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ANALYZING PAST, PRESENT AND FUTURE OF WIND ENERGY INVESTMENTS IN NORTHERN İZMİR SUB-REGION

Zeynep ÖKMEN
İzmir Demokrasi Üniversitesi
Mimarlık Fakültesi Şehir ve Bölge Planlama Bl.
İzmir-Türkiye
zynpkmn850@gmail.com

Umut ERDEM*
İzmir Demokrasi Üniversitesi
Mimarlık Fakültesi Şehir ve Bölge Planlama Bl.
İzmir-Türkiye
umut.erdem@deu.edu.tr

Abstract

The increasing industrialization process and policies within capitalist production relations necessitate the creation of policies that ensure the spread of different and relatively less damaging energy types due to the increase in consumed energy. This necessity also changes the welfare of the regions due to energy investments. In this context, the Northern İzmir region is an important sub-region located in İzmir, the third largest metropolis in Türkiye, and is strategically important due to its industrial zones and national and international ports. The region's private industrial and organized industrial zones and industrial areas have historically led to infrastructure investments for energy conversion facilities and fossil fuel-based energy plants. As a continuation of the green energy policies implemented to minimize the global effects of industrialization, policies, and practices for wind energy have been developed in Türkiye. In addition to the technical infrastructure opportunities it contains, the Northern İzmir Region has become an important wind energy production center over time with its high wind potential. In addition, over time, the region has become a center where the wind energy sector not only produces energy through plants but also where technology and equipment production for wind energy production are carried out. By examining satellite images, internet sources, and reports of institutions in the energy sector, this study analyzes the historical background of wind and other types of energy in the Northern region of İzmir and discusses the roles that the region will undertake in energy production in the future. While renewable energy facilities are clustered in the Aliağa and Bergama districts, fossil fuel-based energy production facilities are clustered in the Aliağa district.

Keywords; Energy sector, Wind energy, Northern İzmir Sub-Region, Capital accumulation, Türkiye

Öz

Kapitalist üretim ilişkileri içinde artan sanayileşme süreci ve politikaları, tüketilen enerjideki artış nedeniyle farklı ve nispeten daha az zararlı enerji türlerinin yaygınlaşmasını sağlayacak politikaların oluşturulmasını zorunlu kılmaktadır. Bu zorunluluk enerji yatırımları nedeniyle bölgelerin refahını da değiştirmektedir. Bu bağlamda İzmir Kuzey bölgesi, Türkiye'nin üçüncü büyük metropolü olan İzmir'de yer alan, sanayi bölgeleri ve ulusal ve uluslararası limanları nedeniyle stratejik öneme sahip önemli bir alt bölgedir. Bölgedeki özel sanayi ve organize sanayi bölgeleri ve endüstri alanları, tarihsel olarak enerji dönüşüm tesisleri ve fosil yakıt bazlı enerji santralleri için altyapı yatırımlarına yol açmıştır. Sanayileşmenin küresel etkilerini en aza indirmek için uygulanan yeşil enerji politikalarının devamı olarak Türkiye'de rüzgâr enerjisine yönelik politikalar ve uygulamalar geliştirilmiştir. İzmir Kuzey Bölgesi, içerdiği teknik altyapı olanaklarının yanı sıra yüksek rüzgâr potansiyeli ile zaman içinde önemli bir rüzgâr enerjisi üretim merkezi haline gelmiştir. Ayrıca bölge, zaman içinde rüzgar enerjisi sektörünün sadece santraller aracılığıyla enerji ürettiği değil, aynı zamanda rüzgar enerjisi üretimi için teknoloji ve ekipman üretiminin de yapıldığı bir merkez haline gelmiştir. Bu çalışmada uydu görüntüleri, internet kaynakları ve enerji sektöründeki kurumların raporları incelenerek, İzmir'in Kuzey bölgesindeki rüzgâr ve diğer enerji türlerinin tarihsel geçmişi analiz edilmiş ve bölgenin gelecekte enerji üretiminde üstleneceği roller tartışılmıştır. Yenilenebilir enerji tesisleri Aliağa ve Bergama ilçelerinde kümelenirken, fosil yakıt bazlı enerji üretim tesisleri Aliağa ilçesinde kümelenmiştir.

Anahtar Kelimeler: Enerji sektörü, Rüzgâr enerjisi, Kuzey İzmir alt bölgesi, Sermaye birikimi, Türkiye

* Sorumlu Yazar/ Corresponding author

1. INTRODUCTION

The increased energy consumption with the Industrial Revolution has made the relationship between energy, economy, and industry inseparable. Since energy is important not only for industrialization but also for economic and social life, establishing an energy strategy is very important in establishing policies that protect the country's interests. In recent years, the rapidly increasing population, industrialization and urbanization have increased energy consumption, which has led to the rapid depletion of fossil fuel resources and environmental pollution. These negative effects have played an important role in energy saving, efficient use of existing resources, and prioritization and diversification of renewable energy resources. With these regards, Türkiye's energy policies have also undergone a significant transformation in the post-2000 period. Several strategic steps were taken for energy security. They were aimed at reducing external dependency. While renewable energy investments were being made, wind energy investments were far behind at the beginning of the period.

Energy is a vital resource for developing and developed countries to continue their progress and capital accumulation. Developing countries need to increase their production capacity to accumulate more capital to reach the living standards of developed countries in line with their capital accumulation levels. For these reasons, countries also need to increase their energy production capacity. Besides, as reported by Çetin, Turan, and Bayrakdar (2019), the economic lifespan of fossil energy resources is 114 years for coal, 51 years for natural gas, and 53 years for oil, according to their 2019 reserve status. It would not be wrong to state that these values will decrease even further by 2025. This situation brings to the fore the causality of diversifying energy production sources and making them renewable. With technological revolutions, the energy demand continues to increase continuously, such as the power obtained from living beings (human and animal power), steam power, and electric energy. The main drive of this progress is the production and accumulation speed of capitalism. Energy consumption has expanded with the increase in cities where capitalism and capital density have increased.

This situation has transformed the relationship between economy, industry, and energy into a relation that is inherent to each other and cannot continue without the presence of one of them (Kaygusuz, 2012). Therefore, as capitalism develops in many countries, the need to further increase energy production to meet the exponentially increasing energy consumption arises. Since energy is important for industrialization and economic and social development, it is vital to create an energy strategy based on green energy (Toman and Jemelkova, 2003).

With the development of urban centers and networks, economic concepts such as production, inflation, unemployment, and current account deficit are closely related to the capacity of energy demand and supply (Rickaby, 1991). The unequal distribution of land uses that are intensive energy consumers such as urban areas, industrial areas, and organized industrial zones, and factors such as the depletion of fossil fuel reserves and global warming have brought the sustainability of energy resources to the forefront (Droege, 2011). This means that many developing countries with low capital intensity, including Türkiye, face the challenge of allocating a significant portion of their GDP to purchasing and importing the energy they need for sustaining their development processes (Hannesson, 2009). Industrial facilities heavily depend on intensive energy use due to their production to maximize their capital accumulation goals. Since their production cycles are not interrupted by power outages and energy interruptions, they produce their own energy and allocate high budgets to energy investments to prevent involuntary production outages.

Besides, central and local governments create energy strategies and policies to reduce energy dependency, reduce environmental damage, and secure the energy they need under the optimum conditions (Mey et al., 2016). The importance of this study lies in the relatedness of the historicity of capitalist development dynamics of regions and their impacts on the energy sector. The fact that this study was carried out in the Northern Sub-Region of İzmir is important due to the energy sector investments that develop in parallel with the heavy industry and urban growth dynamics where they are both tremendously concentrated.

Another topic related to the energy sector is climate adaptation frameworks which has led to the development of upper-scale decisions for the transition from fossil fuel-based energy production to sustainable green energy production in the regions. In parallel with the development decisions and strategies for the future of the regional economies, green energy investments are clearly crucial. Still, even though they are green energy

investments, they need to be integrated into regional plans according to certain regulations and environmental monitoring processes. Uncontrolled investments without regulation can cause environmental disasters and conflicts that are difficult to manage. The public has developed mechanisms to monitor these processes. In this context, determining the establishment processes of facilities for green energy production in the regions with legal regulations and natural thresholds is vital for the future of the regions.

As reported by Pinar et al. (2020), renewable energy types, especially wind energy, are a relatively new energy field for Türkiye. In Türkiye, the first studies for wind energy were based on research conducted at Ankara University in the 1960s, and at Ege University, METU, and TÜBİTAK in the 1970s. As reported by Pinar et al. (2020), in 1989, the Wind Energy Branch Directorate was established within the Electrical Works Survey Department. Kapluhan (2017) reports that the first wind power plant installation in Türkiye was made in the Çeşme district of İzmir. In 1998, 3 1.5 MW turbines were established in the Germiyan village of İzmir-Çeşme and 12 0.6 MW turbines were established in the Alaçatı town. After a long 20 years, in the early 1990s, the wind energy directorate was established in the Ministry of Energy and the first wind turbine was installed in 1998. Wind energy, which is relatively new to Türkiye in terms of its institutional structure and technical infrastructure, has grown rapidly over time.

