Czech University of Life Sciences Prague

Faculty of Economics and Management

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Bachelor Thesis

Analysis of the Adoption of Renewable Energy Sources in Turkey

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Faculty of Economics and Management

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Analysis of the Adoption of Renewable Energy Sources in Turkey

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Objectives of thesis

The main goal of this bachelor thesis is to analyze the current state of the adoption of renewable energy sources in Turkey with the subsequent identification of the main tendencies, as well as with the identification of the main factors that influence the adoption rate in the country on the national level.

Methodology

The methodology of the thesis is represented by the utilization of quantitative techniques, which are based on The World Bank data and which incorporate the following techniques: trend analysis, descriptive analysis, correlation analysis and a linear regression analysis.

The proposed extent of the thesis

45-50

Keywords

Turkey, renewable energy sources, economy, influence, sustainability

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Bulut, U., & Muratoglu, G. (2018). Renewable energy in Turkey: Great potential, low but increasing utilization, and an empirical analysis on renewable energy-growth nexus. Energy policy, 123, 240-250.

Çapik, M., Yılmaz, A. O., & Çavuşoğlu, İ. (2012). Present situation and potential role of renewable energy in Turkey. Renewable Energy, 46, 1-13.

Kaya, D. (2006). Renewable energy policies in Turkey. Renewable and Sustainable Energy Reviews, 10(2), 152-163.

Kaygusuz, K., & Kaygusuz, A. (2002). Renewable energy and sustainable development in Turkey. Renewable energy, 25(3), 431-453.

Kaygusuz, K., & Sarı, A. (2003). Renewable energy potential and utilization in Turkey. Energy conversion and management, 44(3), 459-478.

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Declaration

I declare that I have worked on my bachelor thesis titled "Analysis of the Adoption of Renewable Energy Sources in Turkey" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 15.03.2024 _____

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Analysis of the Adoption of Renewable Energy Sources in Turkey

Abstract

The main goal of this bachelor thesis is to analyze the current state of the adoption of renewable energy sources in Turkey with the subsequent identification of the main tendencies, as well as with the identification of the main factors that influence the adoption rate in the country on the national level.

The methodology of the thesis is represented by the utilization of quantitative techniques, which are based on The World Bank data, and which incorporate the following techniques: trend analysis, descriptive analysis, correlation analysis and a linear regression analysis.

In the conclusion, it is identified that the exchange rate and the real GDP growth are the most influential factors that influence the degree of adoption. Given the current economic situation, it is quite likely that the sustainability agenda should be postponed for the country due to unstable economic situation and the implications that it has for the renewables sources in Turkey.

Keywords: Turkey, renewable energy sources, economy, influence, sustainability

Analýza přijetí obnovitelných zdrojů energie v Turecku

Abstrakt

Hlavním cílem této bakalářské práce je analyzovat současný stav adopce obnovitelných zdrojů energie v Turecku s následnou identifikací hlavních tendencí a také s identifikací hlavních faktorů, které ovlivňují míru adopce v zemi na národní úrovni.

Metodiku práce představuje využití kvantitativních technik, které jsou založeny na datech Světové banky a které zahrnují následující techniky: trendovou analýzu, deskriptivní analýzu, korelační analýzu a lineární regresní analýzu.

V závěru je zjištěno, že směnný kurz a růst reálného HDP jsou nejvlivnějšími faktory, které ovlivňují míru přijetí. Vzhledem k současné ekonomické situaci je docela pravděpodobné, že agenda udržitelnosti by měla být pro zemi odložena kvůli nestabilní ekonomické situaci a důsledkům, které má pro obnovitelné zdroje v Turecku.

Klíčová slova: Turecko, obnovitelné zdroje energie, ekonomika, vliv, udržitelnost

Table of Contents

1 Introduction

The global energy landscape is undergoing a profound transformation as the imperative to combat climate change and achieve sustainable development gains momentum. In this context, the adoption of renewable energy sources has emerged as a pivotal strategy to mitigate greenhouse gas emissions and diversify energy supply. Turkey, as a developing nation with a rapidly expanding economy and increasing energy demand, finds itself at a critical juncture in shaping its energy future. The pursuit of sustainable and clean energy alternatives has become an indispensable facet of Turkey's long-term energy policy.

This bachelor thesis delves into the intricate aspects of renewable energy adoption in Turkey, aiming to provide a comprehensive analysis of the nation's progress, challenges, and potential opportunities in transitioning towards a renewable energy-based economy. The research presented herein encompasses an amalgamation of empirical data and pertinent analysis of this data mainly collected from the World Bank, which traditionally provides many different insights about performance of states in domains of sustainability, energy and economics.

The main motivation for writing this bachelor thesis arises from mainly 2 different points not fully related to each other. The person behind the bachelor thesis comes from a small country living in the post-Soviet environment in Central Asia – Kyrgyzstan. Kyrgyzstan is a country with the majority of population sharing the same Turk ethnicity and cultural heritage as Turkey, which is often regarded as the most prosperous country out of all Turk states. In addition to that, with the rise of sustainability movement all over the world, the author experienced a genuine interest in combining these two factors thus writing a thesis about the current state of adoption of renewable energy sources in Turkey, believing that this study will provide a series of valuable insights for the current state of knowledge.

In conclusion, this bachelor thesis endeavors to contribute to the body of knowledge on renewable energy adoption in Turkey, unveiling crucial insights that can assist the nation in making informed decisions to secure a sustainable and clean energy future. As Turkey embarks on its path towards a greener energy landscape, this research endeavors to pave the

way for an inclusive and successful transition to renewable energy sources, ensuring a harmonious coexistence between economic development and environmental preservation.

2 Objectives and Methodology

2.1 Objectives

The main goal of this bachelor thesis is to analyze the current state of the adoption of renewable energy sources in Turkey with the subsequent identification of the main tendencies, as well as with the identification of the main factors that influence the adoption rate in the country on the national level.

The bachelor thesis is formulated in such a way that the narrative and pertinent analysis will both help to test a few hypotheses that are formulated in this chapter based on the current state of knowledge in the studied domain:

1) Turkey is rapidly expanding its renewable energy impact on the economy and the country.
2) The rate of adoption is significantly influenced by economic factors (GDP growth, exchange rate and unemployment).
3) The country can achieve a relatively sophisticated performance of the sustainability pillar of sustainable growth.

2.2 Methodology

The methodology of the thesis is represented by the utilization of quantitative techniques, which are based on The World Bank data, and which incorporate the following techniques: trend analysis, descriptive analysis, correlation analysis and a linear regression analysis.

The analysis is performed based on the time period between 1990 and 2020, where for some variables there are significant problems with the unavailability of data. The time series analysis helps to address the recent performance of indicators associated with the energy domain, while the descriptive one provides the most important insights about numeric tendencies in the observed data. Consequently, the correlation analysis helps to assess the degree of relatedness or to put it in simple words, the magnitude of the relationship, as well

as their direction. In the end, a linear regression estimation is performed to identify the most influential factor on the renewable energy sources output.

3 Literature Review

3.1 Economy of Turkey

For decades, academics and policy analysts have found the economy of Turkey to be an interesting topic to study and analyze. Turkey's economic development and performance have been impacted by its one-of-a-kind geopolitical location, historical legacy, and policy decisions. Because Turkey is located at the crossroads of Europe, Asia, and the Middle East, its economic development has been particularly significant. The founding of the Republic of Turkey in 1923 is considered to represent the beginning of the modern era of economic history in Turkey. Mustafa Kemal Ataturk, the country's first President and a visionary leader, guided the nation along the road of economic development and reform under his watch. The laying of the groundwork for industrialisation was accomplished by the implementation of a variety of economic policies, including governmental involvement and import substitution (Zürcher, 2017).

