which was established by the European Union (EU) in 2006 to expand its domestic energy market towards Southeast Europe, is of close interest to Türkiye. Along with EU member states, non-member countries, especially in the Black Sea and the Balkans, are included in the union. Türkiye, Norway and Armenia have observer status. Georgia, on the other hand, is not a member of the EU but is a candidate to become a member of this union. However, the Energy Union works to include all these countries, including observers, in a common energy market. Therefore, the privileges granted to foreign capital against privatization and public investments in the energy sector in Türkiye can be considered as an infrastructure preparation for future entry into this union.

### 3.7. R&D and Technology

A model investigating how the use of renewable energy in Türkiye affects economic growth explains that there is a positive interaction between renewable energy and economic growth. However, the methods of capturing and storing carbon by various methods are not very promising in terms of energy efficiency. Carbon markets have been established to respond to this need, but they are only voluntary projects. Studies show that Türkiye's geothermal power plants cause as many greenhouse gas emissions as fossil fuel power plants (Hirtenstein, 2016).

The technology change, the decrease in costs and the increase in productivity do not make an inclusive sense for the development of countries such as Türkiye. Profitability arises from high pricing and is based on the provision of public resources and natural values to companies free of charge or at low prices (Ataay, 2003). Barry Commoner advocated that energy efficiency should be measured based on localities, not on the scale of equipment (Tanuro, 2011:66). This view is suitable for ecological economics and is based on the use of the energy potentials of the economic units that will consume energy in their regions. In Türkiye, energy investments are mostly carried out by the private sector, mostly with large capital groups and foreign capital partnerships.

**Chart 1. Number of Patent Registrations Related to the Energy Sector in Türkiye**




**Source:** https://www.turkpatent.gov.tr/patent-istatistik; Access date: 16.06.2023.

Domestic capital energy companies in Türkiye have an increasing capacity to produce technology: However, it is rare for them to carry out R&D studies in a market managed by foreign capital and where the public is increasingly withdrawing from energy production. Large-capital domestic energy companies cooperate with large foreign-capital companies, leading to the import of high technology for profitability and efficiency.

### 3.8. Financial Structure

Especially after 2008, the German Investment Bank, World Bank, European Investment Bank, French Development Agency, Japanese International Cooperation and International Finance Association (JBIC) increased their financial support to the renewable energy market in Türkiye (Atiyas, Çetin & Gülen, 2012:124). Table 9 shows the loans Türkiye received between 2008 and 2014 for efficiency projects, sustainable energies, natural gas and hydroelectric power plants.

**Table 9. International Energy Loans to Türkiye between 2007-2022 (million USD)**

| Institution | Fossil | Clean | Other | Total |
|---|---|---|---|---|
| Asian Infrastructure Investment Bank | 600 | 600 | 201 | 1,401 |
| China Development Bank | 1,400 | 0 | 0 | 1,400 |
| Euler Hermes (Germany) | 9 | 0 | 0 | 9 |
| European Bank for Reconstruction and Development | 727 | 4,176 | 2,351 | 7,254 |
| European Investment Bank | 743 | 452 | 2,006 | 3,201 |
| Export Development Canada | 156 | 0 | 78 | 234 |
| Export-Import Bank of Korea | 90 | 0 | 0 | 90 |
| Export-Import Bank of the United States | 641 | 0 | 0 | 641 |
| German Investment & Development Corporation | 25 | 0 | 0 | 25 |
| International Bank for Reconstruction and Development (WB Group) | 1,480 | 1,965 | 2,008 | 5,453 |
| International Finance Corporation (WB Group) | 485 | 1,156 | 813 | 2,454 |
| Islamic Development Bank | 25 | 200 | 190 | 415 |
| Japan Bank for International Co-operation | 291 | 502 | 570 | 1,363 |
| KfW IPEX-Bank (Germany) | 53 | 173 | 0 | 226 |
| Korea Development Bank | 180 | 0 | 0 | 180 |
| Korea Trade Insurance Corporation | 890 | 0 | 0 | 890 |
| Kreditanstalt fur Wiederaufbau (Germany) | 192 | 110 | 28 | 330 |
| Overseas Private Investment Corporation (U.S.) | 0 | 60 | 250 | 310 |
| Proparco (France) | 0 | 296 | 0 | 296 |
| UK Export Finance | 30 | 0 | 0 | 30 |
| **TOTAL** | **8,017** | **9,690** | **8,495** | **26,202** |

**Source:** Oil Change International, https://energyfinance.org/#/data, 18.06.2023

In addition to the current relations and dependence on the financial structure, the grants received from the fund established by the World Bank to monitor the carbon markets regarding global climate change are also important. This support, which has been in existence since 2012, was provided to Türkiye in 2013 in the amount of 3 million USD. With this support, it is aimed to ensure the legal and institutional operability of carbon markets in Türkiye. Thus, Türkiye's carbon markets will have adapted to the carbon buying and selling mechanism that is being created on a global scale (T.C. Çevre ve Şehircilik Bakanlığı, 2017).