According to the latest data for 2018, this production has reached 7.811,1 MW of installed power with a total of 3089 wind energy turbines connected to 180 separate wind power plants throughout Türkiye, thus meeting 6.6% of energy production. According to February 2025 data, 13.044 MW of wind turbine-based energy is produced from a total of 376 wind power plants throughout Türkiye. Wind-based energy production corresponds to 11.19% of total energy production in Türkiye (Energy Agency, 2025).

There are studies on wind energy in literature. Akova (2011) analyzed the development potential of wind energy in Türkiye, Pınar et al. (2020) analyzed the distribution of wind power plants in Türkiye from a geographical perspective. Besides, many studies investigated the optimum site selection for installing wind power plants (wpps). Özşahin and Kaymaz, (2014) for Hatay province, Demir (2022) for Kars province, Arslan and Üzülmez (2019) for Bandırma district, Üzülmez and Arslan (2017) for Sındırgı district, Arca and Keskin Citiroglu (2022) for Kozlu district. On the other hand, there are also studies on the social impacts of wind energy in literature. Arslan and Uzun (2017) analyzed the social acceptance dimension of renewable energy investments, and Özen (2009) and Akın (2022) analyzed the reactions of local people to investments affecting the environment.

In this context, this study aims to answer the following questions from a spatio-temporal perspective; How are energy sector investments in the Northern Region of İzmir shaped within their historical context? Where are the power plants distributed in the Northern Region of İzmir for each type of energy? What are the land uses on which energy investments are built? What are their license and environmental impact statuses? Are there any future projects planned and how can the spatial configuration of these projects shape the growth capacity of the İzmir Northern Sub-Region?

The next section examines the change and transformation of energy policies and the energy sector within its historical context. Section 3 the importance of wind energy in the energy sector in Türkiye. Section 4 is about the study area, data, and methodology. Section 5 analyzes the spatial configuration of the energy sector in the Northern Region of İzmir and consists of two main subheadings. In 5.1, the existence and future of wind energy in the Northern Region of İzmir are analyzed. In 5.2, the existence and future potential of other energy types other than wind energy in the Northern Region of İzmir are analyzed. Section 6 is about the conclusion and discussion.

2. HISTORICITY OF ENERGY INVESTMENTS IN TÜRKİYE

It is important to analyze the change and transformation of energy policies within their historical context. In parallel with the capitalization of the country[1], the energy deficit began to increase in the continuation of the process where the energy deficit was relatively low before. The 1960-1980 period was critical as Türkiye's

[1] The capitalization of the country refers to the change and transformation of social, economic, and spatial routines and institutions, which are processes such as privatization, neoliberalism, industrialization as a whole, and multi-layered. For further readings on the capitalization process of Türkiye, kindly see Pamuk, 2012, Boratav, 2006, Berkes,1973.

industrialization speed was fostered, energy demand increased, and external dependency for supplying the higher demands became a problem for the economy. Türkiye began taking important steps towards industrialization in the 1960s, which led to a rapid increase in energy demand. During this period, investments were made in domestic resources such as hydroelectric power plants and fossil fuel-based power plants to meet Türkiye's energy needs. However, these investments were not enough to use domestic resources at full capacity; the lack of infrastructure required for hydroelectric power plants and the efficiency problems of fossil fuel-based power plants were among the main difficulties of this period.

Energy supply was largely based on imports, and the 1973 Oil Crisis showed that this dependency posed a major threat to Türkiye's economic stability (Demir, 1980). The crisis increased oil prices worldwide and made Türkiye's external dependency more apparent. Following this crisis, Türkiye turned to the use of domestic energy resources in its energy policies. However, during this period, serious problems were experienced in terms of energy supply security, and no concrete steps were taken to reduce external dependency. In addition, Türkiye's energy policies were largely shaped by agreements made with Western countries. Although economic relations with Western countries were developed, Türkiye's external dependency increased in parallel with these relations. As a result, the period 1960-1980 was shaped by Türkiye's energy policies' efforts to develop various strategies to meet the increasing energy demand with industrialization and to reduce external dependency (Mutluer, 1990; Yanar and Kerimoğlu, 2011).

In the post-1980 period, the energy sector in Türkiye underwent a significant transformation. The economic liberalization policies implemented in the 1980s also affected the energy sector, and free market transitioning policies were applied. Privatization processes and the increased role of the private sector in the energy sector shaped energy production and distribution according to market conditions. However, the increase in external dependency and the ineffective use of domestic resources during this period brought about energy security problems. Especially in the 1990s, Türkiye's shift towards the use of natural gas was an important step. The agreements made with the Soviet Union allowed Türkiye to start importing natural gas, and the share of natural gas in electricity production increased rapidly (Bayraç, 2009; Çalışkan, 2023). However, the increase in the use of natural gas also increased Türkiye's external dependency and posed a major threat to energy supply security. During this period, investments were made to increase electricity production capacity, but these investments were based on externally dependent energy sources rather than domestic energy resources. Although Türkiye began to turn to renewable energy sources in the late 1990s, investments in this area remained limited, and domestic renewable resources were not sufficiently utilized (Pamir, 2003). In addition, the period 1980-2000 was recorded as a period in which Türkiye's energy policy continued to be dependent on foreign sources and sufficient steps were not taken regarding energy supply security. Energy efficiency and the transition to renewable energy generally dragged on until the 2000s (Kızıl Voyvoda and Voyvoda, 2019).

In the post-2000 period, Türkiye’s energy sector underwent a significant transformation with the cooperation of both the public and private sectors. During this period, major investments have been made to ensure energy supply security, reduce external dependency, and transition to sustainable energy production. Modernization of the energy infrastructure, encouragement of the use of renewable energy resources, and greater private sector involvement have come to the fore. While the public sector continues to play an important role in ensuring energy security, strategic infrastructure, and regulatory frameworks, the private sector has begun to participate more in energy production and distribution (Koca and Yoldaş, 2023; Arslan,2017; Akova,2011).

In the 2000s, the private sector made major investments in renewable energy fields such as wind and solar energy, and the state has provided legal regulations and support to encourage these investments. As of the 2010s, significant privatizations and public-private sector collaborations (Figure 1) have been made in the energy sector, the electricity production capacity of the private sector has increased, and energy distribution networks have been privatized. In addition, great importance has been given to energy efficiency and renewable energy projects. Türkiye has taken concrete steps towards diversification in energy and reducing external dependency by reaching a renewable energy capacity of over 30 percent by 2023 (Yusufoğlu, 2018). In this process, while the state's regulatory role continued in Türkiye's energy policy, the competitive structure of the private sector fostered the energy sector growth and made it more brutal to the environment.

The rapidly increasing population, industrialization, urbanization and the quality of life have increased energy consumption; this has led to the rapid depletion of fossil energy resources and therefore environmental pollution. The most important environmental problems in energy activities are generally caused by using fossil fuels in industry, heating, transportation, and electricity generation. During the processes starting from the production stage of the use of fossil energy resources; preparation for use, transportation, distribution, and consumption, there are a series of negativities that adversely affect the natural balance and human health such as air pollution, environmental pollution, and health problems, global warming, marine pollution, nuclear waste problems, industrial waste, energy bottleneck, and economic stagnation, continuous increase in electricity and fuel prices, unemployment and wars, environmental pollution, and climate changes (Yaman, 2009; Arslan, 2019; Arslan and Üzülmez, 2019).