Agriculture has always been an important industry in Turkey, playing a big role in the country's labor market as well as the economic well-being of rural communities. Cereals, fruits, vegetables, and tobacco are some of the most important crops. The manufacturing industry as a whole has seen significant expansion, with the textiles, automotive, electronics, and machinery sub-sectors emerging as the most important ones. The cities of Istanbul, Izmir, and Ankara are all important centers of industry. Trade, tourism, banking, and telecommunications are all examples of service industries that contribute significantly to Turkey's GDP. The location of the nation is one factor that contributes to the success of its tourist business (Aydin, 2010).

In the early years of the 21st century, Turkey's economy expanded at a rate that was significantly faster than the world average, growing at over 5% per year on average. Growth rates, on the other hand, have been very unpredictable and subject to the impact of both internal and external variables. Over the course of many years, inflation has remained a troublesome issue despite its many shifts. In order to maintain price stability and keep inflation under control, the Central Bank of Turkey has implemented a number of different monetary policies. Due to high public expenditure and insufficient income collection, there

has been a worry over budgetary deficits, which has necessitated the implementation of fiscal discipline (Subasat, 2014).

The economy of Turkey is closely connected into global markets, and both exports and imports make considerable contributions to the country's gross domestic product. Its most important commercial partner continues to be the European Union. Nevertheless, excessive inflation and currency depreciation have had a severe impact on both the purchasing power of consumers and the confidence of investors, which has a ripple effect on the economy as a whole. The economy has become more vulnerable to shocks from the outside world as a result of substantial current account deficits brought on by its reliance on imports for both sources of energy and capital goods (Hoekman & Togan, 2005).

Uncertainty has been brought about as a result of Turkey's political climate and its position in the geopolitical arena, which has an effect on the country's commercial relations and the investments of international companies. Productivity and economic inclusion are both hampered by structural problems in the labor market, such as the existence of informal work and mismatched skill sets. In spite of all of these obstacles, Turkey has a significant amount of untapped development potential. Because of its advantageous position, it serves as a conduit for commercial and financial exchanges between Europe and Asia, so fulfilling the role of a bridge. In addition, a population that is both young and increasing has the opportunity for a demographic dividend, which may be realized to its full potential if education and the acquisition of new skills are prioritized. It is possible to improve economic competitiveness and connectedness by continued investment in infrastructure, such as transportation and electricity (Hale, 2023).

It is possible to foster innovation and activities with a better value-added contribution by promoting the diversification of the economy towards knowledge-intensive industries and services. In order to maintain vigilance in the implementation of policies to strengthen economic resilience, increase productivity, and cultivate an inclusive and competitive economy for the benefit of all citizens, policymakers need to remain watchful (Bachard, 2023).

3.2 Sustainable Development

In the 21st century, there has been a rise in interest in the multifaceted notion of sustainable development. The concept was coined once the world at large acknowledged the critical link between sustainable development, social advancement, and environmental conservation. It's a blueprint for action that seeks to provide for the here-and-now without jeopardising future generations' capabilities to do the same. Sustainable development takes into account the interconnected nature of ecological, economic, and social systems and calls for multidisciplinary efforts to solve pressing global problems (Parris & Kates, 2003).

The World Commission on Environment and Development, chaired by former Norwegian Prime Minister Gro Harlem Brundtland, published a landmark report on sustainable development in 1987. The notion was first introduced in a report written by Brundtland called "The World We Want." The paper emphasised the significance of long-term thinking and intergenerational responsibility in achieving sustainable development, which entails striking a balance between economic development, environmental conservation, and social fairness (Mitlin, 1992).

Sustainable development is predicated on the understanding that ecological, economic, and social systems are interdependent on one another. This all-encompassing view recognises the interconnectedness of several dimensions and the potential impact of individual acts. It highlights the need for knowledge of the complex interconnections among ecosystems, economies, and human welfare as a prerequisite for making effective policy decisions. Promoting social fairness and inclusion is key to the concept of sustainable development. Realising that a sustainable future must be available to all members of society, it tackles issues of poverty, inequality, and social injustice. Achieving sustainable development objectives requires fostering social cohesiveness and guaranteeing equitable access to opportunities and resources (Rogers et al., 2012).

Sustainability relies on careful management of natural resources, hence environmental protection is essential. It comprises the careful administration of, and safeguarding of, natural resources, biological variety, and ecological systems. Sustainable development seeks to maintain the well-being of present and future generations by conserving ecosystem

integrity and protecting the environment. Sustainable development emphasises thinking and acting in terms of the long term. It entails realising the value of preserving future populations and thinking about how current choices may affect them (Elliot, 2012).

Climate change, fueled mostly by human activity, poses one of the greatest threats to sustainable development. Ecosystems, human settlements, and economic activities are all at jeopardy as a result of rising global temperatures, extreme weather events, and sea level rise. Deforestation, habitat degradation, and overexploitation are all human actions that contribute to biodiversity loss. The destruction of these ecosystems disrupts not just the delicate balance of nature, but also the provision of key services necessary for human flourishing and long-term growth. Also, the progress towards sustainable development is hampered by pervasive poverty and socioeconomic inequities. To end poverty and boost shared prosperity, achieving social fairness and include all members of society is essential. Environmental decay and resource scarcity are direct results of unsustainable consumption and production patterns. To guarantee sustainable growth for future generations, responsible resource management is crucial (Holmberg & Sandbrook, 2019).

Rapid urbanisation and the accompanying growth in infrastructure both pose difficulties for long-term sustainability. A key component of sustainable development is striking a balance between the requirements of expanding urban populations and the needs of the environment and the efficient use of resources (Jabareen, 2008).

However, there are some possible routes to long-term sustainability:

1) Climate change mitigation and greenhouse gas emission reduction may be achieved through the transition to renewable energy sources including solar, wind, and hydropower (Chichilinsky, 1997).

2) Food security may be improved and the environmental effect of agriculture lessened by the adoption of sustainable agricultural practises such organic farming, agroecology, and responsible land use (Pezzey, 1992).

3) A more sustainable economy may be achieved by the implementation of a circular economy model that prioritises recycling, waste reduction, and resource efficiency (Brundtland, 1987).

4) Fostering a culture of sustainability and encouraging responsible decision-making at all levels of society requires education and awareness campaigns focused on sustainable development and its principles (Dalal-Clayton & Bass, 2002).

5) To drive transformational change and promote sustainable practises across sectors, it is essential to have policies and governance structures in place that include sustainable development ideas into national and international agendas (Carley & Christie, 2000).

3.3 Renewable Energy Sources

The search for environmentally friendly energy options on a worldwide scale has led to a greater emphasis being placed on renewable energy sources as a practical alternative to conventional fossil fuels. The generation of electricity, heat, or fuel using renewable energy sources does not involve the depletion of finite resources or the emission of damaging greenhouse gases since these processes are harnessed from nature. This chapter takes a look at a variety of renewable energy sources, analysing their technical developments, implications on the environment, and the potential they have to build a more sustainable energy future (Dincer, 2000).

1) Solar energy.

   The sun's rays are used to create either electricity using photovoltaic (PV) cells or heat using solar thermal systems when solar energy is harnessed. Solar thermal systems employ sunlight to heat water or other fluids for use in industrial or household applications, whereas photovoltaic cells directly turn sunlight into energy. Solar energy has been the beneficiary of significant technical breakthroughs, which have led to improvements in both its efficiency and its cost effectiveness. In comparison to power production based on fossil fuels, solar energy generation results in almost no emissions of greenhouse gases and a smaller water

impact. These are two of the environmental benefits of solar energy (Kannan & Vakeesan, 2016).

2) Wind energy.

