Handbook of Research on

Strategic Management for Current Energy Investments

Serhat Yüksel and Hasan Dinçer

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by the forces of supply and demand, began, which developed an interest in the area of many researchers to investigate, theoretically and empirically, the impact of exchange rate volatility on the world trade flows. There are two channels, direct and indirect, through which the change in exchange rate affects domestic prices. Under the direct channel, a fall in exchange rate leads to increase in imports as well as increases the prices of inputs in domestic currency. Secondly, under the indirect channel, a decline in the exchange rate triggers the availability of domestic goods to foreign buyers at a cheaper rate, and the demand for domestic products increased. Thus, the change in exchange rate affects trade flows either positively or negatively.

In this study, energy center selection of G7 countries is examined. In this context, firstly, the studies in the literature have been evaluated in detail, and seven different criteria have been determined which may affect this selection. Taking these seven different criteria into consideration, G7 countries are ranked by fuzzy MOORA method according to energy center selection performance. According to the results, Japan and Germany are the most successful countries. On the other hand, it was concluded that France and Italy ranked last in terms of energy center selection performance. Hence, especially the countries in the last rankings should be more careful in selecting energy center. In this framework, the customer potential, the training profiles of the customers, the potential of the company with investment demand, the previous payment performance of these companies, and the market risks should be considered by the energy companies while opening new branches.

The world economy strives for globalization, and most energy assets are connected with each other through correspondent banks and other mutual operations. The relevance of the topic of the thesis is due to the fact that in September 2019 a number of proposals were made to introduce the practice of negative interest rates in the national banking system due to the fact that Russian energy assets are not profitable to place in foreign currency..

of domestic and renewable energy resources in the early 2000s. With the transition to renewable energy sources as a new concept in Turkey's energy policy "green energy," it has come to the fore. With the transition to green energy, Turkey is trying to prevent pollution of the environment by reducing fossil fuel consumption and aims to reduce energy costs by reducing the use of energy sources that cannot be renewed in production. Turkey, a country rich in renewable energy sources, will be able to use existing renewable energy sources effectively and efficiently using strategic management in energy.

This study investigates the influence of economic freedom on energy consumption and bank performance in Ghana over the period 2000-2017. Specifically, the authors examine the effect of the various components of economic freedom on total energy usage, fossil fuel consumption, and bank performance. The study applies the fully modified ordinary least squares (FMOLS) method to determine the long-run influence of economic freedom indicators on energy consumption and bank performance. The results show that aside from business freedom, all the other sub-economic freedom measures significantly drive total energy consumption. The authors reveal that investment and fiscal freedom significantly influence fossil fuel consumption. The findings also establish that financial, investment, and fiscal freedom indices exert a significant effect on bank performance. These results hold regardless of the measure of bank performance. In light of the findings, the authors discuss relevant policy implications.

The aim of the study is to analyze the underlying reasons for the countries to have access to the energy reserves and the effort to be to holding on those reserves. Energy is the driving force for the production of goods and services. Countries who have access to energy reserves are aware that those reserves provide both economic and political power. The motive for countries to have control of energy reserves are twofold: basis for economic growth and keeping or gaining political power. The result most of the time is a continous power struggle between the countries.

In this chapter, the authors aim to investigate the association between the primary energy sources' prices involving oil and natural gas and sectors indices operating the Turkey stock market for the period covering 2012M1-2021M3. Regarding energy price indicators, Brent oil and natural gas real-time future prices are preferred in the models, and BIST Industrials (XUSIN), BIST Chem-Petrol Plastic (XKMYA), and BIST Electricity (XELKT) indices are used as financial performance indicators. Fourier unit root tests improved by Becker et al. and Fourier co-integration tests improved by Tsong et al. are employed to

Foreword

Energy is a vital issue for the development of countries. In other words, energy is indispensable for a country. Otherwise, industrial production will not take place and the citizens living in the country will not be able to meet their basic needs in a healthy way.

Therefore, it is very important for countries to have their own energy resources. In an environment where this does not exist, countries have to import the energy they need from abroad. This situation increases both the economic and political risks of the countries.

In this book, strategies for countries' energy policies are presented. The ideas to be presented by professors working in different countries are guiding in this context. Therefore, it is thought that this book will contribute to the effective solution of many problems encountered in energy investments.

Selman Duran
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Preface

Thanks to energy, people can meet their basic needs such as heating. On the other hand, energy is also one of the most important raw materials of industrial production. Therefore, countries need to provide the energy they need regardless of the price. As can be understood from here, energy policies are of vital importance for countries. In this framework, both countries should have their own energy resources and the existing energy should be used efficiently.

The main purpose of this book is to identify important energy investment strategies. For this purpose, different topics related to the energy investment projects are taken into consideration, such as solar energy, hydrogen energy and nuclear energy. Therefore, it can be said that this project makes a significant contribution to the literature by focusing on an important topic for the companies.

Target Audience and potential users of this book are defined below.

- Researchers
- Academicians
- Policy Makers
- Government Officials
- Upright Students in the concerned fields
- Members of Chambers of Commerce and Industry
- Top managers of the companies

This book consists of 20 different chapters. In Chapter 1, the importance of hydrogen sulfide resources in the Black Sea region for future energy supply security has been analyzed. Chapter 2 aims to compare various factors that affect the development of the industry. The main objective of Chapter 3 is to identify the relationship between oil supply and oil demand of developed and developing countries on the example of OECD and Former Soviet Union countries. Chapter 4 tries to analyze the innovative working behavior of energy industry. Chapter 5 focuses on the relationship between the exchange rate and energy import.

On the other side, in Chapter 6, energy center selection of G7 countries is examined. Chapter 7 was conducted the world economy strives for globalization, most energy assets are connected with each other through correspondent banks and other mutual operations. Chapter 8 evaluates the use of blockchain technology to ensure the competitiveness of tourism and energy investment using a statistical approach. In Chapter 9, it is aimed to explain the theoretical structure of wave energy and its importance in terms of energy supply security of the country. The main objectives of Chapter 10 are three-fold, firstly to investigate the role of renewables in the global energy transition, examining the parameters such as a share in the primary energy demand, installed capacity etc.

Chapter 11 deals with a model that works under a specific maximum demand. In Chapter 12, the relationship between electricity generation, electricity consumption and economic growth in Turkey was analyzed. The aim of Chapter 13 is to address the importance of strategic energy management in order to ensure the transition of Turkey, a country that is trying to end its dependence on energy, to green energy using renewable energy sources. Chapter 14 investigates the influence of economic freedom on energy consumption and bank performance in Ghana over the period 2000-2017. Chapter 15 analyzes the underlying reasons for the countries to have access to the energy reserves and the effort to be to holding on those reserves.

Chapter 16 investigates the association between the primary energy sources' prices involving oil and natural gas and sectors indices operating the Turkey stock market for the period covering 2012M1-2021M3. Chapter 17 tries to handle the energy issue with an encompassing managerial approach, with a broader perspective. Chapter 18 focuses on the significance of Akkuyu nuclear power plant for Turkey. Chapter 19 aims to explore whether these hypotheses are for 23 developing countries after Global Crisis. Finally, Chapter 20 examines the relationship between the use of renewable energy, CO2, and GDP per capita.

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Second, the editors wish to acknowledge the valuable contributions of the reviewers regarding the improvement of quality, coherence, and content presentation of chapters. Most of the authors also served as referees; we highly appreciate their double task.

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Chapter 1
The Role of Hydrogen in the Black Sea for the Future Energy Supply Security of Turkey

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ABSTRACT

In this study, the importance of hydrogen sulfide resources in the Black Sea region for future energy supply security has been analyzed. In this context, Turkey has been the scope of review. Through the world's largest hydrogen sulfide deposits in the Black Sea region with which hydrogen can be used effectively in the production of this resource, Turkey will be able to meet the annual energy needs face. This will provide benefits to many aspects of Turkey's economic development. Turkey's current account deficit, which would import energy problem, can also be reduced. This situation will contribute to reducing the fragilities in the country's economy. In this respect, Turkey should give priorities for the hydrogen sulphide reserves in the Black Sea. In this framework, detailed studies should be conducted on the conditions of the region.

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INTRODUCTION

Energy is one of the vital needs of a country. First of all, energy is very important in people's lives. For example, essential needs such as enlightenment and heating can be met through energy (Cheng et al., 2020). In addition to the issues mentioned, energy is also the raw material of industrial production. In other words, energy is seriously needed in order to continuously increase the production in the country (Mikhaylov et al., 2021). Energy can be obtained in many different ways. First, energy can be obtained from fossil fuels such as oil, natural gas and coal (Li et al., 2020; Zhong et al., 2020). In addition to the mentioned issues, energy can also be obtained from renewable energy sources such as solar, wind and biomass. Both types of energy have advantages and disadvantages compared to each other (Mikhaylov et al., 2018a,b; Dinçer et al., 2019).

Fossil fuels are seriously criticized in many ways. Primarily, fossil fuels release carbon into the atmosphere. This situation threatens the health of people as it creates air pollution (Qiu et al., 2020). The increase in the number of people who get sick leads to an increase in both social and economic problems in the country. The quality of life of the sick person decreases and this situation creates unhappiness in the society (Wang et al., 2019; Li et al., 2021). On the other hand, these people who are sick will not be able to contribute to the workforce in the country because they cannot work. This situation will cause the production volume of the country to shrink (Mikhaylov et al., 2018, 2021). As a result, the economic development of the country will be difficult. In addition to the mentioned issue, due to the increase in the treatment costs of sick people, this will affect the country's budget balance negatively (Zhao et al., 2021; Yüksel et al., 2019).

If a country has high carbon emissions, this may negatively affect the country's relationship with foreign institutions. Especially in recent years, sensitivity to environmental factors has increased worldwide (Zhou et al., 2021). In this framework, it is on the agenda to create a psychological pressure against countries with high environmental pollution. In other words, businesses may be reluctant to do business with companies in countries with high carbon emissions (Qi et al., 2020). For example, large financial institutions may not give loans to companies in countries with high air pollution. This situation will cause the country to have both financial and economic difficulties. Considering these issues, it is understood that countries should take the necessary measures to address the carbon emission problem. In addition, fossil fuels are also energy sources whose resources are depleted (Mikhaylov, 2019, 2021; Du et al., 2020). In other words, the reserves of non-renewable energy sources such as coal and oil are sufficient for a certain period of time. As can be understood from here, non-renewable energy sources are not a very correct choice in ensuring sustainability in energy production (Mikayilov et al., 2020; Dinçer et al., 2017).

Considering these issues, it is seen that a new energy system is needed for the energy security of the countries. In this context, renewable energy sources have increased in popularity especially in recent years. These types of energy are alternatives that take their source from nature such as sun, wind and geothermal (Dinçer & Yüksel, 2019). Therefore, it is seen that the resources of renewable energy types will never run out (Mikhaylov et al., 2020a,b,c). As can be understood from these points, renewable energy resources are of great importance in order that countries are not dependent on foreign energy (Liu et al., 2021; Xie et al., 2021). In line with the mentioned issues, one of the biggest advantages of renewable energy sources is that they do not emit carbon (Yuan et al., 2021). In this way, they are considered as environmentally friendly energy sources. On the other hand, the initial cost of renewable energy sources is much higher than other types of energy (Haiyun et al., 2021). This situation makes it very difficult for these investments to become operational (Yüksel et al., 2020).

Hydrogen energy can also be considered as an important type of renewable energy. Hydrogen is the most abundant element in the universe. The hydrogen element, which is about 14 times lighter than air, is a completely non-toxic gas. It is accepted that the energy in hydrogen is 2 times that of natural gas and 3 times that of petrol. In addition to the above-mentioned point, only water is released as a result of the combustion of hydrogen. In other words, no gas is emitted to the atmosphere during this process. Considering these issues, hydrogen is a type of energy that is both quality and energy friendly. However, there are some disadvantages in the use of hydrogen energy. For example, storage cost is one of the major problems in using hydrogen as fuel. In addition to these, the fact that investment costs are very high with today's technology is another drawback in hydrogen energy use. Another negativity in this process is that hydrogen is not in pure form in the universe. Generally, hydrogen contained in a compound must be separated from these compounds with a certain operation (Abe et al., 2019).

There are many different methods for obtaining hydrogen. First, it is possible that hydrogen can be obtained from fossil fuels. In this context, hydrogen and carbon monoxide gases in methane gas can be separated by steam reforming of hydrocarbons in natural gas. In addition, hydrogen and carbon monoxide are released as a result of the gasification of coal, which is basically a combination of elements such as carbon, sulfur, hydrogen and oxygen. The most important advantage of hydrogen production from fossil fuels is its low cost. On the other hand, the fact that it causes carbon emission to the atmosphere is considered as the negative side of this process as it causes environmental pollution. On the other hand, hydrogen can also be obtained from renewable energy sources. The basic principle of this method is the use of electricity obtained from renewable energy sources in the electrolysis of water. Thus, there will be no waste of electricity and carbon will not be released into the atmosphere. In this process, the separation of hydrogen and oxygen in the water is ensured by the direct current given into the water (Parra et al., 2019).

Hydrogen sulfide is another source that can be used to obtain hydrogen energy. Electrolysis is also used in this process as it is used for the separation of hydrogen in water. In contrast, electrolysis applied to hydrogen sulfide is much less costly than that applied to water. The main reason for this is that the bond between hydrogen and sulfur is much weaker than the bond within the water molecule. Therefore, the amount of energy to be given in this process is also much less (Stunzhas et al., 2019). As mentioned before, one of the most important problems in hydrogen energy production is high cost. This convenience will also contribute to the reduction of the costs in the process of obtaining this energy.

There is also a very serious amount of hydrogen sulfide in the depth of the Black Sea. This gas is highly toxic and has a very bad smell. One of the most important features of the Black Sea is that there is no oxygen in its depths. This situation causes the formation of poison in the depths of the Black Sea. The bacteria that grow here also generate hydrogen sulfide. Considering this situation, it is understood that hydrogen obtained by using hydrogen sulfide reserves will have two fundamental advantages. Firstly, it is recognized that Turkey can meet the energy requirements of about 100 years of hydrogen energy to be obtained. In this way, the lack dependent on foreign energy situation in Turkey is concerned. This situation will improve the economic performance of the country positively. On the other hand, with the evaluation of hydrogen sulfide gas in this way, it may be possible to get rid of the negative effects of this gas on the Black Sea (Naman & Jamil, 2019).

In this study, the importance of Turkey's future energy supply source of hydrogen sulfide was analyzed on the Black Sea. In this context, firstly, information was given about the importance of energy and energy production methods. In this process, non-renewable and renewable energy sources were explained. After that, detailed information about hydrogen energy was shared. In this context, important issues such as the benefits of hydrogen energy and methods of obtaining it were included in the study. In the other part of the study, information was given about the hydrogen sulfide deposits in the Black Sea. Meanwhile, as energy supply security of Turkey of hydrogen energy obtained from these sources it has attempted to explain the importance of economic development and unsustainable. In this context, a number of strategies have been developed for Turkey's future energy policy.

GENERAL INFORMATION ABOUT ENERGY PRODUCTION

Energy is an important element used in almost all areas of life, from industry to agriculture, from space to the service sector. Energy sources are used in many important areas such as transportation, lighting, electronic devices and heating in industrial facilities. Economic growth and energy are highly interdependent. With the increasing energy demand in parallel with the increase in industries, economies and populations of many countries day by day, most of the countries and international organizations compete with each other to dominate energy resources. It is an important and determining factor that societies take together and evaluate the economic, social and environmental factors they are under their influence in order to ensure their continuity and reach the welfare levels they aim for. The types of energy people benefit from have changed over time and this change continues. People who used resources such as wood and coal in the early days turned to energy resources such as oil and natural gas, especially after the 19th century. The energy transition is a dynamic, ongoing process and is still moving towards better resources (Zhou et al., 2019).

Today, fossil fuels such as coal, oil and natural gas dominate energy markets. According to the BP (2019) report, approximately 85 percent of the world's energy consumption is met by fossil fuels. On the other hand, the share of renewable energy sources in energy consumption is approximately 10 percent. However, due to the fact that fossil energy resources are both exhaustible and the damage caused by these resources to the environment, the dependence of countries on such energy resources poses a significant risk for the future. Today, producing safe, sufficient, cheap and clean energy for countries and not being dependent on foreign countries while doing these are among the basic problems of economic and social life. For this reason, it becomes necessary to re-evaluate energy transformation tools and to develop new methods to obtain maximum efficiency from existing limited energy resources (Zhou et al., 2020). In this context, it is of great importance to use the produced energy with high efficiency and to evaluate the potential of alternative and renewable energy sources as well as the existing energy resources. In addition, changes that will occur in the type and supply of energy in the future will bring about the change of the conditions necessary for a sustainable society.

As stated in the BP (2019) report, almost a quarter of the total energy consumption will be met by renewable energy sources in 2040. Renewable energy sources are sustainable energy sources that are described as ecological due to their sensitivity to the environment and can be reproduced repeatedly by using existing resources. The negative contribution to the environment is very low since renewable energy sources produce less carbon emissions compared to fossil fuels such as coal, oil and natural gas. With the increasing depletion of traditional energy sources, the importance of renewable energy sources increases even more. There are many types of renewable energy sources in the world and these sources are becoming more diverse every day. Solar energy, wind energy, hydraulic / hydroelectric energy, geothermal energy, biomass energy, hydrogen energy, wave energy and tidal energy are among the most well-known examples of this type (Mikayilov et al., 2020).

The importance and use of renewable energy has increased considerably in recent years. The fluctuations in the price of fossil fuels, especially after the oil crises in the 1970s, have started to search for new alternative energy, especially in developing countries. Achieving energy that is sustainable and that can make states more independent in energy has become an important issue. For many foreign-dependent countries in energy, factors such as the exchange rate have had a serious impact on the economies of these countries. Renewable energy sources have gained importance in this context and country policies have begun to change in this direction. Climate change and carbon emissions are another critical factor accelerating the transition towards renewable energy. Many countries signed the United Nations Framework Convention on Climate Change in 1992, the Kyoto Protocol in 1997, and also the Paris Agreement in 2015. Within the framework of these legal practices, many countries have promised to reduce their greenhouse gas emissions and add more renewable energy to their systems (Qiu et al., 2020).

In this context, there is a risk of reputation loss for many countries that do not comply with these rules. Especially with the increasing environmental awareness, many countries with high carbon emissions are faced with embargoes imposed by companies that carry out their trade activities in the international environment. Renewable energy technology is developing day by day and the costs of setting up these energy systems have decreased significantly in recent years. In addition, thanks to technological and economic developments, the global installed capacity of renewable energies has increased significantly and many countries and companies have started to give incentives to increase investments in this direction. For this reason, it is vital that countries abandon fossil fuels, which are likely to be exhausted in the near future and cause irreversible damage to the environment, and switch to environmentally friendly and never-exhausted renewable energy sources (Dinçer & Yüksel, 2019).

GENERAL INFORMATION ABOUT HYDROGEN ENERGY

Hydrogen is the first element of the periodic table, and it is the most abundant element in the universe. Another feature of hydrogen is that it is colorless and odorless. On the other hand, hydrogen is 14 times lighter than air. Because of this feature, hydrogen is less present in the earth's atmosphere (Qi et al., 2018). Due to its lightness, it gets rid of gravity and finds a place in outer space. On the other hand, hydrogen can also be found in compounds such as water and hydrocarbons in the world. One of the most striking properties of hydrogen is that it is a completely non-toxic gas. This stated situation shows that hydrogen is an environmentally friendly energy type (Bakuru et al., 2019; Sorgulu and Dincer, 2018).

Hydrogen has many different uses. For example, hydrogen can be used in air transportation. Thanks to hydrogen, it is possible to fly 2 times more distance than jet fuel of the same weight. Due to this feature, hydrogen can be used in space shuttles and space exploration rockets. Hydrogen has some uses in daily life. For example, fuel cells used in homes contain hydrogen (Khosravi et al., 2018; Ishaq et al., 2018). In addition, it is possible to utilize hydrogen in laptop computers and mobile phones. On the other hand, hydrogen can also be used in the glass industry. One of the most important uses of hydrogen is electricity generation. In this way, both the heating of homes and workplaces can be provided, and a significant contribution can be made to increase industrial production (Yartys et al., 2019; Groppi et al., 2018).

It is possible to talk about many advantages of hydrogen energy. First of all, the energy in hydrogen is 2 times that of natural gas and 3 times that of petrol. This situation shows that hydrogen is a very powerful energy source. In addition to the above mentioned point, there is no harmful gas emission to the atmosphere as a result of the combustion of hydrogen (Midilli et al., 2005; Miranda, 2018). In this process, only water comes out. Based on this, it is possible to say that hydrogen is an environmentally friendly energy type. Another positive aspect of hydrogen is that it is much safer than other gases. Since it is an extremely light gas, in case of the slightest leak, this gas rises to air. In other words, it will not cause any explosion in case of a leak in the system. One of the most important advantages of hydrogen is for the energy supply security of the country (Vezirogle, 2007; Wang et al., 2018). Thanks to this energy, countries will be able to produce their own energy resources. In this way, foreign dependency on energy will be reduced. In this process, it is obvious that the use of hydrogen energy will positively contribute to the current account balance of the country, as the amount of foreign currency paid for energy imported from abroad will also decrease (Zhang et al., 2019; Maleki, 2018).

On the other hand, hydrogen energy has some disadvantages. The most important problem in using hydrogen as fuel is the cost of storage. Hydrogen can be stored in a compressed gas state, liquid state or metal hybrid form. In addition, hydrogen can be transported in gas or liquid form by underground pipelines, as well as by tankers or ships. Since hydrogen is very difficult to store, the tanks used are very large and costly in terms of volume (Elam et al., 2003; Habibollahzade et al., 2018). Another difficulty in using hydrogen as a fuel is that it cannot be found in its pure form under world conditions. Hydrogen contained in a compound needs to be separated from that compound. This means both a new process and additional cost. One of the most important disadvantages of hydrogen energy is that it is very expensive to obtain compared to fossil fuels with today's technology (Shi et al., 2019; Yüksel et al., 2018).

There are many different methods for obtaining hydrogen. First, it is possible to obtain hydrogen from fossil fuels. First, hydrogen can be obtained from fossil fuels. This method is considered one of the oldest approaches in hydrogen production. The best example of this subject is the production of hydrogen from natural gas. Most of the natural gas consists of a hydrocarbon compound called methane gas (CH4). As a result of the reaction of hydrocarbons in natural gas with steam, hydrogen gas can be separated from natural gas. The infrastructure needed to produce hydrogen from natural gas will be cost-effective. The main reason for this is that the natural gas infrastructure is already available. Another example of obtaining hydrogen from fossil fuels is coal. Coal mainly consists of a combination of elements such as carbon, sulfur, hydrogen and oxygen. As a result of the gasification of coal, hydrogen and carbon monoxide are released. The most important advantage of obtaining hydrogen from fossil fuels is its low cost. On the other hand, the occurrence of environmental pollution due to the release of carbon into the atmosphere during this process is considered to be the most important disadvantage (Mostafaeipour et al., 2019).

Another method of obtaining hydrogen is renewable energy sources. Basically, it is possible to obtain hydrogen from all renewable energy types. The basic principle of this method is the use of electricity obtained from renewable energy sources in the electrolysis of water. There are 2 hydrogen and 1 oxygen atoms in water. Separation of hydrogen and oxygen in water using direct current is called electrolysis. In other words, this separation process in electrolysis is done with electrical energy (Cipriani et al., 2014). The electrical energy used in this process can be obtained from renewable energy sources. Thus, excess electricity obtained from renewable energy sources is not wasted. The most important advantage of this method is that it does not create environmental pollution due to the fact that carbon is not released into the atmosphere (Momirlan and Veziroglu, 2005). In addition to the mentioned issue, there is no risk of depletion of reserves due to the use of renewable energy sources. This situation significantly supports the continuity in the production of hydrogen energy (Parra et al., 2019; de Fátima Palhares et al., 2018).

Hydrogen sulfide sources are also an alternative that can be preferred in obtaining hydrogen energy. In this process, the electrolysis method is applied to hydrogen sulfide gas, enabling the separation of hydrogen and sulfur gases in the compound (Ozawa et al., 2018; Nafchi et al., 2018). This point is very similar to the electrolysis method used to obtain hydrogen from water. In contrast, electrolysis of hydrogen sulfide gas is much easier compared to water (Zhang et al., 2018; Blal et al., 2018). The main reason behind this mentioned issue is that the bond between hydrogen and sulfur is much weaker than the bond within the water molecule. This contributes to the reduction of the cost in the process of obtaining hydrogen (Singh et al., 2016; Agbossou et al., 2001). Considering that the most important disadvantage of hydrogen energy investments is the high cost, it is understood that this mentioned issue constitutes a very serious advantage in this context (Bakuru et al., 2019; Wang et al., 20016).

HYDROGEN ENERGY POTENTIAL IN BLACK SEA REGION

The Black Sea is the region with the largest hydrogen sulfide deposit in the world. This gas is poisonous and has a bad smell. One of the biggest reasons for this gas to be in the Black Sea is that there is no oxygen in the depths of this region. The situation in question causes the formation of poison. The resulting bacteria also produce hydrogen sulfide. The mentioned situation both pollutes the Black Sea and threatens the lives of the surrounding creatures. This problem has been the subject of the press in previous periods and the gravity of the situation has been emphasized (Seker & Aydin, 2020).

Another important issue in this process is that this poisonous and dangerous gas is actually a serious source of hydrogen. As mentioned before, hydrogen sulfide sources are one of the most important methods of obtaining hydrogen. In this process, by applying electrolysis to the hydrogen sulfide compound, it is possible to separate the hydrogen and sulfur gases in this compound. In this way, it is possible to obtain the hydrogen in the compound and use it as an energy source. This method is similar to the electrolysis approach applied to obtain hydrogen from water. However, it is known that the electrolysis method applied to hydrogen sulfide is much easier than the other. This is because the bond between hydrogen and sulfur is weak (Uzun et al., 2016).

Considering this situation, it is understood that hydrogen obtained by using hydrogen sulfide reserves will have two fundamental advantages. Thanks to the hydrogen to be obtained primarily, it will be possible to meet the energy needs of the country. In addition, while meeting this energy requirement, the environment will not be harmed. On the other hand, in the process of obtaining hydrogen from hydrogen sulfide gas, the Black Sea region will also be able to get rid of this problematic gas. In this process, hydrogen sulfide gas is split into hydrogen and sulfur gases. While hydrogen is used for energy needs, sulfur gas can also be used in industry. As can be seen, it is possible to benefit the country's economy in many ways as a result of using hydrogen sulfide gas (Iordache et al., 2016).

According to researches, it is known that there is 4.6 billion tons of hydrogen sulfide source in the depths of the Black Sea region. Therefore, it is estimated that around 270 million tons of hydrogen can be obtained by using hydrogen sulfide resources in the Black Sea region. As mentioned earlier, hydrogen has a much richer content compared to petroleum and natural gas. Considering these points, it is estimated that the hydrogen energy that can be obtained from the Black Sea region can correspond to almost 810 million tons of gasoline and 750 million tons of natural gas. It is possible to say that this figure will correspond to the energy need of approximately one hundred years for Turkey (Stunzhas et al., 2019). This situation is of vital importance for both the national economy and the security of energy supply. On the other hand, it is known that hydrogen sulfide formation in the Black Sea region is constantly increasing, especially with the effect of geological formations.

SOLUTIONS AND RECOMMENDATIONS

In this study, the importance of Turkey's energy supply source of hydrogen sulfide in the Black Sea is discussed. In this context, firstly the importance of energy, types of energy sources and risks encountered in energy production are examined. In addition, information about hydrogen energy was also given. In this context, issues such as the obtaining methods of hydrogen and the ways of storage and transportation of hydrogen have been explained. Then, information was given about the hydrogen sulfide deposits in the Black Sea region. In this context, the amount of hydrogen energy that can be obtained is explained. In the examination result, wherein the hydrogen can be obtained from the hydrogen sulfide in said zone is in reserve can meet the energy needs of Turkey 100 years. This situation is of vital importance for the continuity of the domestic energy production of the country. On the other hand, as a result of obtaining hydrogen from hydrogen sulfide gas, it will be possible to get rid of the negative effects of this gas in the Black Sea region. In this way, the lives of the living creatures in the region will not be endangered.

Studies on this subject need to be accelerated seriously. In this context, many different segments of the country play important roles. First of all, it is important that the state supports such research and investments. In this context, certain incentives should be given to enterprises that will invest in obtaining hydrogen energy from hydrogen sulfide. For example, factors such as low-interest credit, ground support and tax cuts will contribute to the shift of investors to this area. On the other hand, the state should also support universities to increase research on this subject. In this way, according to the new research results to be obtained, it will be possible to carry out this process more effectively.

In addition to these issues, it is important to support research and development activities for hydrogen production from hydrogen sulfide sources. In this way, technological developments regarding the subject will be followed and it will be possible to use new applications to reduce the costs in this process. This will contribute to the solution of the high-cost problem, which is accepted as the biggest disadvantage in the process of obtaining hydrogen. In this context, research and development groups can be established within the state staff and support to working groups that can undertake this work by the private sector.

Russian scientists have also been conducting some researches in the region, especially since the 1990s. On the other hand, it is known that Georgia and Ukraine are also conducting researches in the region. Thus, Turkey is of great importance as well as knowledge of these countries lag behind. Another important point in this process is that if this resource is not used within 30 years, it will create serious threats for the region. In this context, it is stated that the intense poison in its content may cause significant problems in the region in the future. In this context, it would be appropriate for our country to accelerate these studies.

As a result, energy is of vital importance for our country. hydrogen energy because Turkey is a country that cannot produce its own energy already has a significant role in this context. The place where hydrogen sulfide compound, which is one of the ways of obtaining hydrogen, is most abundant in the world is the Black Sea. Considering this issue, it is understood that our country is very advantageous in terms of location. Here, a comprehensive analysis should be made to clarify issues such as how hydrogen can be obtained from these sources, where the obtained hydrogen will be stored, how this gas will be transferred to the relevant places and in which areas it will be used.

FUTURE RESEARCH DIRECTIONS

As a result of obtaining hydrogen from hydrogen sulfide, Turkey can produce its own energy resources. Thus, it will be able to gain serious advantages both socially and economically. As a result of the widespread use of this energy, there will be no need to use energies such as coal that cause environmental pollution. This will contribute to a cleaner environment in the country. This matter will contribute to the reduction of diseases caused by environmental pollution. Thus, there will be an increase in the number of people who can participate in the workforce in the country. This will allow the production volume to increase. Thanks to the use of hydrogen energy, the country's energy supply security will increase. The main reason for this is that the country will not have to buy energy from outside. Current energy needs of Turkey is a country that imports a large part abroad. This situation creates a burden for the country's economy. Turkey is a country that for many years the current account deficit and stems from its largest percentage in energy imports. Thanks to the use of hydrogen energy, the necessity of importing this energy from outside will be eliminated. On the other hand, as a country that can produce its own energy, our country's political power may be higher in a possible political crisis.

CONCLUSION

It is more quality than oil and natural gas in terms of hydrogen content. Also, since there is no carbon emission into the atmosphere as a result of combustion of hydrogen, it is accepted as an environmentally friendly energy type. Considering these issues, hydrogen energy has become popular in the energy policies of the countries since it is both quality and clean. There are a number of different methods to obtain hydrogen energy. It can be obtained from fossil fuels in methods such as steam reforming of hydrocarbons in natural gas and gasification of coal. In addition, hydrogen can be released by using electricity from renewable energy sources in the electrolysis of water. Another method that can be used in obtaining hydrogen is the separation of hydrogen in hydrogen sulfide by electrolysis method. In this study, the importance of hydrogen sulfide on the Black Sea for Turkey's future energy supply security is analyzed. Thanks to the fact that this resource in the Black Sea, which has the largest hydrogen sulfide deposit in the world, can be used effectively in hydrogen production, it will be possible to meet the energy needs of the country for 100 years. This will provide benefits to many aspects of Turkey's economic development. The current account deficit problem of the country, which will not import energy, can also be reduced. This will contribute to reducing vulnerabilities in the country's economy. Within this framework, it is important to urgently put hydrogen sulfide reserves in the Black Sea. In this framework, it is necessary to conduct detailed research on the conditions of the region. Starting to obtain hydrogen from hydrogen sulfide deposits through platforms in the Black Sea region is vital for the country's future energy supply security. However, issues such as storage and transportation involve high costs in hydrogen energy production. In this context, these issues need to be carefully analyzed in planning the hydrogen production process in the region. It is thought that the hydrogen energy to be obtained in the Black Sea region can be quite efficient by reducing the costs on these issues.

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Chapter 2
Solar Energy Investment Forecast to 2040:
Evidence From Spain and Switzerland

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ABSTRACT

The main purpose of the study is to compare various factors that affect the development of the industry. The chapter analyzes the literature on various issues related directly or indirectly to the development of the industry. Several research methods are used: comparison of the influence of various factors on the price of solar electricity using the vector autoregression model (VAR model). The chapter describes the risks associated with competition (first of all, for the territories where solar panels are supposed to be located). The result of the chapter is a forecast for the supply of solar energy in the next 20 years. In the 21st century, the use of solar energy has become very popular, primarily due to the fact that solar power plants are least harmful to the environment, compared to other types of power plants. Recent research in the field of solar power engineering has shown that using carbon nanotubes will double the efficiency of power plants, breaking the Shockley-Queisser limit. Such technologies can make solar power the most used electricity in the world.

INTRODUCTION

The main idea of the study is to compare various factors that affect the development of the industry. The result will be a forecast for the supply of solar energy in the next 10-20 years. The paper describes the risks associated with competition (primarily for the territories where solar panels are supposed to be placed, if we are talking about fields, and not about the roofs of buildings). Solar energy began to

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be used in ancient times, building houses in such a way that they received as much heat from the sun's rays as possible for heating during the cold season, but more modern use of solar energy began in 1839 with the discovery of the photoelectric effect. However, there are many risks for this industry. The main reason for most of the risks is the fact that energy cannot be stored anywhere, at least for a long time, so in the electricity market, demand equals supply.

For more than a century, the use of solar energy has been unprofitable due to the high cost of solar panels. At the end of the XX century, due to the cheapening of solar power production due to the use of polycrystalline batteries instead of monocrystalline ones, as well as due to the oil crisis, companies began to appear that produce solar electricity for commercial purposes.

An article written by (Alessandrini, Delle Monache, Sperati, & Cervone, 2015) describes the MASS-UMAP approach, which is more effective than analog models for identifying patterns and predicting weather in a particular region, which can be effectively used when deciding on the location of solar power plants, because the weather is changing in the world. The number of Sunny days per year also changes, and this is a direct factor in the efficiency of a solar power plant. Another prediction method that is directly related to photovoltaic energy production was given in a joint paper by (Almeida, Perpiñán, & Narvarte, 2015). This method relies on combining a combined prediction model with an ensemble empirical mode decomposition. According to studies, when carrying out such integration, the prediction accuracy increases significantly, which in turn allows you to combine work and any other solar power plant with a constant source of generating power without interruption in electricity supply.

In 2018, a group of researchers consisting of (Appino, Ángel González Ordiano, Mikut, Faulwasser, & Hagenmeyer, 2018) conducted a study based on data on household solar power production and consumption. Based on the results obtained, they developed and proposed a new structure that makes it possible to make a forecast for solar power generation, taking into account all safety requirements (Aryaputera, Verbois, & Walsh, 2016). It proposed an NB model for accurately measuring the hourly amount of incoming solar radiation and reducing GHI uncertainty based on four variables, namely, dew point, temperature, relative humidity, and sky coverage. This forecast can be made 2 days in advance. Such an hourly forecast is very useful for solar energy, since solar power plants will be able to offer their products to the market with accuracy to the hours of a certain day. Consumers, in turn, will be able to decide on the purchase of electricity within a day.

LITERATURE REVIEW

Many scientists have studied issues related directly or indirectly to the development of the industry. Forecasts of solar activity, forecasts of growth of volcanic activity. The paper, written by Bessa, Möhrlen, Fundel, Siefert, Browell, Haglund El Gaidi, Hodge, Cali, & Kariniotakis (2017) talks about wind power, wind forecasting, and the further development of this technology. Wind power is a major competitor to solar power in the field of renewable energy sources. Bludszuweit, Domínguez-Navarro, & Llombart (2008) and Bukhsh, Zhang, & Pinson (2016) wrote their articles on wind power, however, 9 years earlier, namely, in 2008 and a year earlier, in 2016, respectively. It is better to forecast solar radiation using the unconditional method for places with a large number of Sunny days per year, and for places with a small number of Sunny days per year, it is preferable to use the conditional probability method. You also need to use different forecasting methods for different periods of the year for the most effective forecasting.

These conclusions are reached by Boland, & Soubdhan (2015) in their paper on space-time prediction of solar radiation.

Bracale, Caramia, Carpinelli, Di Fazio, & Ferruzzi (2013) are convinced that solar power will provide the smart grid of the future, and a more efficient photovoltaic system requires a forecast that can be compiled based on the clarity index using two variables, such as cloud cover and humidity. Candille, & Talagrand (2008) compared two models for precipitation forecasting. Prediction using the multiplication method and the down method, the first of which was more effective.

Cervone, Clemente-Harding, Alessandrini, & Monache (2017) studied the prediction of upcoming solar radiation, the main component of the solar power industry, using various deep irradiation models and concluded that LSTM and GRU are the most effective approaches to make an hourly forecast for the next year. A hybrid computational model was developed for forecasting. Prediction intervals (PiS) were constructed for different time intervals under normal light conditions: one-minute, five-minute, ten-minute, fifteen-minute, and twenty-minute intervals (Chu, Li, Pedro, & Coimbra, 2015). This approach can be effective when placing solar power plants in countries with a large number of sunny days per year. Since large companies engaged in the production of solar electricity have repeatedly reported on the possible placement of solar power plants in the vacant territories of a number of African countries, the approach developed by the authors is not only effective, but also relevant. In the work of other scientists, the exponential smoothing state space (ESSS) method for predicting the time series of solar radiation is presented. This method can be used together with others to confirm or refute the accuracy of the forecast (Dong, Yang, Reindl, & Walsh, 2013; El-Baz, Tzscheutschler, & Wagner, 2018) describe a method for predicting day-ahead energy generation for buildings where photovoltaic cells have been installed. This forecast will be useful for cities where roofs and windows with photovoltaic elements are used. Of course, we are not talking about private homes, but about public ones, since making a forecast is necessary for production or an office, but not for a family with an average daily electricity consumption, since making a forecast for the latter is ineffective. It was rightly said that renewable energy sources are unpredictable and the generating reserve becomes one of the main factors for the success of a company that owns solar power stations in such conditions (Cheng et al., 2020; Li et al., 2020; Zhong et al., 2020). Most of the most accurate forecasts are point-based, so the reserve size is difficult to calculate for the long term, since the full energy cycle is even more than a year (Qiu et al., 2020; Zhao et al., 2021; Li et al., 2021). The authors propose their own method for calculating the reserve (Fahiman, Disano, Erfani, Mancarella, & Leckie, 2019). Continuing to talk about ways to predict solar activity, both in local and global terms, it makes sense to mention the diagnostic approach to evaluating forecast indicators for the purpose of their further calibration. This approach, in general, can be useful in predicting all types of weather events, which affects the production of alternative energy in different ways, that is, different types of alternative energy, but in this case solar (Gneiting, Balabdaoui, & Raftery, 2007). Another way to predict solar power generation by photovoltaic means is to analyze and capture spatiotemporal dependencies in the generation of photovoltaic signals, followed by modeling multidimensional predictive distributions and further generating spatiotemporal trajectories describing the potential evolution of forecast errors through successive lead times and locations (Golestaneh, Gooi, & Pinson, 2016). In another work of the same scientists of the same year, another method of forecasting was proposed, but for a much shorter period: from a few minutes to 1 hour. In their research, they used the Extreme Irradiation Machine (ELM) as a regression model. It can be assumed that the forecast will be very accurate in such a short period, but for longer-term forecasts, it is necessary either to use other approaches, or to improve the proposed approach to obtain a forecast of the expected production of solar electricity in the more distant future (Golestaneh, Pinson, & Gooi, 2016). The GHI method can be used to predict local changes in the dispersion in the case of an exponentially decaying heteroscedastic model for tracking the dynamics of solar radiation (Grantham, Gel, & Boland, 2016). In 2014, the Global Energy Forecasting Competition (GEFCom2014) was launched. In particular, the scientists who wrote the article in question took part in this competition, summing up the results of the latest research in the field of forecasting for the year of participation in the competition. Probabilistic forecasting took into account four components: price, sun, wind, and load (Hong, Pinson, Fan, Zareipour, Troccoli, & Hyndman, 2016). The next paper in question was written by two other scientists also to participate in the competition previously mentioned under the same conditions (Huang, & Perry, 2016; Morkovkin, Gibadullin, Kolosova, Semkina, Fasehzoda, & 2020; Morkovkin, Lopatkin, Sadriddinov, Shushunova, Gibadullin, & Golikova, 2020; Morkovkin, Lopatkin, Shushunova, Sharipov, & Gibadullin, 2020; Morkovkin, Gibadullin, Safarov, & Alpatova, 2020; Gibadullin, Yurieva, Morkovkin, & Isaichykova, 2020; Gibadullin, Morkovkin, Milonova, Progunova, & Isaichykova, 2020; Romanova, Morkovkin, Nezamaikin, Gibadullin, & Ivanova, 2020; Khayrzoda, Morkovkin, Gibadullin, Elina, & Kolchina, 2020; Morkovkin, Gibadullin, Romanova, Erygin, & Ziadullaev, 2019; Kobtseva, Novoselova, Novoselov, Morkovkin, & Sidorchukova, 2017; Morkovkin, Mamychev, Yakovenko, Derevyagina, & Didenko, 2016).

To invest in solar energy, many factors must be taken into account. For example, the impact of inflation on economic growth. This is important because economic growth, in turn, affects all industries, including solar energy. A paper by two researchers examines the sustainability of the impact of inflation on economic growth (Gneiting, & Raftery, 2007). Another article refers to studies claiming that consumption an increase in per capita energy consumption leads to significant economic growth. As a result of the analysis of these studies, the author comes to the conclusion that this is true only for developed countries, and for developing countries it is much more useful to save energy, since the GDP growth from energy consumption in these countries is much lower (Abbas, 2020). The article deals with emotional development and adaptation in the Omdurman preschool community in Sudan (Alwaelya, Yousif, & Mikhaylov, 2021). The next article deals with Russian energy projects in South Africa (An, & Mikhaylov, 2020). In the following article, the authors analyze the strategy of South Korea in the oil market (An, Mikhaylov, & Jung, 2020). Another paper presents a machine learning approach for solving problems in insecure systems (An, Mikhaylov, & Kim, 2020). The following article also presents a machine learning approach, but for a different purpose, namely, to predict oil prices (An, Mikhaylov, & Moiseev, 2019). In their article, the authors write about the machine learning algorithm (An, Mikhaylov, & Sokolinskaya, 2019).

In their article, the authors considered the problem of network revenue management in the context of limited information on demand (An, Mikhaylov, Jung, & S.-U., 2021). About the US-China trade relations, the market reactions of companies in both countries, as well as about the deglobalization in the energy and resource sectors of Africa, is written in another article under consideration. The energy sector in Africa is of the greatest interest in the development of solar energy in several dozen countries (An, Mikhaylov, Richter, 2020). Another author wrote an article on the relationship between GDP growth and foreign direct investment based on the theory of cointegration and the Granger causality criterion (Cheng,1995). The next article deals with the use of metal oxides in order to support the development of civilization and at the same time preserve nature, which has been actively destroyed by new technologies, especially after industrialization (Danish, Bhattacharya, Stepanova, Mikhaylov, Grilli, Khosravy, Tomonobu, 2020). Another article under consideration deals with the energy optimization of technological processes for the production of public catering products (Dayong, Mikhaylov, Bratanovsky, Shaikh,

& Stepanova, 2020).The article deals with such a topic as the consumption of electric energy by mining cryptocurrencies on the example of the 4 most famous cryptocurrencies using the Herfindahl-Hirschman method (Denisova, Mikhaylov, & Lopatin, 2019). The following article describes the cooperation between the Russian Federation and South Korea in the energy and other spheres, as well as the problems that arise during the implementation of joint projects (Dooyum, Mikhaylov, & Varyash, 2020). In another article, the authors consider the issue of new approaches for designing an IP chip for multi-core chips (Gura, Mikhaylov, Glushkov, Zaikov, & Shaikh, 2020). A group of researchers attempted to study the relationship between the economic growth of Greece from 1960 to 1996 using a vector error correction model in their scientific paper (Hondroyiannis, Lolos, & Papapetrou, 2002). Another paper discusses the causal relationship between electricity consumption and economic growth (Kraft, & Kraft, 1978). The next article deals with a new stage in the evolution of the cryptocurrency market (Mikhaylov, Danish, & Senjyu, 2021).

The article examines the effect of volatility between currency and stock markets (Mikhaylov, 2018a). Another article by the same author, also published in 2018, talks about the relationship between world stock indices and the price of oil (Mikhaylov, 2018b). The same author a year later considered the impact of the energy crisis that occurred in 2015 on the budget revenues of the Russian Federation (Mikhaylov, 2019). A year later, the already mentioned author conducted an analysis of the open cryptocurrency innovation market to derive a forecast for this market in the future (Mikhaylov, 2020a). In another article of the same year, the author considered the issue of political and legal features of the organization of renewable energy activities in Iceland (Mikhaylov, 2020b). In this article, the author used the Hurst methods to identify the cyclical dynamics of prices in the cryptocurrency market, as well as to assess the potential risks and the degree of formation of this market (Mikhaylov, 2020c). The following article was written in order to assess the general state of atmospheric air in the ecosystems of cities and towns using modern methods of lichen indication (Mikhaylov, 2021a; Mikhaylov, 2021b; Mikhaylov, 2021c). The main purpose of writing the following article was to analyze the state of banks in Russia after the sanctions imposed in 2014, based on the theory of economic behavior (Mikhaylov, & Sokolinskaya, 2019). In another paper, the authors presented an algorithm for creating artificial neural networks for optimal distribution of tasks in electrical networks (Mikhaylov, & Tarakanov, 2020). About climate changes that occur under the influence of greenhouse gases in the atmosphere is written in this article (Mikhaylov, Moiseev, Aleshin, & Burkhardt, 2020). The following article discusses the optimal investment strategy (Mikhaylov, Sokolinskaya, & Nyangarika, 2018). In another article, the authors addressed the topic of quality of life and anxiety-depressive disorders (Mikhaylov, Yumashev, & Kolpak, 2021; Liu, Panfilova, Mikhaylov, & Kurilova, 2022).

In the article, the authors write about modeling the corruption perception index (Moiseev, Mikhaylov, Varyash, & Saqib, 2020). Another article talks about achieving sustainable development in Russia through e-learning financing models (Nie, Panfilova, Samusenkov, & Mikhaylov, 2020). In the following article, the authors consider forecasting oil prices (Nyangarika, Mikhaylov, & Richter, 2019). The same authors in another paper write about improving the accuracy of oil price forecasting due to the use of a new modification of the autoregressive integrated model and the additional use of exponential smoothing (Nyangarika, Mikhaylov, & Richter, 2019). The degree of dependence of the gross domestic product of the world's leading oil supply countries on crude oil prices on the example of countries such as Russia and Saudi Arabia (Nyangarika, Mikhaylov, & Tang, 2018). In this article, the author considered the previously mentioned topic of the dependence of economic growth on energy consumption, but using the example of Tanzania (Odhiambo, 2009). In another article, the authors consider the relationship between EU GDP growth, dividing them into countries with different income levels. The period of economic growth under consideration is from 1971 to 2005, and the analysis was performed using a panel causality test (Ozturk, Aslan, & Kalyoncu, 2010).

In the article, the authors empirically investigate the relationship between energy consumption and economic growth. As an example, the top ten countries in terms of energy consumption in the world were taken: South Korea, France, Brazil, Germany, Canada, Japan, India, Russia, the United States, and China (Shahbaz, Zakaria, Shahzad, & Mahalik, 2018). Another paper analyzed the relationship between the Triple Bottom Line and corporate and social responsibility performance indicators (Varyash, Mikhaylov, Moiseev, & Aleshin, 2020). In the next paper, the researchers looked at the direction of the relationship between electricity consumption and economic growth in China between 1972 and 2006. A multivariate cointegration approach was used for the analysis (Wang, Wang, Zhou, Zhu, & Lu, 2011). Earlier work by other scientists examined the relationship between GNP and energy consumption in the United States. For the analysis, the time period from 1947 to 1979 was taken. As an additional task, the relationship between energy consumption and employment was investigated (Yu, & Hwang, 1984). In the next paper under consideration, a technique for the controlled incorporation of nanoinclusions into a polymer matrix was proposed (Yumashev, & Mikhaylov, 2020). In another papers, the authors examined the impact of the human development index on energy consumption and quality as a global indicator of sustainable development (Yumashev, Ślusarczyk, Kondrashev, & Mikhaylov, 2020; Zhao, Cherkasov, Avdeenko, Kondratenko, & Mikhaylov, 2021).

This forecast will be very effective and can serve as a basis for forecasting the future development of the solar power industry as a whole (Table 1). The table below shows the supply of solar electricity in Spain and Switzerland between 2011 and 2019.

Table 1. Solar energy supply in Spain and Switzerland from 2011 to 2019

Year	Spain	Switzerland
2011	46134.84539	1957.056
2012	50113.91271	3794.880467
2013	52273.1136	7049.683151
2014	52796.21023	10758.63925
2015	52978.26498	16561.69108
2016	54774.53592	19680
2017	56243.94583	20705.3285
2018	56835.22224	23670.99358
2019	79750.15383	26693.12264

Source: author's chart compiled by Thomson Reuters Datastream

METHODOLOGY

The paper uses a research method: comparing the influence of various factors on the price of solar electricity through a vector autoregression model (VAR model). In this paper, the vector autoregression model (VAR-model) is used to assess the current situation, as well as for further forecasting. This model is mainly used for analyzing the dynamic effect of various types of disturbances on a system with several variables, as well as for predicting further changes in systems with related time series (Dong, Ikonnikova, Rogulin, Sakulyeva, & Mikhaylov, 2021).

The construction of VAR models is based on structural modeling, which considers each endogenous variable as a function of the delayed values of all endogenous variables in the system.

The model of the real price of 1 kilowatt per hour of electricity will be constructed using three variables: the price of oil, gross domestic product, and the supply of solar electricity (Mikhaylov, 2018a; Mikhaylov, 2018b; Mikhaylov & Tarakanov, 2020).

The hypothesis is that the growing supply of solar electricity, which is gradually replacing traditional types of electricity production, affects the growth of electricity tariffs due to the high cost of solar electricity.

$$Y_t = \alpha + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + \varepsilon_t \quad (1)$$

In this model, α is a variable that serves as a K-vector constant used for interception, p is the number of time periods that the variables go before, AP is a time-invariant matrix, and et is a vector of error terms, Yt-p are variables.

RESULTS

This paper uses the VAR model to analyze the factors that affect the price of solar electricity. The assessment was made for two States. The electricity market is one of the most resilient to seasonal fluctuations,

Table 2. Regression summary for Switherland and Spain

Indicator	Spain	Switzerland
Multiple R	0.993344706	0.998544723
R-square	0.986733705	0.997091563
Normalized R-square	0.980100558	0.994910236
Standard error	0.427096651	0.174752925
Regression(SS)	81.4055307	41.87784566
Regression(MS)	27.1351769	13.95928189
Regression(F)	148.7579978	457.1031025
Coefficients	-0.040335572	0.028821093
t-statistics	-6.584523021	4.688974083
P- Value	0.00058905	0.009384894

Source: Author's calculations.

and there are no emissions, so annual averages were applied over a long period of time, since the forecast is made for 20 years ahead (Table 2).

According to the results, are the following: coefficient of error probability in the case of market analysis of solar energy of Spain is on 0,380404596 higher than the case with the Swiss solar electricity Mart, which was quite predictable, as in the dynamics of the Spanish market as much as 5 trend 4 change the nature of the regression. The cost of solar electricity depends most of all on the price of oil, and this dependence is inversely proportional.

However, the price of oil is not the main factor in changing the supply and price of solar electricity. A 1% change in GDP affects the change in the supply of solar electricity only by hundredths of a percent and by tenths of a percent on its price, so it can be assumed that GDP does not affect the supply of solar electricity and its price. With such a ratio of indicators, we can proceed to consider trends in changes in the supply in these columns and directly identify the supply of solar electricity for future years by mathematical means. It is worth noting that this prediction is based solely on current trends and may be distorted by a number of factors.

Among these factors: solar activity, volcanic activity, introduction of new technologies, competition, first of all, for the territories where solar power stations should be located. The forecast is based on a 1% fluctuation in the values of solar activity in the following years. Volcanic activity is not taken into account, since at the moment there are no accurate ways to predict the eruption of a volcano for several decades to come. The impact of volcanic activity on the growth of solar electricity may not be so obvious, but ash can not only block the access of light to solar panels for a certain period of time, but also completely spoil them. New technologies in the field of solar power can increase the efficiency of panels, thereby increasing the supply from installed power plants. Competition is also an important factor that can affect the distortion of forecast values, since territories are important in any type of production activity that may be more profitable, as opposed to solar power, which may slow down the rate of supply growth. The following are the supply growth trends in Spain and Switzerland (Table 3). The following is a table of the average annual growth rates of solar electricity supply in the countries under consideration for the period from 2013 to 2019.

On the second chart, the trend line almost completely coincides with the supply line, so there is no point in highlighting it separately. As you can see, with the introduction of the Cartesian cardinate system, the angles between the trend lines and the positive direction of the abscissa axis are approximately equal on both graphs. however, the coefficient of the annual multiplicative effect on the solar electricity

Table 3. Annual supply growth rates in Spain and Switzerland between 2013 and 2019

Year	Spain	Switzerland
2013	1.043085857	1.857682531
2014	1.010006992	1.526116709
2015	1.003448254	1.539385297
2016	1.033905809	1.188284452
2017	1.026826515	1.052100026
2018	1.010512712	1.143231974
2019	1.403181877	1.127672252

Source: author's chart compiled by Thomson Reuters Datastream.

market in Switzerland is higher than on the same market in Spain, but in Spain this is achieved not by stable growth rates, but by cyclical aditivity, which has its effect once every 10 or 11 years.

Therefore, to predict changes in the supply of solar electricity in Switzerland, it is appropriate to use the existing trend coefficient of 1.127822, followed by the use of a coefficient of 0.1 immediately after the date when the supply is equal to the same market in Spain in the period from 2009 to 2017. For Spain, this coefficient will be equal to 1.03908 for the entire plot area, except for the dates of the influence of cyclic aditivity. According to mathematical calculations, aditivity can be represented by the following expression:

$$2500+(1000*(a-1)) \quad (2)$$

Where a is the number of the decade, and all other values are constants obtained from trend analysis. Thus, we get the following forecast for solar power supply in Spain and Switzerland (Table 4.) The following table shows the forecast of solar electricity supply in Spain and Switzerland for the period from 2020 to 2040.

Table 4. Forecast of solar electricity supply in Spain and Switzerland in the period from 2020 to 2040

Year	Spain	Switzerland
2020	82866.75388	30105.09566
2021	86105.14926	33953.1945
2022	89470.09967	38293.1657
2023	92966.55083	43187.88146
2024	96599.64172	48708.25044
2025	100374.7122	54934.245
2026	104297.3107	55636.30465
2027	108373.2025	56347.33662
2028	117108.3784	57067.45558
2029	121684.9211	57796.77767
2030	126440.3129	58535.42048
2031	131381.5433	59283.50316
2032	136515.8748	60041.14633
2033	141850.8537	60808.47218
2034	147394.3211	61585.60445
2035	153154.4247	62372.66848
2036	159139.6305	63169.79118
2037	165358.7355	63977.10111
2038	177320.8804	64794.72846
2039	184250.5004	65622.80509
2040	191450.9269	66461.46454

Source: author's chart compiled by Thomson Reuters Datastream.

Of course, the developing industry attracts the attention of investors and solar energy is no exception. Nevertheless, although investments in developing projects can bring more profit than in developed ones, however, the latter are more stable in terms of risks. One of the primary tasks of the investor is to determine the future of the industry in which investments are planned, since even stable industries can lose the value of their shares over time and even completely close. In history, there are many cases when developing industries have completely displaced developed ones from the market. This has also happened in the energy sector. For example, the development of internal combustion engines and electric motors about a hundred years ago gradually replaced the steam engines that used steam locomotives of that time from the market. This was due to the low efficiency of the outdated engine. In the 21st century, steam engines are no longer used in transport, at least on a mass scale. Solar energy looks very promising for investment. This conclusion can be reached based on several facts. For example, the number of countries using solar energy has increased since the beginning of the century, and the amount of solar electricity generated is growing annually. Various forecasts of experts also inspire hope for further growth of the industry in the future, including the forecast given in this article also testifies to this. Of course, any forecast can not guarantee its implementation with an accuracy of fractions, but it certainly reflects the general idea of the future of the industry. Also, any forecast can not take into account all factors, including unpredictable ones, that can affect the industry and the investor should be aware of this when making a decision.

One of the most important questions that an investor will have to answer before investing in the securities of a solar energy company is: “will this be a long-term or short-term investment?”. This is very important, not only because short-term investments can be more profitable than long-term ones, but also because even with a high probability of closing the company in the distant future, short-term investments can bring high returns if the optimal time for selling securities is correctly calculated.

When talking about investments in solar energy, we should not forget that any type of renewable energy is unpredictable, that is, it is impossible to predict exactly the full cycle of energy production, which means that there is a risk of the company’s bankruptcy, especially a small one (Zhou et al., 2020; Qi et al., 2020; Yuan et al., 2021). Naturally, companies form a generated reserve, but it is difficult to calculate the necessary reserve, that is, there is a risk of error when calculating the necessary reserve. For an investor, the risk of error of the company’s employees means the risk of losing his own assets invested in this company.

SOLUTIONS AND RECOMMENDATIONS

The paper describes the risks associated with competition (primarily for the territories where solar panels are supposed to be located), as well as other types of risks associated with volcanic activity, solar activity, and new technologies. Calculations are given to determine the dependence of the cost of solar electricity and its supply on such factors as the price of oil and the country’s GDP, as well as supply growth trends and their analysis. The result was a forecast for changes in the supply of electricity in the future for Spain and Switzerland. It is important to understand that forecasts based on regression models do not take into account many factors, especially those that do not yet have an impact on trends, but may have one in the future. Only practice will show how accurate the forecast is.

FUTURE RESEARCH DIRECTIONS

This study can be used to test the effectiveness of regression models in predicting the development of innovative industries. This forecast can be used to calculate the need to increase the capacity of traditional energy, taking into account the expected level of supply of solar electricity in the future, as the need for electricity in countries increases every year. Future work is planned to analyze the growth of solar power supply in developed and developing countries, analyze the prospects of developing countries in the field of alternative electricity, and identify recommendations for developing countries on ways that can allow them to catch up with developed countries in the field of solar power production.

CONCLUSION

The VAR model was used to determine the dependence of the cost and supply of solar electricity on various factors. The calculation error rate for Spain was higher than for Switzerland, which was expected, taking into account 4 points of regression change over the past 11 years in this country, while Switzerland has seen a stable increase in the supply of solar electricity, which can be described by a certain coefficient of annual multiplicativity. Despite the fact that in Spain the supply of solar electricity has increased more than in Switzerland over the past 9 years, however, Switzerland shows a faster growth in percentage terms. But according to the forecast, this trend will not allow Switzerland to catch up with Spain in solar power generation by 2040, but the gap between these countries will be reduced as a percentage.

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Chapter 3
Trends in Global Oil Investments Over the Past 20 Years

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ABSTRACT

Today, energy is an irreplaceable resource without which it is impossible to imagine the life of modern society. Oil, as the most important energy resource, has a significant impact on both individual economies and the world economy. The main objective of this chapter is to identify the relationship between oil supply and oil demand of developed and developing countries on the example of OECD and Former Soviet Union countries. The changes that took place in supply and demand in the oil market from 2000 to 2020 are investigated. The chapter uses graphic and mathematical analysis. It is clear with a fair amount of confidence that the oil demand in developed countries is higher than their supply, and the supply of oil in developing countries is rather more than demand. Also, the chapter draws attention to investments in the oil industry, including on the example of Russia as a former USSR country, analyzes their current state, and draws appropriate conclusions.

INTRODUCTION

Today, the global oil industry is an important factor in stability and the basis for the development of the global economy. The history of the oil industry began in 1859, when the first well was drilled in the US state of Pennsylvania. But as a reference point for the global industry, 1886 should be considered, when Karl Benz received a patent for the world's first car, the movement of which was provided by the Otto four-stroke engine upgraded to run on gasoline, patented a decade earlier. The unique calorific value of liquid hydrocarbon fuel per unit volume and the resulting compactness, autonomy, and efficiency of

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vehicles with an internal combustion engine for many decades to come have provided a huge international oil market for oil. Engines were improved, and the scope of oil was expanded more and more. Not only gasoline, but also heavier fractions have become a popular product. Fuel oil, which until recently was discharged into water bodies near processing plants as an unnecessary waste of production, began to be used as fuel for steam locomotives, steamers, and industrial steam engines. Gradually, he ousted firewood from the transport sector, and then coal. During the First World War, gasoline became a product of prime necessity for actively motorized armies, and control of oil supplies acquired military-strategic importance. If in 1914 364 ships were equipped with oil heating of boilers, then in 1922 - more than 2.5 million. At the beginning of the war, the French army had only a hundred trucks, four years later there were already about 70 thousand of them. Thanks to the optimization inventions of Henry Ford, cars were produced quickly and cheaply. In 1920, about 9 million cars drove around the world, after five years - about 20 million, two years later - almost 30 million. In addition, it was the appearance of the gasoline engine that gave rise to the development of aviation. In the 1930s, petrochemicals expanded the scope of oil applications: it was then that the introduction of such an important material as polyethylene into industrial production began. In general, during the period between the First and Second World Wars, the consumption of petroleum products increased almost six times. And the global injustice in the distribution of oil reserves on the planet has become even more noticeable. Only two centers of oil consumption possessed the reserves necessary to meet domestic needs - the USA and the USSR. The Second World War made oil the true blood of victory. The largest military operations were associated with attempts to gain access to the most important sources of raw materials. Hitler's Germany was torn to the Caucasus and the Middle East, Japan to Indonesia and Burma, and all with only one goal - to gain access to oil fields. The fact that the USSR and the allies managed to leave the enemy armies on a starving fuel ration largely predetermined the outcome of the war. Simple but revealing statistics: over the seven years of World War II, Germany and Italy consumed 52.7 million tons of oil and oil products, the United States - almost 1.5 billion tons. The golden era of oil consumption was a small period from 1950 to 1970 by historical standards. In the 1970s, oil provided 50% of the world's energy demand, which made the oil market a source of special influence on the world economy.

The modern world cannot be imagined without oil products and oil refining. Over the past two decades (2000–2020), significant changes have taken place in the global oil industry, creating a new geo-economic and geopolitical situation. It is affected key indicators such as production, consumption, refining and international trade in oil, which continues to have a significant impact on the global economy despite efforts to increase the share of alternative energy sources.

Today, the global oil market is in a state of profound change, which has an impact on the current and future opportunities for world production and consumption of oil and oil products. At the same time, the oil market tends to form "bubbles", and even countries that are able to independently satisfy their oil needs cannot be isolated from its influence.

There is a hypothesis that an increase in energy consumption leads to economic growth. The paper by Kraft and Kraft (1978) examines the relationship between energy consumption and economic growth in the United States. Therefore, a hypothesis arose that the oil demand in developed countries is much higher than in developing countries, and vice versa, the oil supply in developing countries is higher than in developed countries. The article examines how the demand and supply of oil changed in the period from 2000 to 2020 using the example of the international economic organization of developed countries OECD with developing countries of the post-Soviet space, which include 15 former republics of the USSR: Russian Federation, Ukraine, Georgia, Belorussia, Uzbekistan, Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Moldova, Turkmenistan, Tajikistan, Latvia, Lithuania, and Estonia. The year 2000 was taken as the starting point, because from this time the market economy began to develop quickly in the countries of the post-Soviet space. The article draws attention to investments in the oil industry, including on the example of Russia as a former USSR country, analyzes their current state and draws appropriate conclusions.

LITERATURE REVIEW

The question of the impact of energy on the economy is causing controversy in the scientific community. There are a large number of scientific publications that prove the importance of energy as the main resource consumed in all spheres of production and in creating the well-being of society (Abbas, 2020; Cheng, 1995; Hondroyiannis, Lolos, & Papapetrou, 2002; Odhiambo, 2009; Ozturk, Aslan, & Kalyoncu, 2010; Phelps, 1994). Indeed, energy accompanies us everywhere, without it our life today is simply inconceivable. And since energy is a necessary resource for the comfortable life of society and its absence or shortage causes serious problems and discomfort, the author has no doubts that energy strongly affects the economy. The energy is «of major importance for the competitive performance of firms and of nations and for the long-term growth of the world economy». Thus, thanks to these and many other works, the importance of energy in the economy has increased, it has come to be seen as one of the main factors contributing to economic growth (Denisova, Mikhaylov, & Lopatin, 2019; Gura, Mikhaylov, Glushkov, Zaikov, & Shaikh, 2020; Alwaelya, Yousif, & Mikhaylov, 2020; Mikhaylov & Sokolinskaya, 2019; Mikhaylov & Tarakanov, 2020; An, Mikhaylov, & Jung, 2020; An, Mikhaylov, & Kim, 2020; An, Mikhaylov, & Moiseev, 2019; An, Mikhaylov, & Sokolinskaya, 2019a).

But not all scientists agreed with this hypothesis. Somebodies consider the impact of energy on economic growth to be either negligible or neutral (Ranjbar, Chang, Nel, & Gupta, 2017; Rathnayaka, Seneviratna, & Long, 2018; Shahbaz, Zakaria, Shahzad, & Mahalik, 2018; Yu, & Hwang, 1984; Wang, Wang, Zhou, Zhu, & Lu, 2011).

Scientists who agree that energy consumption has the strongest impact on the economy believe that energy consumption drives the GDP of both developed and developing countries (Cheng et al., 2020; Mikhaylov, 2019; Li et al., 2020; Mikhaylov, Sokolinskaya, & Nyangarika, 2018; Zhong et al., 2020; Qiu et al., 2020).

If we talk directly about oil as one of the most important sources of energy, it should be noted that oil is the determining factor in the real world interest rate, this energy resource also directly affects the demand for labor and, accordingly, unemployment. An increase or decrease in oil prices has a strong impact on the economies of countries and the world economy as a whole. Scientists have established the relationship between oil price shocks and economic downturn, decline in GDP (Nyangarika, Mikhaylov, & Tang, 2018; Mikhaylov, 2020b; Mikhaylov, 2020c).

Thus, it can be said that oil has a strong impact on the economy. By the amount of oil consumption, we can determine the standard of living of the population, the state of the economy and the level of development of the country. And oil prices can lead the economies of countries into a state of recession, economic decline and economic growth (Mikhaylov, 2021a; Mikhaylov, 2021b; Mikhaylov, 2021c; Mikhaylov, Danish, Senjyu, 2021; Mikhaylov, 2018a; Mikhaylov, 2018b; Zhao, Cherkasov, Avdeenko, Kondratenko, & Mikhaylov, 2021).

METHODOLOGY

The hypothesis necessitated a complex and detailed study of the data. Data from Thomson Reuters were used to analyze the dynamics of oil demand and supply in the OECD countries and the former USSR. Tables, diagrams, graphs with indicators of supply and demand of the OECD and Non-OECD, which also includes the countries of the former USSR, are built based on their data. For a more detailed study of the problem, the indicators of some participating countries are given, which account for the majority of oil exports / imports. In the OECD, the leaders of imports are Canada, Japan, the USA, European countries, and the largest exporters are Canada, Mexico, and the North Sea. The largest importers of Non-OECD include China, the rest of Europe, the former USSR, Asia, and the largest exporters are also China, the former USSR, the OPEC countries (An, Mikhaylov, Richter, 2020; Dong, Ikonnikova, Rogulin, Sakulyeva, & Mikhaylov, 2021; Liu, Panfilova, Mikhaylov, & Kurilova, 2022).

As objects of research, data on the supply and demand of oil from the OECD and Non-OECD countries will be taken, and their components will be considered. The article will consider a chronological interval of 20 years, from 2000 to 2020. Thus, it will be possible to analyze quantitative changes in supply and demand in the oil market to identify the reasons and relationships.

The study used the formulas of chain absolute growth (1) to identify the dynamics of changes in indicators and basic absolute growth (2) to quantitatively measure changes in the data of 2020 in relation to 2000.

$$\Delta chain = y_i \tag{1}$$

$$\Delta basic = y_i - y_1 \tag{2}$$

The growth rate formula (3) is used to calculate the percentage change in indicators compared to the previous year.

$$Rinc = \frac{y_i - y_{i-1}}{y_{i-1}} \cdot 100\% \tag{3}$$

The average growth rate formula (4) is used to quantitatively compare the dynamics of growth in exports and imports of countries in relation to each other.

$$Rinc = n - 1\sqrt{\frac{y_n}{y_1}}$$

The article used the association coefficient (5) to study the relationship between supply and demand of developed and developing countries, and therefore to confirm or refute the hypothesis put forward. If the association coefficient Q ³ 0.5, the connection is confirmed.

$$Q = \frac{\frac{\sum_{i=1}^{n} Ai}{n} * \frac{\sum_{i=1}^{n} Di}{n} - \frac{\sum_{i=1}^{n} Ci}{n} * \frac{\sum_{i=1}^{n} Bi}{n}}{\frac{\sum_{i=1}^{n} Ai}{n} * \frac{\sum_{i=1}^{n} Di}{n} + \frac{\sum_{i=1}^{n} Ci}{n} * \frac{\sum_{i=1}^{n} Bi}{n}} \tag{5}$$

After calculating the association coefficient, the contingency coefficient (6) was calculated in order to clarify the randomness / non-randomness of the relationship and confirm the result. If the contingency ratio R³0.3, the relationship is not accidental.

$$R = \frac{\frac{\sum_{i=1}^{n} Ai}{n} * \frac{\sum_{i=1}^{n} Di}{n} - \frac{\sum_{i=1}^{n} Ci}{n} * \frac{\sum_{i=1}^{n} Bi}{n}}{\sqrt{\left(\frac{\sum_{i=1}^{n} Ai}{n} + \frac{\sum_{i=1}^{n} Ci}{n}\right) * \left(\frac{\sum_{i=1}^{n} Bi}{n} + \frac{\sum_{i=1}^{n} Di}{n}\right) * \left(\frac{\sum_{i=1}^{n} Ai}{n} + \frac{\sum_{i=1}^{n} Bi}{n}\right) * \left(\frac{\sum_{i=1}^{n} Ci}{n} + \frac{\sum_{i=1}^{n} Di}{n}\right)}} \tag{6}$$

The following data series were taken to calculate the association coefficient and contingency coefficient: demand of the OECD (Ai), demand of the Former Soviet Union (Bi), supply of the OECD (Ci), supply of the Former Soviet Union (Di) and considered time range (n, years).

RESULTS AND DISCUSSION

The world is constantly balancing between the growth of oil demand and supply. Keeping this balance is very difficult. One of the reasons for this is the low elasticity of demand for hydrocarbons. In economics, elasticity is the reaction of supply or demand to price changes. If a 1% decrease in price results in less than 1% increase in sales, demand is inelastic. Oil has a coefficient of elasticity much lower than one. This is because the use of oil in the short term is driven by very slowly changing factors. Transport cannot instantly switch from one type of fuel to another. The development and implementation of energy-saving programs, and even more the development of alternative energy, is also not a quick matter.

Analyzing oil demand over the past 20 years (Table 1), it is worth saying that it has been dynamically increasing every year both in developed and developing countries. But, if in 2000 the OECD countries consumed 10.41% greater than other countries, then in 2020 this trend has changed and now developing countries consume 11.63% more. In general, oil consumption is growing at a fairly rapid pace. It is associated with the rapid development of new technologies that require energy resources, and an increase in the number of cars per family and its active use compared to 2000. One of the main factors in the price elasticity of demand is the availability of substitute goods. While there are no equivalent substitutes for oil, the market balance will be maintained only within the supply-demand system. And even despite the gradual decline in the share of oil in the structure of world energy consumption, the production and consumption of liquid hydrocarbons is slowly but surely growing along with the world economy (Dayong, Mikhaylov, Bratanovsky, Shaikh, & Stepanova, 2020; Dooyum, Mikhaylov, & Varyash, 2020; Moiseev, Mikhaylov, Varyash, & Saqib, 2020; Varyash, Mikhaylov, Moiseev, & Aleshin, 2020; Yumashev &

Table 1. World Oil Demand in 2000-2020, mbpd

World Oil Demand																					
Actuals (mbpd)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
OECD Demand																					
Canada	2,04	2,07	2,09	2,22	2,31	2,34	2,25	2,28	2,23	2,16	2,28	2,31	2,35	2,46	2,39	2,46	2,47	2,46	2,52	2,42	2,17
Europe	15,22	15,39	15,33	15,48	15,53	15,67	15,69	15,48	15,40	14,70	14,67	14,24	13,78	13,61	13,53	13,87	14,05	14,41	14,32	14,24	12,60
Japan	5,51	5,42	5,32	5,43	5,32	5,33	5,20	5,04	4,80	4,39	4,43	4,45	4,70	4,51	4,27	4,15	4,03	3,94	3,79	3,66	3,24
Other OECD	5,18	5,15	5,13	5,16	5,21	5,34	5,38	5,52	5,45	6,08	6,11	6,18	6,28	6,27	6,20	6,32	6,52	6,59	6,54	6,56	6,01
U.S. (50 States)	19,70	19,65	19,77	20,04	20,73	20,80	20,69	20,69	19,50	18,77	19,18	18,88	18,49	18,97	19,10	19,53	19,69	19,95	20,50	20,54	18,42
U.S. Territories	0,29	0,33	0,32	0,34	0,35	0,34	0,34	0,30	0,29	0,27	0,29	0,27	0,28	0,28	0,15	0,15	0,14	0,14	0,16	0,18	0,16
Total OECD	**47,93**	**47,99**	**47,96**	**48,67**	**49,44**	**49,81**	**49,55**	**49,30**	**47,66**	**46,37**	**46,96**	**46,33**	**45,88**	**46,09**	**45,63**	**46,49**	**46,89**	**47,49**	**47,83**	**47,59**	**42,60**
As % of World Demand	**62,47**	**61,97**	**61,40**	**61,08**	**59,99**	**59,26**	**58,12**	**57,45**	**55,70**	**54,70**	**53,76**	**52,00**	**50,79**	**49,93**	**48,61**	**48,60**	**48,47**	**48,06**	**47,57**	**46,93**	**45,77**
Non-OECD Demand																					
China	4,80	4,92	5,16	5,58	6,44	6,70	7,27	7,53	7,95	8,54	9,33	9,51	10,18	11,09	11,64	12,52	13,04	13,57	14,02	14,52	13,91
Europe	0,70	0,71	0,72	0,72	0,74	0,76	0,77	0,77	0,75	0,67	0,66	0,67	0,66	0,67	0,67	0,69	0,73	0,76	0,76	0,77	0,73
Former Soviet Union	3,72	3,78	3,83	3,91	4,04	4,16	4,26	4,09	4,22	4,11	4,13	4,64	4,62	4,60	4,85	4,74	4,63	4,79	5,26	5,34	5,04
Other Asia	7,34	7,49	7,72	7,92	8,37	8,66	8,91	9,09	9,34	9,85	10,45	10,98	11,33	11,56	11,76	11,97	12,64	13,19	13,76	13,97	12,99
Other Non-OECD	12,23	12,57	12,72	12,88	13,38	13,97	14,51	15,02	15,66	15,24	15,82	16,97	17,69	18,29	19,33	19,24	18,81	19,02	18,92	19,21	17,81
Total Non-OECD	**28,79**	**29,46**	**30,15**	**31,01**	**32,97**	**34,24**	**35,71**	**36,51**	**37,91**	**38,41**	**40,39**	**42,77**	**44,45**	**46,22**	**48,25**	**49,17**	**49,85**	**51,33**	**52,72**	**53,81**	**50,47**
As % of World Demand	**37,52**	**38,03**	**38,60**	**38,92**	**40,01**	**40,74**	**41,89**	**42,55**	**44,30**	**45,30**	**46,24**	**48,00**	**49,21**	**50,07**	**51,39**	**51,40**	**51,53**	**51,94**	**52,43**	**53,07**	**54,23**
Total World Demand	**76,72**	**77,45**	**78,10**	**79,68**	**82,41**	**84,05**	**85,27**	**85,81**	**85,57**	**84,77**	**87,35**	**89,10**	**90,33**	**92,31**	**93,88**	**95,65**	**96,74**	**98,83**	**100,56**	**101,40**	**93,07**

Source: Thomson Reuters

Mikhaylov, 2020; Yumashev, Ślusarczyk, Kondrashev, & Mikhaylov, 2020; Nyangarika, Mikhaylov, & Richter, 2019a; Nyangarika, Mikhaylov, & Richter, 2019b).

However, this trend is worrying, since in addition to serious environmental problems that can be caused by excessive consumption of oil, society should not forget that this resource is depleted. Each additional barrel of oil that we use now reduces oil reserves, and hence the time period for which these reserves will be enough for humanity. It should also be noted that in 2020 oil demand decreased in all countries compared to 2019. According to experts, the global demand for oil by the end of 2020 may decrease by 9-15% compared to last year. Oil demand was undoubtedly influenced by a decrease in traffic flows due to quarantine restrictions caused by COVID-19. OPEC predicts that oil demand in the OECD is unlikely to recover to 2019 levels and, after major ups and downs in 2020 and 2021, will gradually transition from slight growth to a decline towards the end of the medium term. By 2025, oil demand in the OECD will decrease by 1.1 million barrels per day.

Consider the oil supply. Until the mid-1970s, world oil production doubled approximately every decade, then the rate of its growth slowed down. In 1938 it was about 280 million tons, in 1950 about 550 million tons, in 1960 over 1 billion tons, and in 1970 over 2 billion tons. In 1973, world oil production exceeded 2.8 billion tons. World oil production in 2005 amounted to about 3.6 billion tons.