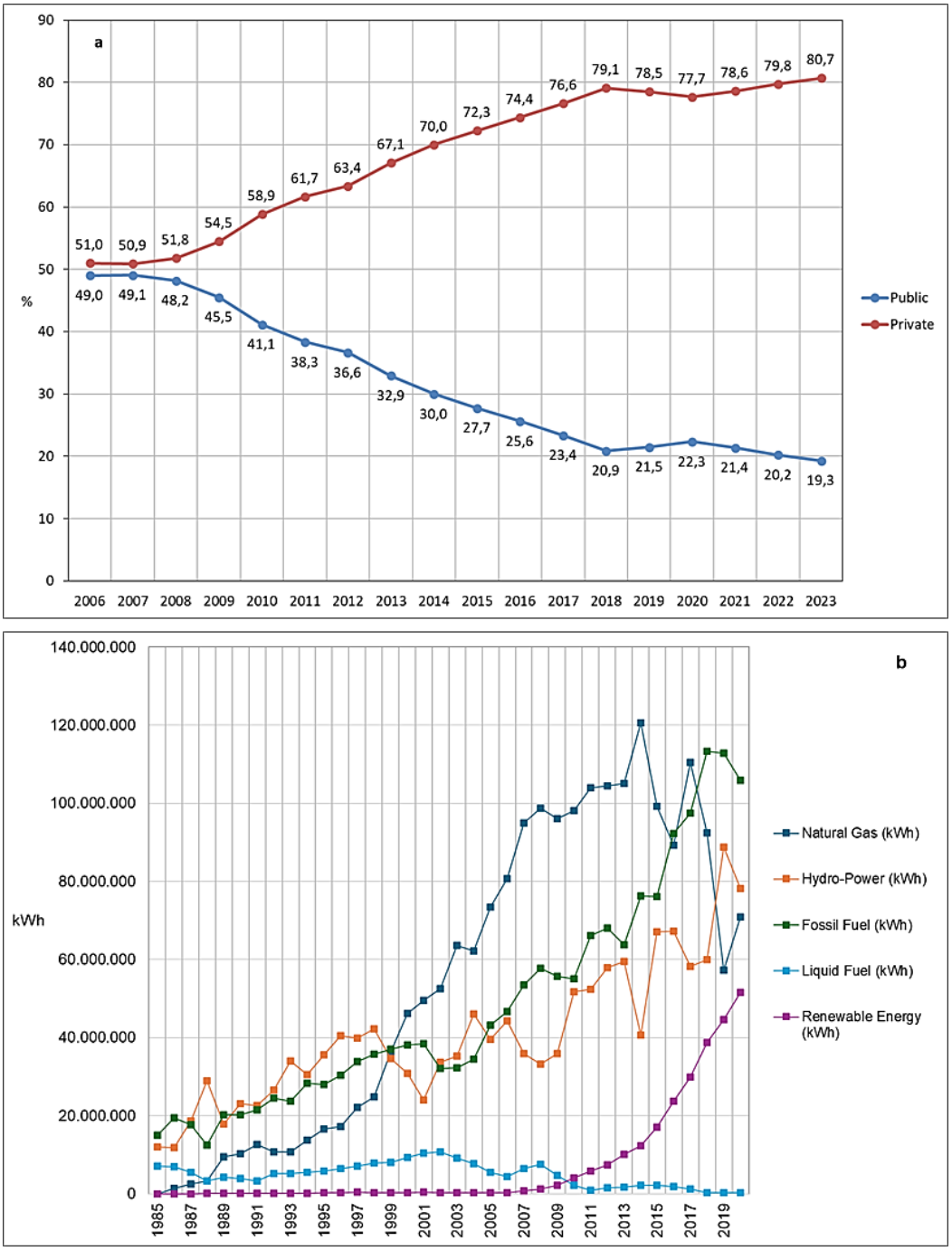

Figure 1- (a) Share of Public and Private Institutions in Energy Production in Türkiye, (b) Türkiye Electricity Consumption Trend by Years and Types

Besides, energy policies in Türkiye aimed to produce environmentally friendly energy solutions and target sustainable development (Arslan and Uzun, 2017). Renewable energy projects were encouraged to reduce environmental impacts and Türkiye made significant investments in this area (Arslan, 2017a; 2017b). During this period, energy efficiency and sustainable development became central to Türkiye's energy strategies (Arslan, 2017a; 2017b). Energy diplomacy also came to the fore and Türkiye increased its international cooperation to ensure energy supply security. In addition, various reforms have been implemented to modernize the energy infrastructure, reduce energy losses, and increase efficiency. These efforts have brought Türkiye one step closer to becoming a regional energy hub. As a result, Türkiye has taken important steps to increase energy security, reduce external dependency, and achieve sustainable development goals by turning to renewable energy (Sevim and Karaman, 2019; Yılmaz, 2014; Alodalı, Kocaoğlu and Usta, 2020).

3. IMPORTANCE OF WIND ENERGY IN TÜRKİYE'S ENERGY CONTEXT

As the economy of Türkiye further grows, the industrialization and the production of the country further increase which leads to an increase in the energy need in parallel. The increase in the energy demand causes energy investments continuously across the country and especially in production hubs such as the İzmir Northern Sub-Region. Besides, the further need for energy requires giving priority to energy saving, efficient use of existing resources, energy recovery, and renewable energy sources. Clean energy sources, known as alternative energy sources, that originate from the sun and have the potential to renew themselves, are defined as renewable energy sources (Arslan and Üzülmez, 2019; Arslan, 2019; Uyar, 2004: 3).

Unlike conventional fossil energy sources, the importance of renewable energy is inherent in causality such as minimizing economic and social risks such as energy security, fuel costs, and supply risks (Yılmaz and Kösem, 2011: 24). Among renewable energy sources, wind energy is the most widespread and technologically fastest developing. Electricity generation with wind energy is a method that does not create CO2 emissions, does not cause acid rain or atmospheric warming, saves on fossil fuel use, and has no radioactive effects (Ji and Yu, 2024; Global Wind Energy Council, 2010). As a continuous and endless energy source, wind is a power source with rapid technological development, and foreign exchange earnings, has no external dependency, and its turbines can be put into operation in a short time and can be dismantled in a short time (Koçaslan,2012). In addition, wind, which is a permanent source, is not a limited and restricted energy source like fossil fuels. This situation brings other renewable energy sources such as wind to the forefront in terms of sustainability. As seen in Figure 2, wind energy electricity production in Türkiye has been increasing over the years, and this shows that the share of wind energy production in the total electricity consumption coverage ratio has also increased.

Among renewable energy sources, wind energy is the most open to development in Türkiye. Surrounded by seas on three sides and having a coastline of approximately 3.500 km, Türkiye receives continuous and regular wind, especially on the Aegean coastline. In the Türkiye Wind Energy Potential Atlas (WEPA), prepared to determine the characteristics and distribution of wind resources, it is stated that the wind energy potential is high, especially on the Aegean coast and that wind energy can be used efficiently with detailed studies to be carried out in these regions (Turkish Wind Energy Association, 2013). The Aegean region has great potential in our country in terms of the availability and continuity of the average 2,5-4 m/s initial wind and 7 m/s production speed required for wind energy conversion plants used to obtain electrical energy from wind (Gençoğlu and Cebeci, 2009). The Aegean Region is rich in terms of wind potential. In parallel with the high wind potential in the Aegean Region, RES investments were first concentrated in this region.

The Aegean Region, where the first wind power plant was established, started to benefit from wind energy in 1988 with 11.7 MW of energy from 15 wind turbines. Today, 2556.1 MW of the total 7581.1 MW wind energy installed power in Türkiye is in the Aegean Region. With this rate, the Aegean Region constitutes 33.72% of the country. When examined on a provincial basis; In terms of cumulative installed power, İzmir ranks first with 1,798 MW, 19.32%, Balıkesir with 1,220 MW installed power and 13.11%, and Manisa with 717 MW installed power and 7.70% (TWEA, 2024b). The fact that İzmir is the first province in the wind energy installed power ranking is due to the wind potential and geographical features of the region. To make wind energy investments, the wind speed must be greater than 7 m/s. Among the regions that provide this potential in İzmir province, Bergama and

Aliağa districts with high mountains and wind speeds come first (Pınar, Buldur, and Tuncer, (2020); Akova,2011; Arslan,2019)

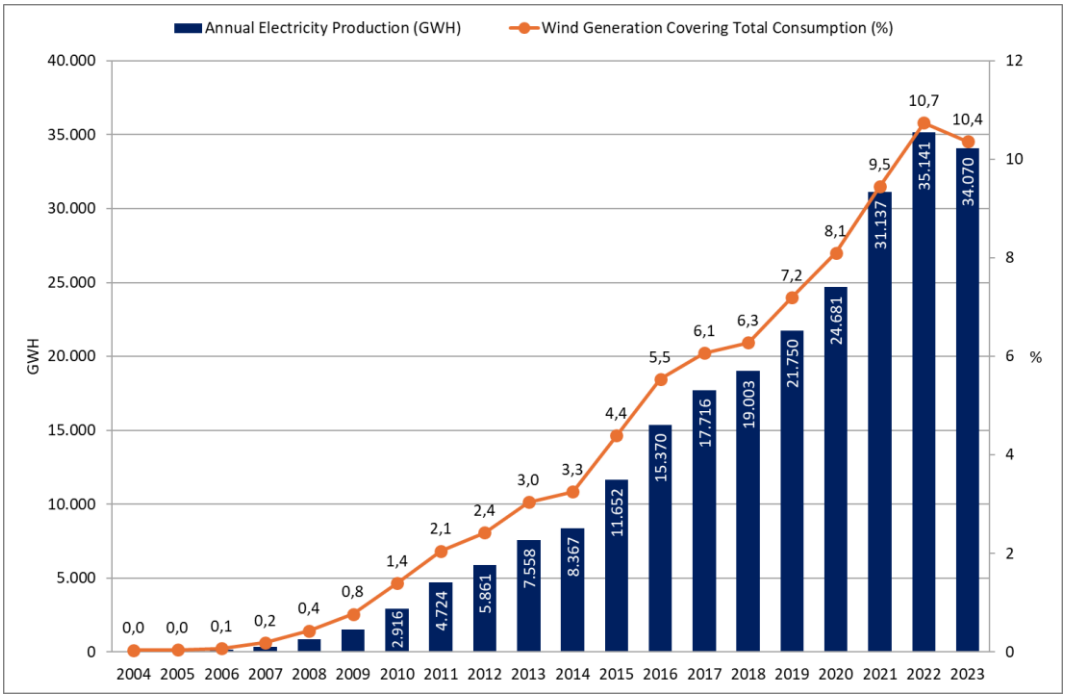

Figure 2- The Place of Wind Energy in Current Energy Production and Consumption in Türkiye (EİAŞ, 2024)