Wind energy is a form of renewable energy that generates electricity by harnessing the kinetic energy of wind to turn wind turbines. Wind power's capacity and efficiency have considerably increased in recent years as a result of the ongoing development and growth of wind turbines. Wind energy projects have grown widespread in many places, particularly in areas that offer circumstances that are favourable for the generation of wind energy. Concerns concerning its influence on bird and bat populations, visual aesthetics, and noise pollution continue to be issues of inquiry and controversy, despite the fact that wind energy can be replenished indefinitely and does not cause any direct emissions (European Wind Energy Association, 2009).

3) Hydropower.

The generation of electricity using hydropower involves harnessing the potential energy of moving water, such as that found in rivers and waterfalls. It continues to be one of the renewable energy sources that is the most well-known and utilised on a worldwide scale. The scale of hydropower facilities can range from enormous dams to very modest run-of-river structures. Concerns have been raised about the environmental and social implications of major dams, including the destruction of habitat, the loss of biodiversity, and the relocation of populations. Hydropower, on the other hand, provides a stable and dispatchable source of electricity (Bagher et al., 2015).

4) Biomass energy.

The energy that is derived from organic materials, often known as biomass, includes things like agricultural wastes, trash from forestry, and energy crops. It may be utilised for the generation of power, for heating, and as a feedstock for the production of biofuels. Because the carbon that is released during burning is then reabsorbed by new plant growth, biomass is considered to be a renewable resource. However, in order for biomass to be a viable source of energy in the long run, it

must be sourced and managed in a responsible manner in order to prevent the destruction of ecosystems and forests (Hall, 1991).

5) Geothermal energy.

   Geothermal energy is a form of renewable energy that generates electricity and directly heats buildings by tapping into the heat that is produced deep under the Earth's crust. Geothermal power plants use heat from subterranean reservoirs to generate electricity, while geothermal heat pumps make optimal use of the relatively constant temperature of the Earth's subsurface to heat or cool buildings. Geothermal energy is an attractive possibility for environmentally friendly power sources since it is dependable and produces very little pollutants (Fridleifsson, 2001).

6) Ocean energy.

   Ocean energy refers to a variety of different methods that are used to create electricity by harnessing the power of the ocean's tides, waves, and currents. Tidal and wave energy systems make use of the rise and fall of tides or the kinetic energy of waves, respectively, while ocean current energy makes use of the movement of ocean currents. Tidal and wave energy systems have been around longer than ocean current energy. The growth of ocean energy is still in its infancy, and it faces obstacles on three fronts: the technological, the environmental, and the economic. However, considering the massive energy reserves that are contained inside the seas of the planet, its potential as a large-scale renewable energy source holds great promise (Melikoglu, 2018).

The incorporation of renewable energy sources into already-established electricity systems presents a number of benefits as well as obstacles. Because of their variable nature, such as the dependency of solar and wind power on prevailing weather conditions, complex grid management and energy storage technologies are required in order to assure the stability and dependability of the system. Innovations in smart grid technology, demand response programmes, and energy storage systems all play important supporting roles in the process of allowing the smooth integration of conventional power generation with renewable energy sources (Moriarty & Honnery, 2012).

In comparison to fossil fuels, the carbon footprints left by renewable energy sources are often much smaller. They provide a substantial opportunity to cut emissions of greenhouse gases and to lessen the severity of the effects of climate change. However, certain renewable technologies, such as hydropower on a large scale and biomass energy, might have distinct environmental repercussions. These consequences can include the transformation of habitats, impacts on water resources, and changes in land use. To reduce the negative effects on the environment, careful planning, environmentally responsible behaviour, and technological advancement are all necessities (Twidell, 2021).

The use of renewable energy sources can have a variety of effects on both the economy and society. On the one hand, the renewable energy industry has been responsible for the creation of new employment and possibilities in the areas of manufacture, installation, and maintenance. In addition, the implementation of community-scale renewable energy projects gives communities the ability to become more energy independent and resilient. However, shifting away from fossil fuels and towards renewable energy sources may also provide challenges for some businesses and ways of life. It is necessary to take proactive legislative measures, invest in workforce development, and participate in social engagement in order to guarantee a just and equitable energy transition (Bull, 2001).

The laws and restrictions enacted by governments have a considerable impact on the development of renewable energy sources and their implementation. Supportive policies, such as feed-in tariffs, tax incentives, and renewable energy targets, have all played significant roles in boosting investments and market acceptance of renewable energy sources. On the other hand, rules that are incoherent or vague can make the adoption of renewable energy more difficult and increase the level of uncertainty for investors and project developers. In order to encourage investments in renewable energy and to nurture innovation within the industry, it is essential to have a policy climate that is both stable and supportive (Lund, 2007).

Research and innovation must be sustained if we are to make progress in the field of renewable energy technology and bring down associated costs. The evolution of science and engineering has made it possible to achieve a better level of efficiency, develop superior methods for the storage of energy, and create new materials. Unlocking the full potential of

renewable energy sources and accelerating the transition to a future with sustainable energy requires substantial investments in research and development from both the public and private sectors (Kaltschmitt, 2007).

4 Practical Part

4.1 Development in Time

The first part of the analysis, where the own contribution of the author on the topic of renewable energy sources in Turkey will be produced, is dedicated to the analysis of the recent development of the selected indicators. Before proceeding to the specification of the dataset, it is important to mention one of the biggest limitations of the study – the unavailability of data for specific variables for the selected time period. However, despite this limitation, the author can continue to carry the analysis on, where the development of variables and their behavior will be discussed. The data was collected mainly with the help of the World Bank, which presents a lot of different compilations for the most studied domains, where the domains of sustainability and energy are one of the most sophisticated ones. Through the utilization of data from the World Bank, the author ensures that data does fully represent the real situation and there is no problem with bias.

The dataset for the analysis is presented in Table 1.

Table 1. The dataset for the time series analysis.