In total, from the beginning of industrial production (from the end of the 1850s) to the end of 1973, 41 billion tons were extracted from the bowels of the world, half of which fell on 1965-1973.

Table 2. World Oil Supply in 2000-2020, mbpd

World Oil Supply																					
OECD Supply																					
Actuals (mbpd)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Canada	2,75	2,81	2,95	3,11	3,14	3,09	3,29	3,45	3,35	3,32	3,44	3,60	3,86	4,07	4,39	4,51	4,60	4,96	5,38	5,50	5,15
Mexico	3,46	3,57	3,59	3,81	3,85	3,79	3,71	3,50	3,19	3,00	2,98	2,96	2,94	2,92	2,82	2,62	2,48	2,25	2,08	1,92	1,89
North Sea	6,18	6,27	6,22	6,00	5,63	5,18	4,78	4,54	4,30	4,08	3,73	3,37	3,07	2,86	2,90	3,06	3,15	3,10	2,96		
Other OECD	1,79	1,70	1,68	1,54	1,50	1,50	1,50	1,55	1,62	1,57	1,64	1,60	1,59	4,38	4,74	4,88	4,96	4,79	4,78	4,77	4,95
U.S. (50 States)	9,06	8,96	9,00	8,80	8,70	8,32	8,33	8,46	8,56	9,13	9,70	10,12	11,10	12,36	14,12	15,15	14,84	15,65	17,93	19,47	18,67
Total OECD	**23,24**	**23,31**	**23,43**	**23,26**	**22,81**	**21,88**	**21,61**	**21,49**	**21,02**	**21,10**	**21,48**	**21,64**	**22,55**	**23,73**	**26,07**	**27,16**	**26,88**	**27,66**	**30,18**	**31,66**	**30,65**
As % of World Supply	**29,88**	**30,01**	**30,43**	**29,22**	**27,45**	**25,88**	**25,52**	**25,42**	**24,62**	**25,01**	**24,58**	**24,45**	**24,94**	**26,00**	**27,70**	**27,97**	**27,54**	**28,18**	**29,93**	**31,44**	**32,39**
Non-OECD Supply																					
China	3,38	3,44	3,53	3,56	3,66	3,79	3,86	3,93	3,99	3,99	4,35	4,39	4,46	4,89	5,01	5,18	4,90	4,78	4,77	4,90	4,93
Former Soviet Union	8,19	8,77	9,43	10,42	11,34	11,76	12,16	12,62	12,54	12,89	13,22	13,49	13,60	13,77	13,90	14,11	14,24	14,34	14,60	14,63	13,48
Other Non-OECD	10,23	10,13	10,34	10,48	10,85	12,17	12,31	12,15	12,32	12,49	13,07	12,99	12,37	11,99	11,96	14,24	14,67	14,55	14,53	14,85	14,80
Total OPEC Supply	32,72	32,03	30,27	31,88	34,45	34,95	34,72	34,37	35,48	33,87	35,26	36,03	37,45	36,90	37,19	36,41	36,91	36,83	36,76	34,65	30,79
Total Non-OECD	**54,52**	**54,37**	**53,56**	**56,34**	**60,29**	**62,68**	**63,06**	**63,06**	**64,33**	**63,24**	**65,90**	**66,89**	**67,88**	**67,54**	**68,07**	**69,94**	**70,71**	**70,50**	**70,66**	**69,03**	**63,97**
As % of World Supply	**70,12**	**69,99**	**69,56**	**70,78**	**72,55**	**74,12**	**74,48**	**74,58**	**75,38**	**74,98**	**75,42**	**75,55**	**75,06**	**74,00**	**72,30**	**72,03**	**72,46**	**71,82**	**70,07**	**68,56**	**67,61**
Total World Supply	**77,76**	**77,68**	**76,99**	**79,60**	**83,10**	**84,56**	**84,66**	**84,55**	**85,35**	**84,34**	**87,38**	**88,54**	**90,43**	**91,27**	**94,14**	**97,09**	**97,59**	**98,16**	**100,84**	**100,68**	**94,62**

Source: Thomson Reuters

Considering the final indicators of oil supply (Table 2) in 2020 and 2001, it is worth noting that the supply of OECD countries as a percentage of the world supply over 20 years increased by 2.51% (from 29.88% to 32.29%), while the supply of developing countries decreased by the same 2.51% from the world supply in 2020 since 2000. In general, due to the dynamic increase in the oil demand, its supply is also dynamically increasing. Analyzing the oil supply, it is important to note its decline in 2020 compared to 2019. First of all, this is happened due to the cancellation of the existing obligations to reduce oil production within the framework of OPEC + in March 2020, as a result of which there was a collapse in oil prices and the media started talking about the “oil war”. World oil prices collapsed in March-April 2020 after the OPEC oil alliance countries and other major oil-producing countries were unable to agree on the amount of production cuts. But then the OPEC + participants agreed to resume market balancing and cut production from May, which led to more than twofold increase in oil prices.

Now the paper analyzes in detail the supply and demand of the OECD countries and the countries of the former USSR (Table 3). It is worth noting that even before the collapse of the USSR, most of its revenues came from the energy sector. The country was the world’s largest oil producer. Today this trend continues. Oil demand in OECD countries is significantly higher than supply. As a result, they have a significant Net Deficit, which, however, has decreased by 12.74 mpbd per day since 2000. In the post-Soviet countries, the opposite picture is observed: the supply of oil is significantly higher than its demand resulting in surplus here, which, on the contrary, increased by 3.97 mpbd per day in 2020 compared with 2000.

However, according to OPEC forecasts, the global oil supply, despite the fall in 2020, will fully recover and even exceed pre-crisis levels in 2022. In the long term, until 2025, the supply will grow by 5 million barrels per day, up to 103.9 million barrels per day.

Table 3. Total OECD and Former Soviet Union Oil Demand and Supply in 2000-2020, mbpd

OECD																					
Actuals (mbpd)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Total Demand	47,93	47,99	47,96	48,67	49,44	49,81	49,55	49,30	47,66	46,37	46,96	46,33	45,88	46,09	45,63	46,49	46,89	47,49	47,83	47,59	42,60
Total Supply	23,24	23,31	23,43	23,26	22,81	21,88	21,61	21,49	21,02	21,10	21,48	21,64	22,55	23,73	26,07	27,16	26,88	27,66	30,18	31,66	30,65
Net deficit / surplus	**-24,69**	**-24,68**	**-24,52**	**-25,41**	**-26,63**	**-27,93**	**-27,95**	**-27,81**	**-26,64**	**-25,27**	**-25,49**	**-24,69**	**-23,33**	**-22,36**	**-19,56**	**-19,33**	**-20,01**	**-19,83**	**-17,65**	**-15,93**	**-11,95**
Former Soviet Union																					
Actuals (mbpd)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Total Demand	3,72	3,78	3,83	3,91	4,04	4,16	4,26	4,09	4,22	4,11	4,13	4,64	4,62	4,60	4,85	4,74	4,63	4,79	5,26	5,34	5,04
Total Supply	8,19	8,77	9,43	10,42	11,34	11,76	12,16	12,62	12,54	12,89	13,22	13,49	13,60	13,77	13,90	14,11	14,24	14,34	14,60	14,63	13,48
Net deficit / surplus	**4,47**	**4,99**	**5,60**	**6,51**	**7,30**	**7,61**	**7,89**	**8,52**	**8,33**	**8,79**	**9,08**	**8,85**	**8,99**	**9,17**	**9,05**	**9,37**	**9,61**	**9,55**	**9,33**	**9,29**	**8,44**

Source: Thomson Reuters

First, let's analyze the data for 2000. At that time, the oil supply of the former USSR countries was more than 2 times greater than their demand. The OECD countries had exactly the opposite situation: the oil demand is 2 times greater than its supply, which confirms the hypothesis that the demand for energy is more in developed countries. The situation in 2020 has changed somewhat. In the former Soviet Union countries the difference between supply and demand increased by 8%, while in the OECD countries the difference between supply and demand decreased by 18%, which indicates the desire of developed countries to increase the supply of oil in order to reduce dependence in this area on developing countries.

Calculating the average demand and average supply of the OECD and NON-OECD countries for the period from 2000 to 2020, it turned out that the average demand for oil in OECD countries is 53%, while in other developing countries it is 47%. The demand for oil in developed and developing countries is practically the same. Such a small gap is due to the fact that the rate of growth in oil demand from developing countries is growing rapidly, as already mentioned above. In the author's opinion, this is primarily due to the very rapid development of the economy of China, and other, including Asian developing countries, which are likely to soon become also developed. If you compare the averaged data with the 2000 data, it turns out that at that time the share in the aggregate demand of the OECD countries was 62% versus 38% of Non-OECD.

Next, the paper analyzes the relationship between supply and demand of developed and developing countries on the example of the OECD and Former Soviet Union countries using a mathematical formula (Table 4). According to calculations, the association coefficient is 0.69, and the contingency coefficient is 0.32, which indicates that the connection is confirmed, and it is not accidental. This means that the hypothesis put forward in the article turned out to be correct, and, indeed, in the developed OECD

Table 4. Calculating the association coefficients

	OECD	Former Soviet Union	Sum
Average demand	47,35492063	4,41718254	51,7721
Average upply	24,41896825	12,54666667	36,96563
Sum	71,77388889	16,96384921	
Q=	**0,692702025**	**R=**	**0,318564**

countries the oil demand is higher than in the developing countries of the former USSR, and the supply of the countries of the former USSR is greater than the supply of the OECD.

It is understood that to date, investment in the oil industry has dropped significantly due to the collapse in oil prices in 2020. Moreover, the oil industry has been one of the hardest hit by the coronavirus crisis. Almost all oil producers announced significant losses, including Exxon ($ 1.69 billion) and Shell ($ 18.5 billion), as well as the Russian largest companies Rosneft ($ 1.5 billion) and Lukoil ($ 0,87 billion). Today, amid uncertainty, the focus of investment interests has shifted from large and complex projects to those that can be brought to the market faster and cheaper.

A certain underinvestment in the oil industry in the world is aggravated by an excessive passion for renewable energy sources - many of the largest oil companies are reducing investments in traditional production in their favor. Of course, oil finds use in many industries, but the transport sector remains the main source of demand. And with the growing popularity of electric vehicles, the question arises: will oil continue to play the role of the main source of energy for the car in the future? And the further dynamics of world oil demand will largely depend on the answer to this question.

Let's consider how things are going with investments in the oil industry in one of the developing oil-dependent countries of the former USSR - Russia. At the moment, the most important problem of oil production in Russia is the need for a gradual transition from the development of traditional reserves, which were actually discovered in the USSR or in the last decade of the last century, which are being depleted, to the development of more complex and less profitable reserves, of which there are a lot, but their input into operation requires additional investments. At the moment, oil production in Russia has reached a certain limit, after which, to maintain it, changes in relations between the state and oil companies are needed. The development of the industry requires additional economic incentives to ensure an increase in investments in new oil production projects and geological exploration. And now it is necessary to clearly determine what prevents the attraction of additional investments in oil production, and, if possible, minimize the influence of these negative factors (An & Mikhaylov, 2020; Mikhaylov, 2020a; Mikhaylov, Yumashev, & Kolpak, 2021; An, Mikhaylov, & Jung, 2021).

The existing fiscal system - its instability and frequent changes in taxation conditions - has a significant negative impact on the investment attractiveness of the oil industry. In this case, this applies not only to oil production, but also to adjacent areas. Since in Russia a large share of the production, processing and sale of oil and oil products is in the hands of vertically integrated companies, changes in tax schemes for any of these areas affect all other companies' activities (Danish, Bhattacharya, Stepanova, Mikhaylov, Grilli, Khosravy, Tomonobu, 2020).

It should be noted that for all the shortcomings of the Russian fiscal system, the imposed sanctions have no less negative impact on the inflow of investments into the oil industry. This concerns both raising funds from wealthy Western companies and the lack of some advanced technologies for oil exploration and production in Russian companies. The reorientation towards partnership with the countries of the Asia-Pacific region has undoubtedly brought some results, but still extremely limited. The richest Chinese investors turned out to be very cautious about Russian oil projects, and the most technologically advanced country in the region, Japan, has a number of political differences with the Russian Federation, which undoubtedly constrains its activity in the Russian market.

As a result, a chain of interrelated negative factors is built. Moreover, attracting investments in new projects related to complex oil production is hindered by the lack of technologies in Russia, the creation of which requires additional investments for their development and testing. Moreover, it is extremely doubtful that foreign investors are ready to invest in technologies. They, first of all, would be interested in oil production projects. Therefore, in terms of technology, to a greater extent, you need to rely on your own strengths or on a quick change in the foreign policy situation, which, however, is unlikely (Mikhaylov, Moiseev, Aleshin, & Burkhardt, 2020; Nie, Panfilova, Samusenkov, & Mikhaylov, 2020).

Summing up all above, one can draw a very paradoxical conclusion. Despite the differences in factors that hinder the growth of investments in domestic oil production - from the instability and complexity of the fiscal system to the lack of an integrated approach to the industry and the effects of sanctions - the main reason that it is impossible to overcome their influence is the dependence of the Russian economy on the oil industry. It is worth mentioning that the revenues of the budgets of many developing oil-producing countries are subject to the most large-scale and unexpected changes, which is mainly associated with the relatively high role of the oil and gas sector in the structure of federal budget revenues. In the area of budget revenues in these countries, fluctuations in oil prices and declining investments in this industry are key sources of fiscal risks. In connection with the above, it becomes simply necessary to search for possible alternatives to oil and gas revenues to the budgets of countries where the oil and gas industry continues to be the main source of income for the state treasury (Morkovkin, Gibadullin, Kolosova, Semkina, Fasehzoda, & 2020; Morkovkin, Lopatkin, Sadriddinov, Shushunova, Gibadullin, & Golikova, 2020; Morkovkin, Lopatkin, Shushunova, Sharipov, & Gibadullin, 2020; Liu et al., 2021; Morkovkin, Gibadullin, Safarov, & Alpatova, 2020; Du et al., 2020; Gibadullin, Yurieva, Morkovkin, & Isaichykova, 2020; Gibadullin, Morkovkin, Milonova, Progunova, & Isaichykova, 2020; Romanova, Morkovkin, Nezamaikin, Gibadullin, & Ivanova, 2020; Khayrzoda, Morkovkin, Gibadullin, Elina, & Kolchina, 2020; Morkovkin, Gibadullin, Romanova, Erygin, & Ziadullaev, 2019; Mikayilov et al., 2020; Kobtseva, Novoselova, Novoselov, Morkovkin, & Sidorchukova, 2017; Yuan et al., 2021; Morkovkin, Mamychev, Yakovenko, Derevyagina, & Didenko, 2016).

SOLUTIONS AND RECOMMENDATIONS

The findings show that over the past 20 years, oil demand and supply have been growing rapidly in volumes. The hypothesis put forward in the article turned out to be correct, and, indeed, in the developed OECD countries the oil demand is higher than in the developing countries of the former USSR, and the supply of the countries of the former USSR is greater than the supply of the OECD. Moreover, to date, investment in the oil industry has dropped significantly due to a number of factors. It is necessary to search for possible alternatives to oil revenue for oil-dependent countries.

FUTURE RESEARCH DIRECTIONS

This study examines the relationship between oil demand and supply in developed and developing countries using the example of the OECD countries and the countries of the former USSR, assesses the need for investment in the oil sector and identifies the main reasons for the decline in the investment attractiveness of the oil sector using the example of Russia. The analysis uses Thomson Reuters data, association and contingency coefficients. In future studies, this hypothesis can be confirmed by examples from other developing and developed countries, as well as using other mathematical formulas and graphical interpretations.

CONCLUSION

Thus, the author of the article is of the opinion that energy has a great impact on the economies of individual countries, which are directly dependent on oil prices, oil supply and demand. It is possible to judge the level of development of the country by the amount of oil consumed. Based on the graphical analysis and the calculations performed, it can be stated with a fair degree of confidence that supply and demand of developed and developing countries are interconnected, and their connection is not accidental. So, it is worth continuing to study this relationship. The hypothesis that the demand for oil in developed countries will be significantly higher than in developing countries, and vice versa, the supply for oil in developing countries is higher than in developed countries was confirmed.

An analysis of changes in the supply and demand of developed and developing countries from 2000 to 2020 showed that global oil demand and supply increased, and assumptions about the reasons for these changes were made. At the expense of rapidly developing countries such as China, for example, the quantitative difference between the oil demand from developed and developing countries is narrowing. Today, there is a tendency towards an increase in oil supply from developed countries. In 2020, compared to 2019, there is a decrease in both demand and supply of oil, which is associated with quarantine restrictions due to the pandemic and with the termination of OPEC + obligations. The negative aspects of the impact of the current situation on the oil market for developing countries are revealed, the term "resource curse" is considered, and the negative consequences as a result of the general increase in oil consumption are estimated. The need for investment in the oil sector is assessed and the main reasons for the decrease in the investment attractiveness of the oil sector are identified using the example of Russia, an analysis is made and a conclusion is made about the need to search for possible alternatives to oil and gas revenues in the budgets of countries where the oil and gas industry continues to be the main source of state revenue.

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Chapter 4
Innovative Work Behavior in the Energy Sector by Fuzzy VIKOR Method

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ABSTRACT

The aim of this study is to analyze the innovative working behavior of the energy industry. Within this framework, 10 different energy companies in Turkey were included in the scope of the review. As a result of the literature review, five different criteria that could affect the performance of innovative working behavior of the energy companies were determined. The fuzzy VIKOR method has been taken into account in the performance ranking process of these companies. According to the results obtained, both private and foreign energy companies were in the first two and last two. The findings show that no company type has superiority over others in terms of innovative working behavior. Hence, it is important that the energy companies, which are in the last place, develop themselves by taking into account the criteria mentioned in this study.

INTRODUCTION

Technology has developed radically all over the world, especially in the last decades. This process can be observed for all sectors in the economy (Saviotti, 2018). For example, after this developing technology, there have been significant changes in the logistics sector. Logistics activities, which used to last much longer, can now be completed in much shorter periods. International trade activities are also very advanced thanks to technology (Cressey, 2018; Magotra et al., 2018). In the past, a significant majority of companies could only trade on a local basis, but with the help of the Internet these companies can now trade with companies on the other side of the world (Söderholm et al., 2019). In addition, the

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health sector is highly affected by technological developments. Today, some diseases can be treated with very modern medical techniques (Naqvi et al., 2018; Safeena et al., 2018). Similarly, innovation is quite important for banking industry. In this context, it is important to make alternative distribution channels such as ATM, mobile banking and internet banking compatible with modern technology (Tunay et al., 2019). In this way, it will be possible to reduce the burden on bank branches (Dinçer et al., 2019a,b). This will contribute to the reduction of the costs of banks in the long run (Yüksel and Zengin, 2016; Yüksel et al., 2016).

Energy is another industry which has different processes. For instance, the renewable energy projects include complex engineering stages. Therefore, in order for these energy companies to be successful in the business, they should give importance to the technological improvement. This situation is also quite similar for the non-renewable energy projects (Mikhaylov et al., 2020). As can be clearly understood from the above-mentioned issues, technological developments have affected the energy sector radically. Therefore, energy companies need to keep up with these technological developments in order to survive in an increasingly competitive environment. In other words, these companies should attach serious importance to research and development activities. Therefore, the indicators which affect the innovative effectiveness of the energy companies should be defined in a clear way (Mikhaylov et al., 2018). For instance, technological capacity of these companies plays a crucial role. In addition to this situation, the quality of the personnel is also quite significant in order to achieve this objective.

In parallel with these issues, this study analyzes the innovative working behavior of the energy companies. In this context, 5 different behaviors developed by De Jong and Den Hartog (2010) are considered as criteria in this study. Based on these criteria, Turkish energy companies are listed in the context of innovative working behavior. In this context, 10 different companies were analyzed. The fuzzy VIKOR method has been taken into consideration in the performance of these companies. As a result of the analysis, it will be possible to determine which company types are better.

It is possible to mention some differences that distinguish this study from other studies. First of all, in this study, energy companies are listed in the framework of their innovative working behavior performance. In this process, a comparative analysis of the performance of state, private and foreign energy companies will be made. In this way, it will be possible to produce strategies specific to company types. However, in such an analysis, the fuzzy VIKOR method is used for the first time in this study. In this way, the results of this model, which is highly preferred in the literature, on the performance of innovative working behavior of the energy companies can be seen.

There are 5 different parts of this study in general. This section is the introductory part of the study and general information is shared. Following this section, the second part of the study provides a literature review on the subject. In this way, it will be possible to identify areas that have not been studied in the literature for innovative working performance. The third part of the study deals with the theoretical parts of the fuzzy VIKOR method used in the analysis process. On the other hand, in the fourth part of the study, the results of the analysis using this method will be shared. Finally, recommendations will be developed on the basis of the results obtained and information will be given about the methods that can be applied in future studies.

INNOVATIVE WORKING BEHAVIOUR IN ENERGY INDUSTRY

There are many studies in the literature focusing on how to improve the innovative working behavior of the companies. Under this title, important works were selected among the studies published after 2015. While making the selection, attention was paid to the review of the journal in which the article was published in accepted indexes such as SSCI and Scopus. In the examinations, it was understood that a significant part of the studies emphasized that companies should follow the unusual issues in the markets. As mentioned in the first part of the study, technology is developing rapidly all over the world. Especially in the banking sector, it is seen that new applications are constantly on the agenda (Raines, 2017; Sorenson, 2018; Edquist, 2016; Hewett, 2016; Yüksel et al., 2018). Therefore, companies need to be aware of these innovations very quickly (Hawken and Hoon Han, 2017; Igarashi and Okada, 2015; Minafam, 2019). Otherwise, the companies will lag behind this developing technology, which will reduce their competitive advantage (Song et al., 2017; Barona and Anita, 2017). In this context, Biesbroek et al. (2018) and Padel et al. (2017) underlined the significance of this situation for different industries, such as agriculture.

Another point that is emphasized in the studies in the literature is the importance of qualified personnel for the high level of innovative working behavior of the companies (Monferrer-Tirado et al., 2016; Sayani, 2015; Han, 2015; Mikhaylov and Sokolinskaya, 2019). Therefore, personnel must be qualified to apply technological developments (Omollo and Oloko, 2015; Sailaja and Naik, 2016). Otherwise, even if the companies follow the technological developments instantly, they will not be able to use this technology (Adeola and Adebiyi, 2016; Meressa, 2016). Rodríguez-Ruiz et al. (2016) made a similar study to make evaluation for Spanish banking industry. They reached the conclusion that companies should give necessary trainings to their employees in order to be successful in innovative working behavior. Another important studies in this area were conducted by Ali (2016) and Oh et al. (2016). They identified that companies should give very much importance to employ qualified people to be successful to apply technological developments to the companies. Additionally, Sangwan (2015) and Goromonzi (2016) also stated this issue in their studies.

Another point highlighted in the literature is the need for new techniques to be used by the companies (Hughes et al., 2018; Kishore et al., 2017). As a result of technological developments, it is possible to observe rapid changes in the applications (Radojicic et al., 2015; Mitra et al., 2017). For example, a significant number of customers now make the majority of their transactions over the Internet (Barros et al., 2018; Kazemi et al., 2015). Mardani et al. (2016), Cooke et al. (2019) and Mohammed (2019) stated that in an environment where a significant majority of the compaies in the sector provide services over the internet, it is not possible to carry out these operations only through its branch. In addition to the aforementioned issues, Saleem et al. (2016), Shafiei Gol et al. (2016), Chakrabarti et al. (2018) and Shen and Tzeng (2015) identified that the companies should follow these techniques and implement them in a short time.

In the literature, one of the prominent issues for this topic is internal motivation. In order for the companies to have innovative working behaviors, they need to turn this into a corporate culture (Nouri et al., 2017; Yoon et al., 2016; Firdaus et al., 2016; Ayad, 2016). The main reason behind this is that all the personnel should adopt the process of adapting to technological developments (Szobiová, 2015; Mardomi et al., 2016; Unhelkar, 2016). Additionally, Khan et al. (2017), Hermawan and Gunardi (2019) and Onyeukwu and Ekere (2018) stated that the performance of the personnel in different departments of the companies is important in terms of starting a new application, designing these applications, answering customer questions and identifying the problems related to these applications. Within this framework, Saeed and Shah (2016), Morschheuser et al. (2015), Narteh and Odoom (2015), Ning and Wang (2019) and Pérez and del Bosque (2015) company management should encourage such practices within the institution. This will both increase the motivation of the personnel and contribute to the easier adaptation of the innovative practices. As a result of the literature review, it is understood that studies mainly underline the issues stated by De Jong and Den Hartog (2010). Hence, it is thought that analyzing these factors with a different methodology can contribute to the literature.

Energy is also significant industry which should focus on the technological development. There are different types of energy in the literature (Cheng et al., 2020; Mikhaylov et al., 2021). One type of them is the renewable energies which consider the natural sources. In this framework, wind, geothermal, solar, biomass and hydroelectricity (Li et al., 2020; Zhong et al., 2020; Mikhaylov, 2018a,b). These have different advantages. For instance, they do not create carbon emission so that environmental pollution can be minimized (Qiu et al., 2020; Zhao et al., 2021; Mikhaylov, 2020a,b,c). However, high cost is the main problem of these alternatives. Because of this situation, technological improvements should be adopted quickly in order to reduce the costs. This situation is almost the same for non-renewable projects. Fossil fuels are taken into consideration in this framework (Qi et al., 2020; Yuan et al., 2021). The main advantage of these projects is the low initial costs in comparison with the renewable energy investment projects. Nonetheless, they create significant environmental pollution due to high carbon emission (Yüksel et al., 2020; Du et al., 2020; Liu et al., 2021). This situation causes many people to become sick. Additionally, this issue also leads to some economic problems. For example, because of the sick people, workforce in the country will decrease which negatively affects the production volume (Yuan et al., 2020; Haiyun et al., 2021; Mikhaylov, 2019, 2021). Similarly, the health expenditure in the countries will go up radically. Hence, technological improvements are significant to minimize negative issues of the non-renewable energy projects. Within this framework, carbon capture technologies should be adopted (Xie et al., 2021; Mikayilov et al., 2020; Mikhaylov and Tarakanov, 2020).

Fuzzy VIKOR Method

VIKOR method (VIseKriterijumsa Optimizacija I Kompromisno Resenje) is firstly presented by Opricovic and Tzeng in 2004 to provide one of best tools for evaluating the alternatives in the complex decision making problems (Opricovic and Tzeng, 2004; Dinçer, 2019). This method seeks the best alternative that is the closest to the ideal solution as well as providing a maximum group utility for the majority and a minimum individual regret for the opponent (Liu et al., 2015). It also considers the linear normalization procedure and the normalized value doesn't depend on the evaluation unit of the criterion function (Opricovic and Tzeng, 2007; Ren et al., 2017). Similarly, fuzzy VIKOR method uses the fuzzy sets in the evaluation process of the alternatives to provide more accurate results in the both qualitative and quantitative data. Fuzzy VIKOR method is widely used in the literature (Awasthi and Kannan, 2016; Dincer and Hacioglu, 2015; Rostamzadeh et al., 2015; Dinçer et al., 2018; Dinçer and Yüksel, 2018). The computation procedure of the method is detailed as below (Dinçer et al., 2019).

First step: decision making problem is defined for constructing the matrix. In this process, set of criteria is determined based on the literature review.

Second step: decision making team is appointed to provide the linguistic evaluations for each alternative. Thus, it is possible to define the linkage between criteria and alternatives with the linguistic evaluation scales.

Third step: linguistic evaluations are converted into the fuzzy numbers. Fuzzy numbers are used for the final decision matrix.

Fourth step: weighted decision matrix is computed if there is a difference between the weights of criteria.

Fifth step: normalization procedure is applied for the normalized decision matrix before the selecting the best and worst values.

Sixth step: best (fi*) and the worst (fi-) criteria are selected. The values of best and worst criteria are selected by the formulas.

Seventh step: the values of Sj and Rj are computed. In this step, the weights for the criteria are used for the weighted values of worst and best criteria with the equations (1) and (2).

$$\tilde{S}_i = \sum_{i=1}^{n} \tilde{w}_j \frac{\left(\left|\tilde{f}_j^* - \tilde{x}_{ij}\right|\right)}{\left(\left|\tilde{f}_j^* - \tilde{f}_j^-\right|\right)} \tag{1}$$

$$\tilde{R}_i = \max{}_j \left[\tilde{w}_j \frac{\left(\left|\tilde{f}_j^* - \tilde{x}_{ij}\right|\right)}{\left(\left|\tilde{f}_j^* - \tilde{f}_j^-\right|\right)} \right]. \tag{2}$$

Eighth step: the value of Qj is calculated for ranking alternatives. The formula is presented as

$$\tilde{Q}_i = v\left(\tilde{S}_i - \tilde{S}^*\right) / \left(\tilde{S}^- - \tilde{S}^*\right) + (1-v)\left(\tilde{R}_i - \tilde{R}^*\right) / \left(\tilde{R}^- - \tilde{R}^*\right) (3).$$

In this equation, $\tilde{S}^*$.epresents min Sj whereas $\tilde{S}^-$.gives information about the maximum value of Sj. Similarly, $\tilde{R}^*$.explains minimum value of Rj. On the other side, $\tilde{R}^-$.indicates the maximum value of Rj. Additionally, "v" is the weight of the strategy with respect to maximum group utility. However, "1-v" is the information about the weight for the regret.

Ninth step: the values of Q, R and S are listed in decreasing order. For that, the alternative with lowest Q value is defined as the best alternative. However, condition 1 and 2 should be also satisfied for the final decision. These conditions are detailed as

Condition 1 - Acceptable Advantage: The difference between the best (Q(A1)) and the second (Q(A2)) conditions should be significant. This situation is given in the equation (4).

$$Q\left(A^{(2)}\right) - Q\left(A^{(1)}\right) \geq \frac{1}{(j-1)} \tag{4}$$

Condition 2 - Acceptable Stability in Decision Making: The best alternative Q(A1) should also have the best score in at least one of S and R.

- If one condition is not satisfied, the following situations are considered.
- If condition 2 is not satisfied, Q(A1) and Q(A2) are accepted as the solutions.
- If condition 1 is not satisfied, Q(A1), Q(A2), …, Q(AM) alternatives are considered.

ANALYSIS RESULTS

In this study, it is aimed to apply the performance of innovative work behavior for the energy companies. For that, fuzzy VIKOR method is used for ranking these companies. First stage of the analysis is to determine the criterion set of innovative work behaviors for the energy industry. Items of innovative work behaviors used in De Jong and Den Hartog (2010) are adopted to the criteria for the innovative work behaviors in the energy industry. The definitions of the criteria are given in Table 1.

Table 1. Criteria for innovative work behaviors

Criteria	Definition
Criterion 1	Concentrating on the unusual issues of daily working behaviors
Criterion 2	Improvement capacity of the personnel for the efficiency
Criterion 3	Using the novel techniques for solving the problems
Criterion 4	Encouragement of the organization for the innovative ideas
Criterion 5	Practicing the ideas in the working process systematically

Source: Adopted from De Jong and Den Hartog (2010)

5 Criteria are selected for evaluating the energy companies. Criterion 1 is to concentrate on the unusual issues of daily working behaviors. Criterion 2 is defined as improvement capacity of the personnel for the efficiency. Criterion 3 entitled using the novel techniques for solving the problems and criterion 4 is the encouragement of the organization for the innovative ideas. Criterion 5 is generated by considering the practices about ideas in the working process in a systematic manner. Thus, criterion set of innovative work behaviors is illustrated by using the questions of De Jong and Den Hartog (2010).

In the second stage of the analysis, decision makers and linguistic choices are determined for constructing the linguistic and fuzzy decision matrices. For that, 5 decision makers that are expert in the field of energy industry are appointed for obtaining their linguistic priorities for each alternative with respect to each criterion. Two of them are also academicians in the finance and energy areas. However, linguistic scales that will be used by the decision makers are illustrated in Table 2.

5 point-linguistic scale is employed to evaluate the alternatives. The scales are named from the lowest to highest degrees as Worst (W), Poor (P), Fair (F), Good (G), and Best (B) respectively. Similarly, triangular fuzzy numbers are scaled in 5-point degrees as (0,0,2.5), (0,2.5,5), (2.5,5,7.5), (5,7.5.,10), and (7.5,10,10). Linguistic evaluations of each alternative are represented in Table 3.

Table 2. Linguistic and fuzzy evaluations

Definition	Triangular Fuzzy Numbers		
Worst (W)	0	0	2.5
Poor (P)	0	2.5	5
Fair (F)	2.5	5	7.5
Good (G)	5	7.5	10
Best (B)	7.5	10	10

Source: Dinçer et. al., 2016

In the following process, decision matrices of each alternative with triangular fuzzy numbers are generated in appendix, Tables A1-A10. After that, the averaged values of decision makers are considered for the fuzzy decision matrix and the averaged fuzzy numbers are seen in Table 4.

Before the computation of Si, Ri, and Qi values, the fuzzy best and worst values of the criteria are determined as seen in Table 5.

Table 3. Linguistic evaluations for decision matrix

	Alternative 1 (Private Company 1)					**Alternative 2 (Foreign Company 1)**					**Alternative 3 (Foreign Company 2)**					**Alternative 4 (Private Company 2)**					**Alternative 5 (Foreign Company 3)**				
	DM1	**DM2**	**DM3**	**DM4**	**DM5**	**DM1**	**DM2**	**DM3**	**DM4**	**DM5**	**DM1**	**DM2**	**DM3**	**DM4**	**DM5**	**DM1**	**DM2**	**DM3**	**DM4**	**DM5**	**DM1**	**DM2**	**DM3**	**DM4**	**DM5**
C1	G	F	F	G	G	F	G	F	F	F	G	G	B	G	F	F	G	F	F	G	F	P	F	P	F
C2	P	F	G	G	F	F	F	P	P	F	G	B	G	F	F	G	F	F	P	F	P	F	F	P	F
C3	F	F	F	F	G	F	F	P	F	F	F	G	F	G	F	F	F	F	F	F	F	F	F	F	F
C4	G	G	F	F	F	P	F	G	F	F	G	G	F	G	F	F	P	F	G	F	F	F	F	F	F
C5	F	G	G	F	F	F	F	P	F	F	F	F	G	G	G	F	F	F	F	F	F	F	P	F	F
	Alternative 6 (Private Company 3)					Alternative 7 (Foreign Company 4)					Alternative 8 (Private Company 4)					Alternative 9 (Foreign Company 5)					Alternative 10 (Private Company 5)				
	DM1	DM2	DM3	DM4	DM5	DM1	DM2	DM3	DM4	DM5	DM1	DM2	DM3	DM4	DM5	DM1	DM2	DM3	DM4	DM5	DM1	DM2	DM3	DM4	DM5
C1	G	G	F	F	F	G	F	F	G	F	G	F	F	F	P	F	F	P	G	F	F	F	F	F	G
C2	F	F	F	F	P	G	G	F	F	F	P	F	P	F	F	P	P	F	F	G	F	F	F	F	F
C3	G	F	F	F	F	P	F	F	F	P	P	P	F	F	F	F	F	P	P	F	G	F	G	F	F
C4	G	G	F	F	F	G	G	F	F	F	F	G	F	F	F	F	G	F	F	F	G	F	F	G	F
C5	G	G	F	F	F	G	F	G	G	F	F	P	F	P	F	F	P	F	F	F	G	G	F	F	F

Under the assumptions of the choices given by the experts with the consensus for each alternative, the value of v is selected as 0.5 and the final results are represented in Table 6.

Ranking results are listed as alternative 3, alternative 1, alternative 10, alternative 6, alternative 7, alternative 4, alternative 9, alternative 2, alternative 5, alternative 8, respectively. According to the results, alternative 3 is the best company for the innovative behaviors while alternative 8 has the worst rank among the companies. Additionally, different values of v to understand the effects of consensus, veto, and stability are considered in the computation procedure of Qi values. The overall results are detailed in Table 7.

The results with the different values of v demonstrate that the overall results are coherent even if the experts do not have any consensus in the decision-making process.

Table 4. Fuzzy decision matrix

	Alternative 1 (Private Company 1)			**Alternative 2 (Foreign Company 1)**			**Alternative 3 (Foreign Company 2)**			**Alternative 4 (Private Company 2)**			**Alternative 5 (Foreign Company 3)**		
Criterion 1	4.00	6.50	9.00	3.00	5.50	8.00	5.00	7.50	9.50	3.50	6.00	8.50	1.50	4.00	6.50
Criterion 2	3.00	5.50	8.00	1.50	4.00	6.50	4.50	7.00	9.00	2.50	5.00	7.50	1.50	4.00	6.50
Criterion 3	3.00	5.50	8.00	2.00	4.50	7.00	3.50	6.00	8.50	2.50	5.00	7.50	2.50	5.00	7.50
Criterion 4	3.50	6.00	8.50	2.50	5.00	7.50	4.00	6.50	9.00	2.50	5.00	7.50	2.50	5.00	7.50
Criterion 5	3.50	6.00	8.50	2.00	4.50	7.00	4.00	6.50	9.00	2.50	5.00	7.50	2.00	4.50	7.00
	Alternative 6 (Private Company 3)			Alternative 7 (Foreign Company 4)			Alternative 8 (Private Company 4)			Alternative 9 (Foreign Company 5)			Alternative 10 (Private Company 5)		
Criterion 1	3.50	6.00	8.50	3.50	6.00	8.50	2.50	5.00	7.50	2.50	5.00	7.50	3.00	5.50	8.00
Criterion 2	2.00	4.50	7.00	3.50	6.00	8.50	1.50	4.00	6.50	2.00	4.50	7.00	2.50	5.00	7.50
Criterion 3	3.00	5.50	8.00	1.50	4.00	6.50	1.50	4.00	6.50	1.50	4.00	6.50	3.50	6.00	8.50
Criterion 4	3.50	6.00	8.50	3.50	6.00	8.50	3.00	5.50	8.00	3.00	5.50	8.00	3.50	6.00	8.50
Criterion 5	3.50	6.00	8.50	4.00	6.50	9.00	1.50	4.00	6.50	2.00	4.50	7.00	3.50	6.00	8.50

SOLUTIONS AND RECOMMENDATIONS

In this study, regarding the issue of innovative work behavior, in Turkey, none of the private and foreign energy companies do not have an advantage over the others. Therefore, comments on the basis of company type will not be correct. There are both good and bad performance companies in each type. On the other hand, the companies that rank at the top of the list have a competitive advantage compared to other ones. Therefore, it is important that the energy companies, which are in the last place, develop themselves by taking into account the criteria mentioned in this study.

Table 5. **The values of $\tilde{f}_j^*$ and $\tilde{f}_j^-$**

	$\tilde{f}_j^*$			$\tilde{f}_j^-$		
C1	5.00	7.50	9.50	1.50	4.00	6.50
C2	4.50	7.00	9.00	1.50	4.00	6.50
C3	3.50	6.00	8.50	1.50	4.00	6.50
C4	4.00	6.50	9.00	2.50	5.00	7.50
C5	4.00	6.50	9.00	1.50	4.00	6.50

Table 6. The values of Si, Ri, and Qi for final ranking

Alternatives	Si	Ri	Qi	Ranking
(Alternative 1)	0.299	0.093	0.405	2
(Alternative 2)	0.820	0.200	0.969	8
(Alternative 3)	0.000	0.000	0.000	1
(Alternative 4)	0.628	0.200	0.860	6
(Alternative 5)	0.860	0.200	0.993	9
(Alternative 6)	0.400	0.164	0.640	4
(Alternative 7)	0.404	0.200	0.731	5
(Alternative 8)	0.873	0.200	1.000	10
(Alternative 9)	0.797	0.200	0.957	7
(Alternative 10)	0.345	0.129	0.520	3

FUTURE RESEARCH DIRECTIONS

In this study, an examination was made on the energy industry. In addition, different countries and groups of countries can be taken into consideration in a new study. As an example, a study for developing country groups is thought to be very guiding. On the other hand, fuzzy VIKOR method was used in the analysis process of the study. Other multi-criteria decision-making methods such as fuzzy AHP, fuzzy ANP, fuzzy DEMATEL, and fuzzy TOPSIS can be considered in another study.

CONCLUSION

In this study, innovative working behavior of the energy companies is analyzed. In order to achieve this objective, the Turkish energy sector was included in the scope of the review. In this context, 10 different companies were evaluated. Firstly, the evaluation criteria were determined. Within this framework, 5 different issues developed by De Jong and Den Hartog (2010) were identified as criteria. On the other hand, the fuzzy VIKOR method has been taken into consideration in the performance ranking process of the companies.

According to the results of the analysis, a foreign company is in the first place. In addition, a private company takes the second place. On the other hand, one of the last two companies is private and the other is a foreign company. As can be seen from this, no company type has superiority over others in terms of innovative working behavior.

Table 7. Qi and Ranking results for several v values

	v:0		v:0.1		v:0.2		v:0.3		v:0.4		v:0.5	
Alternatives	**Qi**	**Ranking**	**Qi**	**Ranking**	**Qi**	**Ranking**	**Qi**	**Ranking**	**Qi**	**Ranking**	**Qi**	**Ranking**
A1	0.467	2	0.454	2	0.442	2	0.429	2	0.417	2	0.405	2
A2	1.000	5	0.994	8	0.988	8	0.982	8	0.975	8	0.969	8
A3	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
A4	1.000	5	0.972	6	0.944	6	0.916	6	0.888	6	0.860	6
A5	1.000	5	0.999	9	0.997	9	0.996	9	0.994	9	0.993	9
A6	0.822	4	0.786	4	0.750	4	0.713	4	0.677	4	0.640	4
A7	1.000	5	0.946	5	0.892	5	0.839	5	0.785	5	0.731	5
A8	1.000	5	1.000	10	1.000	10	1.000	10	1.000	10	1.000	10
A9	1.000	5	0.991	7	0.983	7	0.974	7	0.965	7	0.957	7
A10	0.644	3	0.620	3	0.595	3	0.570	3	0.545	3	0.520	3
	v:0.6		v:0.7		v:0.8		v:0.9		v:1			
Alternatives	Qi	Ranking	Qi	Ranking	Qi	Ranking	Qi	Ranking	Qi	Ranking		
A1	0.392	2	0.380	2	0.367	2	0.355	2	0.343	2		
A2	0.963	8	0.957	8	0.951	8	0.945	8	0.939	8		
A3	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1		
A4	0.832	6	0.804	6	0.776	6	0.748	6	0.720	6		
A5	0.991	9	0.990	9	0.988	9	0.987	9	0.985	9		
A6	0.604	4	0.568	4	0.531	4	0.495	4	0.459	4		
A7	0.677	5	0.624	5	0.570	5	0.516	5	0.462	5		
A8	1.000	10	1.000	10	1.000	10	1.000	10	1.000	10		
A9	0.948	7	0.939	7	0.931	7	0.922	7	0.913	7		
A10	0.495	3	0.470	3	0.445	3	0.420	3	0.395	3		

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KEY TERMS AND DEFINITIONS

AHP: Analytic hierarchy process.
ANP: Analytic network process.
DEMATEL: Decision making trial and evaluation laboratory.
TOPSIS: Technique for order preference by similarity to ideal solution.
VIKOR: Vise Kriterijumska Optimizacija I Kompromisno Resenje.

APPENDIX

Table 8. Fuzzy Decision Matrix of Decision Makers for Alternative 1

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	5	7.5	10	2.5	5	7.5	2.5	5	7.5	5	7.5	10	5	7.5	10
C2	0	2.5	5	2.5	5	7.5	5	7.5	10	5	7.5	10	2.5	5	7.5
C3	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	5	7.5	10
C4	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C5	2.5	5	7.5	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5

Table 9. Fuzzy Decision Matrix of Decision Makers for Alternative 2

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	2.5	5	7.5	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C2	2.5	5	7.5	2.5	5	7.5	0	2.5	5	0	2.5	5	2.5	5	7.5
C3	2.5	5	7.5	2.5	5	7.5	0	2.5	5	2.5	5	7.5	2.5	5	7.5
C4	0	2.5	5	2.5	5	7.5	5	7.5	10	2.5	5	7.5	2.5	5	7.5
C5	2.5	5	7.5	2.5	5	7.5	0	2.5	5	2.5	5	7.5	2.5	5	7.5

Table 10. Fuzzy Decision Matrix of Decision Makers for Alternative 3

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	5	7.5	10	5	7.5	10	7.5	10	10	5	7.5	10	2.5	5	7.5
C2	5	7.5	10	7.5	10	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5
C3	2.5	5	7.5	5	7.5	10	2.5	5	7.5	5	7.5	10	2.5	5	7.5
C4	5	7.5	10	5	7.5	10	2.5	5	7.5	5	7.5	10	2.5	5	7.5
C5	2.5	5	7.5	2.5	5	7.5	5	7.5	10	5	7.5	10	5	7.5	10

Table 11. Fuzzy Decision Matrix of Decision Makers for Alternative 4

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	2.5	5	7.5	5	7.5	10	2.5	5	7.5	2.5	5	7.5	5	7.5	10
C2	5	7.5	10	2.5	5	7.5	2.5	5	7.5	0	2.5	5	2.5	5	7.5
C3	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C4	2.5	5	7.5	0	2.5	5	2.5	5	7.5	5	7.5	10	2.5	5	7.5
C5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5

Table 12. Fuzzy Decision Matrix of Decision Makers for Alternative 5

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	2.5	5	7.5	0	2.5	5	2.5	5	7.5	0	2.5	5	2.5	5	7.5
C2	0	2.5	5	2.5	5	7.5	2.5	5	7.5	0	2.5	5	2.5	5	7.5
C3	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C4	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C5	2.5	5	7.5	2.5	5	7.5	0	2.5	5	2.5	5	7.5	2.5	5	7.5

Table 13. Fuzzy Decision Matrix of Decision Makers for Alternative 6

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C2	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	0	2.5	5
C3	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C4	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C5	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5

Table 14. Fuzzy Decision Matrix of Decision Makers for Alternative 7

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	5	7.5	10	2.5	5	7.5	2.5	5	7.5	5	7.5	10	2.5	5	7.5
C2	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C3	0	2.5	5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	0	2.5	5
C4	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C5	5	7.5	10	2.5	5	7.5	5	7.5	10	5	7.5	10	2.5	5	7.5

Table 15. Fuzzy Decision Matrix of Decision Makers for Alternative 8

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	0	2.5	5
C2	0	2.5	5	2.5	5	7.5	0	2.5	5	2.5	5	7.5	2.5	5	7.5
C3	0	2.5	5	0	2.5	5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C4	2.5	5	7.5	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C5	2.5	5	7.5	0	2.5	5	2.5	5	7.5	0	2.5	5	2.5	5	7.5

Table 16. Fuzzy Decision Matrix of Decision Makers for Alternative 9

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	2.5	5	7.5	2.5	5	7.5	0	2.5	5	5	7.5	10	2.5	5	7.5
C2	0	2.5	5	0	2.5	5	2.5	5	7.5	2.5	5	7.5	5	7.5	10
C3	2.5	5	7.5	2.5	5	7.5	0	2.5	5	0	2.5	5	2.5	5	7.5
C4	2.5	5	7.5	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C5	2.5	5	7.5	0	2.5	5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5

Table 17. Fuzzy Decision Matrix of Decision Makers for Alternative 10

Criteria	DM1			DM2			DM3			DM4			DM5		
C1	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	5	7.5	10
C2	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5
C3	5	7.5	10	2.5	5	7.5	5	7.5	10	2.5	5	7.5	2.5	5	7.5
C4	5	7.5	10	2.5	5	7.5	2.5	5	7.5	5	7.5	10	2.5	5	7.5
C5	5	7.5	10	5	7.5	10	2.5	5	7.5	2.5	5	7.5	2.5	5	7.5

Chapter 5
Exchange Rate and Industry-Level Energy Import:
Evidence From Energy Investments in Pakistan

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ABSTRACT

After the Bretton Woods exchange rate system in 1973, the free-floating exchange rate, the rate determined by the forces of supply and demand, began, which developed an interest in the area of many researchers to investigate, theoretically and empirically, the impact of exchange rate volatility on the world trade flows. There are two channels, direct and indirect, through which the change in exchange rate affects domestic prices. Under the direct channel, a fall in exchange rate leads to increase in imports as well as increases the prices of inputs in domestic currency. Secondly, under the indirect channel, a decline in the exchange rate triggers the availability of domestic goods to foreign buyers at a cheaper rate, and the demand for domestic products increased. Thus, the change in exchange rate affects trade flows either positively or negatively.

INTRODUCTION

This study is novel in many ways, first, little work exists in the literature that study the effect of exchange rate volatility at sectoral level of trade flows. Second, while all previous studies used aggregate export trade of Pakistan and no study exist that examine the effect of exchange rate volatility on Pakistan import flows. Thirdly, all past studies conducted in Pakistan assumed that exchange rate volatility effect trade flows in a symmetric way. In this study, it is argued that volatility can affect trade flows in an asymmetric way. Fourth, little work conducted in Pakistan that validate the existence of aggregation bias

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when checking the effect of exchange rate volatility on aggregate trade flows. Fifth, this study takes the current data set for latest time horizon from Q3-2003 to Q2-2018 which improve the best understanding of exchange rate volatility effect on industry-level disaggregated both imports and exports trade flows. Many developed and emerging countries focused on the stability of exchange rate volatility to protect themselves from the fluctuations. For instance, to maintain its competitiveness China followed manage float system. Similarly, the adoption of one currency, Euro, by European Union is the evidence to mitigate the effect of exchange rate volatility on member countries bilateral trade. The intervention of country central bank in the currency market to stabilize exchange rate volatility is another eventually followed in developing countries.

This study compares the short-run and long-run asymmetric and symmetric effect of exchange rate volatility on Pakistan aggregate and industry-level disaggregated trade flows.

The study explores the effect of various macroeconomic factors, especially exchange rate volatility, on aggregate and disaggregated industry level trade flows of Pakistan. The data used are secondary in nature. For all the variable in this study quarterly data is used to ensure larger samples. The data for this research work is gleaned from a variety of sources. The quarterly exchange rate data is gathered from website of the Pacific Exchange rate system. The data on imports, exports, and interest rate in Pakistan is obtained from the state bank of Pakistan. The data on CPI is gathered from Pakistan Bureau of statistics. The data on foreign remittances, industrial production (IP), and Foreign direct Investment (FDI) is gathered from World Development indicator (WDI) site of World Bank. For all the variables quarterly data covering period Q3-2003 to Q2-2018 used which is the latest dataset to understand the current dynamics of the variables and its effect (Denisova, Mikhaylov, & Lopatin, 2019; Gura, Mikhaylov, Glushkov, Zaikov, & Shaikh, 2020; Alwaelya, Yousif, & Mikhaylov, 2020; Mikhaylov & Sokolinskaya, 2019; Mikhaylov & Tarakanov, 2020; An, Mikhaylov, & Jung, 2020; An, Mikhaylov, & Kim, 2020; An, Mikhaylov, & Moiseev, 2019; An, Mikhaylov, & Sokolinskaya, 2019a).

This study investigate the effect of exchange rate volatility on Pakistan aggregate trade flows, exports, imports, and industry level disaggregated import and export as dependent variables and nominal exchange rate, exchange rate volatility, foreign direct investment, interest rate, remittances, inflation, and industrial production as explanatory variables.

This chapter exhibits the empirical analysis of econometric models provided in the previous chapter. This chapter contains four sections. The first section discuss the descriptive statistics and correlation of all the variables in the study. The second section deal with the unit root analysis to investigate the variables order of integration. The third section is about linear autoregressive distributive lag model (ARDL) models to check the symmetric effect of exchange rate volatility on Pakistan aggregate trade, import, export, 20 exporting and 20 importing industries of Pakistan. The fourth section deal with non-linear autoregressive distributed lag (NARDL) models here by following the methodology to investigate asymmetric effect of exchange rate uncertainty on trade, exports, and imports of country and industries individually and jointly as categorized by State bank of Pakistan (SBP).

LITERATURE REVIEW

There are various studies that examine the relationship between exchange rate volatility and foreign trade flows (Mikhaylov, 2019; Mikhaylov, Sokolinskaya, & Nyangarika, 2018). But most of these studies used aggregated trade flows which are confronted with the possible aggregation bias that led to the inconclusiveness of results and misguiding findings when analyzing for different industries and trading partners because of each different risk profile and trading ties. This study will use aggregate as well as industry level disaggregate data for both import and export trade flows to detect that whether there exists the problem of aggregation bias in the context of Pakistan. Secondly, past studies have mixed results regarding the relationship between exchange rate volatility and trade flows, therefore, this study empirically examine that whether there is a positive or negative relationship between exchange rate volatility and trade flows. Previous studies assumed that exchange rate volatility effect trade flows in a symmetric way current study argued the asymmetric effect of exchange rate volatility on trade flows which will be tested. Lastly, currently, Pakistani economy is confronted with high volatility of exchange rate thus this study is designed to study the relationship between exchange rate volatility and industry level disaggregated trade flows (Uandykova, Lisin, Stepanova, Baitenova, Mutaliyeva, Yuksel, & Dincer, 2020; Danish, Estrella, Alemaida, Lisin, Moiseev, Ahmadi, Nazari, Wali, Zaheb, & Senjyu, 2021; Lisin, 2020a; Lisin, 2020b; Lisin, 2020c; Dong, Ikonnikova, Rogulin, Sakulyeva, & Mikhaylov, 2021; Liu, Panfilova, Mikhaylov, & Kurilova, 2022).

The unpredictable changes in exchange rate between the time of contract and final payments increase uncertainty for both importers and exporters. As Pakistani currency is highly volatile especially in recent time due to the change of political government and its financial policies. Further Pakistani rupee is depreciating continuously due to the budget deficit, deficit in the balance of trade and the shortage of foreign reserves with the state bank. Pakistani imports in the financial year 2016-2017 were $52,910 million and exports value $20,422 million (Pakistan bureau of statistics). As there exist huge and increasing deficit in the balance of trade the volatility in exchange rate significantly affects these trade flows. In addition, due to external debt further Pakistani economy is affected negatively with this high volatility in the exchange rate. Previous studies have mixed results regarding the effect of exchange rate volatility on imports and exports. Some argued that there is a negative effect, and some conclude positive effect while another group of studies shows that there is no linkage. The research argued that the effect of exchange rate volatility on trade is neither entirely significant nor completely unidirectional, differ for the horizon of study and the market of interest and thus require more disaggregated trade data for future research. Therefore, it is vital to study the effect of exchange rate volatility on industry level disaggregated trade flows (Nyangarika, Mikhaylov, & Tang, 2018; Ranjbar, Chang, Nel, & Gupta, 2017; Rathnayaka, Seneviratna, & Long, 2018; Shahbaz, Zakaria, Shahzad, & Mahalik, 2018; Odhiambo, 2009; Ozturk, Aslan, & Kalyoncu, 2010; Phelps, 1994).

Pakistan is an emerging market its integration is increasing with trading partners particularly China, therefore, the direction of imports and exports is changing. Currently, Pakistan is facing severe problems of currency depreciation and balance of trade, the gap is continuously increasing that push Pakistan into debt burden so Pakistani rupee is becoming unstable especially in recent time. To address such issues there are two solutions either to increase exports or optimize imports. There is a strong connection between currency and import and export. Therefore, the government has to manage exchange rate volatility in the short run and taking measures for long-run to effectively manage trade flows (Mikhaylov, 2020b)

Wherever the balance of payment problem arises IMF generally suggest devaluing the currency, a decline in exchange rate trigger to the availability of domestic goods to foreign buyers at cheaper rates thus country exports increased. Conversely, the devaluation of currency leads to an increase in import prices that resulted in the reduction of imports. Thus, the country balance of payment bridges. Currently, Pakistan is facing a huge gap in the balance of payment. For this gap to fill Pakistan need financing and IMF recommended the same solution to devalue the currency. Whether historically this strategy to devalue the currency in Pakistan was worked and helpful to increase exports and mitigate imports. Therefore, this study is designed to examine that whether exchange rate volatility affect trade flows in symmetric or asymmetric way. (Mikhaylov, 2020c).

The government is to be vigilant because exchange rate volatility affects imports and exports which is further connected with the balance of payment and currency appreciation and depreciation.

The objective of this study is to assess and compare the short-run and long-run asymmetric and symmetric effect of exchange rate volatility on Pakistan aggregated and industry-level disaggregated trade flows. Once the effect of exchange rate volatility is determined the government will be able to devise and implement the financial policies accordingly (Mikhaylov, 2021a; Mikhaylov, 2021b; Mikhaylov, 2021c).

To sum up, nominal exchange rate, foreign direct investment, remittances, inflation, and industrial production carries more and only interest rate carries less number of significant coefficients in the non-linear industry-level short term import based model than that of linear import based model (mikhaylov, danish, & senjyu, 2021; mikhaylov, 2018a; mikhaylov, 2018b).

Finally, the estimates of ECMt−1 are significant and negative supporting the long-term cointegration in all importing industries. While t-ratio estimates associated to error correction model where null hypothesis of no cointegration is supported in two sectors 17 and 08, and the decision of long-term cointegration inconclusive in three sectors coded 18, 13, and 01, since the estimates are in between the upper and lower bound critical values (Zhao, Cherkasov, Avdeenko, Kondratenko, & Mikhaylov, 2021)

METHODOLOGY

Past studies that examine the effect of exchange rate volatility on trade flows, imports and exports used standard explanatory variables such as real income, relative prices and exchange rate volatility. But in this study there are some other macroeconomic variables too as explanatory variable that can potentially effect Pakistan trade flows (An, Mikhaylov, Richter, 2020).

Firstly, this study is designed to examine the effect of exchange rate volatility on Pakistan aggregate trade flows. Therefore the study begins with the following equation:

$$LnTFi,t = \theta 0 + \theta 1 LnVt + \theta 2 LnNEXt + \theta 3 LnFDIt + \theta 4 LnIRt + \theta 5 LnRTt \tag{1}$$

The above specifications are that LnTFi,t represent aggregate trade flows of Pakistan where i is for aggregate trade flows and t time period. θ0 is the slope intercept and log of volatility is represented by LnVt at time t. LnNEXt denoted nominal exchange rate, LnFDIt is the log of foreign direct investment at time t. The interest rate in Pakistan is specified as LnIRt. Further, the flow of remittances into Pakistan is denoted by LnRTt. Log of Inflation in the country indicated by LnINFt. Lastly, LnIPt stands for natural log of industrial production index and μt is the disturbance term.

Secondly, the study examine the effect of exchange rate volatility on Pakistan export. Thirdly, the effect of exchange rate volatility on various industries export. Other explanatory variables are added to the equation that have potential effect on Pakistan exports. Thus the given specifications are as under:

$$LnExi,t = \alpha 0 + \alpha 1 LnVt + \alpha 2 LnNEXt + \alpha 3 LnFDIt + \alpha 4 LnIRt + \alpha 5 LnRTt$$

$$+\alpha 6 LnINFt + \alpha 7 LnIPt + \mu t \tag{2}$$

In the above equation LnExi,t denotes log of Pakistan real export in US dollars where i at first show aggregate export and secondly each industry exports at time t, LnVt denotes log of volatility measured through GARCH process. The log of nominal exchange rate (PKR/USD) represented by LnNEXt, measure relative prices at time t. The term LnFDIt denotes log of foreign direct investment in Pakistan. LnIRt Stands for log of real interest rate at time t, Remittances are denoted by LnRTt. The log of quarterly inflation rate in Pakistan is shown by LnINFt. Natural log of industrial production indices as a measure of economic activity is denoted by LnIPt.

Thirdly, this study examine the effect of exchange rate volatility on Pakistan aggregate imports. At fifth the study will check the effect of exchange rate volatility on various importing industries on Pakistan. For import demand function in this study the traditional model with some addition of other macroeconomic variables linked to imports trade flows are added, the import demand function is as follows:

$$LnIMi,t = \beta 0 + \beta 1 LnVt + \beta 2 LnNEXt + \beta 3 LnFDIt + \beta 4 LnIRt + \beta 5 LnRTt + \beta 6 LnINFt + \beta 7 LnIPt + \omega t \tag{3}$$

In the above equation IM represents natural log of Pakistan real import in US dollars at time t, at first i show aggregate import and at second i is for various industries imports. β0 Is the slope intercept, LnVt denotes log of exchange rate uncertainty, LnFDIt is the log of foreign direct investment in Pakistan. The natural log of interest rate at time t is presented by LnIRt, and log of remittances are shown as LnRTt. Natural log of quarterly inflation and Pakistan industrial production are denoted by LnINFt and LnIPt respectively. At last, ωt is for the stochastic term that captures the unexplained portion.

In the next section of modelling approach, to introduce the dynamic adjustment mechanism in equations (1), (2) and (3) to differentiate the short-run effect of exchange rate volatility on trade flows from that of long-run effect. in the equations the there are some additional explanatory macroeconomic variables that have a potential to effect Pakistani trade flows. Here too by following the literature the focus is on Auto regressive distributed lag (ARDL) a bound testing approach of cointegration and the equations (1), (2) and (3) specifying as error correction model in equations, which specifications in the ARDL framework is given below (Dayong, Mikhaylov, Bratanovsky, Shaikh, & Stepanova, 2020; Dooyum, Mikhaylov, & Varyash, 2020; Moiseev, Mikhaylov, Varyash, & Saqib, 2020; Varyash, Mikhaylov, Moiseev, & Aleshin, 2020; Yumashev & Mikhaylov, 2020; Yumashev, Ślusarczyk, Kondrashev, & Mikhaylov, 2020; Nyangarika, Mikhaylov, and Richter, 2019a; Nyangarika, Mikhaylov, and Richter, 2019b).

Fourthly, the symmetric effect of exchange rate volatility on aggregate trade flow, in short-term and long-term.

$$\Delta LnTFi,t = \pi 1 + \Sigma \pi 2 \Delta LnTFt - j + \Sigma \pi 3 \Delta LnVt - j + \Sigma \pi 4 \Delta LnNEXt - j$$

$$+\Sigma \pi 5 \Delta LnFDIt - j + \Sigma \pi 6 \Delta LwnIRt - j + \Sigma \pi 7 \Delta LnRTt - j + \Sigma \pi 8 \Delta LnINFt - j \tag{4}$$

Fifthly, the linear effect of exchange rate volatility on Pakistan export and industry-level export, in short-term and long-term.

$$\Delta LnEXi,t = \phi 1 + \Sigma\phi 2\Delta LnExt - j + \Sigma\phi 3\Delta LnVt - j + \Sigma\phi 4\Delta LnNEXt - j$$

$$+\Sigma\phi 5\Delta LnFDIt - j + \Sigma\phi 6\Delta LnIRt - j + \Sigma\phi 7\Delta LnRTt - j + \Sigma\phi 8\Delta LnINFt - j \tag{5}$$

The symmetric effect of exchange rate volatility on Pakistan import and industry level imports, in short-term and long-term.

$$\Delta LnIMi,t = \Gamma 1 + \Sigma\Gamma 2\Delta LnIMt - j + \Sigma\Gamma 3\Delta LnVt - j + \Sigma\Gamma 4\Delta LnNEXt - j$$

$$+\Sigma\Gamma 5\Delta LnFDIt - j + \Sigma\Gamma 6\Delta LnIRt - j + \Sigma\Gamma 7\Delta LnRTt - j + \Sigma\Gamma 8\Delta LnINFt - j$$

$$+\Sigma\Gamma 9\Delta LnIPt - j + \lambda 1 LnIMt - 1 + \lambda 2 LnVt - 1 + \lambda 3 LnNEXt - 1 + \lambda 4 LnFDIt - 1$$

$$+\lambda 5 LnIRt - 1 + \lambda 6 LnRTt - 1 + \lambda 7 LnINFt - 1 + \lambda 8 LnIPt - 1 + \omega t \tag{6}$$

The Δ in above specifications is the first difference operator, j represent number of lags from 1 to n, π1 ϕ1, and Γ1 are equations intercept terms while εt, μt, and ωt are white noise terms without any contemporaneous correlation.

In above equations (4), (5) and (6) error correction models short-run effects of exchange rate volatility on trade flows are shown in the estimates of coefficients first difference variables and long-run effects of exchange rate volatility on trade flows in aggregate trade flow equation (4) is measured by ρ2−ρ8 which is normalized by ρ1. In capturing the long-run effect the normalization procedure considers the variable of difference as zero and then solve the demand equation to calculate the normalized long-term estimates. Similarly, in Error-correction model equation (5) short-run effect is measured by the estimates of coefficient of first difference and long-run effects are measured by the estimates of δ2 − δ8 normalized by δ1. In equation (6) too the short run effect is measured by first difference coefficient estimates and long-run effect are measured by the estimates of λ2−λ8 normalized by λ1.

As a unit increase in volatility of exchange rate may have different effect on trade flows than a unit decrease in exchange rate volatility. This will do by first the ΔLnV includes negative changes, ΔLnV −, and then the changes in ΔLnV includes positive changes, ΔLnV +. For such measurement of asymmetric effect of volatility, I have to establish two further time-series variables one capturing decreased volatility representing the partial sum of negative changes, denoted by NCH, and the second measuring increased volatility representing the partial sum of positive changes, denoted by PCH, as given below:

$$NCHt = \Sigma\Delta LnVj- = \Sigma min\left(\Delta LnV, 0\right) \tag{7}$$

$$PCHt = \Sigma\Delta LnVj+ = \Sigma max\left(\Delta LnV, 0\right) \tag{8}$$

For measuring volatility most of the past studies used standard deviation where the volatility of exchange rate is measure as the degree to which exchange rate fluctuates from the mean value over time method of exchange rate volatility faced with two severe problems. First, it took the assumption of normal distribution. Second, this method does not express the distribution between the unpredictable component of exchange rate process therefore it does not account for the past information of exchange rate. Due to the empirical flaws of the standard deviation technique hence this study uses the Generalized autoregressive conditional heteroskedesticity (GRCH) model or also called generalized ARCH (GARCH) for the measurement of exchange rate volatility, which is developed, because the exchange rate best follows the GARCH process (McKenzie, 1999) and second it best capture the past values of the exchange rate as opposed by the process of ARCH (Dooyum et al., 2020; An & Mikhaylov, 2020; Mikhaylov, 2020a; Mikhaylov, Yumashev, & Kolpak, 2021; An, Mikhaylov, & Jung, 2021).This section provide a brief of all the linear and nonlinear models. This section has three parts. The first part is about the short-term and long-term symmetric and asymmetric effect of exchange rate volatility on Pakistan aggregate trade flows. Second part deals with the short-term and long-term symmetric and asymmetric effect of exchange rate volatility on Pakistan 20 exporting industries. Third part show the short and long-term symmetric and asymmetric effect of exchange rate volatility on Pakistan 20 importing industries like in technical studies (Danish, Bhattacharya, Stepanova, Mikhaylov, Grilli, Khosravy, &Tomonobu, 2020).

RESULTS

The results indicate that there is significant long-term asymmetric effect of exchange rate volatility on aggregate trade, since the coefficient attached to NCH_t is significant. The long-term symmetric effect of volatility is insignificant, indicated by the coefficient attached to LnV_t. Further, the significant coefficient of Wald-L.

Table 1. Long-term coefficients of linear and nonlinear aggregate trade flows

Particulars	Long-Term Coefficient Estimates			
	LnV_t	PCH_t	NCH_t	Wald-L
Ln Aggregate Trade	0.006	0	0.027**	18.67**
Ln Export	0.018**	-0.038	0.08**	15.35**
Ln Import	-0.007	-0.018	0.02	13.15**

Likewise, there is significant symmetric and asymmetric effect of exchange rate volatility on Pakistani total exports. Additionally, cumulative effect asymmetric of volatility on exports. On the other hand, there is neither long-term linear or nonlinear effect of exchange rate volatility on Pakistani imports, but the long-term cumulative effect of exchange rate volatility on imports is present.

The short-run coefficients of linear and nonlinear aggregate trade flows are reported in Table 1-2. The results show short-term asymmetric effect, short-run cumulative impact, and short-run adjustments of exchange rate volatility in aggregate trade. There is no symmetric effect of exchange rate volatility on Pakistani aggregate trade flows.

The results indicate significant short-term symmetric and asymmetric effect of exchange rate volatility on Pakistan exports as well as short-run adjustment and short-run impact asymmetric in exports is

Table 2. Short-term coefficients of linear and nonlinear aggregate trade flows

Particulars	Short-Term Coefficient Estimates		
	LnV*t* PCH*t* PCH*t*−1 NCH*t*−1	**NCH*t*−3**	**Wald-S**
Ln Trade	0.01 -0.014 0.020** -0.031	-0.012	4.53**
Ln Export	0.018** 0.018** 0.007 -0.028**	-0.075**	6.43**
Ln Import	-0.008 -0.03** 0.037** -0.05**		5.70**

observed. Likewise, there exist significant short-run asymmetric effect, short-run cumulative effect, and short-run adjustment asymmetry in Pakistan imports but the symmetric effect of volatility on imports is found insignificant.

This section provides a brief of the linear and nonlinear effect of volatility on Pakistan all exporting industries.

Table 3. Long-term symmetric and asymmetric effect of volatility on exporting industries

Coefficients	Long-Term Effect of Volatility		
	LnV_t	**PCH_t NCH_t Total Significant**	**Wald-L**
Significant	11	10 7 13	14
Positive	7	5 6	
Negative	4	5 1	

In the Table 3 the linear and nonlinear effect of volatility on the number of Pakistan exporting industries is reported. The results conclude that there is long-term symmetric effect of exchange rate volatility on eleven Pakistan exporting industries. In these eleven industries, the effect of exchange rate volatility is positive in seven industries and negative in remaining four industries. Among the significant positive effect industry (Vegetable products) and industry 05 (Mineral products) are the large industries with market share of 11% and 5.3% respectively. Once the nonlinear adjustment is introduce in the volatility measure, by separating increase volatility from decrease volatility, there is now significant effect of exchange rate volatility in thirteen exporting industries. The two industries, Chemicals and Vehicles, becomes significant after nonlinear adjustments to the volatility measure, where PCH has negative and NCH has positive significant coefficients, implying that positive changes in exchange rate volatility has different effect than negative changes in exchange rate volatility. In short, the nonlinear results indicate long-run effect in thirteen, long-run cumulative effect in fourteen, and long-run asymmetric effect in almost all exporting industries of Pakistan.

In Table 4, the results show significant short-run effect of exchange rate volatility in twelve exporting industries in the linear models and in eighteen exporting industries in the nonlinear models. The significant linear effect of volatility in the short run is positive in six and negative in three industries. In the positive effect of exchange rate volatility industry 05 (Mineral products, 5.3% market share) and 08 (Raw hide and Skins, 4.7% market share) are the large industries. Further the results conclude short-run

Table 4. Short-term symmetric and asymmetric effect of volatility on exporting industries

Coefficients	Short-Term Effect of Volatility			
	LnV_{t-j} PCH_{t-j} NCH_{t-j} Total Significant			Wald-S
Significant	12	14	11 18	17
Positive	6	8	5	
Negative	3	5	6	
Mixed	3	1	-	

asymmetric effect in eighteen, short-run cumulative effect in seventeen, short-run adjustment asymmetry in fourteen exporting industries of Pakistan.

SOLUTIONS AND RECOMMENDATIONS

The aim of this study is to first investigate the symmetric and asymmetric effect of exchange rate volatility on aggregate trade, imports, and exports. Second, to examine the symmetric and asymmetric effect of exchange rate volatility on exporting industries and importing industries of Pakistan as determined by State bank of Pakistan (SBP) on commodity level. This study used two methodologies, linear autoregressive distributed lag (ARDL) and second the nonlinear autoregressive distributed lag (NARDL) by using quarterly data covering period Q3-2003 to Q2-2018. The exchange rate volatility is measured through Generalized Autoregressive Conditional Heteroskedasticity (GARCH) process, as volatility best follows GARCH process. By following the study, the maximum of four lags are used and for optimum models selection AIC is used by following general-to-specific approach. Thus, all the results belongs to each optimum model. In this study, the null hypothesis of no cointegration is tested through F-statistic, and alternatively through $ECMt-1$ by replacing the lagged level specifications in equations. The basic, long-run, short-run and number of diagnostic statistics associated to each model are reported (Morkovkin, Gibadullin, Kolosova, Semkina, Fasehzoda, & 2020; Morkovkin, Lopatkin, Sadriddinov, Shushunova, Gibadullin, & Golikova, 2020; Morkovkin, Lopatkin, Shushunova, Sharipov, & Gibadullin, 2020; Morkovkin, Gibadullin, Safarov, & Alpatova, 2020; Gibadullin, Yurieva, Morkovkin, & Isaichykova, 2020; Gibadullin, Morkovkin, Milonova, Progunova, & Isaichykova, 2020; Romanova, Morkovkin, Nezamaikin, Gibadullin, & Ivanova, 2020; Khayrzoda, Morkovkin, Gibadullin, Elina, & Kolchina, 2020; Morkovkin, Gibadullin, Romanova, Erygin, & Ziadullaev, 2019; Kobtseva, Novoselova, Novoselov, Morkovkin, & Sidorchukova, 2017; Morkovkin, Mamychev, Yakovenko, Derevyagina, & Didenko, 2016).

To begin with linear aggregate trade model, as for the F-statistic trade demand model is cointegrated. This cointegration is further confirmed by the negative significant coefficient of error correction model. To determine the long-run effects, exchange rate volatility has a significant positive effect on Pakistan aggregate trade at 10% significance level. The exchange rate, foreign direct investment and remittances has adverse effect on trade flows of Pakistan while the interest rate, inflation, and industrial production have positive effect on Pakistan aggregate trade.

As for the short-run effects, contrary to the expected a higher exchange rate uncertainty improves Pakistan trade, since the volatility coefficient is positively significant at 90% confidence level. Similar findings of positive significant effect of exchange rate volatility on trade flow was reported. Other variables in the model also have short run significant effect on Pakistan trade volume include foreign direct investment, interest rate, remittances, inflation, and industrial production.

Further extending the discussion to short and long run effects. There is short-run significant effect of uncertainty on the export of 12 sectors. Similarly, short-run significant effect of uncertainty on 30 exporting industries among 97 total industries was reported. In case of growing exchange rate uncertainty Pakistan exports less of six industries and more in 3 industries while remaining 3 sectors show varying behaviour by carrying positive and negative significant lagged level coefficients. A mixture of negative and positive short-term significant effect of volatility on exporting sectors is supported. The long-run significant effect of volatility is present in eleven industries. The significant long-run effect of uncertainty on exporting industries is consistent. Exchange rate uncertainty in the long run have significant positive effect on the exports of 8 industries and negative significant effect on remaining 4 sectors. Similarly, the study reported significant positive effect of uncertainty in 6 and significant negative effect of uncertainty on 4 exporting industries out of total 65 industries. Similarly, the findings show long-run negative significant effect of volatility on Pakistan exporting industries (Mikhaylov, Moiseev, Aleshin, & Burkhardt, 2020).

To summarize linear models long-run effects so far, it is clear that exchange rate uncertainty has a significant effect on 11 exporting and 8 importing industries out of each total 20 industries. The findings are similar to the previous study by using annual data and different measure for volatility of exchange rate report significant effect of volatility on 10 exporting sectors out of total 20 sectors and significant effect of uncertainty on imports of 38 industries out of 101 industries. The long-term results are further supported by a similar study. They used monthly data and GARCH process to measure exchange rate volatility and report significant long run effect of exchange rate volatility on 13 exporting industries of Malaysia out of total 54 industries and long-term significant effect of uncertainty on 35 importing industries out of total 63 importing industries of Malaysia.

Now to summarize the short run effects of exchange rate volatility. The volatility of exchange rate has a short-run significant effect on 12 (20) exporting industries and significant effect of uncertainty on 15 (20) Pakistan importing industries.

Furthermore, the optimum model of aggregate trade is free from serial correlation and model misspecification indicated by the insignificant estimates of LM and RESET respectively. Moreover, model is statistically stable as for CUM, CUMQ and bound test and data is normally distributed since Jarque-Bera carries insignificant estimate.

Secondly, the discussion is of nonlinear export-based model. Where long-term positive significant estimate of ΔNCH and negative insignificant coefficient of ΔPCH, suggest that once decomposition of volatility measure into increasing and decreasing volatility indicate that decreasing volatility encourage Pakistan exports volume while increasing volatility do not significantly affect Pakistan exports. The size and sign of ΔPCH are significantly different from ΔNCH, showing long-run asymmetric effect of exchange rate uncertainty on Pakistan exports. Further, the significant Wald-L estimate show long run cumulative adjustment asymmetry. In long-run foreign direct investment, remittances, and economic activity has a significant positive effect on Pakistan export volume. First, in shortrun ΔPCH has a significant positive effect and ΔNCH has a significant negative effect of Pakistan exports, implying that increasing volatility encourage Pakistan exports and decreasing volatility discourage Pakistan short-term export volume. Second, adjustment asymmetry is observed since the lag order follows by ΔPCH is different from ΔPCH.

Thirdly, the nonlinear model of import demand is subsequently reported. Where the long-run coefficient estimate attached to ΔPCH is negatively significant and ΔNCH is positively significant, both significant at 90% confidence level, implying that increasing volatility reduce Pakistan long-term import demand while decreasing volatility improve Pakistan imports. The long-run asymmetric effect of exchange rate uncertainty on import volume is observed since both size and sign of ΔNCH different from ΔPCH. Additionally, the long-term impact asymmetry of uncertainty is supported by the significant coefficient of Wald-L. The effect of industrial production on Pakistan aggregate import trade is positively significant, implying that increasing economic activity in Pakistan encourage industries to import more. In short-run the coefficients of ΔPCH and ΔNCH are significant, demonstrating the significant effect of uncertainty on Pakistan import. Secondly, the number of lags associated to ΔPCH are different from ΔNCH indicating shortrun adjustment asymmetry. Thirdly, short-term cumulative asymmetry or impact asymmetry is observed, since the coefficient estimate of Wald-S is significant showing that sum of the short-term coefficients from ΔPCH is not equal to the shortterm sum of coefficients from ΔNCH. Finally, the size or sign attached to ΔPCH has different from ΔNCH supporting the short-run asymmetric effect of exchange rate variability on Pakistan total import volume. The significant short-run effect of nominal exchange rate, foreign direct investment, interest rate, inflation, and industrial production on total import demand is observed, since the coefficients attached to these variable are significant. A battery of diagnostic statistics supports these results reported. The import demand model residuals are do not serially correlated and the model is correctly specified, since LM and RESET tests estimates are insignificant. The insignificant coefficient of Jarque-Bera show that data is normally distributed. Finally, the model is statistically stable as for the significant bound test, cumulative sum, and cumulative sum of square (Nie, Panfilova, Samusenkov, & Mikhaylov, 2020).