Although the wind energy sector was still far behind in Türkiye in the early 2000s, wind energy investments began to develop rapidly with the Renewable Energy Law (Law No. 5346) enacted in 2005 to encourage the use of renewable energy sources in electricity generation. This law prepared the legal infrastructure for supporting electricity generation facilities based on renewable energy sources (Official Gazette, 2005). The first license applications began to be received in 2007. Although applications for a capacity of 78.000 MW were made, a limited number of licenses were granted (World Bank, 2015). Türkiye, which had a total wind energy capacity of 20 MW in 2000, launched Türkiye's first large-scale investment projects in the Balıkesir, Çanakkale, İzmir, and Manisa regions in 2008-2010 (İlkiliç, 2012; İlkiliç and Türkbay, 2010). An installed capacity of 1.300 MW was reached by 2010, but due to the technological infrastructure being largely dependent on foreign countries and the low rate of domestic production, the share of wind energy in electricity generation was quite low (Chamber of Mechanical Engineers, 2010). After 2010, wind energy investments entered a period of rapid growth. The Renewable Energy Resources Support Mechanism (YEKDEM) law, which provides a fixed price guarantee to producers, entered into force in 2011 and encouraged wind energy projects. This law also introduced additional incentives for the use of domestic equipment (EPDK, 2024).

During this period, the rapid development of wind turbine technology also attracted the attention of foreign investors. International companies such as Siemens, Gamesa, Nordex, and Enercon took part in projects in Türkiye. Türkiye's installed capacity increased to 5.000 MW by 2015 (İlkılıç, 2016). Domestic production increases also occurred during this period. Domestic production reached 60% by 2020. The increase in wind energy investments ensured that approximately 8% of electricity production in Türkiye was met by wind energy (SHURA Energy Transformation Center, 2018). The wind energy installed capacity, which was 1.300 MW in 2010, exceeded 8.000 MW in 2020 when investments were concentrated in the Aegean Region. After 2017, the Renewable Energy Resources (YEKA) model came into force to encourage large projects. A tender was made with this model, and a capacity of 1.000 MW was allocated. In this project won by Siemens Gamesa, a domestic production requirement was determined. In the second tender held in 2020, an additional 1.000 MW capacity was allocated. In the post-2020 period, wind energy has followed a strategy focused on both domestic production and environmental

sustainability. As of 2023, Türkiye's total wind energy installed capacity has reached 12.000 MW. The share of wind energy in Türkiye's electricity production has also been increased to over 10% (Günay and Yıldırım, 2024). In the next section, we discussed the study area, data, and methodology.

4. STUDY AREA, DATA AND METHODOLOGY

This study covers the sub-region known as the Northern Region of İzmir, which is the third province with the highest capital and population density in Türkiye and includes the districts of Aliağa, Bergama, Dikili, and Kınık located in the north of İzmir (Figure 3). The Sub-Region is in the northern part of the metropolitan center of İzmir, where capital accumulation and density have been prominent throughout history in Türkiye. In addition, transportation facilities such as the Northern Aegean Motorway, TCDD Aliağa railway line and Biçerova station connections, Aliağa Port and ports located in Nemrut Bay located in the sub-region increase the connectivity of the sub-region to global production and value chains. The economic externalities created by the production and transportation infrastructure investments made in İzmir throughout history have attracted intensive domestic and foreign capital investments to the region, and the capital density in the İzmir region has increased, leading to new industrial areas, free zones (Western Anatolia Free Zone), refineries (Star Refinery, TÜPRAŞ İzmir Refinery) and port investments (Çandarlı Port) (Aliağa Chamber Of Commerce, 2024; İzmir Development Agency, 2023). In parallel with all these investments, the need for energy investments is increasing and energy investments continue in the region for heavy industry and complementary sectors (Arslan,2019). Energy production in the region is carried out by fossil fuel, natural gas, wind, and solar power plants (Table 1-Table 3).

Figure 3- Location of the Study Area

Within the scope of the study, the development process of the energy sector in Northern İzmir Sub-Region was examined in an integrated manner using Internet printed sources and satellite imagery data. The location of all the energy facilities for various energy production types that were received from the Energy Atlas (Energy Atlas, 2024a-2024f) website is visualized by tidygeocoder[2] Geocoding package with Nominatim API in the R environment.

Environmental impact assessment information for energy facilities in the Northern İzmir Sub-Region was compiled from TEİAŞ (Turkish Electricity Transmission Inc.) (TEİAŞ, 2024) Environmental Impact Assessment (EIA) Reports database. Land-use information on the land where energy facilities were established was obtained from the website where the MEUCC publishes Environmental Planning Plans (MEUCC, 2024a). The license information for energy facilities was compiled from the Ministry of Energy and Natural Resources Electricity Market license database (MENR, 2024), and the information on the establishment year, districts where the energy facilities were established, number of turbines and power were compiled from TWEA (TWEA. 2024a), company websites, EIA reports and plan change reports.

5. ANALYSIS FOR THE DEVELOPMENT OF THE ENERGY SECTOR IN NORTHERN İZMIR SUB-REGION

5.1. Existence and future of wind energy in Northern İzmir Sub-Region

Wind energy investments in Türkiye are primarily concentrated in the Aegean Region due to its high wind potential (Tagliapietra et al., 2019). This concentration has also caused complementary sectors related to wind energy to choose and concentrate in the Aegean Region (Koçarslan, 2012). According to the Turkish Wind Energy Statistics Report prepared by the Turkish Wind Energy Association (TWEA), approximately 3.5 MW of wind energy plants in Türkiye are in the Aegean Region. Within the Aegean Region, the İzmir region has approximately %20 of the installed capacity. The reason why İzmir is the region where the most wind energy investments are made is that in addition to its high wind potential, İzmir is a trade center with important export and import ports of Türkiye (Koçaslan, 2010). Due to its high-capacity transportation connections, it is the center of the strategic region surrounded by Balıkesir, Çanakkale, and Manisa, other provinces with high wind potential and installed capacity in the Aegean Region (Köktürk and Tokuç, 2017).

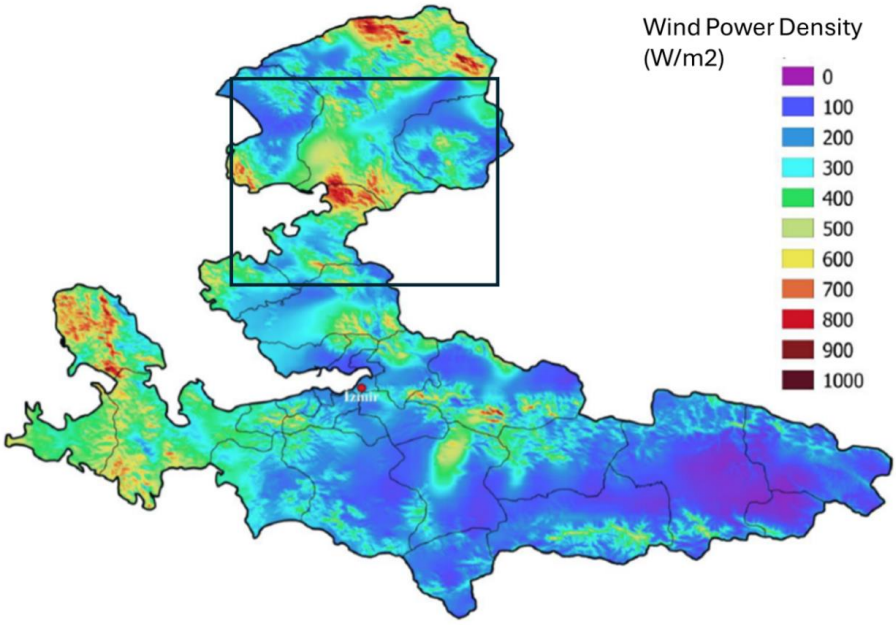

Figure 4- Study Area and Wind Power Density (ETKB, 2024)

[2] For more information on tidy-geocoder please see https://cran.rproject.org/web/packages/tidygeocod er/readme/README.html

All these economic, social, and spatial dynamics, in addition to electricity generation from wind energy, bring the İzmir region to the forefront in the field of wind turbine equipment manufacturing. The ecosystem formed by national and international investors clustered in İzmir and its surroundings can produce all the main components that make up the turbine for wind energy generation and export them to various parts of the world. All 4 wind blade factories, 3 of 6 tower factories, and 1 of 2 casting facilities included in the WindEurope "Wind Energy and the European Economic Recovery Report" in Türkiye are in İzmir. In addition to international companies, important national and local businesses, as well as the supply chain of manufacturers, including services for the sector, are also densely located in İzmir. For example, global turbine manufacturers Siemens Gamesa[3], Enercon, and General Electric (GE) manufacture the main equipment of their wind turbines in İzmir. In addition, independent equipment manufacturer TPI Composites has 2 blade factories and an R&D center in İzmir, CS Wind has a steel tower factory, and Ateş Wind Power has a tower and direct drive generator factory. All these manufacturers are important players in the wind energy sector on a global level and their presence in İzmir provides important insights into İzmir's position in the sector.