A study comparing the financial structures of companies in the European energy sector and energy companies in Türkiye finds that European companies have higher short-term solvency, according to ratio analysis. Companies in both Europe and Türkiye produce with debt rather than equity, however, European companies' long-term borrowings are higher than their short-term debts, and the opposite is true in Türkiye. When the turnover ratios are examined, European companies use their resources more effectively. The profitability ratios of companies in Türkiye fluctuate more than those in Europe (İskenderoğlu, Karadeniz & Ayyıldız, 2015:95-96).

## 3.9. Labour

The energy sector is considered to be a "capital-intensive" sector, and as it has been so far, its ability to create jobs on its own is limited. However, despite its "capital-intensive" structure, it is one of the most important sectors that indirectly creates employment because it produces one of the basic inputs of other sectors (Atiyas, Çetin & Gülen, 2012:133).

### 3.9.1. Characteristics of the Workforce

Whether in crisis or not, the capitalist production-distribution system is incapable of keeping employment at high levels over the long run. Newly created jobs also tend to be temporary, low-paid, part-time and insecure.

**Table 10. Average Yearly Wages* in the Renewable Energy Sector (USD)**

| UK - The Poverty Threshold for a Family of 4 in 2019 (census.gov) | Advanced Economies – Average Wage of Solar and Wind Industries in 2019 (IEA) | Türkiye - The Poverty Threshold for a Family of 4 in 2023 (DISK) | Türkiye - Average Wage of Solar and Wind Engineers Industries in 2023 (Salaryexplorer) |
|---|---|---|---|
| 25,926 | 30,142 | 20,561 | 4,412 |

**Sources:** IEA (2019), US Census Bureau (2023), Revolutionary Trade Union Confederation (2023), Salaryexplorer (2023).
*Average wages in the table were calculated by the author of this study, using the aforementioned sources.

The fact that the wages of the labour force in the renewable energy sector are below the poverty threshold in Türkiye shows that the workers cannot adequately meet their basic needs. Access to basic needs is an income problem in the capitalist production-distribution system. However, at the same time, when considered independently of prices, it is the inability to reach goods and services at a level that will eliminate poverty within the cycle of the economic system. Goods and services are obtained by passing energy from one form to another. The production and delivery of goods and services to consumers is essentially the distribution of energy flow. On the other hand, the use values of products cannot be evaluated only with energy flows, there is also an ecological system that ensures the continuity of nature, that is, a qualitative aspect.

In terms of employment in lignite and hard coal quarries, Türkiye is far behind developed countries in productivity per capita. The productivity, which is 5-20 tons/shift in developed countries, is 0.5-2 tons/shift in Türkiye. Only the PARK company in Çayırhan Underground Quarries, whose license is in EÜAŞ, has approached the level of companies in developed countries. Deficiencies in geographical structure and technical sense, as well as in organizational sense, create this difference in efficiency (Devlet Planlama Teşkilatı, 2009:77).

In the 8th FYDP prepared in 2001, it is determined that the qualified workforce who retired or left TKİ could not be replaced during the past 15 years, and as a result, the financial burdens increased (Devlet Planlama Teşkilatı, 2001a:107-108). Therefore, with the privatization policies that started in the mid-1980s, a loss of qualification in the workforce in public institutions in the energy sector began to occur. Since the energy sector is a capital-intensive sector, the preference of the private sector for workers is in favour of unqualified and low-paid workers. The higher-tech energy sector, along with the minority administrative and technical personnel; it turns into a sector that mostly benefits from the labour force of unemployed agricultural workers.

### 3.9.2. Organization

Unless people become the focus of development, they cannot go beyond being an economic unit that implements the decisions taken by experts. This global situation does not allow organizations to go

beyond taking measures that respond to the capitalist production-distribution needs. Therefore, developing countries can only develop as much as the system allows. The nature of development becomes a state where natural resources and labour are rapidly depleted and transferred to developed countries instead of permanent and sustainable development, and the problems of the country are not resolved permanently. For all these reasons, the main problem in development in Türkiye is that the practices under the name of development policies are not people-oriented; It is focused on the growth of goods and services.

In these countries, whose population is increasing rapidly, it is criticized that employment cannot be created due to a lack of capital. However, since capital is a phenomenon that grows with human labour, it is obvious that developing countries need to develop the qualities of their people to create their capital (Schumacher, 2010:132). Thus, while employment will no longer be a problem, the most important step for development will be taken.