Finally, either the size or sign associated to ΔPCH is different from ΔNCH in almost every exporting industry suggesting long-run asymmetric effect of volatility on Pakistan industry-level exports. The long-run asymmetry effect of volatility on industry-level exports is supported by the study. Additionally, a similar study reports long-run asymmetric effect of exchange rate in five cases out of total 12 exporting industries, implying that exports do react stronger to depreciation than appreciation.

FUTURE RESEARCH DIRECTIONS

After this thorough study here are some suggestions for future studies in this area. One open task for further studies is to conduct analysis on Pakistan bilateral trade flows with major trading partners like China and US etc. Moreover, this would be interesting to examine the potential reason of these nonlinearities in exchange rate volatility. This may be due to prices of imports and exports or due to their compositions. Further a comparative study can be conducted to measure the symmetric and asymmetric effect of volatility on aggregated and disaggregated industry-level trade flows of different countries and different time span. Similarly, the asymmetric effect of volatility seems to be industry specific and have implications for industries in other countries thus, need further investigation to arrive at general conclusion.

The limitation of this study is data of a short time span as Pakistan industry level disaggregated data for longer period is not available. The other potential limitation is of a very diverse study of its type by therefore, compromising the conciseness of the study.

CONCLUSION

This study is useful in number of ways. Like exchange rate volatility has a significant positive effect on the imports of industry 16 (Machinery and Mechanical Appliances, with 16% market share) both in short-term and long-term. While on the other hand exchange rate volatility has a significant long-term symmetric and asymmetric effect on the imports of industry 11 (Textiles and Textile Articles, with 7.5% market share). Thirdly, this study can be helpful for Pakistan policy makers to devise policies accordingly to resolve a severe Pakistan a balance of payment issue by addressing the nonlinearities in exchange rate and focusing on each industry trade flows. Because the effect of exchange rate is different from industry-to-industry, in some industries the effect is positive and in others negative.

Finally, the findings of this study show that what Pakistan importing and exporting industries might benefit or worsen from exchange rate volatility, exchange rate, foreign direct investment, interest rate, remittances, inflation, and industrial production. Furthermore, also separate that whether increasing or decreasing volatility effect individual industry trade flow positively or negatively. Thus, it helps the management of respective industries to forecast and implement strategies accordingly.

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Chapter 6
Energy Center Selection in G7 Industry With Fuzzy MOORA

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ABSTRACT

In this study, energy center selection of G7 countries is examined. In this context, firstly, the studies in the literature have been evaluated in detail, and seven different criteria have been determined which may affect this selection. Taking these seven different criteria into consideration, G7 countries are ranked by fuzzy MOORA method according to energy center selection performance. According to the results, Japan and Germany are the most successful countries. On the other hand, it was concluded that France and Italy ranked last in terms of energy center selection performance. Hence, especially the countries in the last rankings should be more careful in selecting energy center. In this framework, the customer potential, the training profiles of the customers, the potential of the company with investment demand, the previous payment performance of these companies, and the market risks should be considered by the energy companies while opening new branches.

INTRODUCTION

There is a very serious competition in the energy sector, especially in recent years. This situation negatively affected the sales volumes of energy companies. On the other hand, as a result of this, there is a significant decrease in the profitability of energy companies (Cheng et al., 2020; Mikhaylov et al., 2021). In order to effectively manage this problem, energy companies want to take some measures that increase both cost and income (Li et al., 2020; Mikhaylov, 2018a,b). In this way, the relevant companies aim to

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gain a competitive advantage compared to their competitors. Otherwise, it will be very difficult to survive in this competitive environment. As a result, there is a possibility that energy companies established with huge investments will go bankrupt and leave great losses behind (Zhong et al., 2020; Qiu et al., 2020).

There are many different situations that can reduce the costs of energy companies. For example, the dismissal of personnel who do not contribute to increasing efficiency may contribute to the reduction of costs (Zhao et al., 2021; Li et al., 2021). However, this action has a motivation-reducing effect within the company. Therefore, energy companies may turn to other actions in order to reduce their costs. In this context, energy companies give priority to technological investors (Mikhaylov, 2020a,b,c; Zhou et al., 2020). Thanks to the integration of developing technology into investments, it is possible to reduce the costs in energy investments. This can help increase the efficiency of the company's activities. The ability to reduce costs increases the profit margin of the company, which provides a cost advantage to the energy company (Qi et al., 2020; Yuan et al., 2021).

On the other hand, energy companies can take certain actions to increase their sales volumes. In this context, the most important action that can be taken into consideration is increasing customer satisfaction (Yüksel et al., 2020; Liu et al., 2021). If customers can be more satisfied with the services provided, then the energy company will become more preferable. In other words, by increasing customer satisfaction, it will be possible to increase the sales volumes of energy companies. Therefore, it is very important for energy companies to take actions that can increase customer satisfaction (Du et al., 2020; Yuan et al., 2020). In this context, the customer solution center to be created by the companies will help achieve this goal. In this context, selection of energy centers is an important issue in terms of customer satisfaction. Therefore, if energy companies can choose the right energy centers, it will be much easier for customers to be satisfied (Haiyın et al., 2021; Mikayilov et al., 2020).

Energy companies must develop strategies to survive in this increasingly competitive environment. Some companies give importance to technological infrastructure in this process. Thanks to this new technology, energy companies are able to produce products that attract more and more customers' attention (Donou-Adonsou et al., 2016). On the other hand, some energy companies prefer to produce strategies that meet customer expectations. In this context, they first try to determine the expectations of their customers (Kassab et al., 2017). In this process, they also analyze different customer groups and aim to learn what their customers demand from energy companies (Flammer, 2015; Fabrizio et al., 2017).

It is also important for customers to have access to the products of energy companies at any time. Customers will not choose to work with energy companies where their products are not easily accessible (de Aguiar et al., 2017). It is important that energy companies develop strategies for this purpose. In this process, where energy companies open their branches is vital. In this case, these companies need to pay attention to two different issues. First, the places where the customers' demands should be identified, and a branch should be opened in this region (Larsson and Viitaoja, 2017). The second important point is that energy companies should not open branches in unnecessary locations since opening a branch involves significant costs.

When choosing a location to open centers, energy companies should pay attention to many different issues at the same time. Firstly, there should be customer potential in the region where the branch will be opened. But it is very difficult to understand this situation clearly. Within this framework, energy companies should make serious analyzes in the region where they plan to open centers and thus determine whether they have customer potential. Otherwise, the center will not be able to cover the costs due to the small amount of transactions in the branch opening to the region without customer potential (Basar et al., 2017).

In addition, the level of training of potential customers in this region is important. In an environment of more educated people, energy centers are likely to carry out more transactions. In addition, people with low levels of education may be reluctant to make transactions with the branches. As can be seen here, there is a significant correlation between the transaction density of the branch and the training level of the customers. Therefore, regions with higher customer potential play an important role in the selection of the energy centers. Hence, in the analysis, in addition to the customer potential, it is very important that the level of education of these customers should be identified (Demir et al., 2019).

The aim of this study is to analyze the success of the energy companies in location selection. In this context, G7 countries were included in the scope of the review. The analysis process of the study consists of two stages. Firstly, similar studies in the literature have been examined and 7 different criteria which are thought to affect the center selection of energy companies have been determined. In addition, in the second stage of the analysis process, the G7 countries subject to the study were ranked according to the center selection performance. Fuzzy MOORA method was used in this success ranking. In this ranking process, 7 different criteria were assumed to have equal importance weight.

This study is thought to contribute to the literature in many ways. First of all, in this study, a very detailed literature review has been conducted and a set of criteria that may affect the center selection of the energy companies has been determined. This set of criteria is guiding in the development of strategies by the energy companies and in researches by academicians. In addition, center selection performance of the energy companies in G7 countries is taken into consideration for the first time in this study by fuzzy MOORA method.

In this study, there are basically 5 different sections. This section, which is the first part of the study, provides general information about the subject. In this context, competition in energy, importance of center selection and factors affecting this selection are discussed. In addition, in the second part of the study, a literature review was made. In the third part of the study, detailed information about fuzzy MOORA method is presented. In the fourth part of the study, the results of the analysis are given. The last section contains the shared recommendations based on the results of the analysis.

LITERATURE REVIEW

Energy center selection has been considered in the literature by different researchers. In some of the studies, it was stated that energy companies should first pay attention to customer potential when choosing locations. In this context, energy companies should make a detailed analysis before deciding the location to determine the customer profile for the regions they are considering (Allahi et al., 2015; Basar et al., 2017; Basar et al., 2018; Cabello, 2017). Additionally, Basar et al. (2015), Demir et al. (2019), Eklof et al. (2017) and Koç and Burhan (2015) stated that in this way, it will be possible to determine whether there are enough customers in this region to open a new branch. Otherwise, when such an analysis is not carried out, energy companies are at risk of opening branches in the wrong region (LaPlante and Paradi, 2015; Met et al., 2017). Moreover, Parise et al. (2016) and Paul et al. (2016) defined that although the physical equipment and technological infrastructure are good, branches opened in regions that do not have sufficient customer potential will not be able to cover their costs. This will result in the closure of this branch.

On the other hand, a significant part of the researchers stated that the education level of the people in that region is important when choosing a location for the energy companies. In this context, Bashir and Forouzanfar (2016), Arora and Kaur (2019) and Yang et al. (2015) identified that during the branch location selection process, an analysis is needed to determine the education levels of the people living in the location (Lázaro et al., 2018; Mikhaylov et al., 2018). If this analysis is not done, the energy companies will be able to decide to open branches by just looking at the population of the region. In this case, it is considered that there are too many customer profiles due to the population density. However, due to the low educational profile, in fact this overpopulation does not actually have a customer profile for the energy companies (Maudos, 2017; Ergeç et al., 2016; Masocha and Matiza, 2017). As a result, the selection of branch locations without considering the level of education by considering only the density of people is at high risk of being wrong.

An important part of the researchers stated that the investment potential of the region should be paid attention when choosing the location of the energy companies. For example, Pugi et al. (2016) and Aisyah (2018) argued that the investment needs of the companies should be at the forefront rather than the issues of the region's population and education profile. According to these authors, if a company intends to invest, it means that there is a person to work for that company and a customer profile for that company's products. In other words, the region, which has investment potential, also informs that it has employee and customer potential (Heard et al., 2018). Therefore, it is sufficient for the energy companies to pay attention to this issue only when choosing a branch location (Okpara and Onuoha, 2015; Mavri, 2015). Otherwise, the energy companies that pay attention to the customer potential will not consider the employee potential (Newberger et al., 2016; Murphy, 2018). On the other hand, Ramakrishna and Trivedi (2018) and Leuz and Granja (2018) defined that examining only the employee profile means incomplete analysis, as it will ignore customers. In summary, it is an incomplete assessment not to take into account the investment potential of the region when choosing location for energy companies.

Some of the studies emphasize that the quality of the companies should be taken into consideration when determining the locations for the energy companies. According to these authors, it is a wrong approach to consider only the investment profiles of companies (Shukla et al., 2017; Martin-Oliver, 2019). Furthermore, Luo et al. (2017) and Kuehn (2018) concluded that paying attention to the investment demands of only companies in a region is an indicator for increasing the transaction volume of energy companies in the short term (Mukhtarov et al., 2018). This will result in a significant loss of energy companies (Goodstein and Rhine, 2017; Cabello, 2017; Aliero et al., 2018). In other words, short-term transaction volume of opened energy companies will be high, but in the long term these centers will close due to low profitability.

According to some researchers, when choosing a location for the energy companies, an important issue to consider is market risk. Market risk, which indicates the loss of energy companies due to volatility in the market, should affect the decision of energy companies to choose a location (Aggelopoulos and Georgopoulos, 2017; Viritha and Mariappan, 2017; Płuciennik and Hełdak, 2017; Mikhaylov and Tarakanov, 2020). For example, in a country with high inflation, energy companies should not be very keen on opening branches. This is also the case for an environment with high interest rates (Kodrat, 2018; Granados, 2018; Boďa and Zimková, 2019; Yüksel and Zengin, 2016). Therefore, it would be more appropriate for energy companies to wait for these problems to disappear in order to open a new location. Another point that energy companies should consider when choosing locations to open branches is exchange rate volatility (Başar et al., 2015; Vafadarnikjoo et al., 2015; Alamá et al., 2015; Quaranta et al., 2018; Mikhaylov et al., 2020). The energy companies operating in a country where the exchange rate is highly valued should first check the exchange rate position (Mukhtarov et al., 2019). Since an energy company with open positions is at high risk, it must manage this risk before opening a new branch.

As a result of the literature review, it was seen that the location selection of the energy companies was handled less compared to the subjects such as new product and service development and profitability analysis. However, there is still a sufficient number of studies in the literature on this subject. In these studies, issues such as customer potential, training profile of customers, investment profile of companies, quality of companies requesting investment and market risk are frequently emphasized in this context. On the other hand, in these studies, it is understood that an analysis is usually conducted on an energy company and the factors affecting the center selection are tried to be determined. Therefore, it is thought that a new study comparing the performance of different energy companies or countries on location selection will contribute to the literature.

Fuzzy MOORA

MOORA approach is a kind of multi-criteria decision-making models. It mainly aims to rank the alternatives according to their importance based on ratio analysis (Brauers and Zavadskas, 2006). There are some limitations for the people who aim to make decision because of the complex environment. MOORA method helps to solve this problem by making optimization. This methodology has many advantages in comparison with the similar approaches. First of all, it takes a very short time to make analysis by using MOORA model (Dinçer, 2015). Another important advantage of this method is that negatively affecting criteria can be taken into consideration in the analysis process. MOORA method can also be used with fuzzy logic. In the first step, fuzzy decision matrix is generated that is given in the equation (1).

$$X_{ij} = \begin{bmatrix} (X_{11}{}^{l}, X_{11}{}^{m}, X_{11}{}^{n}) & \cdots & (X_{1n}{}^{l}, X_{1n}{}^{m}, X_{1n}{}^{n}) \\ \vdots & \ddots & \vdots \\ (X_{m1}{}^{l}, X_{m1}{}^{m}, X_{m1}{}^{n}) & \cdots & (X_{mn}{}^{l}, X_{mn}{}^{m}, X_{mn}{}^{n}) \end{bmatrix}. \tag{1}$$

The second step is related to the normalization of this matrix. For this purpose, equations (2)-(4) are taken into consideration (Karande and Chakraborty, 2012).

$$r_{ij}^{l} = \frac{X_{ij}{}^{l}}{\sqrt{\sum_{j=1}^{m} (X_{ij}{}^{l})^2 + (X_{ij}{}^{m})^2 + (X_{ij}{}^{n})^2}}. \tag{2}$$

$$r_{ij}^{m} = \frac{X_{ij}{}^{m}}{\sqrt{\sum_{j=1}^{m} (X_{ij}{}^{l})^2 + (X_{ij}{}^{m})^2 + (X_{ij}{}^{n})^2}}. \tag{3}$$

$$r_{ij}^{n} = \frac{X_{ij}{}^{n}}{\sqrt{\sum_{j=1}^{m} (X_{ij}{}^{l})^2 + (X_{ij}{}^{m})^2 + (X_{ij}{}^{n})^2}} \tag{4}$$

urthermore, in the third step, weighted results of different alternatives are calculated with the help of equations (5)-(7).

$$v_{ij}^{l} = W_j r_{ij}{}^{l}. \tag{5}$$

$$v_{ij}^{m} = W_{j} r_{ij}^{\ m} . \tag{6}$$

$$v_{ij}^{n} = W_{j} r_{ij}^{\ n} \tag{7}$$

.In addition, the ratings of beneficial and non-beneficial criteria are identified. In this process, equations (8)-(13) are used in the calculation.

$$S_{i}^{+l} = \sum_{j=1}^{n} v_{ij}^{\ l} \tag{8}$$

$$S_{i}^{+m} = \sum_{j=1}^{n} v_{ij}^{\ m} \tag{9}$$

$$S_{i}^{+n} = \sum_{j=1}^{n} v_{ij}^{\ n} \tag{10}$$

$$S_{i}^{-l} = \sum_{j=1}^{n} v_{ij}^{\ l} \tag{11}$$

$$S_{i}^{-m} = \sum_{j=1}^{n} v_{ij}^{\ m} \tag{12}$$

$$S_{i}^{-n} = \sum_{j=1}^{n} v_{ij}^{\ n} \tag{13}$$

The fifth step includes the calculation of overall performance index (Si) with the equation (14).

$$S_{i}\left(S_{i}^{+}, S_{i}^{-}\right) = \sqrt{\frac{1}{3}\left[\left(S_{i}^{+l} - S_{i}^{-l}\right)^{2} + \left(S_{i}^{+m} - S_{i}^{-m}\right)^{2} + \left(S_{i}^{+n} - S_{i}^{-n}\right)^{2}\right]}. \tag{14}$$

In the final step, alternatives are ranked. Fuzzy MOORA approach was taken into consideration by many researchers in the literature with different purposes. They are detailed in Table 1.

Table 1. Studies using Fuzzy MOORA approach

Author	Subject
Mallick et al. (2016)	Inventory classification
Gürbüz and Erdinç (2018)	The best hotel selection
Abdi (2018)	Hospital leanness assessment
Dursun et al. (2017)	Agility evaluation
Mavi et al. (2017)	reverse logistic provider selection
Akkaya et al. (2015)	Industrial engineering sector choosing
Dinçer et al. (2018)	Economic effects on green supply chain management
Arabsheybani et al. (2018)	Supplier selection
Matawale et al. (2016)	Supplier selection
Siddiqui and Tyagi (2016)	Reliability estimation of component-based software systems
Khan et al. (2020)	Selection the optimum combination of titanium
Dinçer and Yüksel (2019)	Investment strategies for European tourism industry
Hafezalkotob and Hafezalkotob (2016)	Materials selection
Majumder and Maity (2018)	Optimization of surface roughness
Paydar et al. (2017)	Supplier selection
Stanujkic (2016)	Supplier selection
Ghoushchi et al. (2019)	Prioritization of failures
Ohlan (2016)	logistic provider selection
Deliktas and Ustun (2017)	Student selection
Dinçer et al. (2019)	Service quality of energy companies
Erkayman and Özkal (2016)	Evaluation of framed building types
Sen et al. (2018)	Supplier selection
Dahooie et al. (2019)	Technological forecasting
Goker et al. (2019)	Agile supplier evaluation
Thao (2021)	Selecting materials for mushroom cultivation
Srivastava et al. (2021)	Agile testing efficiency
Feizi et al. (2021)	Knowledge-driven procedures for mineral potential mapping in greenfields
Haiyun et al. (2021)	Analysis of the innovation strategies for green supply chain management in the energy industry
Mishra et al. (2021)	The selection of sustainable third-party reverse logistics providers using improved generalized score function
Shah and Kant (2021)	Influence of knowledge management enablers in manufacturing organisations
Alvand et al. (2021)	Identification and assessment of risk in construction projects
Dhanalakshmi et al. (2021)	Biomass material selection for sustainable environment

APPLICATION ON G7 ECONOMIES

Fuzzy MOORA method is applied for ranking the location selection performances of G7 energy industry. For this purpose, a set of factor is determined based on the literature review and the details of center selection factors are given in Table 2. According to the table, criterion 1 is the potential of energy services, criterion 2 is the profile of education that it could affects the energy volume, criterion 3 is the centralization of energy services by focusing on the city center for the energy operations, another criterion is the potential of investments for the long term. However, criterion 5 is defined as a negative impact of center selection because of the defining the instability conditions of economy. The final criterion examines the energy industry conditions that could cause a potential growth in the financial industry.

Table 2. Proposed factors of Branch Location Selection

Factors	Definition	Supported Literature
Potential of Eenrgy Services (criterion 1)	Potential increase in the customers for the energy services	Moutinho and Brownlie, 1989; Naser et al. 1999; Mikhaylov, 2019
Profile of education (criterion 2)	Effects of well-educated population on the energy volume	Gorener et al. 2013; Kaynak et al. 1991; Mikhaylov and Sokolinskaya, 2019; Xie et al. 2021
Centralization (criterion 3)	Profile of energy customer stated in the city center	Gorener et al. 2013; Panagariya, 2006
Potential of investment (criterion 4)	Credit expectancies for the long-term investment projects	Ramasamy et al. 2012; Gormley, 2005; Mikhaylov, 2021
Instability of purchasing power (criterion 5)	Consumer changes with the volatile prices	Javalgi et al. 1989; Martenson, 1985
Quality of Firms (criterion 6)	Impact of qualified firms on the profitability	Holmlund and Kock, 1996; Dick, 2007
Industry conditions (criterion 7)	Potential growth in the industry	Katircioglu et al. 2011; Abbasi, 2003

Initially, fuzzy decision matrix is provided from the decision makers. For that, a decision maker team from the industry experts in the international energy and services is appointed and their linguistic choices are collected according to the consensus. Several appointments are arranged and then, at the final process of discussions, a final decision is given for each alternative. The final fuzzy decision matrix is seen in Table 3.

Table 3. Fuzzy decision matrix

Alternatives/ Criteria	C1			C2			C3			C4			C5			C6			C7		
A1 (Canada)	0.75	1	1	0.75	1	1	0.5	0.75	1	0.5	0.75	1	0.25	0.5	0.75	0.5	0.75	1	0.5	0.75	1
A2 (France)	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1	0.25	0.5	0.75	0.5	0.75	1
A3 (Germany)	0.75	1	1	0.75	1	1	0.5	0.75	1	0.75	1	1	0.25	0.5	0.75	0.5	0.75	1	0.5	0.75	1
A4 (Italy)	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1	0.75	1	1	0.25	0.5	0.75	0.5	0.75	1
A5 (Japan)	0.75	1	1	0.75	1	1	0.5	0.75	1	0.5	0.75	1	0.25	0.5	0.75	0.75	1	1	0.5	0.75	1
A6 (United Kingdom)	0.5	0.75	1	0.5	0.75	1	0.75	1	1	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1
A7 (United States)	0.75	1	1	0.5	0.75	1	0.75	1	1	0.75	1	1	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1

Secondly, normalization process is applied to the fuzzy decision matrix and the results are provided in Table 4.

Table 4. Normalized Fuzzy decision matrix

Alternatives/ Criteria	C1			C2			C3			C4			C5			C6			C7		
A1 (Canada)	0.19	0.25	0.25	0.19	0.26	0.26	0.13	0.20	0.27	0.13	0.20	0.27	0.08	0.15	0.23	0.15	0.22	0.29	0.14	0.21	0.28
A2 (France)	0.13	0.19	0.25	0.13	0.19	0.26	0.13	0.20	0.27	0.13	0.20	0.27	0.15	0.23	0.31	0.07	0.15	0.22	0.14	0.21	0.28
A3 (Germany)	0.19	0.25	0.25	0.19	0.26	0.26	0.13	0.20	0.27	0.20	0.27	0.27	0.08	0.15	0.23	0.15	0.22	0.29	0.14	0.21	0.28
A4 (Italy)	0.13	0.19	0.25	0.13	0.19	0.26	0.13	0.20	0.27	0.13	0.20	0.27	0.23	0.31	0.31	0.07	0.15	0.22	0.14	0.21	0.28
A5 (Japan)	0.19	0.25	0.25	0.19	0.26	0.26	0.13	0.20	0.27	0.13	0.20	0.27	0.08	0.15	0.23	0.22	0.29	0.29	0.14	0.21	0.28
A6 (United Kingdom)	0.13	0.19	0.25	0.13	0.19	0.26	0.20	0.27	0.27	0.13	0.20	0.27	0.15	0.23	0.31	0.15	0.22	0.29	0.14	0.21	0.28
A7 (United States)	0.19	0.25	0.25	0.13	0.19	0.26	0.20	0.27	0.27	0.20	0.27	0.27	0.15	0.23	0.31	0.15	0.22	0.29	0.14	0.21	0.28

However, each criterion weight is equal due to the criteria have similar impacts on the center selection performance. Also, the final ranking results for the center selection are presented in Table 5.

Table 5. The ranking of G7 energy industry

Alternatives	The values of Si	Ranking
A1 (Canada)	0.1664	3
A2 (France)	0.1354	6
A3 (Germany)	0.1721	2
A4 (Italy)	0.1298	7
A5 (Japan)	0.1727	1
A6 (United Kingdom)	0.1507	5
A7 (United States)	0.1614	4

Table 5 shows that the ranking results are listed as alternative 5 (Japan), alternative 3 (Germany), alternative A1 (Canada), alternative 7 (United States), alternative 6 (United Kingdom), alternative 2 (France), and alternative 4 (Italy) respectively. Accordingly, it is concluded that Japan energy industry is the best alternative for the center selection whereas Italy is the worst alternative.

SOLUTIONS AND RECOMMENDATIONS

In this study, center selection performance of energy companies of G7 countries are listed. As a result of this ranking, especially the countries in the last rankings should be more careful in choosing locations. Otherwise, the branches will be opened in the wrong places and these branches will not have continuity. In other words, these branches that are opened in the wrong places will be unable to cover their costs after a certain time. Therefore, it is important that the energy companies wishing to open new branches take into account the customer potential, the training profiles of the customers, the potential of the company with investment demand, the previous payment performance of these companies and the market risks.

FUTURE RESEARCH DIRECTIONS

In this study, center of energy companies in G7 countries is analyzed. Therefore, in another future study, this issue can be examined for E7 countries. On the other hand, it was assumed that all 7 different criteria identified in the study had the same importance. Thus, in another study, these criteria can be weighted according to their severity. In this process, it is possible to benefit from methods such as fuzzy AHP, fuzzy ANP and fuzzy DEMATEL. In addition, G7 countries are listed with fuzzy MOORA method in this study. In another study, comparative analysis using fuzzy TOPSIS and fuzzy VIKOR will contribute to the literature.

CONCLUSION

In this study, center selection for energy companies is analyzed. In this context, firstly, a large literature review has been made. As a result, 7 different criteria were determined which might affect the location choices for the energy companies. In our study, it was assumed that all of these criteria had equal importance weight. In addition, branch selection performances of G7 countries were compared by taking these criteria into consideration. The fuzzy MOORA method was used to rank the performances of the aforementioned countries. According to the results of the analysis, it was determined that Japan was the most successful country. In addition, Germany ranks second and Canada ranks third. On the other hand, the branch location selection performance of the energy companies in France and Italy was the most unsuccessful.

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KEY TERMS AND DEFINITIONS

AHP: Analytic hierarchy process.
ANP: Analytic network process.
DEMATEL: Decision making trial and evaluation laboratory.

E7: Seven emerging countries which have the highest GDP that are Brazil, China, India, Indonesia, Mexico, Russia, and Turkey.

G7: Seven developed countries which have the highest GDP that are United States, United Kingdom, Japan, Germany, France, Italy, Canada.

MOORA: Multi-objective optimization on the basis of ratio analysis.

TOPSIS: Technique for order preference by similarity to ideal solution.

VIKOR: Vise Kriterijumska Optimizacija I Kompromisno Resenje.

Chapter 7
Role of Negative Interest Rates for Energy Assets Pricing in Financial Markets

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ABSTRACT

The world economy strives for globalization, and most energy assets are connected with each other through correspondent banks and other mutual operations. The relevance of the topic of the thesis is due to the fact that in September 2019 a number of proposals were made to introduce the practice of negative interest rates in the national banking system due to the fact that Russian energy assets are not profitable to place in foreign currency..

INTRODUCTION

Understanding the issue of the formation of negative interest rates, it is impossible not to touch upon the concept of an economic model. An economic model is a structuring and simplification of economic reality, which most objectively reflects the main factors influencing the model itself and their interaction within it. Historically, three types of economic models are distinguished (traditional economy, administrative-command economy, market economy), as well as the concept of a mixed economy, which includes aspects of the transition from an administrative-command economy to a market economy. The theoretical and methodological basis is the chapter is of domestic and foreign researchers devoted to the impact of monetary policy on the country's economy, including the works of the English economist, the founder of Keynesian direction in economics, John Keynes, the American economist, the creator of the theory of monetarism Milton Friedman, the author of the book "Capital", Karl Marx and the American

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economist Ben Bernanke. The information base of the research is the statistical materials, materials on the research issues; published in periodicals, posted on the Internet, as well as the author's own calculations.

At the moment, most countries are striving to move to the ideals of a market economy in order to minimize the influence of the state, the formation of competition in the markets close to absolute, the operation of the market pricing mechanism due to the balance of supply and demand.

After the collapse of the USSR, the Russian economy can be described as "mixed". It is characterized by both market features (maintaining antimonopoly legislation, adopting a labor protection law, developing exports and imports, attracting private investors to stock exchanges) and "echoes" of a command-and-control economy (development mainly through government support in the form of subsidies, stimulating demand through government orders, a large share of enterprises with government participation). Unfortunately, one way or another, but the contribution of the public sector to Russian GDP is about 33%.

The main body that currently regulates most of the financial market in Russia is the Central Bank of the Russian Federation (hereinafter referred to as the Bank of Russia). Since 2013, the powers of a mega-regulator of the financial market have been transferred to him, which means that the Bank of Russia exercises supervision, regulation and is responsible for the development of all sectors of the financial market, including: the banking system, the insurance sector, the sector of pension savings and collective investments, the securities market. Among other things, as a mega-regulator, it also controls the infrastructure of the financial market, namely rating agencies, the stock exchange and other professional participants. Pursuing its own policy, the Bank of Russia is the main issuing and monetary regulator of the country.

LITERATURE REVIEW

Depending on the current economic requirements, the mega-regulator adjusts the money supply through the policy of "expensive" or "cheap money". In the event of high inflationary processes, the money supply is subject to reduction through the issue of bonds, an increase in the key rate, an increase in the required reserves of credit institutions and other operations aimed at withdrawing the surplus of funds from circulation. When signs of recession and stagnation appear in the economy (such as: a decrease in the level of GDP growth, an increase in unemployment, a transition of inflation to zero or negative values, a decrease in consumption with a simultaneous increase in savings), the policy of the Central Bank is oriented towards issuance in order to inject additional liquidity into the market, (through the reduction of interest rates, the repayment from the market bonds offer lines of credit and so on) thus Central Bank formulates demand and maintaining production (Dinçer, & Yüksel, 2018a; Dinçer, & Yüksel, 2018b; Dinçer, & Yüksel, 2018c).

Depending on the period for which it is necessary to give the economy additional cash funds of Bank of Russia toolkit is divided into short-term (1 day), medium (from one week) and long term (one year). More detailed information on the types of operations to regulate liquidity, their purposes, forms and frequency of carrying out is indicated (An, Mikhaylov, Richter, 2020).

As can be seen in accordance with the above table, the provision of liquidity is carried out for a sufficiently short period for the real sector, which leads to imbalances in the banking sector - while receiving additional short-term liquidity from the Bank of Russia, commercial energy assets are forced to provide long-term loans to enterprises. For energy assets, this lending sector often does not seem profitable at all. If an enterprise belongs to a medium and small business, then the risk of loan defaults increases, the interest rate on it increases, as a payment for riskiness and urgency. As a result, a vicious circle arises: the liquidity provided to energy assets goes to short-term lending or to the stock market, which turns out to be more profitable and liquid for energy assets, while high rates impede the flow of funds into the real sector of the economy. Despite the "emission" of additional liquidity, GDP growth may not follow (Mikhaylov, Moiseev, Aleshin, & Burkhardt, 2020; Nie, Panfilova, Samusenkov, & Mikhaylov, 2020).

Thus, we can conclude that it is important to consider not only what measures of economic incentives are used in a particular country, but also how effective they are. The mechanism of introducing negative interest rates is a direct continuation policy aimed at monetary expansion by lowering one or more betting executive agency regulating the money. Considering the experience of the Bank of Russia, we can say that a gradual reduction in the key rate (up to September 13, 2013 - the refinancing rate) really has a stimulating effect borrowing the money to small and medium-sized businesses as well as lending more "cheap" and affordable. During the most severe decline from 2010 to 2013 the volume of loans increased by 85.94%, while in the period of growth the key rate from 2013 to 2016 the volume of loans has reduced vivo Recording at -32.04% (Denisova, Mikhaylov, & Lopatin, 2019; Gura, Mikhaylov, Glushkov, Zaikov, & Shaikh, 2020; Alwaelya, Yousif, & Mikhaylov, 2020; Mikhaylov & Sokolinskaya, 2019; Mikhaylov & Tarakanov, 2020; An, Mikhaylov, & Jung, 2020; An, Mikhaylov, & Kim, 2020; An, Mikhaylov, & Moiseev, 2019; An, Mikhaylov, & Sokolinskaya, 2019a).

However, the application of such a policy does not always lead to the same positive results. Many European countries with advanced economies (such as Sweden, Switzerland, Denmark, the Eurozone) and Japan faced a problem when the decrease in the interest rate band did not have a sufficient effect on the economy, doing little to reduce deflationary processes. In the fight against the signs of recession, these countries have become forced to lower their own rates into negative territory, but at the same time faced with such problems as «carry trade», negative government bond yields, increase the risk s for institutional investors, the cash outflow from the deposits into the stock market and cash currency. At the same time, if you compare the relative values, such as the percentage increase in GDP at constant prices (Euro Area of GDP by Constant Prices) and the percentage increase in the index EURO STOXX 50 in the period from 2014 through 2019, you can see that despite the high volatility in Growth Trends of EURO STOXX 50 Index has doubled its GDP growth, especially in 2019 (An & Mikhaylov, 2020; Mikhaylov, 2020a; Mikhaylov, Yumashev, & Kolpak, 2021; An, Mikhaylov, & Jung, 2021; Danish, Bhattacharya, Stepanova, Mikhaylov, Grilli, Khosravy, Tomonobu, 2020).

Thus, it can be assumed that a significant share of funds is still redirected by energy assets not to lending to the real sector, but to the stock market. As a solution to this problem, we can turn to history, when the economy also needed a strong recovery, mainly due to production, since enterprises provided people with jobs, provided wages, increased the welfare of the population and, thereby, directly generated new demand. Such stimulus was needed by the US economy during the Great Depression. Many analysts believe that one of the most effective economic decisions of the time was the adoption of the Glass - Steagall Act. Adopted on June 16, 1933, this regulation imposed a ban on commercial energy assets simultaneously carrying out traditional types of banking and securities operations (not counting securitization), dividing energy assets into two independent categories. At the same time, this legislative act contained a clause on the creation of the Federal Deposit Insurance Corporation and mandatory deposit insurance so familiar to the modern economy. As another example of stimulating the real sector, one can consider economic relations during the period of the New Economic Policy (NEP), carried out in Soviet Russia and the USSR in the 1920s. At that time, more than half of the lending operations of the State Bank of the USSR were associated with the accounting and circulation of bills. Energy assets, through accounting and pledge operations, regulated the size of commercial loans, borrowing terms, and also set the discount rate (Mikhaylov, 2019; Mikhaylov, Sokolinskaya, & Nyangarika, 2018; Nyangarika, Mikhaylov, & Tang, 2018; Mikhaylov, 2020b; Mikhaylov, 2020c; Mikhaylov, 2021a; Mikhaylov, Danish, Senjyu, 2021; Mikhaylov, 2018a; Mikhaylov, 2018b; Zhao, Cherkasov, Avdeenko, Kondratenko, & Mikhaylov, 2021; Dong, Ikonnikova, Rogulin, Sakulyeva, & Mikhaylov, 2021; Liu, Panfilova, Mikhaylov, & Kurilova, 2022).

With the help of bills accounting, organizations could increase their sales, quickly receiving their own revenue minus the discount, which could then be used in the form of net profit to reorganize the enterprise, incentivize workers with bonuses, and improve the quality of the production process (Dayong, Mikhaylov, Bratanovsky, Shaikh, & Stepanova, 2020; Dooyum, Mikhaylov, & Varyash, 2020; Moiseev, Mikhaylov, Varyash, & Saqib, 2020; Varyash, Mikhaylov, Moiseev, & Aleshin, 2020; Yumashev & Mikhaylov, 2020; Yumashev, Ślusarczyk, Kondrashev, & Mikhaylov, 2020; Nyangarika, Mikhaylov, & Richter, 2019a; Nyangarika, Mikhaylov, & Richter, 2019b).

Currently, advanced economies are increasingly showing signs of recession and stagnation. This trend became widespread after the spread of the covid-19. However, before this event the individual prerequisites recession occurred in countries such as switzerland, denmark, the euro area countries, in japan and sweden. In most of them, to combat the slowdown in economic growth, they have introduced such a monetary policy instrument as negative interest rates (mikhaylov, 2021b; mikhaylov, 2021c).

METHODS

However, it should be noted that in addition to the corridor of basic rates, the values of which are set by the Central Bank of the country or another body responsible for monetary regulation, such an important factor as inflation also has an impact on the economy. If the world economy is accustomed to its high values, now there is a different trend - the most economically developed countries are trying to "accelerate" inflation to the target of 2-3% annually, and some are fighting deflation altogether . It should also not be forgotten that in countries where a fairly large key rate is currently in force (Turkey, Mexico, Russia), the real profitability of financial instruments is also subject to inflation adjustment .

As you can see from the table, negative real profitability is no longer an exception and is quite common. In such a situation, it is the developing countries that become the most attractive for investment, of which Russia looks like a fairly justified priority.

For the first time, a negative interest rate (-0.2%) on deposits for commercial energy assets was introduced in Denmark in July 2012. This measure was primarily aimed at stimulating the country's GDP growth after the 2008 crisis. Following the example of Denmark, the eurozone countries adopted a negative rate (-0.7%) on deposits in June 2014 . This decision was made with the aim of returning inflation to the target values of 2-3% annual growth, since in the period from 2012 to 2014 this indicator gradually decreased. Also, being one of the most common world currencies, which are part of the so-called "reserve currencies", the Euro rate gradually increased, which became an unprofitable factor in international trade. Switzerland was the next country to drop the rate below zero. In December 2014, the Swiss National Bank announced that the interest rate (analogue of the key) rate was reduced to 0.25% . After this, in January 2015 the deposit rate was negative (-0.11%), as well as interbank market rate lending (Swiss of Franc of LIBOR the Three Month Rate) reached la mark of 1%, then stabilizing around 0.8%. The main reason for taking these measures was the fight against deflation, which in the summer of 2012 reached about -1.1% .Such dynamics is associated with the guaranteed minimum fraudulent exchange rate of the franc against the euro at the level of 1, 20 CHF = 1 EUR, in effect until January 15, 2015 . Also, Switzerland has always been considered one of the most expensive countries in the world, which does not contribute to the growth of export volumes. As an alternative to the purchasing power index, the Big Mac Index is sometimes used, which reflects the cost of a burger in different countries in terms of currency. This index can be regarded a thief to be considered as the stomps be burger includes the cost of the ingredients, depending on the value of leases s production facilities, packaging, labor costs, marketing costs and other factors. The fourth country that lowered the rate to negative values was Sweden. In July 2014, the deposit rate dropped to -0.5% . In February 2015, the Swedish Central Bank decided to continue its policy of quantitative easing and set the repo rate at -0.1%. After that, in March 2015, the rate for interbank lending dropped to -0.1%. The reason for taking these measures was deflation over the past two years before the introduction of negative interest rates. In addition to reducing the level of deflation, the negative rate should contribute to the depreciation of the Swedish krona, which for the period from January 2013 to January 2015 increased by 38.03% against the US dollar. The last country that has introduced in its toolkit policy of negative interest rates become Japan declined in January 2016 the discount rate (Policy Rate) to the level of - 0.1% . Behind her in the negative zone entered rate on deposits, amounting to about 0.6% by February 2016 and on the interbank lending rate (- 0.4% in May 2016).

Strange as it may seem, Japan has been fighting deflation the longest. Since 1995, the inflation rate has been constantly moving in the range of values from + 2% to -2%, with the exception of rare “emissions” beyond its borders.

RESULTS

The problem for the Japanese economy is a pronounced deflationary spiral. After the crisis of 1986 to 1991, caused by the “bubble” in the market of assets (primarily real estate), both companies and ordinary people have started to create a sufficiently large amount of savings is not involved in the economy. In turn, the measures taken by the state and the Central Bank of Japan, aimed at stimulating demand and increasing lending, did not reduce the amount of funds held in deposits or current accounts. Thus, due to the periodic strengthening of the national currency, it became increasingly difficult for enterprises to maintain their own competitiveness in the world market. They were forced to reduce the cost of the goods / services produced by reducing wages or cutting jobs. Due to the strength of traditions in the land of the rising sun, older people cannot be reduced, as a result of which a paradox arises - young people are forced to work in low-paid jobs, which is why they try to save more and save in order to provide for their elderly parents, not confident that they will ever be able to earn more. Consumer demand is not growing and the country’s economy is not developing. This is also associated with the low rate of GDP growth from year to year.

Only one of the listed countries refused to further support the policy of negative interest rates. On December 19, 2019, the Swedish Central Bank raised its benchmark repo rate by a quarter point to 0%, although inflation was below the 2-3% target, industrial activity is at its lowest level since 2012 and business confidence falls.

At the moment, economic theory, which deals with the use of negative interest rates, does not exist. As the English economist J. Hicks noted, it was believed that if you cannot take into account the costs of keeping money, it will always be more profitable to keep money than to lend it if the interest rate is not more than zero. However, an assessment of the impact on the commodity and money markets of the budgetary policy of the state and the monetary policy of the Central Bank can be found in neo-Kantian models. The IS-LM model reflects the situation of simultaneous equilibrium in the commodity (Investments - Savings) and money (Liquidity - Money) markets .

This model was created by John Hicks and Alvin Hansen in 1937. Despite the fact that the model is considered obsolete due later created modifications consumption function (used in the calculation of the curve), it is still used to describe situations, known as “trap liquidity ”and“ investment trap ”. In a liquidity trap situation, the model’s equilibrium is established at the minimum interest rate (r min), due to which further monetary expansion does not affect the level of investment, employment in the economy and does not entail a change in GDP . It is believed that in this case, fiscal policy becomes more effective, directly affecting aggregate demand through tax cuts and an increase in government spending. To get out of the investment trap, fiscal expansion is also taken, which entails both an increase in aggregate demand and the likelihood of an increase in inflation. It is believed that fiscal expansion is most productive in an open economy, since under these conditions, after assistance from the Central Bank, the rate gradually drops to the previous level (through foreign exchange interventions), which makes it possible to increase both demand and output, without crowding out private spending by public investment. By dropping rates to negative values, central energy assets have radically changed the fundamentals of the banking system. If earlier, when attracting money and funds, energy assets paid their depositors a certain percentage, now they are forced to pay on their own account balances with the Central Bank. The “benchmark” of the debt securities market - government bonds, the yield of which in many countries also went into negative territory, was not ignored either. In a sample of 66 countries, which includes developed and emerging economies, 17 countries have already issued state. bonds with negative yield (the data are relevant for May 2020), and in 7 of them it is observed at all circulation periods - from 1 month to 10 years .

The lower the yield produced by the bond, the more likely foreign investors are entering the market, in order to obtain “cheap” financing, which creates a great competitive national company. The opposite situation occurs when bond yields are just starting to descend more and more into the negative zone. Such bonds attract the attention of speculative investors. Anticipating that their yield will continue reducing and t s camping, and the price - rise, speculators purchase them for resale. At the moment, the most popular for such trade are the Japanese government bonds.

Among other things, another fundamental change is happening - the inversion of the yield curve. In many countries, a tendency is beginning to be seen where the yield on bonds circulating for a year or less is higher than the yield on bonds with maturities of 2 and 3 years. Such dynamics indicates, first of all, that investors are not confident in the stability of the current economic situation and assess the risk as quite high, along with investing money in bonds with a circulation period of about 4 years. The very fact of a decrease in the profitability of state bonds to negative values undermines the functioning of institutional investors, such as pension funds and insurance companies, which, in accordance with the specifics of their activities, should receive a guaranteed return on their own investments. Especially in countries where the majority of citizens rely on private pensions (UK, USA). In addition to institutional investors, negative interest rates directly affect banking. While big energy assets may establish additional commissions only for large customers and at their own expense to cover its own costs, the medium and small energy assets are forced to either install the negative interest rates on deposits and deposits for all its clients, the risk of losing part of them, or to increase their own costs.

Moreover, changing interest rates also entails transaction costs. Financial models are programmed to positive rates, are beginning to inaccurately estimate the risk of complex m kind of am derivatives. Another example is the situation in which the largest bank Skandinaviska Enskilda Banken found itself. In Sweden, the tax authorities oblige energy assets to generate reports on the interest received and paid by customers. The first time after the decision to introduce a negative rate on repo transactions, the authorities allowed energy assets to temporarily consider it as a commission, which, albeit for a short time, entailed a substitution of concepts.

The next to suffer from the policy of negative rates are the depositors themselves. When the instrument of saving and accumulation ceases to fulfill its main functions, they are faced with a choice of where to keep their money further. More financially literate investors will prefer to transfer their funds into investment products, since they are quite liquid, while more conservative investors will start buying real estate. So, after the reduction of the deposit rate to negative levels, in Denmark the value of real estate in Copenhagen increased 5.5% in annual terms at the end of 2014 and by 14.5% in the last quarter of 2015. In the Swedish capital Stockholm over the same period the increase was 10% and 17%, respectively. Such a boom in the mortgage market makes the authorities of the countries worry about whether households will be able to pay off mortgages if rates suddenly rise by 2-3% or property prices fall. However, under a policy of negative interest rates, 50% of the portfolio structure becomes meaningless for the preservation and growth of capital, since bond yields, following rates, go into a negative zone, and the national currency rate falls.

SOLUTIONS AND RECOMMENDATIONS

The effectiveness of stimulating the real sector of the economy, with the introduction of negative rates, is also undermined by the carry trade strategy. This strategy implies that the investor obtains a loan at a low interest rate and transfers this money to an asset with a higher interest rate. An example is the situation when an investor draws up a consumer loan in Denmark, converts funds into rubles and opens a deposit in Russia. Despite the riskiness, this strategy is quite popular, because of which, instead of an inflow of foreign investment from a country with a current negative interest rate, there may be an opposite outflow of funds from the economy. The volume of cash in circulation also has a relative influence on the effectiveness of negative rates. Since when deposits are depreciated in combination with deflation, many will prefer to keep money in the form of cash, especially if the national currency has high denominations (1000 francs in Switzerland). In accordance with the report « World Cash the Report 2018 ” Company of G4S, Article wounds with the lowest percentage of operations with the use of cash are: South Korea, Sweden, US, Australia (Meynkhard, 2019a; Meynkhard, 2019b; Meynkhard, 2020a; Meynkhard, 2020b).

In conclusion, we can conclude that the effectiveness of the policy of introducing negative rates depends on many factors, and also affects the yield on government bonds. When working with such a controversial instrument of monetary policy should take into account the same e factors as: the share of cash in circulation, the degree of protection of national issuers of bonds with foreign competition, it is necessary to control the outflow of capital from the country, as well as improve the monitoring of the markets in which contributors can go. Particular attention should be paid to the problem of the profitability of institutional investors by revising the list of instruments in which they can invest the funds of their participants.

In September 2019 a number of major energy assets turned to the Bank of Russia with a request to examine the possibility of commercial energy assets the right and set the negative interest rates on foreign currency deposits. In accordance with Article 834 of the Civil Code of the Russian Federation, which defines a bank deposit agreement, the bank "undertakes to return the amount of the deposit and pay interest on it on the terms and in the manner prescribed by the agreement." Thus, at the moment, Russian energy assets do not have legal rights to use negative interest rates on deposits. Reasons s for the creation of this treatment by the commercial energy assets began several factors: in - first, the increase in the share of export payments in Euro with the countries of the EU (40%), as well as with the BRICS countries (> 30%) ; secondly, an increase in the number of foreign currency deposits; third, the strengthening of measures taken to devalue by the Bank of Russia.

The second reason for the growth of inflationary processes was the fall in oil prices. In the period from October 4, 2018 (82.62 USD) to December 24, 2018 (48.27 USD), the cost of the Urals brand (it is its cost that is included in the budget of the Russian Federation) decreased by 71,16% .

Thus, after the inflow of funds into foreign currency deposits, energy assets faced another problem - the strengthening of the devaluation policy. Its main goal is to reduce the volume of foreign exchange in the banking sector, to stabilize money circulation and reduce dependence on sanctions measures, through tightening the amount of mandatory reserve requirements. Initially, after the division of energy assets into energy assets with a basic and universal license, for the first category on December 1, 2017, the reserve ratio for obligations to individuals was reduced by 4%. Persons and other obligations in the currency of the Russian Federation up to 1%. This measure was aimed at increasing offers by medium and small energy assets on deposits and deposits in the national currency due to the reduced cost of reserves. At the same time, the percentage of reserves on liabilities in foreign currency has gradually increased and is currently 8%, regardless of their type. In addition to the deduction to the Bank of Russia, when attracting a deposit, the bank must make a contribution to the deposit insurance fund. The rates that are in effect from 01.01.2018 to 01.07.2020, subject to deduction, have become the maximum for the entire time since the creation of deposit insurance in Russia. The 2018 base rate of 0.15% was applied at the same level only when the fund was created to fill it. Having reduced the attraction of funds in foreign currency to deposits, commercial energy assets began to offer a more diversified range of services for clients who wish to make their money investments in a currency other than the national one. Thus, Alfa-Capital Management Company launched a program for the placement of corporate and sovereign Eurobonds through trust management. FC Otkritie began to provide premium clients with the service of forming individual investment portfolios. Bank "Saint-Petersburg" has offered an analogue of the transaction to repurchase the basis of which will lie not valuable securities and the currency. Eurobonds denominated in euros (for example, the sovereign issue of the Ministry of Finance of the Russian Federation) began to enjoy particular popularity. Summing up, we can conclude that the prospect of the introduction of negative rates on deposits in Russia is unlikely. Implementing this idea will require significant regulatory changes. Also, the introduction of such a rate will entail a revision not only of the structure of deposits, but also of loans provided by commercial energy assets, and may entail the risk of arbitrage transactions.

Despite the fact that the use of the mechanism of negative interest rates was initially temporary in nature, in Denmark, the Eurozone, Sweden and Japan they are still in effect. More than that, more and more countries over the past few years lowered their rates closer to near-zero levels. However, now the experience of countries in which x this extraordinary measure is valid from 8 to 4 years can be judged on its effectiveness. One way or another, when introducing a mechanism of negative interest rates as an instrument of monetary policy, central energy assets sought to achieve two main goals - to ensure a stable inflation rate of 2%, and also to stimulate an increase in the rate of GDP growth.

It should be noted that Sweden and the Eurozone countries also showed the best dynamics here, while Denmark and Japan showed both positive and negative dynamics. However, the average growth rate of 0.5% per quarter is also not a progressive growth. Analysis has shown that negative interest rates have a greater impact in countries with a low share of cash in circulation. This factor is primarily due to the fact that energy assets, in the struggle for competition, decide for what percentage / cluster of clients to set a negative rate not only on borrowed funds, but also on borrowed funds. Thus, at the initial stage, there is a flow of liquidity to energy assets, which are the last to decide to lower their own rates.

In addition, the long - term instability in the financial sector, associated with a change in cash flows due to the introduced negative rate and, becomes a certain “trigger”, prompting the population to increase savings.

The same problem applies to liquidity, which central energy assets overeat commercial ones. Such as the Euro - a global currency that can be freely convertible into any national money, so part of the issue carried out by the ECB on the ” secondary market “, leaves the zone of monetary union in the form of investments in emerging economies because of the country in which higher rates, especially if in these countries there are certain preferential regimes for foreign investments, the legislation has created favorable conditions. Transnational energy assets are very popular.

The next tool performs quantitative easing in the form of repurchase by the central energy assets of its own, the state x and sometimes commercial bonds with the aim of increasing the money supply in circulation. The adoption of this decision leads to an increase in the government’s balance sheet of debt, often with a low credit rating, leads to an increasing use of bonds for speculative purposes (instead of investment) due to rising prices and lower yields ; with Produces competition on the domestic market between national and foreign enterprises to attract “cheap” funds; increases the share of bonds with floating coupon yield, which only increases the elasticity of the previously conservative instrument to a volatile economic situation. In the case of the Eurozone, this measure only exacerbates the debt crisis, reducing costs to countries with large public debt. Through the purchase of state. bonds of these countries, the ECB assumes the risk of the solvency of these countries, reducing the likelihood of default, acting as an analogy of “donor” for more problematic economies that are members of the union. However, this measure reflected in the reduction of the interest on the national governments to make decisions on the regulation and control of the debt burden.

CONCLUSION

To stimulate demand in the domestic and foreign markets, the central bank must form stable inflationary expectations, through them influencing the expectations of economic agents. These expectations are formed on the trust the central bank and its ability to adhere to the announced and the target values of the indicators. Unfortunately, many central energy assets have failed to achieve 2% inflation when trying to target inflation. Another factor that should have been influenced by the negative rate is the exchange rate of the national currency. Its devaluation should, in a chain reaction, lead to an increase in the cost of imported goods, which contributes to higher inflationary expectations. But here too, difficulties arose due to the fact that the euro, franc and yen - act as “reserve” currencies, which leads to the fact that during periods of increased economic instability, the demand for them increases. Also, the increase in the rate of the national currency is facilitated by the inflow of foreign issuers into the bond market.

The depreciation of the exchange rate leads to the strengthening of the country's export-oriented industries, increasing their competitiveness in the world market. However, the dynamics shown in Figure 2 7 may contain only a comparative nature, since it was mainly due to the change in the dollar exchange rate, and not the currency that is paired with it. Another important indicator is the volume of private sector lending. Its dynamics directly shows how increased the amount of loans, granted directly to enterprises. Despite the positive dynamics of recent years, a stable trend is observed only in Switzerland and Japan (which is most likely due to the fact that these countries changed interest rates less often than others, which gave rise to a feeling of confidence among borrowers and depositors), while the data from Denmark and the Eurozone, in which the very first moved in the negative zone rate is the deposit does not allow us to make an identical conclusion. Thus, summing up, we can conclude that the effectiveness of the application of the mechanism of negative interest rates has not yet been proven. Although in the short term, the injection of large amounts of liquidity does stimulate inflation - it is not followed by stronger economic growth.

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Chapter 8
Role of Blockchain Technology in Ensuring the Competitiveness of Tourism and Energy Investment

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ABSTRACT

This study was conducted to research the use of blockchain technology to ensure the competitiveness of tourism and energy investment using a statistical approach. The chapter offers a comprehensive approach to examining the aforementioned topics and confirms the conclusion of the revitalization of the financial market (tourism and energy) development. Moreover, it also plays a role regarding the factors of inflation, devaluation, and proposes benefits – the activation of entrepreneurial activity, expansion of the service sector. Based on the results of the study, financial market (tourism and energy) clients (especially buyers) can benefit most from the lower costs of capital market transactions and securities servicing. Retail and wholesale investors can participate in a larger volume of deals among themselves with guaranteed execution in the open market.

INTRODUCTION

A new area of research in the field of information technology concerns the use of distributed ledgers based on data, the structure of which consists of combined into blocks (blockchain). These ledgers can be used as reliable repositories of records in environments where there is a high-risk of tempering, since this technology allows you to ensure that there is no forgery or malicious changes in records.

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Transaction logs (registers, registers) have been the backbone of trade since ancient times and have been used to record numerous types of information, most often about assets - cash receipts, costs, property purchases and sales. Initially, the recordings were made on clay tablets, then on papyrus, parchment, and finally – paper. However, during all this time, the only noticeable innovation was computerization, which initially consisted of translating information stored on paper into bytes. Algorithms are now enabling the co-creation of digital distributed ledgers with properties and capabilities that go far beyond traditional paper ledgers, and that mitigate some of the risks associated with human error.

In a risky environment, trust allows to cooperate and voluntarily engage in mutually beneficial transactions that are otherwise costly, especially to third parties. By taking the risk of trust, collaboration across society increases and strengthens, and, simultaneously, costs are cut.

Fintech (financial technology) is a term that refers to the proliferation of new applications that provide financial services directly to devices. Technology transforms into trust. It is manifested in many forms, including reputational ranking systems, from points on Amazon, to vendor ratings on eBay, to collaborative filtering on many sites, to social networks with referral systems. Society changes radically when people can afford to trust each other even in their first meeting. People use trusted third parties in finance, as guarantors, payment providers, etc. There are three main functions that these trusted third parties perform:

1. Confirmation: Determining whether there is anything to be sold in the trading community and its membership.
2. Operations: Avoiding duplicate transactions.
3. Record: Keeping records of transactions in the event of a dispute.

The creation of a centralized ledger is traditionally beneficial when communication occurs between multiple parties who need to keep track of complex sets of transactions. A centralized transaction ledger needs a trusted third party that makes records (verifies), prevents double-counting or double spending (safeguards), and stores transaction histories (saves). For centuries, centralized ledgers can be found in government treasuries (land, shipping, taxes), stock exchanges (stocks, bonds), or libraries (indices and borrowing records). However, centralized ledgers historically suffered from two obvious disadvantages: insecurity and complexity.

A register is a book, file, or other record of financial transactions. People have used various technologies for keeping books of accounts for centuries. The Sumerians used clay cuneiform tablets to record transactions. Medieval people used split sticks. In the modern era, ledger technology is a database found in all modern accounting systems.

LITERATURE REVIEW

If confidence in the integrity of the technology continues to grow, distributed ledgers could replace the trusted third-party roles, preventing duplicate transactions and providing all their verifiable public records. Trust moves from third parties to technology (Dinçer, & Yüksel, 2018a; Dinçer, & Yüksel, 2018b; Dinçer, & Yüksel, 2018c; Dong, Ikonnikova, Rogulin, Sakulyeva, & Mikhaylov, 2021; Liu, Panfilova, Mikhaylov, & Kurilova, 2022).

In 2008, a historical document written by an as of yet unidentified person under the pseudonym of Satoshi Nakamoto "Bitcoin: A Peer-to-Peer Electronic Cash System" proposed a new approach to transferring money in the form of Bitcoin from user to user (P2P, peer-to-peer) (An, Mikhaylov, Richter, 2020).

Bitcoin and other cryptocurrencies attracted significant attention in 2013 due to the sharp increase in the price of Bitcoin, the local maximum of which was $ 1,124.76 on November 29, 2013. However, the Bitcoin market capitalization had declined from $ 13.9 billion on December 4, 2013 to about $ 3.3 billion in May 2015 (Mikhaylov, Moiseev, Aleshin, & Burkhardt, 2020; Nie, Panfilova, Samusenkov, & Mikhaylov, 2020).

That being said, Bitcoin has grown in price and, consequentially, capitalization significantly since then. In December of 2018 the price reached $ 19,666.0. That is larger than the previous maximum by almost 20 times. Less than three years, the maximum doubled, with the price reaching $ 42,000 on January 8th, 2021. And there are prospects of future growth and recording a new all-time high in the same year. This is accompanied by the cryptocurrency's capitalization reaching well over $ 900 billion and rising, making it one of the ten largest assets in the world.

This success of Bitcoin is translated to the whole cryptocurrency market with the emergence of altcoins. Crypto assets such as Ethereum, Litecoin, Monero, Chainlink and others have all proven to be profitable, although their capitalization and volume of trades is minuscule when compared to that of Bitcoin. That being said, research has shown that altcoins are more volatile than Bitcoin, and in bull-markets may have a higher yield than the main cryptocurrency. Moreover, these cryptocurrencies present projects, with developers interested in making the use of this unique technology more widespread and accessible to the general public (Taskinsoy, 2020).

For example, the second largest cryptocurrency Ethereum utilizes blockchain technology and makes use of smart contracts. They are, as discussed in the article, another tool for eliminating trusted third parties. Smart contracts allow to embed certain functions into the code, as well as store data. Thus, a developer can program autonomous execution of specific actions if the prerequisite conditions are met. The result is a bound network of transactions (Wohrer & Zdun, 2018).

Amongst factors like additional functionality using innovative technology, such as smart contracts, cryptocurrency, many articles examine the possibility of using Bitcoin specifically as a form of money. In order to evaluate this, the main functions of fiat money are often considered. Hazlett & Luther (2020) conclude that the demand for the cryptocurrency can be compared to fiat money and within certain limits and boundaries, Bitcoin can be observed to be a form of money.

High prices and volatility have attracted speculation and the proliferation of competitive and complementary cryptocurrencies. According to various estimates, including CoinMarketCap, there are now over 8,000 cryptocurrencies, but Bitcoin remains dominant. Their market capitalization, including Bitcoin itself, is about $ 1.2 trillion (Denisova, Mikhaylov, & Lopatin, 2019; Gura, Mikhaylov, Glushkov, Zaikov, & Shaikh, 2020; Alwaelya, Yousif, & Mikhaylov, 2020; Mikhaylov & Sokolinskaya, 2019; Mikhaylov & Tarakanov, 2020; An, Mikhaylov, & Jung, 2020; An, Mikhaylov, & Kim, 2020; An, Mikhaylov, & Moiseev, 2019; An, Mikhaylov, & Sokolinskaya, 2019a).

The underlying Bitcoin technology, described in Nakamoto's article, is called blockchain, and refers to a particular way of organizing and storing transaction information. Subsequently, other ways of organizing information and transactions for the transfer of assets in a P2P manner have been developed, which has led to the term "distributed ledger technology" falling into a broader category of technologies (An & Mikhaylov, 2020; Mikhaylov, 2020a; Mikhaylov, Yumashev, & Kolpak, 2021; An, Mikhaylov, & Jung, 2021; Danish, Bhattacharya, Stepanova, Mikhaylov, Grilli, Khosravy, & Sengyu, 2020).

While Bitcoin is legally, socially and economically problematic as of now, technical problems have also risen regarding Crypto wallets. But blockchain technology has proven to be ambitious and promising and, more importantly, reliable. In fact, as an experiment to prove the reliability of blockchain technology, Bitcoin has demonstrated that its technology protects against a wide variety of attacks. The growing popularity of distributed ledgers and, in particular, blockchain has led to the fact that numerous firms, especially in the financial services industry, have announced their interest in using them: Nasdaq, BNY Mellon, UBS, USAA, IBM, Samsung and many others. In turn, a number of firms have realized that the very essence of distributed ledgers provides an opportunity to adapt technology for use in almost all sectors of the economy (Mikhaylov, 2019; Mikhaylov, Sokolinskaya, & Nyangarika, 2018; Nyangarika, Mikhaylov, & Tang, 2018; Mikhaylov, 2020b; Mikhaylov, 2020c; Mikhaylov, 2021a; Mikhaylov, Danish, Senjyu, 2021; Mikhaylov, 2018a; Mikhaylov, 2018b; Zhao, Cherkasov, Avdeenko, Kondratenko, & Mikhaylov, 2021).

Bitcoin blockchain is important because it has shown that distributed ledgers can operate in troubling environments with little or completely absent trust. In addition, although distributed ledger technology is more complex than a centralized ledger, the complexity of the blockchain is understandable and provides commensurate benefits for multilateral transactions (Mikhaylov, 2021b; Mikhaylov, 2021c). In studies, the following technologies are distinguished, similar to tpp, and developed:

– 1993 - Encrypted open books
– 1995 - WebDNA
– 1996 - Ricardo Payment System
– 1999 - Stanford University CLOCKSS (Controlled Multiple Copies Ensures Security)
– 2004 - Ripple, Consensus Approach to Currency Transactions.

Blockchain is a transactional database based on a mutually distributed cryptographic ledger shared by all nodes participating in the system. It is publicly available, decentralized, and also used by all nodes in a network. It is consistent and reliable as double spending is prevented by block validation. Blockchain does not require coordination of interactions, verification of transactions and control of behavior by a central authority or a trusted third party. A complete copy of the blockchain contains every transaction ever performed, making information about the value of each active address (account) available at any time. The main innovation of the blockchain is accounting for the integrity of public transactions without centralized administration. The decentralized nature of blockchain means the system and underlying network does not rely on a single server, and each node possess the entire copy of interaction configurations, contributing to the its independence (Dayong, Mikhaylov, Bratanovsky, Shaikh, & Stepanova, 2020; Dooyum, Mikhaylov, & Varyash, 2020; Moiseev, Mikhaylov, Varyash, & Saqib, 2020; Varyash, Mikhaylov, Moiseev, & Aleshin, 2020; Yumashev & Mikhaylov, 2020; Yumashev, Ślusarczyk, Kondrashev, & Mikhaylov, 2020; Nyangarika, Mikhaylov, & Richter, 2019a; Nyangarika, Mikhaylov, & Richter, 2019b).

New records (transactions, deals) in the database are initiated by one of the participants (nodes), which creates a new block of data, for example, containing several transaction records. The information about this new block of data is then transmitted across the entire network containing the encrypted data, so the details of the transactions are not made publicly available, and all network participants jointly determine the validity of the block according to a predetermined algorithmic verification method (the consensus mechanism).

Cryptocurrency and their underlying technology has received so much attention, that many governments have considered issuing Central Bank Digital Currency (CBDC). A few countries have begun a pilot project of this idea, mainly Sweden and Canada. Research on CBDC shows theoretical benefits, which motivate states to examine these pros in a practice, empirical manner. Moreover, developed countries show prospects of high demand for CBDC due to the growing use of electronic money, with cash losing its significance. Other than that, CBDC gives the possibility for monitoring cash flow and new methods of executing monetary policy. For example, the problems of the effective lower bound may be negated in the case if a country primarily uses CBDC (Bordo & Levin, 2017; Engert & Fund, 2017).

However, a number of downsides have been identified in blockchain technology, including it not being a medium of exchange or serving a significant purpose regarding the key functions of money, but being a speculative instrument for investing. The problem of required electricity due to the large number of miners, which also increases during bull-runs on the market, has also been an object for concern in recent years. Concerning this issue, the use of DLTs in the energy sector should be expanded upon (Omote & Yano, 2020)

Regarding the energy sector and tourism, blockchain is a method of achieving higher levels of transparency and safety, as well as energy democratization. Of course, research continues to be ongoing, but the prospects have led researchers to believe in the benefits of these innovations. It goes without saying that blockchain can also be accompanied by challenges involving regulation barriers, competition and market penetration barriers. The mixed opinions and aspects have also been observed in the costs of blockchain integration. The low costs of transferring data utilizing blockchain, while a positive, is possible due to the maintenance of servers and networks, which significantly increase the costs. Data and information storage may be expensive, and it is not confirmed if these costs would reduce in the case of larger mass integration by market participants (Brilliantova & Thurner, 2019).

Moreover, focusing specifically on the energy sector, it should be noted that research on blockchain in the industry is intense emphasis of developing renewable energy. It can be concluded that the innovative technology plays a role in sustainability growth (Wang & Su, 2020). Taking into consideration the energy required for maintenance of blockchain technology, these developments present positive prospects. The peer-to-peer network can also be implemented into the sector, with emerging renewable energy trading systems. Blockchain offer a safe and secure solution for these issues, simultaneously eliminating the need for third-party participants (Rahmadika, Ramdania., & Harika, M., 2018).

The benefits for the tourism sector are also evident and share a parallel in the energy sector. DLT is a method of automation in the industry and decreasing the load of each consecutive operation. Moreover, as with energy, safety and security can increase with the integration of blockchain, addressing issues regarding fraud in the sector, data on clients and other sensible information. Moreover, smart contracts can increase the efficiency of debt payment, as well as tax filing. Overall, blockchain is a solution for business growth and improving its consequent performance (Valeri & Baggio, 2020).

The article of Thees, Erschbamer, & Pechlaner (2020) expanded on the cases in which blockchain technology can be utilized. Amongst these, are improvements in the search of the most suitable hotels, transportation services and food tracking, as well as easier booking and a network for occupancy regulation. DLTs in tourism also grow to be larger than the sector itself, developing the prospects of use of cryptocurrencies, Bitcoin, for example, in airlines, hotels, restaurants and even shopping centers. Moreover, this may also spread to the adoption of electronic passports, that may utilize the security of blockchain technologies, and, most importantly, the inability to manipulate and tamper with the information stored in datasets.

The benefits and peculiarities of blockchain technology in these sectors are, evidently, not restricted but only these industries. DLTs may be incorporated in many, if not all industries, with the benefits often being universal, including the much-needed safety and security, tamper-protection, as well time-saving automation and the creation of a central network. The energy and tourism sectors, however, are interesting to study in tandem, as, finally, they are inter-connected, with tourism relying on energy in some aspects, as well as the other way around. And, considering the renewable energy inclination of DLTs in the specific, the benefits may not be only micro- and macroeconomical, but expand to ecological effects (Ben Jebil & Hadhri, 2018; Nepal, Al Irsyad, & Nepal, 2019).

METHODS

The specific method for reaching consensus varies between different types of blockchain. An important feature of any consensus mechanism is that when trying to mine blocks, the user must incur certain costs and obtain the rewards for successfully adding a node to encourage and promote good behavior among other participants. The winning node selects a set of pending transactions and groups them into a block, which is added to the chain. Requiring consensus between a large network of (financially and organizationally) unrelated nodes to add any data to the chain ensures that a malicious agent cannot insert false data. Moreover, considering that the entire chain is required to change an older record, tampering with an entry is virtually impossible.

Anyone with Internet access and the computational power to solve cryptographic puzzles can contribute to the ledger, and they are known as bitcoin miners. The analogy with mining is appropriate because the Bitcoin mining process is energy intensive as it requires a lot of computing power. It has been estimated that the energy needs to run Bitcoin are in excess of 1 GW and could be comparable to electricity consumption in Ireland.

Bitcoin is an online cash equivalent. Funds are authenticated by their appearance and characteristics, and in the case of banknotes, by serial numbers and other security devices. However, in the case of cash, there is no register in which transactions are recorded, which creates the problem of counterfeiting coins and banknotes. In the case of Bitcoin, the ledger of transactions ensures their authenticity. The cryptocurrency needs to be securely stored in real or virtual wallets, and if not properly cared for, crypto assets can be stolen. The fundamental difference between conventional currencies and Bitcoin, for example, is that the former are issued by central banks, while the latter is issued in agreed amounts by a global joint venture that is the blockchain Bitcoin system. Cash as a medium of exchange and commerce dates back millennia, and in this regard, there is a parallel that links cowrie shells, hammered pennies and bitcoins.

The distributed ledger, the backbone of blockchain technology, is a database of assets that can be shared across the network through multiple sources, from multiple geographic regions or institutions. All network members can have their own identical copy of the ledger. Any changes in the registry are reflected in all copies within a few minutes, and sometimes even a few seconds. Assets can be financial, legal, physical, or electronic. The security and accuracy of the assets stored in the registry is maintained cryptographically through the use of keys and signatures to control the identity of the change.

Distributed ledgers are not new - parallel and distributed databases have been an area of research since at least the 1970s. Historically, the main purpose of a distributed database has been the permanent existence of a registry in multiple locations under extreme circumstances, such as during a war. Distributed databases were persistent and widespread. For this reason, defense organizations used distributed databases in the 1970s. The slightly more sophisticated distributed database approach allows people to keep writing new transactions in multiple locations with only periodic data exchanges.

In today's world, innovators across many industries are experimenting with blockchain for a range of use cases, including verifiable education certification, data integrity and access, as well as IoT applications.

RESULTS

Distributed ledger technology has many potential applications beyond cryptocurrencies in the financial sector and a host of other industries. Publicly available applications use blockchain infrastructure but may differ from the underlying cryptocurrency (such as Bitcoin) or have a conventional cryptocurrency value tagged to it as a digital representation of the asset. The two main trends in blockchain app development are:

1) commercial startups in the financial technology sector develop digital applications for various purposes using public blockchain infrastructure, mainly, Bitcoin and Ethereum;
2) Industry consortia are formed to research and develop a private, authorized blockchain for industry-specific enterprise solutions.

Since 2009, cryptocurrencies have evolved from little-known, niche technology curiosities to fast-growing financial instruments that generate a lot of public interest. They have recently been incorporated into a number of other financial transaction systems and products. For example, cryptocurrencies have been sold to investors to raise funding through Initial Coin Offerings (ICOs), and some derivatives are now crypto-based. Some government central banks have explored the possibility of issuing cryptocurrencies or other digital currency. Media coverage of cryptocurrencies is widespread, with various researchers characterizing cryptocurrencies as the future of monetary and payment systems that will crowd out government-backed currencies or excess value.

Cryptocurrencies are increasingly integrated into global financial systems, and interest from tourism and energy investment remains high. According to one American study that polled over 400 American institutional investors to formulate an understanding of the investors' opinions of digital assets, about 22% of participants have already had some relationship with digital assets in the past three years. Furthermore, institutional investment in digital assets is likely to increase over the next five years. However, a consensus has yet to be reached on whether the investments in digital assets should be made directly or passively.

Since the beginning of history, banks have offered services for making reliable value transfers between parties that are not physically close and do not necessarily trust each other. Customers give their money to banks particularly for their safe storage and the ability to send payment to a recipient located elsewhere (initially using paper checks or bills of exchange). Keeping accurate books of account is a vital tool for providing this type of service. This allows people to store money as numerical data stored in a ledger, rather than as a physical item that could be lost or stolen. In its simplest form, the payment system works with the bank, registering how much money an individual has and, on instructions, adds to corresponding receipts and reduces others in accordance with the specified amount of funds.

Regarding the role of the financial sector in the GDP of Russia, the share and consequent contributions of the financial and insurance sector organizations has been observed to be reducing.

The share of manufacturing industries increased by 9.2%, mining enterprises - by 45.1%, the share of financial and insurance organizations decreased by 4.4%, and this negative trend has been evident for over five years.

Thus, the main features of the formation of the Russian financial market include a short history of existence in the history of the Modern era, the rapid pace of development due to the combination of existing privatized enterprises and the adaptation of foreign practices, and at the present stage - an increase in the concentration of competition with an increase in the money supply and a decrease in the number of credit organizations.

The money supply has changed over the past nine years. The obvious increase in money supply in circulation and a decrease in cash turnover, is accompanied by the growing share of deposits, indicating a more active use of financial market (tourism and energy) organizations.

Despite the increase in the money supply, the number of banks since 2008 has decreased by more than half, which confirms the conclusion of the revitalization of the financial market and its development. Other than that, it is also significant regarding the factors of inflation, devaluation. The benefits of this include the activation of entrepreneurial activity, expansion of the service sector.

As of December 2019, 838 credit institutions were registered, of which 444 were operating, including 268 banks with a universal license, 137 with a basic license, 39 non-bank credit institutions. Since the beginning of 2019, 29 licenses of credit institutions have been revoked, and another 12 have been reorganized.

Participants must trust the banks, be sure that accounting is accurate and only change as a result of valid transfers. Otherwise, the money of an individual may be lost or stolen if the bank registers an inaccurate amount in the payer's account or transfers any amount of funds without permission. Numerous mechanisms can build trust in banks. For example, a bank has a market (tourism and energy markets) incentive to be accurate, since the lack of a good track record of protecting customer funds and accurate, timely processing of transactions, banks lose customers. In addition, governments tend to subject banks to laws and regulations designed in part to help keep households safe. Thus, banks are taking significant steps to ensure safety and accuracy.

Money is freely exchanged electronically today, but electronic payment systems can face certain difficulties due to the lack of scarcity (a digital file can be copied many times, keeping accurate information as a predecessor) and a lack of trust between the parties. Electronic money transfers depend on what observers call a double spending problem. In an electronic money transfer, the payer may wish to send the digital file directly to the recipient in the hope that the file will act as a transfer of value. However, if the recipient cannot confirm that the payer has not sent the same file to several other recipients, the transfer becomes problematic, since money in such a system can be spent twice (or any number of times) and will not retain its value.

Tourism and energy investment around the world are constantly faced with external innovations that often fail to be adapted and implemented. The emergence of innovative digital finance technology has challenged traditional players in the sector by showing new ways to create value. Blockchain, or distributed ledger technology, is a disruptive innovation.

SOLUTIONS AND RECOMMENDATIONS

If the technological mechanism of related sectors and industries would be completely revamped with the present access to efficient, well-designed blockchain technologies, the structure and processes in tourism and energy markets would expectedly look differently. Considering that each security will be kept on a single basis of accounting, that is, with several levels of beneficial ownership in one register. There will be no need to manage data normalization, harmonize internal systems, or risk and liability. Processes and services would be standardized, reference databases would be publicly available, there would be standardized processing capabilities, near real-time data availability, and a better understanding of counterparty value. For privileged participants such as regulators, there would be transparent data on reserves and more.

1. Transactions with securities. Customer A and Customer B collate the transaction details at the place of execution and automatically verify that the parties have the means to complete the transaction. Customer A and Customer B jointly sign a transaction agreement using individual keys to unlock the asset or funds, and then transfer ownership to the recipient using the public key. The signed transaction is submitted to the ledger for verification and recording in the next block, along the simultaneous update of the ledger.
2. Asset maintenance. For new issues, assets are issued directly to the asset register. In fact, the securities themselves can be segregated so that the individual cash flows and the rights they encapsulate can be transferred separately.

Mandatory events can be managed through smart contracts embedded in securities. Complex events can be structured as simple post-payment delivery transactions between issuers and investors. Fund managers would be able to see all the pools of investment in securities to manage investor deposits in their funds using units created as tokens in the fund registry. With fixed accounting, multiple storage levels are reduced to a single function. Currently, one security can be stored at different levels: the stockbroker, seller's bank, central depository, etc. Each of them has their own accounting units. In the case of using distributed ledger technology, the asset is stored in the form of a wallet with a record of the ultimate owner (Morkovkin, Gibadullin, Kolosova, Semkina, Fasehzoda, & 2020; Morkovkin, Lopatkin, Sadriddinov, Shushunova, Gibadullin, & Golikova, 2020; Morkovkin, Lopatkin, Shushunova, Sharipov, & Gibadullin, 2020; Morkovkin, Gibadullin, Safarov, & Alpatova, 2020; Gibadullin, Yurieva, Morkovkin, & Isaichykova, 2020; Gibadullin, Morkovkin, Milonova, Progunova, & Isaichykova, 2020; Romanova, Morkovkin, Nezamaikin, Gibadullin, & Ivanova, 2020; Khayrzoda, Morkovkin, Gibadullin, Elina, & Kolchina, 2020; Morkovkin, Gibadullin, Romanova, Erygin, & Ziadullaev, 2019; Kobtseva, Novoselova, Novoselov, Morkovkin, & Sidorchukova, 2017; Morkovkin, Mamychev, Yakovenko, Derevyagina, & Didenko, 2016).