The Northern İzmir region located in the north of İzmir, is also one of the regions with the highest wind speed in Türkiye (The annual average wind speed, which is the ideal environment for the efficient operation of turbines in the region, reaches high values such as 7-8 m/s (İzmir Development Agency, 2016). Unlike other regions, in the Northern İzmir region, in addition to energy production through turbines, turbines, blades, and other parts are produced.

The port, located in the northern part of İzmir, has wind potential, as well as; as revealed in the İzmir Development Agency (2023) report, when the ports serving the wind energy sector in İzmir province are ranked according to their density, the first four ports, namely Batıliman, SOCAR Terminal, İzmir Demir Çelik, and Nemport, are located in the Aliağa district of the Northern İzmir Region, infrastructure facilities such as highways and railways, and also the fact that the iron and steel sector, which will provide input for turbine manufacturing, is located in this region have made the region an important production center (Eroğlu and Bozyiğit, 2013).

In the regional plans prepared by the İzmir Development Agency, the northern region of İzmir has been determined as a wind energy and renewable energy region, and public investments are being made in this direction. In addition to the development potential provided by the dense heavy industry facilities in the region, the fact that the installed power share of other energy types other than wind energy in the region is large creates the potential for the Northern İzmir Region to be a center for both clean energy production and manufacturing. The locations of the wind turbines are shown in Figure 5 and Figure 6 and the details of the wind turbines located in the northern region of İzmir are shown in Table 1 and Figure 7.

As seen in Figure 5 and Figure 6, wind turbines are clustered in the red areas in Figure 4 and the areas with the highest wind power potential. Besides, the figures also show that wind turbines are not only clustered in Yunt Mountain but also located in some small clusters consisting of relatively few turbines appearing in different areas in the study area. These are in the areas where industrial areas are concentrated in Aliağa district and the Güzelhisar Dumanlıtepe location, in the north of the area selected as a free zone in Bergama, and on the top of the mountains extending from Konukburun village to Kocaömerli village in the south of the center of Kınık district (Figure 7). Where and on what land use the turbines are placed is important in terms of predicting where they will be placed in the future. As presented in Table 1, when the current positioning of wind turbines is examined on the İzmir-Manisa 1/25,000 Scale Environmental Plan, it is seen that the wind turbines in Aliağa district have selected areas designated as forest areas and industrial zones. It is seen that the wind turbines in Bergama district have selected areas designated as agricultural areas, forest areas, and free zones, the wind turbines in Kınık district have selected areas designated as forest areas and the wind turbines in Dikili district have selected areas designated as agricultural area (Figure 7).

[3] Siemens Gamesa has decided to close Türkiye's only wind turbine R&D center. Access Link: https://sd.com.tr/siemens-gamesa-turkiyedeki-ilk-ve-tek-ruzgar-turbini-ar-ge-merkezini-kapatiyor/, Access Date: 18.03.2025

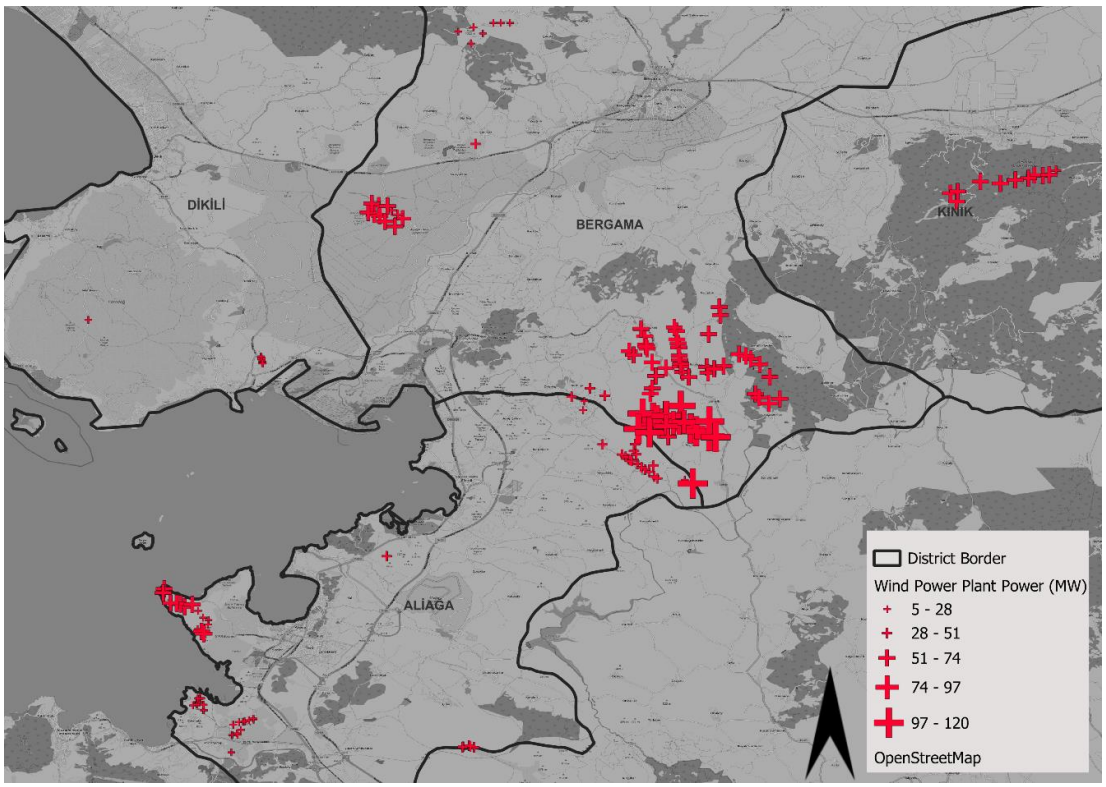

Figure 5- Spatial Distribution of The Wind Power Plants by Power

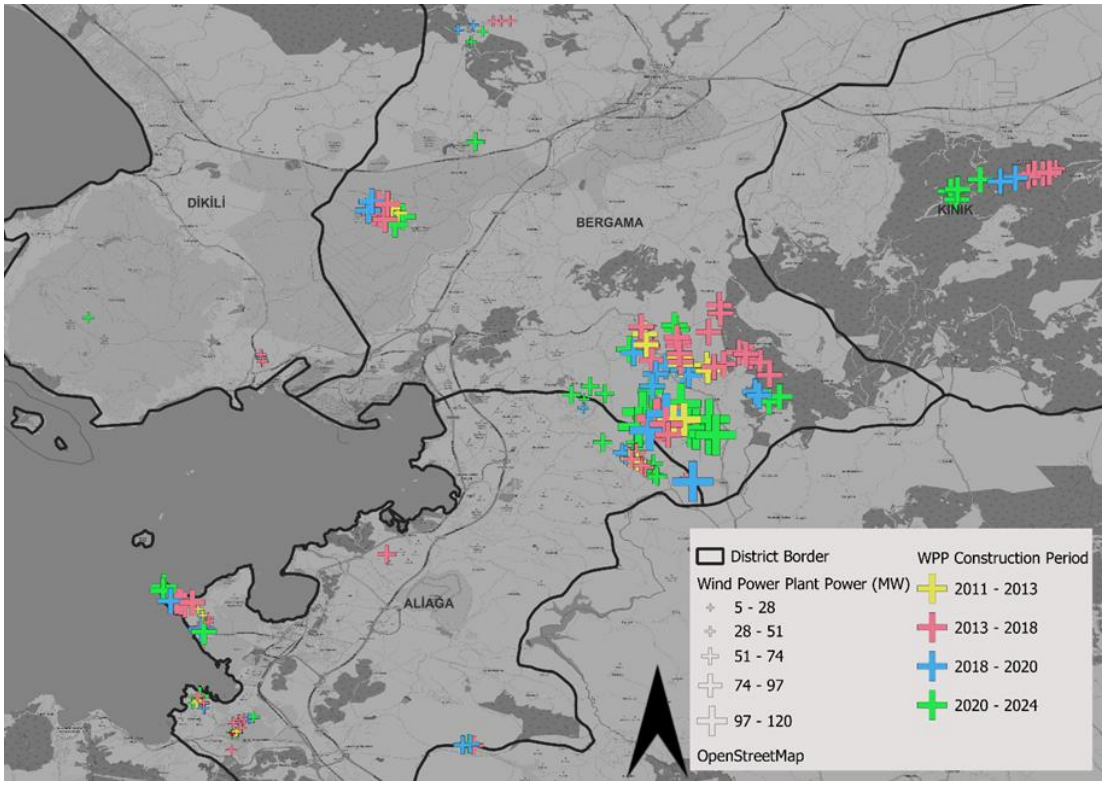

Figure 6- Spatial Distribution of The Wind Power Plants by Power and Construction Period

In addition, analyses of the installation times of wind turbines can reveal the development dynamics in the region. As seen in Figure 6, the first turbines in the area were installed in the Aliağa district Industrial Zones and on Yunt Mountain between 2011 and 2015 (TWEA, 2024a). It is seen that the turbines with the highest power capacities until 2024 are concentrated in Yunt Mountain and its surroundings, in the industrial zones of Aliağa district, near the Free Zone in Bergama district, and in the mountains around Kocaömerli village in Kınık district. Figure 5 shows that higher-capacity wind turbines have been built throughout history.