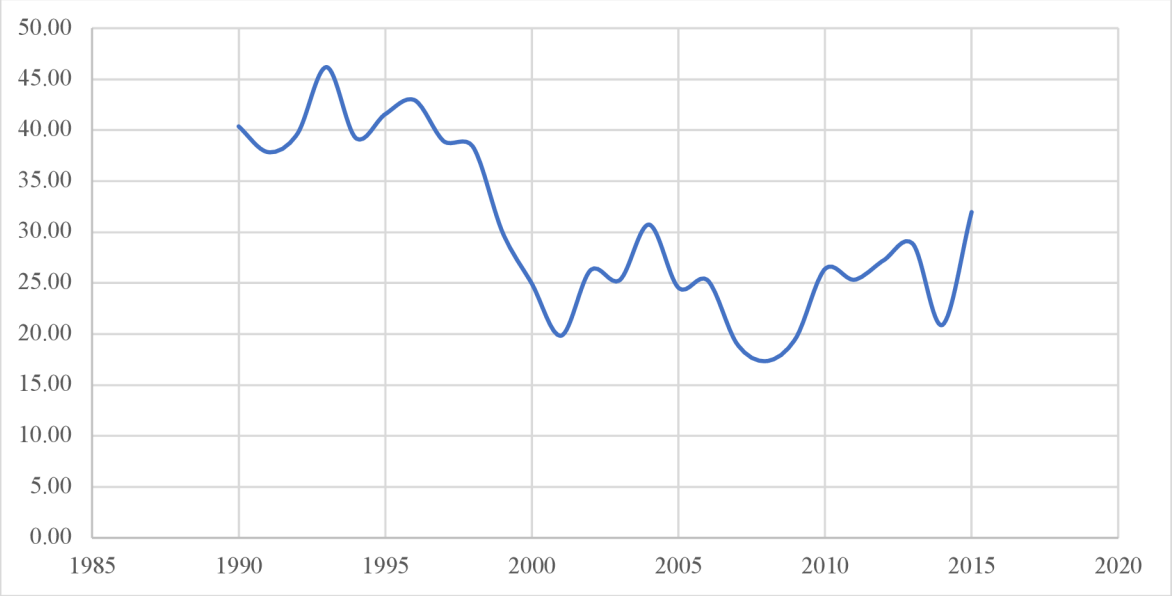
Year	*Renewable output, %*	*Renewables consumption, %*	*Fossil fuel consumption, %*	*Electric consumption, kwh per capita*	*CO2 emissions, kt per capita*
1990	40.37	24.37	81.77	922.81	2.56
1991	37.85	23.98	81.42	956.92	2.60
1992	39.63	23.98	81.37	1034.10	2.66
1993	46.18	23.55	81.39	1102.69	2.72
1994	39.22	24.05	81.62	1130.85	2.64
1995	41.57	21.90	82.59	1210.38	2.84
1996	42.94	21.04	83.24	1309.17	3.07
1997	38.91	20.69	83.78	1418.71	3.16
1998	38.33	21.53	83.63	1497.81	3.11
1999	29.98	20.47	84.53	1534.21	3.05
2000	24.94	17.29	86.25	1630.23	3.38
2001	19.84	18.12	86.07	1591.19	3.04
2002	26.25	17.49	86.07	1646.06	3.15
2003	25.29	16.29	87.04	1751.21	3.28
2004	30.73	16.78	86.70	1870.23	3.31
2005	24.54	15.34	88.06	1990.40	3.42
2006	25.25	14.23	89.00	2152.63	3.75
2007	19.03	12.48	90.50	2318.09	4.10
2008	17.35	12.53	90.56	2392.07	4.03
2009	19.58	13.12	89.90	2285.71	3.99
2010	26.38	14.21	89.12	2462.07	4.07
2011	25.33	12.68	89.97	2668.53	4.30
2012	27.23	13.03	89.41	2746.00	4.38
2013	28.82	13.80	88.16	2732.21	4.17
2014	20.89	11.51	89.54	2815.04	4.37
2015	31.96	13.34	86.84	-	4.44
2016	-	13.23	-	-	4.65
2017	-	11.40	-	-	5.09
2018	-	11.83	-	-	5.00
2019	-	14.12	-	-	4.78
2020	-	13.72	-	-	4.84

Source: The World Bank, 2023

It becomes pretty clear that all variables' data availability allows the author to implement both correlation and regression analyses on the time period between 1990 and 2014. Furthermore, there is no data for the renewable energy output between 2016 and 2020; no data for the fossil fuel consumption between 2016 and 2020 and no data for the electric power consumption per capita between 2015 and 2020. The first variable discussed in the

context of the time series analysis is the renewables output, the chart for which is presented in Figure 1.

Figure 1. The chart for the renewables output (1990-2015).



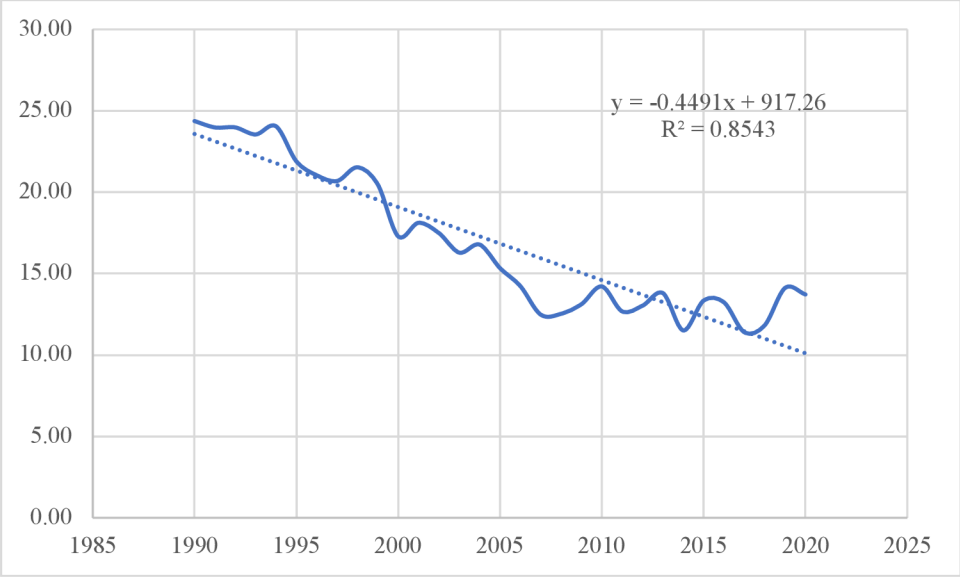
Source: own investigation based on The World Bank, 2023

Contrary to the international dynamic of switching to renewables and following the sustainability agenda, the behavior of the variable suggests that Turkey was following a slightly different path compared to developed countries and societies really focused on making their energy sectors sustainable. At the beginning of the 90s, the share of renewables output in the overall energy output of the country was approaching the boundary of 50%, which was a really outstanding result, especially when considering the fact that it was far before the world became really aware of the pace of the climate change and destructive power of fossil fuels. However, as the time progressed, Turkey started to rely less and less on the renewable energy output and instead of accumulating further production sites of renewable energy, the country shifted to traditional sources of energy that resulted in a dramatic decrement in the share of the renewable energy output in the country.

The situation started to change for better in 2000-2004, when there was a slight increment in the share, but it was soon reversed once more until reaching the all-time low in 2007-2009, which is almost certainly likely to have been caused by the Great Recession and the blow to Turkish economy that the crisis inflicted. As of the 10s, the situation was reversed

once more, and it seems that the country is focused at expanding its production of renewable energy once again. Due to the data unavailability, it is impossible to properly address the period between 2015 and 2020, but the renewable consumption variable is expected to help with this task. The chart for the second variable is presented in Figure 2.

Figure 2. The chart for the renewables consumption (1990-2020).



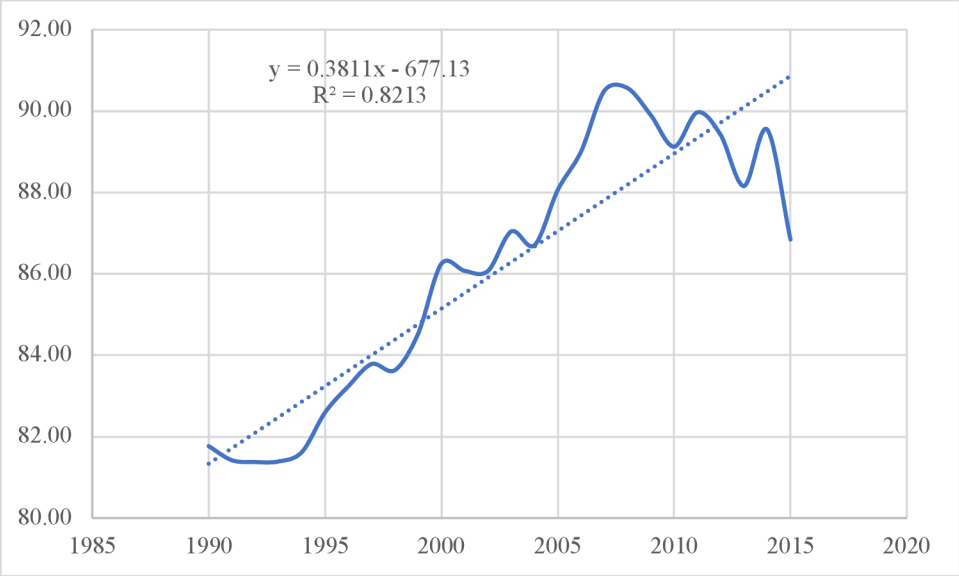
Source: own investigation based on The World Bank, 2023

The situation with the share of renewables in the total consumption of energy in Turkey underpins that the focus on the renewable energy sources was being shifted to traditional sources of energy. The development of the renewable energy consumption does seem to have a specific kind of downward-sloping trend, which suggests that an annual decrement in the share of the renewable energy consumption in Turkey was equal to 0.4491 percentage points annually, which is definitely a bad sign for the renewable sector in the analyzed country.