Now the share of inter-company agreement interactions is growing. From the consumer's point of view, increasing their expectations, the relative speed of operations, quality and availability, accessibility to tourism and energy investment services. The demand is growing of large companies' aggregators for the tourism and energy investment supermarket (tourism and energy), where the consumer is able to review and compare key features and specifics to find the most useful and needed financial resources services. Using these platforms, they can take advantage of not only the financial market, but also tourism and energy, allowing for the analysis of consumer reports preferences: usage, formations, competitive offers, and even consider the limited capacity of building price in flexibility services.

Moreover, there is a possibility of share growth of nonpositive lines on the studied markets. In order to achieve this, service-providers require availability of investment projects tools, namely the use of remote identification, quick payments, reloading (use robots for provide consulting services in communication with the consumer), as well as the expansion range of available investment resources.

The utilization of robots is capable of improving the margin of revenue in the long-term, since they can potentially cut costs, the main of which would be the maintenance of servers, on the which data is stored information. Due to abbreviations in the cost of production the potential price flexibility member policies in markets (tourism and energy) may increase and open a new niche - investments for people with low income. This may be an unambiguous client-centric trend – the creation of new account offers, development of pricing policies, systems that satisfy growing queries of consumers for factors such as comfort, availability, simplicity, and often interfaces of interaction with tourism and energy investment organizations.

FUTURE RESEARCH DIRECTIONS

With the use of distributed ledger technology, real-time cash transactions with assets would no longer need to be centrally approved. Since both parties are transparent, counterparties can be confident that the opposite party will fulfill the terms of the transaction, which allows settlements to occur almost instantly. However, transactions with a longer life cycle still need to mitigate future counterparty credit risk.

CONCLUSION

The conducted study analyzed the risks and prospects of cryptocurrencies in the global financial system, as well as specific industries such as tourism and energy. The theoretical aspects of the concept of "cryptocurrency" were examined, along with the stages of development of the term itself and the technologies associated with it. The research featured the analysis of the current market of digital currencies, a comparative analysis of existing cryptocurrencies with fiat money and other assets. Data on competition in markets is presented.

Based on the results of the study, financial market clients (especially buyers) can benefit most from the lower costs of capital market transactions and securities servicing. This is especially relevant to the tourism and energy sectors. Retail and wholesale investors can consider participating in long-term projects with guaranteed execution in open market (tourism and energy).

Dealers still play a valuable role in markets. However, with distributed ledger technology, they could better understand the sources of liquidity for assets or take on the main risk when liquidity is low. Their primary value is in pricing, advising on transactions and managing their execution, rather than providing market access.

The real-time settlement process will have serious implications for private trading companies, in particular for market makers and high-frequency traders. If trading moves to a pre-ownership check before selling an asset, active traders specifically will need to wait for each settlement cycle before they can trade again. This can significantly slowdown their activity, which may mean that the scope of the blockchain is limited only to post-trade processes in market. In these conditions, the share of active traders is negligible. Alternatively, they may consider markets that can operate on hybrid models, providing opportunities for active traders to trade with lines of credit, which are regularly cleaned up during a consistent blockchain cycle.

The cryptographic signature data generated during the transaction also serves as the data required for calculations, which adds value. However, given that trading strategies account for a large proportion of trading volume and therefore fee and commission income, profound changes in market structure can have an indirect impact on exchanges and other service providers.

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Chapter 9
Theoretical Structure of Wave Energy and Its Importance in Terms of Energy Supply Security

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ABSTRACT

The establishment of wave power plants helps the country reduce its dependence on fossil resources. In this regard, the country is least affected by the changes in fossil resource prices. Energy supply security is ensured when the sustainability and availability of electrical energy obtained from wave energy is ensured. This is an important issue for the development of the country's economy. Therefore, attention should be paid to the effect of studies on wave energy on energy supply security. In this study, it is aimed to explain the theoretical structure of wave energy and its importance in terms of energy supply security of the country. In this study, it is intended to generate appropriate strategies for Turkey to improve wave energy system. For this purpose, four different criteria are defined based on balanced scorecard methodology which are finance, customer, organizational effectiveness, and research and development. An evaluation has been conducted by DEMATEL methodology. It is identified that finance is the most significant criterion for Turkey to improve wave energy projects.

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INTRODUCTION

Energy refers to the force expended in carrying out actions. It is the power that is consumed while acting or doing business. Therefore, energy is needed in all areas of life (Dinçer & Yüksel, 2019). Throughout history, people have met their energy needs by using fossil resources. However, fossil resources are scarce in nature and adversely affect the environment and human health (Qi et al., 2020; Du et al., 2020). However, the use of fossil resources is not evenly distributed all over the world. This situation negatively affects countries in need of energy economically (Bekun et al., 2019; Cheng et al., 2020). For this reason, it is necessary to use resources that are constantly in nature, that do not harm the environment and human health and that will ensure the economic development of countries. These resources are renewable energy resources. Renewable energy sources are constantly found in nature and when used, they do not adversely affect the environment and human health. However, countries have a positive effect on the current account balance. Therefore, the use of renewable energies in the world is important (Li et al., 2020; Dinçer & Karakuş, 2020).

Energy in the world can be obtained from different renewable energy sources. Wind, solar, biomass, geothermal, hydrogen and wave energy are considered as renewable energy sources (Zhao et al., 2021; Li et al., 2021; Zhou et al., 2020). These resources constantly renew themselves in nature (Khare et al., 2016). Therefore, some systems are being developed to obtain energy from these sources. Wave energy is one of the energy types that is important in renewable energy sources (Mikhaylov et al., 2021). The wave is formed by the wind formed on the surface of the ocean or seas. Wave energy, on the other hand, involves the conversion of force obtained from oceans or seas into electrical energy. For this reason, it is important to identify areas where wave velocities are high. 75% of the earth is covered with water (Mustapa et al., 2017). Therefore, the potential of wave energy becomes important. Wave energy is not running out. However, maintenance costs are very low. The potential of electrical energy obtained from wave energy is high. On the other hand, wave speeds and lengths must be high in order to generate electricity from wave energy. However, generators used in wave energy are noisy. Therefore, these issues should be taken into account in the use of wave energy (Younesian & Alam, 2017).

One of the important issues in renewable energy is energy supply security. Energy supply security is about the sustainability, availability and financing of the energy obtained. When energy supply security is ensured, countries also ensure their sustainable economic growth (Kınık, 2009; Zhong et al., 2020). The use of renewable energy resources reduces the import dependency of countries (Mikhaylov et al., 2018a,b). Therefore, when the use of renewable energy resources is ensured, the current account balance of the countries is positively affected. However, energy supply security for renewable energies must be ensured. In this way, it contributes to the sustainable economic development of the countries and the energy demand is provided uninterruptedly (Dinçer & Karakuş, 2020).

The electrical energy obtained from wave energy is important in meeting the energy demand. Therefore, necessary attention should be paid to wave energy systems (Qiu et al., 2020). However, energy security for wave energy needs to be provided. Wave energy must be sustainable, accessible and economically financed (Loschel et al., 2010). In this way, energy supply security is ensured. When energy supply security is ensured, the use of energy becomes sustainable and contributes to the environmental and economic development of countries (Saltık, 2016).

LITERATURE REVIEW

Wave energy is one of the renewable energy sources. It is constantly present in nature and is important in meeting the energy demand. This issue has been addressed by many researchers in the literature. As an example, Jahangir et al. (2020) investigated the subject of wave energy in his study. In the said study, Iran was included in the scope of study. As a result, it has been determined that the electrical energy obtained from wave energy is important in meeting the energy demand. However, it has been emphasized that wave energy is one of the safest ways to generate energy compared to other sources. In addition to these studies, Hemer et al. (2017) researched wave energy, which is one of the renewable energy sources. In the relevant study, Australia was included in the review. As a result, it has been stated that the areas where wave power plants are installed are important. Therefore, it has been determined that the share of these power plants in meeting the energy demand is important.

Wave energy meets the energy demand. Therefore, it is necessary to invest in wave energy systems. There are many studies on this subject in the literature. Mustapa et al. (2017) conducted research on wave energy in his study. In the study, it has been determined that wave energy is important in meeting the energy demand. On the other hand, it has been determined that many difficulties arise in wave energy investments. In parallel with these studies, Lavidas (2019) investigated the socio-economic benefits of wave energy in his study. In the relevant study, Greece was included in the study. As a result, it has been observed that wave energy ensures energy independence of countries. However, it was stated that new job opportunities emerged. Considering all these benefits, it was emphasized that investment in wave energy should be made.

Wave energy is a safe energy source. Sustainability of energy is ensured by improving wave energy systems. There are many studies on this subject in the literature. As an example, Akar and Akdoğan (2018) investigated the environmental and economic effects of wave energy in their study. As a result, it has been determined that wave energy is one of the safe energy sources. Samrat et al. (2016) focused on the supply of wave energy in his study. Malaysia Island was included in the study. As a result, it has been emphasized that there are some difficulties in wave energy systems. It has been determined that solving these difficulties will ensure energy sustainability.

There are important issues in the use of wave energy systems. Considering these issues, wave energy safety is provided. Therefore, it is important to focus on these issues. Many researchers stand on this subject in the literature. Quitoras et al. (2018) evaluated the technical and economic dimensions of wave energy in his study. The Philippines was included in the study in this study. As a result, it has been emphasized that the technology used in wave energy is important. However, it has been stated that environmental and economic aspects are important in using wave energy. Wave energy reduces carbon dioxide emissions and meets the electrical energy demand. Therefore, economic and environmental issues in wave energy need to be addressed (Felix et al., 2019).

Wave energy is important for the economic and environmental development of countries. Therefore, it is necessary to invest in wave energy. However, there are some shortcomings in wave energy systems. This issue has been addressed by many researchers in the literature. Dışkaya (2017) researched the issue of renewable energies and energy security in his study. Related work has been to study the scope of Turkey. As a result, it was emphasized that renewable energy sources should be used in order to reduce fossil resource dependency. Therefore, it has been stated that wave energy should be preferred. However, it has been determined that energy cannot be produced from the wave due to technological insufficiency. Uygur et al. (2006) examined the potential of wave energy in his study. In the study, Western Black Sea was included in the study. It has been determined that wave energy is one of the cheap, clean and high potential energy sources. However, it has been emphasized that the technological infrastructure has not yet developed in wave energy. For this reason, it has been stated that the desired efficiency cannot be obtained from wave energy.

According to the results of the literature review, there are many studies on wave energy. While a single country is examined in some of these studies; in some countries were not included in the scope of investigation. In general, it is seen in the study that wave energy is important in meeting the energy demand. However, it is seen that economic and technical issues are important in wave energy. It was stated that these issues affect the demand for wave energy systems. Therefore, in this study, it is aimed to examine the theoretical structure of wave energy and its effect on the energy supply security of countries.

GENERAL INFORMATION ABOUT WAVE ENERGY

Energy is one of the most basic needs of a country. Therefore, the managers of the countries have sought the most efficient ways to provide energy. In this context, many different factors have been taken into account at the same time. For example, the cost of energy supplied should not be too high. Otherwise, this issue will cause the countries to experience economic disadvantages (Mikhaylov, 2019, 2020a,b,c, 2021). In this context, energy provided at high costs causes countries to experience budget deficit and current account deficit problems. Due to these issues, countries are seriously investigating ways to obtain energy at an effective cost.

In this context, researchers have determined that oceans can also be a very good source of energy. Winds cause wave movements on the surface of oceans and seas. Wave energy can be defined as a type of energy obtained from this movement. In this framework, a turbine system specific to the oceans is being created. The movements created by the waves under the water surface can transform electrical energy with these turbines (Lavidas, 2020; Clemente et al., 2021).

It is possible to talk about some advantages of wave energy. Thanks to this type of energy, it is possible to produce clean energy. In this way, the natural balance can be maintained. On the other hand, thanks to the generation of electricity with wave energy, no noise pollution occurs. In addition to these issues, fertile agricultural areas are not destroyed since wave energies are established on the sea (Liang et al., 2020, 2019; Ahn et al., 2020).

However, there are some disadvantages of wave energy. Electricity generation in wave energy occurs in the middle of the sea. Therefore, additional costs may be incurred for transmitting the obtained electrical energy to the center. On the other hand, a country may need strong waves in order to obtain wave energy (Xu et al., 2019; Xi et al., 2019). Therefore, it is not possible for every country to provide this energy. In other words, even if a country has a sea border, it is not enough to obtain electricity with wave energy. This area should also be exposed to strong winds (Ning et al., 2019).

AN EVALUATION WITH DEMATEL METHODOLOGY

In this study, it is aimed to generate appropriate strategies for Turkey to improve wave energy system. Turkey is a country surrounded by sea on three sides. There is the black sea in the north of the country, the Mediterranean sea in the south and the Aegean Sea in the west. On the other hand, the Marmara Sea is located in the northwest of the country. As can be seen, Turkey is a very rich country in terms of the sea. In this framework, it is thought that the country may have a wave energy potential. In contrast, the wave energy system has not developed in the country at all.

In this study, it is aimed to determine the appropriate strategy suggestions for the development of the wave energy system. In this framework, an analysis was carried out by taking the DEMATEL method into consideration. This method is taken into consideration in determining the importance weights of different criteria in the literature (Toosi and Samani, 2017; Pandey and Kumar, 2017; Sangaiah et al., 2017; Tooranloo et al., 2017; Khompatraporn and Somboonwiwat, 2017). DEMATEL method has been preferred by many researchers in the literature. Some of these studies are listed in Table 1.

It is obvious that DEMATEL methodology provides quality solutions because this approach has been preferred by different researchers. In this study, 4 different criteria are defined based on balanced scorecard methodology which are finance (C1), customer (C2), organizational effectiveness (C3) and research and development (C4). In the evaluation process, 3 different experts gave opinions about these criteria. Within this framework, 5 different scales are considered that are no influence (NI) for 0, somewhat influence (SI) for 1, medium influence (MI) for 2, high influence (HI) for 4 and very high influence (VHI) for 5. The opinions of the experts are given on Table 2.

By considering these evaluations, direct relation matrix is created. In this process, the average values are taken into consideration. Table 3 gives information about the direct relation matrix.

In the next process, this matrix is normalized by considering the maximum value of the row sums. The normalized decision matrix is indicated in Table 4.

The weighted results are demonstrated on Table 5. On the other side, detailed calculations are indicated in the appendix part.

It is concluded that finance is the most significant criterion for Turkey in order to improve wave energy projects. In addition to this condition, research and development is also another important factor in this regard.

SOLUTIONS AND RECOMMENDATIONS

Energy is needed in all areas of life. Therefore, energy use becomes important. Generally, people obtain energy by using fossil resources. But fossil resources are scarce in nature. However, it has a negative effect on the environment and human health. For this reason, it is necessary to use energy resources that are constantly found in nature and meet the energy demand uninterruptedly. This energy source is a renewable energy source. One of the renewable energy sources is wave energy. Wave energy is the force that occurs on ocean or sea surfaces. For this force, there must be wind. Therefore, areas where wave energy systems are installed become important. Wave energy meets the energy demand of countries. However, it does not have a negative effect on the environment and human health. Wave energy is one of the important issues in terms of ensuring the energy supply security of the countries. Energy supply security is the availability, availability and financing of resources. For this reason, the current state of wave energy must be accessible and financed. In this way, energy supply security is also ensured.

Table 1. Studies with DEMATEL Methodology

Authors	Subject
Dong and Huo (2017)	Identification of financing barriers to energy efficiency in small and medium-sized enterprises
Gupta et al. (2017)	Evaluating TQM adoption success factors to improve Indian MSMEs performance
Özdemir and Tüysüz (2017)	Evaluation of the education system
Si et al. (2018)	A systematic review of the state-of-the-art literature
Dinçer et al. (2019)	Evaluation of financial services in E7 economies
Dalvi-Esfahani et al. (2019)	Social media addiction
Nilashi et al. (2019)	Factors influencing medical tourism adoption
Dinçer et al. (2020)	Kano-based measurement of customer expectations
Mao et al. (2020)	Handling dependent evidences
Zhang et al. (2020)	Strategic mapping of youth unemployment
Abdullah et al. (2019)	Sustainable solid waste management
Zhang and Su (2019)	Estimating participants in knowledge-intensive crowdsourcing
Yazdi et al. (2020)	Probabilistic safety analysis in process systems
Dinçer et al. (2020)	Data mining-based evaluating the customer satisfaction for the mobile applications
Haleem et al. (2019)	Traceability implementation in food supply chain
Jiang et al. (2020)	Identifying key performance indicators in hospital performance management
Xu et al. (2020)	The critical barriers to the development of hydrogen refueling stations
Dinçer et al. (2020)	BSC-based evaluation for the factors affecting the performance of wind energy companies
Kilic et al. (2020)	Personnel selection
Dinçer et al. (2019)	SERVQUAL-based evaluation of service quality of energy companies in Turkey
Zhang et al. (2019)	Identifying critical risks in Sponge City PPP projects
Dinçer and Yüksel (2020)	Defining the strategic impact-relation map for the innovative investments
Khan et al. (2019)	Evaluation of barriers in the adoption of halal certification
Yüksel et al. (2021)	The negative role of environmental pollution on international trade
Kaya and Yet (2019)	A supplier selection case study
Korsakienė et al. (2020)	Strategic mapping of eco-innovations and human factors
Chen et al. (2019)	Evaluating sustainable value requirement of product service system
Dinçer et al. (2019)	Strategy selection for organizational performance of Turkish banking sector
Kalkavan et al. (2021)	Impacts of trade war upon social indicators
Song et al. (2020)	Analyzing barriers for adopting sustainable online consumption
Chen et al. (2020)	Explore and evaluate innovative value propositions for smart product service system
Jun et al. (2021)	Measuring the innovation capacities of financial institutions
Lin et al. (2020)	Analyzing the factors influencing adoption intention of internet banking
Yuan et al. (2021)	The theory of inventive problem solving (TRIZ)-based strategic mapping of green nuclear energy investments
Yüksel et al. (2020)	The role of technological development on renewable energy usage
Liu et al. (2021)	A multidimensional outlook to energy investments for the countries with continental shelf in East Mediterranean Region
Yuan et al. (2020)	Evaluating recognitive balanced scorecard-based quality improvement strategies of energy investments
Haiyun et al. (2021)	Analysis of the innovation strategies for green supply chain management in the energy industry
Mikayilov et al. (2020)	Elasticity analysis of fossil energy sources for sustainable economies
Xie et al. (2021)	Renewable energy investments.

Table 2. Evaluations of the experts

Linguistic Value-Evaluation of Expert 1				
	C1	**C2**	**C3**	**C4**
C1	0	4	3	3
C2	1	0	1	1
C3	2	3	0	3
C4	2	3	2	0
Linguistic Value-Evaluation of Expert 2				
	C1	**C2**	**C3**	**C4**
C1	0	4	4	4
C2	1	0	1	2
C3	2	3	0	2
C4	2	2	2	0
Linguistic Value-Evaluation of Expert 3				
	C1	**C2**	**C3**	**C4**
C1	0	4	3	4
C2	1	0	1	2
C3	2	2	0	3
C4	3	3	2	0

Table 3. Direct relation matrix

	C1	**C2**	**C3**	**C4**
C1	0.00	4.00	3.33	3.67
C2	1.00	0.00	1.00	1.67
C3	2.00	2.67	0.00	2.67
C4	2.33	2.67	2.00	0.00

Table 4. Normalized matrix

	C1	**C2**	**C3**	**C4**
C1	0.00	0.36	0.30	0.33
C2	0.09	0.00	0.09	0.15
C3	0.18	0.24	0.00	0.24
C4	0.21	0.24	0.18	0.00

Table 5. Analysis results

Criteria	D	R	D-R	D+R	Weights
Finance (C1)	2.46	1.36	1.11	3.82	0.2758
Customer (C2)	0.98	2.17	-1.19	3.15	0.2270
Organizational Effectiveness (C3)	1.77	1.53	0.24	3.29	0.2377
Research and Development (C4)	1.72	1.88	-0.16	3.60	0.2595

FUTURE RESEARCH DIRECTIONS

This study aims to identify the important points of wave energy for the economic development of the countries. It is intended to underline the key issues to develop wave energy in the countries. In the future studies, it can be possible to rank different countries based on their performance regarding wave energy. Hence, it can be much easier to develop appropriate strategies for the countries to improve these energy projects. In addition to this situation, in the following studies, different renewable energy types can also be taken into consideration. This situation provides an opportunity to make a comparative evaluation between different types. Because energy is a significant issue for the economic and industrial improvement, countries should find the optimal energy type in order to improve this situation. Owing to this condition, the academic studies related to the energy investments play an essential role for the policy makers to identify the best energy investment projects.

CONCLUSION

People need energy to survive. Energy is important in order to provide the needs of people without interruption and to continue their lives. Throughout history, people obtain energy by using sources such as coal, oil and natural gas. However, it is expected that these energy resources will not be able to meet the increasing energy demands over time. Therefore, renewable energy sources should be used. Renewable energies are constantly in nature. They are harmless to the environment and provide uninterrupted energy demand. One of these energy sources is wave energy. The wave is formed by the wind blowing to the sea and ocean surface. The energy obtained from the movements formed is wave energy. In this context, the greater the wavelength and the wave velocity, the greater the energy obtained. Electricity is produced with the obtained wave energy.

One third of the energy demand is met by electricity generation. At this point, particular attention should be paid to wave energy. Wave energy is a cheap, clean and environmentally friendly energy source. However, there are no costs other than the initial investment and maintenance costs. On the other hand, wave power plants are loud and there is a possibility of damaging the live ecosystem in its location. Therefore, the location where the wave power plants will be installed is important. The establishment of wave power plants helps the country to reduce its dependence on fossil resources. In this regard, the country is least affected by changes in fossil resource prices. However, when the sustainability and accessibility of electrical energy obtained from wave energy is provided, energy supply security is also provided. This is an important issue for the development of the country's economy. Therefore, attention should be paid to the impact of studies on wave energy on energy supply security. In this study, it is aimed to explain the theoretical structure of wave energy and its importance in terms of energy supply security of the country. For this purpose, 4 different criteria are defined based on balanced scorecard methodology which are finance (C1), customer (C2), organizational effectiveness (C3) and research and development (C4). An evaluation has been conducted by DEMATEL methodology. It is identified that finance is the most significant criterion for Turkey in order to improve wave energy projects. Moreover, research and development is also another important factor in this regard.

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KEY TERMS AND DEFINITIONS

BSC: Balanced scorecard.
DEMATEL: Decision making trial and evaluation laboratory.

APPENDIX

Table 6. Identity Matrix

	C1	C2	C3	C4
C1	1	0	0	0
C2	0	1	0	0
C3	0	0	1	0
C4	0	0	0	1

Table 7. Identity Matrix – Normalized Matrix (I-X)

	C1	C2	C3	C4
C1	1.00	-0.36	-0.30	-0.33
C2	-0.09	1.00	-0.09	-0.15
C3	-0.18	-0.24	1.00	-0.24
C4	-0.21	-0.24	-0.18	1.00

Table 8. (I-X) (Inverse)

	C1	C2	C3	C4
C1	1.34	0.81	0.61	0.71
C2	0.22	1.21	0.23	0.31
C3	0.39	0.58	1.27	0.53
C4	0.41	0.57	0.42	1.32

*Table 9. X * (I-X) (Inverse)*

	C1	C2	C3	C4
C1	0.34	0.81	0.61	0.71
C2	0.22	0.21	0.23	0.31
C3	0.39	0.58	0.27	0.53
C4	0.41	0.57	0.42	0.32

Chapter 10
Conceptualizing the Role of Renewables in Determining Energy Security

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ABSTRACT

All countries worldwide demand energy for economic growth. The main objectives of the chapter are three-fold: firstly, to investigate the role of renewables in the global energy transition, examining the parameters such as a share in the primary energy demand, installed capacity, etc.; secondly, to identify the factors that affect determine deployment of renewable energy such as energy imports, R&D funds, energy prices, etc.; and thirdly, to examine the role of renewables in contributing to energy security by computing a renewable energy security index (RESI) by deploying the methodology of principal component analysis (PCA) method. The renewable energy security index has been improving over the period 2000-2018 and is significantly correlated with all the four aspects of energy security availability, accessibility, acceptability, and affordability. Consequently, the economies across all nations should adopt appropriate pathways of the energy transition towards renewable energy sources not only to achieve energy security but also energy efficiency.

INTRODUCTION

Energy security has emerged as the most significant policy agenda since the OPEC oil embargo of 1973. The formation of a cartel holds considerable relevance in terms of oil prices and production. It also signifies the importance of world politics and the role of geopolitics in governing production and prices. International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price". Energy security, as defined by IEA, has a long-term dimension of energy security, which deals with investments necessary to supply energy to attain economic development and achieve sustainable environmental needs. Short-term energy security focusses on the ability of an energy system to react to the sudden changes in the supply-demand balance. It is realized that lack

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of energy security is associated with negative socio-economic impacts such as physical unavailability of energy or volatility of prices.

Energy security can be defined as “the ability of households, businesses and government to accommodate disruptions in supply in energy markets” (Metcalf, 2013). It is also addressed as ‘availability of sufficient supplies at affordable prices, (Yergin, 2006). On the other hand, Sovacool and Mukherjee (2011) proposed that “energy security should comprise five dimensions related to availability, affordability, technology development, sustainability and regulation”.

Brown and Sovacool (2010) defined energy security as “adequate energy supply and affordable prices as well as social and cultural sustainability and environmental preservation”. European Commission described energy security as “uninterrupted physical availability of energy products on the market at an affordable price for all consumers” (Cherp et al., 2012). While International Atomic Energy Agency (IEA) redefines energy security as “adequate, affordable and reliable access to energy fuels and services, it includes the availability of resources, decreasing dependence on imports, decreasing pressures on the environment, competition and market efficiency, reliance on indigenous resources that are environmentally clean and energy services that are affordable and equitably shared”.

With the advent of climate change as the most significant global challenge, The Paris Agreement sets a goal to limit the increase in average temperature below 20C (IRENA, 2018). Addressing the emerging global challenge of Climate Change, energy transition to renewable energy sources is imperative. It brings forth the genesis of energy transition driven by renewable energy sources. The chapter overviews the emerging role of renewables in energy transition across the globe. The energy transition is a consequence of the interplay of various determinants that govern the pathways of the energy transition. In this context, a series of variables affecting the role of renewables have been critically analysed to evaluate the role of renewables. However, renewable energy is highly constraint by its inherent dependency on technology and innovation, which is evolving at a rapid rate making the use of renewable energy more efficiently. Consequently, the countries have adopted Nationally Determined Contributions (NDCs) that differs from country to country, identifying the role of renewable energy in meeting the greenhouse gas emission reduction targets.

Renewable energy capacity has experienced a growth of 8.3% during 2017, increasing approximately 64% of the share of renewable in total installed capacity in Asia in 2017. Wind and Solar share of new capacity increased by 85% in 2017. At the same time, the primary energy demand for each source is consistently rising, with oil experiencing the highest demand among all energy source. However, the share of renewables in power has substantially increased from 1% in 2000 to 8% in 2017 (IRENA). It is observed that the cumulative installed capacity of photovoltaic (PV) power is much higher than the cumulative capacity of wind turbine across the world.

Among all the significant factors contributing towards the role of renewables, technological innovations in the case of renewables are the most significant aspect. It is further determined by expenditure on RD&D and the number of patents. Investment in renewable energy is highest in China, around 102900 million dollars, followed by the USA. India and Brazil also invest in renewable energy. The number of patents filed in solar energy is much more significant than other technologies such as wind, bioenergy and hydropower. However, the number of patents declined sharply after 2012. China has filed the most considerable number of patents for renewable energy technologies. The number of patents in solar PV technology has increased more than other technologies in solar energy.

Economic factors constitute another set of factors in evaluating the factors that determine the deployment of renewables. The market forces of demand and supply play a crucial role, and it is realized that renewable energy consumption indicating the demand side has been consistently rising over the period 1990-2017. Simultaneously, the installed capacity of wind has shown a steep rise, especially after 2005, followed by solar energy across the world. However, the installed capacity of bioenergy and renewable municipal waste has remained constant. On the other side, the costs of RE, measured by the Levelized cost of electricity (LCOE). There is a significant decline in LCOE of solar PV, while it has not declined in the case of other renewable energy sources.

Energy policies adopted for the deployment of RE is another crucial factor that facilitates the role of RE in the energy transition. It is observed that among all the policy measures, power regulation is the most popular policy deployed by the countries, providing RE incentives. Very few countries adopt heating and cooling regulations for RE incentives. Various regulatory policies are deployed to achieve renewable energy targets set by different countries. Various regulatory policies such as feed-in-tariffs, premium payments, net metering, tendering, tradable renewable energy certificates. Other fiscal incentives adopted are tax credits, loans, grants, capital subsidies, rebates etc.

In the domain of all the factors that affect the role of renewables, the socio-economic and political factors constitute another set of crucial variables affecting RE deployment. The pattern of consumption is dependent on climatic conditions as well as socio-economic conditions in a region. Any successful energy transition has to encounter bottlenecks of vested interest groups associated with the political economy of energy at that particular time and region. The process of long-term structural economic change leading to technological progress and industrial growth will be successful by preventing vested interests from blocking structural change.

Finally, computing an energy security index by deploying Principal Component Analysis, the role of renewables will be highlighted in ensuring energy security. Such an index is referred to as Renewable Energy Security Index (RESI). The entire purpose of computing RESI is not only to capture the energy security guaranteed through the deployment of renewable energy sources from the prism of 4 A definition of energy security, but it also incorporates significant factors that determine renewable energy deployment at large. Four of the components, namely, availability, accessibility, affordability and acceptability, are comprising of 4 A definition explains the energy security ensured by the renewable energy in a particular country while the other two aspects, energy intensity and structural composition, are among several significant factors that determine renewable energy deployment in a country.

The main objectives of the chapter are three-fold, firstly to investigate the role of renewables in the global energy transition, examining the parameters such as a share in the primary energy demand, installed capacity etc. Secondly, identify the factors that affect and determine deployment of renewable energy such as energy imports, R&D funds, energy prices etc. Thirdly, to examine the role of renewables in contributing to energy security by computing a Renewable Energy Security Index (RESI) by deploying the methodology of Principal Component Analysis (PCA) method.

The chapter has been planned in different sections. Introducing the topic of the chapter and describing the notion of energy security in section 1, section 2 describes the role of renewables in the journey of the global energy transition. Section 3 conceptualizes energy security incorporating climate change and geopolitical concerns. The role of renewables in determining energy security is discussed in section 4, describing various dimensions of energy security in renewable energy. Results and discussion are presented in section 5, followed by conclusion 6. In this evolving era of the energy transition, the role of renewables is critical for visualizing the transition in the global energy regime, as discussed in section 2.

ROLE OF RENEWABLES IN GLOBAL ENERGY TRANSITION

General Information About Mortgage Loans

People The world's rising energy demand is evident. This rising energy demand creates not only real opportunities to enhance business, resulting in greater returns to the investors but also threatens environmental sustainability by increasing carbon emissions. The role of renewables in the energy transition is visualized by an increasingly low carbon business that is committed to emission reduction. Net growth in operational emissions out to 2025 is negligible, targeting methane intensity of 0.2% and holding it below 0.3%, providing lower gas emissions. Further developing more efficient and lower-carbon fuels, lubricants and petrochemicals, approximately 500 million investment in low carbon activities each year and collaborate and invests in Oil and gas Climate initiative for about one billion funds for research and technology.

The energy system is changing at its fastest rate since the industry is changing faster at any time in today's times. The rising concerns about climate change and environmental sustainability have changed economic growth and development across all nations. The entire economics of oil, as well as the market, has witnessed energy disruption owing to geopolitical change. Consequently, energy dynamics associated with oil are transforming, the energy mix is shifting

To reduce the impact of Climate change, the Paris Agreement sets a goal to limit the increase in average temperature below 2^0C (IRENA, 2018). Addressing the emerging global challenge of Climate Change, energy transition to renewable energy sources is imperative. It brings forth the genesis of energy transition driven by renewable energy sources. Renewable energy is highly constraint by its inherent dependency on technology and innovation, which is evolving at a rapid rate making the use of renewable energy more efficiently. Consequently, the countries have adopted Nationally Determined Contributions (NDCs) that differs from country to country, identifying the role of renewable energy in meeting the greenhouse gas emission reduction targets.

A global energy transition is well underway, augmented by new additions of installed renewable energy capacity, rapidly falling cost of solar PV and wind power, decoupling economic growth and emissions. The evolving new business models adopting new energy-efficient and clean technologies encourage the paradigm shift based on conventional energy to renewable energy. At the end of 2017, global renewable generation capacity amounted to 179 GW, with hydro accounting for the largest share of the worldwide total with an installed capacity of 1,152 GW, wind with the capacity of 514 GW and solar 397 GW of installed capacity (IRENA, 2018). The total RE electricity capacity is consistently rising, as evident in Appendix figure A1. Among the full electricity capacity, it is wind energy that exhibits a more significant rise as compared to solar. Bioenergy and other renewable energy experience a very low increase in capacity, as observed in Appendix figure A.2.

Renewable energy capacity has experienced a growth of 8.3% during 2017, increasing approximately 64% of the share of renewable in total installed capacity in Asia in 2017. Wind and Solar share of new capacity increased by 85% in 2017. Approximately 146 million people were deployed by off-grid renewable power. The emerging role of renewables in energy transition resulting in an increased share of renewables is also responsible for the change in energy dynamics. It is evident in Table 3.1, which depicts capacity expansion in different regions of the world.

Table 1. Region-specific capacity, change and growth of renewables, 2017

S. No.	Region	Capacity of renewables	Global share of renewables	Change	Growth rate
1	North America	348 GW	16%	+16 GW	+4.9%
2	Central America and the Caribbean	14GW	1%	+0.4GW	+2.9%
3	South America	202GW	9%	+9.0GW	+4.7%
4	Europe	512GW	24%	+24GW	+4.8%
5	Middle East	20GW	1%	+0.9GW	+5.0%
6	Africa	42GW	2%	+3.5GW	+9.2%
7	Eurasia	96GW	4%	+4.9GW	+5.4%
8	Asia	919GW	42%	+106GW	+13.1%
9	Oceania	27GW	1%	+1.5GW	+5.9%

Source: Renewable capacity statistics 2018, IRENA (2018)

Table 1 highlights that Asia accounts for 42% of the global share, followed by Europe and North America. The rest of the regions of the world comprise the deficient proportion of renewables in the global percentage. The growth in the share of renewables is also maximum in Asia, followed by Africa.

Table 2. Source wise growth of renewables in various regions of the world

S. No.	Renewable energy sources	Capacity growth of renewable energy mix in various regions
1.	Hydropower	Brazil and China (1.4GW, 60%) India(>1GW)
2	Wind energy	China (15GW), USA(6GW), Germany(6GW), UK(4GW), India(4GW), Brazil and France (>1GW)
3	Bioenergy	China (2.1GW), India (510MW), Thailand(439MW), Europe(1 GW) and South America (low)
4	Solar energy	Asia (72GW) China (53GW, +68%), India 9.6 GW (+100%), Japan (+17%). China (>half of all new capacity installed)
5	Geothermal energy	Indonesia(306MW), Turkey (243 MW), Turkey (>1GW)
6	Off-grid electricity	Overall (6.6GW, 10%), 146million people using off-grid renewables, 115 million using solar lights.

Source: Renewable capacity statistics 2018, IRENA (2018)

It is evident from Table 2 that, among all other renewable energy sources, solar energy has exhibited a tremendous increase in its capacity, with the highest rise in India, followed by China. Wind energy also witnessed an increase in capacity, China showing the maximum growth.

Non-conventional, renewable energy sources are a primary energy source that addresses primary energy demand along with conventional energy source, reflected in figure 1. The secondary demand for energy prevails in electricity demand that is also addressed by renewable energy sources, as depicted in figure 2.

Figure 1. Primary energy consumption, 2017

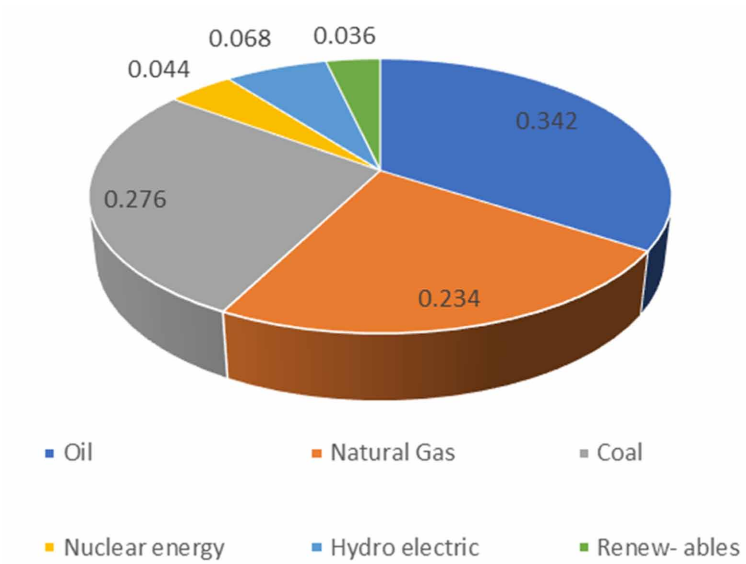
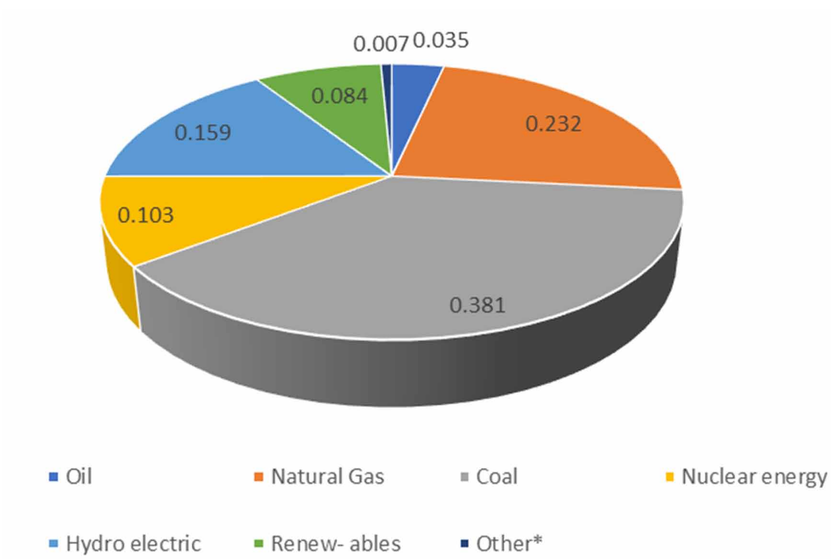
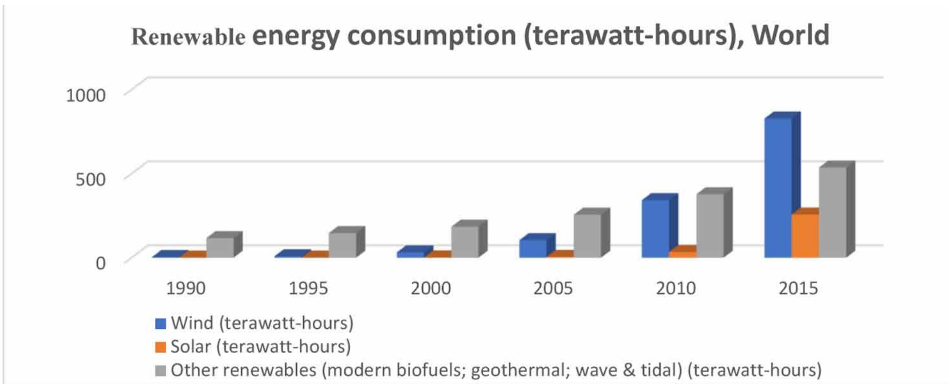


Figure 2. Electricity generation, 2017
Source: BP Statistical Review of Global Energy



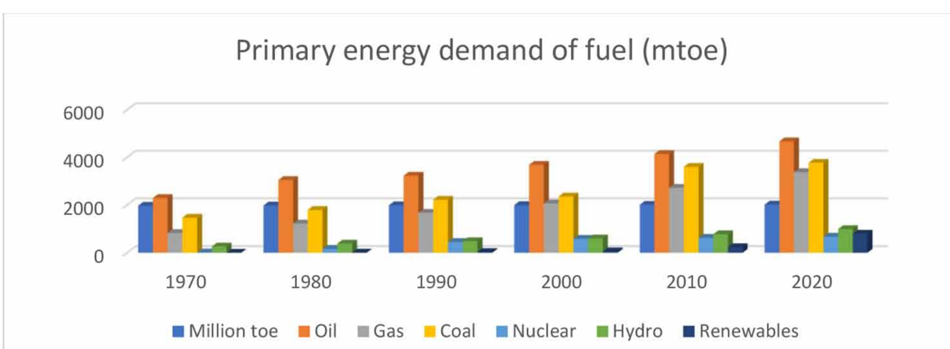
In 2017, out of the total primary energy demand, about 3.6% of the total demand was fulfilled by renewable energy sources, while the renewable energy sources have contributed approximately 8.4% of total electricity generation.

Figure 3. Renewable energy consumption, World
Source: BP Statistical Review of Global Energy 2017



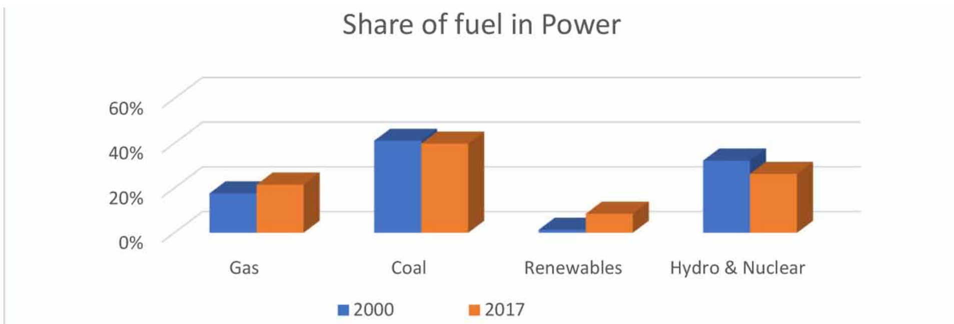
The overall renewable energy consumption in the world was almost non-existent before 1990, from 1990-2000, the renewable energy sources in the form of biofuels, geothermal, wave and tidal started contributing, 116.44 TWh, wind about 3.63 TWh and solar only 0.38 TWh in 1990, as shown in figure 3 However, the contribution of renewables other than wind and solar increased consistently reaching 561.66 TWh. From 2000, wind energy consumption increased substantially from 21.23 TWh in 1999 and later showing a drastic increase in 2010, approximately 341.41 TWh, almost reaching the level of other renewables at 376.49 TWh. On the other hand, solar energy consumption exhibited a sudden rise in 2012 from 64.69 TWh in 2011 to 100..03 TWh in 2012 and further increased to 256.19 TWh in 2015 though much less than wind and other renewables. In 2015, the contribution of wind was largest as compared to solar and other renewables.

Figure 4. Growth in primary energy demand, World
Source: BP Statistical Review of Global Energy 2017



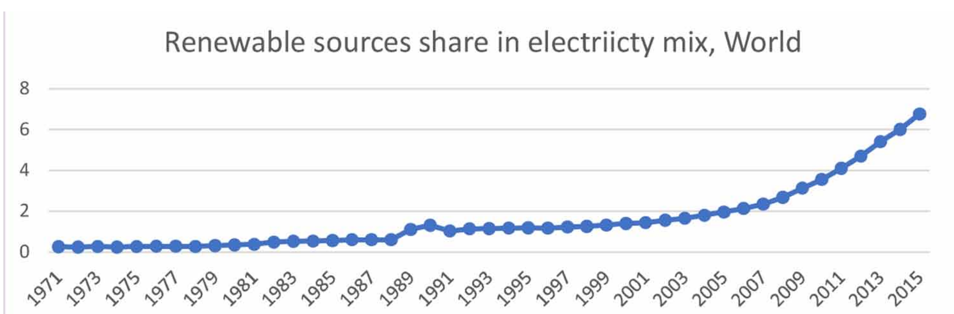
It is observed in figure 4 that oil has played a significant role in determining the primary energy demand since 1970, which has been substantially increased, followed by coal and gas. The role played by hydro is visible after 1990 along with nuclear. The role of renewables in comparison to other conventional sources is very minimal, and it is visible as an energy source only since 2000.

Figure 5. Change in the share of fuel in power, World
Source: IRENA



It is evident in figure 5 that the share of renewables in 2017 in comparison to 2000 has been substantially relatively high, while the share of hydro and nuclear declined in 2017 comparing the contribution in 2000. However, the contribution or share of gas in power has substantially increased in 2017 compared to 2000. Consequently, in 2017, the share of gas and renewables has substantially increased in comparison to 2000.

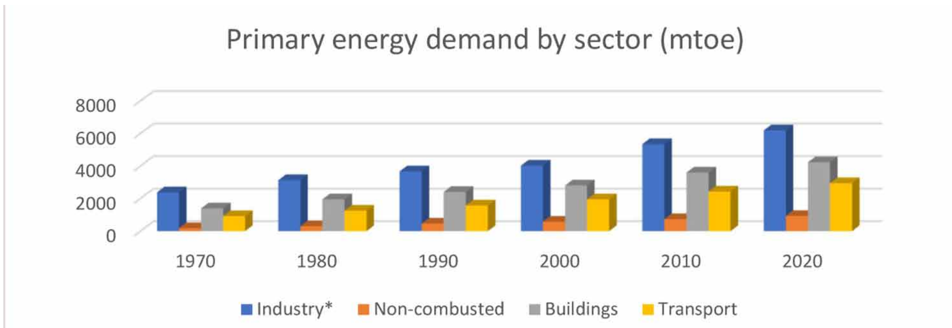
Figure 6. Share of renewable sources between 1971 - 2015
Source: IEA, data source.



The share of renewable production in the electricity mix is measured as a percentage of total electricity production. The renewable sources in figure 6 include solar photovoltaic (SPV), wind (offshore and onshore), geothermal and biomass electricity production. However, hydroelectricity production is separated from other renewable sources.

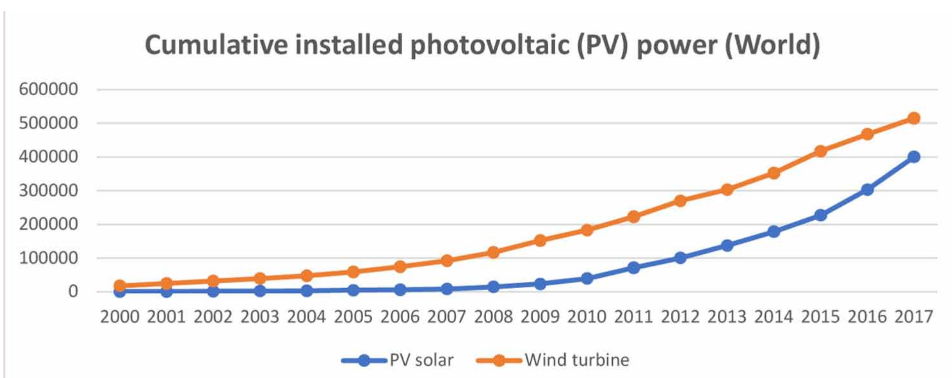
Figure 6 indicates that the share of renewables comprising of solar photovoltaic, wind (offshore and onshore), geothermal and biomass in the electricity mix has been rising since 1979, it experienced a kink in 1989-1990 and later increased steeply after 1991, reaching a share of 6.76% in the electricity mix.

Figure 7. Primary energy demand by sector, World
Source: BP Statistics



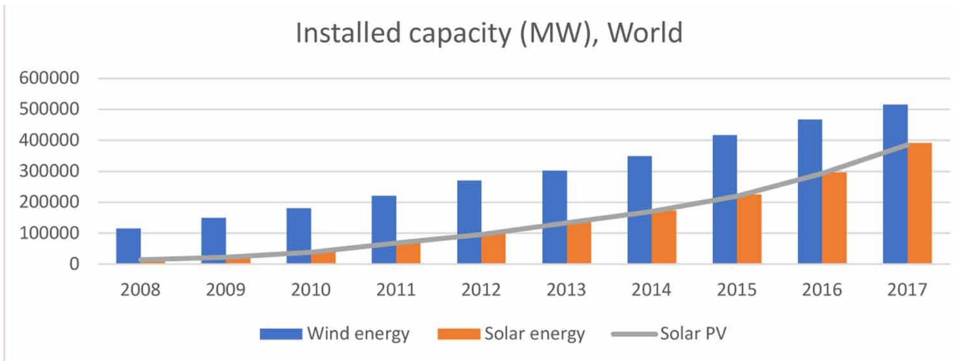
The primary energy demand by industrial sector has been the largest among other sectors such as non-combusted, buildings and transport sector across the world as observed in figure 7, and it has been increasing consistently since 1970. The transport sector requirement for primary energy has also been increasing though it is lowest in comparison to other sectors as in figure 7

Figure 8. Cumulative installed photovoltaic (PV) power, World
Source: BP Statistics



The cumulative installed capacity of PV solar is substantially more than the wind turbine, and the installed capacity is rising steeply from 2007 onwards, as observed in figure 8. At the end of the year 2017, global renewable generation capacity accounted for 2,179 GW (Renewable capacity statistics, 2018). The total growth in renewable capacity during 2017 accounted for 8.3%, increasing the global renewable generation capacity in 2017. Out of this new capacity in 2017, wind and solar accounted for 85%. Approximately 146 million people were served by off-grid renewable power. Out of the total ca-

Figure 9. Pattern in a change of installed capacity between 2008 - 2017
Source: IRENA, data source



pacity, hydro accounted for the largest share of full installed capacity, 1152 GW, wind energy accounted for 514 GW, followed by solar energy with 397 GW (Renewable capacity statistics, 2018).

The installed capacity for wind energy has been increasing more than that of solar energy. It increased from 114799 MW in 2008 to 513939 MW in 2017, much larger than solar energy, 390625 MW in 2017, as shown in figure 9. Among the solar energy technologies, PV solar technology is increasing at a very high rate, reaching 385674 MW accounting for a large proportion of total solar energy technologies. The total renewable energy generation has been rising consistently, as shown in Appendix figure A3. The proportion of electricity generation in total RE is most significant in wind energy, followed by bioenergy and solar energy, as visualized in Appendix figure A4.

Renewable energy electricity generation mix has immensely contributed to primary energy demand; it is imperative to explore the role played by renewables in contributing to the overall global energy security. In this context, section 3 conceptualizes energy security augmenting the concerns of climate change and geopolitics.

CONCEPTUALIZING ENERGY SECURITY

Ever since the countries in the world realized that the unequal distribution of resources is the primary challenge for sustainable economic stability, the nations are very proactive in securing energy supplies. Energy is the pre-requisite for economic growth and development, and therefore each country aspires to be energy secure. Energy security as a concept has evolved over the years, as discussed in the section of renewable energy security index. In simple words, energy security implies an uninterrupted, reliable supply of energy at affordable prices. With the emergence of a new global challenge of climate change, the concept of energy security has expanded to include environmental and sustainability concerns. Fossil fuel technology or conventional energy technology fails to address the newly emerged concept of energy security. There are broadly four dimensions of energy security such as availability, accessibility, affordability and acceptability.

In the present time, renewable energy technology is the most plausible energy technology that unfolds all four aspects of energy security. As a result, energy security becomes one of the most critical factors determining the role of renewables in the energy transition.

CLIMATE CHANGE CONCERNS

The Earth's climate is changing on account of consistently rising human consumption and production, as confirmed by the Third Assessment Report (IPCC UNEP, 2001). These processes of production and consumption are excessively energy-intensive. Also, the increase in energy use of conventional energy generates greenhouse gas emissions, which is detrimental to the ecosystem and results in climate change. As a result, climate change becomes a crucial factor affecting the large-scale deployment of renewable energy sources. The use of renewable energy is expected to stabilize carbon-dioxide emissions and control climate change in turn.

Sims (2004) analysed the role of renewable energy in reducing carbon-di-oxide emissions by comparing the costs of renewable energy systems with fossil fuel. Mathiesen et al. (2017) present a 100% renewable energy system and asset that, along with the benefit of reducing carbon-dioxide emissions, the renewable energy system generates a positive socio-economic effect, employment and many other benefits from enhanced exports.

As a consequence, apart from the potential gains from the business model of renewable energy deployment, the extended value chains and international trade, the key motive of significant -scale deployment of renewable energy is climate change mitigation

GEOPOLITICAL CONCERNS

Unequal distribution of natural resources is responsible for enhancing the competition over resources. Exhibiting preponderance of power on limited resources becomes a geopolitical concern or strategy of every nation. The geopolitics of energy and its transition has been discussed substantially in Chapter 2, Energy Transition. However, the transition towards renewable energy sources involves geopolitics out of various newly emerging aspects. The United States has exhibited one of the remarkable examples of energy transition and shift in global energy dynamics. We have demonstrated that energy independence and national security are inter-changeable concepts where the international energy sector, as well as multilateral tools, play a significant role in shaping the new global energy dynamics (Brazilian et al., 2017).

Hache (2018) asserted that energy transition to renewable energy sources poses new challenges for energy geopolitics. Regional, local and decentralized energy systems add a new geopolitical layer to actors of energy geopolitics. The author addresses this shift in energy geopolitics as the new geopolitics of patents. The new centres of geopolitics will be created determined by new factors influencing global energy dynamics such as access to technology, power lines, rare earth materials, patents storage etc. (Paltsev, 2016).

Consequently, the balance of power shifts from the owners of fossil fuels to the countries that are developing low-carbon technologies. Overland (2019) critically evaluates some of the emerging concerns about the geopolitics of the rise of renewable energy. The author argues that the risk of geopolitical competition over rare earth metals used for renewable energy is overrated; the chances of resource curse reappearing as in the case of conventional fuels is quite meek. Transboundary electricity cut-offs will not be a suitable tool as a geopolitical weapon, and whether the use of renewable energy will accelerate cyber-security risk is dubious.

The entire set of equations of international relations related to energy will now depend on an entirely new set of factors affecting renewable energy transition such as technological know-how, R&D

sources of finance, human resource, capital endowment and sources of finance. The entire geopolitical bent would be in the hands of those countries that are privileged with these factors affecting renewable energy transition. Scholten (2018) presents a novel analytical framework showing a movement from geography and technology to economics. The work highlights the shift of priorities from economics to geopolitics. The strategic shift from the role of producers to consumers and consequently shifting of both market power, as well as geopolitical power in the hands of prosumers (Lorimer, 2014), will set the new geopolitical balance.

Consequently, the renewable energy transition is determined by geopolitical factors that favour the countries that are privileged in terms of availability of capital, technological advancement, human resource, sources of finance of clean energy technologies and R&D in renewable energy technologies.

Further, the deployment of renewables is critical for energy security. Therefore, the role of renewables in contributing to energy security has analysed in section 4 by computing a renewable energy security index comprising of four crucial aspects of 4 A definition of energy security.

Role of Renewable Energy in Energy Security

In the present context of the newly emerged definition of energy security, the environmental sustainability component is embedded in the "acceptability" aspect of the 4A definition of energy security. Consequently, renewable energy technologies play a critical role in determining energy security. An energy security framework augmented to visualize the role of renewable energy in ensuring energy security has been presented in the section below. A renewable energy security index has been computed, referred to as (RESI), by deploying various indicators that contribute to constructing the Principal component index based on Principal component analysis.

RENEWABLE ENERGY AUGMENTED ENERGY SECURITY INDEX (RESI)

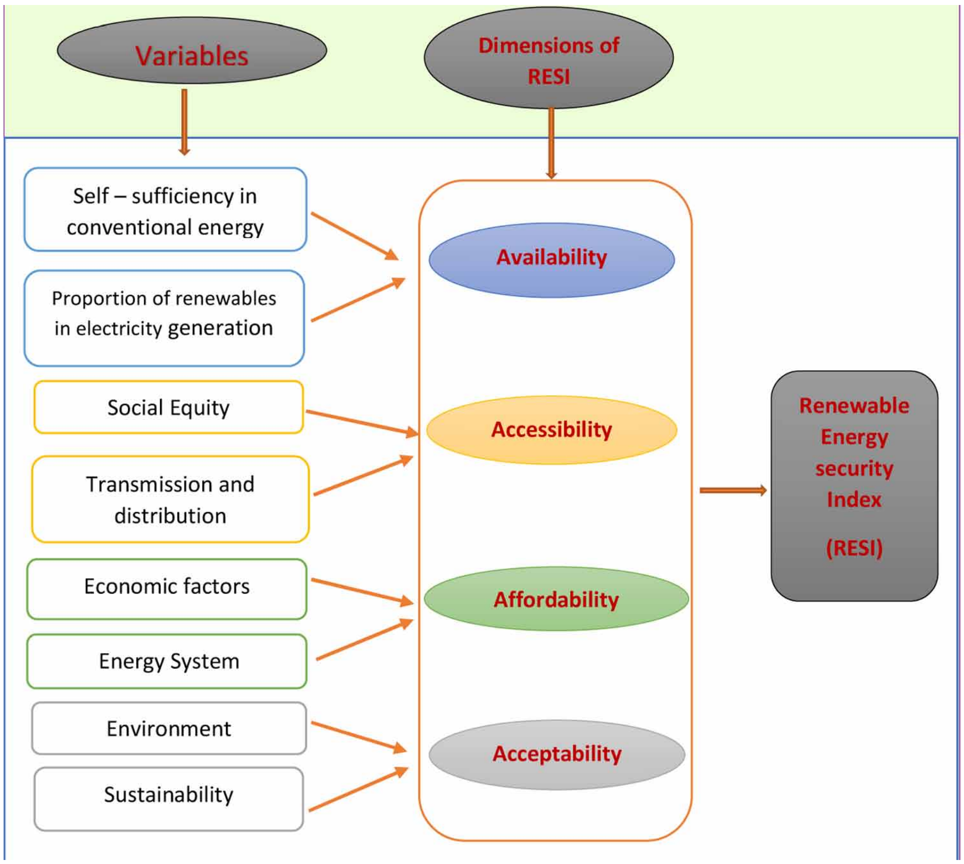
Energy security, conceptualised in the framework of 4 A definition incorporating availability, accessibility, affordability and acceptability, has been used to construct an energy security index, referred to as Renewable Energy Security Index (RESI).

The four dimensions of RESI, mainly availability, accessibility, affordability and acceptability, are captured and assessed by selecting the appropriate indicators that reflect all the variables affecting that particular dimension.

The chart in figure 10 clearly outlines the indicators deployed in assessing the four dimensions of the renewable energy security index. A detailed account of all indicators selected is compiled in the following table 3

Using the above indicators that explain the variables of four dimensions of RESI, an index is constructed. To construct this index, principal component analysis is used. A large number of variables that affect the components are reduced to smaller set so that the index value finally obtained still retains all the information. The method of PCA method is described in the following section.

Figure 10. A schematic representation of the construction of the Renewable energy security index (RESI)



Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is a dimension-reduction tool that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set (Pearson, 1901). This method of PCA was first invented by Karl Pearson in 1901, later adopted by developed by psychologist Harold Hotelling in the 1930s (Hotelling, 1933).

Sometimes, the methodology is a multivariate approach that involves transforming the correlated variables into uncorrelated variables. Such uncorrelated variables referred to as components. These components (sometimes called indicators of variables) are the linear combinations of original variables. The main objective behind the PCA methodology is to reduce dimensionality associated with data and later convert interdependent coordinates to independent ones. PCA based energy security index has been constructed using SPSS (Version 22) statistical software. Eigenvalues of each variable identified, explaining the maximum variation within the data and using the selected Eigenvalues, components corresponding to the selected Eigenvalues extracted from the Rotational matrix. The product of each selected Eigenvalue with the corresponding component is attained and summed up for each variable. The value of each variable is multiplied by the related weight. "A sum of all the cross products is obtained and divided with the total of all the weights to achieve one composite index" (Shlens, 2003).

Table 3. Description of indicators selected for Renewable energy security index construction

Sno.	Dimension			Indicator	Unit	Source
1.	Availability	Self-sufficiency in conventional energy		Net energy imports (Energy imports % of TPES)	Proportion	IEA
				Reserve / production ratio	Proportion	BP Statistics
				Reserve / consumption ratio	Proportion	BP Statistics
		Proportion of renewables		% of RE in electricity generation	Proportion	IEA
2.	Accessibility	Social equity		Access to electricity in rural areas		Worldbank data source
				Access to clean energy technology for cooking		Worldbank data source
				RE consumption by households		IEA
3.	Affordability	Economic factors		Average prices of primary fuel		IEA
				LCOE of RE		IRENA
				FDI in RE		IRENA
				RE invest		IRENA
		Energy system		TFEC per capita		IEA
				RE sector share		IEA
				Energy Efficiency	TPEC/GDP	IEA
4.	Acceptability	Environment		CO2 emissions per capita		World Bank datasource
				Carbon intensity (emission/ GDP)		World Bank data source
		Sustainability		Share of renewables		IRENA
				R&D Funds		IRENA
				Innovation	No. of patents	IRENA
				Public investment in RE		IRENA

The RESI formulation is based on selected indicators on variables- chosen from the 4A model on energy security. ESI is considered as a variable that cannot be observed directly, essentially a latent variable, which is assumed as linearly dependent on six indicators –the representation of the four aspects variables on the 4A model. The secondary data on variable indicators collected from the World Bank collection of development indicators compiled from officially recognized international sources. Accuracy of data ensured from confirming from multiple sources as it resents the most current and accurate global development data available and includes national, regional, and international estimates. The calculations have been done to frame ESI on variable indicators.

Principal Component Analysis PCA method is deployed to capture the entire real picture of energy security contributed by renewable energy sources since this method provides a comprehensive way of incorporating all attributes affecting and determining energy security in one value. All the attributes considered are interlinked and interconnected; these attributes are correlated to each other; the PCA method is used in explaining the variance-covariance structure of the set of variables through linear combination. It is a dimensionality reduction technique.

AN OVERVIEW OF INDICATORS OF FOUR DIMENSIONS OF RESI IN THE WORLD

In the 4 A framework of energy security as visualized from the renewable energy sources, the role of each dimension availability, accessibility, affordability and acceptability is significant. An overview of indicators that influence or explain the four dimensions provides an overall assessment of the role of renewables in assuring energy security in the period 2000-2016.

The availability of renewable energy sources and their contribution to electricity generation is critical in evaluating renewable energy from energy security.

AVAILABILITY

The availability of renewable energy in the world can be assessed by indicators such as the trend in the electricity installed capacity of total renewable energy over 2000-2016, electricity generation by renewable energy sources and their respective proportions.

Renewable energy capacity in the world has been increasing consistently, more steeply after 2010, as shown in figure Appendix 3a, it had increased from 753946 MW in 2000 to 2350755 MW in 2018. The electricity capacity of wind is growing at the highest rate compared to the rest of the renewable energy sources, followed by solar energy, Appendix figure A.2.

The total renewable energy generation has also been increasing consistently over the period 2000-2018, as observed in Appendix figure A.3. The total renewable energy generation had increased from 2836289 GWh in 2000 to 5885504 GWh in 2016. The proportion of electricity generation is the largest by wind energy, and it is rising steeply compared to other renewable energy sources in Appendix figure A.4. Among wind energy, there is a massive rise in the contribution to electricity generation by onshore wind in comparison to offshore wind.

The proportion of electricity generation by solar energy is substantially less than wind and bioenergy. However, the proportion of the total renewable energy electricity generation increased after 2011. Solar PV (SPV) contribute to electricity generation much more than concentrated solar power (CSP), with the contribution of SPV steeply rising since 2008 in comparison to CSP. The contribution to electricity generation by off-shore wind and concentrated solar power is minimal in the available wind and solar energy technologies. The trends and the pattern convey that there has been a significant increase in the renewable energy potential (capacity) as well as the role of renewables in electricity generation has been increasing over the years, with wind energy taking the lead followed by solar energy, mainly SPV.

Accessibility, in today's era, where all essential facilities' inclusiveness is the primary focus of Sustainable Development Goals (SDGs), it is essential to examine the renewable energy sources from the prism of accessibility.

ACCESSIBILITY

The accessibility dimension of energy security pertains to making renewable energy accessible to remote and rural areas. Examining the statistics of access to electricity in rural areas and access to clean energy technologies for cooking, both the parameters are increasing with time. However, access to electricity is much higher than access to clean energy technologies, as observed in figure Appendix figure A.5. Transmission and distribution losses significantly reveal the final quantity available for consumers after the losses; the lesser the losses greater is the amount available for consumption. It can be seen from Appendix figure A.5 that access to electricity in rural areas has been increasing since 2000, along with access to clean fuel and technologies for cooking. The electric power losses in transmission and distribution have been maintained a constant proportion as a percentage of output. It is observed that transmission and distribution losses (T&D losses) are also under control as they remain constant over the period as the percentage of T&D losses are almost constant in the period 2000-2018.

AFFORDABILITY

Energy security revolves around the prices from the consumers perspective and costs from the perspective of the provider or investor. As a result, the affordability of renewable energy sources plays a critical role in ensuring energy security. In renewable energy, the Levelized costs of renewable energy are the main indicator of affordability. It is observed that the Levelized cost of solar PV is drastically reducing from 0.36USD/kWh in 2010 to 0.1 USD/kWh in 2017. While the Levelized cost of onshore wind was much lesser than Solar PV in 2010, approximately 0.08 USD/kWh in 2010, declined only to 0.06 USD/kWh in 2017, as shown in figure Appendix figure A.6

The other factors that affect the affordability of renewable energy sources are the investment cost associated with the renewable energy source. The investment cost for condensed solar power is much higher than the other renewable sources, while the investment cost for solar PV reduced drastically from 4394 USD/kW in 2010 to 1388 USD/kW in 2017. In terms of investment costs, Solar PV has become comparable to onshore wind and hydropower, as depicted in figure Appendix figure A.7 and figure A.8.

Visualizing renewable energy integration is highly dependent on overall investment across the world and sources of finance. Solar energy has received the highest amount of investment, reaching the amount 158.1 USD billion in 2011 and 179.3 USD billion in 2015, followed by wind energy approximately 124.7 and 121.6 USD billion in 2015 and 2016, respectively, Appendix figure A.8.

It is observed that public markets have funded renewable energy to the maximum, reaching a maximum in 2007, 20.8 USD billion and 15.1 USD billion in 2014, Appendix figure A.9. Government and corporate R&D both have remained the same over the years. Further, investments by China have shown an all-time high reaching a maximum of 102,900 million dollars in 2015 and 2017, Appendix figure A.10. Apart from prices and costs associated with renewable energy sources, the level of energy intensity also reflect efficiency and contribute to the affordability of an energy source.

ACCEPTABILITY

In the present era, when climate change is the biggest global challenge, the concept of acceptability of energy source depends on the ability of energy source to address various environmental concerns. Indicators such as carbon-di-oxide emissions per capita, C02 emissions per GDP reflect the environmental factor associated with an energy source.

Apart from the environmental aspect, the sustainability of an energy source is another crucial component of the acceptability of the renewable energy system. Sustainability is measured by the number of patents, expenditure on research and development etc. The number of patents for solar energy technology increased to 39411 in 2011, followed by wind energy technology at 13549 in the same year. In 2016, the number of patents for solar and wind energy declined to 5862 and 1812, respectively, as shown in Appendix figure A.11. Both CO2 intensity and energy intensity are gradually worsening over time, indicating that a gradual shift in energy systems is affecting the environment though not substantially. Still, the rate of change in the emissions has been controlled substantially, as visible in Appendix figure A.12.

On the primary note, it is observed that there has been a significant increase in the renewable energy potential (capacity), and the role of renewables in electricity generation has been increasing over the years, with wind energy taking the lead followed by solar energy mainly SPV. Renewable energy is observed to be accessible, and the transmission and distribution losses are under control. Further, the Levelized cost of solar PV has drastically come down in 2017 as compared to 2010. The Levelized Cost of onshore wind was much lesser in 2010; however, now the cost is comparable with solar PV.

The investment costs of solar PV have become comparable to onshore wind and hydropower. Solar energy has received the highest amount of investment along with the number of patents for solar energy technology increased, followed by wind energy technology. Both CO2 intensity and energy intensity are gradually declining over time, indicating that a gradual shift in energy systems affects the environment though not substantially. Still, the rate of change in emissions has been controlled substantially.

Results and Discussions

After normalizing all the indicators by the min-max normalization method, the normalized values are plotted to observe the trends and pattern of the variable for all the dimensions. Figure 11 reveals the pattern of normalized values of availability of both the conventional and renewable energy sources for the time -period 2000-2017. The results of the PCA method are compiled in Appendix II.

Figure 11 depicts the pattern of availability, affordability, accessibility and acceptability aspects of renewable energy. It can be visualized from the figure that all the four aspects are gradually improving from 2000 to 2018. The correlation values in table 4 indicate that all four aspects of energy security are significantly positively correlated and are positively considerably correlated with the energy security index.

By deploying the PCA method, the energy security index for renewable energy is computed. The indices are calculated for the time 2000 to 2018. During the initial years, the index is negative, suggesting insecurity related to renewable energy. Figure 3 indicates the pattern or status of the renewable energy security index, which improves steadily over the time 2000 to 2018.

It is observed in figure 12, the renewable energy security index improves from 2011 onwards and consistently improves till 2018. The analysis points out the significant correlation between all the four dimensions of energy security related to renewable energy.

Figure 11. Trends in the normalized values of four dimensions of 4 A definition of energy security

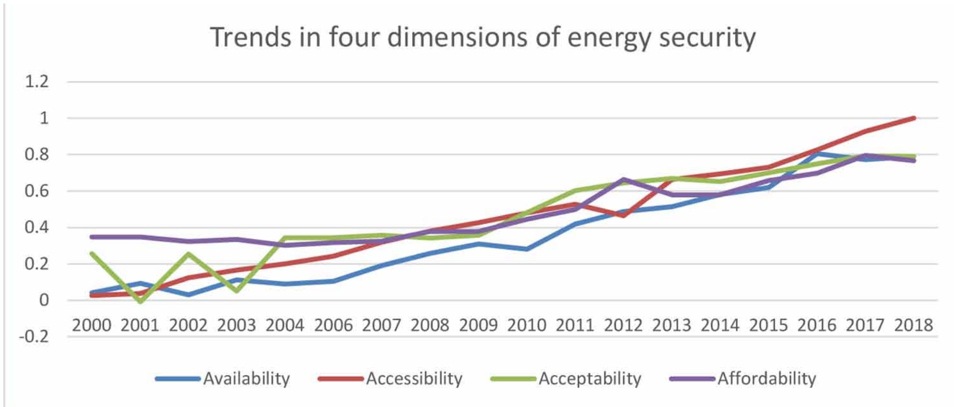
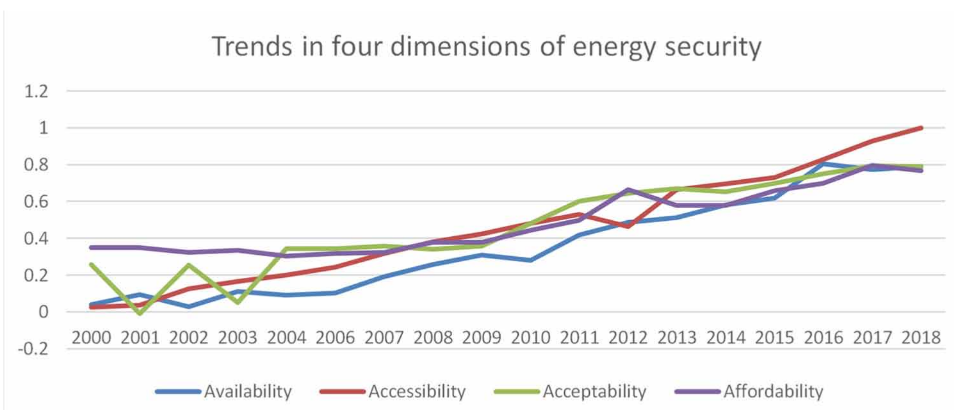


Table 4. Results of correlation

	Availability	*Accessibility*	*Acceptability*	*Affordability*	*ESI*
Availability	1				
Accessibility	0.972201006	1			
Acceptability	0.911242804	0.927730073	1		
Affordability	0.961720467	0.915122016	0.892274623	1	
ESI	0.987781429	0.979990547	0.957849041	0.968032	1

Figure 12. Renewable energy security index, World



The correlation results further indicate that increase in public investment in renewable energy and spending on Research and Development significantly enhances the status of energy security related to renewable energy. Moreover, more and more use of renewable energy consumption and electricity generation significantly improves energy security. However, it is observed that energy intensity is significantly negatively correlated with the energy security index. This mainly suggests that between 2000 to 2018,

Table 5. Results of correlation

	RE consn	*R&D funds*	*Public investment in RE*	*Electricity generation (GWh) RE*	*AFF RE*	*INT*	*ESI*
RE consn	1.000						
R&D funds	0.964	1.000					
Public investment in RE	0.895	0.953	1.000				
Electricity generation (GWh) RE	0.988	0.988	0.928	1.000			
AFF RE	0.955	0.963	0.939	0.958	1.000		
INT	-0.582	-0.667	-0.756	-0.601	-0.689	1.000	
ESI	0.969	0.990	0.951	0.992	0.968	-0.620	1.000

an increase in energy consumption per unit of GDP, also suggesting lower levels of energy efficiency is negatively associated with energy security. As economies across the world increase the energy intensity, mainly suggesting energy inefficiency, a substantial fall in energy security is observed, suggesting that the world on average experience insecurity related to renewable energy.

It is also crucial to observe that as renewable energy consumption increases, the energy intensity declines, suggesting an improvement in energy efficiency. Therefore, the use of renewable energy is associated with an improvement in energy efficiency. Further, public investment and research and development funds are also significantly negatively correlated with energy intensity, depicting improved energy efficiency.

CONCLUSION

With the advent of climate change as the most significant global challenge, the energy transition to renewable energy sources is imperative. It brings forth the genesis of energy transition driven by renewable energy sources. The renewable energy transition is determined by geopolitical factors that favour the countries that are privileged in terms of availability of capital, technological advancement, human resource, sources of finance of clean energy technologies and R&D in renewable energy technologies. Further, the deployment of renewables is critical for energy security. Therefore, the role of renewables in contributing to energy security has been analysed by computing a renewable energy security index comprising four crucial aspects of 4 A definition of energy security. The renewable energy security index has been improving over the period 2000-2018 and is significantly correlated with all the four aspects of energy security availability, accessibility, acceptability and affordability. An increase in public investment in renewable energy and spending on Research and Development significantly enhances the status of energy security related to renewable energy. Moreover, more and more use of renewable energy consumption and electricity generation substantially improves energy security.

The results suggest that the deployment of renewable energy is associated with significant improvement in energy efficiency. Besides, spending on research and development and public investment in renewable energy significantly improves energy efficiency. Consequently, the economies across all nations should adopt appropriate pathways of the energy transition towards renewable energy sources not only to achieve energy security but also energy efficiency.

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Chapter 11
Optimizing the Power Consumption of Household Appliances Using IoT

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ABSTRACT

This chapter deals with a model that works under a specific maximum demand. It will distribute the power among the thermal appliances effectively with a given capacity. The research is carried out on the consumer side demand management and designs an admission controller for the appliances to decide which ones are accepted. In developing the algorithm to schedule the thermal appliances, the authors have studied different cases. The algorithm is simulated in the platform of MATLAB/Simulink. The simulation results recommend that the provided power is effectively used by the appliances, and the wastage of the power consumption is reduced significantly in all cases. Finally, the operation of the appliances can be controlled based on the requirement of the consumer and the available capacity by using IoT.

INTRODUCTION

It is important to ensure reliable and uninterrupted power to the appliances which is a major concern for successful operation of power systems. Ideally, the appliances should always be provided constant power and frequency sources. That means the voltage and the frequency must be in a range so that the appliances may operate reasonably (IEO, 2016). In a result, the order of the system become relatively

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enlarged and the complexity is risen. Consequently, the analysis of dynamic stability and the control design of these large interconnected systems become difficult (Fischer, 2013).

The energy consumption in buildings is increasing world-wide over the years. According to the International Energy Outlook 2016 Reference case, the buildings' consumption increases 1.5/year on average world-wide from 2012 to 2040 (IEO2016). With the growing urbanization, approximately 80% people of the world get advantages from electric power. In the US, a typical household energy consumption is approximately 11,700 kWh each year. Besides, in France, UK and China, it is 6,400kWh, 4,600 kWh and 1,300 kWh, respectively. The average household consumption is around 3,500 kWh globally (Crystal, 2015). The countries with below 5% people living under poverty level have four times higher energy consumption. In Europe, the energy consumption is 33% of the world's consumption, where it is 26% in North America. The efficiency of energy usage is only 39% approximately based on the report of the Lawrence Livermore National Laboratory (LLNL) (Fischer, 2013). Hence, almost 60% of energy is wasted, which is more than half of energy.

The energy consumption in residential sector is almost 50% in many developing countries. In Bangladesh, for example, the residential buildings consumed about 47% of the total energy in the last few decades, where the agriculture and industrial sectors consumed around 45% (Masuduzzaman, 2012). Nevertheless, a significant amount of power is wasted in residential and commercial buildings due to the lack of proper utilization of energy. The use of Internet of Things (IoT) may reduce the wastage of total energy by utilizing the building consumption effectively.