Although electricity production from wind energy is expressed as “relatively" sustainable and low-environmental-destructive energy, they can transform the areas where they are built, and there are many studies in the literature on the transformation of the areas where wind energy plants are built affecting rural areas. The formation of production cycles and routines in rural areas has been an evolutionary process from ancient times to the present day. Renewable energy investments, which must be created intrinsically with the causality of economic, social, and spatial dynamics, have the potential to interrupt and/or change and transform the rural production cycles. For example, when wind turbines built in pasture areas are surrounded by fences, the agricultural production process may be negatively affected because the areas previously used for feeding animals cannot be used in agricultural processes (Arslan and Uzun, 2017). In this context, it is important whether the environmental impact assessment processes are positive and whether they have licenses during the installation processes of the plants. While the public encourages low-environmental-destructive energy, it should also guarantee the sustainability of rural areas.

There are studies in the literature reporting that the quality of rural areas is deteriorating and being transformed into energy fields to meet the energy needs that arise with the increase in the population in urban areas (Hazar Kalonya and Özçam, 2021; Özçam, 2018). Rural İzmir is also one of the areas where energy investments are concentrated. Wind farms, solar power plant fields, and geothermal field investments tend to transform ancient production basins (Hazar Kalonya and Özçam, 2021; Özçam, 2018). According to the IPCC (İzmir Provincial Pasture Commission), pastures and fertile lands, especially in the districts of Aliağa, Bergama, Dikili and Karaburun, are allocated to energy plant fields for the country's economy (Hazar Kalonya and Özçam, 2021; Özçam, 2018; IPCC, 2017). The fact that energy investments are in rural areas where activities such as pasture, animal husbandry, and agriculture take place negatively affects the economic income sources of the regions. As power plants render fertile lands unproductive, they also lead to a decrease in rural production activities (Hazar Kalonya and Özçam, 2021; Özçam, 2018).

As seen in Table 1, it is determined that all wind turbines in the region are licensed following the Electricity Market License Regulation dated 2013 (Energy Atlas, 2024d). Still, the Karel Demir Wind Power Plant, which generates electricity within the Karel Demir Tel company located in the Industrial Zone of Aliağa district, the Aldur Wind Power Plant located in the west of Aliağa Organized Industrial Zone, and the Samer Ruzgar Power Plant located in Yunt Mountain are unlicensed. When the EIA reports are examined, it is seen that there is no wind power plant with a positive EIA report except Seyit Ali Res located in Aliağa district, there are wind power plants with positive EIA reports in Bergama district such as Bergama Res, Yunt Dağ Res and Aliağa-Bergama Res, and the wind power plants located in Kınık and Dikili districts do not have positive EIA reports.

The turbine density distribution in the area is in areas with high wind potential shown in red in Figure 5 and Figure 6. It is seen that a total of 173 wind power plants currently provide 731,5 MW of power (Table 1). Of the total 173 wind power plants, 90 have an installed capacity of 417 MW in Bergama district, 68 have an installed capacity of 254,5 MW in Aliağa district, 11 have an installed capacity of 55 MW in Kınık district and 4 have an installed capacity of 5 MW in Dikili district (TWEA, 2024a). Although it is possible to separate them into districts, it is seen that most wind energy facilities are clustered around Yunt Mountain.

Table 1- Wind Power Plants in The Northern İzmir Sub-Region (Aliağa Chamber of Commerce, 2024; Energy Atlas, 2024d-2024e; EPDK, 2024; MENR, 2024; MEUCC, 2024a; TEİAŞ,2024; TWEA, 2024a)

WPP	Year	Power (Mw)	License	EIA*	EDP**	Turbines	District
Samurlu	2011	44	+	-	Forest	11	Aliağa
Bozyaka	2011	20	+	-	Industrial Zone	11	Aliağa
Karadağ	2011	28	+	+	Forest	5	Aliağa
Petkim	2011	51	+	+	Industry	17	Aliağa
Seyitali	2011	42	+	+	Power Plant	16	Aliağa
Bergama	2011	90	+	+	Agriculture	15	Bergama
Yuntdağ	2011	60	+	+	Power Plant	30	Bergama
Düzova	2012	51,5	+	-	Free Zone	11	Bergama
Pitane	2012	5	+	-	Agriculture	4	Dikili
Aliağa-Bergama	2012	120	+	+	Agriculture	18	Bergama
Berg	2013	70	+	-	Forest	9	Bergama
Kınık	2013	55	+	-	Forest	11	Kınık
Karel Demir	2016	2	-	-	Industrial Zone	1	Aliağa
Samer	2016	2	-	-	Forest	1	Aliağa
Aldur	2016	0,5	-	-	Agriculture	1	Aliağa
Bergama	2016	25,2	+	+	Forest	7	Bergama
Akça	2019	37	+	-	Power Plant Site	3	Aliağa
Örlemiş	2020	28	+	-	Forest	2	Aliağa

* Environmental Impact Assessment Report,

** Environmental Plan Land Use Decision, ?, +, and -, refers to could not be detected, yes, and no, respectively

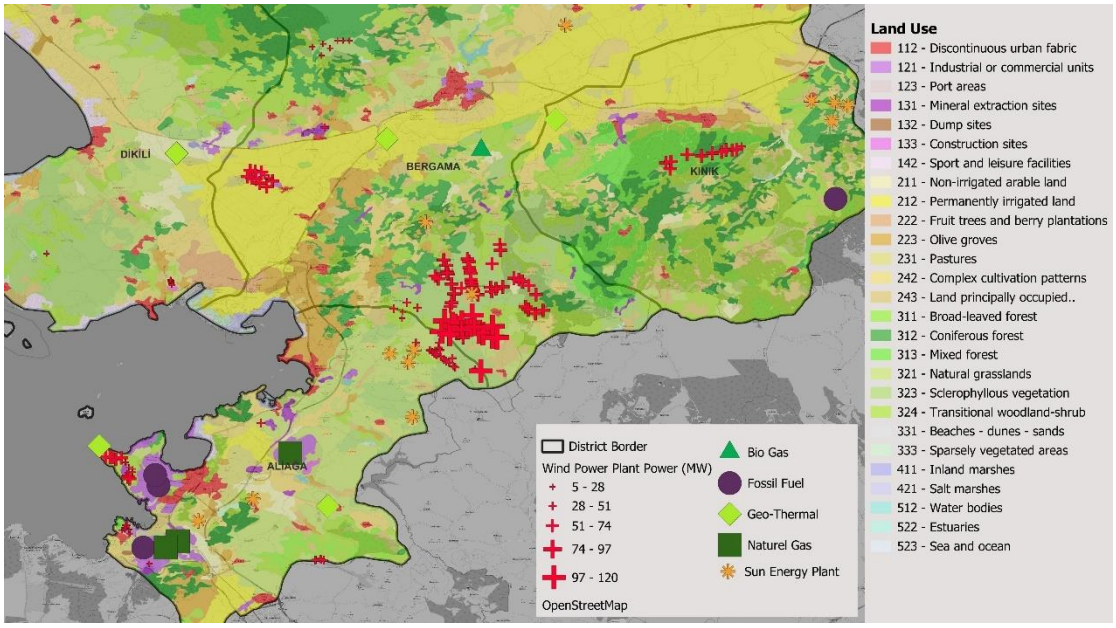

Figure 7- Land Use and Spatial Distribution of Power Plants According to Type and Power in Northern İzmir Sub-Region

Table 2, created with the data obtained from the Energy Atlas (2024a) and the Turkish Wind Energy Association (TWEA, 2024b), shows the status of wind power plant investments under construction and those with pre-licenses in the Northern Region of İzmir. The table shows that 5,4 MW of the total 297,4 MW investment is planned in the Aliağa district and 292 MW in the Bergama district. Information on the license and EIA reports of the wind power plants planned in the Aliağa district could not be accessed. It is seen that the wind power plants planned in the Bergama district have licenses and EIA reports except for the Bergama - Karaburun Wind Power Plant.