Furthermore, it seems that there were no significant efforts to increase the indicator until approximately the mid 10s, when the first substantial increment in the value of the indicator was identified in 2016, but it is quite fair to anticipate that the pandemic of COVID-19 took a negative toll on the renewable energy sector, so the development of the variable after the pandemic was over is likely to continue the downward sloping trend's movement even further thus reaching the all-time historic minimum for the share of renewables in Turkish

consumption. The third variable is the fossil fuel share in the total consumption, whose chart is presented in Figure 3.

Figure 3. The chart for the fossil fuel consumption (1990-2015).



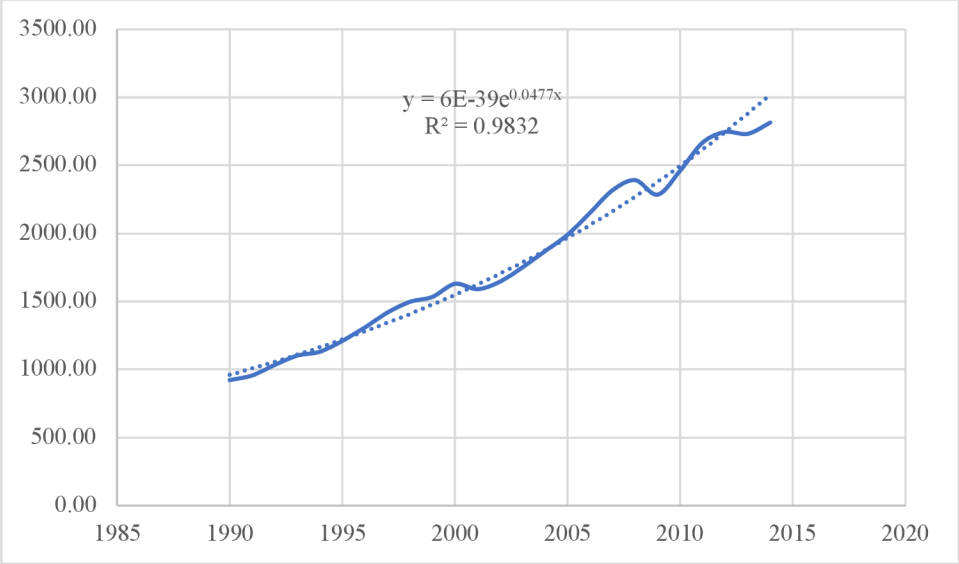
Source: own investigation based on The World Bank, 2023

It was quite anticipated that the chart for the fossil fuels' consumption will be an upward-sloping curve due to the fact that the country was rapidly decreasing its reliance on the renewable sources of energy in the total energy consumption in the country. Furthermore, according to the estimated linear trend, it can be said that the annual increase in the share of fossil fuels was 0.3811 percentage points, which is quite a lot and unusual, when considering the fact that countries were focused on reaching the opposite kind of behaviour in the variable. However, there seems to be a structural change in 2015, which might be the consequence of the adoption of the Paris Agreement that explicitly stated the goals of reversing the global warming and stopping the world from entering the path of attaining the point of no return.

The development of the renewable energy sources, which has the time period between 2015 and 2020 included in the chart as well suggests that the sharp drop in the value of the fossil fuel consumption did not persist there for a long time and the indicator quickly returned back to its ordinary values of approximately 88-90 per cent. The fourth variables describes

the consumption of electricity in Turkey per capita, the chart for which can be found in Figure 4.

Figure 4. The chart for the electric consumption per capita (1990-2014).



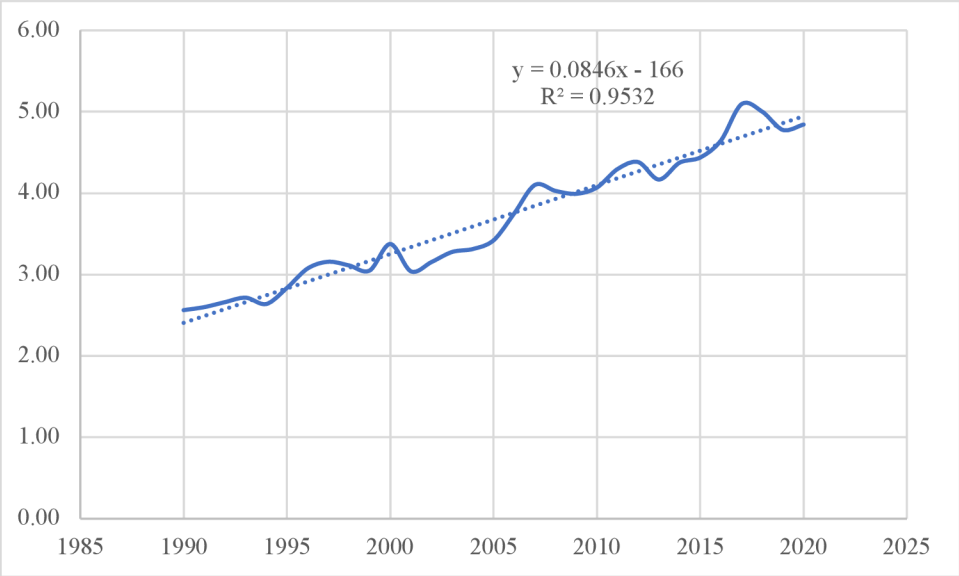
Source: own investigation based on The World Bank, 2023

The nature of the behaviour of the studied variable over time indicates not a linear pattern but rather an exponential one, which is pretty logical, especially when considering the fact that the electric consumption per capita inevitably consists of two components – the total electric consumption and the population, where the second indicator traditionally increases in the exponential way. According to the fitted trend, whose direction is perfectly clear, the annual increase in the consumption per capita between 1990 and 2014 was 0.0447 per cent, which is a good sign indicating that the country's production of energy is able to keep up with the rapidly increasing population of Anatolia.

As of 2014, it seems that the country was able to achieve its goal of keeping up with the population growth, but it is still uncertain of whether the tendency persisted for the further time period covering 2014-2020, but it cannot be verified due to the unavailability of data in the World Bank for the aforementioned time period. However, for the country to experience a sharp fall in the value of indicator, it is quite certain that a lot of years would have to pass due to the identified positive tendency that is quite likely to persist in the nearest future for the country. The very final variable is more concerned with the imprint that the country

leaves behind in terms of carbon dioxide emissions per capita. The chart for the variable is presented in Figure 5.

Figure 5. The chart for the carbon dioxide emissions per capita (1990-2020).



Source: own investigation based on The World Bank, 2023

Unfortunately, the country was keen on rapidly expanding the volume of CO_2 emissions that it produces per capita with the annual increase in the value of the indicator approximately equal to 0.08 kt per capita, which is definitely not good and given its large population, this is expected to be taking a serious toll on the atmosphere of the planet thus accelerating the rate of the global warming rather than stopping it, as it was suggested in the Paris Agreement from the year 2015.

If Turkey will not stop producing more and more emissions, it is likely that the country will soon join the ranks of the world's most polluting nations alongside with China and the Russian Federation, which might quite soon become the reality since the pace at which the indicator increases is really high, which is obviously a bad sign. The next chapter of the thesis is dedicated to the same series of variables.

4.2 Descriptive Insights

In this chapter, a descriptive analysis is performed on the same set of variables from the previous chapter. The first variable for which descriptive statistics will be computed is the renewable energy output – the table with the results is presented in Table 2.

Table 2. Descriptive statistics of the renewable energy output.