During the past few decades, a number of studies has been accomplished for the management of energy consumption in buildings. It is shown in a variety of research works that pick power reduction can manage energy consumption in smart buildings efficiently (Adika & Wang, 2014; Costanzo, Zhu, Anjos & Savard, 2012; Pipattanasomporn, Kuzlu & Rahman, 2012; Yao, Costanzo, Zhu & Wen, 2014). The household appliances are scheduled by applying a mixed integer programming approach in Agnetis, Pascale, Detti and Vicino (2013). A greedy approach has been proposed to find the optimal start time of the appliances in Chavali, Yang and Nehorai (2013), which eventually reduce the energy consumption of the appliances. Another greedy approach was developed in O'Brien and Rajagopal (2015) that reduces the pick consumption by considering known and unknown load demands. A nonlinear model was developed in Setlhaoloa, Xia and Zhang (2014) to schedule household appliances, that reduces the electricity cost by shifting the load consumptions. In Sadid, Abobakr and Zhu (2017), peak consumption has been reduced by developing two different scheduling algorithms.

To optimize the power consumption, the appliances are controlled in a way that they may not operate simultaneously at the same time. Hence, a scheduling algorithm is designed to control the appliances by considering a thermal coupling among the rooms of the building. Finally, the control actions of the appliances are sent using IoT after implementing the algorithm. IoT is an internetworking system which is used to send data or information through an input device to a server. Among many real-world applications of IoT, 'Smart Home' or 'Smart Building' is an important one. It helps to improve the resource performance, to utilize the energy consumption and to reduce the environmental impact of the buildings. In a smart building or smart home, all the physical objects or devices are interconnected through a network and they use sensors, actuators, microchips etc. to collect user data or environment data and automatically control the operation of the building. For example, a consumer can give a command to the system to switch on the air conditioning system before entering the house or can update the stock of the refrigerated items. In regular basis, the user can switch on or off the lights after entering and leaving the house. Controlling the ventilation system or lock or unlock the doors in emergency situations are also some of the smart operations of the building that can be handled using IoT. That means, it helps to improve the resource performance, to utilize the energy consumption and to reduce the environmental impact of the buildings. In that case, a specific decision-making process is applied to control the thermal appliances based on the data or information.

This research is motivated by the fact the operation of thermal appliances which will be controlled in a practical environment that optimizes the energy consumption and ensures the comfort level of the building. Therefore, it is required to build such a system which encapsulates the appliances functionality, ensures cooperation between them, provides easy maintenance and allows upgrading the system with the fast-moving world. In addition, optimizing the power consumption has a great impact on the environment. It will reduce the greenhouse gas emission. So, while it ensures the comfort level to the consumer by reducing the overall consumption, it also provide positive impact on the environment by reducing the amount of carbon footprint by the consumer.

The contribution of this work is two-fold: (i) design an algorithm to distribute the power among the thermally coupled appliances efficiently, and (ii) optimize the power consumption of the appliances by controlling them remotely using IoT, which also reduces the emission of the greenhouse gases.

The rest of the paper is organized as follows. Section II discusses the background of this research. The model of thermal appliances (e.x., air condition, refrigerator, washing machine) is shown in Section III. Section IV presents the admission controller for scheduling the appliances. Three different cases are considered in this section with the proposed algorithm. The simulation setup is described in Section V. Section VI shows the simulation result with some analysis. Finally, some concluding remarks are given in Section VII.

PRELIMINARIES

The efficient and effective use of energy consumption in buildings motivates to work in the development of smart grid. Demand side management (DSM) on the consumer side is one of the important concepts of the smart grid. It works on reducing the power consumption in buildings effectively. It is the "planning, implementation and monitoring of those electric utility activities designed to influence customer uses of electricity in ways that will produce desired changes in the utility's load shape" (Gellings, 1985).

Different types of appliances are used in the buildings. Based on their basic characteristics, they are categorized into three types, which also leads to manage the load efficiently. These are i) baseline load, ii) regular load and iii) burst load.

i) Baseline load: A minimum percentage of the capacity should be kept for these loads, because the demand from these loads can come any time. Figure 1 shows examples of the baseline load including lighting, computer, fan, cooking stove, TV, etc. The operation of these loads is beyond the control of the admission controller. They perform their operations based on the requests of the consumers and they consume power accordingly.

ii) Regular load: This type of loads consumes a major amount of energy. That's why, their operation should be managed efficiently. The admission controller accepts or rejects the requests of the loads based on their priority. They can be performing their operation for long time. Figure 2 shows few

Figure 1. Examples of baseline load

Figure 2. Examples of regular load

examples of regular loads, which includes water heaters, refrigerators, HVAC (heating, ventilation, and air conditioning), etc.

iii) Burst load: The operation of these loads depends on their starting time and ending time. This type of loads has a significant impact on the efficient energy consumption. Hence, it is one of the critical issues to manage the burst loads efficiently. Some examples are shown in Figure 3, which includes washing machine, dryer, dishwasher etc.

We are motivated and started our research from a layered architecture proposed by Costanzo et al. (2012). There are three layers in the architecture: admission controller (AC), load balancer (LB) and

Figure 3. Examples of burst load

demand response manager (DRM). While the AC interacts with the appliances to ensure the comfort level by considering some constraints, the DRM and LB act as an interface with the power supply and the long-term scheduling to distribute the load for a specific time duration. However, we are restricted only to the bottom layer, i.e. AC, in this chapter. Besides, consumer side demand management is of the particular interest, because one of the main objectives of this research is to optimize the energy consumption of residential and commercial buildings. In addition, we assume the effect of thermal coupling between the rooms. The grid and the upper layers of the architecture are beyond the scope of this work.

The layered architecture provides some advantages including the ease of integration, high interoperability and modularity. In addition, the architecture holds some important features. It can be used in buildings, factories, commercial centers, campuses, military bases, and also in micro-grids. Different complexity can be presented among the components but the structure of the system remains the same. This structure allows integrating renewable resources and handles the energy storage and exchange. It is also suitable for conventional electricity load management. As DSM can be implemented for individual consumers or a group of consumers including industrial or commercial purpose, the system can be organized in a hierarchical manner so that the price bidding can be carried out at different level.

MODEL OF APPLIANCES

We consider three types of thermal appliances in this chapter. These are air condition, refrigerator, and washing machine. Based on the thermo-dynamic model, the mathematical models of air condition and refrigerator are almost similar to each other. The thermal model of air condition can be defined based on the model in Godwin, Ogbonna and Lawrence (2015).

$$\frac{dT_r}{dt} = \frac{1}{C_r R_r^a}\left(T_a - T_r\right) - \frac{A_c}{C_r}\varphi_c + \frac{1}{C_r}\sum_{p=1,\, p\neq r}^{R} \frac{1}{R_{pr}^d}\left(T_p - T_r\right) \qquad (1).$$

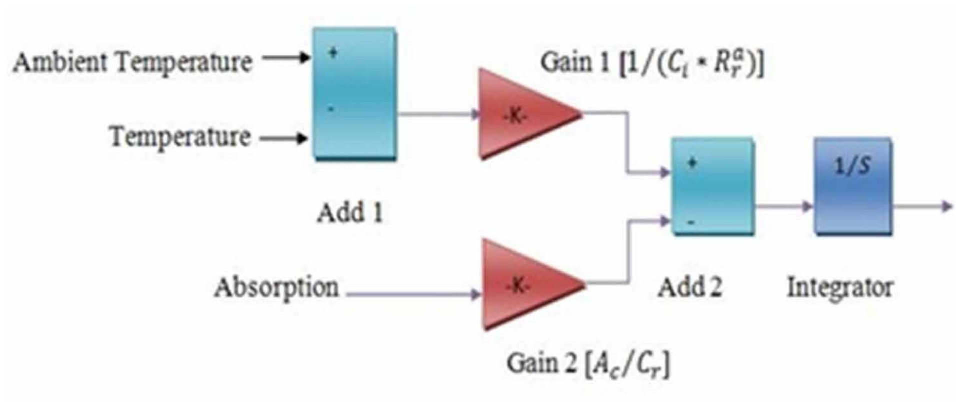
Here, T_r is the room temperature, T_a is the ambient temperature, C_r is the heat capacity of the room, R_r^a is the thermal resistance between the room and the ambient temperature, A_c is the overall coefficient performance, ϕ_c is the power input to the room, and R_{pr}^d .is the thermal resistance between room *p* and room *r*.

After that, a refrigerator can be modeled similarly as the air condition with slight modification. All the parameters are same for the refrigerator except T_r and T_a. In contrast to the air condition, T_a and T_a corresponds to the room temperature and the chamber temperature (i.e., the inside temperature), respectively for the refrigerator.

The thermal model for washing machine is modeled from Meinicke and Ribas (2012). The heat exchange by conduction is modeled by the following equation:

$$Q = \frac{kA}{l}\left(T_1 - T_2\right), \qquad (2).$$

Figure 4. Thermodynamic Model



Here, k is the conductivity, A is the area, and l is the length of the wall of conducting the heat. T_1 and T_2 are the temperatures of the two parts that exchange heat between each other. Similarly, the heat exchange by the convection and radiation are modeled. Please see Godwin et al. (2015), Jung, Chung and Lee (2009), and Meinicke and Ribas (2012) for the details of the model. A typical thermodynamic model of an appliance is shown in Figure 4.

The operation of each appliance is characterized by four factors: (a) status, (b) preemption, (c) heuristic value, and (d) requested power (Costanzo et al., 2012). The status declares the current state of the appliance. It can be easily represented by a finite state machine (FSM), shown in Figure 5. The status of an appliance is formally defined by the following states:

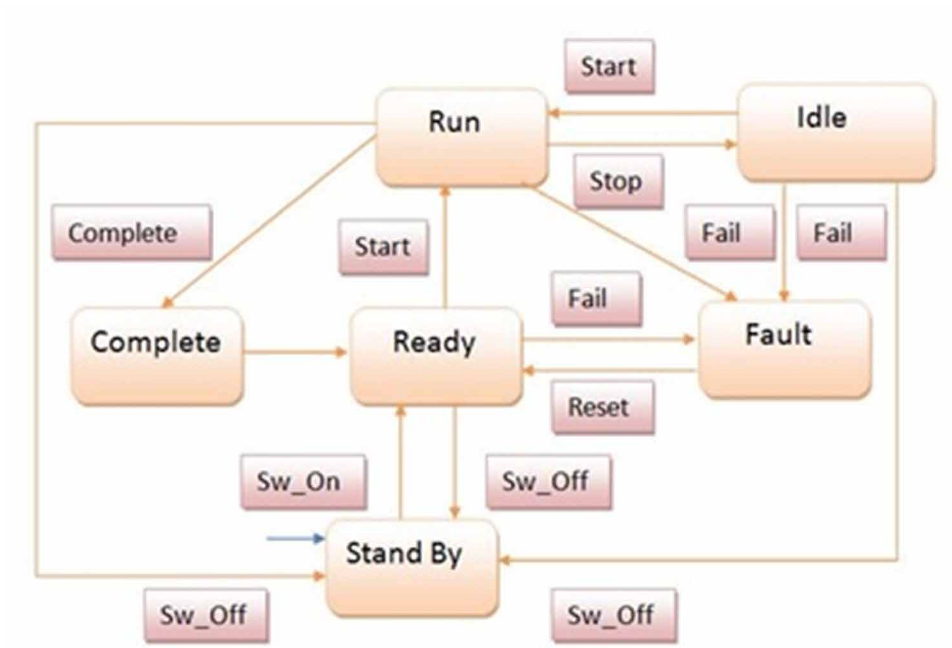
- Off State: Appliance is switched off, that means it is not enabled.
- Ready State: Appliance is enabled and ready to run.
- Run State: Appliance consumes power because it is running.
- Idle State: Appliance consumes no power because it is not running and does not receive any command from the controller.
- Complete State: The job of the corresponding appliance is done and returns to the 'Ready State'.
- Fault State: Fault occurs in the appliance.

The operation of some appliances may not be interrupted, which is defined by the preemption. In addition, the control action of the appliances is executed by their priority. It is determined by their heuristic value, which is measured between 0 and 1.

MODELING OF ADMISSION CONTROLLER

The AC directly handles the request coming from the appliances. The request of the appliances is accepted based on the available capacity. That means a request can be rejected depending on a particular moment, which eventually degrades the performance of the system as well as of the appliance. It also causes an inefficient utilization of the power. For that reason, an algorithm is proposed in Sadid et al.

Figure 5. Appliance Finite State Machine



(2019), where the available power is distributed among the appliances in such a way that all the appliances are able to be optimally operated.

We initially define the admission control of appliances as a linear problem. We consider a set of n appliances that are indexed by $N = \{1, 2, \ldots, n\}$. Then the distribution of power among the appliances is defined as a linear programming, by considering $t \le P_i$. as below:

max t.

s.t. $t - P_i \le 0$. where $i \in N$ $(3a)$.

$P_i \ge P_{lb_i}$. where $i \in N$ $(3b)$.

$\sum_{i \in X} P_i \le C.$ $(3c)$.

Here P_i is the decision variable, and P_{lb_i} .s the lower bound of the power for the appliance i. Then a scheduling algorithm is developed based on the concept of progressive filling. The new algorithm initially distributes the minimum power to the appliances, and then maximizes according to the status of the appliance and the available capacity. Hence, it can distribute the power efficiently among the appliances.

The appliances are initially sorted in descending order according to their heuristic values. Then it distributes the minimum required power to all the appliances to start their operation. In the simulation, six appliances are considered including four air conditions, one refrigerator and one washing machine. The refrigerator is considered as non-preemptive. So, it has the highest priority and its operation cannot be interrupted. In addition, appliances get their maximum required power for ON/OFF controller. If the controller is PI, then the corresponding appliance gets minimum required power. In our simulation, we have considered the minimum required power of an appliance as 20% of its maximum power.

The algorithm is given below:

Variables:

N = request set

i = request $\in N$

Algorithm 1: Scheduling of appliances

Sort the request according to the heuristic value in descending order.

```
for all appliance i ∈ N do
     if the request i is running and non-preemptive then
               Accept the request i from N
         if the request i comes from ON/OFF controller then
                give the requested power to i
                        remove the request i from N
                    end if
        if the request i comes from PI controller then
                give the minimum power to i
end if
       end if
  end for
  for all appliance j ∈ N do
      if the request is running and there is available power then
                 Accept the request j from N
           if the request j comes from ON/OFF controller then
                give the requested power to j
                        remove the request j from N
                    end if
        if the request j comes from PI controller then
                give the minimum power to j
end if
        end if
    end for
```

Note that the maximum demand or capacity is defined depending on the characteristics and the requirement of a building. It can be determined in advance from the historical power consumption of the building. If the capacity is not bounded, then there is an absolute chance of an increase in the peak demand in addition to the increase in the energy consumption of the building. On the other hand, the electricity bill usually not only depends on the energy consumption but also the peak demand of the building during the billing cycle. Hence, there is an adverse impact on the billing of the consumers, because they need to pay a lot regarding the peak demand of the building. That's why, we mainly focus on the reduction of the peak demand, which eventually reduces the total consumption of the building as well as the electricity bill of the consumers. Hence, the capacity (or the maximum demand) of the building is determined, from the record of the previous energy consumption, before implementing the proposed algorithm.

Depending on the type of the appliances, a minimum required power is initially distributed. Then, the remaining capacity can be distributed in different ways. We have considered three different cases through which we can distribute the remaining capacity to the appliances and compare their performances. So that, there are different options available to the consumer who can choose one based on one's requirement. The three different cases are given below:

Case 1: **Priority of the appliances:** The appliances are sorted in a descending order depending on their priority. Then, the remaining capacity is distributed to the appliances from the top of the requests from the sorted list. The appliance having the highest priority will be given the remaining capacity according to its required power. If any capacity is left, then the appliance of the next priority will get its required power. This process will be continued until the available power becomes zero.

Case 2: **Average remaining capacity:** Based on the controller type and the appliances, first the minimum required power is distributed to the non-preemtive and other appliances. Then the average of the remaining capacity is calculated and distributed to the appliances accordingly.

Case 3: **Proportional wrt the priority:** After giving the minimum required power to the appliances, the remaining power will be distributed according to the ratio of their heuristic values. The proportion of the remaining capacity for each appliance is calculated as:

Remaining capacity * Heuristic value of each appliance / Total heuristic value.

Through these algorithms, we can utilize the energy consumption of the appliances efficiently and reduce the wastage of the energy. The detail of the algorithms and flow charts are given in Sadid et al. (2019).

Simulation Setup

We consider a two-storied building for the simulation. We also consider that there are two rooms on each floor, and each room has an air condition. In addition, there is one refrigerator and one washing machine in the building. In the simulation, the external temperature is set to 28^0C for the building. The required room temperature is assigned as $(23\pm1)^0$C. The actual room temperature is defined as the external temperature of the refrigerator. The refrigerator is considered as non-preemptive. So, it is switching between the desired temperature, which is between 2^0C and 3^0C.

In this simulation, the heuristic value is measured between 0 and 1. The heuristic value of the air condition system is measured by the following formula:

(i) If $T_r \geq T_{ub}$, then the heuristic value is 1.
(ii) If $T_r \leq T_{lb}$, then the heuristic value is 0.
(iii) If $T_{lb} < T_r < Tub$, then the heuristic value is determined as

Here, T_r is the corresponding room temperature of the air condition placed in that particular room, and T_{lb} and T_{ub} are the lower and upper temperature setpoint of the comfort zone, respectively.

The heuristic value of the refrigerator also depends on the lower and upper bound of the temperature as below:

(i) If $T_f \geq T_{ub}$, the heuristic value is 1.
(ii) When $T_f \leq T_{lb}$, the heuristic value is 0.
(iii) When $T_{lb} \leq T_f \leq T_{ub}$, the heuristic value is also 1 because of the ON/OFF controller.

Here T_f is the inside temperature of the refrigerator, and the upper and lower bound of the comfort zone of the refrigerator are T_{ub} and T_{lb}, respectively.

The heuristic value of the washing machine is defined with respect to the start time. It is determined by the latest time before which the machine should be started as below:

(i) If $t \geq t_{st}$, then the heuristic value is 1.
(ii) If $t \leq t_{at}$, then the heuristic value is 0.
(iii) (iii) If $t_{at} < t < t_{st}$, then the heuristic value is computed as

$$\frac{t - t_{at}}{t_{st} - t_{at}}, .$$

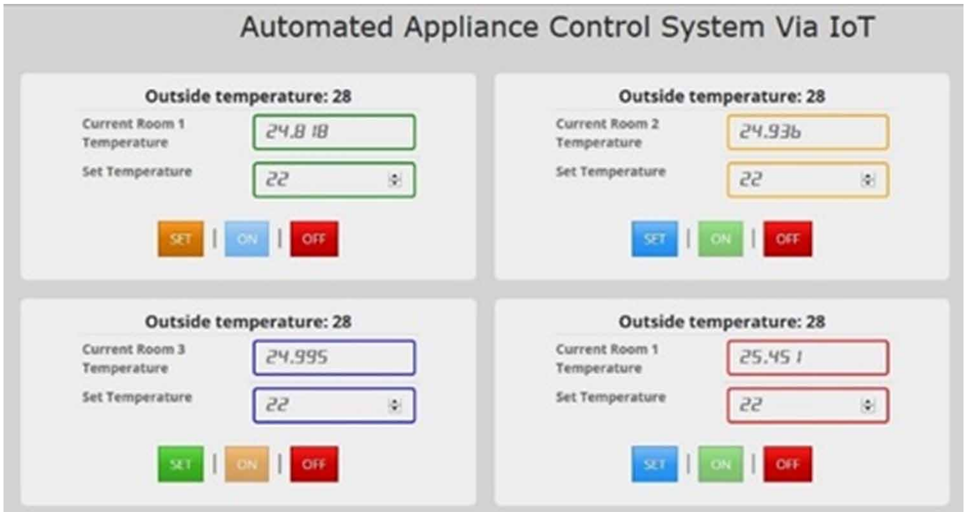
where, t_{st} is the latest start time and t_{at} is the arrival time of the request, and t is the current time.

In the simulation, we consider the controller for the refrigerator as ON/OFF controller, and the required power for the refrigerator as 500W. That means if the refrigerator is accepted, it needs the maximum required power. Note that, if it is a PI controller, then it may need the minimum required power to run. We consider the same air condition for each room. It is a PI controller for the air condition and the maximum power required for each air condition is 1800W. We also consider the PI controller for the washing machine and its maximum required power is 600W.

IoT setup: Figure 6 shows an IoT based application, where the current room temperature is assumed as 28°C for each room. We have considered the set point of the room temperature as 22°C. The data received from the simulation is stored in a local server. The temperature of each room will be displayed in the web application which was fetched from the local server. An Arduino Ethernet Shield and Arduino Mega are used to control the system.

In our web application, there are three buttons to control the system: (i) SET, (ii) ON, and (iii) OFF. By pressing the "ON" button, the command straightly goes to the Arduino. Then the Arduino sends the corresponding command to the air conditioning system to run, and temperature decreases from 28°C to 22°C. Note that the room temperature is shown in 3 seconds interval. When the temperature decreases from 28°C to 22°C, the power consumption level is decreasing gradually. When the room temperature reaches the setpoint (i.e., 22°C), the relevant power of the air conditioning system becomes 0. It is kept until the room temperature reaches to 24°C. On the other hand, when the temperature goes down in the range from 24°C to 22°C, the air condition consumes power.

Figure 6. IoT based application



RESULT AND ANALYSIS

First, we have validated the algorithm developed in Costanzo et al. (2012). Then we simulated the algorithm by considering the fact that the appliances are thermally decoupled and presented in Sadid et al. (2019). In this chapter, we present the simulated result by considering the thermal coupling among the appliances. We consider three different capacity level during the simulation time. For the first 40 time units, the capacity is considered as 5kW, then for the next 80 time units, the capacity is limited to 2kW, which is finally reduced to 1kW for the remaining time units. This is reasonable for the pre-cooling (or heating) or the start-up during off-peak period, which resulting less power consumption during peak hours. Note that, the time span is normalized to 200 time units in our simulation.

Case 1: Distribution in Terms of the Priority of the Appliances

In Case 1, the appliances are accepted according to their priority. The status of the request coming from the appliances is shown in Figure 7. The operational status is indicated by 0 and 1 where 0 and 1 represent the acceptance and rejection, respectively. In the figure, the top 4 represent the requests of the air conditions, the next one is the request of the refrigerator and the last one is for the washing machine. All the requests are accepted at the beginning when the simulation starts. It is reasonable, because a percentage of the requested power is distributed initially to the appliances controlled by the PI controller. It also shows the less frequent switching of the appliances. Hence, the algorithm is more effective when more requests come at the same time from different appliances.

The temperatures of the rooms and the refrigerator are shown in Figure 8. The bottom temperature represents the refrigerator temperature, while the others represent the room temperatures corresponding to the air conditions. It is clear that all the temperatures are in the comfort level. The room temperatures are in the expected range between 22°C to 24°C. It is also notifiable that the temperature of the rooms reaches to the comfort zone in a reasonable time, because all the appliances are accepted at the beginning.

Figure 7. Acceptance of the appliances with the distribution in terms of priority

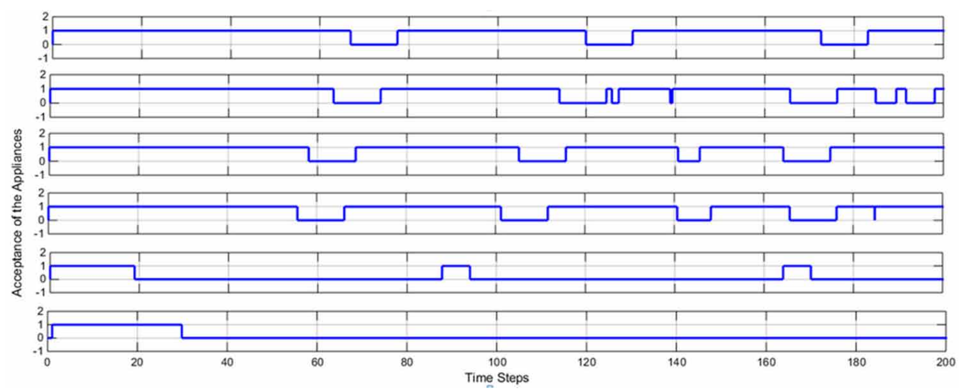
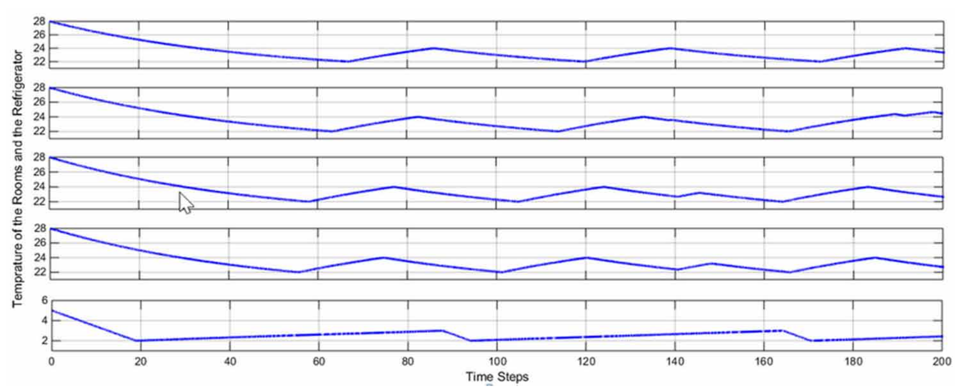
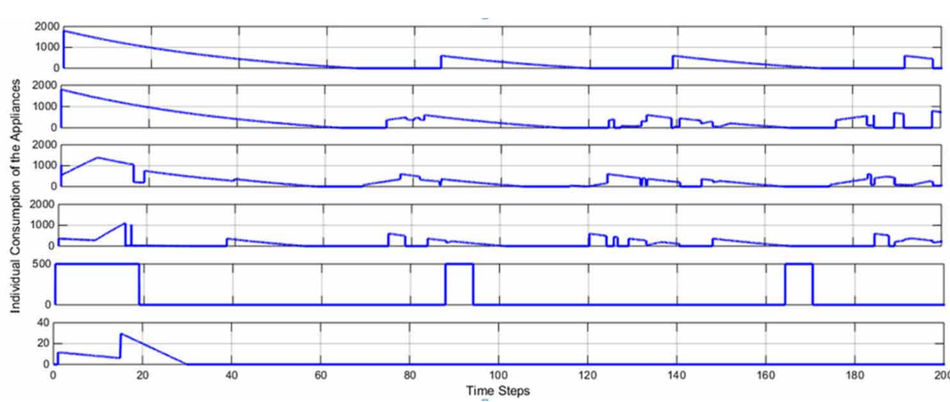


Figure 8. Temperature of the rooms and refrigerators with the distribution in terms of priority



The refrigerators are also in the comfort level (2°C to 3°C). Note that when the temperature reaches to the upper bound of the comfort range, the corresponding appliance sends a request to the AC. Since there is enough capacity, the AC accepts the request and the appliance is functioning. Then the temperature

Figure 9. Total consumption of the appliances with the distribution in terms of priority

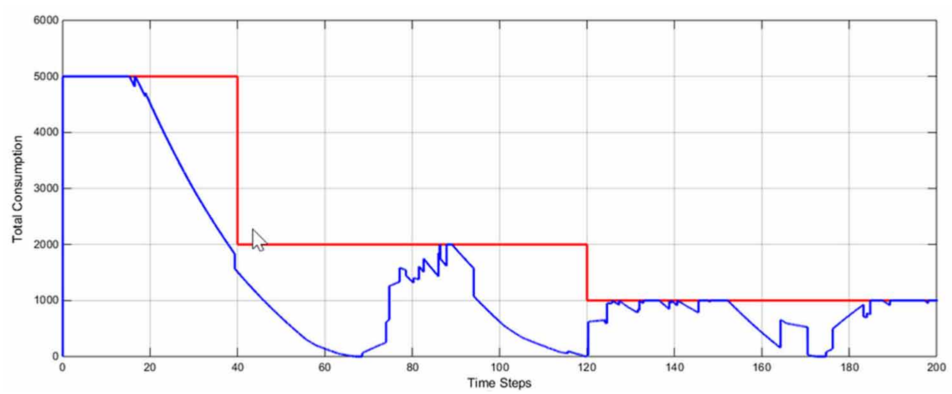


drops slowly to the lower bound of the comfort range. In this way, the appliance completes its task and stops its request to the AC.

Figure 9 shows the individual consumption of the appliances. Since the controller of the refrigerator is an ON/OFF controller, it consumes the requested power (2^{nd} from the bottom) when the request is accepted. The other controllers are PI controller, so their consumptions (bottom one is for the washing machine and the top 4 are for the air conditions) vary depending on their request as well as the available capacity. Initially the minimum required power is given to the appliances. Then the power is given to the appliance with the highest priority depending on its requested power and the remaining capacity. The same procedure is continuing until the remaining capacity becomes zero.

Figure 10 shows the total consumption of the appliances. It is clear from the result that it utilizes the energy in an efficient way. Initially, the total consumption is higher. It is justified because the systems need to be pre-cooling or pre-heating at the beginning of the simulation. Once the temperatures are brought in the comfort zone, the appliances need less energy to maintain the temperature in the required level. Specially, in the second time slot, the appliances consume less power. This is because, the room temperatures reach to the comfort zone at approximately similar time around the ending of the first time slot. Hence, all the air conditions request less power on that time.

Figure 10. Total consumption of the appliances with the distribution in terms of priority



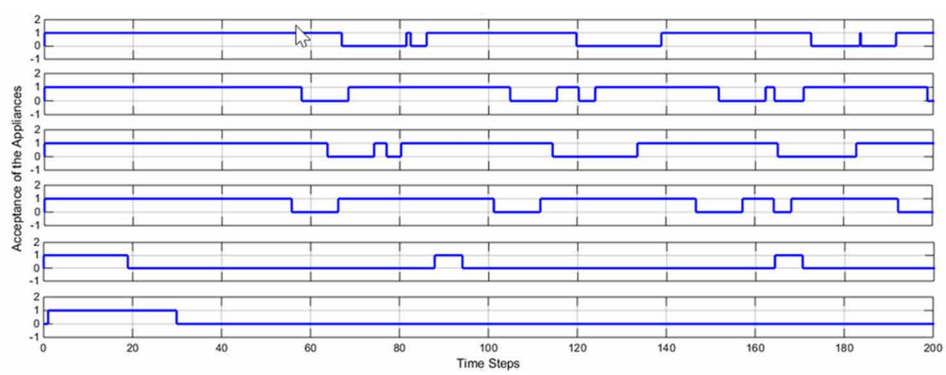
According to our developed algorithm, most of the appliances are accepted at the same time. This is reasonable because all the appliances are given a minimum required power to run at the beginning. This indicates that this model is more efficient than the previous one. After giving the minimum power, the remaining capacity is distributed among the appliances based on their priority.

Case 2: Distribution in Terms of the Average of the Remaining Capacity

In Case 2, after distributing the minimum required power to the appliances, the remaining capacity is evenly distributed. Figure 11 shows the acceptance of the appliances. As before, the operational status is indicated by 0 and 1. All the appliances are accepted after the simulation starts, and it is also very clear from the figure that the appliances switch less frequently. Since the average of the remaining capacity is given to all the appliances, they are always in run state unless there is no request from any appliance. Hence, the appliances switch to ON and OFF depending on their request.

The temperatures are shown in Figure 12. It shows clearly that the room temperature and the inside temperature of the refrigerator relies in the comfort zone. As Case 1, the room temperatures are in the expected range, and the refrigerators are also in their comfort level. It is clear that when the room temperature or the refrigerator temperature reaches to the maximum of the defined range, the corresponding appliance sends a request to the AC. Then the AC accepts the request based on the available capacity on that particular moment.

Figure 11. Acceptance of the appliances with the distribution of the average



The individual consumption of the appliances and their total consumption are shown in Figure 13 and 14, respectively. The refrigerator consumes the requested power when the request is accepted, because the controller of the refrigerator is an ON/OFF controller. In contrast, the consumption of the air conditions changes with respect to time. It depends on the minimum required energy that is needed to operate them, and the average of the remaining capacity.

Figure 12. Temperature of the rooms and the refrigerator with the distribution of the average

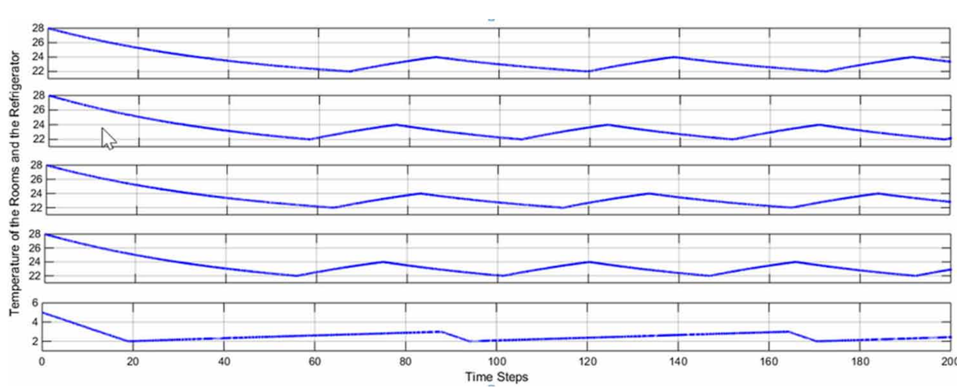
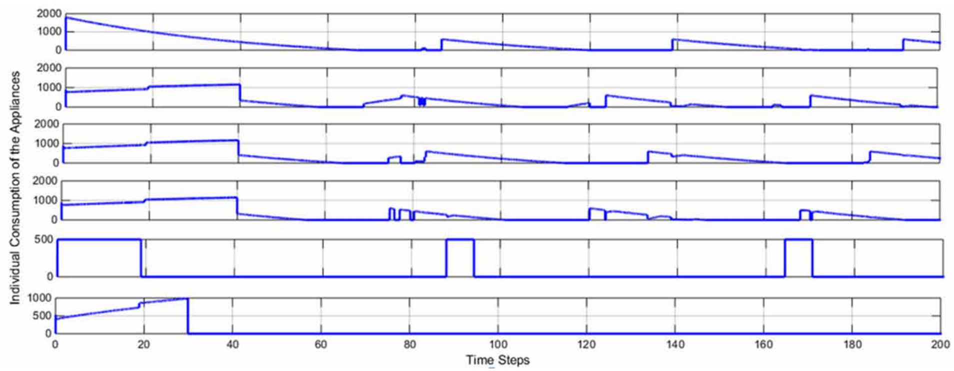


Figure 13. Individual consumption of the appliances with the distribution of the average



Case 3: Distribution in Terms of the Heuristic Value of the Appliances

In the last case, the heuristic value of each appliance is calculated depending on their priority. Then after initial distribution of the minimum required power to the appliances, the remaining available power is distributed as the proportion to their heuristic values. The acceptance of the appliances, based on their heuristic value, is shown in Figure 15. Note that all the appliances are accepted at the beginning as the previous two cases. This is obvious because the initial distribution of the power is same as Case 1 and Case 2. The status of the acceptance and rejection of the appliances is denoted by 0 and 1. We may notice that the switching of the appliances is also not very frequent like the other cases. It is rational because the appliances always receive a percentage of its requested power during their acceptance, which leads them to stay in the run state.

Figure 16 shows the temperature of the rooms and the refrigerator. It is obvious from the figure that the temperature lies within the comfort level. While the room temperatures are kept between 22°C and 24°C, the refrigerator temperature is kept between 2°C and 3°C.

The individual consumption of the appliances and the total consumption are shown in Figure 17 and 18, respectively. It is noticeable that the appliances consume less power at the beginning time slot of the

Figure 14. Total consumption of the appliances with the distribution of the average

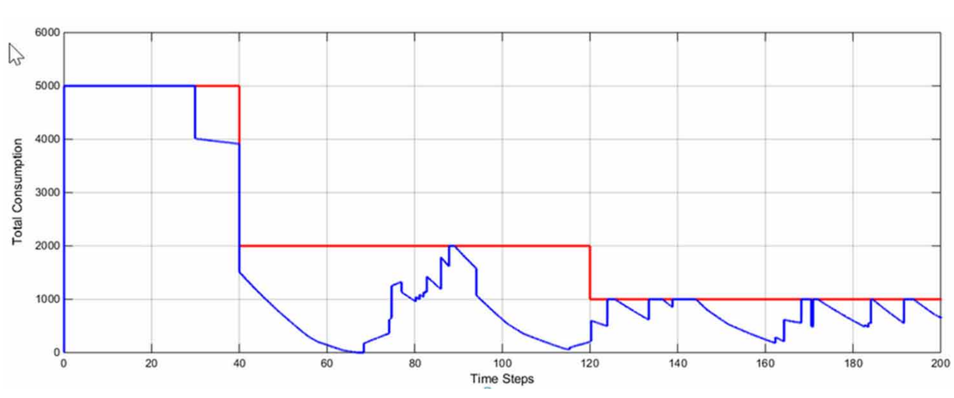
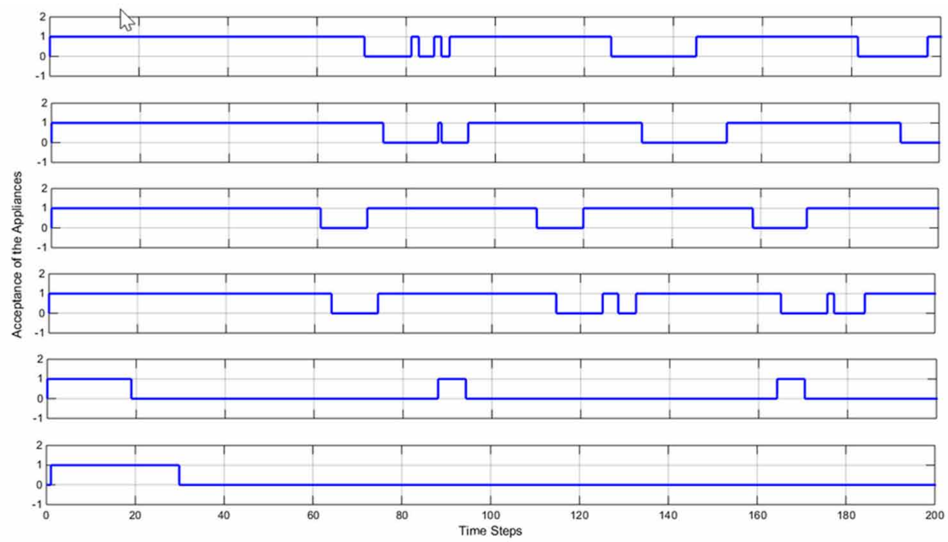


Figure 15. Acceptance of the appliances with the distribution of the heuristic value



simulation compare to the other cases. Hence, the room temperatures reach to the comfort zone slower compare to the other cases. Note that, the total consumption respects the available power in all time slots.

From the simulation result, it is shown that all the cases perform very similar and utilize the energy efficiently with a given limited capacity. The request of all the appliances are accepted and the available power is distributed among them depending on the conditions defined in the different cases. Though in all cases the total consumption respects the predefined available capacity, however, the Case 2 (the average of the remaining capacity) shows more even distribution compare to the other cases, and also the total consumption is more effectively utilized. Hence, to that end, the consumers can choose one of

Figure 16. Temperature of the rooms and the refrigerator with the distribution of the heuristic value

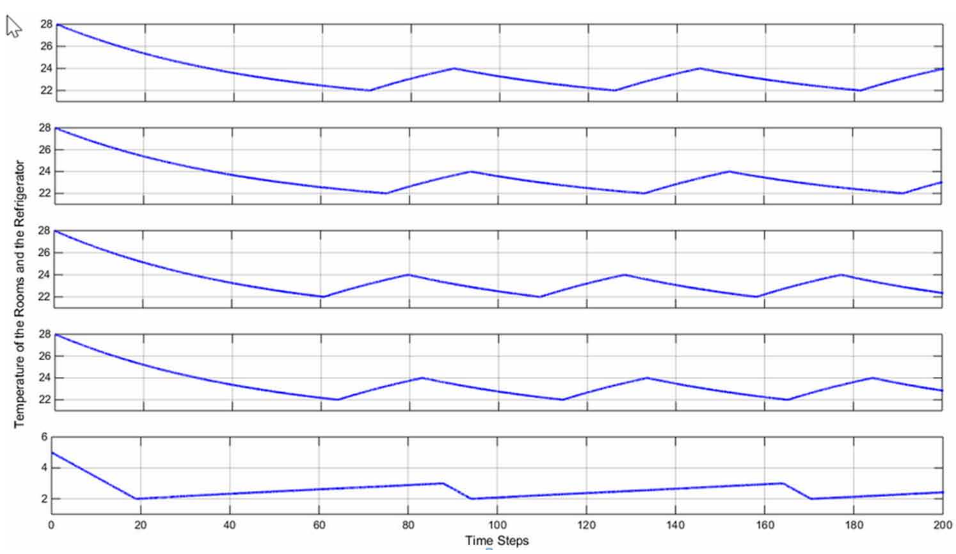
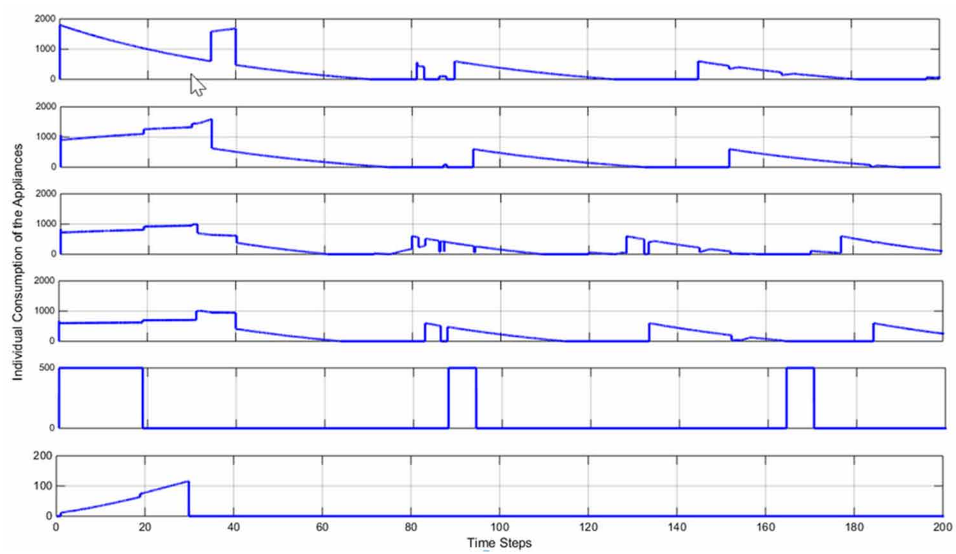


Figure 17. Individual consumption of the appliances with the distribution of the heuristic value

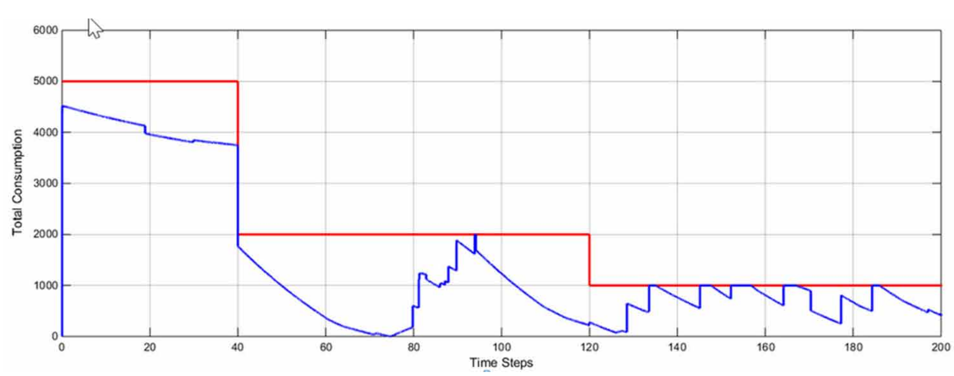


the distribution cases which best fits depending on their individual criteria. We can also clearly mention from the simulation results that the given power is utilized with higher efficiency, which also helps to stabilize the grid system. Note also that, the generation of electricity produces greenhouse gases depending on the materials used in the generating system. The optimization of the power consumption among the household appliances certainly reduces the overall consumption. Hence, it has a significant impact on the environment by reducing the amount of greenhouse gases.

FUTURE RESEARCH DIRECTIONS

Grid side management would be an interesting topic for the future research. The main concern to work with the smart grid is to deal with different technologies and system. Power generation, power transmission, efficient distribution and power consumption with less energy wastage are also some of the big

Figure 18. Total consumption of the appliances with the distribution of the heuristic value



challenges in this case. Besides, it would be a good idea to consider the upper layers of the architecture of Costanzo et al. (2012) in future. In this phase, we can schedule the appliances for the long-term period by considering the weather prediction and the top layers coordinate with the bottom layer to distribute the power based on the demand and the availability. Optimization of grid and consumer side management can be another exciting topic which may provide win-win condition. In addition, one may consider dynamic or real-time pricing to make the grid more stable by reducing the demand during the peak time.

CONCLUSION

We have adopted an algorithm to schedule the household appliances of a building. Note that, the power utilization of the previous algorithms was not efficient, because the appliances are only accepted when there is enough capacity. Hence, we have proposed to distribute the power among the appliances in an efficient way, so that the available power is utilized optimally. In addition, we have considered thermal coupling among the rooms of the building. The proposed model also considers three different cases, and all of them show the efficient distribution of power among the thermally coupled appliances with a given capacity. That means there are different options from where the consumers can choose depending on their requirements. The simulation results show the effectiveness of the models. In addition, one can give command to the system using IoT and control the operations of the appliances from remote place. It is also worthy to mention that the emission of the greenhouse gas will be significantly reduced by optimizing the power consumption in the residential and commercial buildings. In future, we can consider other layers of the architecture of Costanzo et al. (2012). It would also be an interesting topic to work grid side management in future.

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KEY TERMS AND DEFINITIONS

Admission Control: The admission control manages the requests coming from the appliances to decide whether the appliances are accepted.

Coupling: If the heating or cooling of one room affect other rooms, then they are thermally coupling, otherwise, the system is decoupled.

Demand Side Management: Demand side management works with the planning, implementation and monitoring of the electricity usage at the customer side.

Internet of Things: The internet of things is a network of physical devices, home appliances and other things embedded with software and different sensors to control the appliances from a remote place.

Layered Architecture: The layered architecture is developed to encapsulate the system functionality, interoperability of the components and the ease of maintenance.

Peak Power Reduction: The maximum demand of a building is optimized by controlling the request of the appliances. It accepts or rejects the request of appliances to minimize the peak power consumption.

Scheduling: The scheduling of home appliances is designed in such a way that the power consumption of the appliances satisfies the capacity constraints.

Thermal Appliances: The thermal appliances are used to control the heating and cooling system of a building.

Chapter 12
The Relationship Between Electricity Generation, Electricity Consumption, and Economic Growth in Turkey 1975–2019

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ABSTRACT

Electric energy is very important both technologically and economically in today's countries. Countries can generate and consume more energy according to their level of development and the resources they have. In the literature, it is estimated in parallel with the development of countries; there will also be an increase in electrical energy generation and consumption. Similarly, in economies that generate and consume more electricity, it is assumed that this will affect their economic growth. But these assumptions need to be calculated econometrically. This study has been prepared for this purpose. In this study, the relationship between electricity generation, electricity consumption, and economic growth in Turkey was analyzed. In the analysis conducted for the period 1975-2019, the Toda-Yamamoto causality test method was preferred as the method. As a result of the analysis, it was determined that there is a causal relationship from electricity consumption and electricity generation to economic growth, valid for the period 1975-2019 in Turkey.

INTRODUCTION

Whether there is a relationship between energy consumption (EC), energy generation (EnG) and economic growth (EG) is a topic that has been debated in the economic literature for many years. Especially with new econometric models included in the literature along with developing technology and scientific

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research, the number of studies on this subject is increasing (Xie et al., 2021). Of course, the lack of consensus in the literature on whether this relationship exists is also effective in experiencing this situation. The most intriguing issue among economists is whether EG comes before EC-EnG or whether energy affects EG (Acaravcı and Öztürk, 2010). In other words, the direction, source and effects of this relationship represent the main research area of the studies in the literature.

Energy has an important place in the economy in terms of both supply and demand. This importance stems from the structural interconnection of the energy sector with other sectors of the economy. Energy is a necessary input to be used in production and to increase the welfare of societies. Energy affects the development levels of countries and has a serious impact on determining the international policies of countries (Zhao et al., 2021; Liu et al., 2021). For this reason, the relationship between EC and especially electricity energy consumption (EEC) and EG has been a topic that has been debated among scientists for years (İsmiç, 2015). Especially with today's developing technology and increasing needs, it is possible to say that there is more interest in discussing this issue,

As can be guessed, the concept of energy expresses a collective meaning. In other words, energy consists of a number of components. When we examine energy by separating it into its components, it is claimed that electricity is the best quality energy component and its share in EC is increasing rapidly. (Karagöl, Erbaykal and Ertuğrul, 2007). The most important reason for this is that electricity can be generated from all primary energy sources. What these primary sources are will be explained later in the study. In addition, EEC is considered to be one of the most important indicators of the development level of countries with its characteristics such as being able to transmit electrical energy easily, be divided into desired amounts, not creating environmental pollution, demand at every stage of daily life and being an indispensable source in parallel with technological progress (Akbaş and Şentürk, 2013; Saatçi and Dumrul, 2013). Because, according to the general opinion, it is accepted that the energy demand will increase with the increasing prosperity.

As a result of the dynamics of the electrical energy sector, it is both affected by developments in other sectors and affects developments in other sectors. The main reason for this situation is that the electrical energy sector is a sector that provides large amounts of input to other sectors in the economy (Berberoğlu, 1982). The insufficiency of the electricity supply, which should increase in parallel with the EG to meet the demand, not only negatively affects the EG but also prevents the energy supply from creating a stimulating effect on the economy (Özdemir and Yüksel, 2006). Despite the important advantages of electrical energy, there are some drawbacks. The most important of these is that this source is an energy source that must be consumed as soon as it is generated since the storage facilities are very limited and very expensive. Consequently, EEC follows a course parallel to its generation (Akan and Tak, 2003).

Another aspect that can be stated at the point of the relationship of this energy with EG is its effect on growth. Research shows that the increase in electrical energy generation (EEG) also has a positive effect on EG by increasing the use of resources. Increasing EEG makes it easier to access energy in various production areas in the economy. And it enables the realization of various activities that could not be carried out before due to lack of energy. In other words, the increase in the production of this energy can have a stimulating effect on the economy. Similarly, it is possible to say that it affects both domestic and foreign investments. Because both domestic and foreign investors attach importance to the availability of energy resources in their research for the country, they will invest in. It is quite possible that the investors who think that they will not be able to reach sufficient energy for the production they will perform as a result of their investment, take this into consideration and this situation will have a deterrent effect on the investors. Looking at this issue from another perspective, the fact that energy resources are produced in an efficient and uninterrupted manner in a country, easy access to these resources, and relatively low external dependency in energy resources can warn both domestic and foreign investors positively.

As can be seen from all these statements, it can be conceptually expressed that there is a relationship between EEG, EEC and EG. However, it is essential to demonstrate the existence, direction and size of this relationship econometrically. As can be seen from the literature review part, the vast majority of studies on this subject have focused on the relationship between EEC and EG. But given the driving force of EEG on EG and its positive impact on the current balance due to reducing imports, it is thought that this issue should be included in the analysis. This study was put forward with this motive.

In this study, the relationship between EEG, EEC and EG for the period 1975-2019 was analyzed econometrically. In the first part of the study, the relationship between electrical energy and EG is conceptually summarized. In the following section, a literature review with studies on this subject is given. Subsequently, the data obtained on the subject were analyzed by Toda-Yamamoto Causality Analysis Method and the results were shared.

ELECTRICAL ENERGY AND ECONOMIC GROWTH

The concept of energy is defined as the ability or power to do business and is considered as a necessary input in the realization of production and consumption activities in every sector of the economy. Energy is generated concretely by using two different sources (Liu et al., 2021; Du et al., 2020). These are primary energy sources and secondary energy sources. Primary energy sources are coal, natural gas, petroleum, etc. refers to fossil energy resources and renewable energy sources such as solar, wind, geothermal energy, biomass energy and hydraulic energy (Li et al., 2021; Zhou et al., 2021; Xie et al., 2021). Secondary energy sources consist of heat and electrical energy (Ergün and Atay Polat, 2015).

The need for energy is increasing in almost all areas due to industrialization and urbanization in the world. But in contrast, it is known that energy sources found on earth are scarce. This leads countries to take new measures on energy, create policies and research alternative energy sources (Altıntas and Koçbulut, 2014). Electric energy, which is a secondary energy source, has a different place in general energy sources. Because electrical energy is not an energy source like others, but a form of energy obtained by using different technologies of energy sources. Electrical energy, which can be applied to many technologies and is also easy to use, does not pollute the environment during its use. Therefore, electrical energy is accepted as an important energy source due to its superiority in quality and use (Kar and Kınık, 2008). Besides, electrical energy increases the productivity of capital, labor and other production factors and thus supports growth, contributes to the increase of exports through industrial and infrastructure investments, and ultimately contributes to an increase in welfare (Yapraklı and Yurttançıkmaz, 2012).

In addition, it is easy to use and is a clean energy source, can be converted to other types of energy at any time, is an indispensable resource in parallel with technological progress, etc. considerations lead to the assessment of EEC as one of the most important indicators of the level of development of countries (Zhao et al., 2021; Yuan et al., 2021; Haiyun et al., 2021). In other words, the use of electricity is recognized as an indicator of the increase in the welfare of societies (İsmiç, 2015). For example, EEG and EEC in Turkey have been increasing continuously over the years. The main reason for this situation is; It is the increase in the need for electrical energy due to EG and developing technology level. Although this is the main reason for increasing EEC, population growth, infrastructure investments, urbanization, etc. considerations can also be given as reasons (Altıntas and Koçbulut, 2014)

From the point of view of imports to the issue of generation and consumption of electrical energy, it can be easily said that Turkey is a dependent country on the outside. Besides the imported electrical energy, Turkey's generation of its own electrical energy using natural gas is also a very important indicator of its external dependence in this sector. As stated before, being dependent on foreign sources for such an indispensable source for both generation and consumption negatively affects the import level and thus the current account balance in the economy and may cause many other economic problems. Naturally, this situation may have a negative effect on the EG levels of countries (Altıntaş and Koçbulut, 2014).

As stated by Apergis and Payne (2009), the causality relationship between EEC and EG is tested according to four hypotheses in the literature. These are; "*Growth Hypothesis*", "*Conservation Hypothesis*", "*Feedback Hypothesis*" and "*Neutrality Hypothesis*" (Altıntaş and Koçbulut, 2014).

Growth Hypothesis: according to this hypothesis, EC is seen as a complement to labor and capital in the production process and directly or indirectly affects EG. Accordingly, if the increase in EC causes an increase in real EG, the economy is considered to be dependent on energy. In this case, conservation policies that will reduce EC will negatively affect EG. On the other hand, the negative impact of EC on real EG may contribute to capacity constraints, greater EC in non-productive sectors of the economy, or inefficiency in energy supply (Apergis and Payne, 2009; Payne, 2010).

Conservation Hypothesis: according to this hypothesis, energy-saving policies regulated to prevent EC and waste do not negatively affect real EG. The conservation hypothesis is supported if the increase in real EG leads to an increase in EC. However, EG may slow due to political instability or lack of good management of resources and reduced demand for goods and services, including EC. EC will also be negatively affected by this situation. Accordingly, policies aimed at reducing EC or losses will have little or no impact on EG (Apergis and Payne, 2009; Squalli, 2007).

Feedback Hypothesis: This hypothesis assumes that EC and real EG are two different variables that are interrelated and complement each other. According to the theory, there is a two-way causality relationship between EC and EG. In this case, policies aimed at increasing efficiency in EC do not cause any negative effect on EG (Apergis and Payne, 2009). In other words, this hypothesis expresses a bilateral causality and shows that EC and EG determine each other together and also affect each other (Jumbe, 2004; Yoo, 2005).

Neutrality Hypothesis: this hypothesis assumes that EC is a small component of total output. So according to the hypothesis, there is either a very small relationship between EC and EG, or there is no causal relationship. Energy-saving policies do not have a positive or negative impact on real EG in the impartiality hypothesis (Payne, 2010; Squalli, 2007).

According to ISO (1981), if the energy consumed is based entirely on domestic resources, the energy generation sector creates added value like any other industry segment. If this sector does its production more efficiently compared to other sectors, it develops faster than the general growth rate of the economy over time and affects the economy positively. As the more efficient energy input is consumed, the rate of development of the economy will increase. Hence, EC is closely related to economic development, as more energy use leads to more economic development through increased efficiency. However, at the same time, more efficient energy use resulting in a reduction in EC could lead to a higher level of economic development. In this way, EC and economic development can be determined together (Ang, 2007; Saatçi and Dumrul, 2013).

However, besides these explanations about consumption based on domestic resources, being one of the main inputs used in industry and on the other hand, the use of new goods to increase the quality of life is dependent on electricity, increasing dependence on electrical energy (Nişancı, 2005). The fact that energy is an indispensable input in industrial production poses a serious obstacle especially for developing countries that do not have sufficient energy resources. The mentioned countries use their already limited foreign exchange reserves in the import of various energy types to generation, which causes large deficits in the foreign trade of these countries (Ersoy, 2010). The foreign dependency of these countries in terms of electricity, transportation, industrial and residential energy needs strengthens the relationship between EG and energy use. Therefore, any shortage in EEG, natural gas and oil supplies can directly constrain economic activities by reducing the rate of growth. The decreasing supply of the specified sources of energy both increases the input prices and affects the prices of other goods leading to an increase in the general inflation rate and therefore decreases the growth rate and aggregate demand (Saatçi and Dumrul, 2013; Mallick, 2007).

When looking at the relationship between electrical energy and EG from this point of view, it can be understood how the generation, as well as EEC, can have an impact on growth. Developed and developing countries, which are aware of this situation, are looking for alternative ways to generate electrical energy day by day and thus try to reduce foreign dependency in EEG. Considering all these, contrary to the general trend in the literature, in this study, in addition to the relationship between EG and EEC, the relationship between EEG and EG is also included in the analysis.

LITERATURE REVIEW

The relationship between electrical EC and EG is attracting more and more attention from researchers and policymakers. From the perspective of researchers, it is often emphasized that there is an important relationship between EEC and EG. Because while EG affects the sector by causing electrical energy demand and consumption, bottlenecks in electrical energy can cause negative effects on economic development. Considering the relationship between these two variables from the perspective of policymakers, it can be easily said that a good analysis of the relationship is very important in the process of establishing energy policies (Kar and Kınık, 2008). It is understood from the literature that there is no consensus about the results of the relationship (Karagöl, Erbaykal, and Ertuğrul, 2007). Information on some of the mentioned studies is given below.

The first study in the field of energy economics was carried out by Kraft and Kraft (1978) and the relationship between the United States EC and GNP was investigated for the period 1947-1974 using Sims' causality analysis. Kraft and Kraft found a unidirectional causality relationship from GNP to EC in this study. And also, as a result of the study, they used Granger causality analysis and VAR analysis; they found that there is a causal relationship from EEC to EG for Canada, Pakistan, Singapore, Hong Kong, Turkey, Malaysia and South Korea.

Ferguson, Wilkonsin, and Hill (2000) analyzed the relationship between EG and electricity use for the period 1971-1995. They aimed to cover 99% of the global economy by using data from more than 100 countries in the analysis. Correlation analysis between EEC per capita and EG per capita has been analyzed; These results are compared with the correlation between total EC per capita and EG per capita. As a result of the comparisons, it is concluded that the relationship between EEC and EG is stronger in countries with high income compared to countries with low-income levels. Also, it has been found that for the world economy in general, the EEC - EG relationship is stronger than the total EC- EG relationship.

Shiu and Lam (2004) found one-way causation from EEC to EG in their work for China between 1971 and 2000.

Altınay and Karagöl (2005) examined the relationship between EG and EEC in Turkey between 1950-2000 and found one-way causation from EEC to EG.

In a study conducted by Nişancı (2005), electricity demand in Turkey for the period 1970-2003 was estimated in different sectors and a causal relationship between EEC and national income was tried to be tested. Analyses were made with cointegration and Vector error correction models taking into account the property of time series. It has been determined that there is a co-integration between national income and EEC and that there is a one-way causal relationship from EEC to income. In all sectors, short-term income flexibility was found to be smaller than the unit, and long-term flexibility was found to be larger than one.

Rufael (2006) examined the relationship between EEC and EG of 17 African countries with the boundary test approach for 1971-2001 and found a co-integration relationship in 9 countries and a Granger causality relationship in 12 countries. In 6 of these countries, the relationship from EG to EEC was determined, while in 3, the causality from EEC to EG was found. Also in 3 countries, a two-way causality relationship was found.

Yoo (2006) analyzed the relationship between EEC and EG in ASEAN countries for the period 1971-2002. As a result of the study which he used Hsiao's Granger causality analysis and Johansen Cointegration test; It revealed that there is a causality relationship from EEC to EG and from EG to EEC for Malaysia and Singapore. The same study found a causality from EG to EEC for Thailand and Indonesia.

Karagöl, Erbaykal and Ertuğrul (2007) examined the relationship between EG and EEC in Turkey for the period 1974-2004. The relationship between them was examined with the boundary test approach and the cointegration relationship between the series was determined. While a positive relationship emerged between variables in the short run, it was observed that this relationship was negative in the long run.

Kar and Kınık (2008) analyzed the relationship between total EEC, industrial EEC and residential EEC and EG in their study for the Turkish economy for the period 1975-2005. As a result of their analysis using the Johansen cointegration test and Vector Error Correction Mechanism Methods, they concluded that the direction of causality is from EEC to EG.

Aktaş (2009) investigated the causality between EEC, employment and GNP for the Turkish economy with annual data for the period 1970-2006. In the analysis, since the EEC, employment and GNP variables are equally integrated, Granger Causality Test was applied, while a one-way causality relationship was found from EG and employment to EEC in the short and long term, a two-way causality between employment and EG was also found.

Yoo and Kwak (2010) investigated the causality relationship between EG and EEC in 7 South American countries for the period 1975-2006 and concluded that causality varies from country to country. One-way short-run causality relationship from EEC to EG has been found for Argentina, Brazil, Chile, Colombia and Ecuador. For Venezuela, a bidirectional causality relationship was found between EEC and EG, while no causality relationship was found for Peru. It has been interpreted that these different results are closely related to the energy policies of the governments in these countries.

Yoo and Lee (2010) tested whether there was a systematic relationship between EEC and EG based on data from 88 countries for the period 1975-2004. The countries were categorized as OECD and non-OECD and developed and developing countries and the analysis was carried out in this way. According to the results, while there is a statistically significant relationship between EEC and EG in OECD countries and developed countries; The relationship between EEC and EG in non-OECD countries and developing countries was found to be insignificant.

In a study conducted by Ertuğrul (2011), the relationship between EEC and EG in Turkey was examined for the period 1998 Q1 – 2011 Q3. After the co-integration relationship between the EG and EEC series was found, the dynamic relationship between the series was studied with the Kalman Filter Model, which is a parameter approach that changes with time. As a result of the study, it was found that EEC has an increasing impact on EG over time, especially since 2003. The relationship, which began to decline since 2009 due to the impact of the global crisis, has started to increase again since 2011.

Zaman et al. (2012) tested the multivariate EEC function for Pakistan. EG, EEC, population and foreign direct investment variables were used in the analysis for the period 1975-2010 and the model was examined using the border test approach. According to the results, EG, population and foreign direct investment have a positive impact on EEC. Although the direction of the variables is the same as each other, it was found that they have effects of different sizes. The 1% increase in population, EG and foreign direct investment increase EEC by 1.6%, 0.9% and 0.05%, respectively.

Yapraklı and Yurttançıkmaz (2012) examined the causality between EG and EEC in Turkey for the period 1970-2010. The relationship between total EEC and EG has been studied from an econometric point of view using cointegration and error correction-enhanced Granger Causality Testing techniques. The results of the analysis indicate that there is a two-way causality between EEC and EG in Turkey.

Kamaludin (2013) analyzed the relationship between EEC, EG and oil prices using the Generalised Method of Moments (GMM) based on 1999-2004 data for 32 developing countries in his study. While EG was statistically significant on EEC at the level of 5%, it was concluded that the oil price variable was insignificant in explaining EEC.

Karakaş (2014) made a panel data analysis based on the national income, population and EEC data of 22 OECD and 22 non-OECD countries with the highest income for the period 1990-2011. According to the results of the analysis, it has been revealed that there is bidirectional causality between the population and EEC and between the population and national income, as well as the bidirectional causality between income and EEC.

DATA SET AND METHODOLOGY

Within the scope of the study, the relationship between EEG, EEC and EG for the period 1975-2019 was examined. The data were compiled and used annually. The data on EG has been obtained from the open data system of the World Bank as Gross Domestic Product (GDP) per year and the data on EEC and EEG have been obtained from the Turkey Electricity Transmission Company open data system. Data on EEG and EEC were analyzed in Gigawatts (GWh). Basic information regarding the data used is shown in Table 1.

In the study, the causality relationship between EEC, EEG and GDP was examined using the Toda-Yamamoto Causality Analysis method. However, before looking at the causality relationship, the series were subjected to logarithmic transformation to interpret the analysis more clearly and to reduce the effect of extreme values in the series. Descriptive statistics of the series obtained after logarithmic transformation are shown in Table 2.

As can be seen from Table 3, according to Jarque-Bera statistics, LNCONS (P = 0.209172> 0.05), LNEGROWTH (P 0.150820> 0.05) and LNGEN (P 0.181195> 0.05) series are seen to have normal distribution at 5% significance level.

Table 1. Variables and Abbreviations

Variables	Abbreviations	Type
Gross Domestic Product	GDP	Dependent Variable
Electricity Consumption	CONS	Independent Variable
Electricity Generation	GEN	Independent Variable

Unit Root Tests

The relationship between GDP, EEC and EEG variables was analyzed by the Toda-Yamamoto causality test. However, before performing the analysis, it is necessary to look at whether the series are stationary or not. Stationary time series data can be defined as fluctuating around a fixed average and the variance of fluctuation remains constant over time. In regression models with non-stationary series, the high R^2 value caused by the spurious regression phenomenon can be deceptive. This situation may mislead researchers. For this reason, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, which are frequently used by researchers, were used to test the stagnation of GDP, EEC and EEG series.

The regression equations developed for the ADF test used to examine the stationarities of the series are as follows:

$$\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \varepsilon \;.\; 1$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \varepsilon \;.\; 2$$

$$\Delta Y_t = \alpha_0 + \alpha_2 trend\; \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \varepsilon \;.\; 3$$

$(H0 : \gamma < 0$.

There is a unit root.

$(H1 : \gamma \geq 0$. There is not a unit root.

Hypotheses obtained from the ADF unit root test are tested using the MacKinnon critical value. The null (H0) hypothesis states that the series is not stationary, that is, it has a unit root. The alternative hypothesis (H1), which shows the opposite of this situation, states that the series is stationary.

Table 2. Descriptive Statistics

	LNCONS	LNEGROWTH	LNGEN
Average	11.14005	26.10126	11.33080
Median	11.26350	25.94690	11.50276
Maximum Value	12.46161	27.58790	12.62742
Minimum Value	9.509830	24.52176	9.656487
Standard Deviation	0.886335	1.019410	0.911825
Jarque-Bera	3.129197	3.783338	3.416366
Probability	0.209172	0.150820	0.181195
Observation	44	44	44

Phillips and Perron developed a new unit root test with a non-parametric approach for unit root. In this test, Phillips-Perron makes a new hypothesis using the distributions of random shocks in addition to the stationary model developed by Dickey-Fuller. In the PP test, heterogenicity is allowed between the error terms of the Dickey-Fuller test, eliminates the autocorrelation problem and adds the lagged value of the dependent variable to the regression equation. PP test offers a simple approach to determine the presence of unit root in stationery and trend-effect time series and univariate time series. The regression equations developed for the PP test used to examine the stationarities of the series are as follows:

$Y_t = \delta Y_{(t-1)} + u_t$ 4

$Y_t = \beta_1 + \delta Y_{(t-1)} + u_t$ [With Constant] 5

$Y_t = \beta 1 + \delta Y_{(t-1)} + \beta_2 \left(t - T/2\right) + u_t$ [With Constant & Trend] 6

There is a unit root.
$(H1: \gamma \geq 0$ There is not a unit root.
Table 3 evaluates the results of these unit root tests is below.

Table 3. Unit Root Tests Results

	PP (Level)			PP (1. Dif.)		
	LNGROWTH	**LNCONS**	**LNGEN**	**LNGROWTH**	**LNCONS**	**LNGEN**
With Constant	-0.9270	-2.7884	-3.0131	-6.8889	-6.0407	-4.7039
Probability Value	0.7700	0.0683*	0.0416**	0.0000***	0.0000***	0.0004***
With Constant & Trend	-2.2915	-1.3459	-0.5023	-6.8284	-6.3194	-5.0942
Probability Value	0.4293	0.8625	0.9797	0.0000***	0.0000***	0.0009***
	ADF (Level)			**ADF (1. Dif)**		
	LNGROWTH	**LNCONS**	**LNGEN**	**LNGROWTH**	**LNCONS**	**LNGEN**
With Constant	-0.9283	-2.5902	-3.0131	-6.8897	-6.0293	-4.7241
Probability Value	0.7696	0.1028	0.0416**	0.0000***	0.0000***	0.0004***
With Constant & Trend	-2.1251	-1.3459	-0.5023	-6.8294	-6.2733	-5.0891
Probability Value	0.5177	0.8625	0.9797	0.0000***	0.0000***	0.0009***

(*) %10 significance level, (**) %5 significance level, (***) %1 significance level.
Note: Levels are looked at according to MacKinnon (1996).

The stationarities of the variables in the study were tested using Augmented Dickey-Fuller (ADF) (1979) and Philips Perron (PP) (1988) unit root tests. According to the PP test results, GEN and CONS series are stationary at the level. According to the ADF test, only the GEN series is stable at the 10% level. Then, at the end of the series, the first difference of the series was taken and the stationarity study was conducted. As a result of the tests performed with ADF and PP unit root tests, it was determined that all variables were stationary at the level of 1% in the first differences in constant and constant & trend models.

Toda-Yamamoto Causality Test

In this study, the Toda-Yamamoto (1995) causality test was used about whether there is causality among variables or its direction. The Toda-Yamamoto causality test is an improved version of the Granger causality test (1969) (Yüksel and Oflaz, 2020; Ersin, 2018). The Toda-Yamamoto approach also provides the opportunity to investigate the relationship of causality between series that are integrated to different degrees. Another difference from Granger causality analysis is that the test is independent of whether there is cointegration between the series (Toda and Yamamoto, 1995). Since the Toda-Yamamoto causality analysis developed to investigate Granger causality is applied to the level values of the series, it is an approach that prevents the loss of information due to difference. This method suggested by Toda-Yamamoto (1995) is an extended version of the VAR method developed by Sims (1980).

In the Toda-Yamamoto (1995) method, the first step is to determine the appropriate lag level (p) in the VAR model. In the second step, the integrated level (dmax) of the variable with the highest integration is added to the lag p. At this point, it is necessary to determine the k and dmax values for the test. It is important to determine these two parameters correctly in order to predict the causal relationship correctly (Mert and Çağlar, 2019). The Toda-Yamamoto (1995) causality test equation for the Y and X variables is shown in the figure below.

$$Y_t = {}^{3}{}_{0} + \pounds_{i=1}^{k} \pm_i Y_{t-i} \pounds_{j=k+1}^{k+d_{\max}} \pm_j Y_{t-j} + \pounds_{i=1}^{k+d_{\max}} {}_j Y_{t-j} {}^{2}{}_i X_{t-i} + \pounds_{j=k+1}^{k+d_{\max}} {}^{2}{}_j X_{t-j} + \mu_{2t} \quad 7$$

$$X_t = {}^{3}{}_{0} + \pounds_{i=1}^{k} {}'_i Y_{t-i} \pounds_{j=k+1}^{k+d_{\max}} {}'_j Y_{t-j} + \pounds_{i=1}^{k+d_{\max}} {}_j Y_{t-j} \,,_i X_{t-i} + \pounds_{j=k+1}^{k+d_{\max}} \,,_j X_{t-j} + \mu_{1t} \quad 8$$

In the above model, the degree of freedom k shows that Wald tests based on a VAR model of the degree to be estimated (k+dmax) have a distribution $\chi 2$, while the maximum degree of integration is dmax. Toda and Yamamoto (1995) proved that the MWALD test has an asymptotic $\chi 2$ distribution in a VAR system of order (k+dmax) to be predicted by specifying the number of lags k and the maximum degree of integration of the dmax series. To test the existence of Granger causality from Y to X, the limitation of $\beta \mathrm{i} \neq 0$ is tested using Wald statistics. The $\theta i \neq 0$ limitation of causality from X to Y is tested.

Table 4 shows the analysis results of 5 different information criteria. All information criteria (LR, FPE, AIC, SC and HQ) suggested the optimal lag value as 1 lag. Considering the above analysis results, the VAR model created by considering the lag length and unit root tests was estimated as 2 (1 + 1) lags. Then Tado-Yamamoto causality test was performed and the results are presented in Table 5.

Toda-Yamamoto test results used to test the relationship between GDP, EEG and EEC are shown in Table 5. The maximum degrees of integration obtained from the unit root test are used here. By adding the maximum degree of integration to the optimal lag length obtained in the classical VAR analysis, a (k + dmax) lagged developed VAR model was obtained and by applying Wald statistics to the k lagged values in this model, it was determined whether the causality or not. The (dmax) value for lag length is taken as 2, based on unit root tests. Considering the probability values of the Wald statistics, according to

Table 4. Determining the Appropriate Lag Length in the VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	42.48929	NA	2.65e-05	-2.025092	-1.897126	-1.979179
1	223.7036	325.2565*	3.88e-09*	-10.85660*	-10.34473*	-10.67294*
2	226.6251	4.794258	5.35e-09	-10.54488	-9.649115	-10.22349
3	232.1465	8.211210	6.54e-09	-10.36649	-9.086822	-9.907353
4	235.2231	4.102145	9.27e-09	-10.06272	-8.399160	-9.465850
5	241.5941	7.514520	1.14e-08	-9.927901	-7.880441	-9.193290
Each test at 5% level. * Indicates lag order selected by the criterion						

empirical findings; The causality relationship from GDP to EEC and EEG has not been found. However, a causality relationship from EEC to GDP and EEG was determined at a 5% significance level. In other words, EEC is the cause of GDP and EEG. While there is a causal relationship between EEG and GDP at the 5% significance level, there is no causality from EEG to EEC.

SOLUTIONS AND RECOMMENDATIONS

The findings show that electricity generation and consumption in Turkey are accelerating economic growth. For this reason, it is recommended to increase electricity production in Turkey and to make various incentives for those who want to invest in this field. Examples of these incentives include tax incentives applied in various countries and the provision of investment land. Similarly, it is essential to facilitate the access of all individuals to energy and to take measures to reduce costs.

FUTURE RESEARCH DIRECTIONS

Currently, research on the relationship between electrical energy and economic growth tends to increase. Some of these studies are related to the results of past experiences, while others are aimed at ensuring the

Table 5. Toda-Yamamoto Causality Test Results

Hypotheses	χ^2 Test	P-Value	Direction of Causality
GROWTH=f(CONS)	0.041108	0.9797	No Causality
GROWTH =F(LNGEN)	0.121124	0.9412	No Causality
CONS =f(GROWTH)	3.592698	0.0479**	CONS >> GROWTH
CONS =F(GEN)	7.126085	0.0284**	CONS >> GEN
GEN =f(GROWTH)	6.149444	0.0462**	GEN >> GROWTH
GEN =F(CONS)	0.628130	0.7305	No Causality

Note: * indicates 1% significance level, ** indicates 5% significance level and *** indicates 10% significance level.

accuracy of decisions that need to be made on this issue in the future. This is very important as countries try to reduce their dependence on foreign energy and avoid energy shortages in their production. However, studies on this subject should be comparable and should be done in terms of energy resources. For this reason, researchers who are considering working on this issue are advised to examine and compare countries in the same economic situation as Turkey in their future work. Similarly, while analyzing the production of electrical energy, it will be beneficial to include the primary energy sources that this energy is produced in the analysis scope.

CONCLUSION

Even developed countries, which are in a very good economic situation, are constantly working and researching and looking for alternative solutions to meet their energy needs without being dependent on foreign sources. Because the energy need is one of the most important needs of today's countries. In particular, the need for energy, which increases with the developing technology, causes countries to enter this search and increases the demand for energy resources. When this situation related to energy is viewed from a broad perspective, the importance of electrical energy can be seen. Because the most preferred energy, today is electrical energy. Even other energy sources such as natural gas, petroleum and nuclear are used to generate electrical energy. Of course, the most important reason for this situation is technological developments and the nature of electrical energy. Because advancing technology increases the need for more electrical energy and its use does not harm nature, causing electrical energy to be preferred. Even in automobiles, sea and air vehicles, it is seen that oil is abandoned and attempts are made to switch to electrical energy.

Electrical energy, which is so important for today's countries, is also very important economically. Because economic resources are needed for both generation and consumption of electrical energy. This is especially important for countries that cannot generate enough and import electrical energy to fully meet the current demand. In fact, when we look at the other energy resources used by the countries that generate electrical energy, it is seen that even these other energy resources are provided by import from place to place to generate electrical energy. For this reason, the generation and consumption of electrical energy can have a significant impact on the current account balance in some countries.

One of the most important issues regarding this economic aspect of electrical energy is its relationship with EG. Today, in developing countries, it is seen that individuals can access technological opportunities more easily and therefore demand more energy to use them. Similarly, it can be said that developing countries need more energy due to the investments they make in areas such as transportation, communication and health in order to increase social welfare. All of this is happening mainly with EG. Increases in both public and individual purchasing power of growing economies increase their EEC, which in turn causes countries to generate more energy. In other words, it can be said that more consumption and generation of electrical energy is a normal result of EG. On the other hand, increasing energy generation and consumption can also have a stimulating effect on growth, as it enables the use of idle resources in the economy. For example, as a result of the possibility of using more energy, various underground resources that were not previously available can be brought into the economy, and also increase productivity in agriculture, reduce transportation, communication costs, etc. considerations can be cited as an example of this situation. As a result, it can be said that there is a mutual relationship between EEC, EEG and EG, where they affect each other. This study has been prepared as a product of this assumption.