The most important organization in the development of a country's human resources is the workers' organization. With the 1980 military intervention in Türkiye, the effectiveness of workers' organizations was eliminated. With the privatizations in the energy sector after 1990, the union and collective bargaining rights of the workforce began to erode. Especially the privatization of public energy companies has accelerated this process. The weakness of the unions, their depoliticization from politics and the depoliticization of the whole society have led to the failure of internal democracies and uncontrolled capital dominance.

The liberal trend, which entered the country's agenda strongly in the 1990s, brought its contradictions with it. While investments that require large capital ensure the growth of the country, environmental problems and financial crises have begun to show themselves. The public also had the opportunity to make their voices heard in this liberal environment. For example, the protests of the people in İzmir in 1994 prevented the establishment of a thermal power plant in Aliağa. However, these protests were made for environmental purposes, lacking knowledge of ecology, as stated before. Participation in these protests is very low compared to the working population in the country, and in most investments with great environmental damage, such protests did not receive participation and support throughout the country.

The existence of coal-fired power plants not only creates health problems but also pollutes the resources of the agriculture, tourism and fisheries sectors. There are still reactions from those working in the tourism sector against the existing power plants in Aliağa and those planned to be established. The power plant wastes are left in the forests in Foça. This situation eliminates the natural areas that allow tourism. While the public approached the establishment of a mine positively because it would create employment in Amasra, there was a negative reaction to the plans for the establishment of a thermal power plant. In Soma, on the other hand, the opposite is the case. Power plants associated with the factory and better working conditions are more in demand than unsafe conditions in the mine (Ekoiq, 2017).

In summary, until the awareness of the employees, their demand for democratic rights, their organization capability, their interest in environmental and ecological information and their desire to learn increase, the working class in Türkiye do not perceive the signals for change sent by the system.

## 4. Conclusion and Recommendations

First of all, nature conservation and the methods of relating to nature in Türkiye are generally discussed in the context of environmentalism. Conserving nature with ecological sensitivities and

necessities and establishing a relationship with nature is almost nonexistent, except for a few resistances. It is striking that this approach dominates in nature conservation actions.

Environmental actions in Türkiye always have the potential to turn into political ground. Behind the transformation of simple actions to protect the environment lies the fact that the development policies implemented in Türkiye cannot be decided by anyone other than the central government. From this point of view, it is possible to say that environmental actions in Türkiye inadvertently turn to a political attitude and that the root of environmental problems is not only the damage to nature.

Citizens prioritize improving their economic situation before obtaining their democratic rights. As a result of both trying to determine development policies within the free market and keeping the income of citizens above everything else, the relationship with nature turns into a relationship of exploitation. In short, there is a self-sustaining circle of failure - political pressure - economic inadequacy - overuse and consumption of natural resources. This circle is mostly reflected in academic studies and forms the framework of studies.

The energy production-consumption structure changes depending on the economic production-distribution system. It is related to the avoidance of lowering the use of fossil fuels by stating the development problem that energy production systems in Türkiye are typically reliant on fossil fuels, and this trend is expanding over time. It is not possible to reduce the increase in the use of fossil fuels in Türkiye with international agreements, because the problem of consuming fossil fuels in Türkiye is not only related to global climate change. In addition to its impact on global climate change, the use of fossil fuels deprives future generations of their right to use fossil fuels, fossil fuel mines and wells pollute the environment. The dependency on imported coal or natural gas, which is essential for quality and high efficiency, increases and negatively contributes to the foreign exchange problem. Fossil fuels obtained by burning not only pollute the atmosphere. In addition, atmospheric, water and soil pollution directly affects public health. As a result, the energy sector in Türkiye does not have a sustainable structure.

Existing 'development' policies that harm individual and social health in the short term and completely stop economic functioning in the long term need to be changed as soon as possible. It is a basic need to abandon the economic policies pursued by developed countries, to stay away from the guidance of international organizations and 'deregulation' and loans given for large power generation plants. To do this, energy inputs must be made local and sustainable. Therefore, the energy sector offers opportunities to be considered for the transition to an independent economic policy. However, when such an independent economic policy is not pursued, this sector has the potential to deepen its dependency and continue to increase environmental problems.

From this point of view, to prevent ecological problems in Türkiye, I propose the following recommendations:

<u>Legal and institutional recommendations:</u>

- Both natural values and labour must be included in the calculations of output and inputs. New calculation methods are needed for the accurate calculation of costs.
- To keep environmental data together, an energy-environment data bank should be established, as well as ecology monitoring units that collect and compile continuous nature-related reports from local observers and experts.
- No tax should be levied on ecologically sustainable energy types, except central power plants. The people should be encouraged to produce their energy; All obstacles to this transformation must be removed.