Renewable output, %	
$\hat{X}$	30.26
S.E	1.73
$\bar{X}$	27.23
$\tilde{X}$	#N/A
σ	8.64
σ^2	74.62
Kurt.	-1.25
Sk.	0.29
R	28.83
Min	17.35
Max	46.18
Σ	756.42
N	25.00

Source: own investigation based on The World Bank, 2023

The average value of the renewable energy output for the analyzed period was 30.26 per cent, which remains to be a decent result. On the other hand, the standard deviation and standard error both indicate that the development of the variable was highly variable and fluctuating. Furthermore, the variable has a striking range of 28.83 units, which is influenced by the fact that the gap between the all-time low – 17.35 per cent and the all-time high – 46.18 per cent is quite enormous. Overall, the country was not experiencing a single pattern of the development of the variable over the studied period of 25 years. The next discussed variable is presented in Table 3.

Table 3. Descriptive statistics of the renewable energy consumption.

Renewables consumption, %	
$\hat{X}$	17.78
S.E	0.88
$\bar{X}$	17.29
$\tilde{X}$	23.98
σ	4.41
σ^2	19.43
Kurt.	-1.49
Sk.	0.19
R	12.86
Min	11.51
Max	24.37
Σ	444.46
N	25.00

Source: own investigation based on The World Bank, 2023

Contrary to the output variable, the average percentage of renewable energy consumption is almost 2 times lower – 17.78 per cent during the studied period of 25 years. The standard error and standard deviation both indicate a certain degree of variability, which is visibly less than for the case of the production variable. Furthermore, the assumption about a lower degree of variability and instability is supported by the range value – just 12.86 units, which is significantly lower than the case of the output variable. This is influenced by the minimum value – 11.51 per cent and the maximum – 24.37 per cent. The next variable to be discussed is presented in Table 4.

Table 4. Descriptive statistics of the fossil fuel consumption.

Fossil fuel consumption, %	
$\hat{X}$	86.07
S.E	0.66
$\bar{X}$	86.25
$\tilde{X}$	#N/A
σ	3.28
σ^2	10.75
Kurt.	-1.49
Sk.	-0.16
R	9.19
Min	81.37
Max	90.56
Σ	2151.70
N	25.00

Source: own investigation based on The World Bank, 2023

Quite naturally, the average share of fossil fuels in the overall consumption of Turkey is equal to 86.07 per cent on the studied period, which is significantly higher than the consumption of renewables. Additionally, the deviation is really high and almost non-existent as the share is fluctuating between the value of 81 and 90 per cent, which is an enormous number. As of now, it does not seem that Turkey was making a huge effort to turn the tide and focus on the renewable sources of energy as it was doing at the beginning of the 90s. The descriptive statistics for the fourth variable are presented in Table 5.

Table 5. Descriptive statistics of the electric consumption per capita.

Electric consumption, kwh per capita	
$\hat{X}$	1806.77
S.E	122.48
$\bar{X}$	1646.06
$\tilde{X}$	Not identified
σ	612.42
σ^2	375060.06
Kurt.	-1.24
Sk.	0.23
R	1892.23
Min	922.81
Max	2815.04
Σ	45169.34
N	25.00

Source: own investigation based on The World Bank, 2023

The average consumption per capita of electricity in Turkey was 1806.77 kwh, which is quite a high number, but when bearing in mind the fact that Turkey is a highly industrialized and developing country, this number does not surprise anymore. On the other hand, the indicator was rather volatile and not stable, which is visible when looking at the values for the standard error, standard deviation and the range. The range is higher than the mean, which is an indicator of huge instability of the indicator. This is mainly explained by the fact that the difference between the minimum of 922 and the maximum of 2815 is strikingly huge. The final variable is presented in Table 6.

Table 6. Descriptive statistics of CO_2 emissions.

CO2 emissions, kt per capita	
$\hat{X}$	3.41
S.E	0.12
$\bar{X}$	3.28
$\tilde{X}$	Not identified
σ	0.61
σ^2	0.37
Kurt.	-1.32
Sk.	0.28
R	1.82
Min	2.56
Max	4.38
Σ	85.14
N	25.00

Source: own investigation based on The World Bank, 2023

The average value of CO_2 emissions per capita in Turkey is 3.41 kt, which is definitely not a small number but Turkey is still significantly lagged behind China and the United States, who both are the biggest producers of carbon dioxide emissions to the atmosphere with the values of 7.44 and 15.32, respectively, as of 2016. Effectively, the indicator was also not stable and was rapidly moving, which is observed when looking at the standard error, standard deviation and the range of the indicator. Overall, the range is somewhat medium, which is explained by the fact that the absolute minimum of emissions was 2.56 and the absolute maximum was 4.38, but it is anticipated that the absolute maximum's figure is likely to increase with every single year due to the identified tendency. The next part of the empirical analysis is dedicated to the correlation analysis.

4.3 Correlation Verification

The correlation analysis will help to assess the degree of associations between the discussed variables with the matrix of correlations computed in Microsoft Excel presented in Table 7.

Table 7. Correlations.

	Renewable output	*Renewables consumption*	*Fossil fuel consumption*	*Electric consumption*	*CO_2 emissions*
Renewable output	1				
Renewables consumption	0.87	1			
Fossil fuel consumption	-0.89	-0.99	1		
Electric consumption	-0.76	-0.96	0.94	1	
CO2 emissions	-0.73	-0.95	0.94	0.99	1

Source: own investigation based on The World Bank, 2023

According to the matrix of correlations and when considering the sample size (25 observations), it becomes pretty evident that literally all correlation pairs are expected to be statistically significant, so there is no need for a pertinent hypothesis testing procedure. All correlation coefficients have values higher than 0.72 in absolute terms, which indicates a strong linear association between variables.

The renewable output is positive correlated with the renewables consumption, which is pretty logical since they both indicate the expansion of the renewables sector. The association between the renewables output and the fossil fuel consumption is negative, which is explained by the fact that fossil fuels and renewable energy sources are substitutes. The correlation between the electric consumption and the renewables output is also negative, which might prompt the author to consider that as the consumption increases, the country starts to rely more and more on fossil fuels. Finally, the correlation between the carbon dioxide emissions and renewable output is also negative, which is pretty common as the renewable output is a universal remedy from accelerating the growth of emission values in the atmosphere.

The correlation between the renewables consumption and fossil fuel consumption is perfectly colinear and negative, which is quite logical due to their complete substitution to one another, while the electric consumption and CO_2 emissions do also follow the same logic described in the previous paragraph dedicated to the renewable output. Fossil fuel consumption is positively correlated with the electric consumption and CO_2 emissions,

which underpin the general belief that fossil fuels are something that inevitably accelerate the pace of global warming and pollution of the atmosphere. Finally, the correlation between the electricity consumption and CO_2 emissions is almost perfectly colinear, which underpins that the energy sector, if it does not specialize on the renewable energy sources, is likely to constantly inflict a serious amount of damage on the atmosphere of the planet. The final part of the empirical analysis is dedicated to the regression estimation, which is presented in the final subchapter of the practical part of the work.

4.4 Regression Estimation

The regression estimation is based on the OLS method, where first a linear regression model will be estimated and then it will be applied to calculate the value of the renewable output in Turkey in 2023. In addition to that, the identification of the most influential factors for the renewable energy output in Turkey will be done with the help of the following model:

$$Q(Renewable) = f(RATE, U, \Delta GDP)$$

It is assumed that the total production of renewable energy in Turkey (in %) is a function of the exchange rate (lira for USD), unemployment (%) and the change in the real GDP (%). The econometric form of the model has the following characteristics:

$$Q = \rho_0 + \rho_1 RATE + \rho_2 U + \rho_3 \Delta GDP + U_e$$

It is expected that the sign of the exchange rate will be negative due to the fact that Turkey is quite likely to import equipment that help countries to properly absorb the energy and process it; the unemployment is also likely to have a negative degree of association, while the GDP growth rate will have a positive effect. The underlying assumption is that during the times of economic instability, the country turns its back on renewables and shifts to fossil fuels due to less complicated and more straightforward production. The dataset used for the estimation purposes in presented in Table 8.