In the study, the relationship between EEG, EEC and EG was examined using the Toda-Yamamoto causality test method. As a result of the analysis, it has been determined that there is causality from both EEC and EEG to EG. On the other hand, no causality relationship has been determined from EG to EEC and EEG. As a result, as mentioned above, the idea that EEG and EEC in developing countries such as Turkey can have a positive impact on EG has been proven and supported by econometric methods in this study.

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KEY TERMS AND DEFINITIONS

ADF: Augmented Dickey-Fuller.
EC: Energy consumption.
EEC: Electricity energy consumption.
EEG: Electrical energy generation.
EG: Economic growth.
EnG: Energy generation.
GDP: Gross domestic product.
PP: Phillips-Perron.

Chapter 13
The Strategic Importance of Green Energy in Energy Management:
The Case of Turkey

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ABSTRACT

The aim of this study is to address the importance of strategic energy management in order to ensure the transition of Turkey, a country that is trying to end its dependence on energy, to green energy using renewable energy sources. With the excessive use of nonrenewable energy sources by Turkey, in order to reduce environmental pollution and foreign dependency in energy, it started studies to increase the use of domestic and renewable energy resources in the early 2000s. With the transition to renewable energy sources as a new concept in Turkey's energy policy "green energy," it has come to the fore. With the transition to green energy, Turkey is trying to prevent pollution of the environment by reducing fossil fuel consumption and aims to reduce energy costs by reducing the use of energy sources that cannot be renewed in production. Turkey, a country rich in renewable energy sources, will be able to use existing renewable energy sources effectively and efficiently using strategic management in energy.

INTRODUCTION

Human beings need energy while maintaining their life since settled life. In the early days, when using fire in production, with the development of technology, there was a diversification of resources in energy production. Increasing population and technological developments have increased the need for energy. Until the 90's, the use of fossil fuels in energy production led to the pollution of the world and climate

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degradation. The use of non-renewable energy sources in production has caused both a decrease in resources and environmental pollution. Although the use of fossil fuels has enabled cities and countries to develop and expand, it has left us with two problems such as *limited fuel resources* and *pollution from its combustion* (Lee and Kim, 2016). Although the increase in energy demand is a result of development, the effort to improve living conditions causes more energy demand to increase and energy supply to be insufficient. With the aim of sustaining development and leaving a clean world for future generations, it has now become necessary to move towards renewable energy sources.

Although the use of renewable energy resources is important for the environment, financial problems are encountered in the inclusion of energy resources into production. With the Industrial Revolution, developed countries have completed their development by using excessive fossil fuels, thus easily meeting the costs incurred during the transition to renewable energy sources. However, underdeveloped or developing countries are not in a position to meet the costs required to change their existing energy systems and switch to energy systems using renewable energy sources. Although it was decided in the Framework Convention on Climate Change to provide support to underdeveloped and developing countries for the sustainability of development, developed countries remained silent on this issue. The damage caused by developed countries, which have primary responsibility for climate degradation and environmental pollution, caused negative externalities for developing and undeveloped countries.

Energy, which causes serious costs in the production phase, must be produced with an effective management in this process. The increase in population and urbanization and the increase in the welfare of people have caused an increase in energy demands. It has also become difficult to control and manage energy supply in order to meet the increasing energy demand. At the same time, the problems encountered during the transition from non-renewable energy sources to renewable energy sources increased the importance of strategic management in energy management. The need for an effective management approach has increased in order to ensure the efficient and productive use of resources, to increase the use of domestic resources in energy production and to reduce external dependency in energy.

Turkey, a country dependent on foreign energy, in fact is a country with a high potential for water and wind power generation. Because of past problems in the economy Turkey that cannot pass the renewable energy production has increased its use of renewable sources of energy since the early 2000s. In order for energy production to be more effective and efficient, this process should be managed with national action and development plans together with all public institutions and organizations. In order to ensure energy efficiency, it is necessary to have both an effective energy management understanding and an awareness of energy saving at the citizens' level.

In this study, it has been tried to emphasize Turkey's transition to green, renewable energy and the importance of strategic management in energy management in this process. By analyzing Turkey's situation in terms of renewable, green energy sources, the importance of the strategic energy management transition and this process has been discussed.

THE ENERGY MANAGEMENT

Energy defined as "capacity to do work" (Svensson, 2021) is a concept that is used in the development of many fields such as agriculture, industry, transportation, telecommunication and therefore is of great importance for human life (Chofreh et al., 2021). Increasing of economic activities in developing countries causes a big increase in energy consumption. This increase has enabled people to improve their lifestyles

(Bilgen, 2014). Li et al. (2014) stated that energy demand decreased in many developed countries during the 2008 economic crisis and stated that there is a strong link between economic indicators and energy consumption. Throughout the ages, states have tried to dominate certain sources of production in order to become a dominant power. With the industrial revolution, energy resources have emerged as the most important source of production and states have fought serious wars in order to seize these resources. It is known that all wars and crises that have taken place from the industrial revolution to these days have been carried out either directly or indirectly in order to possess the energy resources.

It is for this reason that both the welfare and security of states are directly related to energy resources (Sevim, 2012). There has been an increase in energy demand, which is an indispensable need in development, due to the increasing industrialization rate with the increase of the population and the desire to increase the quality of life. As a result of the inability of existing resources to meet the energy demand, the country becomes dependent on imported energy and as a result, it is exposed to cuts in energy supply and price shocks (Fernando & Hor, 2017). Dependence on foreign energy brings with it the collapse of the country's economies. In case the existing resources are not sufficient in energy production, an effective and efficient energy management policy must be implemented in order to produce maximum energy with available resources. Until the end of the 20th century, fossil fuels became the leading actor in energy production, which led to the depletion of existing resources and pollution of the environment.

Fossil fuels, the most used type of energy, are under the monopoly of a few countries. The demand for increasing growth and prosperity in developed and developing countries has led countries to increase their efforts to access energy resources. Developing countries spend great power to reach the goods and energy markets around the world, which increases both competition and consumption for all resources. Analyzing the future energy consumption, which is important in order not to stay out of this competition, will be a guide for future energy investments. Ensuring the continuity of energy supply will be possible by managing the dynamics of economic, ecological and political factors (Bilgen, 2014). The policies required to regulate the energy supply in line with the energy demand should not be limited to a single area, but should be made with a total struggle. Policy makers will not only reduce external dependency in energy by carrying out energy management effectively and efficiently, but also contribute to the protection of the environment. Policy makers are obliged to act in the awareness that energy management takes the fight against climate change as the main objective as well as providing energy savings.

The purpose of energy management, which is defined as the planned use of energy, is to save energy by using energy in an efficient and planned manner (Mumlu, 2008). While energy management aims the efficient use of energy, it does not aim to reduce production and quality (Fernando and Hor, 2017). The main purpose is to save without reducing the production or reducing the quality. Here, too, the concept of energy efficiency emerges.

ENERGY EFFICIENCY

The fossil resources used in energy production will be depleted in the future, the high cost of using alternative energy sources, the increase in energy demand also increases the prices, the domestic energy resources cannot meet the demands and the pollution of the world, which is faced with the consequences of climate change, necessitates us to increase energy efficiency (Bozkurt, 2008). While the increase in energy consumption indicates that economic activities are at a high level, a higher level of economic development is required to sustain this increase. For this reason, while countries continue to develop, they prioritize energy efficiency in order to meet their increasing energy needs. While finding a new energy source and producing energy from that source is costly; saving energy does not require any cost. "… The cheapest way to produce a unit of energy is to conserve it" (Fernando and Hor, 2017). In order to use our existing resources effectively and efficiently and to minimize the costs arising from energy supply, energy savings must be realized. Energy efficiency (Sağbaş and Başbuğ, 2018);

It is the most effective measure alone in achieving national strategy objectives such as utilizing energy in production, transmission, distribution and consumption processes with high efficiency, ensuring safe energy supply, combating the problem of external dependency in energy supply, establishing sustainable energy policies that encourage economic growth and environmental protection.

Many different classifications have been made in the literature on energy saving. In classifications related to individual energy saving, individuals are required to prefer energy efficient household appliances in their purchasing process of electrical household appliances. In the use of these electrical household appliances, the frequency of use and the amount of use are important. Repairing new household appliances instead of purchasing them also saves energy (Dursun and Belı̇t, 2017). Energy saving is an issue that should be pursued with an all-out struggle, starting from individuals, to the highest level of the state.

In order to manage all these factors, to control energy demand and to avoid competition in the global economy, strategic management in energy should be implemented.

STRATEGIC ENERGY MANAGEMENT

The world economy is becoming more and more global in a continuous structural change. In order to compete in this globalization, all institutions must transform this competition into a strategy. The conflict between economic reality and political reality will be resolved by determining the strategic management (Drucker, 2014). Strategic management (Eren, 1990 cited in Durna and Eren, 2002):

is the collection of processes that include putting them into effect by taking all kinds of structural and motivational measures, the research, evaluation and selection efforts required for planning the strategies, within the organization in order for these planned strategies to be implemented and then include checking the strategies once more in terms of their suitability to the objectives before the implementation of the strategies and which involve the activities of the high-level staff of the enterprise.

Strategic management enables the organization to evaluate its environment and to predict future events. In addition, the decisions taken and the goals planned to be achieved by this management enable all units within the organization to act jointly from the top to the bottom (Güçlü, 2003). The continuous and significant change in the environment of public organizations requires public organizations to take precautions against these change processes. This is possible with strategic management and, unlike the classical management approach, it makes it more successful (Özgür, 2004).

Chofreh et al. (2021) examined strategic management in energy in three parts as "scope, strategic management process and strategic management model". Scope, which is the first step of strategic management is defined as the region where policy makers plan to implement their strategies. Determining the scope at both local and national level is important for the strategic energy plan. Determining models and scenarios by policy makers at the stage of making decisions regarding energy systems is an important element to achieve the goals (Krog and Sperling, 2019). It is made possible by the strategic management process that policy makers can both achieve an above average return and achieve a strategic competitive power by adopting a consistent approach. This process also helps to reduce energy consumption and maintain energy performance in the long term by increasing energy efficiency and saving energy (Chofreh et al., 2021).

The management process is an indispensable process in terms of energy management, as it enables policy makers to understand which issues are more important, enable strategic decisions, and facilitate the evaluation of future directions to achieve better performance (Posch et al., 2015). The third stage, the strategic management model, which includes important elements in strategic management, is defined as a resource-based model and an industrial organization model. With these models, policy makers facilitate the analysis of the internal environment of the organization. Resources, core competencies and abilities are more easily analyzed (Chofreh et al., 2021).

Strategic management, unlike traditional management, is a management approach that develops itself, has the power to predict the future, and enables effective and efficient use of its resources. It is now inevitable to use this management approach in energy management. Nowadays, when the damage caused by fossil fuels to the environment has become indispensable, the necessity of transition to renewable, clean and green energy has emerged. We have focused on the concepts of scope, process and model in strategic energy management above. We are aware and of the opinion that the model to be determined in this strategic energy management should be a green energy model. In the second part of the study, the efficiency and productivity of energy resources in the world will be discussed; Turkey's transition to green energy on the axis of this discussion and the functioning of this process will be examined.

UTILIZATION OF ENERGY RESOURCES AND GREEN ENERGY

People who had used natural resources such as wind, wood, etc. until the Industrial Revolution for their energy needs started to use coal as an energy source with the Industrial Revolution. With the development of industry and the increase in population, when wind, wood, plant and animal remains were insufficient for energy need, energy resources that first evolved into coal and then to oil have emerged as natural gas and nuclear energy over time (Akbulut, 2008).

The total energy supply in the world has increased by 2.6 times from 1971 to 2018, from 5,519 Mtoe to 14,282 Mtoe. The proportion of natural gas in energy supply increased from 16% to 23%; oil production rate fell from 44% to 32%. While the rate of biofuels decreased from 11% to 9%, the coal supply rate did not change, but the nuclear rate increased from 1% to 5%. (Table 1).

Total energy consumption, which was 4.243 Mtoe in 1971, increased to 9.938 Mtoe in 2018. Considering the sectoral distribution of the energy consumed, there is no big difference in other areas except transportation, while the ratio of transportation to total consumption was 23% in 1971, this rate increased to 29% in 2018 (Table 2).

When the two tables above are compared, we encounter a large gap between the amount of production and consumption. As of 2018, the total energy produced was 14,282 Mtoe, while the consumed energy was 9,938 Mtoe. This overproduction in between is a proof of why a strategic energy management is needed. Fossil fuel economies have led to a dangerous era for humanity and the future. Increasing global warming, drought and hunger have become an increasing consensus for the transition to renew-

Table 1. Total energy supply by fuel (IEA, 2020a)

		1971	2018
Biofuels		%11	%9
Hydro		%2	%2
Nuclear		%1	%5
Nature Gas		%16	%23
Oil		%44	%32
Coal		%26	%27
Other Renewable			%2
	TOTAL MTOE	**5 519 Mtoe**	**14 282 Mtoe**

able energy systems, a process of substitution for fossil fuels over the past 30 years to end the fossil fuel age (Burke and Stephens, 2018). Fossil resources that are used as if they will never end both harm the environment and reduce energy efficiency. It is time for us to switch to green energy by using renewable energy resources in order to leave a livable world to future generations and to spend a better quality time in the world we live in.

RENEWABLE ENERGY RESOURCES AND GREEN ENERGY

When classifying energy resources, they are divided into two as non-exhausted and reusable resources and resources that cannot be reused once used. Non-renewable energy sources are divided into "fossil sourced" and "core sourced". Non-renewable energy sources of coal, oil and natural gas fossil sources; uranium and thorium are non-renewable energy sources originating from the nucleus. Solar, water, wind and hydrogen have taken their place in the literature as renewable energy sources (Koç and Kaya, 2015). Renewable energy sources, which are the substitutes of fossil-based non-renewable energy resources that pollute the environment, do not harm the environment (Önal and Yarbay, 2010).

The Paris Agreement signed in 2015 aimed to keep the global temperature increase below 2 ° C in the long term. It is stated that this goal will be possible by reducing the use of fossil fuels and turning to renewable energy (T.R. Ministry of Foreign Affairs). Increasing efficiency in the allocation of energy

Table 2. World total final consumption by sector (IEA, 2020a)

		1971	2018
Agriculture/Forestry		%3	%2
Commerce and Public Services		%8	%8
Residential		%24	%21
Transport		%23	%29
Industry		%38	%38
Non-specified (other)		%4	%2
	TOTAL MTOE	**4 243 Mtoe**	**9 938 Mtoe**

resources should be determined as a priority for policy makers in order to overcome environmental risks with regard to reducing the impacts of climate change targeted in the Paris Agreement and to reduce greenhouse gas emissions (Choi, 2020).

Regarding fossil fuels, which are the primary source of global electricity generation, the International Energy Agency's (IEA) report dated 2015 stated that 67% of electricity generation was provided by fossil fuels. However, the use of renewable energy resources has become mandatory for electricity generation, both because fossil fuels are not unlimited and the damage to the environment during production from these fuels is at a high level (Aboagye et al., 2021). According to IEA, renewable energy is defined as "Bioenergy for electricity and heat generation includes geothermal, hydroelectric, concentrated solar energy, wind and marine energy." (IEA, 2020b). After 2000, the rate of coal use in electricity generation has been decreasing. While the use of renewable resources and natural gas in electricity generation has increased, there has been no major change in the rate of oil and nuclear use (IEA, 2020a).

In the UN Framework Convention on Climate Change, where climate change is accepted as the "common concern of humanity", the assistance of developed countries to support the sustainable development of developing countries is mentioned and it is emphasized that development should be global. It has been stated that this development will be possible by using renewable energy sources in energy management (Climate Change Framework Agreement, 2002). With the Vienna Convention, the Montreal Protocol, the Kyoto Protocol, the UN Framework Convention on Climate Change and the Paris Agreement, all governments have begun to agree that fossil fuels are harmful to humanity and the future, and the necessity of transition to renewable energy sources for energy production. All these meetings have started to produce a little good results. In OECD countries, while energy production from coal decreased significantly in 2019, the use of renewable energy sources also increased. In OECD countries, the utilization rate of coal in energy production decreased by 90%, while the utilization rate of natural gas in production increased by 45%. However, the rate of use of renewable energy resources in electricity generation has increased by 18% in OECD countries (IEA, 2020a).

GREEN ENERGY

To combat climate change, which is one of the most pressing problem areas of present and future generations, reducing the consumption of fossil energy resources and increasing the use of renewable energy resources must be priority policies (Neumann and Mehlkop, 2020). The excessive increase in energy use causes an increase in carbon emissions. In order to reduce carbon emission, it is necessary to increase the use of low carbon or green energy sources in production. However, policy makers do not prefer to bear these costs because the transition to green energy is extremely costly (Cheng et al., 2021). Despite these costs, it has become mandatory for policy makers to support the renewable energy transition, considering the environmental damage of fossil fuel-based energy systems (Boffardi et al., 2021).

At the Sustainable Development Conference held in Rio in 2012, governments conclude that the transition to green economy is necessary in order to achieve the objectives of "… sustaining economic growth by eliminating poverty while maintaining the healthy functioning of the earth's ecosystems, increasing human well-being and creating employment and decent job opportunities for all". (Herrero et al., 2020). After the oil crisis, mostly OECD countries adopted many policies regarding energy production and consumption from renewable energy sources (Carfora et al., 2018). Green energy, which has been at insignificant levels for the last two decades, has taken important steps in this process and as of 2018, 26.2% of global electricity production was realized with green energy. In addition, it is seen that green energy is used effectively in transportation with heating and cooling. Green energy had a 10% share in heating and cooling and 3.3% in transportation in 2016 (Detemple and Kitapbayev, 2020).

The adoption of green energy policies by countries is a driving force in the use and development of renewable energy sources in terms of reducing the use of fossil fuels and gas emissions. The adoption of green policies helps to take a stand against climate change, It is also useful in creating jobs in new industries and increasing energy security. Many countries have started to see the transition to green energy as an "additional policy tool" to cope with the consequences of the 2008 economic crisis (Carfora et al., 2018). Schaffer and Bernauer (2014), who believes that the current energy supply systems, the structure of the political system and the EU membership are effective in the transition of countries to green energy, stated that EU member countries have intensely exchanged information on renewable energy and the EU supports these policies.

Transition to renewable and green energy is possible with the determination of policy makers, government supports and incentives. If we categorize them; it appears as "Regulatory policies" that encourage companies producing energy from renewable energy sources and regulate these opportunities through laws, "financial incentives" that provide investment and production loans to companies, accelerate investments with grants and repayments, provide tax reductions, and "public finances" that support direct production. With these state-sponsored regulations, the transition to a green economy will be faster and easier (REN21, 2015).

TURKEY'S SITUATION IN RENEWABLE AND GREEN ENERGY

Turkey, which provide more than half of its energy needs from imported sources. While oil ranks first in energy production; natural gas has been used in the energy sector since the early 2000s. Because of the large lignite reserves of coal in energy production in the territory of exhibits focused approach, Turkey is a rich country in terms of renewable energy sources (Önal and Yarbay, 2010). Turkey has made great progress in the production of energy from renewable sources since 2009, efforts have been made to reduce the use of fossil-based fuels by focusing on alternative energy resources by policy makers and to reduce external dependence on energy in this context. However, despite these efforts, non-renewable energy production is still significantly high. The proportion of renewable energy sources in Turkey's electricity production by the year 2018 is around the 32%. Turkey, a rich country in terms of solar, wind and renewable energy sources due to its geographical structure, has a capacity to turn these opportunities into an advantage but deficiencies in infrastructure for education on renewable / green energy sources in Turkey so far have prevented the full use of efficient energy resources (Sharif et al., 2020). In Turkey, while the increase in the use of renewable energy sources for energy production seen after 2009 is noticeable, the use of coal, oil and natural gas is currently extremely high. While the use of natural gas in energy supply was 3000 ktoe in 1990, it reached 35000 ktoe in 2019. Although the ratio of renewable energy sources in energy supply was stable until 2010, it seems to increase after 2010. The reason is that after 2009, Turkey's new policies are created at the point of use of renewable energy sources (IEA, 2021).

What is important for Turkey is to develop renewable energy technologies that rely entirely on domestic resources by setting long-term strategy for energy management. This will both reduce external dependency in energy and advance the economic development due to the lack of fuel costs of renewable technologies (Balat, 2008). For Turkey making a commitment to reduce carbon emissions and increase the supply of clean energy for sustainable development with Kyoto Protocol, increasing clean energy production should be a top priority. Transition to clean energy generated from hydro, solar, wind and geothermal sources will both support sustainable development in Turkey and reduce the environmental pollution rate brought about by energy production from non-renewable sources (Sohag et al., 2019). Turkey being richer than many countries in terms of renewable energy sources, will be an effective power in the region by reducing its external dependency in energy and economy by using these opportunities. Harrington's (1992) saying that "empire follows power" will come into existence by using Turkey's unlimited renewable resources in production.

T.R. The Ministry of Energy and Natural Resources targeted 7 main objectives in the 2019 Strategic Plan (Republic of Turkey, Ministry of Energy and Natural Resources, 2019):

- To ensure sustainable energy supply security
- To prioritize and increase energy efficiency
- To strengthen institutional and sectoral capacity
- To increase regional and global efficiency in energy and natural resources
- Technology development and localization in the field of energy and natural resources
- To increase predictability in markets
- To increase production capacity with sustainable mining

Under this strategic plans, as of 2019 the number of electricity production plants in Turkey rose to 8069 8069. These are (Republic of Turkey Ministry of Energy and Natural Resources, 2021);

"669 hydroelectric, 68 coal, 262 wind, 52 geothermal, 330 natural gas, 6435 solar and 253 other sourced power plants."

In electricity production in Turkey in recent years it has been increased by the use of renewable resources; while the share of renewable energy sources in electricity generation was 1.2% in 2009, this share increased to 12.7% as of 2018 (Table 3). According to the Wind Energy Potential Atlas document, 1.30% of Turkey's square measure is suitable for wind energy potential. However, Turkey is using only 14% of this area (Zorlu, 2021).

The share of renewable sources in electricity production in power generation in OECD countries from 2000 to 2019 doubled, in Turkey showed 12 times increase between 2009 – 2019.

STRATEGIC MANAGEMENT OF ENERGY IN TERMS OF TURKEY

Efficiency in energy means "increasing the benefit obtained from the energy source" (İbiş, 2018). In the 'Energy Efficiency Strategy Document' adopted by the High Planning Council in 2012, it is a concept that complements national strategic objectives such as ensuring supply security in energy, reducing risks arising from external dependency, making energy costs sustainable, increasing the effectiveness of combating climate change and protecting the environment and cuts them horizontally (High Planning Council, 2012). Turkey's having a growing population, rising of its prosperity with the increase in quality of life, strengthening of industrialization and the service sector with the rapid increase in industrialization and urbanization have also caused an increase in energy demand in our country. The energy market

Table 3. Electricty genaration by source in Turkey (TUIK, 2021)

Year	Total (GWh)	Coal	Liquid Fuels	Natural Gas (%)	Hydro	Renewable Energy and Wastes
2009	**194.813**	28,6	2,5	49,3	18,5	1,2
2010	**211.208**	26,1	1,0	46,5	24,5	1,9
2011	**229.395**	28,8	0,4	45,4	22,8	2,6
2012	**239.497**	28,4	0,7	43,6	24,2	3,1
2013	**240.154**	26,6	0,7	43,8	24,7	4,2
2014	**251.963**	30,2	0,9	47,9	16,1	4,9
2015	**261.783**	29,1	0,9	37,9	25,6	6,5
2016	**274.408**	33,7	0,7	32,5	24,5	8,6
2017	**297.278**	32,8	0,4	37,2	19,6	10,0
2018	**304.802**	37,2	0,1	30,3	19,7	12,7

has entered into a transformation with the development of technology, the integration of the smart city concept into life, and the emergence of environmental-themed developments. Productive and effective execution of this transformation will be possible within the framework of the strategic plan. Strategy, also defined as "what societies do to secure their future", has necessitated energy efficiency to be handled as a strategic concept in order to guarantee the future of Turkey (Republic of Turkey The Ministry of Energy and Natural Resources, 2020).

Turkey is one of the countries with the fastest increase in energy demand among the Organization for Economic Cooperation and Development (OECD). Turkey kocated in a region with approximately 70% of proven oil and natural gas reserves is one of the largest natural gas and electricity markets in its region. The basic elements of Turkey's energy strategy in this context are summarized as follows (https://www.mfa.gov.tr/turkiye_nin-enerji-stratejisi.tr.mf to):

- Giving priority to energy security related activities by taking into account the increasing demand and import dependency,
- Considering environmental concerns at every stage of the energy chain in the context of sustainable development,
- Creating a transparent and competitive market by providing the necessary reform and liberalization, increasing productivity and efficiency,

Increasing R&D studies related to energy technologies.

Difficulty in storing electricity after its production causes the necessity to consume the production immediately. Electricity generation, which should be carried out according to demand, has a strategic importance in this respect. Integrating the energy supply into a single resource also makes it difficult to use the resource effectively and efficiently. For this reason, it is necessary to focus on resource diversification in electricity generation. In order to reduce the production of import substitution electricity, it is necessary to use domestic resources in energy supply (İbiş, 2018). While Turkey's natural gas use in electricity production in 2009 was 50%, in 2018 this rate dropped to 30%. The reduction in electricity production of the imported sources indicates that Turkey has adopted the strategic management in energy management and has increased use of domestic resources (Table 3).

In Turkey, many laws and regulations have been enacted to increase energy efficiency. In addition to this, strategic management in energy has been adopted. (Republic of Turkey Ministry of Energy and Natural Resources, 2020);

- Energy Efficiency Law '(2007)
- Regulation on Increasing Efficiency in Energy Resources and Energy Use (2008) (2011 Revision)
- Regulation on Energy Performance in Buildings (2008) (2011 Revision)
- Regulation on Procedures and Principles for Increasing Energy Efficiency in Transportation (2008) (2019 Revision)
- KOSGEB Support Programs Regulation (2010)
- National Climate Change Strategy Document (2010)
- Energy Efficiency Strategy Document 2012-2023 (2012)
- Communiqués on Support, Authorization Certificate and Education (2012)
- 10th Development Plan 2014-2018 (2014)
- Communiqué on Procedures and Principles for Calculating the Efficiency of Cogeneration and Microgeneration Plants (2014)
- National Energy Efficiency Action Plan 2017-2023 (2018)

In the 2023 Industrial Strategy Document, it was stated that one of the most important elements of economic development is the sustainable use of energy and natural resources, and it was stated that the use of alternative energy resources should be increased in order to reduce the increase in energy demand and foreign dependency. Efficient and productive maintenance of energy management necessitates the effective use of technological developments in the industry. Turkey must maintain strategic management in energy jointly with all public institutions and organizations (Republic of Turkey, Ministry of Industry and Technology, 2019). With the importance of the environment, many countries have increased the use of renewable energy sources in energy production, but have not switched to green plans (Neumann and Mehlkop, 2020). Green planning is as important as the use of renewable energy sources in energy production. The implementation of green plans together with the transition to green energy means a total fight against climate change.

SOLUTIONS AND RECOMMENDATIONS

Developed countries have easily transitioned to renewable energy sources in energy production, but developed and developing countries have had difficulty meeting the costs required for the transition to renewable energy sources. The developed countries of the present, which use non-renewable energy resources excessively with the industrial revolution, did not have much difficulty in meeting the cost of transition to new energy systems as they completed their development process. Underdeveloped or developing countries, on the other hand, have been in a difficult position in the face of these costs, and their already not very good economies have gotten worse with the transition to new energy systems. However, in order to protect the environment and leave a clean and livable world to future generations, these countries, which risk these costs, have met the energy management problem. With the increase in economic activities, the increase in energy demand has created problems in energy management. Controlling energy supply and demand, analyzing the need for and to be needed for energy, and ensuring the effective and efficient use of energy resources are the objectives of energy management. In order to achieve success in these objectives, it is imperative to use strategic management in energy management.

Since the early 2000s, Turkey has initiated efforts to ensure the transition to strategic management in public administration and has tried to implement this management approach in all areas. With the Public Financial Management and Control Law No. 5018 issued in 2003, strategic management was introduced in the public administration. With this law, it has become mandatory for all state institutions and organizations to prepare strategic plans. Embracing strategic management in public administration, Turkey has a very good understanding of the importance of strategic management in energy management. Turkey, which is in the category of developing countries, has faced many financial problems caused by being an energy dependent country, but has made it a priority to end this external dependence with the use of renewable energy sources within itself.

FUTURE RESEARCH DIRECTIONS

Turkey, a country rich in wind and water energy, will both end its dependence on energy and exist as an economic and political power in the region with the use of these resources. The way to achieve this is to adopt strategic management in energy from the bottom to the highest level with all state institutions and organizations of Turkey. Ensuring the efficient use of energy with the aim of reducing energy consumption contributes to economic and political development, but is also of great importance in terms of leaving a clean, green and livable world for future generations.

CONCLUSION

The production costs of energy that come up at every stage of life are quite high. The fact that energy sources are not evenly distributed all over the world leads to different costs for each country. In our age when the development of societies is possible with industrialization, the energy used in production is extremely important for the development of countries. Countries are going through serious costs to access their energy sources and even waging wars to have energy sources. However, the importance of the balance of energy production with consumption should not be ignored. The fact that energy is very difficult to store has caused countries trying to seize energy sources to colonize the regions where the resources are located. When the overuse of energy resources made the world uninhabitable with the industrial revolution, countries agreed on the use of green, renewable energy sources, and efforts were initiated to reduce the use of non-renewable energy sources. Environmental awareness has been created with many congresses and conferences organized within this scope; decisions were made that the use of non-renewable energy sources should be reduced and the transition to renewable energy sources should be accelerated for the future of humanity.

Turkey will be able to reduce external dependence on energy management by exhibiting a stable stance, but it is necessary to create awareness on energy in Turkey's citizens. The fact that the water used in electrical energy has become depleted due to climate change in recent years has led to the realization that renewable energy resources are not unlimited. Seeing renewable energy resources as national wealth and protecting them is the duty of citizens as well as the state. In case of movement of this awareness is not dependent on foreign energy self-sufficient, there will be a strong Turkey.

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Chapter 14
Does Economic Freedom Matter for Bank Performance and Energy Consumption?

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ABSTRACT

This study investigates the influence of economic freedom on energy consumption and bank performance in Ghana over the period 2000-2017. Specifically, the authors examine the effect of the various components of economic freedom on total energy usage, fossil fuel consumption, and bank performance. The study applies the fully modified ordinary least squares (FMOLS) method to determine the long-run influence of economic freedom indicators on energy consumption and bank performance. The results show that aside from business freedom, all the other sub-economic freedom measures significantly drive total energy consumption. The authors reveal that investment and fiscal freedom significantly influence fossil fuel consumption. The findings also establish that financial, investment, and fiscal freedom indices exert a significant effect on bank performance. These results hold regardless of the measure of bank performance. In light of the findings, the authors discuss relevant policy implications.

INTRODUCTION

For decades, economists have tried to unearth the fundamental forces that stimulate economic growth. It was earlier assumed that cultural standards and institutions explicate why some countries are more affluent than others (Landes, 1998). In recent times the effect of economic liberty or economic freedom

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has also been noted as a motivating factor of growth. According to Hafer (2013), economic growth is significantly influenced by the development of the financial sector and greater economic freedom. Countries with greater economic freedom develop faster and reach higher per-capita income levels compared with those economies with less freedom (De Haan et al., 2006). According to the growth literature, economic freedom is associated with higher real per capita income levels, and increase living standards of the poor in developing economies.

Evidently, the growth-enhancing effect of economic freedom is somehow settled in the literature. Aside from the economic growth implications of economic freedom, its consequence may be greater in other contexts. Nevertheless, researchers have done little in examining the influence of economic freedom and other factors. In this regard, we seek to look at how economic freedom affects energy demand and the performance of banks in Ghana. Until now, there has been a significant body of existing research on energy consumption in developing economies especially its determinants. Given that energy is key in the production processes, understanding the factors that influence energy demand is crucial. We argue that economic freedom promotes efficiency in firms' operations as they have access to state-of-the-art technologies which can influence energy demand as consumption increases. The effect of economic freedom on energy consumption remains elusive as it has received far less attention in the literature. This study thus fills a huge gap in the literature by looking at the effect of economic freedom on energy consumption in the Ghanaian context.

Our second objective is to assess whether economic freedom fosters firm performance. In the case of this study, only banks are considered given the aggregate data availability of the banking sector. The significance of banks is reflected in the fact that they serve as the primary channel of deposits and credit allocation in the economy (Levine, 1997). By transforming deposits into viable investments, the banking sector plays an essential economic role in financial intermediation and economic stimulation. The financial system as a whole, as well as the entire economy, are therefore severely impacted by the performance of the banking sector.

Undoubtedly, a stable and efficient banking sector is best equipped to deal with adverse disruptions and contributes to the financial system's resilience. As a result, the factors determining bank profits have drawn the attention of researchers as well as bank management and regulatory authorities. The recent literature has illustrated that banks' profitability in both developed and emerging economies is influenced by bank-related factors, market or industry indicators, and macroeconomic conditions (see Davydenko, 2010; Sufian, 2012; Dietrich and Wanzenried, 2011; Messai et al., 2015; Menicucci and Paolucci, 2016; Yakubu, 2016; Islam and Rana, 2017; Salike and Ao, 2018; Yakubu, 2019; Hasan et al., 2020; Jilenga and Luanda, 2021; Ozili, 2021). In the banking literature, the relationship between economic freedom and bank performance is virtually missing as few studies have examined this nexus (Sufian and Habibullah, 2010; Smimou and Karabegovic, 2010; Chortareas et al., 2013; Sufian, 2014; Aziz and Knutsen, 2019). The scanty attempts in this area are quite unexpected, considering the position of banks in fostering economic development and the possible effect of economic freedom on the operations of banks (Sufian and Habibullah, 2010). This study seeks to show how economic freedom affects bank profitability in Ghana, hence adding to the few findings on the economic freedom-profitability relationship.

In a number of ways, the study contributes to the existing body of literature. First, given the initial objective, the researchers are unaware of any existing study that has analyzed the effect of economic freedom on energy demand in Ghana. This research thus offers a first attempt in assessing the economic freedom-energy consumption nexus in Ghana. Second, given the increasing fossil fuel usage which also takes a larger portion of the overall energy consumption mix in Ghana, we examine how economic freedom affects fossil fuel consumption. The third contribution is that the study presents a first-time analysis on the link between economic freedom and profitability of banks in Ghana, per the authors' knowledge. Finally, rather than using the aggregate economic freedom index, the paper examines the effect of the individual components of economic freedom on energy demand and bank performance.

LITERATURE REVIEW

In line with the study objectives, we review the literature on the influence of economic freedom and other factors on energy consumption and bank performance.

Factors Influencing Energy Consumption

Theoretically, the basic consumption theory postulates that income and consumption level are related. In the same disposition, income correlates with energy consumption. On the justification of this relationship, in the USA, Kraft and Kraft (1978) evidenced a causal link regarding economic growth and the level of energy consumption. Following Kraft and Kraft's (1978) earlier work, several studies have used a variety of econometric approaches to explore the energy-growth nexus, spanning various time frames and samples and yielding varying results.

Though the literature is scanty on the effect of economic freedom on energy demand, other variables have been uncovered as drivers of energy consumption (total energy, renewable energy, and non-renewable energy consumption) ranging from macroeconomic to socio-economic indicators. The influence of these factors including economic freedom are discussed below.

In the African context, Amoah et al. (2020) examined the effect of economic freedom and well-being on the consumption of renewable energy. The study applied the dynamic OLS with data for the years 1996-2017. The results showed that renewable energy demand is increased when economic well-being improves. Regarding the various components of economic freedom, the researchers noted that the tax burden which measures fiscal freedom and property rights reduce renewable energy consumption. Improved trade and business freedom indices on the other hand raise the demand for renewable energy.

Using data of selected emerging economies covering from 1990-2006, Sadorsky (2010) investigated the influence of financial sector development on energy usage. The researcher applied the system generalized method of moments (GMM) technique and evidenced that financial sector development (measured by stock market dimensions) positively and significantly drives energy consumption.

Abidin et al. (2015) studied the link between FDI, the development of the financial sector, trade, and energy consumption in the ASEAN nations. The results from the ARDL method and the granger causality test indicated that the variables have cointegration and FDI exerts a unidirectional influence on the amount of energy used.

Komal and Abbas (2015) empirically looked at the relationship amid financial sector development, growth, and the level of energy consumption in Pakistan for the years 1972 to 2012. Using the GMM approach, the results established that energy consumption is directly and significantly driven by urbanization, the level of economic growth, and financial sector development. The authors further noted that energy prices have a negative and significant influence on energy demand.

Azam et al. (2016) examined the macroeconomic variables influencing energy usage in Greece over the period 1975-2013. Using the vector error correction model (VECM) technique, the results presented

FDI, infrastructure development, population, urban development, income, and trade as the key determining factors of energy consumption.

Alawin et al. (2016) used the ARDL model to analyze the factors determining electricity demand in Jordan for the years 1985-2006. The findings revealed that population and economic growth have a direct significant influence on electricity consumption. The study also found that manufacturing efficiency decreases electricity demand.

Applying the ARDL technique with data covering from 1971-2012, Shahbaz et al. (2016) studied the effect of globalization on energy demand in India. The results established that an increasing level of globalization reduces the demand for energy.

Topcu and Payne (2017) analyzed how the development of the financial sector influences energy consumption in high-income nations. Employing heterogeneous panel regression methods, the study found no significant relationship between the overall index of financial development and the amount of energy consumption. Turning to the sub-components of financial development, the stock market index showed a decreasing effect on energy consumption.

Sineviciene et al. (2017) analyzed the drivers of energy consumption in Eastern Europe over the period 1996-2013. In determining the long-term link among the variables, the study employed the stochastic frontier technique. The results established that GDP growth keenly contributes to the rising level of energy utilization.

Gamoori et al. (2017) explored the causes of energy consumption in the OIC countries for the years 2000-2014. Applying the fixed effects method, the researchers posited that FDI and financial development significantly and positively influence energy consumption.

Rafindadi and Ozturk (2017) looked into the influence of trade openness, financial sector development, and economic growth on the level of energy demand in the context of South Africa over the period 1970-2011. Relying on the VECM technique, the results evidenced that as the financial sector develops, energy demand increases. Also, affluence and the level of openness to trade cause energy consumption to increase in South Africa.

Invoking the ARDL approach with the STIRPAT model, Shahbaz et al. (2017) scrutinized the influence of urbanization along with other factors on energy demand in Pakistan during the period 1972Q1-2011Q4. The authors found that urbanization contributes to energy demand. The study also revealed that technology and the level of affluence positively enhance energy demand.

Destek (2018) assessed the effect of financial sector development, price of energy, and real income on energy utilization using annual data of 17 emerging markets which spanned 1991-2015. Employing the common correlated effects (CCE) technique, the findings showed that bond market development (a dimension of financial development) negatively induces energy consumption. Also, from the findings, real income increases energy demand while energy prices reduce energy consumption.

Hassan (2018) examined the determinants of energy demand in the ASEAN-5 countries for the years 2000-2016. Using the fully modified OLS technique, the findings established that urbanization, access to energy, and the level of economic growth significantly drive energy demand.

In assessing the influence of financial sector development on the consumption of energy in Turkey, Dumrul (2018) applied the fully modified OLS and the dynamic OLS techniques on data for the years 1961-2015. According to the findings, economic growth and the advancement of the financial sector have a positive effect on energy use.

Ergun et al. (2019) explored the factors determining the utilization of renewable energy in Africa over the period 1990-2013. The authors discovered that FDI exhibited a positive influence on renewable energy use through the random effects technique. The findings also revealed that renewable energy usage is inversely related to human development index and GDP per capita. Furthermore, democracy was noted to possess an indirect influence on renewable energy consumption.

Using the fully modified OLS, Kwakwa and Adusah-Poku (2019) tested for the drivers of energy intensity and consumption of electricity in South Africa during the period 1975-2014. The results established that energy intensity and the consumption of electricity decrease as income increases. The findings also evidenced that manufacturing intensifies energy usage and electricity consumption.

In a comparative analysis using emerging and developed countries, Mrabet et al. (2019) assessed how urbanization affects non-renewable energy demand for the years 1980-2014. Applying the augmented mean group technique, the results established that as urbanization increases, the use of non-renewable energy increases. In addition, the study found that urbanization has the greatest impact on non-renewable energy demand compared with other factors included in the analysis.

Morelli and Mele (2020) examined the relationship amid CO_2 emission, economic growth, and demand for energy in Vietnam. Applying different analytical techniques on time series data over the period 1970-2014, the researchers reported a unidirectional effect of economic growth on the level of energy utilization.

In Malaysia, Ridzuan et al. (2020) analyzed the influence of macroeconomic variables on electricity consumption over the period 1970-2016. Using the ARDL method, the authors found that economic growth and urbanization increase electricity usage. Inflation and the level of financial deepening, however, correlated negatively with electricity consumption.

Onisanwa and Adaji (2020) assessed the key factors affecting electricity consumption in the Nigerian economy for the years 1981-2017. Relying on the ARDL estimator, the results showed that population and income per capita are the paramount long-term factors influencing electricity consumption. The study also revealed that the shortage of electricity and the total number of electricity consumers matter for electricity consumption.

Uzar (2020) investigated the income inequality-renewable energy demand nexus in a panel of 43 countries over the years 2000-2015. Applying the panel ARDL method, the researcher found that reducing income inequality in the sampled countries will help increase renewable energy consumption. Also, the author found no significant connection between economic growth and the use of renewable energy.

Yu et al. (2020) analyzed the link between urbanization and energy demand in China's Yangtze River Economic Belt for the years 2003-2014. Applying the fixed effects model, the results unveiled a positive significant effect of the various urbanization measures on energy demand.

Fernandes and Reddy (2021) investigated the drivers of energy consumption using selected countries in Asia classified among the newly industrialized economies. The study covered from 1980-2018 and applied the VECM technique. On a country-level analysis, the results reported that in China, the growth of the financial sector, industrial growth, openness to trade, and exchange rate drive energy usage. For India and Thailand, energy consumption increases as industrialization intensify. Demand for energy in Malaysia increases with an increase in openness to trade.

Murshed and Alam (2021) investigated the macroeconomic factor influencing energy consumption in Bangladesh over the period 1980-2014. The authors used the ARDL technique and classified energy consumption into total, renewable, and non-renewable energy consumptions. The findings showed that while economic growth and household consumption expenditure positively motivate energy demand, the impact of income inequality is negative. In addition, whereas demand for total energy and non-renewable energy is reduced by technology, the results found a positive influence of technology on the use of renewable energy.

The Effect of Economic Freedom and Other Factors on Bank Performance

In the banking literature, the relationship between economic freedom and corporate profitability seems rare. Also, theoretical models are in reality yet to be established that specifically assess the economic freedom-performance link. For the few studies on the economic freedom and performance relationship, Sufian and Habibullah (2010) in Malaysia empirically revealed that economic freedom as a whole and business freedom directly impact bank profitability. Smimou and Karabegovic (2010) analyzed the influence of economic freedom on market return on equity in the Middle East and North Africa (MENA) countries. The study showed a positive effect of changes in the economic freedom index on equity returns. In the European Union, Chortareas et al. (2013) found that improved financial freedom gives a significant cost efficiency benefit to banks. Similarly, Sufian (2014) points to the fact that financial freedom impacts positively on Islamic banks' performance in the MENA. Aziz and Knutsen (2019) studied the effect of economic freedom on the profitability of banks in Arab nations employing data from fourteen countries from the period 1986 to 2016. Using the system GMM technique, they found that the profitability of Arab banks is positively affected by a greater level of economic freedom.

Aside from economic freedom, the literature provides a detailed analysis on bank performance determinants in both emerging and advanced economies. Al-Tamimi and Hussein (2010) for example, researched the financial performance indicators of banks in the United Arab Emirates (UAE). They suggested that liquidity and banking concentration matter for bank profitability. Mirzaei et al. (2013) assessed whether bank market structure drives profitability in a sample of 1,929 banks across the globe. The results reported that while market structure increases bank performance in advanced countries, it does not matter for bank profits in emerging markets. Applying the CAMEL rating technique, Echekoba et al. (2014) established that bank liquidity is a significant factor driving banks' profit in Nigeria. Capraru and Ihnatov (2014) have shown that the efficiency level of management, adequacy of bank capital, and the level of inflation influence bank efficiency in Central and Eastern European nations. Albulescu (2015) documented that bank profitability in emerging economies is determined by bank capitalization ratio, interest rate, and liquidity level of banks. Using a sample of 13 banks, Ashatti (2016) established that whereas leverage of banks and capital adequacy level directly drive bank profitability, bank assets decrease profits in Jordan. In his evaluation of the factors affecting Ghanaian banks' profit growth, Yakubu (2016) found bank-specific indicators such as bank size, bank liquidity level, and the management of bank expenses to affect profitability significantly. Also, in Ghana, Yakubu et al. (2017) noted that short-term and long-term debt negatively affect bank profits. Belke and Unal (2017) revealed that the performance of Turkish banks is driven by bank-level factors such as bank capital, size, and the level of liquidity risk. Yuksel et al. (2018) revealed that while economic growth and non-interest income positively affect profit, loan-to-GDP ratio reduces the level of bank profits in the post-Soviet nations. Using different panel analytical techniques, Al-Homaidi (2018) found that bank branches, leverage, and size significantly motivate banks' profit levels in India. Hossain and Khalid (2018) posited that loan to deposit ratio has a positive effect on bank profitability in Bangladesh. Prasanto et al. (2020) found a similar result in Indonesia. In addition to the loan to deposit ratio, the authors also found non-performing loans to positively influence bank profits. In Vietnam, Batten and Vo (2019) examined the key drivers of bank performance for the years 2006-2014. They reported that bank profit is strongly influenced by bank-level variables such as capital adequacy, risk level, size, and bank expense. Using the generalized method of moments technique, Saleh et al. (2020) found that capital levels, liquidity, and credit risks significantly stimulate bank profits in emerging markets. In a more recent analysis, Jilenga and Luanda (2021) examined bank profitability determinants in Tanzania over the period 2008-2019. The study noted bank deposits and expense as the key bank-level factors driving profit growth.

From the extensive literature review, we can deduce that several factors have been noted as key drivers of energy consumption and bank performance. Studies on the influence of economic freedom on both energy demand and bank performance are very little, therefore, proving the prospect to examine these links. Hence, the aim of our study.

RESEARCH METHODOLOGY

Data and Sources

The study employs annual data spanning 2000 – 2017. The dependent variables are energy consumption and bank performance. The energy consumption variable is further disaggregated into fossil fuel usage and the consumption of renewable energy. However, we consider only fossil fuel utilization for the aim of this research. For the explanatory factors, we use the sub-components of economic freedom to examine their impact on the dependent factors. Data for total energy usage and fossil fuel consumption are sourced from World Bank's World Development Indicators. Bank performance data are gleaned from the Global Financial Development Database of the World Bank. The economic freedom data is retrieved from the Heritage Foundation. The economic freedom indicators are scored from 0 to 100, where a higher value denotes greater freedom.

Description of Variables

Dependent Variables

As stated, energy consumption and bank performance serve as the dependent variables. We measure energy consumption (enercon) as the total energy use (kg of oil equivalent per capita). For fossil fuel consumption (fossil), it is the amount of fossil fuel utilized (% of total energy consumption). In this study, we gauge bank performance using return on asset (roa) which is the ratio of net income to total assets and return on equity (roe) described as net income divided by shareholders' equity.

Independent Variables

Our independent variables are the sub-indices of economic freedom encompassing financial freedom (finfree), business freedom (busfree), investment freedom (invfree), and fiscal freedom (fiscfree). For the definitions of the variables, financial freedom measures the efficiency of the banking sector and how banks operate independently from government control and interference. Business freedom gauges the freedom to establish a business and ease of obtaining a license to operate and close a business. While investment freedom measures how investment capital moves without constraints, fiscal freedom measures the tax burden government imposes on firms.

Empirical Model

In evaluating the influence of economic freedom indicators on total energy and fossil fuel consumption with all variables in natural logarithm, the following models are specified:

$$logenercon_t = \alpha_0 + \beta_1 logfinfree_t + \beta_2 logbusfree_t + \beta_3 loginvfree_t + \beta_4 logfiscfree_t + \varepsilon_t \quad (1)$$

$$logfossil_t = \alpha_0 + \beta_1 logfinfree_t + \beta_2 logbusfree_t + \beta_3 loginvfree_t + \beta_4 logfiscfree_t + \varepsilon_t \quad (2)$$

Likewise, the models for analyzing the effect of economic freedom indicators on bank performance are state as:

$$logroa_t = \alpha_0 + \beta_1 logfinfree_t + \beta_2 logbusfree_t + \beta_3 loginvfree_t + \beta_4 logfiscfree_t + \varepsilon_t \quad (3)$$

$$logroe_t = \alpha_0 + \beta_1 logfinfree_t + \beta_2 logbusfree_t + \beta_3 loginvfree_t + \beta_4 logfiscfree_t + \varepsilon_t \quad (4)$$

where the time dimension is indicated by t. α, β, and ε represent the constant, coefficients of the independent factors, and error term respectively.

Estimation Approach

To avert spurious results from the regression analysis, the study follows the standard method of checking for stationarity. Consequently, to establish how our factors are integrated, the Phillips-Perron (PP) unit root test is applied. Unlike other methods (e.g., Augmented Dickey-Fuller test), the PP test resolves serial correlation and heteroskedasticity, particularly in the error term. The autoregressive distributed lag (ARDL) cointegration test is used to confirm the existence of a long-run relationship amid the variables. The Fully Modified Ordinary Least Square (FMOLS) technique by Phillips and Hansen (1990) is applied to investigate how economic freedom influences energy consumption and bank performance after the cointegration of the variables has been verified. The robustness of the FMOLS approach to serial correlation and endogeneity problems justifies its application.

EMPIRICAL RESULTS

Stationary Test Results

The behaviour of a time series is heavily influenced by whether it is stationary or non-stationary. A study can generate spurious regression results if the time series variables are non-stationary. In order to prevent this issue, stationary tests should be carried out to understand the unit root properties of the series. The Phillips-Perron (PP) unit root test is used in this study. The results of the PP test are depicted in Table 1. We observe that none of the variables is integrated at level. They all show stationarity at first difference, thus allowing us to apply the FMOLS method as the best technique compared with other estimators.

Table 1. Phillips Perron (PP) unit root test results

Variables	Level	First Difference
logenercon	0.071	-2.283**
logfossil	2.561	-3.140***
logroa	-0.548	-3.846***
logroe	-0.777	-4.098***
logfinfree	0.782	-7.605***
logbusfree	0.120	-4.644***
loginvfree	1.662	-3.651***
logfiscfree	2.561	-3.140***

Note: **,*** denote the significance level at 5% and 1% respectively.

Cointegration Test Results

To check for the presence of a long-term relationship between economic freedom indicators and energy consumption as well as economic freedom and bank performance, we use the ARDL bound test method to cointegration following the work of Kwakwa and Adusah-Poku (2019). The cointegration analysis is carried for each of the dependent variables and the explanatory factors. The cointegration results are outlined in Table 2. It can be observed from the results that each of the cointegration tests shows a long-term relationship amid the variables given that at 1% significance, their respective F-statistics values surpass the upper bound critical values. In brief, the cointegration tests show that the economic freedom measures used in the analysis are long-run determinants of energy consumption and bank performance in Ghana.

The Results of the Effect of Economic Freedom on Energy Consumption

Table 3 shows the long-run regression estimates with energy consumption and fossil fuel usage as the primary dependent variables. From Model 1, financial freedom exerts a positive effect on the level of energy consumption and the effect is significant at 10% level. Precisely, total energy consumption rises by 0.159% as financial freedom increases by a percentage. The result suggests that as banks are given more freedom to operate, they may tend to commit funds into sectors and activities with high energy demand without any strict monitoring and control from the government. Also, in the case of less monitoring, the banks advance credit to individuals and corporations without proper scrutiny. These credits may be used for the purchase of automobiles and machinery which increases the level of energy consumption.

We find that business freedom has a negative influence on overall energy consumption. It is noted that a percentage increase in business freedom reduces energy consumption by 0.061%. The impact however is not significant. The negative result implies that as businesses are granted the freedom to operate and obtain a license, their operations tend to lower the level of energy consumption in Ghana. However, the insignificance of business freedom depicts that the environmental policies instituted by the Environmental Protection Agency for businesses operating in Ghana have not been effective enough to yield the desired results.

Table 2. Cointegration test results

Dependent variable: Energy consumption (enercon)			
F-Statistics	**Significance**	**I(0)**	**I(1)**
5.151***	1%	3.29	4.37
	5%	2.56	3.49
	10%	2.2	3.09
Dependent variable: Fossil fuels (fossil)			
F-Statistics	Significance	I(0)	I(1)
6.719***	1%	3.29	4.37
	5%	2.56	3.49
	10%	2.2	3.09
Dependent variable: Return on assets (roa)			
F-Statistics	Significance	I(0)	I(1)
15.387***	1%	3.29	4.37
	5%	2.56	3.49
	10%	2.2	3.09
Dependent variable: Return on equity (roe)			
F-Statistics	Significance	I(0)	I(1)
14.843***	1%	3.29	4.37
	5%	2.56	3.49
	10%	2.2	3.09

Note: *** denotes the significance level at 1%.

Investment freedom exercises a positive and significant effect on energy consumption suggesting that as investment capital moves without constraints, energy demand increases in Ghana. This positive relationship can be ascribed to the fact that investment freedom makes it simpler and less costly for firms to raise funds that can be used to start or expand businesses such as purchasing or constructing more factories, recruiting more staff, and purchasing more machinery. As a result of these factors, energy consumption increases.

The findings also established that fiscal freedom significantly reduces energy demand. A percentage increase in fiscal freedom leads to a 0.993% reduction in energy demand. The results basically suggest that firms tend to conserve more energy as government imposes more taxes on their operations.

In Model 2, we examine the effect of economic freedom on fossil fuel consumption. Similar to the finding in Model 1, financial freedom has a positive effect on fossil fuel demand although the impact is not significant. Contrary to total energy consumption, business freedom positively affects fossil fuel consumption. A percentage increase in business freedom raises fossil fuel consumption by 0.021%. The effect however is insignificant. Investment freedom and fossil fuel consumption are positively and significantly related. This is consistent with the results of the total energy consumption. We further establish that fiscal freedom significantly and positively influences fossil fuel consumption. Specifically, fossil fuel demand intensifies by 2.216% relative to a percentage increase in fiscal freedom. The finding signifies that irrespective of the volume of tax imposed by the government, firms' level of fossil fuel consumption

Table 3. Regression estimation results (Economic Freedom-Energy Consumption)

Variables	Model 1 (enercons)	Model 2 (fossil)
logfinfree	0.159*	0.077
	(0.081)	(0.392)
logbusfree	-0.061	0.021
	(0.609)	(0.867)
loginvfree	0.683***	0.278**
	(0.000)	(0.039)
logfiscfree	-0.993***	2.216***
	(0.002)	(0.000)
c	3.014***	-3.239***
	(0.000)	(0.000)
R^2	0.735	0.880
Adj. R^2	0.647	0.840

Notes: *,,*** ** denote the significance level at 10%, 5% and 1% respectively; *p*–values are in parentheses.

is not diminished. From Model 2, it can be observed that all the economic freedom indicators positively drive fossil fuel consumption. This shows that fossil fuel which takes the largest share of the final energy mix in Ghana contributes significantly to the country's growth despite its environmental threats.

The Results of the Effect of Economic Freedom on Bank Performance

Table 4 shows the results of the regression analysis on the effect of economic freedom on bank performance based on the Fully Modified OLS estimation. We rely on return on asset (roa) and return on equity (roe) as our performance measures. From Table 4, the results in Model 3 and Model 4 are quite similar with regards to coefficient signs and statistical significance. This implies that the influence of the economic freedom indicators on bank performance is robust to alternative measures of bank performance. From the results, financial freedom shows a negative significant effect on performance. This suggests that minimal interferences by the government in banking sector activities reduce banks' profitability. The result reflects the fact that the government excessively intervenes in banks' activities in Ghana and exerts some control over the central bank in the quest of achieving an efficient banking sector.

The effect of business freedom on bank performance is positive though insignificant. The finding suggests that greater licensing ability for starting, operating, and closing businesses enhance bank profitability in Ghana. With the ease of obtaining a license, banks are able to avoid unnecessary costs which improve their operations.

The coefficient of investment freedom is positive and significant. This infers that reducing restrictions to investment capital flows, allowing more transfers and payments, and providing access to global financial markets are crucial means to enhancing bank performance. The positive impact could be attributed to the large number of foreign banks operating in Ghana as a result of lower restrictions on foreign banks' entry. This increases competition among banks which impacts positively on banks' efficiency.

Fiscal freedom which measures the tax burden government imposes on firms has a significant negative influence on performance. A percentage increase in fiscal freedom reduces banks' performance by 4.251% and 6.652% respectively for each of the performance measures. The result suggests that as banks pay more in taxes, their profit level reduces.

Table 4. Regression estimation results (Economic Freedom-Bank Performance)

Variables	Model 3 (roa)	Model 4 (roe)
logfinfree	-1.676***	-1.651***
	(0.000)	(0.000)
logbusfree	0.639	0.320
	(0.140)	(0.448)
loginvfree	2.179***	1.685***
	(0.000)	(0.001)
logfiscfree	-4.251***	-6.652***
	(0.001)	(0.000)
c	6.587***	13.493***
	(0.001)	(0.000)
R^2	0.706	0.831
Adj. R^2	0.608	0.775

Notes: *** denotes the significance level at 1%; *p*–values are in parentheses.

CONCLUSION

This paper investigated the influence of economic freedom on energy consumption and bank performance in Ghana over the period 2000-2017. Specifically, we scrutinized how the various components of economic freedom influence total energy and fossil fuel consumption. Also, the "eminent" profitability measures (return on asset and return on equity) are used to quantify bank performance. After ascertaining that the variables showed stationarity at first difference and that they are cointegrated, the study applied the Fully Modified OLS method to establish the long-run influence of economic freedom indicators on energy consumption and the performance of banks. The findings showed that aside from business freedom, all the other sub-economic freedom measures significantly drive total energy consumption. We revealed that investment and fiscal freedom significantly influence fossil fuel consumption. The analysis also established that business freedom and investment freedom are positively correlated with bank performance while financial freedom and fiscal freedom negatively affect performance. However, only financial freedom, investment freedom, and fiscal freedom are significant, implying that they are the key economic freedom indicators explaining bank performance in Ghana.

RECOMMENDATIONS

The findings present important policy recommendations. As we have revealed from the analysis, the reduction in restrictions to investment capital flows may allow firms to boost production by easily sourcing funds to acquire machinery and equipment which increases energy demand. To reduce the environmental consequence of this, stringent environmental regulations should be imposed on such firms. Also, firms need to be encouraged to adopt environmentally friendly technologies that reduce pollution risks. Imposing more taxes on firms particularly environmental tax will help reduce energy consumption and its associated perils. For banks, the results suggest that giving banking institutions the freedom to operate with proper regulatory mechanisms and relaxing constraints for investable capital flows are essential for banks' profitability in Ghana.

FUTURE RESEARCH DIRECTIONS

Economic freedom research is only in the early stages and much more needs to be explored. The study recommends that aside from the economic freedom variables included in this paper, other freedom indicators (such as trade freedom, corruption freedom, and monetary freedom) can be considered in future research. This can be done in the context of panel studies with refined panel techniques for instance the generalized method of moments.

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KEY TERMS AND DEFINITIONS

Bank Performance: It is a measurement related to the bank specific variables.
Economic Freedom: It is freedom for economic activities of individuals.
Energy Consumption: It is the amount of energy used by individuals, firms, and countries.

Chapter 15
Evaluation of the Progress of Sustainable Energy Management in World Economies

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ABSTRACT

The aim of the study is to analyze the underlying reasons for the countries to have access to the energy reserves and the effort to be to holding on those reserves. Energy is the driving force for the production of goods and services. Countries who have access to energy reserves are aware that those reserves provide both economic and political power. The motive for countries to have control of energy reserves are twofold: basis for economic growth and keeping or gaining political power. The result most of the time is a continous power struggle between the countries.

INTRODUCTION

Energy consumption is a growth thermometer. It is possible to state that the macro factors that underlie energy growth in economic terms are primarily related to demography. Another factor strongly linked to economic growth is the expansion of the middle class. Energy is among the basic elements of economic growth and development. As is known, the world has faced an unprecented humanitarian, social and economic crisis since February 2020 due to the Covid-19 outbreak. OECD warns against the negative impact of corona virus on the global economic system. The predictions made so far outweigh the worst economic predictions. Therefore, the OECD recommends urgent economic and fiscal policy measures. As early as March 2020, the OECD predicted that the Covid-19 crisis could halve the growth of the world economy by 2020, and even while publishing reports on this issue, it is thought that the negative effects of the epidemic may continue until 2022, and it will continue for even longer. The most important

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feature that distinguishes Covid-19 from other epidemics is that it does not focus only on developing countries and less developed countries, it affects all countries beyond the level of development and creates uncertainty. Therefore, the uncertainty of the development of the virus and its economic impact also makes it difficult for policy makers to formulate an appropriate macroeconomic policy. This issue, which deeply shakes the economies of the countries, creates the concern that the scenario will get worse day by day. Therefore, the economic urgency of Covid-19 requires targeted economic policy intervention from all countries. This epidemic is the third major economic, financial and social shock of the 21st century, following the attacks of September 11, 2001 and the global economic-financial crisis of 2008. Among the negative effects of the crisis, the problem of production collapse was experienced in all countries affected by the pandemic. This will hurt global value chains with negative consequences on consumption and consumer confidence. In addition, while drastic measures are necessary to contain the virus, the situation is pushing economies into an unprecedented state of chaos where a recovery is taking place. Therefore, in addition to taking action to minimize the loss of human life, a coordinated effort against this new major economic crisis is a priority that will continue even after the worst of the health crisis has passed. On a theoretical level, it can be said that this pandemic will affect world economies through three different channels (Magazzino, et al, 2021:1). Thus, death affects production by permanently removing some people from the workforce. In the case of illness, hospitalization and absenteeism - production is temporarily suspended. People change their behavior in the event of an epidemic, quarantine prevents travel to / from infected areas and reduces consumption of services such as restaurants, tourism, entertainment, public transport and offline purchases. The economic impact of this epidemic on the world economy with few exceptions are negative. The policies to be determined by governments as energy policies may vary from country to country. Therefore, countries facing the shocks have to implement a strategic plans. If countries could anticipate the negative effects of contamination on the economy with their targeted economic policies, they could slow down the economic crisis process. The policy choices to be implemented should be based on a rapid structural change in the economy. In particular, the increasing investment in renewable energy, could accelerate GDP growth. This proposal could mitigate the effects of the economic recession. It is known that some of the countries have great potential for all renewable resources thanks to their geographical location that provides a perfect natural cycle related to climate problems. Countries such as Brazil, has plenty of sun, wind, biomass and ocean energy resources. This will enable the maintenance of the long-term renewable feature that differentiates its energy for Brazil. The important factor in energy is to try to ensure sustainability and the implementation of government policies for this.

The concept of "Sustainable" was used for the first time in the Bruntland Report in the 1980s, and this concept refers to the use of existing resources in a way that will be sufficient for future generations (Seydioğulları, 2013). In addition to the global warming experienced due to the change in the world order and the change of climates, the power struggles of the countries on a global scale cause the resources to change or even disappear. In particular, energy consumption can support growth by increasing productivity, but also may damage the environment (negative externalities) makes the results paradoxical. Therefore, in light of this contradictory results, scientific research analyzes the link between energy consumption and economic power. (Magazzino et al, 2021). The growth hypothesis suggests that energy is a determinant of economic growth. Therefore, an increase in energy use has a direct impact on the economy. On the contrary, if the contribution to energy useage decreases, economic growth will be negatively affected. According to the conservation hypothesis, there is a unidirectional causality effect ranging from economic growth to energy consumption. According to the feedback hypothesis, it shows that there is a two-way relationship between economic growth and energy use. The neutrality hypothesis denies the existence of a causal relationship between energy consumption and economic growth. Therefore, a negative change in energy consumption will not cause a decrease in economic growth. The neutrality hypothesis is confirmed by empirical studies stating that an increase in economic growth does not cause an increase in energy consumption and vice versa.

POWER STRUGGLE FOR ENERGY MANAGEMENT OF WORLD ECONOMIES

In order to be the most powerful economy in the world countries enter into a trade war with each other. What is meant by the trade war is that a country imposes a restriction on its imports from that country for various reasons, the counterparty country responds in the same way and imposes other sanctions such as customs duties and quotations on imports from that country. With these sanctions, the trade capacity between the two countries gradually decline. Past experiences show that, in the short run, protectionism may be beneficial. In the long run however the economies slow down and experience ecomic crisis. The main causes of the trade wars that occurred over the years, were usually selfish government economic policies weighed towards their benefit. Since the earliest days of history, trade wars have often been confronted by powerful countries, but the highest rate of destruction that has occurred as a result has been observed to affect countries that are less powerful and weaker. Countries wishing to grow due to in the future are willing to have energy power. However, today many countries are faced with energy shortages. The advances in the world economy and population, and the uninterrupted change in growth and the focus of energy consumption on emerging Asian and other economies are causing a steady increase in demand for energy services. Renewable energy has a small share of the total energy mix (Awan and Khan, 2014). Technology alternatives that can be obtained to reduce carbon emissions in the energy sector include renewable energy sources that are not always available but normally do not contain carbon. However, the cost of these technologies exceeds the cost of traditional fossil fuels (Popp, Hascic and Medhi, 2011).

Energy is an important issue to ensure the social welfare and economic development of countries. When a country's population increases and its technology improves, the amount of energy used is high. At this point, it is important that the energy used is sustainable. In order for the energy to be sustainable, it is necessary to use renewable energy resources and to implement the necessary policies in the country (Dinçer and Karakuş, 2020) .

The resources from which the existing energy is obtained in the world are divided into two as renewable and non-renewable, and non- renewable energy sources are the resources that take a long time to replace and will be used up. Renewable energy; It includes energy generated from solar, biofuels, geothermal, wind and hydro, and ocean sources. Non-renewable energy sources, also known as fossil energy sources, are divided into primary and secondary energy sources. Primary energy sources are resources that are used in the form they are in nature, in other words, obtained in their original form. There is no interference with primary resources other than cleaning and separation. For example; coal, crude oil, natural gas, wind, uranium and similar energy sources. On the contrary, other energy sources obtained by subjecting to various processes are classified as secondary energy (Pata and Yurtkuran, 2017). Secondary energy sources are obtained as a result of transformation and transformation of primary sources. Fuel products can be given as an example. Renewable and non-renewable energy sources are very important. Nuclear energy, which is included in these resources, is among the renewable energy sources as it does not harm the nature and among the non- renewable energy sources due to the limited availability of materials such as thorium and uranium in the world. In the energy production process, it is necessary to use national resources more efficiently, to diversify the number of countries where primary energy resources, especially natural gas, are imported, to establish nuclear power plants and to make alternative energy investments in order to reduce foreign dependency in energy (Çalışkan, 2009).

Energy is an important item in terms of production elements. This item, which is very important in terms of economic growth and development, significantly affects the foreign policies of the countries, and even contains threats to the importing country to counter difficult situations such as quotas or emborgoes. As it is known, if a country does not have energy reserves or if they cannot reach the level of sustainability, it is inevitable that they will not be dependent on other countries. This situation will even prepare the ground for the other country to intervene in internal events.

Why Are Energy Resources So Important?

The most important feature of energy resources is both their scarcity and their unbalanced distribution on the earth (Boz et al, 2017). As it is known in the economic literature, scarce goods are more valuable. While the world population is increasing rapidly, it is getting harder to meet unlimited human needs with scarce resources. Therefore, whichever country has the available resources gains both a strategically strong position and monetary gains. This leads countries to gain financial power and political power. Energy supply is also important in capital inflows in countries' balance of payments. If a country is dependent on the other country in terms of energy, it is normal for the country to have current account deficit or balance of payment problems.

Renewed energy sources and diversification of energy supplies, will contribute to the regional and rural development opportunities and the creation of new resources resulting in a wide range of socio-economic benefits (Del Rio and Burguillo, 2009). Many problems such as water, air and environmental pollution arise due to the insufficient attention paid to renewable energy sources. The spread of greenhouse gas, carbon dioxide, methane and sulphur to the environment plus global warming, acid rains, urban air pollution triggers cancer, which starts with respiratory complaints. Since these fuels are fed by decaying plants left over from nature, their continuous use both harms the nature and affects human and animal health. In countries faced with this dangerous situation, concerns have started to be felt increasingly and steps have been taken to reduce the use of fossil energy resources. Measures are taken towards consuming renewable energy sources more carefully and confidently in order to meet the necessary energy needs without any risk in order to leave a clean air to the next generations. Even if renewable energy materials are imported they create employment in production centers abroad and contribute to the increase in renewable energy employment in the world (Güllü and Kartal, 2021).

With the development of the industry, the increase in the mandatory demands for development, defense, heating and transportation, the need for fossil energy resources has started to increase continuously around the world. In order to meet the energy demand, military power were frequently used. Later, the demand for these resources affected the commercial, military and political strategies of the countries. The majority of world energy consumption is based on oil, natural gas and coal. If renewable energy is taken more seriously by countries, a different allocation of resources will be possible in the future. To summarize the renewable energy briefly; They are energy resources that use natural processes for energy production and can renew themselves in a much faster time than the depletion rate of the resources used.

Resources with high carbon emissions should be abandoned when it is desired to proceed towards the reduction of global warming. Brazil is the eighth largest electricity producer in the world, which is among the top 10 producers such as China and the USA, ahead of countries such as France and South Korea. Brazil has an advantage in energy production. They are also among the cleanest resources in the world. Regarding wind power, Brazil is the most promising market for wind power in the Latin America region. In recent years, wind power has become an increasingly important component of the national power grid.

In 2019, China became the world's largest producer of hydroelectric, wind and solar power. China is again the world leader in terms of annual growth rate in total energy production. The most important source of naming fossil fuels as early bulletin oil, coal, natural gas and nuclear energy comes. These energy resources constitute a large part of the world's energy production (Koç and Şenel, 2013: 35) However, the other important issue here is the necessity of taking steps to try to prevent the damage of these fuels to the environment (Yılmaz, 2012).

Oil

It is possible to say that one of the indicators of energy need is the daily oil consumption of the world (Sevilgen and Kılıç, 2013). One of the most important commodities for the world economy is crude oil. Crude oil price is applied to determine the spot price of various oil barrels. There are a number of factors affecting the supply and demand of crude oil, on which crude oil prices from which many products such as gasoline are obtained depend. Household cooking oil, gasoline, electricity production and manufacturing are directly affected by high crude oil prices, depending on their costs. Since the first oil shock in the early 1970s, the role of energy consumption in output growth has become the focus of many economic studies. Energy has a direct link to a country's GDP through consumption, investment, exports and imports, and therefore can affect all components of aggregate demand. Given the positive relationship between energy consumption and economic growth, a negative shock to energy, such as an increase in energy prices or energy saving policies, will adversely affect real GDP. (Eslamloueyan and Jokar, 2014).

The importance of energy supply stability was better understood after the 1973 oil shock (high increases in energy prices). Following the oil shock, developed and developing countries understood the importance of obtaining energy from healthy, cheap and alternative sources as well as the effective use of existing and imported energy. Accordingly, energy supply stability and efficient use of energy occupy an important place among the issues that require planning for the future, especially economic growth (Karakaş et al., 2019).

Venezuela is the country with the highest oil reserves in the world. However, it is behind many countries in terms of production of visible oil reserves. Saudi Arabia, Russia and the United States are the leading countries in production. The USA has been the world's largest oil producer for the last 3 years in a row . The USA produced 17% of the world's oil and 23% of natural gas in 2019. China accounts for 18% of the world's population, 16% of the world economy, produces 20% of the world's energy resources and consumes 24%. USA, having 4% of the world population and 24% of the world economy consumes 16% of the world energy. In the global distribution of proven oil reserves, the Middle East is the region with the highest oil reserves of 48.1%.

Oil price imbalances and foreign dependency as a result of growing energy needs affect the consumption structure. (Hi et al.,2013). In order to reduce foreign dependency, efforts are focused on finding alternative energy resources and especially on the use of renewable energy resources. Turkey is neighbors with Middle East countries which hold more than half of the proven oil reserves in the world. Turkey's geographical location between the Caspian, Europe and Middle East gives her a strategic importance. Turkey's neighbors have the most important oil deposits known in the world, though she has almost no oil reserves. In this context, Turkey has been facing significant energy supply problems which makes her heavily dependent on energy imports.

It is possible to say that the two most important energy resources on the global basis are natural gas and oil. The transportation of these two important resources is generally carried out by sea and land. Therefore, the geographical location of the countries is important. Therefore, pipelines have been developed in Central Asian and Caucasian countries, which have rich oil and natural gas deposits in countries that have achieved this superiority. Russia can meet a certain part of Europe's natural gas needs thanks to its natural gas pipelines. The USA continues to be the world's largest oil producer for the last 3 years in a row. The USA produced 17% of the world's oil and 23% of natural gas in 2019. In 2019, the rate of carbon emissions continued to decline for the USA and many other developed countries, but increased for China. The energy production of the USA increased by 6% in 2019, but the biggest increase came from oil and natural gas, while coal production continued to decrease significantly. USA is the country with the highest increase in oil production for the last 3 years in a row. China constitutes 18% of the world's population, 16% of the world's economy, produces 20% of the world's energy resources and consumes 24%.

Natural Gas

Although there are many types of energy, natural gas has the advantage of having both the low carbon concentration and cost advantage provided by producers. The first community to discover natural gas was the Chinese. First of all, they obtained salt by evaporating the salt water by transporting it to salt water sources thanks to the pipes they made with bamboo reeds and additionally used it for heating purposes. Then, Italians used it for lighting purposes, and it was the first to use natural gas around the salt mines in the US West Virginia region (Çetin and Demirci, 2016) . The countries are trying to improve natural gas production in order to meet the increasing energy demand. Demand and supply, like other commodity prices, primarily improves natural gas prices. However, crude oil price and petroleum products also improve natural gas prices.

The most important feature of natural gas is that it is a clean fuel and does not pollute the environment. Natural gas is supplied by a pipeline from Russia, Iran and in liquefied form from Algeria and Nigeria in tankers. Natural gas consumption increased by 78 billion cubic meters (bcm), or 2%, well below the strong growth seen in 2018 (5.3%). Growth was driven by the USA (27 billion cubic meters) and China (24 billion cubic meters), while Russia and Japan saw the biggest decreases (10 and 8 billion cubic meters, respectively) . Gas production increased by 132 billion cubic meters (3.4%), and the USA accounted for almost two-thirds of this increase (8.5 billion cubic meters). Australia (23 billion cubic meters) and China (16 billion cubic meters) were the major factors contributing to the growth run.

Coal

Coal, one of the oldest mines in the world; although its main component is carbon, it is a flammable organic rock fragment that contains hydrogen, oxygen, sulfur and nitrogen. Britain is the first country in the world to be considered important for the first time in the world, with the formation of a society based on industrialization in the first industrial revolution, the establishment of factories and the beginning of the mechanization and railway age. Coal is an energy resource such as oil and natural gas that has reserves not only in certain regions of the world but also throughout the world. After oil it is second in primary energy consumption. Worldwide reserves are abundant, low cost and easiness of storage makes it a highly demanded energy source. According to the report prepared by Exxon Mobil, the world's leading American multinational petroleum products producer and distributor, it is predicted that coal will be totally consumed at the end of a period of 115 years, while fossil energy resources will extend their maturities if the available reserves are sufficient for the potential population. The production of coal, which is a leading energy source as it accounts for approximately 40 percent of the world's electricity production, has doubled in the orld in the last thirty years. It is also predicted that the increase in coal production is largely due to the electrical energy demand in the Asian continent, especially in China and India.

Changes occurring in the economic conjuncture are a criterion that affect the coal demand in the world. Significant changes in climatic conditions significantly affect the heating demand of coal, for example 1968 and 1969 were cooler in Europe than in 1967. This has increased fuel consumption (especially coal consumption). During this period, partly melted coal stocks in Western Europe.

Most of the coal, which is among the primary energy sources, is produced by China. The energy that China obtains from its total coal production is greater than the combined oil, natural gas and coal production of the USA. The total amount of energy imported by China is more than Japan's total energy consumption. While 17% of the energy consumed in the world is met from coal, China meets 58% of its total energy consumption from coal.

World coal consumption fell by 0.6% (-0.9 EJ), with a fourth decline in six years. There have been notable increases in non-OECD countries, China (1.8 EJ), Indonesia (0.6 EJ) and Vietnam (0.5 EJ), but growth in India is only 0.3% (0.1 EJ). Led by the US (- 1.9 EJ) and Germany (-0.6 EJ), it quickly dropped to the lowest level in our data series (dating back to 1965). Global coal production increased 1.5%, with China and Indonesia providing the only significant increases. (3.2 EJ and 1.3 EJ, respectively). The biggest decrease in production came from the USA (-1.1 EJ) and Germany (-0.3 EJ). The energy that China obtains from its total coal production is greater than the combined oil, natural gas and coal production of the USA. The total amount of energy imported by China is more than Japan's total energy consumption. While 17% of the energy consumed in the world is met from coal, China meets 58% of its total energy consumption from coal. In some countries affiliated with the European Union, coal production is reduced in line with government policies, and domestic or imported natural gas and fuel oil are substituted. Undoubtedly, natural gas production in the North Sea off the Netherlands has been an important factor in this regard.

Nuclear Energy

The word nuclear comes from the English word nucleus. When it comes to nuclear reaction, it is called fission and fusion reactions, which are formed when a heavy atomic nucleus is shattered by any external neutron attack and divided into smaller atomic particles and these light atom particles grow and form a heavier atom (Collins, 1995) . The world first heard of the term nuclear energy in World War II with the bombs that the United States dropped on Japan's Hiroshima and Nagasaki cities 3 days apart. This powerful nuclear attack, in which thousands of civilians were killed and mutilated, was recorded as the only atomic bombs used in world war history. At the time of the first discovery of nuclear energy, it was thought that it could easily meet the energy demand in the world on its own, but it was observed that nuclear energy was a troublesome and costly energy source when the accidents, explosions and the supervision of the facilities with high radiation and the risks that could not be prevented were taken into consideration.