- Promoting a high-growth renewable energy sector first requires a comprehensive strategy. Along with tax exemption, there ought to be government-sponsored direct R&D research as well as R&D support, project finance, grants, and cooperative support.

Developmental policy recommendations:

- Planning studies must be started to assess the potential and viability of all sustainable energy sources.
- Investing in energy-intensive sectors, 70% of which are dependent on fossil fuels, such as the steel industry, is not preferable in terms of Türkiye's development and foreign trade balance. Sectors that require intense energy, create pollution and cause foreign exchange expenditure should not be directed without ensuring their sustainability. For existing facilities, maximum downsizing should be achieved as a result of a transition period.
- In the first stage, attention should be paid to the establishment of sustainable energy facilities that do not require advanced technology and should be given priority.
- Participation should be ensured from all segments of society, especially from scientific research institutions, especially from organizations specializing in energy (for example, professional chambers, and unions) in planning studies.
- Local plans must be created before the creation of the national plan; they should be created by local producers, citizens, and scientific institutions.
- The resulting plan's final iteration should be binding and forward-looking rather than conclusive.

Natural resource use:

- Wind, solar and hydroelectricity energy should be combined to obtain electrical energy.
- Geothermal energy is a continuous, very clean and inexpensive source of electricity and heating energies. For the emissions of geothermal plants to be at zero level, they must be subject to continuous inspection by locals, private associations and governmental bodies.
- Solar energy is used in Türkiye for heating energy and it can be used much more.
- Marine energy is one of the cleanest and most sustainable energies. Studies have been carried out on the energy potential that can be obtained from the seas in Türkiye. It is possible to obtain energy throughout the year from the currents in the Bosphorus and the Dardanelles, as well as from the waves formed in the Kalkan offshore and southwest coasts of Türkiye. While evaluating offshore wind potentials, taking advantage of wave and current potentials will facilitate access to local, cheap, clean and sustainable energy. However, while investments in marine energy are being made, it should be ensured that the people living in the region where the energy will be produced are partners in these investments, that they have access to energy without intermediaries or with the least possible intermediary, and that their right to make decisions on the facility is protected.
- Investments in non-renewable energy sources should be channelled into renewable energy investments and financing rapidly, for example, within five years. Instead of building new hydroelectric power plants, which I consider among non-renewable energy sources, expenditures could be continued to meet the 2050 CO2 targets for the protection of the existing capacity, but R&D investments should be made directly by the government and the private sector should be encouraged in this regard to search for alternative solutions to these power plants.

Market, technology and finance:

- Energy efficiency investments in transmission and distribution lines should be made before the new power plant license is granted, and then conversion to production with local sustainable resources should be started.
- After the projects and licencing requirements have been met, the decision to build an energy facility should be filed with the province that will host the project. Voting should take place in a discussion-friendly setting with enough time. Even after the company has started operating, the site should be open to inspections for reporting by professional associations, locals and municipal officials. The public should have access to these reports.
- Utility-scale PV investments have profitable LOCE for electricity generation today. It is essential that R&D studies planned to be carried out in Türkiye focus on this technology and cooperate in public partnership with countries that conduct scientific studies to obtain cheap, sustainable and clean solar energy.
- The fact that the world's energy needs will continue to be met with fossil fuels in the foreseeable future, besides creating difficulties for Türkiye, should be seen as an opportunity and policies should be developed on this. Countries that will make the first transition after countries such as Denmark, where sustainable energy use is widespread, can be pioneers in new energy use technologies. Developing these technologies in Türkiye is not possible only by increasing R&D studies in universities and companies. Sustainability, as a necessity of life, should be placed in the most important position among social culture and acceptance. In addition to informing and educating all the people about local energy production, it should be aimed that the state does the national planning by giving up the central power generation plants to a large extent and eliminating possible conflicts. The transition from the national capitalist structure to a structure where national planning is made and local transformations are continuous should be essential in energy production and distribution.

Labour:

- From an early age, education should be given in touch with nature, and students' education limited to school buildings and areas should be changed.
- There are Alternative Energy Sources Technology associate degree programs in Turkey for the intermediate staff needed for the establishment of facilities operated with sustainable energy sources. They are not in high demand by students. They have to be promoted nationally.
- Programs that train technical intermediate staff specializing in fields such as wind, solar, geothermal and biomass should be opened. Along with these programs, financial support should be given to students studying in associate degree programs such as chemistry, metal, electricity, etc., who are likely to work together in business life, during their studies.
- Statistics on the renewable energy workforce should be healthily collected by Turkish Statistical Institute.
- State-supported policies regulating the labour standards, wages and fringe benefits of people working in renewable energy should be put in place, at least until sector development is complete.

## Author's contribution

*This entire article is the author's own product.*

## Fundings and Acknowledgements

*This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.*

## Competing interests

*There is no conflict of interest in this research.*

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