Table 8. The dataset for the regression.

Year	*Renewable output, %*	*Lira/USD*	*Unemployment, %*	*Real GDP growth, %*
1990	40.37	0.00	7.54	9%
1991	37.85	0.00	8.21	1%
1992	39.63	0.01	8.51	5%
1993	46.18	0.01	8.96	8%
1994	39.22	0.03	8.58	-5%
1995	41.57	0.05	7.64	8%
1996	42.94	0.08	6.63	7%
1997	38.91	0.15	6.84	8%
1998	38.33	0.26	6.89	2%
1999	29.98	0.42	7.69	-3%
2000	24.94	0.63	6.50	7%
2001	19.84	1.23	8.38	-6%
2002	26.25	1.51	10.36	6%
2003	25.29	1.50	10.54	6%
2004	30.73	1.43	10.84	10%
2005	24.54	1.34	10.64	9%
2006	25.25	1.43	8.72	7%
2007	19.03	1.30	8.87	5%
2008	17.35	1.30	9.71	1%
2009	19.58	1.55	12.55	-5%
2010	26.38	1.50	10.66	8%
2011	25.33	1.67	8.80	11%
2012	27.23	1.80	8.15	5%
2013	28.82	1.90	8.73	8%
2014	20.89	2.19	9.88	5%
2015	31.96	2.72	10.24	6%

Source: The World Bank, 2023

First, the presence of multicollinearity (any $r_{xy} > |0.8|$) has to be checked, which will be accomplished with the help of the matrix of correlations, which was already used earlier in the bachelor thesis. The new matrix of correlations, but this time between regressors of the linear regression model, is presented in Table 9.

Table 9. Multicollinearity check.

	Lira/USD	*Unemployment*	*Real GDP growth*
Lira/USD	1		
Unemployment	0.63	1	
Real GDP growth	0.13	-0.06	1

Source: own investigation based on The World Bank, 2023

The condition for detecting multicollinearity stated earlier is not fulfilled, so it is possible to say that the model does not suffer from the multicollinearity problem at all. Therefore, it is possible to implement the OLS method, the output for which (containing the most important elements) can be found in Table 10.

Table 10. Regression output.

Regression Statistics	
Multiple R	0.79
R Square	0.63
Adjusted R Square	0.58
Standard Error	5.49
Observations	26

	df	**SS**	**MS**	**F**	**Significance F**
Regression	3	1131.54	377.18	12.53	0.00
Residual	22	662.27	30.10		
Total	25	1793.81			

	Coefficients	***Standard Error***	***t Stat***	***P-value***
Intercept	36.38	7.78	4.68	0.00
Lira/USD	-8.00	1.79	-4.47	0.00
Unemployment, %	-0.07	0.95	-0.07	0.94
Real GDP growth, %	53.63	23.53	2.28	0.03

Source: own investigation based on The World Bank, 2023

According to the regression output:

$$Q = 36.38 - 8RATE - 0.07U + 53.63\Delta GDP + U_e$$

- In case of all regressors are equal to zero, the average value of the renewable energy output in Turkey will be equal to 36.38 per cent, according to the coefficient of the intercept. The intercept is significant at the significance level of 5 per cent.

- In case if all other regressors remain constant and the exchange rate in Turkey depreciates by 1 lira to the USD, the renewable energy share will drop by 8 percentage points. The parameter is significant at the significance level of 5 per cent.

- In case if all other regressors remain constant and the unemployment rate in Turkey goes up by 1 percentage point, the share of renewables in the total energy output of Turkey will drop by 0.07 percentage points. The regressor is not significant at the significance level of 5 per cent.

- In case if all other regressors remain constant and the real GDP increases by 1 percentage point, the share of renewables in the total energy output of Turkey will increase by 53.63 percentage points. The regressor is significant at the significance level of 5 per cent.

Overall, the model created by the author evidently lacks some other regressors that could be included when judging solely by the value of the R square, which is equal to 0.58 or 58%, when looking at the adjusted coefficient. In addition to that, it is important to note that the signs fully coincide with the economic theory, so the model can be used for making general assessments and evaluation. In addition to that, the whole model is statistically significant at the 5 per cent, based on the probability associated with the computed F-ratio. For the very final part of the empirical analysis and right before proceeding to the interpretation and further generation of reflections dedicated to the subject, it is essential to apply the model on the case of Turkey in 2023, which has the following macroeconomic indicators as of 27th of July 2023:

1) Exchange rate = 26.96 Turkish lira to USD.
2) Unemployment = 9.5%.

3) GDP growth rate = 2.7%.

Therefore, based on the current macroeconomic values, the share of renewables output in Turkey is likely to be somewhat equal to -34.164 per cent, which is not a realistic number, but this number arises from the fact that there is no specific consideration in the empirical structure of the model that the value of the dependent variable cannot go below 0. In other words, this negative value indicates that the output of renewables in Turkey as of now is likely to be close to 0 and the country will entirely focus on getting energy from fossil fuels. Further interpretation is presented in the next chapter of the bachelor thesis.

5 Results and Discussion

Turkey, according to the results of the analytical part of the thesis, is a country that experiences serious problems with its transition to green energy. Based on the time series analysis, it was concluded that Turkey, instead of reaching a substantial progress in the rate of adoption of renewable energy sources, has in fact reached a degeneracy and regress, where the country now, in the 21st century has a lower degree of contribution from renewables than back in the 90s. Therefore, it is already possible to reject the very first hypothesis of the bachelor thesis that stated that Turkey is rapidly expanding its renewable energy impact on the economy and the country. The real situation is absolutely opposite to what has been assumed in the goals and objectives of the thesis. In fact, one of main reasons for that, without going into the details of the author's further analysis is the fact that starting from approximately mid-2000, with the growing power of Turkey's current leader – Recep Erdogan, the country significantly changed its vector of development, notably in the aspect of its external policy.

If back in the 90s and even prior to the studied period, Turkey was often regarded as one of the most liberal Muslim countries, whose accession to the European Union was just a matter of time, the rule of Erdogan changed this picture as the country moved towards the policy of rapid accumulation of power and closer cooperation with both China and Russia, where the second partner of Turkey is coincidently one of the world's biggest exporter of fossil fuels and energy retrieved from traditional sources. In fact, the author's assumption about the negative effect that the cooperation with Russia played for Turkey's sustainable potential is also highlighted by Özertem (2017) and Winrow (2017), who both believed, just as the author of the bachelor thesis, that deeper communication and cooperation with Russia allowed Turkey to have a really good bargain and shift back to the specialization on fossil fuels due to quite good terms of trade with the Russian Federation.

Continuing to the second hypothesis of the thesis, where it was stated that the rate of adoption of renewables in Turkey is significantly influenced by economic factors, such as the GDP growth, exchange rate and unemployment, it is definitely possible to conclude that there is a very strong connection between the rate of adoption of renewables and the

economic performance of the country. Therefore, this hypothesis is not rejected entirely, but it is essential to specify that there was seemingly no direct connection between the unemployment rate's performance and the share of renewable output in Turkey, while the relationship between the rest of macroeconomic indicators and the rate of adoption was classified to be statistically significant.