Table 2- Under Construction and Pre-Licensed Wind Power Plant Investments in Northern İzmir Sub-Region (Aliağa Chamber of Commerce, 2024; Energy Atlas, 2024a; EPDK, 2024; MENR, 2024; TWEA, 2024a-2024b)

WPP	Power (Mw)	License	EIA*	EDP**	Turbines	District
Dere	3,40 MW	?	?	Renewable Energy Zone		Aliağa
Samer	2 MW	?	?	?	46	Aliağa
MFA Bergama	200 MW	+	+	Forest, Pasture, Olive Grove	58	Bergama
Bergama	48 MW	+	-	Agriculture, Pasture, Forest	16	Bergama
Karlık	44 MW	+	+	?	9	Bergama

* Environmental Impact Assessment Report, ** Environmental Plan Land Use Decision, ?, +, and -, refers to could not be detected, yes, and no, respectively.

A total of 83 turbine investments were made in the areas designated as Field, Forest, and Pasture in the 1/25.000 scale İzmir-Manisa Environmental Plan in Bergama district, and a wind turbine investment with a total power capacity of 3,4 MW was made in the area designated as Renewable Energy Zone in Aliağa district. In the next part, we discussed the present and future potential of other energy types in the Northern İzmir Sub-Region.

5.2. Existence and future of the other energy types in Northern İzmir Sub-Region

The Northern İzmir Sub-Region is a region where energy consumption is intense due to its industry, and in this context, it is important to examine other energy infrastructures other than wind energy. Fossil energy production other than wind, natural gas conversion facilities, and solar energy facilities were examined together under this heading without distinguishing between non-renewable and renewable energy sources due to the lack of detailed data. In the northern İzmir Sub-Region, there are also energy production types such as power plants that depend on fossil fuel consumption to produce energy for the industrial sector, natural gas conversion plants, and renewable energy production types such as solar, geothermal, and biogas. In this regard, the locations of the renewable energy production facilities in the Northern Region of İzmir are shown in Figure 7 and Figure 8 with the natural gas conversion plants and fossil fuel-based energy facilities to better analyze the energy infrastructure in Northern İzmir Sub-Region.

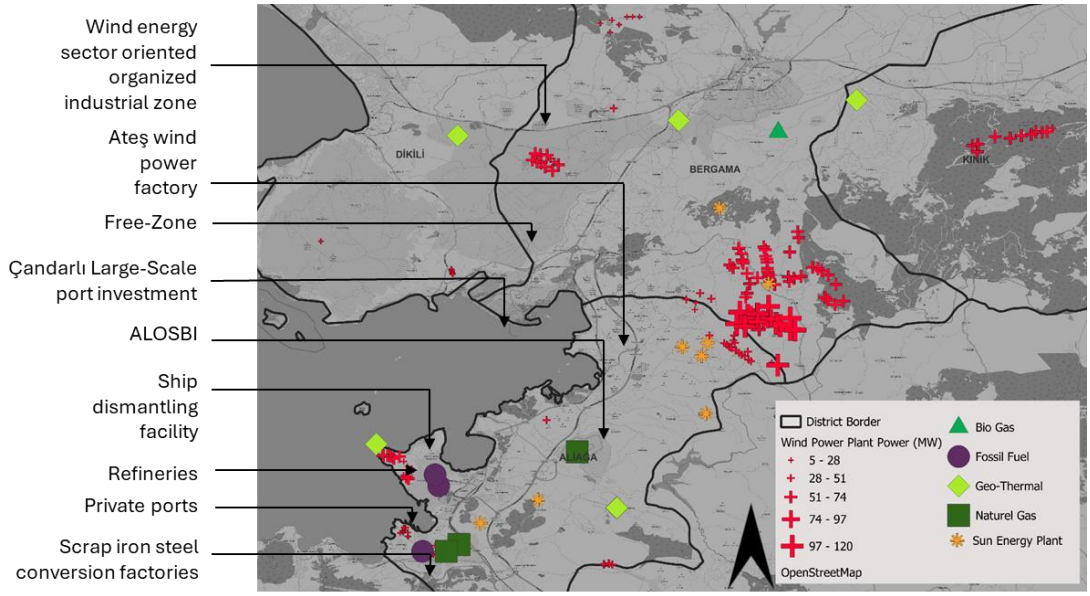

Figure 8- Spatial Distribution of Power Plants According to Type, Power and Establishment Period in Northern İzmir Sub-Region

As seen in Figure 8, the renewable energy production facility plant sites, natural gas, and fossil fuel power plant sites are concentrated in the Aliağa district, while solar energy fields are concentrated in Bergama, Kınık districts, and Yuntdağ. A total of 4.110,92 MW of energy is produced as green energy from renewable energy facilities in the area. 4.067 MW of the total installed power is provided by natural gas and fossil fuel-based power

plants in the Aliağa district (Table 1-Table 3). It is seen that the oldest facility site in the area was established in 1972 (Table 3) in the Aliağa district, and the facilities established subsequently chose locations in the same district (Energy Atlas, 2023b; TÜREB, 2024a).

The details of fossil fuel, natural gas, biogas, and solar power plants in the Northern Region of İzmir, are shown in Table 3. Regarding land use, it is seen that fossil fuel based and natural gas power plants are established in areas designated as Industrial Zones in the Aliağa district, while solar power plants are established in areas designated as agricultural areas and forest areas in all districts (Figure 7). Regarding the EIA reports, it is seen that most of them do not exist, and their data cannot be accessed. According to the installed power data in Table 3, approximately 4.076 MW of the total installed power of 4.110,92 MW is provided by solar power plants, natural gas, and fossil fuel-based power plants in the Aliağa district (Energy Atlas, 2023f). It is seen that facilities such as fossil fuel power plants with higher energy production capacity are in the Aliağa district. It is seen that facilities with high energy conversion capacity are in the Aliağa district to minimize the effects of interruptions in the main network and external resource dependency on production processes.

Table 3- Natural Gas, Fossil Fuel, Biogas and Solar Power Plants in the Northern İzmir Sub-Region (Aliağa Chamber of Commerce, 2024; Energy Atlas, 2024b-2024f; MEUCC, 2023a-2023b, 2024; TEİAŞ, 2024)

Plant Type	Name	Year	Power (Mw)	EIA*	EDP**	District
Fossil Fuel	TÜPRAŞ	1972	92 MW	-	Industrial Zone	Aliağa
Fossil Fuel	Petkim	2010	222 MW	-	Industrial Zone	Aliağa
Fossil Fuel	İzdemir	2014	370 MW	-	Industrial Zone	Aliağa
Fossil Fuel	Polyak Eynez	?	700 MW	+	Forest	Aliağa
Natural Gas	ENKA	2003	1.532 MW	+	Industrial Zone	Aliağa
Natural Gas	HABAŞ	2002	871 MW	+	Industrial Zone	Aliağa
Natural Gas	Çakmaktepe	2010	280 MW	-	OSB	Aliağa
SPP	Hacıömerli	2023	6,5 MW	-	Agriculture	Aliağa
SPP	İlhan Okan	2016	0,003 MW	?	Shrubby	Bergama
SPP	Kasım Kutlu	2015	0,003 MW	?	Agriculture	Aliağa
SPP	Fortis	2018	5,94 MW	?	Agriculture	Kınık
SPP	Fortis	2018	17,82 MW	-	Forest	Kınık
SPP	Fortis	2019	2,970 MW	*	Shrubby	Aliağa
SPP	Aliağa	2020	0,2 MW	?	Agriculture	Aliağa
SPP	Yuntdağ	2023	1 MW	-	Energy Field	Bergama
SPP	Trakya	?	1 MW	?	Forest	Bergama
Biogas	Bergama	2020	8,484 MW	+	Solid Waste F.A	Bergama

* Environmental Impact Assessment Report,

** Environmental Plan Land Use Decision, ?, +, and -, refers to could not be detected, yes, and no, respectively

The data on fossil fuel and solar power plants under construction and pre-licensed in the Northern region of İzmir were obtained by the Energy Atlas and the results are shown in Table 4. It is seen in Table 4 that 13 MW of the solar power plant investments are in Bergama and 24 MW in Aliağa districts. It is observed that investments in solar energy production have increased in the region after 2010. In the Kınık district, it is seen that a fossil fuel-based power plant investment with an installed capacity of 700 MW was made in the area determined as an Agricultural Area in the 1/25.000 scale İzmir-Manisa Environmental Plan. The fossil power plant under construction in Kınık district is due to the presence of Soma coal mines 50 km away to the east of the district. Although the development of energy types such as wind energy in the region is evaluated within the scope of the regional plan, it is seen that facilities for energy production based on fossil consumption have also been established.