Uranium, which is used as the fuel of nuclear power plants in the world and is a raw material of nuclear energy, has been the main energy source where countries with nuclear power plants meet their electricity needs. Uranium, which was used in paint production in ancient times, is used as nuclear power plant fuel, acetate analytical applications, military vehicles, especially in the field of armor coating, ship and aircraft construction, production reactors, plutonium hydrogen bomb production and many nuclear explosives. There are a limited number of enrichment facilities in a limited number of countries in the world. Australia ranks first in the world uranium reserve.

Members of the European Union meet most of their energy needs with nuclear power. Having nuclear power is believed to be the ends to economical development. Countries such as Nigeria, Ghana, Tanzania, Kenya, Zambia, and Uganda are aiming to cooperate with Russia, especially South Korea, China and Japan, as they realize the superiority of nuclear energy will bring. Especially Russia's Rosotom company aims to establish nuclear power plants in many countries, especially in South Africa, by 2040. It is known that countries such as Russia and China benefit a lot from nuclear energy while countries such as Japan and South Korea benefit from nuclear energy. The nuclear consumption increased by 3.2% (equivalent to the input base), and the fastest growth of 10% was realized since 2004, above the -0.7% average. As in 2018, China recorded the largest increase of any country and it was China 's largest so far (0.5 EJ). Japan also experienced a remarkable growth of 0.15 EJ, or 33% continued to recover from a total shutdown of production in 2014. Hydroelectric consumption increased by 0.8%, falling below the 10-year average of 1.9%. Growth, China (0.6 EJ), Turkey (0.3 EJ) and India (0.2 EJ) side has managed to n. USA and Vietnam have seen the biggest declines. (both -0.2 EJ) . Russia continues to take steps to increase its dependence on nuclear power within the scope of its future plans. Planning to increase its nuclear share in energy production to 30 percent by 2030, Moscow aims to reach 50 percent by 2050 and 80 percent by the end of the century. In Japan, which made radical changes in nuclear energy after the Fukushima disaster in 2011, there are still 43 reactors in operation. The country, which aims to reduce its dependence on nuclear power to 22 percent by 2030, has taken measures to increase nuclear safety since the disaster, but has not set itself a goal of shutting down all reactors. Nuclear energy is a sector that not only meets energy needs but also has economic political reflections. Nuclear power is unlike natural gas and oil production because nuclear energy is irreversible. Therefore, in the policies to be implemented, they have to consider not only the needs but also the people of the countries and the future of the environment they live in.

The importance of energy in international markets is mostly due to the current geographical position of the country. While most of the strategically located countries are net exporters, other countries are in the position of importing energy. This causes countries to be connected to each other on a global scale. The policies of the countries cause changes in the policies of the countries that depend on them in terms of energy. Main energy consumption (biofuels, including but excluding hydro) increase is 12.1% which is below the historical averages. Increase in energy (3.2 EJ) was highest in 2019 which is a record level. China, contributes immensely to the renewable energy (0.8 EJ) followed by US (0.3 EJ) and Japan (0.2 EJ). Wind contributed the most to the growth of renewable electricity generation (16 0 TWh). It is followed by solar energy (140 TWh). Solar has continuously increased its share in renewable energy production and reached 26%.

Policies for Reducing Dependence in Energy

The aim of countries is not to be dependent on the outside world by reducing imports, but to become a great country by gaining economical power. Of course, the concept of size here is not related to population or surface area. The important thing is to turn the terms of trade to their advantage by creating famine in the world markets as a great country. Large countries can affect world prices by creating famine and restricting the supply of goods, or they can change their terms of trade by creating abundance and again affecting the price level. For this reason, countries always want to have power. The increase in industrial investments of the countries, especially the rapid changes and developments in the manufacturing industry, the increase in the population of the country, the increase in the demand for energy used in the industrial sector and residences increase the demand for energy (Konak, 2019). However, energy can not be produced at a level to meet the energy demand in Turkey. In this case, Turkey's need for natural gas, oil and coal dependency from external sources has increased. In particular, the expansion of the usage areas of natural gas in terms of both production and consumption has been extremely effective in the increase of energy dependency.

Renewable energy sources are an important component of economic development. The population is growing rapidly around the world, and as a result, the demand to generate energy from consumable traditional sources is increasing (Li et al, 2021) . A country's economic growth increases the energy consumption in each sector. The fact that energy is an indispensable input in industrial production poses a serious problem especially for developing countries that do not have sufficient energy resources. These countries use their already limited foreign exchange reserves in the import of some energy types in order to be able to produce, which causes large deficits in the foreign trade of these countries.

Dependency of countries for instance Turkey's dependency on Russia for natural gas affects the foreign policies of those countries. This situation leads to the implementation of a policy against the country in a possible political conflict (Hodaloğulları and Aydın 2015).

Within 25 to 30 years by nearly all future energy supply and demand from developing countries is projected to increase in the use of fossil fuels consumed (BP, 2019). However still should also be noted that; it is again in the hands of human beings to extend the depletion period of fossil resources by reducing external dependency in energy demand.

In case the energy demand cannot be met by domestic production, there are two solutions to the energy deficit in terms of both demand and supply, but the main factors in the occurrence of the energy deficit are growth, high increase in energy prices, demographic effects, urbanization, technological development and illegal energy.

Within the scope of supply-side solutions; it may not always be possible to provide energy continuously and economically under market conditions. It requires the initiation and commissioning of new investments and the development and improvement of existing facilities by giving priority to domestic resources. The current potential of domestic and renewable energy resources, which can be an alternative to energy resources sensitive to price increases such as oil and natural gas, constitutes an important basis for overcoming the energy shortage of the country, reducing dependency on imported energy inputs and preventing the exchange rate from losing value.

Within the scope of demand-side solutions; in countries with scarce energy resources, especially in production, to avoid an inefficient use of energy, fieldwork is needed to analyze energy costs. On the consumption side, saving in the use of all kinds of energy resources and minimizing network losses, especially during the transmission and distribution of energy, through infrastructure, modern transportation systems and renewal works are the main measures taken to eliminate the energy deficit. For an efficient use of energy, measures can be taken to reduce the burden of energy costs on the economy and to close the energy gap by opening the way to more production with the same energy. In this context, the issue that countries should focus on should not only be improving energy supply, but also measuring the power of the change in energy demand to reflect on the economy. Especially for the active and rational use of energy used in the housing, industry, service and transportation sector, the idea of improving consumption habits at no cost or at a very low cost and measures to prevent waste should be adopted.

Within the scope of scientific and technological development; as is known, the process of accessing and making energy resources available is a long and costly action. In order to fulfill this process in the most efficient and cost-effective way, the technical and scientific facilities of the country must be developed. With the development of science and technology, energy exploration and production studies in deep areas and seas that were previously impossible to find, extract and produce in the country become possible (Turgay, 1984). Thanks to technology, it will be possible to increase the efforts to discover new energy resources and to achieve significant savings in energy production costs, and thus, new R & D studies will be allocated. The extension of the life of existing reserves brought by technological developments can also be considered as a development that reduces the energy deficit by contributing positively to the sustainability of energy supply (Pamir, 2003).

Within the scope of preventing loss and leakage; Issues such as the problems experienced in the production, transmission and distribution of energy, untaxed unregistered energy use, and especially electricity smuggling, cause the losses of the produced energy. This situation puts the country's economy in serious trouble and pushes the energy supply, which is currently scarce, to further narrow. For this reason, priority should be given to the renewal and revision studies of the power plants operating with low efficiency and modern, efficient networks should be included in energy transmission such as electricity. Secondly, deterrence in criminal terms should be overcome, as a priority, it should be ensured that the inspections on illegal fuels and illegally used energy services should be increased, and then legal provisions should be implemented without prolonging the process.

Renewable Energy Financing

The momentum needed to make renewable energy production and consumption to replace or at least to lower the share of the oil, coal and natural gas is dependent on proper financing of the new renewable energy investments. There are several ways of supporting the renewable energy sector. One method is purchasing the equity of a company investing in renewable energy. Another common method is to invest at the funds investing in renewable energy. The renewable funds sector is a subgroup of ESG funds. The ESG stands for environmental, social and governance related investments.

The "G": Governance Providers of capital usually face the drawback that there are agents (i.e., management for companies and governments for sovereign bonds) acting on their behalf when putting their investments to work. The concept of good governance now means ensuring that these agents act in the best interest of investors, rather than their own. Governance covers seven issues including the composition of the board of directors, anti-corruption policy, structure of the audit commitee etc. (Table 1) "S" stands for social issues regarding customer satisfaction,equal pay, diversity and other points to protect the rights of the employees."E" stands for environment which is our main area of importance. All energy related issues are includes under this subtitle such as energy efficiency, carbon emissions and pollution.

Table 1. List of ESG criteria

Environment	Social	Governance
Climate Change	Customer satisfaction	Composition of the board of directors
Carbon emissions	Relations with unions	Structure of the audit committee
Biodiversity	Data protection	Enterprise policy
Depletion of natural resources	Relations with civil society	Anti-corruption policy
Energy efficiency	Equal pay	Compensation committee
Waste management	Policy regarding the hiring of disabled people	Lobbying policy
Water/air pollution	Diversity and non-discrimination of minorities	

Source: Handbook on Sustainable Investments 2017, Swiss Sustainable Finance.

An investor interested investing only in renewable energy would be limited in number of choices. If a mutual fund is an ESG fund it will include some of the environmental, social and governance topics. The investor will either pick an ESG fund or a renewable energy related fund. The investor can also invest directly in the stocks of renewable energy companies.

There are a large number of studies on the performance of ESG and Structural Investment (SI) funds compared with conventional peers. Most studies show that the returns from sustainable funds do not significantly differ from those of conventional funds, leading to the conclusion that ESG funds at least do not lag their conventional peers in terms of risk-adjusted performance (Nagy, 2015).

Dealing specifically with environmental topics, there are also several studies that find a positive correlation between environmental performance or events and subsequent stock performance. It should be emphasised that as the effects of global warming unfold, triggering related governmental actions, we will be entering "uncharted territory," as there is no issue comparable to this, both in impact and scope, within the observation periods covered by the studies mentioned (Dowell, 2000 and Derwall, 2004). An empirical study finds that firms operating in the renewable energy sector suffer financial difficulties due to such activities not integrating in their core business strategies (Paun, 2017).

Reboredo (2015) suggests that subsidization programs that support renewable energy sources should also depend on the behaviour of crude oil prices to protect investors from shocks associated with their renewable energy investments. In order to channel funds into renewable energy mutual funds, the returns should be attractive to attract the investors. Renewable energy looks to be one of the areas set to receive the greatest amount of investment over the next 10 to 20 years. However, some market commentators have argued it's a sector not worth backing. There is a possibility that renewable energy investment trusts could end up becoming a 'victim of their own success', as growth in carbon-free energy slashes the cost of electricity and so reduces the amount of money they can generate. Cracks are already appearing in

Table 2. Framework for sustainable finance

Sustainable Finance Typology	Value Created	Ranking of Factors
Finance as usual	Shareholder value	F
Sustainable Finance 1.0	Refined shareholder value	F>>S and E
Sustainable Finance 2.0	Stakeholder value	I=F+S+E
Sustainable Finance 3.0	Common good value	S and E>F

Note: F=Financial Value S=Social Impact E=Environmental impact I=Integrated value
Source: (Schoenmaker,2017)

the sector with falling power prices putting a question mark about the strength of future dividends from renewable energy investment trusts. There have also been declines in long-term cash flow assumptions resulting in falling net asset values (NAVs).

Table 2 gives the stages of Sustainable finance (Schoenmaker, 2017). A first step in sustainable finance is that financial institutions avoid investing in, or lending to, so-called ‘sin’ companies. These are the companies such as tobacco firms, weapon producers or companies that exploit human labor. In Sustainable Finance 2.0, financial institutions explicitly incorporate the negative social and environmental externalities into their decision-making. Over the medium to long-term horizon, these externalities might become priced (e.g. a carbon tax) and/or might impact negatively on an institution’s reputation. Sustainable Finance 3.0 moves from risk to opportunity. Rather than avoiding unsustainable companies from a risk perspective, financial institutions invest only in sustainable companies and projects. In this approach, finance is a means to foster sustainable development, for example by funding healthcare, green buildings, wind farms, electric car manufacturers and land-reuse projects (Schoenmaker, 2019). As the sustainable funds table below shows the number of sustainable funds was 99 in 2011 whch doubled in 2017. At the end of 2020 the number of funds reached almost 400 indicating that since 2011 the number of funds had a fourfold increase.

Table 3. The evolution of sustainable funds

Year	Number of Sustainable Funds
2011	99
2012	104
2013	108
2014	111
2015	139
2016	173
2017	220
2018	269
2019	302
2020	392

Source: https://www.morningstar.com/articles/1033389/not-all-sustainable-funds-are-equally-sustainable, 18.04.2021.

Looking at Table 4 we see that the returns of renewable energy has been increasing especially after 2018. The appetite for these funds will hopefully increase bringing more and more investments into renewable funds plus create more demand for startup companies investing in renewable energy.

Table 4. European Renewable Energy Total Return(ERIX)

Year	European Renewable Energy Index
2010	633
2011	398
2012	305
2013	580
2014	629
2015	930
2016	904
2017	969
2018	1057
2019	1502
2020	2882

Source: https://tr.investing.com/indices/european-renewable-energy-tr, 22.04.2021

SOLUTIONS AND RECOMMENDATIONS

In order for the countries to be less dependent on imported energy they should be increasing their renewable energy investments. The possible sources of renewable energy differs from one country to another. Still each country will have an access to at least one or more of these sources such as sunlight, wind, rain, tides, waves, biomass and geothermal heat. Two developments will facilitate the investments. The cost of investments should be going down as advanced technology improves which will shorten the time for recouping the investment. The sources of funding will increase as more ESG and renewable energy only funds become accepted as common types capital market investments.

FUTURE RESEARCH DIRECTIONS

This study examines the current status of energy dependency in the world. It also looks at the ESG funds and renewable funds from the financial side. Future studies needed to compare the types of energy sources since the cost of investments and the investment recovery periods change all the time. An investment not feasible today will be feasible in the coming years. Also both individual investors and institutional investors should be kept informed regarding the benefits of investments in the ESG funds, renewable energy funds or directly supporting the IPO's of renewable energy companies.

CONCLUSION

Industrialization phenomenon, increases the energy demand per capita rapidly. It is necessary to solve the energy need, which has become the biggest problem of the world, with renewable energy sources and clean energy sources without harming the environment. The world is facing more and more energy needs day by day. Fossil fuels constitute the largest energy resources currently used. In short, non-renewable energy sources are used more intensively. Since the necessary importance is not given to renewable energy sources, many problems, especially air, water and environmental pollution, arise with the energy need. In order to meet the energy needs of future generations and to minimize the damage to the environment, we need to turn to sustainable energy resources. Successful conversion of energy into renewable requires extensive investment and strategic support, in addition to the government's ongoing programs and projects. It is possible to see renewable energy sources in nature at any time. Both free and endless solar energy, which both warms our world and gives light, which has become the most basic need of mankind, the wind energy created by the sudden change in the air, the potential energy generated by the accumulation of water flowing from the streams and rivers we see in the plateaus, the hot water sources under the ground, animal and biomass energy produced from plant wastes are a few of the energy sources we can utilize. Renewable energy sources are in a system that will last as long as humans and other living things exist.

The increasingly high levels of world energy consumption raise the question of how much this demand will be met from what sources. Within the scope of domestic energy resources; Sufficient budgets should be allocated to reveal the existing energy potential of the countries at the national level and priority should be given to R&D activities for important energy resources such as oil, coal and natural gas. In addition, investment and development policies towards alternative energy sources should be accelerated so that the energy deficit of the country can be reduced and the dependence on imported energy can be reduced.

It has been concluded that in the energy production process, it is necessary to use national resources more efficiently, to increase and diversify the number of countries where primary energy resources, especially natural gas, are imported, to establish nuclear power plants and to make alternative energy investments in order to reduce foreign dependency in energy. Economic growth and development will be affected by the energy dependency and the investments of the countries, their production of goods and services, and their gross domestic product. Countries that want to control energy in the world by holding energy will have political disagreements. The use of energy in many areas and therefore of importance is perceived as a threat to all developed or developing countries. It is quite normal that the disagreements between the countries are suddenly sanctions or doors are closed to each other and the country's growth and development is prevented, it is quite normal to try to hold the power and to wage war against all the elements that will come before it. As the world population growth cannot provide the demanded energy, it causes countries to compete against the scarce amount of energy. The policies that countries will adopt in the field of energy direct many issues both on the balance of payments of the country and in order to ensure full employment.

Financing is one of the driving factors for increasing the level of renewable energy around the world. We understand that some investors will invest in renewable funds regardless of the returns of those funds since their initial motive is the proliferation of renewable investments. The remaining investors will always compare the returns of ESG funds or renewable funds in order to invest. The fund managers can not magically increase the returns but aim for returns that will at least match benchmarks. Those funds can be also marketed as funds to help regular funds to diversify in less correlated markets.

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Chapter 16
Investigation for the Role of Oil and Natural Gas in the BIST Sector Indexes in Turkey

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ABSTRACT

In this chapter, the authors aim to investigate the association between the primary energy sources' prices involving oil and natural gas and sectors indices operating the Turkey stock market for the period covering 2012M1-2021M3. Regarding energy price indicators, Brent oil and natural gas real-time future prices are preferred in the models, and BIST Industrials (XUSIN), BIST Chem-Petrol Plastic (XKMYA), and BIST Electricity (XELKT) indices are used as financial performance indicators. Fourier unit root tests improved by Becker et al. and Fourier co-integration tests improved by Tsong et al. are employed to investigate the relationship between considered variables. As a result of the models, it is found that the energy prices and financial performance index do not move together in the long run; in other words, change in oil and natural gas prices seem not to have an impact on the sector indexes.

INTRODUCTION

Apart from the increasing developments in renewable energy sources, oil and natural gas have still been at the forefront of energy sources. As for energy importing countries, an increase in oil and natural gas prices induces cost-push inflation and higher unemployment creating economic imbalance because many industries and social life are profoundly dependent on oil and natural gas as input. Besides, economic imbalances created by extensive energy prices harm countries' competitiveness because the industries' growth and performance are closely associated with the input cost (Eksi et al., 2012; Mikayilov et al., 2020; Liu et al., 2021).

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Along with the first oil crisis that occurred in 1973, the effects of oil prices on macroeconomic activity have been introduced to massive attention by policy-makers, researchers, and investors. Among these investigations, a milestone study conducted by Hamilton (1983) reaches a piece of evidence that there is an essential correlation between an increase in oil prices and the US recession. Following this pioneering study, various studies were managed to investigate the relationship between oil price changes and different macroeconomic indicators such as inflation, unemployment, and industrial performance (Hamilton, 1983; Bohi,1991; Goldfajn & Werlang, 2000; Hooker, 2002). According to the investigation, oil appears as the primary fuel of industrial activity, and change in oil price plays an essential role in growing the countries' political and economic structure. Regarding the literature, the topics linked to the connection between the stock market and the energy price changes have been among the leading topics because the companies' revenues and costs are entirely affected by a change in energy prices. The prime studies investigating the role of the energy prices on the stock market returns were conducted by Jones & Kaul (1996) and Huang et al. (1996). According to them, equities are prices associated with the market valuation based on the expected profits and firms' performance. Moreover, energy is one of the most vital production factors, and an increase in energy prices leads to the rise of the production costs, which have a detrimental effect on the cash flows and companies' market values which induces the decline in the overall stock market returns regarding companies operating in energy-importing countries (Berk & Aydogan, 2012; Yu et al., 2020). Therefore, observation of energy price changes and understanding more detailing connections between energy prices and stock market performance can allow a piece of information to forecast equity prices (Asteriou et al., 2013).

The main objective of the present paper is to investigate the relationship between energy prices involving oil and natural gas prices on the stock market performance in Turkey by accounting for the possible structural breaks. Turkey is an interesting case because The Turkish economy is highly reliant on oil and natural gas imports, and the stock market in Turkey has received substantial foreign funds, which are used to overcome the country's traditional bottlenecks such as low savings. We use two different energy prices within this aim, including Brent oil and natural gas real-time future prices, and we also decide on three sector indices consisting of BIST Industrials (XUSIN), BIST Chem-Petrol Plastic (XKMYA), and BIST Electricity (XELKT) which is entirely linked to energy as user input or output. Besides, Fourier cointegration test developed by Tsong et al. (2016) is applied because of its several advantages, such as the halting of the structural breaks on the cointegration test power. Therefore, this study will produce essential information for investors and managers with the help of using different variables and contemporary econometric techniques.

This study involves seven sections. Following this introduction part, the second section presents a theoretical framework related to the relationship between energy prices and the stock market. Additionally, the third provides the literature, and the fourth section includes data and methodology. Moreover, the fifth section delivers the analysis results, and the sixth and the seventh section provide solution-recommendation and future research directions, respectively. The final part is related to the conclusion.

THEORETICAL FRAMEWORK

The relationship between the macroeconomic indicators and the stock market has been massive attention in the theoretical and empirical studies. Concerning the theoretical framework, two essential theories are established to examine the effects of macroeconomic variables on the stock market. Firstly, Malkiel

& Fama (1970) introduced the Efficient Market Hypothesis. According to this approach, it is identified that the stock market returns are not associated with the fluctuations in macroeconomic fundamentals because the current stock prices embrace all knowledge about variation in macroeconomic fundamentals. Consequently, this implication of this approach confirms that abnormal profits seem not to be even a subject of conversation (Bilgin & Adalı, 2020). In contrast, the Arbitrage Pricing Theory has been established against the efficient market hypothesis, and it suggests that fluctuations in macroeconomic fundamentals can change stock prices through various mechanisms (Fama & Scwert, 1977). Regarding this hypothesis, change in energy prices, especially oil and natural gas prices, is one of the leading events because energy prices can directly affect firms' sales, production costs, and profit regardless of energy-importing or energy-exporting stock prices. Besides, fluctuations in energy prices also impact other macroeconomic variables such as budget, the balance of payment, households' income, etc., which also affect the stock market.

There are five vital transmission mechanisms to explain the effects of the energy price changes on the stock market returns. The first transmission mechanism is named as stock valuation channel. According to this channel, energy prices change can directly influence the stock market by changing expected cash flow and the discount rate. Still, the direction and magnitude changes depend on whether the energy sources involving oil, natural gas, and coal are used as input or output. For example, assuming an oil-consuming firm, oil is one of the most critical production inputs, and hence an increase in oil price will lead to higher production costs which harm profit levels and future cash flow. In contrast, as for an oil-producer firm, an increase in oil prices will induce a higher profit margin, leading to more expected cash flow. The second channel is based on actual economic activities and is named the output channel. Adverse oil supply shocks in the 1970s can be accepted as fountain heads for the output channel. According to this transmission mechanism, increases in energy prices, especially oil and natural gas prices, tend to directly lower household income due to the raised gasoline and heating prices and indirectly because of the change in retail price resulting from higher production costs. Contracting in household income provokes lower consumption and, therefore, aggregate economic activity. Put differently, the terms of trade for an energy importing country are worsened by an expansion in energy prices, occurring in lower-income and lower aggregate economic activity. Such experiences tend to shorten predictable cash flow for firms, which induces lower stock prices (Degiannakis et al., 2018; Mohanty & Nandha, 2011; Hamilton, 1983; Bernanke, 2006).

Moreover, the energy price changes will tend to affect the discount rate through the monetary channel. An increase in energy prices induces higher production costs, which carry higher retail prices and higher expected inflation. In response to higher inflation and/ or higher expected inflation, short-term interest rates are expected to increase through monetary rules such as the Taylor rule (1993) followed by the central banks. The effects of raised short-term interest rates on the stock market consist of two significant ways. Initially, a higher short-term interest rate induces a rise in borrowing rates, increasing the firm's borrowing costs for any future investment. The second way is that raised borrowing costs result in lower cash flows. Two ways generated by monetary action against higher inflation or higher expected inflation caused by an increase in energy prices have a detrimental impact on the stock market (Bilgin & Adalı, 2020).

The fourth transmission is the uncertainty channel improved by Brown and Yücel (2002). In particular suggestion thereof, it is argued that fluctuations in energy prices affect many macroeconomic fundamentals regardless of energy exporter or energy importer, which cause higher uncertainty. For example, an increase in oil prices for the oil-importer country has a detrimental impact on output, consumption, investment, and inflation. Uncertainty resulting from higher future energy prices will reduce firms' irreversible investment, shrink consumers' durable goods, dampening economic activity, and, therefore, stock market returns.

Furthermore, the fifth channel is associated with the fiscal side. An increase in energy prices conduces to induce removal of wealth from energy-importing countries to energy-exporting ones and which causes decreasing government purchase and increasing tax. Assuming that consumption and government expenditure are accepted complements, increasing tax rate and decreasing government purchase resulting from an increase in energy prices will harm the private firms' cash flow and profitability. Such experiences will induce lower stock prices (Degiannakis et al., 2018; Ayadi, 2005).

LITERATURE REVIEW

The topics of energy prices and stock market index are among the most popular topics in the literature. Some of the literature is presented in table 1.

Cong et al. (2008) evaluated the relationship between oil price shocks and the Chinese stock market applying multivariate vector auto-regression. The result approved that oil price shock does not play an essential role in most Chinese stock market indices while oil price shocks influence the manufacturing index. Besides, oil price shocks have a detrimental impact on oil company stock prices, whereas a rise in oil price volatility leads to higher stock returns of mining and petrochemical companies.

Nandha & Faff (2008) found an indirect connection between oil prices and equity prices for 35 global industries. According to them, economic activity is negatively associated with the oil price; in turn, unfavorable economic activity influences stock prices.

Oberndorfer (2009) emphasized the relationship between energy prices and energy corporations' stock prices from Eurozone. The study implied that oil and coal seem to be a vital factor affecting energy stocks, while there is no relationship between natural gas prices and energy companies' equity prices.

Arouri & Rault (2010) concentrated on the relationship between oil prices and the stock market index in the GCC. They implemented the panel-data approach of Konya (2006) based on SUR system using weekly and monthly datasets covering 7 June 2005 -21 October 2008 and January 1996- December 2007, respectively. The model's result identified that a bi-directional causal relationship holds for Saudi-Arabia. Simultaneously, there is uni-directional causality moving from oil price shocks to stock prices for other GCC member countries. Hammoudeh & Elesia (2004) supported a bi-directional connection between oil price changes and Saudi stock market returns while the other GCC countries' stock returns are not directly oil price changes. Still, the domestic factors appear significant drivers of the stock market returns.

Narayan & Narayan (2010) strived to model the effect of oil prices on Vietnam's stock prices. They used daily data spanning the period 2000-2008, and the nominal exchange rate was also added in the model as an extra determinant of stock prices. Various time series techniques were applied to understand the relationship between variables. According to the analysis, it was understood that there is a cointegrated relationship between the variables, and an increase positively influences Vietnam's stock prices in oil prices.

Acaravci et al. (2012) purposed to analyze the long-run connection between natural gas prices and stock prices in EU-15 countries by using Johansen and Juselius cointegration test and error-correction based Granger causality analysis on quarterly data spanning the period 1990:01-2008:01. The analysis results confirmed a unique long-term equilibrium connection between natural gas prices, stock prices,

Table 1. Similar studies in the literature

Author	Scope	Methodology	Result
Hammoudeh & Elesia (2004)	GCC Countries 1994-2001	VECM Model	It was confirmed that there is a bi-directional relationship between oil prices and stock market returns in Saudi Arabia.
Nandha & Faff (2008)	35 global industry indices 1983-2005	Regression	It was concluded that oil price harms stock indices.
Cong et al. (2008)	China 1996-2007	Multivariate VAR Model	It was determined that oil prices shock have an effect on stock prices.
Oberndorfer (2009)	Eurozone 2002-2007	GARCH	It was indicated that oil and coal are important factors, but natural gas is not determinants of stock prices.
Narayan & Narayan (2010)	Vietnam 2000-2008	Time Series Techniques	An increase in oil prices stimulates stock prices.
Arouri and Rault (2010	GCC Countries 2005-2008,1996-2007	Konya Causality Analysis	It was verified that bi-directional relations hold for Saudi Arabia and uni-directional causality operating running from oil prices to stock prices hold for other GCC countries.
Filis et al. (2011)	Oil-Exporting and Oil-Importing Countries 1988-2009	DCC-GARCH-GJR Approach	It was argued that the oil price shocks resulting from the supply side do not impact the stock market on both sides.
Acaravci et al. (2012)	EU-15 Countries 1990-2008	Johansen Cointegration and Granger Causality Analysis	It was found that change in natural gas price affects industrial production, which impacts stock prices.
Wang et al. (2013)	Oil-Exporting and Oil-Importing Countries 1999-2011	SVAR Model	It was defined that the effects of oil price shock on the stock market depend on whether a country is an oil exporter or oil importer.
Mensi et al. (2018)	BRICS Countries 1997-2016	VAR Model based On Wavelet Approach	It was understood that the stock markets move with the oil prices.
Khamis et al. (2018)	Saudi Arabia 2012-2015	Granger Causality Analysis	It was indicated that the fluctuations in oil prices have an asymmetric impact on the stock market appears..
Delgado et al. (2018)	Mexico 1992-2017	VAR Model	An increase in oil prices induces an appreciation in the currency, which positively affects the stock markets.
Masood et al. (2019)	G7 Countries 2009-2016	Regression	It was found that the stock market is not affected by oil prices.
Sun et al. (2019)	China 2010-2016	VAR Model	It was emphasized that oil prices are not significant determinants of stock prices.
Dursun and Özcan (2019	25 OECD Countries 2005-2017	Panel Cointegration and Causality Analysis	It was posed that energy prices and stock market indexes move together in the long run.
Kumar (2019)	India 1994-2015	NARDL	It was found that oil price shocks have a detrimental impact on stock prices.
Youssef and Mokni (2019)	Oil-Exporting and Oil-Importing Countries 2000-2018	DCC-FIGARCH Approach	It was concluded that the stock market response to oil price fluctuations is more significant in the oil-importing countries.
Wei et al. (2019)	China 2005-2017	Nonlinear Threshold Cointegration Analysis	It was found that the oil futures market has an essential impact on the stock market.
Hanif (2020)	Pakistan 2009-2020	Regression	It was showed that an increase in oil prices stimulates stock return
de Jesus et al. (2020)	Oil-Exporting and Oil-Importing Countries 2001-2017	DOLS and nonlinear Co-integration Analysis	It was concluded that the wealth effect holds for oil-exporting and oil-importing countries ranked as developing.
Hashmi et al. (2021)	Oil-Exporting and Oil-Importing Countries 1997-2020	ARDL Approach	Asymmetric effects hold for all countries except Norway.

and industrial production in Austria, Denmark, Finland, Germany, and Luxembourg. In contrast, the relationship between variables did not hold for the other ten EU-15 countries. According to the Granger causality analysis, it was approved that there is an indirect causal relationship between natural gas prices and stock prices. The indirect causal relation implied that an increase in natural gas prices impacts industrial production growth, which in turn influences stock prices.

Sun et al. (2019) made a study to determine the influence of fossil energy prices on China's new energy companies' stock prices in China. They focused on the three fossil energy involving oil, coal, and natural gas price fluctuations. They used the Divisia price construction method to integrate these three prices into a composite price index because of the deficient substitution among fossil fuels. VAR model was applied to achieve the dynamic relationship between the fossil price fluctuations and stock prices. Therefore, it was concluded that fossil energy prices seem to account for only a small part of new energy companies' stock price fluctuations.

Sharma et al. (2018) analyzed the relationship between Crude Oil prices and India's Stock market, utilizing weekly data covering January 2010- January 2017 by applying VAR model. Considering data in this study consist of crude oil futures prices, nifty index, and BSE energy index. The results indicated that the Energy Index is robustly associated with crude oil future prices, nifty index, BSE energy index, and stock indices adversely influencing crude oil prices.

Khamis et al. (2018) examined the stock market's response to oil price changes in Saudi Arabia considering sectoral level for 2012-2015. Their results exhibited that the stock market appears asymmetric reaction towards oil price fluctuations. Negative oil price change conduces to have a more significant impact stock market than favorable oil prices. Nearly all sector's stock prices adversely reacted to a decrease in oil prices with different intensities. Delgado et al. (2018) made a study to analyze the interaction connection between oil price, exchange rate, and stock market index in Mexico. The VAR model was employed to achieve the interaction relation, and the results of the model identified an indirect, interactive relationship between oil price and stock market index. According to the model, an appreciation in the currency generates a positive influence on the stock market. An increase in oil price leads to an appreciation in the Mexican currency against the US dollar.

Mensi et al. (2018) analyzed the co-movements across oil prices with BRICS stock markets using VAR model based on the Wavelet approach on data spanning September 29, 1997- March 4, 2016. They used two different oil prices: WTI and Europe Brent expressed in US dollars per barrel. The wavelet approach concluded that the stock markets move with the WTI crude oil price at low frequencies.

Dursun & Özcan (2019) managed an investigation to determine the connection between the change in energy prices and stock market indices in 25 OECD countries for the period spanning from 2005-2017. They employed three energy sources' prices involving oil prices, natural gas prices, and electricity, and they also used the multiple structural break cointegration analysis and panel causality analysis. The result of the study identified that a long-run connection between variables holds for OECD countries; that is, energy prices and stock market indexes appear to move together in the long run. Also, the causality analysis approved a causal connection operating from stock market indexes to oil prices, while natural gas causes stock market indexes in the OECD countries. In contrast, a causal relationship between electricity and stock market indexes does not exist.

Kumar (2019) tried to detect the asymmetric influence of oil prices on India's exchange rate and stock prices by utilizing Hiemstra and Jones (1994) nonlinear Granger causality and NARDL model. The results indicated that a bidirectional connection between oil price and stock prices is verified. However, the results of NARDL revealed that lag positive and negative shocks experienced in the oil prices harm stock prices.

Wei et al. (2019) investigated long-run associations between crude oil futures price and China's stock market. They used a nonlinear threshold cointegration method. However, they build a model using three major macroeconomic determinants involving foreign exchange rate, domestic economic development, and total foreign trade to understand transmission mechanisms between the oil futures market and China's stock market. The results emphasized that the oil futures market has significant influences on the stock market directly and indirectly by impacting other macroeconomic variables. Moreover, the existence of the long-run cointegrated connection between crude oil futures price and the stock market holds for China, and exchange rate comes to the forward among other macroeconomic variables considering transforming the effects of oil prices on stock markets, especially after the financial crisis.

Masood et al. (2019) tried to analyze the connection between the oil prices and G7 countries' stock market using regression analysis on data covering September 2009- August 2016. They indicated that Oil price does not have a significant impact on real stock markets of G7 countries.

Hanif (2020) researched the relationship between the three global market price variations involving oil, gold, and currency exchange and two PSX indices comprising conventional and Islamic in Pakistan. Hence, the result emphasized that an increase in oil price stimulates the stock return generation process in both traditional and Islamic.

Hashmi et al. (2021) investigated whether there is an asymmetric connection between oil prices and stock market prices in oil-exporting and oil-importing countries using different ARDL approaches involving ARDL, quantile ARDL, and the nonlinear ARDL. The NARDL model showed no long-run asymmetric connection, whereas an asymmetric link in the short run holds for all countries except Norway. In addition to the results of NARDL, the quantile ARDL indicated that oil prices seem to asymmetrically impact stock prices in both the short and long run for all countries. Another study investigating the relationship between oil prices and stock prices in oil-importing and oil-exporting countries was managed by de Jesus et al. (2020) for March 13, 2001-August 25,2017. They used the DOLS method and Siklos cointegration analysis, and the models found an asymmetric long-run relation between variables. In the case of oil-exporting countries, the wealth effect was affirmed; in other words, there is a positive relationship between oil price and stock prices. As for oil-importing countries rated as developed countries, a negative relationship is found while a positive link holds for oil-importing countries ranked as developing countries. Youssef & Mokni (2019) also managed a study to test the relationship between crude oil prices and stock markets in oil-importing and oil-exporting countries over 200-2018. They applied DCC-FIGARCH model, and as a result of the model, it was underlined that the stock markets in oil-importing countries seem to be more sensitive to oil price change than the stock market in oil-exporting countries. Filis et al. (2011) managed a study to investigate the dynamic correlation between oil price and the stock market in three oil-importing and three oil-exporting countries. They employed DCC-GARCH-GJR approach on data covering the period January 1988-September 2009. As a result of the models, it was claimed that the correlation rises positively in answer to oil price shocks resulting from the aggregate demand side, while the time-varying correlation does not seem to differ for both sides. They also found that oil price shocks resulting from the supply-side do not influence the stock markets on both sides. Wang et al. (2013) used SVAR model to examine the connection between oil price shocks and stock market activities of oil-exporting and oil-importing countries for January 1999-December 2011. They underlined that the response of the stock market activities to oil price shocks very different in the light of the magnitude, duration, and direction depending on whether the country is oil-exporting or oil-importing. Also, the oil price shocks caused by the supply or demand side play an essential role in the stock market's response to oil price shocks.

Literature Review for Turkey

Investigating a long-run relationship between energy prices and stock market indices is one of the leading topics in Turkey. Researchers prefer various econometric techniques, indicators, and time-interval. Table 2 present some of the studies' details consisting of considered indicators, econometric methods, and a brief conclusion.

Eryiğit (2009) made a study to investigate the effect of oil price changes on the sector indices of the BIST for 200-2008. According to the finding, it was argued that the impact of the oil price fluctuation is found as significant for Wholesale and Retail Trade, Insurance, Basic Metal, Electricity, Holding, Investment Metal Products, Non-Metal and Mineral Product and Paper and Printing. In contrast, oil prices do not affect other sub-index consisting of Banks, Transportation, Real Estate Investment and Leasing, and Factoring.

Torul & Alper (2010) tested the asymmetric impacts of oil prices on the manufacturing sector by using VAR model for 1991-2007. As a result of the model, it was posed that the manufacturing sector in aggregate terms is not affected by an increase in oil prices, but some sub-sectors are negatively impacted.

Toraman et al. (2011) focused on the impacts of crude oil price fluctuation on sector indexes involving ISE 100 composite index, services index, industrial index, and technology index. Cointegration analysis and VECM model were employed, and the models identified that the Industrial index and ISE 100 INDEX are responsive to oil price change.

Eksi et al. (2012) used the VAR model to investigate seven manufacturing sub-sector index responses to oil prices for 1997-2009. ECM model was used, and the model showed a long-run causality running from oil prices to two sub-sectors involving chemical-petroleum-plastic and basic metal sub-sectors. This implication referred that these two sectors are susceptible to crude oil prices. In contrast, other sector indexes are not associated with oil prices in both the short and long run.

Güler & Nalın (2013) managed an investigation to detect the effects of oil prices on ISE indices involving Petroleum, Chemicals, and Plastic by using cointegration and Granger causality analysis. The models reached a shred of evidence that variables move together in the long run, whereas there is no causality relationship between variables.

Abdioğlu & Değirmenci (2014) tried to determine the relationship between oil prices and BIST sectoral analysis by using Granger causality analysis. As a result of the research, it was found that bi-directional causality relation holds for the trade sector, and there is no causal relationship between the technology sector and oil prices. Besides, the Industrial sector is the most dependent on oil prices, among other sectors.

Yıldırım et al. (2014) investigated the impacts of energy prices on the Industry sector's stock prices. Energy price variables are based on two energy source prices consisting of crude oil and natural gas prices. Moreover, Johansen-Juselius cointegration and Granger causality analysis were preferred to reach the evidence. As a conclusion of the study, it was underlined that a long-run connection between variables is confirmed. In addition to this find, it was also concluded that crude oil prices induce the sector's stock prices, whereas there is a causal link moving from industrial index to natural gas prices.

Yıldırım (2016) made an investigation to detect whether there is an asymmetric connection between energy price shocks and the stock market. They traced asymmetric model techniques improved by Granger

Table 2. Similar studies in the literature for Turkey

Author	Scope	Methodology	Result
Eryiğit (2009)	Electricity, Whole Sale and Retail Trade, Insurance, Holding, Investment, Wood, Paper, Printing, Basic Metal, Metal Products, Machinery and Nonmetal and Mineral Product Indices 2000:01 And 2008:11	Regression	It was found that changes in oil prices have an essential effect on indexes.
Toraman et al. (2011)	Brent Oil Prices, ISE 100 Index, Industrial Index, Technology Index, Financial Index and Services Index 02.01.2009–15.02.2011	VECM Model	It was showed that Oil price changes have an impact on ISE 100 and the industrial index.
Eksi et al. (2012)	Crude Oil Prices, Sectors Including Food-Beverage, Basic Metal, Chemical-Petroleum- Plastic, Textile-Leather, Wood-Paper-Printing, Metal Products- Machinery and Non-Metal Mineral Products (NMP) 1997:01-2009:12	VECM model	It was concluded that the chemical-petroleum-plastic and basic metal sub-sector is highly associated with the oil price change.
Güler & Nalın (2013)	Crude Oil Prices, Petroleum, Chemicals, and Plastic 03.02.1997-30.11.2012	Granger Causality Analysis and ECM Analysis	It was emphasized that variables move together in the long run, whereas a causality relationship between variables does not exist..
Yıldırım et al. (2014)	International Crude Oil Prices, Natural Gas Prices, Industry Index 1991:01-2013:11	Johansen-Juselius Cointegration Analysis and Granger causality Analysis	It was confirmed that energy prices positively stimulate the industrial index.
Eyüboğlu & Eyüboğlu (2016)	Brent Oil Prices and Natural Gas Price Nonmetal Mineral Products, Basic Metal, Chemical Petroleum Plastic, Metal Products Machinery, Food Beverage, Textile Leather and Wood Paper Printing 2005:10-2015:09.	VECM Model	It was verified that a long-run relationship between energy prices and sub-indexes is found.
Kendirli & Çankaya (2016)	Crude Oil Price Ber Barrel, BIST 100 Index, Transformation Index. 04 01.2000- 30.04.2015	Granger Causality Analysis	It was indicated that crude oil price change causes transformation index.
Ege & Şahin (2017)	Natural Gas Price (Henry Hub Crude Price (WTI), Chemical, Industrial Sector Market Price 2003: 08-2017: 01	Toda-Yamamota Causality Analysis	The results do not approve of the causal relationship between variables.
Tursoy & Faisal (2018)	Current Oil (Brent, $/Bbl) January, Stock Prices (Equity Price) 1986- 2016	ARDL Approach-FMOLS,DOLS and CCR	It was affirmed that the positive connection between oil prices and stock prices is valid.
Altintas & Yacouba (2018)	The World Oil Prices, The Stock Prices 1998:01- 2014:12	NARDL Approach	It was approved that there is a significant negative relationship between oil price and stock market prices.
Toparlı et al. (2019)	Real Brent Crude Oil Prices, Real Return Stock Price 1988:02-2017:03	TVP-VAR Approach	It was confirmed that the oil price is not mainly determinants of the stock market returns.
Bildirici & Badur (2019)	Crude Oil Futures Contract, Retail Unleaded Gasoline, Chemical Petroleum Plastic Index Price, 2000:08-2017:09	MS-VAR and MS-GC Analysis	It was underlined that the energy companies' stock return associates with fluctuations in oil prices.
Polat (2020)	WTI Spot Crude Oil Prices, World Crude Oil Production, Stock Market Return 1988:02- 2018:12	TVP-VAR model	The first response of the stock returns is adverse to an increase in oil price shocks while the response modifies back and becomes smooth in the long run.
Gürlevik & Gazel (2020)	Brent Oil Prices, Electricity Price, Natural Gas Prices, Electricity Index 2010:03-2019:03	NARDL model	There is no long-run relationship between variables.

and Yoon (2012), and many asymmetric time series techniques were used, such as cointegration, causality, and impulse-response function. According to the models, it was confirmed that an asymmetric connection between variables is found. Positive changes in oil prices have an insignificant influence on the stock market index, while an adverse change in oil prices stimulates the stock market index.

Kendirli & Çankaya (2016) utilized Granger Causality analysis to investigate the connection between crude oil prices, BIST 100 index, and the BIST Transportation index. According to the investigation confirmed that there is a causality connection running from the transportation index to crude oil prices.

Eyüboğlu & Eyüboğlu (2016) administered a study to examine the relationship among natural gas, oil prices and Sub ındex of BIST-Industrial. by using Johansen cointegration analysis. They informed that there is a long-run relationship between two energy prices and sub-index of BIST-Industrial. VECM model also indicated a short-run connection between oil prices and the BIST-Industrial sub-index. However, Granger causality analysis revealed that there is a causality relationship running from oil prices to indexes.

Ege & Şahin (2017) administered an investigation to examine the causal connection between natural gas and crude oil prices and two sectors index involving industrial and chemical sectors.Toda-Yamamota (1995) approach was employed. The result indicated a causal connection between oil prices and industrial and chemical sector index indices, while a causal relationship moving from natural gas prices to these two sector indexes is found.

Altintas & Yacouba (2018) tried to identify the asymmetric response of stock price to oil price shocks by using NARDL approach. The model affirmed the asymmetric association between stock prices and oil shocks and the existence of a critical adverse association between oil prices and stock market prices.

Tursoy & Faisal (2018) strived to investigate the long-run and short-run connection between stock prices and gold prices and crude oil prices in Turkey regarding monthly data covering January 1986-November 2016. ARDL model was applied to estimate the cointegration and short-run relationship between variables. Besides, FMOLS, DOLS, and CCR cointegrating equations were employed to determine the variables' long-run coefficients. The result of ARDL model indicated that the existence of a solid long-run connection between variables is valid. Furthermore, it was also confirmed that short-run and long-run negative associations between the gold price and stock prices are revealed, and there is a positive connection between crude oil and stock prices. Moreover, the Granger causality test also affirmed that a short-run and long-run unidirectional causality operating from gold prices to stock prices exist.

Toparlı et al. (2019) used TVP-VAR model to examine the impacts of oil prices on the stock returns. According to the findings, it was underlined that the effect of the oil price on the stock market return has substantial time variation appearances, and its shocks are found as lower contrasted with exchanging rate and interest rate. This relation implied that the exchange rate and interest rate primarily describe the stock market returns.

Bildirici & Badur (2019) conducted a study to test the effects of oil and gasoline oil prices on the energy companies' stock returns by applying MS-VAR and MS-GC analysis. The models indicated that the stock returns of the energy companies are moving with shifts in oil prices.

Bari & Adalı (2020) tried to investigate the stock market prices' determinants in Turkey by applying the Fourier co integration analysis developed by Tsong et al. (2016) on data covering the period between January 2009 and March 2020. According to the model, it was found that the absence of the long-run co integration between stock price and oil price is verified.

Polat (2020) used on TVP-VAR model to investigate the time-varying transmission mechanism between oil price indicators involving WTI spot crude oil prices and world crude oil production and stock market returns in Turkey. The dynamic of the impulse-response function showed that the first response of the stock returns is adverse to an increase in oil price shocks while the response modifies back and becomes smooth in the long run.

Gürlevik & Gazel (2020) made a study to investigate the asymmetric relationship between change) in energy prices and the electricity index by used NARDL model. In the study, electricity prices, natural gas prices, and Brent oil prices were selected as independent variables. According to the model, it was emphasized that a negative connection between the electricity index and gas price is confirmed in the long run, but there is no connection between Brent oil prices, electricity prices, and electricity index. Regarding the short run, the connection between positive components of electricity prices and Brent oil prices the electricity index is approved.

Considering the literature presented above, the relationship between energy prices and various financial performance indices has received enormous attention. This study uses two different energy prices involving Brent oil and natural gas real-time future prices because investors and managers operating firms are expected to consider future events affecting firms' production and profit structure. Moreover, we also select three sector indices consisting of BIST Industrials (XUSIN), BIST Chem-Petrol Plastic (XKMYA), and BIST Electricity (XELKT) which are entirely associated with energy sources. Furthermore, the Fourier cointegration test improved by Tsong et al. (2016) is employed because of its several advantages, such as preventing structural breaks on the cointegration test power. All in all, this study will generate essential knowledge for investors and managers because of using different variables and contemporary econometric techniques.

DATASET AND METHODOLOGY

Dataset

This study will study the long-run connection between energy prices and the firms' financial performance in Turkey. As for energy prices indicators, Brent oil and natural gas real-time future prices are employed in the models established, and financial performance indicators are defined among Borsa Istanbul's share market indices. Moreover, the indices based on companies that use energy resources or operate in energy production play a significant role in determining the sector indices. Within this concept, BIST Industrials (XUSIN), BIST Chem-Petrol Plastic (XKMYA), and BIST Electricity (XELKT) are preferred, and all series are obtained from Trinvesting web site database. Within the scope of the research, all series are used in the logarithmic form to increase stability, and monthly data for the period spanning 2012M1-2021M3 are employed.

Methodology

Before investigating the long-run relationship between considered variables, the stationary analysis of the variables is conducted by using Fourier KPSS unit root test and Augmented Dickey-Fuller test. The reason for FKPSS test traces to a study introduced by Perron (1989). Perron (1989) conducted a milestone study to investigate the effects of the structural breaks on the unit root test. The study results show that the structural breaks, structural breaks number, and forms of the variables impact the robustness of the unit root test. İt is also argued that ignored structural breaks can induce losing the power traditional unit root test. Many unit root tests have been improved following this study to detect structural breaks regarding their locations exogenously or endogenously. On the other hand, Becker et al. (2006) criticize these studies because these studies cannot consider the areas, number, and pattern of the breaks that influence the unit root test results. Because of the deficiency of the traditional and later developed unit root tests, Becker et al. (2006) develop KPSS (1992) test added by Fourier function, which can capture the presence of an unknown function regardless of periodic or nonperiodic function. Additionally, FKPSS is introduced and can detect breaks regardless of sharp or smooth breaks, and the times, numbers, and the form of the breaks seem to be unimportant factors affecting the power of the test (Yılancı, 2017).

Within this context, Becker et al. (2006) introduce the equation based on the data generation's method as accompanying:

$$y_t .\ X_t^{'2} + Z_t^{'3} + r_t + \mu_t . \tag{1}$$

$$r_t .\ r_{t-1} + u_{t,} .$$

In the equation, μ_t . and $u_{t,}$. represent stationary error and independent and identically distributed with variance, respectively. Moreover, Z_t .also define vector covering trigonometric terms.

One of the equations presented below is measured, and residuals can be obtained from one of the following equation, which is necessary to analyze the null hypothesis ($H_0 .\ \sigma_u^2 .0$)

$$y_t = \alpha + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + e_t . \tag{2}$$

$$y_t = \alpha + \beta_t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + e_t . \tag{3}$$

Accordingly, the test statistic is estimated exercising equation 4 as supporting:

$$\tau_\mu(k) or \tau_\tau(k) = \frac{1}{T^2} \frac{\sum_{t-1}^{T} \tilde{S}_t(k)^2}{\sigma^2} \tag{4}$$

$\tilde{S}_t(k) = \sum_{j=1}^{t} \tilde{e}_j$ pictures $\tilde{e}_j$ indicating the residuals produced from Equation 3 and 4 and $w_j, j = 1,2,\ldots,l$ and the pruning lag parameter of I is recommended to obtain the nonparametric measure of as following (Becker et al. 2006):

$$\sigma^2 = \tilde{a}_0 + 2\sum_{j=1}^{l} w_j \tilde{a}_j \tag{5}$$

When the series contain a nonlinear trend which convert the null-hypothesis as $H_0 . a_1 . a_2 .0$ implying the nonlinear trend's non-existence. F-test statistic is used to check the null hypothesis and represents as follow:

$$F_i(k) = \frac{\left(SSR_0 - SSR_1\left(k\right)\right)/2}{SSR_1(k)/(T-q)} \; i = \mu, t \tag{6}$$

The F-test is used as the null hypothesis is accepted, and therefore the series is not stationary when the power of F-test statistics fails (Yılancı & Eriş, 2012).

This study investigates a long-run relationship between energy prices and companies associated with energy resource financial performance using Fourier co-integration (FSHIN) introduced by Tsong et al. (2016). Like FKPSS unit root test, FSHIN co-integration test prevents the impact of structural breaks ' form and number on the test statistic, and hence, FSHIN presents sound outcomes.

The data production is showed as comprehending (Tsong et al., 2016):

$$x_t . v_t . y_t \delta . \propto_t . \propto_t . x_t . \rho_{1t} . x_t . x_{t-1} . \theta_t . y_t . y_{t-1} . \rho_{2t} . \tag{7}$$

The null hypothesis $\sigma_u^2 = 0$ shows co-integration, while the alternative hypothesis $\left(\sigma_u^2 > 0\right)$ poses that no co-integration between variable hold and regarding this event, equation 7 can be managed as following:

$$x_t . \alpha_0 . b_k .\sin(2\pi kt/T .+ \delta_0 .\cos(2\pi kt/T .+ v_. \delta . \rho_{1t} . \tag{8}$$

Finally, equation 9 presents the calculation of FSHIN cointegration test statistics as accompanying:

$$CI_f^m = T^{-2}\hat{\omega}_1^{-2}\sum_{t=1}^{T} S_t^2 \tag{9}$$

FINDINGS

Before investigating whether the variables are co-integrated in the long run, the variables should be reviewed to determine whether the variables are stationary. In this study, along with the ADF unit root test, Fourier KPSS unit root test is also employed because FKPPS can eliminate the effects of the number, form, and structural breaks related to the variables' unit root statistics. Therefore, table 3 presents the FKPSS unit root test results belonging to the oil price, natural gas prices, and sectoral indices.

Hypotheses for the FKPSS test; H_0: The Series does not Contain Unit Root. H_1: The Series Contains Unit Root.

Significance hypotheses of trigonometric variables;

Table 3. Fourier KPSS (FKPSS) unit root test results

Variables	I(0)				I(1)			
	K	Min SSR	FKPSS	F stat	K	Min SSR	FKPSS	F stat
BRENTOIL	2	9.0905	0.8256	39.3831	2	1.5444	0.2984	1.9174
NATURAL GAS	2	3.6426	0.4696	42.0124	2	1.4591	0.1099	1.4088
XUSIN	1	7.7678	0.4962	49.6109	3	0.3889	0.2125	2.4286
XKMYA	1	8.2616	0.5178	93.2070	3	0.4881	0.1020	2.2575
XELKT	1	7.1172	0.3231	41.8770	3	0.7140	0.2317	2.6401

H_0: Trigonometric terms are equal to zero (insignificance). H_1: trigonometric terms are different from zero (significant).

The table value of F-test at 5% level is 4,929

The table critical values of Becker at all. (2006:389) for the number of samples and Frequency Values

According to this method, if FKPSS value calculated is greater than the table values, the null hypothesis should be rejected. In other words, the series contains a unit root. Table 3 poses that all FKPSS calculate the value in level is greater than the critical table values, and the null hypothesis is not accepted and therefore, it can be said that the series is not stationary at the level values. When all series are converted into their first differences, they become stationary because FKPSS values calculated at the first differences are small than the table critical values. In other saying, all series become stationary at their first difference.

Moreover, F statistic values provided by Becker et al. (2017) are used to detect the significance of the trigonometric terms. Accordingly, the F statistic values measured for I (1) are not greater than the critical table values, and hence the null hypothesis can be accepted. According to the model, when trigonometric terms are insignificant, standard unit root tests are employed. Within this context, standard ADF unit root is employed, and the detail of the test result is presented in Table 4. According to table 4, it is implied that all series are stationary at I (1) in 1% significance level.

The empirical evidence of the unit root tests implies that all variables become stationary at their first difference. Therefore, the variables seem to be integrated at the same, order I (1) in which investigation

K	1	2	3	4	5
T=100 and %5	0,1720	0,4152	0,4480	0,4592	0,4626

Table 4. ADF unit root test results

Variables	I(0)		I(1)	
	Constant	Constant, Linear Trend	Constant	Constant, Linear Trend
BRENTOIL	-1.9493	-2.6702	-8.7805*	-8.7813*
NATURAL GAS	-2.5951	-3.2061	-11.483*	-11.439*
XUSIN	0.7286	-1.2666	-9.6647*	-9.7833*
XKMYA	0.2870	-2.3146	-10.137*	-10.205*
XELKT	0.5319	-0.9699	-9.0240*	-9.2330*

* p < 0,01

cointegration (FSHIN) test is applied to analyze the long-run connection between energy prices and the BIST sector indices. The results are detailed in Table 5.

Table 5. Fourier Shin cointegration test results

Variables	k	Min SSR	Fourier Cointegration Test stat	Shin Test stat	F stat
XUSIN&BRENTOIL	1	4.2999	0.2333	0,7196	6.3986
XUSIN&NATURALGAS	3	5.2338	0.7059	0,9793	6.9674
XKMYA&BRENTOIL	1	4.0064	0.2533	0,7476	35.827
XKMYA&NATURALGAS	1	6.4524	0.4577	0,9378	60.461
XELKT&BRENTOIL	1	4.1908	0.1070	0,5601	3.3975
XELKT&NATURALGAS	1	6.1968	0.2278	0,5670	2.4283

The table value of F-test at 5% level is 4,066

The table critical values of Fourier cointegration test

The table critical values of Shin cointegration test are 0.231, 0.314 and 0,553 at the %10, %5 and %1 levels, respectively.

The null hypothesis FSHIN test considering structural changes in the long-term interaction between variables tests refers to a cointegration relationship, and The F statistic value is used to detect the significance of trigonometric terms. If trigonometric terms are meaningful, FSHIN test statistics should be used; otherwise, Shin test statistics should be used. In this direction, trigonometric terms are significant in the models established to test the cointegration connection between XUSIN and XKMYA indices and energy prices, while the models built for the XELKT index are insignificant. When the results are analyzed within the framework of the established models, since both FSHIN and Shin test statistics are greater than the table critical values, the null hypothesis is rejected for all models. Cointegration relationship between variables could not be determined. It can be stated that the change in energy prices has no long-term effect on XUSIN, XKMYA, and XELKT indices.

SOLUTIONS AND RECOMMENDATIONS

Turkey is still dependent on non-renewable energy sources involving oil, natural gas, and coal. An increase in non-renewable energy prices generates many drawbacks encountered by Turkey. One of the detrimental impacts resulting from a rise in energy prices is inflation. Non-renewable energy sources are widely accepted as a critical production factor and used for heating and transportations. An increase in non-renewable energy sources can directly impact the production costs linked to energy and indirectly other business activities, which affect the final price of goods and services. Therefore, higher inflation rates and interest rates resulting from a monetary reaction to a higher inflation rate become a matter of

m=0, p=1 and %5	k=1	k=3
	%1 %5 %10	%1 %5 %10
	0,198 0,124 0,095	0,507 0,304 0,225

one of the results provided by higher energy prices. Turkey has experienced higher inflation rates, and the monetary authorities and policymakers have strived to a stable price level. Another adverse effect of the higher energy price is based on consumption and investment. An increase in energy prices has a destructive force directly on the expenditure exemplars of households since the price elasticity of oil demand is generally below. This mechanism showed that higher oil price forces the households to cut down on their expenditure on other goods and services, which leads to lower the demand for those goods and services. Besides, increase non-renewable energy prices result in uncertainty about the future in which households are to postpone their investment and consumption decisions. Therefore, an increase in non-renewable energy prices is associated with higher cost production, lower productivity, and low output growth. Regarding all adverse effects resulting from the energy-important situation, investment in renewable energy sources and diversifying energy portfolio will be an obvious solution to overcome many drawbacks such as lower productivity, higher inflation, higher interest rate, and deficiency domestic saving and investment rate.

FUTURE RESEARCH DIRECTIONS

Renewable energy sources have gained momentum have been accepted as outlet for overcoming energy dependence. Turkey is also one of the leading countries regarding diversifying energy sources and investing in various renewable energy sources such as solar, wind, and nuclear energy. Gradually, firms and households have adopted renewable energy sources, although nonrenewable energy sources are still the dominant energy source in the economy. Additionally, different sectors show different responses to this shifting, and the change in nonrenewable energy and renewable energy prices have a different impact on the firms' performance. Therefore, we recommend a further research direction for the researcher that all energy price changes and all sectors indexes shared in the stock market in Turkey shall be considered to reach a more solid knowledge concerning the role of the energy prices in the economy.

CONCLUSION

Energy resources are one of the irreplaceable elements used in all areas of social life and economic life. Whether a country is energy-exporting or energy-importing causes the diversifying effect of energy price change. If a county is an energy-importer, an increase in energy prices leads to a rise the production costs, which harms the financial performance of firms operating in the energy-importer country. Notably, sectoral characteristics also play an essential role in the differentiating effects of the energy price changes on the financial performance of enterprises.

Although various alternative energy sources such as solar, nuclear, wind, etc. have also been discovered used in daily and economic life, oil has been accepted as the primary energy source. Natural gas seems to be the energy source at the forefront among the alternative energy sources. Accordingly, we endeavor to investigate the long-run relationship between oil and natural gas prices and the financial performance of companies operating Borsa İstanbul, which are based on most energy used filed as energy production and energy consumption.

Fourier Shin Cointegration analysis is employed to achieve the study objective. According to analysis, it is found that there is no long-run interaction between oil and natural gas prices and sector indices involving BIST BIST Industrials (XUSIN), BIST Chem Petrol Plastic (XKMYA), and BIST Electricity (XELKT) indices. This implication argues that the change in energy prices and the share market indices do not move together in the same direction; in another saying, fluctuations in energy prices are not reflected in the companies' financial performance. This finding support some researchers' result (Arouri and Rault, 2010; Hammoudeh and Elesia, 2004; Acaravci et al. 2012; Nandha and Faff, 2008). Furthermore, all studies achieving no long-run connection between energy prices and financial performance emphasize that the positive or negative effects of oil price fluctuations on the economy may disappear in the long run (Trang et al., 2017).

Regarding Turkey as an essential energy-importing country, it is expected that changes in energy prices do impact companies' costs, sales, and profitability, whereas the results of the cointegration do not affirm this expectation. Regarding this implication, it can be implied that effective energy policies implemented for energy efficiency and used alternative energy sources besides oil and natural gas may be a fundamental reason why a cointegration relationship between oil and natural gas prices and Industrials, Chem Petrol Plastic, and Electricity indices could not be determined in the long run. In addition to this foresight, other factors influencing the stock may be possible. For example, sectoral development, macroeconomic indicators, national and international political and economic events, and sectors' internal and external dynamics can be regarded as the main factors. All in all, it cannot be ignored that energy price changes influence business activities and performance while this effect disappears or is not reflected in prices at magnitude; in other words, energy price and stock market indices are not co-integrated.

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KEY TERMS AND DEFINITIONS

XELKT: BIST Electricity.
XKMYA: BIST Chem-Petrol Plastic.
XUSIN: BIST Industrials.

Chapter 17
To Be Strategic or Not to Be Strategic for the Energy Investments:
That Is the Question

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ABSTRACT

This study tries to handle the energy issue with an encompassing managerial approach with a broader perspective. In the study, which aims to contribute to the evaluation of the subject from the perspective of entrepreneurship and business administration, efforts are made to explain energy by using the basic principles/approaches that are significant in the business literature. Vital issues such as energy production and energy management are handled based on managerial discipline. It takes care to bring together many different approaches that can be associated with the subject, touching upon essential concerns such as consumption, market, and competition factors. Since the matter can differ in short and long-term outlooks, the concepts of energy and strategy are examined together. In this way, because it stands within the common field of many disciplines, it is desired to make a journey to energy not only with the perspective of the basic science but also through the viewpoint of the social sciences. And the connotations of the concept of energy are deepened.

INTRODUCTION

The concept of energy increases its importance day by day for today's world and becomes an indispensable position in our lives. Many studies have been put forward on this concept, which we feel more and more necessary both individually and organizationally. It is thought that a holistic view should be developed with the support of social sciences to fully address energy, which is the focal point of basic

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sciences due to its nature (Sovacool, 2014). This study is prepared in order to contribute to the issues related to energy by touching the management area to support this position.

First of all, when we look at the definitions of energy, naturally, we will encounter many expressions that concern fundamental sciences. In many research, expressions reflect the production method of energy and, they are probably within the scope of natural and engineering sciences. When we examine the databases related to energy, this dominance will immediately attract attention, and the absolute superiority of basic sciences will be encountered in the publications and citations. However, it should be stated that besides all mathematical calculations, the energy issue has a human dimension. For this purpose, the study begins by mentioning the importance of energy for human life; continues with its managerial interpretation, and culminates in why it is essential to analyze it strategically.

EVALUATING ENERGY FROM ENTREPRENEURIAL PERSPECTIVE

While talking about social sciences and, in particular, management, the headline/starting point may have seemed strange to some. Nevertheless, it is supposed that entrepreneurship is an application area under the management area. However, since it is thought that entrepreneurship heaps more and should be considered as a seed/beginning in the business world (Aernoudt, 2004), it is more appropriate to start with this title. For human beings to survive, they must meet their various needs. The gap felt for these needs, which are more different in today's world, has become much greater. At this point, the entrepreneur whose job is to identify the problem/need comes into play. It is always possible to see his signature in suggestions/solutions about what is not be, what exists but is not adequate, what is sufficient but not liked; because the entrepreneur's job is to create value. As long as there is an unfulfilled gap in human beings' needs, entrepreneurs' works always continue (Fayolle, 2007).

The value-generating entrepreneur has a really simple formula that he handles/uses: capital, raw material, and labor. By bringing these three together, he plays an active role in both commercial and social affairs (Audretsch and Keilbach, 2004). When looking at the issue with a prosaic/cursory sight, energy can be ignored by thinking of it only as if it were raw material. From this aspect, it is able to be considered as one of the required inputs obtained from nature for targeted production. Therefore, it must be included in the input lists. However, it is thought that energy should be handled more comprehensively in this definition when compared to the era of the first economists who created this definition of entrepreneurship and today's conditions.

When considering as raw material, energy can be regarded as one of the required inputs that shape the form change. When it comes to value production, it is impracticable to think of energy-free manufacture in today's technology, especially in the industry field. It would not be erroneous to contemplate one of the main breaking points in the value-added production carried out with the industrial revolution as owning/dominating energy. It is essential to relate the dehulling effect of individual production with energy. Energy, which caused human power to control the conditions he could not afford, changed the image of civilization. For this purpose, it would be unfair to consider energy only as a raw material input even if it is not explicitly mentioned in the equation. Besides, the resources needed for energy production, namely raw materials, will also emerge as another issue that entrepreneurs should consider. In other words, energy is in a priority position both for obtaining power and for processing the raw material subject to production (Arto et al., 2016).

Raw material preferences are among the factors that determine his status, for the entrepreneur, who always aims to focus on better. He selects this required input for the continuation of his activities, which is sometimes obtained from the market and sometimes by utilizing idle sources. And considering the competition conditions that drive the entrepreneur to change within the market mechanism, he must reveal his innovative properties in the search for raw materials for power. While at some points change is achieved with differentiated production, sometimes it can direct its activities with variations in production techniques. It can sometimes mean the alter of the energy supply method, and sometimes it can be expressed as the change of energy requirement. In this way, the entrepreneur either performs different jobs or does it by differentiating them (Karakeçe and Çemberci, 2020). The entrepreneur takes action by taking into account many factors while revealing his entrepreneurial initiative, and energy can be pronounced among the elements that make a difference for today's entrepreneur (Acs and Audretsch, 2005). The fact that entrepreneurs can stand out from their peers, in an environment where many interlocutors consider energy as an obstacle, by producing their solutions and getting ahead of others makes them a real entrepreneur. Since the entrepreneur is the person who can discover the way that will be a solution to himself in cases where his environment qualifies as a problem and sees it as an opportunity.

On the other hand, there are explanations to be said about energy when it is associated with the capital in the equation. That is to say, if the entrepreneur does not have his energy resources of the value he will reveal, then he will choose the way of demanding this need from external sources, just as we have stated in the raw material part. In this case, it will be crucial to separate venture capital as establishment and operational one. Of course, funds demand to be allocated for the machinery and equipment required for manufacture. However, if the fiscal power is not allocated correctly, financial power will be needed again for the energy requires in production. It may seriously requires a great amount of capital, depending on the type of production or the nature of the sector. For this reason, not meeting the capital requirement in the financing of the energy investments of an entrepreneur who intends to produce his energy and in the energy expenses of a company that demands the energy from the market, may constitute an obstacle to the production process. For this purpose, it is deemed unavoidable to pay special attention to the energy issue in both the establishment and operation management of the part taken under the capital title (Kuratko, 2016).

Even there are some issues in labor that are not regarded as relevant, they should be interpreted from the entrepreneurial perspective. Again, labor, which is described as only an input according to the classical mind, is among the factors that can make the most crucial difference for today's entrepreneur. Especially after the industrial revolution, the differentiation of human perspective modifies the labor function in this area. Because the factor we call labor is essentially human resources and can be described as a form of output/energy (Ucbasaran et al., 2008). Every human being has been created in a different construction due to his creation. While it can be described as a puzzle of companies that need to be solved, it can be depicted as opportunity/power/energy for entrepreneurs who will invest in this field, which will be discussed in more detail in the management discipline section (Becker and Huselid, 2006).

The notion of how an entrepreneur trying to control so many inputs, should bring new questions to mind. While human beings seek answers to these, they usually focus on these questions during the establishment phase. And after start-up, these questions can be considered to lose their importance. However, for an entrepreneurial mindset (Çemberci and Karakeçe, 2020), these issues are seen as vital enough to be evaluated only at the establishment stage and not neglected afterward. These inputs will always be necessary to ensure the continuity of operations, whether a new company or an existing one. For this reason, the necessity of handling these issues as a process arises. naturally, although it will be mentioned in more detail in the management and strategy section, it is essential to pay attention to every step to be taken in this process. Humankind chases after their dreams, and most companies set out great goals during the establishment phase. However, when considered statistically, it cannot be said that the energies of most of them are sufficient to reach their dreams. Even the dreams of the less fortunate are falling apart and they go bankrupt and disappear. Well, when we think about what is the problem at this stage, we wonder whether the requirements are not fulfilled even though big ideas are made, or whether it was actually started wrong at the very beginning with unattainable dreams, or whether the process was not managed correctly even though things started right. These and similar questions also reveal that the event cannot be overcome only by the entrepreneurial intention and that it should be supported in the managerial area. However, it is seen that visions that have failed, even in three various instrumentation, will cause ruin, and the expended labor, capital, raw material, and therefore energy are wasted (Olaison and Sørensen, 2014).

Risk analysis should be done in order not to waste the power/savings/energy expressed in entrepreneurship readings. As it is believed, the entrepreneur is not a gambler, he does not continue by putting his business at risk. As Drucker (2014) stated, it minimizes the risks as much as possible. Reducing risks should not be perceived as risk aversion. Research on the market supports the entrepreneur in revealing the risks they may face, their likelihood of realization, and the likelihood that they will affect the entrepreneur when they occur. For this reason, entrepreneurs have the opportunity to review all their efforts/expenditures we have mentioned regarding energy. It strives to direct its power to the right areas by calculating cost-benefit with its entrepreneurial mindset (Stevenson, 1983).

Of course, using precise expressions for such calculations and analysis can be very misleading and dangerous. At this stage, many factors such as entrepreneurial characteristics or various market conditions may lead to contradictory results. Success factors required for one may lose their validity for another entrepreneur. Another valid criterion at this stage is to determine the diameter of the entrepreneurial energy that the entrepreneur intends to achieve. If the entrepreneur has limited opportunities, if he describes inexperience as an obstacle to himself, if he is not confident enough, if he thinks that he will lose his investment to reach the value he is trying to reveal, he may feel the need to secure himself and his job in such situations (Ettlie et al., 1984). In such a structure, it can be expected that it will choose a more guaranteed path by taking small steps in the elements that are spoken for energy. Perhaps it makes sense to focus on less risky values by choosing the sample of the market leader. The struggle to survive in intense competition can lead him to tiny differences by keeping him away from areas he sees as risky. In this case, a way that it determines in the market completes the border and eliminates the needs within the existing order can be adopted. The entrepreneur, who has adopted this form of innovation, which we describe incrementally, may prefer to evaluate his energy in a more limited way to survive, prove himself and gain power (Dunlap-Hinkler et al., 2010).

However, it should be mentioned that if incremental progress is not accepted, this time the game will change. At this stage, the entrepreneur can turn to initiatives expressed as radical innovation. In this way, it is possible to choose ways that are more comprehensive than the previous one, that may require more investment, maybe more risky, but that will generate more gain/power when uncertainties can be managed. Thus, by trying to advance the power/energy game, he plays with his opponents with more permanent steps, he may want to prevent the competition from progressing like a tennis match. Even if the entrepreneur has enough preparation, he will make such a touch on the market that he may desire to have the potential to change the game, not only the rules of the game as put forward by the expression "creative destruction". In this way, it creates a destructive effect by shaking both its own market and other related markets and paves the way for the formation of a new order (Norman and Verganti, 2014). It is expected that vital changes will occur for such a development to occur. For example, with the discovery of the steam engine, the way of doing business started to change radically and, the industrial revolution was ignited, where the necessity of energy was felt more. In these two styles, it is expressed that the entrepreneur directs his energy to the right areas, regardless of whether it is small or large, and the interaction of the chain reaction it creates. With the energetic interpretation of Kirzner (2015) and Schumpeter's (1942) entrepreneurship efforts, it is deemed essential in terms of evaluating the required and emerging energy on both input and output basis (Aghion and Howitt, 1990).

MANAGEMENT DISCIPLINE AND REFLECTIONS ON ENERGY

Although the previous entrepreneurship part and the management discipline part are handled together in most sources, when the role differences between the leader and the manager are focused, the issue to be explained becomes clearer. While the leader activates the new venture with an innovative outlook; the manager represents responsibility in a position that maintains the existing conditions. While this separation is not required in small-scale enterprises, this distinction can be felt with the effect of scale size and time. After this information is made, no matter how well the works are calculated, a good management process for organizations is shown as a must for success.

When management is handled from micro to macro level, it is ordinary for some changes in requirements to occur. However, according to management thinking, it is understandable that the larger the scale, the more effort required to make and manage decisions. According to this view, the person who plans, organizes the necessary items, implements, coordinates, and controls the actions realizes the management process (Koçel, 2015). Although it seems to overlap with entrepreneurship so far, it should be mentioned that there are more routine jobs belonging to the manager. From this point of view, the energy issue again needs managerial contributions. Because decision-making, which is one of the essential jobs of management, is required in many places for energy.

First of all, some calculations need to be made in the phase of generating energy. With this effort, it is aimed to estimate the need of the market and thus determine the investment that will meet the energy demand. But, while obtaining energy, there are various alternatives. At this level, it is inevitable to try to determine the most efficient one among the available choices by considering natural resources and geographical forms. When the energy generation in the world is examined, it is seen that many options have been implemented considering this fundamental condition. For example, if the geographical shapes are hilly, investment and energy transfer lines on such a ground can be relatively costly. On the other side, if there are regional underground resources, it is seen that these opportunities are used for energy production. In such a situation, coal, oil, natural gas, shale gas, geothermal resources, etc., is used in power generation. If a country has plentiful water potential and its geography is suitable, energy can be produced by hydroelectric power plants. If a territory is exposed to strong winds, wind turbines can be activated in this scenario. Or if meteorological circumstances in the region are suitable, solar panels provide energy production (Da Rosa and Ordonez, 2021).

In order to evaluate such different alternatives, it would be appropriate to benefit from the contributions of management science. The mode of production and transfer suitable for a region may not be suitable for another one. In this case, it is possible to evaluate two different approaches. First, based on the contingency approach, the manager in the structure should know/study the construction he has while designing the energy production. With this approach, it includes many elements such as market realities and administrative requirements, apart from the geographical situation. Thus, planning for energy can be avoided from monotony and, more optimal options can be preferred. The second approach is the resource dependency approach (Hillman et al., 2009). With this view, while making a decision, the current conditions are examined and, the focus is on the source of energy. Thus, it is aimed that managers can make more accurate decisions. For example, the decision of diversifying energy operations, shaping the investment according to energy preference can be taken more easily with the support of this view (Zhong et al., 2020).

With the support of both views, while planning energy investors reflect the amount to their customers; energy consumers are affected by this reflection. It can make more realistic calculations about the energy policies and costs they will be exposed to. Considering the distance to sources and the relations to be established between parties, both the producer and the consumer can benefit from the resource-based approach. Although organizational structures are prioritized when dealing with contingency, it should not be forgotten that varied situations drive management to make different decisions, and it should be stated that it is a requirement to activate unique/individual actions. Considering the factors affecting the organization, "while considering customers, technology, market conditions, competition, state authority, socio-cultural conditions as external factors; Under the heading of internal factors, goals, vision, mission, jobs, owned personnel and technology are scrutinized" (Koçel, 2015). It is unthinkable not to benefit from the contributions of management science during the establishment and management of the energy business in such a complex system.

In another aspect, both the parties demanding and supplying energy desire to reach an output as a result of these actions. Both parties invest and want to get the return of their expenses in return. At this point, whether the organization in question aims for commercial purposes or social benefits, it is a matter of bearing a cost for the planned output. For this reason, a financial fund requirement arises whether it is for profit or not. Considering this aspect, it is unavoidable to ensure that the business continues with financial management.

Also, a financial return planning is expressed in response to the mentioned expenditures. In this case, breakeven analysis and cost-benefit analysis, which are also used in the financial field, come into play. The sooner the breakeven point, which expresses the equality of the income expected to be obtained with the expenditure, is reached, the more the investor is satisfied with the thought of making a profit. For this reason, cost-benefit analysis estimates in the project management studies to be carried out seem to be closely related to both finding investors and obtaining returns. It is seen in the studies conducted in the energy field that this expectation has come true. Energy investors whether public or private companies are obliged to take into account their income by taking the mentioned calculations. In addition to the profit expectation of the private sector, these evaluations, which may be deemed indispensable for the public budget balance, are included in the company and state budgets (Brigham et al., 2004). However, for the energy-consuming segment, the approach of the energy producer is of great importance. If there is no restrictive/controlling structure by the state authorities in a market and energy producer prioritizes commercial profit, the energy cost can be reflected consumers at a relatively high price. It will negatively affect the input costs of all sectors that have to use energy. Therefore, the price increase, which started as micro, will be reflected in the consumption basket, and in cases where it cannot be controlled, it causes macro imbalances. The existence of administrative institutions can be shown as an example to prevent this unwanted situation. In this way, it is aimed to preserve the current balances in the market, to make the relationship between producer-consumer more sustainable. Energy management, which is started individually with these aspects, produces results that can be both organizational and public.