Therefore, it is possible to blame the turbulent economic performance of Turkey for such a huge degeneracy of the renewable energy sector. In other words, the country is not able to follow the path of sustainable development when the internal economic situation is not stable, which is likely to have been caused by rather an ambitious external policy of the Turkish leader and also very unusual economic policies, such as the recent one, where Erdogan is believed to have vetoed the initiative of the Turkish Central Bank to raise interest in order to tackle inflation, which resulted in country experiencing a period of hyperinflation, which is absolutely not common for a European country. Effectively, when bearing in mind the fact that the current economic environment is less optimistic and reassuring than the studied one from earlier years of the 21st century, it is projected that Turkey will not enter the path of sustainable development any time in the nearest future.

Therefore, the last hypothesis of the thesis, suggesting that the country can achieve a relatively sophisticated performance of the sustainability pillar of sustainable development is also rejected. The author's findings fully coincide with findings of Ozturk & Yuksel (2016) and Kuleli Pak et al. (2015) who believed that it is not likely that any policymaker in Turkey will pay attention to sustainability and sustainable development, when the country's economy is in ruins, which was additionally worsened by one of the most devastating earthquakes in the history of humankind that happened not a while ago on the south-east of the country, close to the border with Syria.

Overall, Turkey remains to be a country with huge economic and social potential, but when comparing the country's performance in the 90s with the current one and even with the one from earlier years of the 21st century, it becomes pretty likely that the government in charge is not able to fully use all of this potential and help the country to enter the path of sustainable development due to their focus on external policy and fight against minorities,

such as Kurds and other groups that pose a certain degree of political threat to the current Turkish government in charge, which is also noted by Landau (2016).

6 Conclusion

In the end, it is essential to once more recall what were the main objectives of this bachelor thesis. This bachelor thesis was concerned with the current rate of adoption of renewable energy sources in Turkey, which is a country lying between Europe and Asia thus serving as a bridge between two different parts of the world and hosting the population of approximately 85 million people and having the biggest economy out of all countries from the region where it is situated.

However, the current state of adoption of renewable energy sources in Turkey is substantially far from being called optimistic, positive or even reassuring due to the fact that the country faced a very serious degeneracy in all indicators related to the expansion of the renewable energy sector. In addition to the identification of the main direction of the country's development in the domain of sustainability, there were three hypotheses, 2 out of which were rejected. Notably, the hypothesis that the country is rapidly developing its renewable energy sector, was rejected due to the degeneracy and deterioration of all indicators related to the sustainability domain that were identified. The other rejected hypothesis was concerned with the current state of the sustainability pillar of Turkey, where the rejection is explained by fact that the country was rapidly distancing itself from the path of sustainable development.

The only hypothesis that was not rejected was concerned with the suggestion that the economic performance has a huge effect on the country's overall rate of adoption of renewables and sustainability. It was identified that both the exchange rage and GDP growth have significant contribution to the rate of adoption. Furthermore, it can be suggested that one of the main reasons of why the country is currently in such a situation is the series of economic problems that were encountered by the country over the course of the whole 21st century, where the overall GDP might have been increasing, but the overall development level was surely not thus prompting the author to consider that an overwhelming share of Turkish population is trapped in the so-called cycle of poverty from which they have no deliverance, as of now, and the situation is likely to get even worse in the nearest future.

The final recommendation to the Turkish government would be stabilizing their economy by finally letting go their ambitions of becoming one of the world's biggest political powers and focusing instead on the wellbeing of inhabitants of the country by finally entering the path of sustainable development.

7 References

Aydin, Z. (2010). Neo-Liberal transformation of Turkish agriculture. *Journal of Agrarian Change*, *10*(2), 149-187.

Bagher, A. M., Vahid, M., Mohsen, M., & Parvin, D. (2015). Hydroelectric energy advantages and disadvantages. *American Journal of Energy Science*, *2*(2), 17-20.

Barchard, D. (2023). *Turkey and the West*. Taylor & Francis.

Brundtland, G. H. (1987). What is sustainable development. *Our common future*, *8*(9).

Bull, S. R. (2001). Renewable energy today and tomorrow. *Proceedings of the IEEE*, *89*(8), 1216-1226.

Carley, M., & Christie, I. (2000). *Managing sustainable development*. Earthscan.

Chichilnisky, G. (1997). What is sustainable development?. *Land Economics*, 467-491.

Dalal-Clayton, B., & Bass, S. (2002). Sustainable development strategies.

Dincer, I. (2000). Renewable energy and sustainable development: a crucial review. *Renewable and sustainable energy reviews*, *4*(2), 157-175.

Elliott, J. (2012). *An introduction to sustainable development*. Routledge.

European Wind Energy Association. (2009). *The economics of wind energy*. EWEA.

Fridleifsson, I. B. (2001). Geothermal energy for the benefit of the people. *Renewable and sustainable energy reviews*, *5*(3), 299-312.

Hale, W. (2023). *The political and economic development of modern Turkey*. Taylor & Francis.

Hall, D. O. (1991). Biomass energy. *Energy policy*, *19*(8), 711-737.

Hoekman, B. M., & Togan, S. (Eds.). (2005). *Turkey: Economic reform and accession to the European Union*. World Bank Publications.

Holmberg, J., & Sandbrook, R. (2019). Sustainable development: what is to be done?. In *Policies for a small planet* (pp. 19-38). Routledge.

Jabareen, Y. (2008). A new conceptual framework for sustainable development. *Environment, development and sustainability*, *10*, 1

Kaltschmitt, M., Streicher, W., & Wiese, A. (Eds.). (2007). *Renewable energy: technology, economics and environment*. Springer Science & Business Media.

Kannan, N., & Vakeesan, D. (2016). Solar energy for future world:-A review. *Renewable and sustainable energy reviews*, *62*, 1092-1105.

Kuleli Pak, B., Albayrak, Y. E., & Erensal, Y. C. (2015). Renewable energy perspective for Turkey using sustainability indicators. *International Journal of Computational Intelligence Systems*, *8*(1), 187-197.

Landau, J. M. (2016). *Radical politics in modern Turkey*. Routledge.

Lund, H. (2007). Renewable energy strategies for sustainable development. *energy*, *32*(6), 912-919.

Melikoglu, M. (2018). Current status and future of ocean energy sources: A global review. *Ocean Engineering*, *148*, 563-573.

Mitlin, D. (1992). Sustainable development: A guide to the literature. *Environment and urbanization*, *4*(1), 111-124.

Moriarty, P., & Honnery, D. (2012). What is the global potential for renewable energy?. *Renewable and Sustainable Energy Reviews*, *16*(1), 244-252.

Özertem, H. S. (2017). Turkey and Russia: a fragile friendship. *Turkish Policy Quarterly*, *15*(4), 121-134.

Ozturk, M., & Yuksel, Y. E. (2016). Energy structure of Turkey for sustainable development. *Renewable and Sustainable Energy Reviews*, *53*, 1259-1272.

Parris, T. M., & Kates, R. W. (2003). Characterizing and measuring sustainable development. *Annual Review of environment and resources*, *28*(1), 559-586.

Pezzey, J. (1992). Sustainable development concepts. *World*, *1*(1), 45.

Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2012). *An introduction to sustainable development*. Earthscan.

Subaşat, T. (2014). The political economy of Turkey's economic miracle. *Journal of Balkan and Near Eastern Studies*, *16*(2), 137-160.

The World Bank. (2023). World Bank Open Data. [Online] Available at https://data.worldbank.org/indicator. Accessed on 31st of July 2023

Twidell, J. (2021). *Renewable energy resources*. Routledge.

Winrow, G. (2017). Turkey and Russia: The importance of energy ties. *Insight Turkey*, *19*(1), 17-32.

Zürcher, E. J. (2017). *Turkey: A modern history*. Bloomsbury Publishing.

8 List of Appendices

8.1 List of Figures

8.2 List of Tables

8.3 List of Abbreviations

GDP	Gross Domestic Product
USD	United States Dollar
OLS	Ordinary Least Squares
CO_2	Carbon Dioxide