An analysis of the potential usage areas of geothermal fields in the Northern region of İzmir is given in Table 4. Although no investment has been made yet, there is also geothermal energy potential in the region. In parallel with the intensive energy use in the region, geothermal energy can also be used to minimize energy consumption based on fossil fuels. As seen in Table 4, the Ilıca Burun natural geothermal resource is located at the tip of the Nemrut cape of Aliağa district, and nine geothermal wells next to the Güzelhisar Stream clustered in the east of Aliağa district. It was reached that the Ilıca Burun natural geothermal resource emerged because of the

earthquake that occurred in the past and that it was 55 degrees in temperature. The temperature of the nine geothermal resource wells ranges from 80 degrees to 109 degrees.

Table 4- Fossil Fuel and Solar Power Plants Under Construction and Under Pre-Licensing in Northern İzmir Sub-Region (Energy Atlas, 2024b-2024f)

Plant Type	Name	Power (Mw)	EIA*	EDP**	District
SPP	Bergama Ahmetbeyler	13 MW	+	Forest	Bergama
SPP	Berrak Enerji Aliağa	4 MW	+	?	Aliağa
SPP	Aliağa 1	20 MW	+	?	Aliağa
Fossil Fuel	Kınık	700 MW	-	Agriculture	Kınık

* Environmental Impact Assessment Report,

** Environmental Plan Land Use Decision, ?, +, and -, refers to could not be detected, yes, and no, respectively

In the Dikili district, there are nine natural geothermal resources mainly including Nebiler, Kocaoba, Karadere, and Kaynarca and these natural resources reach a temperature of 100 degrees. In the Bergama district, there are four natural geothermal resources including Dibek, Mahmudiye, Geyikli Dağ and Kozak and these natural geothermal resources are 80 degrees and four geothermal wells are reaching a temperature of 132 degrees; In Kınık district, it has been obtained that there is a natural geothermal source of Sucahlı with a temperature of 100 degrees (Eşder, Yakabağ, Sarıkaya , Çiçekli, 1991).

Table 5- Northern İzmir Sub-Region Geothermal Fields

Geothermal Field Name	Heat	District	Potential Areas of Use
Ilıcaburun	55	Aliağa	Agriculture-Tourism-Health-Greenhouse-City Heating
Güzelhisar	109	Aliağa	Can be used in Cooling Process
Dikili Geothermal	130	Dikili	Can be used in Cooling Process
Bergama Geothermal	80	Bergama	Agriculture-Tourism-Health-Greenhouse-City Heating
Kınık Geotermal	132	Kınık	Can be used with Cooling Process

Potential usage areas of geothermal fields in the Northern İzmir Sub-Region can be listed as greenhouse farming, agriculture, tourism, health and city heating (Table 5). For geothermal resources to be used in areas such as greenhouse farming, agriculture, tourism, health and city heating, they must be at a minimum temperature of 30 degrees and a maximum temperature of 100 degrees (İzmir Development Agency, 2022). As can be seen in Table 5, the geothermal fields in the study area are within the usable temperature range and this situation shows that geothermal resources have the potential to be used in greenhouse farming, thermal tourism, and city heating in the Northern Region of İzmir.

All these analyses show that energy production in the northern region of İzmir is rapidly increasing in parallel with energy consumption and that policies are being developed by the public to provide energy production with wind energy in the northern region of İzmir.

Wind investments also gained momentum with the Renewable Energy Law (Law No. 5346) that came into force in 2005. Especially the Aegean coasts with fest wind speed and potential have become suitable regions for RES investments. The concentration of RES investments in the Aegean Region has continuously attracted the sector and investors to this region. In 2010, major project investments were directed to İzmir due to its strong highway and seaway connections, logistic infrastructure, wind energy potential, and strong port infrastructures. The Northern İzmir Sub-Region, which is the research area, is also the region with the highest wind speed in Türkiye. For this reason, wind industry and energy investments have recently been drawn to the northern part of İzmir. In addition to Aliağa Port, which is in the region and has a strategic location in terms of logistics, the planning of Çandarlı Port for the wind energy sector is considered an important opportunity for the export and import of wind energy equipment in the northern part of İzmir.

Table 6 shows the number of facilities for energy types currently in existence and in the investment phase in the Northern İzmir Sub-Region. It is seen that sustainable green energy production such as wind and solar is

available in all districts, but due to the high wind potential, it is more concentrated in the Aliağa and Bergama districts, which share the Yunt Mountain with their borders.

Table 6- Number Of Current Energy Production Facilities in The Northern İzmir Sub-Region (Energy Atlas, 2024a-2024f; TWEA, 2024a)

District	Natural Gas	WPP	SPP	Geothermal	Fossil Fuel	Biogas
Aliağa	3	68 (46)	6(2)	0	3	0
Bergama	0	90 (83)	4(1)	0	0	1
Dikili	0	4	4	0	0	0
Kınık	0	11	4	0	0(1)	0

The values shown in parentheses in Table 6 show the number of energy plants in the investment phase. Of the wind energy plants in the Aliağa district, ¾ of the wind energy plants and 1/3 of the solar energy plants are in the investment process. On the other hand, as shown in Table 6, as many wind energy plants are in the construction process as the wind energy plants currently operating in Bergama district. The number of solar energy plants increases from 4 to 5 in Bergama. On the other hand, fossil fuel thermal power plants and natural gas conversion plants are in Aliağa district, where heavy industry facilities are located.

6. DISCUSSION AND CONCLUSION

The energy investments for meeting the energy demand created by the economic growth resulting from Türkiye's development and growth policies after 2000 are examined from a spatiotemporal perspective in the Northern İzmir Sub-Region. The Northern Izmir Sub-Region is an important wind energy production area for Türkiye and significant energy investments have been made in the Northern Izmir Region throughout its history.

It is important to examine spatial and regulation dynamics of energy investments in a time-spatial perspective since energy investments are crucial for the future of the regions both economically and environmentally. In this context, this study has analyzed the historical context of the energy sector investments in the study area, the locations of the energy plants, the land uses they constructed, the license and environment impact statuses, and the projects planned for their growth.

Wind power plants and other energy sources such as solar energy, natural gas, fossil fuel and biogas power plants were also examined as energy-producing facilities in the region. As can be seen from the analysis, the locations of the wind turbines are established in locations close to the industry, free zones, wind zones, and sub-industries. Over the years, investments have been made in the region by increasing the turbine power capacities and ignoring the environmental impact assessment processes and regulations for land use categories like forest and agricultural areas. These facilities, like the wind sector, have transformed the natural environment with their capacity increase over the years. Aliağa and Bergama districts have become investment focus areas due to factors such as industrial assets, logistics potential, port infrastructures, and wind potential. Renewable energy facility investments currently under construction have also preferred to be in these regions.

The location of the fossil fuel and natural gas plants is heavily related to industrial production. These facilities produce energy for industry to produce billets and coils by converting scrap iron into liquid steel through heat treatments. At the same time, steel obtained from the recycling of scrap steel is also used in the production of wind turbines. The northern region of Izmir is also determined in the regional plan as a region where manufacturing companies producing wind energy are clustered.

Regarding the future renewable energy sector, it is not difficult to foresee that fossil fuel use is not sustainable and that the scenario of abandoning it and converting green energy to green energy is inevitable because it has various negative effects on nature and people. However, fossil fuel-based energy plant construction is in question in the region in parallel with green energy investments. On the other hand, the concentration of the industry and energy sector in the same region attracts the industry sector and the necessary infrastructure investments to the same region, causing more industrial facilities and more energy production facilities in the region. Although green energy causes relatively little damage to nature when it is considered that it changes nature

and the ecosystem it is in, it affects the sustainability of the existing natural environment. The analyses clearly show that the share of the wind and renewable energy sector in the Northern İzmir region will grow rapidly in the future.

The analyses reported important results for policymakers and decision-makers responsible for the future of Türkiye's cities and rural areas. In the Northern İzmir Sub-region, an intensive capital accumulation process continues, which increases both the consumption of fossil and green energy resources and the production to meet this consumption. Although wind energy, which is focused on in this study, is relatively less damaging to nature, it transforms natural areas and disrupts and interrupts the socio-economic systems created by natural area users. Policymakers need to be aware that their preferences do not disrupt natural areas and traditional production methods in natural areas when creating green energy policies.

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Yazar Katkıları / *Author Contributions*	**Yazarlar / *Authors***
Çalışmanın içeriği ve tasarımı/Conception/Design of Study	Z. Ökmen – U. Erdem
Metodoloji / Methodology	Z. Ökmen – U. Erdem
Veri toplama-oluşturma-iyileştirme / Data Curation	Z. Ökmen – U. Erdem
Analiz/Analysis and interpretation of data	Z. Ökmen – U. Erdem
Görselleştirme / Visualization	Z. Ökmen – U. Erdem
Yazı taslağı / Writing - Original Draft	Z. Ökmen – U. Erdem
Yazma - İnceleme ve Düzenleme / Writing - Review & Editing	Z. Ökmen – U. Erdem
Proje yönetimi / Project administration	Z. Ökmen – U. Erdem

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