When the energy issue is viewed from a managerial and somewhat philosophical perspective, it is seen that the management tries to address the elements necessary for the production and management of energy. It is possible to say that there is a transition of form between the elements that are used and controlled for energy production. Administration moves forward by focusing on both concrete and intangible elements to achieve the targeted output in the whole process. When evaluated with this view, all similar functions, from production to transfer, from marketing to finance, from planning to human resources, show the manager's effort to handle the power/energy he has/is trying to have. It is possible to consider the information emerging/handled within the whole process as energy. So, it becomes possible to increase the energy generated while achieving the targets, saving the energy consumed. Besides, other managerial factors determine the flow of information/energy while handling the whole process. The organizational structure that will fundamentally change many facts about the organization should also be taken into account. With organizational theories, which are seen as the door of a very deep field, the balance of the whole game can be changed radically on behalf of the organization (Keskin et al, 2016; Sargut et al., 2010). In this way, both the perspective of the organization, the way the organization does business can be completely changed. Structures that start as closed systems can shift to open-system-natural organization systems as they change their shell. In this way, the most common area of management, which is not seen, but makes its presence felt at every level, is achieved. For this reason, this stage, which is considered as the source of the solution for some, can be considered as the biggest dilemma for others. In this respect, even if organization theory is not accepted as a sacred text, it can be considered as a bedside book for the energy world that will need management. It is possible to benefit from the subtleties of this area in understanding both the internal and external structure. Being able to correctly understand, and interpret the organization and the environment is also decisive for the planned actions. For this reason, it is expected that every segment that wants to manage energy will benefit from the energy of the administration (Eren, 2002).

In the management adventure, a macrostructure is reached, starting from individuals, the organization, and then to the whole. It brings out the public as both influencing and affected. When evaluated in terms of civil, it can be said that the energy issue does not differ fundamentally from individual and organizational. Of course, if the state authority is kept aside, the size and intricacy of the diameter of the equation put forward draw attention as the enormous difference. However, as we tried to change above, focusing on the energy issue at the state level means further widening the circle of thought. First of all, energy is seen as a vital financial requirement for the realization of state planning. The energy required to produce value both economically and socially is on the agenda of the state as well as the society. It is conceivable to see the effects of energy on significant issues such as production, employment, and foreign trade that can be associated with the welfare of the country (Lee and Chang, 2008; Belke et al, 2011). Apart from this, the energy concern is not only addressed in terms of economic consequences. When taken from a broader perspective in the historical course, it is seen that energy has a political side. For this reason, it is unfortunately experienced that energy is sometimes soft power and sometimes harsh environments open a door into war. Therefore, it would be appropriate to say that energy turns into a weapon when coming to sovereignty. As explained in resource dependence, the fact that energy is a symbol of power in the light of these explanations makes it possible to establish alliances as struggles around it. With the energy/power issue that changes the equations, interests can be combined and separated. It obliges the parties that intend to benefit from the energy table to share the same environment.

The developments taking place in the Middle East and the Mediterranean can be shown as examples of these statements. It proves that energy is a geopolitical and geo-strategic instrument, as will be explored in the strategy section. The power possessives take action to aspire rich underground wealth, and deeply affect the geography, and nations living there. Besides, in another aspect, it becomes possible to read from the stories of the rise and fall of nations that soft values can also turn into an energy potential, just as it is expressed at an organizational level. Also, in such a competitive atmosphere, technology should be addressed as well as the environment (Kaltschmitt et al., 2007). Thus, observations and analyzes in the field of energy become more meaningful and seeing the big picture gets on easier.

STRATEGIC HANDLING OF ENERGY

Although it is discussed in detail in the upper parts, the existence of deficiencies at some points still does not go unnoticed. At this point, strategic management comes to our rescue (Ülgen and Mirze, 2010). Failure to use strategy in a vital issue such as energy will cause serious problems. For this reason, taking advantage of the opportunities of strategic management to take a holistic view of the energy issue has the potential to radically change the course of the event. Anyway, in field readings related to both entrepreneurship and administration, the issue turns around and evolves into a strategy. If we have accepted that energy is also a matter of entrepreneurship and management, then our current stop in the energy journey should be the strategic perspective.

There is an anecdote in the strategy readings, which is explained by the expression of red and blue oceans. By establishing a connection between this metaphor and much complex information, the issue is tried to be made more visual. The entrepreneur pursues the blue ocean to manage his comfort, profitability, sustainability, and leadership. Because the blue ocean evokes a monopoly market in economics. The supplier, who has power, rules the market as he wishes. Since he has all the control, he prevails in the business as he wishes. However, as mentioned, the existence of positive conditions and this pleasant situation do not escape the attention of other actors. If protection could not be provided with entry barriers, it invites the shark flock, that is another entrepreneur, to this area. Such a deep blue ocean will inevitably turn red many times (Kim, 2005). When we associate the energy assessment of the event with the producers, if a shield is not created by the political authority (such as licensing), the first private sector investors (or the public) may reveal structures that see themselves as absolute power, symbolized by the blue ocean. However, as the market will react more to external factors with technology and globalization, the emergence of different actors/actions in the market becomes more likely. Although it is not felt in the production phase in the energy market, tough struggles are exhibited in licensing tenders. Thus, many key concepts such as market realities, competition, protectionism, monopoly, supply-demand, income-expenditure, profitability, sustainability can be associated with this metaphor (Mi, 2015).

Continuing the evaluation for producers, the dependence of energy on input/raw material in terms of production should be expressed. Of course, competition is expected to occur in terms of owning resources/gaining concessions. However, it should be reminded not to act by focusing only on the present in this competitive struggle. Because with the strategic perspective, it is aimed to make the competitive element sustainable (Posch et al., 2015). In other words, if a source of superiority cannot be sustained for a long time, it is seen as one of the factors that will activate the cyclical process that increases the intensity of competition. One of the providers of strategic action for energy generation is to reach a position that will provide a sustainable competitive advantage. At this stage, it is expected that the source or technology to be selected will fill this deficiency (Wang et al., 2020). The contribution of investments to sustainability will become even more vital when it is remembered that concession rights supported by the state authority can be shaken by political turmoil. Besides, profitability exceeding the market average is required for strategic energy generation. It is possible to explain this with resource dependency or technological developments explained above. It is quite notable to recognize the need for strategy. Because while the management demands stability and an environment that it can control, the entrepreneur is in search of environments where he can discover new opportunities to reveal the difference. It leads us to act strategically in energy (Cheng et al., 2020).

Another fundamental issue touched by the strategy during energy generation is the consideration of environmental sustainability (Googdland, 1995). Of course, it seems possible to pass the day in energy production with methods that do not take the environment into account. But, when considering both the continuity of resources and production waste, sustainability can cause problems in terms of non-strategic ones. Due to its adverse effects on both nature and human life, this issue is taken more seriously in societies with awareness. For this reason, although it seems that money is spent and imports are being made, developed societies carry their production processes to developing or undeveloped countries on a global scale. In this way, they think that they protect themselves from environmental pressures and wastes (Yüksel et al., 2021). It is not possible to say that this approach coincides with the strategy we mentioned. However, it would be appropriate to say that the issue has been avoided for a while with short-term solutions. Since there is no other planet currently discovered and where we can live.

However, although such tricks are preferred, as the role of energy in our lives is deepening, the energy required for the industry can be shifted from one geography to another, while environmentally friendly sustainable energy methods needed in daily life are gradually increasing their popularity (Arto et al., 2016). But, when the power demands of developed and underdeveloped countries are examined, it has been determined that developed countries need more. This explains the relationship between civilization and energy in one aspect. At the same time, the strategic importance of energy is emphasized with this criterion, which can be described as an indicator of development and prosperity.

It will not be sufficient to consider energy strategically only in terms of production. Also, consumption should be handled as well as production. As stated before, the energy demand felt in developed societies is relatively high compared to the undeveloped ones. It is possible to qualify this as a criterion in consumption, just as we have dealt with in production. Demands of individuals, organizations, and societies for technological and industrial products require energy consumption also fuel energy consumption. While this means increased prosperity and easier lives, it also increases energy dependence. Also, continuity of activities without interruption for energy-consuming producers is related to uninterrupted energy supply. Besides, it is foreseen that companies will strategize their competition with alternative solutions to be developed specifically for their energy consumption (Amasyali and El-Gohary, 2018).

Continuing the consumption part, it is thought that sustainable energy can be selected by individuals who have the opportunity. Of course, this can be described as both a cost and a matter of consciousness (Delmas et al., 2013). At this stage, while individuals can turn to their independent energy solutions, they can turn to different environmental solutions suppliers. Besides, energy-friendly products can be chosen in energy consumption with environmental and long-term savings awareness (Abrahamse et al., 2005).

When it comes to the adoption of sustainable energy by organizations, companies can turn to different alternatives to reduce energy costs, just like individuals. It may be to produce their energies, or they may prefer to use smart and environmentally friendly systems for sustainable profitability. It can also take place in the form of having strategic sources or establishing strategic alliances to professionalize and strategize its operations. At this stage, organizations may try to gain strategy in their actions by growing horizontally and vertically when necessary. It can be observed that they direct their actions by simplifying or downsizing when required. Since this expression sometimes means giving up the centralization in energy, it leads to a diverse situation for competition markets (Bale et al., 2012), as will be mentioned later. When evaluated from another point of view, investments can be diversified by focusing on abstract resources as physical ones. Thanks to the investments to be made in these elements that cannot be expressed in material terms and educational activities, vital elements such as human resources energy, intellectual accumulation, information energy, innovation, management energy can be improved. And so, sustainability and strategy can be encouraged.

If the concern of strategic energy is mentioned in terms of the public, effective and efficient use of production resources will enable the state to bring inactive resources to production. It can be described as the indicator of the development and production of these countries. Also, technological activities to be supported by investments can contribute to the level of leap forward to countries (Liu et al., 2021). In this respect, sustainable energy can be described as an indicator of prosperity, a symbol of civilization. Besides, it is thought that considering energy with a strategic perspective will make improvements in trade and foreign trade balances as well as in the fields of production, industry, and employment. It should not be forgotten that energy is an indispensable element in both geo-political and geo-strategic games, and its effect on the balance of power should not be overlooked. It can be said that it has reached the level of international playmaking with strategic alliances, mergers, acquisitions based on countries.

To comprehend strategy, it is necessary to recognize the nature of competition. For this goal, the necessity to know oneself as well as understanding the competitive environment arises. For this purpose, the SWOT analysis, that is one of the most crucial analyzes in the field of management, should be used. Thus, strengthening/supplying the deficiencies to struggle in competition; protecting the strengths; discovering opportunities; a preparation process is initiated to protect against threats. With this approach in an attractive market such as the energy market, the organization will take a step towards the roadmap for its future (Gürel and Tat, 2017).

While evaluating energy decisions, Porter's 5 forces model can be used to monitor the market closely. To make sense of energy competition, it becomes easier to assess actions more strategically with the interpretation of 5 different variables whose effects can be felt. First of all, it can be stated that the energy market is competitive with its structure and necessitates analysis (Porter, 2008). Even if it is assumed to be relatively limited and secure in some markets due to state mechanisms or concession rights, it should be borne in mind that the equation may be distorted by another parties. It should not be ignored that the balances may change with the intervention of raw material suppliers in the energy markets. It is also possible for new entrants to include new technologies and new raw materials into the system. There may be fluctuations in the market balance with equivalent products and solutions in existing energy systems. It is probable to evaluate the emerging individual and environmentally friendly energy solutions at this level (Burkhardt et al., 2021). Also, customers who demand a more conscious evaluation of their energy demands can cause both production and consumption to shift towards environmentally friendly alternatives (Li et al., 2020).

Additionally, another helpful analysis can be used to interpret the competition and the struggle it brings. With the PESTEL or PESTLE analysis, which takes its name from the combination of the initials of the values it represents, the decisions about the energy market can be evaluated more healthily (Yuksel, 2012). First of all, political actors that have a say in determining energy production and consumption and their practices should be taken into account. Thus, energy supply and demand can be predicted more easily. Besides, it is aimed to strengthen the step to be taken by controlling the economic indicators related to this field (Chontanawat et al., 2008). More accurate decisions can be made by having information about the socio-cultural reasons of the market. Also, another influential factor in both production and consumption stages is technology, as explained. For those whose relationship with the environment is concerned with energy, it can sometimes emerge as an opportunity and sometimes as a threat. While conducting all these relationships, it is unthinkable to have a legal basis and not to comply with this area (Srdjevic et al., 2012).

It may become inevitable to struggle to stay competitive. To achieve this, it is vital to take action within the organization as well as to analyze the external environment. In this area, the focus should be on organizational functions or functional structures that should be harmonized with strategies. Also, the value chain to be created should be well designed and the available energy should be allocated accordingly. Of course, what can be done in the energy markets is not limited to what is explained. Within the strategies such as cost leadership, differentiation strategy, focused internships, combined competition strategies, a suitable strategy may be selected to be determined and a road map that carries the organization to the future (Porter, 1997).

While all this is happening, it should not be neglected that the whole system is in motion more or less. It can be thought that the system has a natural selection in which the old ones disappear while there are new ones appears. It should not be overlooked that every effort made for the competition can be noticed and followed by every competitor who has the means. Considering that new and distinctive standards become commonplace and cannot drag competition after a while due to organizational isomorphism, the importance of looking at the issue strategically becomes clear (Boxenbaum and Jonsson, 2017).

SOLUTIONS AND RECOMMENDATIONS

As new model trials are put forward in the energy market, the rules of the current order will change, thus existing solution proposals may lose their validity. While power and energy games bring fluctuations and breakages with them, existing energies can be directed to wars and cause destruction. Perhaps, by choosing more autonomous solutions instead of more centralized structures in new model trials, a wider spectrum can be used in the field of energy. By using the concepts of outsourcing and core competence in the energy business, the models in which the work is majored on only energy and this is transformed into competitive advantage can shape the world of the future (Prahalad, 1993; Quinn and Hilmer, 1994). In this way, by focusing on the real issue, a contribution will be made to the prevention of energy waste. Besides, with the principle of learning organizations, it is possible to emphasize what the organization should focus on while achieving its goals, while at the same time, new Chernobyl and Fukushima disasters can be prevented by providing lessons from mistakes.

FUTURE RESEARCH DIRECTIONS

Strategic management plays a very key role for the effectiveness of the energy investments. Regardless of the type of the energy, investors should mainly focus on appropriate strategies to overcome any problems in this process. For this companies, in the following studies, the detail models should be created to understand the optimal strategies to improve these investments. In this context, multi-criteria decision-making models can be taken into consideration (Li et al., 2021; Zhou et al., 2021; Zhao et al., 2021; Xie et al., 2021; Liu et al., 2021). On the other side, some econometric models can also be considered to make more effective analysis in this context (Mikayilov et al., 2020; Yüksel et al., 2020; Dinçer et al., 2019; Yu et al., 2019).

CONCLUSION

Although evaluating from an economic point of view, energy is accepted as an input, it is able to be considered as power for organizations. If it is accepted that a business strives to make competition factors unique to maintain its existence, it is reasonable to consider energy as a competitive element in today's world. For this purpose, it is essential to benefit from the management and even strategic management opportunities in the moves to be taken in the energy field. Naturally, the situation of companies that need, consume, produce and manage, energy may change according to their conditions. However, even if it seems unclear to come up with a correct statement/criterion, strategic handling of energy in many areas from production to consumption, from transportation to storage, from investment to financing, from marketing to utilization as a geopolitical argument can change the balance of power between the parties. So, it is recommended to look at the strategy as a long-term requirement, instead of focusing on energy-matter short range (Gustafsson et al., 2015). To the accompaniment of these explanations, energy is considered as an area that social scientists will contribute as much as researchers and practitioners working in fundamental sciences. Regarding sustainability and ethical issues, it appears that energy is not only a matter of calculation, but it also needs administrative support. Although the misconception that transactions can go on with the solutions that save the day in the energy issue is assumed, the need for long-run, sustainable, and environmentally friendly approaches can be described as a strategic requirement (Rudberg et al., 2013).

Accompanied by all these explanations, it is seen that energy, which is one of the destiny issues of human beings, concerns the humanities as much as it touches the countenance of basic sciences (Amasyali and El-Gohary, 2018). Of course, while detailed explanations are required for each analysis mentioned above, the usage of short and ordinary expressions shows that this field is not insignificant, but there is a relationship between matters. With this perspective, it is desired to give more weight to the energy issue in the social sciences area by considering many crucial elements that may come to mind. With these inferences and associations, it is aimed to be beneficial both to the academy and to the energy parties in practice. Energy and management are able to considered to be an inseparable duo (Sovacool et al., 2014). For this reason, it is aimed to take a step with the hope and dream of a more livable, more prosperous world with the harmony and synergy of values that will emerge.

"Power is nothing without control"

from Pirelli

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Chapter 18
The Economic and Environmental Importance of Akkuyu Nuclear Power Plant in Turkey

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ABSTRACT

Turkey's energy consumption grown because Turkish economic volume, industrialization, and population have increased. The way to meet this energy need is to have a sustainable energy resource. Turkey does not have the enough reserves of fossil fuels such as oil and natural gas. Therefore, it is an energy importer country. So, the current account deficit is one of the main problems of the Turkish economy. When it is considered that increase in the importation of fossil fuel costs and these fuels' damages to the environment, Turkey has the need for environmentally friendly and sustainable energy sources. In this context, Turkey plans to meet energy needs with nuclear power plants (NPP). The first NPP will come into operation at Akkuyu location in Mersin with a total installed power of approximately 10,000 MW. Turkey aims to reduce the current account deficit by reducing energy imports. In addition, environmental protection will be ensured as much as provided economic growth. In this study, the importance of Akkuyu NPP for Turkey and relevant literature are investigated.

INTRODUCTION

The need for energy is one of the most important needs for all people. People use energy directly or indirectly in their daily lives. Energy has contributed economically and socially to the increase of living standards all over the world and to global development (Li et al., 2021; Zhou et al., 2021; Zhao et

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al., 2021). After years of the agricultural economy, there has been a strong industrialization revolution. While industrialization increases the importance of the energy concept, energy has been used in every field. Therefore, the increase in production caused by the intensive use of energy has been one of the driving forces of the increase in people's welfare (Xie et al., 2021; Liu et al., 2021). The industrialization revolution has brought about an intense urbanization. Therefore, it has increased people's need and demand for energy resources day by day. Considering the developments in the industrial field and the increasing human population in the same direction, energy use will become more widespread. Thus, the energy issue will be more important in the 21st century. Therefore, it is of great importance to examine the energy issue (Stern and Cleveland, 2003; Madlener and Alcott, 2009; Li and Lin, 2015).

To express simply, energy sources have three clear properties. Energy resources are limited (Ellabban, et al., 2014), unevenly distributed, and the use of some energy resources causes environmental pollution (Bose, 2010). Energy resources are divided into 2 according to their use. Depletable (Non-Renewable) Energy Sources and Non-depletable (Renewable) Energy Sources constitute these 2 groups. Non-renewable energy sources are divided into 2 as Fossil Sourced and Nucleus Sourced. Coal, petroleum, and natural gas can be given as examples of fossil originated ones. Uranium and thorium can be given as examples for those with a nucleus origin. Solar, wind, wave, biomass, hydraulic, geothermal and hydrogen can be given as examples of renewable energy sources (Liu, et al., 2010; Ünak, 2000; Waldrop, 2012).

Energy resources can also be classified under two headings as commercial and non-commercial energy sources. Commercial energy sources include energy types that meet the national and international needs of industrialized economies. Commercial energy resources are oil, natural gas, nuclear energy, etc., (Sarkar, et al., 2003). It can be said that non-commercial energy sources are formed by animal wastes and agricultural wastes. Throughout history, as the economies have developed, the demand for commercial energy resources has increased, while the demand and production of non-commercial ones have decreased (Yu et al., 2019).

Fossil Fuels

Fuels such as coal, oil and natural gas are fossil fuels (Akella, et al., 2009). Most of the energy found and needed in all areas of life in the world is obtained from fossil sources (Klass, 2004). Over millions of years, fossil fuels have been formed by the decay of plants and animals. Carbon element forms the basis of these fuels. Fossil fuels are still formed under the influence of heat and pressure, but the rate of formation of fossil fuels is much lower than the rate of consumption. Therefore, fossil fuels can be classified as non-renewable energy. Production after the industrial revolution was based on one of fossil fuels, coal (Mikayilov et al., 2020). Later, natural gas and oil that are other fossil fuels, were added to coal. Although fossil fuels contributed to the increase in production in those years, these energy sources became questionable after years. The 1973 Oil Crisis further increased the distrust of fossil fuels. Although the distrust in these resources continues to increase, fossil fuels still maintain their leadership in world energy production. Being cheap and easily accessible, being used in many fields of industries are the positive aspects of fossil fuels. Although population growth, urbanization and industrialization necessarily increase the need for these fuels, the damages of fossil fuels are quite high (Du et al., 2020). They are air pollution that fossil fuels cause the greatest damage. They are one of the main actors of global warming due to high carbon emissions (Doğan and Erol, 2019). They are the main cause of many natural events that occur. They increase the carbon dioxide ratio by causing the oxygen to decrease. They cause acid rain and climate changes directly or indirectly. Gases and particles released into the environment due to fossil fuels are harmful to human health (Liu et al., 2021). It can be the cause of many cancers and respiratory diseases, even deaths. Therefore, it can be said that fossil fuels cause environmental pollution and make countries uninhabitable (Kampa and Castanas, 2008). It is possible to talk about more than one negative economic consequences with increasing environmental pollution. Increasing number of patients in a country due to environmental pollution increases health expenditures. With the increasing number of patients, intense labour loss occurs in countries. Therefore, although the industry depending on fossil fuels seems profitable in a short time, it has harmful consequences in the long term. Thus, it is essential to find alternative energy sources to fossil fuels, considering the depletion of fossil fuels and the continuous increase in prices, the damages they cause on the environment as a result of their burning and their effects on human health. Renewable energies and nuclear energy can be shown as an alternative to fossil fuels with extremely low carbon emissions.

Renewable Energies

Depending on the reasons such as the increase in the world population, industrialization and technological developments, the need to provide sufficient energy that does not threaten environment is increasing day by day. This increasing energy need has led to an increase in investments for renewable energy, as fossil fuel reserves are decreasing day by day. The use of renewable energy sources is an important step in meeting energy needs and reducing carbon emissions (Komendantova, et al., 2012). Frequently used renewable energy resources are hydraulic, wind, solar, geothermal and biomass energies (Bull, 2001). It is a reassuring type of energy because these energy sources do not cause environmental problems encountered during the production and conversion of energy. In addition to being a clean and promising energy source, it is possible to mention some disadvantages. Renewable energy investments are quite large investments. Hence, it is high cost. The energy received varies depending on the weather conditions. Thus, problems can be experienced at the point of uninterrupted energy production (Yüksel and Çağlayan, 2020). In this context, the use of other energy sources together with renewable energies will also be rational.

Nuclear Energy

Simply, the type of energy obtained from atomic nuclei through fission is called nuclear energy. Uranium, the element that contains the most protons and neutrons, is enriched and used as fuel for nuclear energy production. Neutrons collide with the uranium nucleus, causing division. Thus, uranium by splitting, produces a high amount of heat. Considering the size of the energy released, it is essential to keep it under control. Uncontrolled fission reactions cause serious losses. In this context, neutron holders formed with elements such as boron are important for controlling the energy generated in energy production. The high temperature caused by the splitting of uranium vaporises water and provides the necessary motion energy for electricity generation by turning the turbines. When all these processes take place, an energy that can be called zero carbon emission is produced. In this context, nuclear energy is one of the important resources in meeting the increasing energy need due to its carbon-free energy (Xie, et al., 2020). Considering that carbon emission is a global problem, nuclear energy has an active role in combating global warming. In this context, various advantages of nuclear energy can be mentioned. First of all, air pollution caused by fossil sources can be minimized when nuclear energy is used. Thus, nuclear energy has a direct positive effect on human health. Nuclear energy prevents a loss of work force by protecting human health from air pollution, death and diseases caused by air pollution (Dinçer, et al., 2020). Another point is that the reserves of uranium and thorium that can be used as fuel are quite high. Nuclear power plants generate 24-hour uninterrupted electricity, unlike renewable energy generation. It is not affected by weather and climate conditions. Therefore, it can be said to be more effective and efficient. The high amount of energy obtained from nuclear power plants significantly reduces energy import of nuclear energy investor countries. In this way, the current account deficit problems of countries can be prevented by nuclear energy investments. Nuclear energy investments can stimulate the energy sector and provide employment, as well as stimulate other sectors by offering cheap and efficient energy to other sectors. Most of the developed and developing countries have more than one nuclear power plant. Therefore, studies are also carried out to ensure nuclear safety. Thanks to technological and scientific progress, nuclear power plants will be prevented from encountering possible accidents. Thus, the risk of explosion will be minimized. Apart from that, it is aimed to minimize radioactive pollution by working on environmentalist methods in waste management. It can also be said that nuclear energy investments can only be realized with a good financial management. Because nuclear energy investments are high-cost investments such as renewable energy investments. Considering all these, nuclear energy investments to be realized with a strong business management, waste management and financial management will help to solve the energy problems of countries (Yüksel, et al., 2020). Therefore, by leaving the place of fossil fuels to nuclear energy, especially at the point of combating global warming, environmental and economic advantage can be obtained.

ENERGY RESOURCES IN TURKEY

Energy is the most basic need of people living in a country. Therefore, this need must be met in a cheap, clean, reliable, and uninterrupted manner. Turkey's economy has grown in recent years. The demand for electricity in the country parallel to the growth of Turkey's economy has also increased by almost the same rate. Therefore, Turkey needs an energy policy and energy infrastructure to meet the rising demand for energy if it wants to continue its growth targets. Turkey does not have a large amount of oil and natural gas reserves. Almost all resources such as high-quality coal, oil and natural gas are imported (Toklu, et al., 2010). Thus, Turkey is an energy importing country. Most of its imports are devoted to energy needs (Akdeniz, et al., 2002; Jewell and Ates, 2015). Turkey produces electricity mainly from thermal power plants and renewable energy sources. Coal and natural gas are the main resources used in electricity generation. So, Turkey is importing large quantities of coal and natural gas. When the need for intensive and high-cost energy sources is considered, it can be said that Turkey's energy need is the most important factor causing the current account deficit. The current account deficit makes the economy more vulnerable Turkey (Kok and Benli, 2017). At the same time, the environmental problems due to fossil fuel use is another problem for Turkey (Toklu, 2013). Since environmental pollution causes health problems, it causes loss of workforce and increases health expenditures. Therefore, accelerating energy investments in Turkey aims to prevent the economic fragility, prevent environmental pollution and raise living standards. Turkey has a strong potential for renewable energy, but renewable energy sources will be insufficient to meet the future energy demand in Turkey thus, it is necessary to find resources what are more efficient and effective. In this context, Turkey plans to meet about 30% of the growing electricity demand from renewable energy investments in line with Turkey's 2023 targets. Additionally, Turkey plans to generate power from two nuclear power plants with a total installed capacity of approximately

10,000 MW (Melikoglu, 2016). There are 440 nuclear power plants that continue to produce energy worldwide. Nuclear energy is the dominant energy source in some countries. For example, Lithuania meets about 77% and France 76% of their energy needs from nuclear power plants. It is also known that dozens of different countries are planning to open new nuclear power plants (Aras, 2013). Nuclear energy is not a new concept for Turkey. Although attempts were first started in 1965 for the power plants, the trials were unsuccessful due to various obstacles. Financing problems, political problems, pressure from anti-nuclear groups were the major problems experienced by Turkey. Despite all these problems, it is possible to talk about the various benefits of nuclear energy for Turkey. By considering different perspectives, nuclear energy is more efficient and effective compared to other energy sources. Nuclear power plants will prevent air pollution with their zero- carbon emission feature and will be a supportive factor in combating global warming. Reduced air pollution will have a role in reducing labour loss by preventing health problems. In addition, Turkey is a country that has raw materials that can be used in nuclear power plants such as uranium, thorium. Although, uranium reserves less than thorium reserves, thorium is a promising fuel for nuclear power plants. If necessary studies are done, thorium can also be used as fuel for nuclear energy production (Akıska, et al., 2019). At the same time, since nuclear power plants are high-security power plants, the risk of accidents is very low. When the planned nuclear power plants in Turkey starts its operations, it will contribute to the country's economy by reducing imports and current account deficit. When this is considered, saying that nuclear energy investment in Turkey is one of the most important and worthwhile investment to Turkey, will not be wrong.

THEORY FRAMEWORK ABOUT NUCLEAR ENERGY

Increase in industrialization since The Industrial Revolution, fast international trade volume with globalization and neo liberal policies' implementation since 1980s, rising demand and need amount for goods and services with population growth, raising competitiveness between sectors, exponential urbanization and modernization in the world have increased carbon dioxide (CO2) emission rate and cause to more sustainable economic models (Peter, 2018; Owusu and Asumadu-Sarkodie, 2016). Besides, fossil fuel- based energy generation leads to increase CO2 emission rates and it affects human health. Therefore, it will cause negatively affecting employment rates and economic development will be influenced negatively in high CO2 emission rates countries as well. Thus, nuclear energy is one of the most discussed and crucial energy resources and it is considered as alternative energy resources instead of fossil fuel energy resources. There is vast amount of research in the literature in order to explain relationship between economic growth, environmental impact, and nuclear energy. As researches denoted that nuclear energy- based energy generations in countries have an impact on economic growth and it increases economic growth and advantages and decreases CO2 emission rates (Prăvălie and Bandoc, 2019). According to OECD countries' 1995- 20015 data, it is remarked that nuclear energy-based electricity production increases also economic growth and reduces down CO2 emission rates in long run (Lau et al., 2019). According to the studies, it is figured out that there is relationship between nuclear energy consumption, economic growth, real gross fixed capital, income level, labour force, and foreign direct investments (FDI). In addition to that, these researches noted that CO2 emission rates, greenhouse gas (GHG) emission rates decrease with NPP. For instance, Polland is coal energy dependent economy, and their CO2 emission rates is in high level. Also, some researches emphasized that fossil fuel energy resources' consumption reduces down when nuclear energy resources' consumption increased

(Piłatowska et al., 2020; Zawalińska et al., 2020; Kim, 2020; Saidi and Ben Mbarek, 2016; Poinssot et al., 2016; Baek and Pride, 2014; AlFarra and Abu-Hijleh, 2012; Nazlioglu et al., 2011; Wolde-Rufael, 2010; Apergis and Payne, 2010; Wolde-Rufael and Menyah, 2010; Yoo and Ku, 2009). However, there is not found any affect in nuclear energy consumption rates when oil price and consumption is changed. (Luqman et al., 2019). Otherwise, a research made in Latin America denoted that oil rent price has influenced GDP per capita negatively, but there is positive relationship between renewable energy (RE), nuclear energy, fossil fuel energy resources and CO2 emission rates with GDP per capita (Ozturk, 2017). Additionally, nuclear energy support rates have been increased when oil, natural gas and coal become expensive and scarce in USA, because nuclear energy is another alternative resource instead of fossil fuel energy resources (Gupta et al., 2019) On the other hand, there are some arguments which is about nuclear energy future. For example, a study denoted that nuclear power can be future for China, Russia and other countries that have high amount state owned enterprises, but it might not be a future for other countries. Moreover, nuclear energy could not fight with climate change as renewable energy. In this consideration, some researchers analysed that RE ensures to reduce down CO2 rates more than nuclear energy. Also, RE resources more beneficial for economy and environment than nuclear energy However, there is storage problem for RE resources and it leads to decrease RE investments and prevent usage preferences. Also, nuclear energy has problems which prevents NPP projects' investments. These problems are hard licencing, safety concerns, running out NPPs life cycle because of slowing down technologic development against to the other resources' technologic advancement and high costs of plants (Markard et al., 2020; Jin and Kim, 2018; Dong et al., 2018; Menyah and Wolde-Rufael, 2010; Apergis et al., 2010). Otherwise, some researches remarked that nuclear energy is more beneficial and friendlier for environment than RE resources. Thus, it leads to provide lower CO2 emission rates against RE resources. With regard of these, NPP generates energy more efficient than RE and fossil fuel- based energy production (Alekseev et al., 2020; Dong et al., 2018; Vaillancourt et al., 2008). In addition to those, NPP technology export has gained economic value and power such as Russia (Aalto et al., 2017). Also, this economic advantage affects public perception and acceptance. For example, South Korean public acceptance was low because of high-risk perception against to nuclear energy after Fukishima accident. However, NPP technology export to UAE has changed the nuclear energy safety perception and image positively (Roh and Kim, 2017).

As economic and environmental importance of nuclear energy, finance, cost, and investment management are also another aspect of NPP projects. Hence, there are some nuclear project financing problems. In this respect, these problems stated as prescriptive regulatory oversight, vast completion risk, and limiting nuclear liability regimes. According to IEA reports, nuclear energy is important because of low carbon emission resources, but it is required high amount investments (Dalton, 2019). Furthermore, these problems can be solved with a strong banking law, security interest, ensuring ownership and financial requirements (Sainati et al., 2019). Therewithal, NPP investments are so costly and dangerous. In this respect, the fifth nuclear power reactors' projects in Finland have been rejected until businesses offered to the government as nuclear energy is green and eco-friendly energy resources (Jensen-Eriksen, 2020). On the other hand, nuclear energy investments do not give quick respond as revenue. Thus, it is considered that RE investments would be better than NPPs investments in order to get revenue without losing time (Gozgor and Demir, 2017). After Fukishima nuclear power accident, high level nuclear energy support and invested to NPP companies' share prices were declined. However, their market portfolio and returns have changed to countries' regulatory system. Also, abnormal returns have obtained from RE and nuclear energy investments (Lopatta and Kaspereit, 2014)

On the other hand, NPPs construction process, operation management, timing and location choices influences nuclear energy efficiency. For instance, NPPs location choice is important for economic development and it is required high amount of investments. With regard of these, high investment required nuclear power reactors have ended up with low level carbon emission rate. Moreover, there are some issues in order to ensure secure electricity generation. These are time of NPPs' contruction, countries energy policies for nuclear facilities' management, and electricity generation and distribution process, public opinion, determination life cycle of NPPs, cost management of reactors, and technologic developments (Zawalinska et al., 2020; Siquera et al., 2019; Heffron, 2013). Also, some studies showed that decarbonization cost will reduce with achievement of decreasing nuclear reactors costs. Nuclear energy is so valuable energy resources because of electricity generation is provided within low carbon technology (Buongiorno et al., 2018). It has to be added that nuclear waste is so dangerous for humanity, environment and economy and it has to be managed so carefully. Particularly, it has become harder in long lived NPPs (Prăvălie and Bandoc, 2018). On the other hand, size of NPPs could be a solution for energy supply security with low carbon technology energy resources. For example, Africa electricity deficit problem with limited capital and safety problem. Small- size unit reactors might be solved this problem (Kessides, 2014). Also, Russia can export nuclear power ships to Arctic region as only country that have nuclear reactor ships (Gagarinskiy, 2018). Accordingly, it is estimated that NPP will reduce down operating cost in Brazil by generating cheaper electricity (dos Santos et al., 2013)

In addition to that, nuclear energy provides to decrease foreign energy dependency. Besides, energy dependent countries have economic vulnerabilities. Also, fossil fuel- based energy generation dependent countries have economic vulnerabilities (Sarkodie and Adams, 2018). For example, Turkey has also economic vulnerabilities which is current account deficit because of energy import and its' costs. Turkey has imported coal and natural gas. Hence, nuclear power plant (NPP) project will decrease energy dependency such as natural gas import from Russia will reduce down (Aydın, 2020; Ağbulut, 2019; Kok and Benli, 2017). Also, Czech Republic and Slovakia have also supported nuclear power because of not to live 2009 gas crises again which can create vulnerabilities and economic damages (Kratochvil and Mišík, 2020). Moreover, Israel has limited energy resources and struggled to build NPP in their country with many failed initiatives (Rabinowitz, 2016). Nevertheless, Middle East countries have petroleum, but they have taken into account NPP, because nuclear energy is significant for civil liberties, national security, international relations, cost effectiveness, energy supply security, technologic developments, and strategic power (Krane et al., 2016)

On the other hand, there is a trend which is nuclear energy reactor decommissioning. After Chernobyl and Fukishima nuclear accident, some countries have decided to phase out nuclear energy facilities in their countries -particularly, European region countries- because of any nuclear accident risks, running out of nuclear reactor life cycle, low public acceptance caused by strong anti -nuclear supporters or not being any economic and environmental benefits of NPPs. Therewithal, nuclear reactor phase out has decreased value added of nuclear energy industry, but it is estimated that this value added would be obtained by increasing RE investments. In addition to that, NPPs decommissioning will increase expenditures a lot (Kim and Jeon, 2020). With regard of these, nuclear reactor phase out is also costly too much. For example, it is claimed that Fessenhim NPP's shut down has caused high cost because of wrong legislation and agreements of the process. It is warned, electricity generation can be influenced negatively if the shutdown remains costly (Mauger et al., 2018). In addition to that, fossil fuel-based energy generation, foreign dependency, price volatility and high CO2 emission rate influenced positively, and energy supply security affected negatively with NPP reactor phase out in Belgium (Kunsch and

Friesewinkel, 2014). Additionally, Italia cut energy generation from NPP and it caused to damage economic development (Esposto, 2008). However, some countries have made plan to build new NPPs. For example, China is one of them and the government gives incentives and promotes nuclear energy with RE resources. Therefore, they focused waste nuclear fuel recycling, because China has limited uranium reserves for NPP plans and nuclear fuel export will create extra cost (Meng and Yu, 2018; Dong et al., 2018; Gao et al., 2017;).

Nuclear energy technologies' developments are so crucial in order to decrease NPP cost, nuclear accident risks, provide adequate waste nuclear fuel management, safety, and energy supply security. Therefore, nuclear energy tests have play important role in order to ensure efficiency for energy efficiency. For example, ion beams' tests are more cost- effective and useful for nuclear power reactors. Moreover, improving of this kind of tests and technologies is going to assure nuclear energy system efficiency (Heidrich et al., 2019). Hence, satisfying industries' and population's energy demand easily, waste nuclear fuel recycling achievements ensure with nuclear energy technologic developments. Also, artificial intelligence (AI) and computational systems have been used in nuclear reactor technology in order to determine any nuclear reactor risks and prevent any NPP accident before. These computational systems create digital doppelgangers and provide also fast business process and bring outcome without any losing time. (Alekseev et al., 2020; Belokrylov et al., 2020; Fernandez et al., 2017). On the other hand, hydrogen (H) energy is one of the cleanest energy resources in the world. Furthermore, it is seemed that H can be acquired from nuclear energy reactors during process (Nowotny, 2016). Moreover, Gen IV reactors has cost- effective technology. They service with advanced waste nuclear fuel cycle technology and uranium utilization as nuclear reactor fuel. Accordingly, these are led to decrease electricity cost in South Korea. Additionally, some tests based on high-temperature gas-cooled nuclear reactor made in order to develop thorium-plutonium nuclear fuel cycle and Gen IV nuclear reactor technologies. With regard of these, economic feasibility will be ensured with safety and, computational cost and NPPs engineering problems will be solved (Gao et al., 2019; Bedenko et al., 2019). Technological developments in NPPs are useful for nuclear energy support. For example, UK is one of the countries that phase out nuclear reactor and has planned to build Gen IV nuclear reactors. Gen IV nuclear reactors are one of the most secured nuclear reactor types. However, there have been strong nuclear energy opposers, but they are willing to pay R&D studies for Gen IV NPP's process. Therefore, public acceptance for nuclear energy is also dependent on R&D studies (Contu and Mourato, 2020). In addition to that, USA and Japanese people are willing to pay nuclear power, because it reduces GHG emission rates. However, they are more willing to pay for RE than NPPs (Murakami et al., 2015).

Also, there are green nuclear energy studies. As it is stated that uranium and thorium utilization ((U-Th)O2) increases NPPs' energy generation efficiency, ensures economic feasibility and safety. Furthermore, some studies try to claim that thorium- based usage with uranium utilization in nuclear reactor can become more environment- friendly. Besides, thorium fuel- based nuclear reactor called as green nuclear energy. Moreover, thorium is an element which is in the ground more than uranium. On the other hand, accelerator driven system (ADS) based green nuclear energy reactors decreases GHG emission rates. With regard of these, it is analysed that green nuclear energy reduces down radioactive waste and nuclear proliferation (Maiorino et al., 2018; Humphrey and Khandaker, 2018; Demirdogen and Askar, 2017; Hossain et al., 2015).

Therefore, CO2 emission rates, social perception, NPP technologic developments and information trust have impact on nuclear energy perceived risk and benefits, and willingness to pay for energy resources which is about energy resources types of choice (Vainio et al., 2017; Jun et al., 2010).

AKKUYU NUCLEAR POWER PLANT (NPP) IN TURKEY

Turkey is developing country. Industrialization, urbanization, developments of other sectors, emerging economic growth, raising population and modernization in Turkey increase constantly energy demand and energy consumption. According to 2019 reports, electricity in Turkey is generated by 19,87% imported coal, 1,85% coal and asphaltite, 15,42% lignite, 18,85% natural gas, 0,11% liquid fuels, 29,22% water (damn, lake and stream), 7,15% wind, 1,52% renewable waste and waste heat, 2,95% geothermal, and 3,04% sun (TEIAS, 2019). Furthermore, it is expected that energy consumption is going to increase approximately 160% by 2030 to the estimations. Turkey is one of the foreign energy dependent country and this increment in Turkish energy consumption might rise energy dependency and import energy resources from outside. With regard of these, this causes current account deficit and economic vulnerability. Coal, natural gas, and oil are imported at most. Therefore, foreign energy dependency and import will be broken, and economic development will be raised with nuclear power plant projects in Turkey (Kok and Benli, 2017; Güngör and Buldurur, 2017; Ergün and Polat, 2012). Nuclear power plant projects have been made in Turkey since 1950s. Hence, there are many agreements initiatives, but the most of them cancelled because of many reasons. Therewithal, Turkey decided to build NPP in 1970s and they encountered financial, administrative, and technical problems. For example, one of the nuclear agreements made in 2008 was cancelled, because of lack of energy policy and inadequate technological development for nuclear energy management. However, Turkey has overcome these problems by dealing with Russia and Japan in order to decrease gas import dependency from Russia. In May 2010, there was signed an Agreement between Russia and Turkey in order to build nuclear power plant (NPP) in Akkuyu, Mersin. According to the Agreement, 51% of NPP will belong to Russia and this NPP type will be VVER-1200. Therewithal, NPP in Akkuyu is going to be operated by Russia (Ferat and Göral, 2016). In addition to that, Presidency of the Republic of Turkey and Ministry of Energy and Natural Resources announced that Akkuyu Nuclear Power Plant's (NPP) first reactor in Mersin is going to be in process in 2023 and generate 4.800 MW electricity by operating 24/7 (Presidency of the Republic of Turkey, 2021). As they stated that this NPP will satisfy approximately 10% Turkish electricity demand. Furthermore, there will be four nuclear reactors, the construction started in 2015 for the first reactor, and it is going to be four stages. Turkey has not adequate NPP staff, technic equip and equipment in order to be employed. In the first stage, AKKUYU NUCLEAR Joint-Stock Company was found in 2010 and nuclear energy engineering studies has started in order to be proper NPP process and management. Moreover, 190 Turkish students were sent to National Research Nuclear University for training in 2014 and become technical and scientific skill readiness for the project (Akkuyu Nuclear Power Plant, 2014). Besides, it is considered that there are still some problems against to construction of nuclear reactor. These problems consist of stakeholder concerns because of trust to government problem, public conflict, and environmental concerns (Sirin, 2010; Erdoğan et al., 2016; Aydın, 2020). However, it is investigated that the relationship between USA, France and Japan NPP and economic growth. There is found directly relationship between economic growth and NPP; and there is directly relationship between CO2 emission rates and NPP in France. Therefore, NPP is so important for Turkish economic growth. As researches are noted that NPP requirement in Turkey will be originated by some problems. These are current account deficits because of high energy imports in some years, energy imports' cost and risks because of inadequate energy reserves, nuclear power- based energy generation provides more energy supply than renewable energy resources, it is clean and green energy resources against global warming, and nuclear energy is crucial for strategic and politic reasons (Güllü and Güngül, 2019).

Turkey decided to build NPP cooperation with Russia in Akkuyu, Mersin in order to decrease energy dependency which will reduce foreign energy resources such as natural gas from Russia, because Turkey imported 78% of its energy demand. 98% of natural gas demand has also been imported. On the other hand, NPP financing is another issue for Turkey, because Turkey is developing country and it has economic vulnerabilities a lot. NPP investment and finance is so crucial for Turkish economic health. According to the 2016 studies' estimation, Turkey spent to energy investments by 90% as nuclear energy and RE investments. In addition to that, Turkey has planned to use 10.000 MW nuclear power generated electricity in 2023. However, it might only be 2.400 MW to the estimations. Thus, scientists have warned to authorities in order to take precautions for energy generation plan, because few energy generations can make harder financing of NPP (Melikoglu, 2016). Otherwise, electricity price will decrease with nuclear energy generation in Turkey. On the other hand, nuclear energy fuel resources are important to reduce down the cost of NPP in process. As it is known, nuclear fuel utilization by uranium and thorium are significant in order to provide nuclear waste management, more green nuclear power, minimization of possible nuclear accidents and cost (Maiorino et al., 2018). In this respect, Turkey is a sixth country where have been the largest thorium reserve in the world. With regard of these, it is stated that these reserves can be used as nuclear fuel in NPP operations' process, and these resources can export to other countries so they would also employ in NPPs. Accordingly, these will lead to increase economic growth of Turkey and social welfare (Agbulut, 2019). As it is emphasized before, Turkey is dependent approximately 90% foreign fossil fuel- based energy resources and it causes economic problems. NPP will provide cleaner, greener, cost- efficient energy and it will increase energy security in Turkey. In this respect, NPP will help economic growth and sustainability. NPPs increases economic and politic leverages, but it is remarked that NPPs has safety problem and security risks. Moreover, most of developed countries have been used to nuclear energy in their countries. Therefore, NPP studies and development plans should be accelerated in Turkey. As IEA also reported, nuclear energy importance should be kept (Shepherd, 2018; Özalp, 2017; Telli, 2016).

Nuclear energy's environmental impacts have also investigated. NPPs are generally constructed in waterfront regions for NPP process and safety. There are studies which have inquired radioactivity and heavy metals in drinking water Mersin province in order to measure environmental impact, before Akkuyu NPP construction. Also, some studies made in Turkey in order to determine appropriate location choice for NPP operations. In these studies, it is noted that active faultlines, earthquake effects and cooling water are some of determinants for choice of NPP locations (Karahan et al., 2018; Başkurt and Aydın, 2020)

On the other hand, nuclear power management, well- regulated policies, government decisions, international implementations and commitments are so significant in order to satisfy nuclear energy safety and trust for public. Turkey is considered to use Europe policies and ideas for NPP. Turkey is constructing nuclear reactor in Akkuyu with Russia at the end of dealing. As it is mentioned before, Turkey has tried to focus Europeanization on policies about nuclear energy reactors' management, nuclear safety, radioactive waste management, NPP safety, protection from radiation for environmental and public health, public awareness, fiscal constraints, and law acts. However, the most important thing from these policies' considerations is social learning in order to provide safety. (Gunay and İşeri, 2017; Sever, 2019). Also, nuclear energy risk/ benefit perception, nuclear energy credibility, government trust, having nuclear energy awareness and being informed are significant and it affects public acceptance (Wang et al., 2020). In this consideration, there are studies which measured to Turkish people's nuclear energy risk/benefit perception. According to the most of Turkish people, Akkuyu NPP is considered that the NPP has high accident risk, radioactive waste problem, and installation and dismantling costs.

Moreover, they denoted that nuclear energy has dangerous for environment. Additionally, some of them they do not think that Akkuyu NPP can provide economic benefit and sustainability a lot and the NPP can also construct within safety conditions. Thus, Turkish nuclear energy public perception has negative considerations as economic and social norms. Hence, these negative considerations should be reduced with proper strategic precautions. In order to provide nuclear safety and reduce down radioactivity risks, legal framework and implementations must be regulated. Accordingly, nuclear energy security determinants should be improved by public, organizations, governments, ant other authorized bodies. One of the most important strategy is that people should be in the decision process and informed public constantly, completely and objectively (Harmanda, 2020). When it is looked at energy importer countries' public acceptance for nuclear energy investments, security conditions are the most significant consideration for public acceptance with economic and environmental issues. In this consideration, NPPs safety controls must be done properly, and the process should be shared with the public openly. Moreover, an independent and autonomous organization can be established in the country which will control NPPs regularly and shared results objectively and clearly (Xie et al., 2020).

Also, media system matters for energy debates and they have impact on public perception and ideas about nuclear energy. Additionally, alternative media is effective with other ideas about unspoken energy debates in polarized media system for Turkey (Ersoy and İşeri, 2020). As it is mentioned before, science and communication are so important for nuclear power trust, credibility, funding, and publication. Moreover, it is emphasized that science evidence will provide communication with public, government and other stakeholders. So, these should be improved by scientists (Berdahl et al., 2016; Li et al., 2018). In this point, it is remarked that technologic and economic discourses will prevent politicize for nuclear energy discussions in Turkey against anti-nuclear supporters (İşeri et al., 2018).

CONCLUSION

In this study, the importance of Akkuyu Nuclear Power Plant for Turkey and relevant literatures are investigated. Energy consumption due to high energy demand and needs with industrialization, modernization, urbanization, high global competitiveness, and production and increment in population has been rising all around the world. Also, Turkish energy demand and needs increase because of these reasons. However, Turkey is energy dependent country. Turkey has imported 78% of its energy demand and 98% of these energy demand includes natural gas demand which the large part of purchased from Russia. Thus, energy import and high foreign dependency causes to current account deficit for Turkey, and it is significant economic vulnerability. With regard of these, there have been lots of nuclear power plant initiatives in Turkey since 1950s throughout the history. However, the most of them ended up with failures because of political reasons, economic problems, inadequate policies and disagreements, lack of technologic equipment and staffs.

In May 2010, there was signed an Agreement between Russia and Turkey in order to build nuclear power plant (NPP) in Akkuyu, Mersin. As stated in the Agreement, 51% of NPP in Akkuyu, Turkey will belong to Russia and NPP technology ype will be VVER-1200. Furthermore, NPP in Akkuyu is going to be operated by Russia and AKKUYU NUCLEAR Joint-Stock Company was found in 2010. Presidency of the Republic of Turkey and Ministry of Energy and Natural Resources announced that Akkuyu Nuclear Power Plant's (NPP) first reactor in Mersin will be in operation actively in 2023 and generate 4.800 MW electricity. Also, it is added that the NPP will meet approximately 10% Turkish electricity demand. In addition to that, 190 students were sent to Russia for training in order to be proper the NPP management. Therefore, nuclear energy will decrease foreign energy dependency and energy import. It is considered that this will also reduce economic vulnerability -current account deficit- of Turkey. As it is mentioned before, nuclear energy is one of the cleanest energy resources. Therewithal, it is stated that Akkuyu NPP project will cause decreasing CO2 emission rate in Turkey and provide sustainable energy resources with RE resources by reducing fossil fuel-based energy generation.

Also, the studies showed that public nuclear energy awareness and acceptance is so important for NPP management process. However, some studies emphasized that Turkish people nuclear energy safety trust was low, and they do not think about its economic and environmental benefits. So, it is suggested that nuclear energy trust should be created by public, organizations, governments, ant other authorized bodies with sharing process openly. Accordingly, it is stated that complete energy policies should be prepared and implemented. Moreover, it is recommended to establish independent organization in order to control NPPs regularly and share the results with public objectively.

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Chapter 19
Investigation of the Foreign Direct Investment and Environmental Pollution Nexus for Developing Countries

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ABSTRACT

In theory, the foreign direct investment and environmental pollution nexus is explained by three hypotheses. Firstly, pollution haven hypothesis assumes that there is a positive nexus between these variables. Secondly, pollution halo hypothesis supposes that there is negative connection between these variables. Lastly, neutrality hypothesis asserts the non-existence of the connection between these variables. In recent years, many researchers have frequently tested whether these hypotheses are valid for different countries. In this study, applying Westerlund panel cointegration test, the authors aim to explore the nexus between foreign direct investment and environmental pollution for 23 developing countries after global crisis. For this aim, they use annual data covering the period 2009-2019. According to the obtained empirical findings, the presence of the long-term nexus between foreign direct investment and environmental pollution is not detected for 23 developing countries. Accordingly, the authors can say that there is neutrality hypothesis.

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INTRODUCTION

The 1970s have been accepted as a turning point for understanding the human being's devastating effects on the earth. The policies which increase industrialization, international trade and access to natural resources had been accepted as the best action for a higher standard of living by policy-makers, economists, and even ordinary people until this period. The developed countries had achieved many significant yields of higher economic growth involving technological development, higher income, better education opportunities, and increasing life expectancy. On the other hand, the devastating effects of economic activities such as pollution, global warming, the dramatic increase in CO2 emission, extreme weather events such as rising sea levels, and drought have become observable events worldwide. Therefore, many reports prepared by researchers and organizations have focused on the influences of economic activities on the environment. Inter governmental Panel on Climate Change (2018) report confirmed that human and economic activities caused warming reached approximately 1 ° .C compared to the pre-industrial level. Just the current global warning results have been generated melting of the Arctic sea and the devastating events above-mentioned. Besides, the report also affirmed that if the increase in environmental degradation proceeds in its dominant form, global warming will pass 1.5 ° .C between 2030 and 2052. Many developed countries signed many international agreements (e.g., the Kyoto Protocol and Paris agreement) along with observable devastating natural events and scientific evidence to improve environmental consciousness. These agreements and social awareness for the environment and established new political parties, especially in the European Union (hereafter EU), have urged the developed countries to create and implement policies and regulations to protect the environment. Generally, these policies lead to higher pollution abatement costs and punish dirty industries. Tax, limited production, and the obligations for modified production through environmentally friendly methods have been experienced by the firms operating in the developed countries (Guzel & Okumus, 2020).

In this period, the world experienced another important event named globalization, and the liberalization of international trade shaped the current political and economic structure. Multinational firms operating in developed countries have gradually transferred some part of production or entire production and built new firms to developing countries through foreign direct investment (hereafter FDI). Lower labor costs, natural resources, access to the market, and transformation cost reduction provide an attractive comparative advantage for FDI. This relocation of the production has been welcomed to the developing countries because of many reasons. For example, FDI and other forms are generally seen as factors increasing managerial abilities, overcoming the foreign exchange shortage, creating alternatives against deficient domestic savings, and improving the balance of payment in the developing countries. However, many former developing countries such as Asian countries used FDI, international trade, and other foreign capital forms as the engine of growth and essential factors for achieving the standard of living in developing countries (Nunnenkamp, 2001; Destek & Okumus, 2019).

Globalization and the environmental policies implemented in the developed countries have been cointegrated and generated new ways for the dirt pollution industries to escape the encountered additional environmental costs. This new phoneme is named the pollution haven hypothesis (hereafter PHH). The hypothesis suggests, FDI plays a considerable role in the migration of the unfriendly environmental industries from developed countries to developing countries. This view is based on the comparative cost advantage resulting from the developing countries' weak pollution restrictions. Developing countries specialize in dirty goods and export, and developed countries practice environmentally friendly or high-tech goods. Along with this phenomenon, the developing countries become the world's pollution industrial hubs transferred from the advanced countries. The advanced countries favor transferring their parts of production in some developing countries to reduce production costs because the environmental laws are more rigorous in the advanced countries, which dramatically increases production costs. Entrepreneurs shift their production to developing countries with undersized stringent environmental laws to avoid the additional cost based on the environmental regulations. According to this view, the developed countries prone to practice in clean production while developing countries prone to specialize in unclean production with their soft environmental criteria (Waldkirch & Gopinath, 2008; Zhu et al. 2016; Gill et al. 2018).

The global financial crisis that occurred in 2008 induced the most profound global financial crisis since World War II, and a significant reduction in output, employment, and trade were experienced around the world. The detrimental effects of the global financial crisis can be classified that GDP in developed countries decreased by 4.5 percent in 2008, the unemployment rate increased to 9 percent across OECD economies, and world trade shrunk by more than 40 percent. The performance of FDI during the global crisis and post-era seem to be less stressed in the debate, and according to UNCTAD (2009), the multinational corporation decisions concerning FDI appeared a complex pattern (Alfaro & Chen, 2010). That is why the global crisis's role should be considered to explore the FDI and the environmental pollution (hereafter EP) nexus. This study purposes to explore the FDI and EP linkage for the selected 23 developing countries after Global Crisis, using panel cointegration test. For this aim, we use an annual dataset covering the period 2009-2019. Concerning the literature, several studies investigate the nexus between these variables by using different econometric techniques. As far as we know, the contribution of our study to the literature is that we investigate the nexus between FDI and CO2 for selected 23 developing countries after Global Crisis.

This study purposes to explore the linkage between FDI and CO2 emissions for selected 23 developing countries after Global Crisis, using panel cointegration test. For this aim, we use an annual dataset covering the period 2009-2019. The study unfolds as follows. Section 2 gives information regarding the theoretical background. Furthermore, Section 3 reviews the previous studies investigating the nexus between FDI and CO2 for developing countries. Section 4 presents detailed information about data and methodology. Section 5 gives the obtained empirical findings. Moreover, Section 6 and Section 7 present solutions and recommendations, and future research directions. The final part is related to discussion empirical findings.

THEORETICAL FRAMEWORK

The PHH is first developed by Pethig (1976) and followed by the many theoretical and empirical studies against or approving this pioneering study. For example, Walter and Ugelow (1979) argued that the environment is one of the production factors, and environmental regulations can play an essential role in altering the international capital's flow. Besides, Copeland and Taylor (1994) made another early contribution, and they established a general framework of equilibrium to understand the international trade and pollution nexus. Also, they made this contribution in the light of North-South Trade considering NAFTA. According to this observation, they suggested massive competitions between the firms operating in the advanced countries facing the stringent environmental regulations like the USA and the firms in the developing countries facing comparatively weak rules like Mexico. This difference related to the environmental perspective leads to transferring the dirty goods from the advanced countries to the developing countries under the trade liberalizations. This argument emphasized that the product distribution under NAFTA leads Mexico to become a pollution haven; on the other side, NAFTA would display a USA's job failure (Gill et al., 2018). Later, theoretical studies established three dimensions to understand the process of the PHH. The first dimension is transferring industries based on massive polluting from developed countries with severe environmental regulations to developing countries with more negligible or nonexistent environmental regulations. Trade liberalization seems to accelerate and encourage polluting industries to move to less developed countries. The second dimension is that the developing countries are the evacuation area for the developed countries of hazardous waste (e.g., industrial and nuclear energy production). Finally, the last dimension is that the developing countries' non-renewable resources and other sources involving petroleum, petroleum products, and forest resources are extracted and processed by multinational corporations.

Along with approving these frameworks, many empirical conducted studies have been administered following pioneer studies. Their results identified that the effects of the FDI on environmental pollution have an inconclusive appearance. Some researchers disapproved of the PHH. They claimed that FDI could be accepted as a factor improving environmental welfare because many environmentally friendly factors such as energy-efficient technology and production methods belonging to advanced countries can be utilized by the developing countries with the help of FDI (Liang, 2008). Furthermore, Cole et al. (2008) emphasized that FDI improves environmental quality by transporting clean technology and know-how, and this optimistic view of the FDI and the environment's host countries connection is named the pollution halo hypothesis (hereafter PHHH).

The halo effect hypothesis is based on the suggestion of Grossmand and Krueger (1995). According to Grossmand and Krueger (1995), GDP's effect on the environment is classified as three stages involving scale, technique, and composite effect. Though the scale effect is supposed to degrade the environmental quality, the other two impacts seem to balance this effect. The PHHH was tested by Tamazian et al. (2009) for BRIC countries, and they approved the PHHH. Porter and Van der Linde (1995) develop another argument against the PHH. They stated that stringent environmental regulations implemented in the home country led to installing technologies based on environmentally friendly, decreasing the marginal cost and raising the firms' productivity. Therefore, the firms convert further competitive.

Though the PHHH seems to be the most crucial and popular alternative against the PHH, there are some alternative hypotheses and frameworks against the PHH. For instance, the green haven hypothesis (hereafter GHH) is another argument against the PHH. According to the GHH, consumers, especially in advanced countries, become more responsible for the environment, and they may cop an attitude against the pollution industries. Moreover, the pollution industries are concerned with maintaining their reputations in the eyes of the consumers. Therefore, they invest in green technology to minimize their ecological degradation to increase the public's reputations (Herzig & Schaltegger, 2006). In addition, Letchumanan and Kodama (2000) criticized some assumptions of the PHH. According to them, the PHH is based on the root linked to neo classical theory of comparative advantage that views the environment as another determinant providing comparative cost advantage. The neo-classical theory does not consider the dynamic process involving technology, market access, or innovation, which have more effects on the export's competitiveness than conventional comparative cost's endowment. Also, the PHH is criticized because industries are perfectly mobile to achieve locational advantages of pollution haven in the light of the PHH. Another controversial argument against the PHH belongs to the capital-labor hypothesis (the KLH). In the eyes of the KLH, trade, and investment flows are determined by the factor endowment, especially from the advanced countries to the developing countries. The factor endowment theory argued that firms based on capital-intensive invest in the countries linked to labor abundant whereas firms based on labor-intensive in the country linked to capital-abundant. According to this view, the capital-abundant advanced countries tend to specialize in capital-intensive goods that are also pollution-intensive, and labor-abundant developing countries tend to specialize in labor-intensive goods that seem to be less pollution-intensive (Ethier,1982; Markusen, 1984; Gill et al. 2018).

LITERATURE REVIEW

The linkage between FDI and environmental pollution has received massive attention in the literature, and mainly three different hypotheses detailed in the theoretical section in this study are established to identify this relation. They are the PHH, the PHHH, and the neutrality hypothesis (hereafter NH), respectively.

In the recent studies, many researchers confirmed the PHH using various econometric techniques, time-spanning, and countries' scope or regions (Al-Mulali, & Ozturk, 2015; Terzi & Pata, 2019; Rana & Sharma, 2019). Nevertheless, some studies also supported the PHHH (Tang & Tan, 2015; Mert et al. 2019; Ozturk & Oz, 2016; Balsalobre-Lorente et al., 2019). Furthermore, some researchers achieved the NH (Kearsley & Riddel, 2010; Albulescu et al., 2019; Destek & Okumus, 2019).

Therefore, in this section, the expanding and detailing literature review related to the FDI and environmental degradation connection underlines the topic's importance worldwide. The investigation of the PHH has been conducted on some regional areas or more comprehensive panel data. For example, Regarding EU, Cave and Blomquist (2008) employed a panel regression model, and the result posed that foreign investment related to energy-intensive sectors is in harmony with the PHH, toxic intensive trade does not follow the PHH. Later, Kellenberg (2010) investigated the determinants of the US's foreign investment by using OLS and GMM-IV estimations. The result is in keeping with the PHH because the US's foreign investment favors the following countries based on lower environmental standards. In the UK case, Manderson and Kneller (2012) did not support the existence of the PHH as the environmental regulation differences are not determinants for UK firms' foreign investment decisions. Omri et al. (2014) tested the connection between variables involving trade-openness, urbanization, financial development, FDI and C02 emissions, capital stock, and GDP belonging to 54 countries during the period spanning 1990-2011. They used GMM approach, and the results verified the soundness of the PHH in these countries. Also, Shahbaz et al. (2015) concentrated on the data belonging to 99 countries to probe the connection and FDI and CO_2 emissions. They employed FMOLS for the period covering 1975-2012. The results indicated that an inverted U-shape connection between variables holds for selected countries. Furthermore, many researchers have investigated the effects of the environmental standards' degree on FDI decisions managed by the developed countries.

Along with the studies mentioned above, the literature linked to the developing countries will be presented in detail in this section. Table 1 is presented following this purpose, summarizing information and studies' conclusion confirming the PHHH or the PHH is showed. Later, detailed information related to these studies presented in the Table 1 is explained.

The PHH and PHHH have been tested for individual countries or countries based on specific regional or economic structures such as less-developed, developing, advanced, etc. MINTS and BRICS countries have been one of the leading FDI destinations, and they aim to attract foreign and domestic entrepreneurs to improve their industrial structures. Thus, the influences of FDI on the environment have been one of the vital topics for researchers. For instance, Besides, Zakarya et al. (2015) analyzed the validity of the PHH for BRICS countries for 1990-2012, and they confirmed that the presence of

Table 1. Literature review

Author(s)	Period	Country(s)	Methodology	Result
Merican et al. (2007)	1970-2001	ASEAN-5	ARDL	PHHH for Thailand, Malaysia, and the Philippines
Kearsley & Riddel (2010)	1980-2004	27 OECD	Regression	NH is valid
Tamazian & Rao (2010)	1993-2004	24 TE	GMM	PHHH
Cole et al. (2011)	2001-2004	China	Regression	PHH
Al-Mulali & Tang (2013)	1980-2009	GCC	Panel FMOLS	PHHH
Asghari (2013)	1980-2011	MENA	Regression	PHHH
Ridzuan et al. (2014)	1970-2008	ASEAN-5	ARDL	PHH
Kivyiro & Arminen (2014)	1971-2009	6 SSA	ARDL	PHH holds for Kenya and Zimbabwe
Bu et al. (2014)	1996-2009	China	Conditional Logit Model	PHH
Zakarya et al. (2015)	1990-2012	BRICS	Panel FMOLS-DOLS	PHH
Zhu et al. (2016)	1981-2011	ASEAN-5	Panel Quantile Regression	PHHH
Zhang & Zhou (2016)	1995-2010	China	STIRPAT model	PHHH
Baek (2016)	1981-2010	ASEAN-5	PMG	PHH
Sapkota & Bastola (2017)	1980-2010	14 LA	Regression	PHH
Rasit & Aralas (2017)	2000-2010	ASEAN-OECD	Regression	NH
Solarin et al. (2017)	1980-2012	Ghana	ARDL	PHH
Sun et al. (2017)	1980-2012	China	ARDL	PHH
Destek & Okumus (2019)	1982-2013	10 NIC	CCE	NH
Balsalobre-Lorente et al. (2019)	1990-2013	MINT	Panel FMOLS-DOLS	PHHH
Shao et al. (2019)	1982-2014	BRIC-MINT	Panel VECM and Cointegration	PHHH
Guzel & Okumus (2020)	1981-2014	ASEAN-5	CCEMG, AMG	PHH
Khan et al. (2020)	1970-2016	China, India, Pakistan	Panel and time-series techniques	PHH
Mert & Caglar (2020)	1974-2018	Turkey	Hidden cointegration	PHHH
Bulut et al. (2021)	1970-2016	Turkey	Nonlinear Analysis	PHH

Notes: MINT: Mexico, Indonesia, Nigeria, Turkey; BRIC: Brazil, Russia, India, China; BRICS: Brazil, Russia, India, China, South Africa; ASEAN-5: Indonesia, Malaysia, the Philippines, Singapore, Thailand; NIC: Newly Industrialized Countries; GCC: Gulf Cooperation Council; TE: Transition Economies; LA: Latin American; SSA: Sub Saharan African.

the PHH is approved. Balsalobre-Lorente et al. (2019) analyzed the non-linear connection among FDI and the ecological footprint (hereafter EF) to detect the confirmation of the PHH in MINT countries for 1990-2013. Panel FMOLS and DOLS econometric methodologies were employed. The model results underlined that an inverted-U connection between FDI and the EF is approved. However, the validity of Environmental Kuznets Curve (hereafter EKC) is affirmed for MINT countries, and the PHHH is also affirmed. There is an adverse nexus among renewable energy use, the urbanization process, and the EF changes. Shao et al. (2019) compared the BRICS and MINT countries in the light of the PHH. They strived to investigate the nexus between environmental performance indicators and other potential factors, involving trade, energy consumption, trade, and urban population, influencing the environment as well as FDI. Panel VECM and panel cointegration tests were conducted for the two countries mentioned above during 1982-2014. The results illustrated that a bi-directional and negative causality link among FDI inflows and environmental degradation indicators is detected. This implication refers to the rejection of the PHH for both the BRICS and MINT countries.

Furthermore, ASEAN countries are also one of the leading research scopes in the investigation of the PHH. Merican et al. (2007) used ARDL approach to investigate the connection between FDI and CO2 emission in ASEAN-5 countries for the period covering 1970-2011. They concluded that the PHH holds for the Philippines, Thailand, and Malaysia. Later, Ridzuan et al. (2014) strived to whether the PHH is valid or not in ASEAN-5 countries by employing ARDL approach on annual data covering 1970-2008. The model emphasized that the PHH is confirmed; in other saying, CO2 emission is positively associated with FDI. Baek (2016) managed research to determine the existence of the PHH for ASEAN-5 countries for 1981-2010, focusing on various variables involving FDI, energy consumption, and CO2 emission. PMG estimator was utilized to reach the evidence, and the result of the model showed that the existence of the PHH is affirmed for ASEAN countries. In contrast, Zhu et al. (2016) found no evidence for existence of the PHH in ASEAN-5 countries by employing panel quantile regression model for 1981-2011. As a result of the model, it was argued that FDI mitigates CO2 emissions, and an increase in trade openness appears a mitigation factor of the rise in CO2 emissions. Rasit and Aralas (2017) administered a study to test the presence of the PHH in ASEAN and OECD countries for years covering 2000-2010. This objective is analyzed by concentrating on the impacts of environmental regulation on trade openness and FDI by using panel regression model. The result of the model indicated a strong connection between environmental regulation and trade openness. In contrast, the relationship between environmental regulation and FDI is not found, which implied that the PHH is not approved. Moreover, Rasit and Aralas (2019) investigated the PHH in ASEAN countries by examining the penetrations of the volume of exports and imports related to dirty goods on environmental regulation. Panel data involving the period 2002-2017 was used. The model's results posed that the PHH linked to the relationship between import and environmental regulation is not confirmed while the PHH related to the relationship between export and environmental regulation is approved. Guzel and Okumus (2020) tested the PHH for ASEAN-5 countries by using the dataset covering 1981-2014. According to the panel regression model, it was concluded that the existence of the PHH is affirmed in ASEAN-5 countries; in other words, an increase in FDI causes to a rise in environmental degradation focusing countries in this study.

These days there are various classifications for defining countries such as newly industrialized, transition countries, and emerging seven countries. In the recent times, some studies have focused whether these hypotheses are valid for these countries. For instance, Javorcik and Wei (2003) administered a study to investigate whether the PHH is valid or not for 24 transition economies during 1989-1994 using firm-level data. They reached a finding affirming the PHH, but not substantial. Another examination focusing on transition economies is managed by Tamazian and Rao (2010). GMM approach was used to investigate the PHH for 24 transition economies for 1993-2004. The investigation verified the validity of the PHHH, which means a higher level of FDI, is a factor lowering C02 emission. Al-Mulali and Tang (2013) explored the soundness of the PHH in the GCC countries with the non-stationary panel techniques. As a result of the model, it was concluded that CO2 emission is positively associated with energy consumption and

GDP growth while FDI has a long-term adverse connection with CO2 emission. The causality analysis did not affirm the causal nexus between FDI and CO2 emission, but the energy consumption and GDP growth cause CO2 emission. Therefore, it was concluded that the pollution sources are GDP growth and energy consumption, not FDI. Asghari (2013) considered the validity of the PHH for MENA countries using by panel regression model for 1980-2011. It was concluded that the finding presenting an adverse connection between FDI and carbon emissions is obtained, which means the rejection of the PHH. In African countries, six sub-Saharan countries were examined by Kivyiro and Arminen (2014) by using ARDL approach to search the connection between FDI and CO2 emissions. The model emphasized that CO2 emissions increase with a rise in FDI in Kenya and Zimbabwe; that is, the PHH holds for Kenya and Zimbabwe. In Latin American countries, Sapkota and Bastola (2017) found a piece of robust evidence verifying the PHH. Solarin et al. (2017) administered research to test the PHH in Ghana for 1980-2012. They selected many series consisting of CO2 emission as an indicator of air pollution and its determinants consisting of GDP, GDP square, energy consumption, FDI, urbanization, trade openness, institutional quality, fossil fuel energy consumption, and renewable energy consumption. ARDL methodology was used to achieve the study's objective, and the result of the model indicated that the PHH does endure in Ghana. Also, CO2 emission is positively influenced by GDP, FDI, urban population, international trade, and financial development. In contrast, it is also found that institutional quality plays a beneficial role in decreasing environmental degradation. Destek and Okumus (2019) purposed to detect whether the PHH is valid or not in 10 NIC. They utilized second-generation panel data methodology on data involving real income, energy consumption, FDI, and ecological footprint for 1982-2013. The model results showed that a U-shaped connection between FDI and ecological footprint exists, and increasing energy consumption and economic growth have a detrimental impact on the environment. Nathaniel et al. (2020) tried to assess the PHH in Coastal Mediterranean countries (hereafter CMS) over the last few decades with a quantile panel data analysis. The result revealed that the validity of the PHH for CMS is not affirmed. Furthermore, they concluded that the initial levels of environmental degradation play a vital role in the effects of FDI on environmental degradation, and energy consumption harms environmental quality for all countries. In contrast, the impacts of economic growth and urbanization on the environment seem to have diverse conclusions for various indicators and across quantiles.

In addition to panel data, some researchers have tried to investigate individual countries to detect the validity of the PHH and PHHH by using different econometric techniques, time intervals, and different countries.

Yuan et al. (2010) found a controversial result in which FDI is not seen as the driver of environmental pollution in China. In other saying, the truth of the PHH does not hold regarding Yuan et al.'s (2010) empirical study. Zhang and Zhou (2016) also did not support the holding of the PHH in China by using STIRPAT model on the period for 1995-2010. However, the validity of the PHH in China is also confirmed by Cole et al. (2011) and Bu et al. (2014).

For example, Sun et al. (2017) administered a study to test the presence of the PHH by using ARDL approach on annual data spanning 1980-2012. According to the model, it was argued that an increase in CO2 emissions is associated with a rise in FDI. This finding means the validity of the PHH. Nadeem et al. (2020) employed four pollutant indicators involving C02 emissions, CO2 emissions from sloid fuels, SO2 emissions, and GHG emissions to explore the approval of the PHH for Pakistan over the period spanning 1971-2014. ARDL approach was applied, and a positive connection between FDI inflow and three pollution indicators such as CO2, CO2 from solid fuels, and GHG emission is found. In contrast, there is a long-term connection between FDI inflow and SO2 emissions. All in all, all results do not confirm the evidence of the presence of the PHH for Pakistan. Khan et al. (2020) explored the PHH for China, India, and Pakistan over 1970-2016. Both panel and time-series techniques were adopted on variables such as FDI, electricity consumption, real GDP, and ecological footprints. The results revealed that the long-term connection among variables confirms, and the PHH is affirmed for all countries. Mert and Caglar (2020) aimed to investigate the asymmetric and long-run causal connection between FDI and emission to examine the PHH and pollution halo hypothesis for Turkey over the time covering 1974-2018. Hidden cointegration techniques were preferred to achieve asymmetric pollution haven and pollution halo hypothesis. Crouching error model and vector error correction model (VECM) were also applied to examine the asymmetric causal relationship between variables. According to the study's result, it was posed that the presence of asymmetric causal link FDI's positive shock and emissions' positive movement in the short-run is achieved. Besides, the presence of an asymmetric causal connection between FDI's positive and negative shocks and emissions' positive trend in the long-run. Moreover, the study also underlined that a rise in FDI causes a decrease in the emission growth rate. This implication represents the approval of the asymmetric pollution halo hypothesis in the case of Turkey. Bulut et al. (2021) tried to reveal the evidence of the existence of the PHH for Turkey over the period spanning 1970-2016 by using a nonlinear approach. The model affirmed the validity of the PHH for Turkey. In China's case, the topic of the PHH has been received massive attention because of its attractive FDI destination and economic performance. In contrast, there are mixed shreds of evidence regarding the validity of the PHH.

Considering the literature, it can be implied that there is no consensus concerning the validity of the PHH. PHH is confirmed by Cole et al. (2011), Bu et al. (2014), Zhang and Zhou (2016), Sun et al. (2017), Khan et al. (2020), Mert and Caglar (2020), Bulut et al. (2021). Nevertheless, some studies reject the validity of the PHH and affirm the PHH or the NH (Yuan et al. 2010; Al-Mulali & Tang, 2013; Rasit & Aralas, 2017; Nathaniel et al. 2020). The best of our knowledge based on the literature, most of the studies focus on individual data or limited panel data, and the effects of the global financial crisis on FDI are not considered in the light of the investigation for the PHH. Extending panel data and considering the global financial crisis will contribute to the knowledge for the PHH. Therefore, this study investigates the linkage between FDI and CO2 emissions for selected 23 developing countries after Global Crisis, using the panel cointegration test. We discuss and recommend policies in light of the relationship between FDI and environment degradation with achieving the evidence.

DATA AND METHODOLOGY

To research the nexus between FDI and environmental pollution for 23 developing countries[1] after Global Crisis, we use annual data covering the period 2009-2019. Moreover, we use the percent share of foreign direct investment in GDP (net inflows) as independent variable and obtain from World Development Indicators (2021) (hereafter WDI) database. We also use carbon dioxide emissions (million tons) as dependent variable. We achieve this data from BP Statistical Review of World Energy June 2020. Table 2 shows the descriptive statistics. The logarithmic form of carbon dioxide emissions (million tons) is used.

As is seen in Table 2, FDI is averagely 2.186% in 23 developing countries for the period 2009-2019. While the minimum value of FDI (-7.39%) is shown in Trinidad and Tobago for 2012, the maximum value (11.74%) is seen in Chile for 2012.

In analyzing of the long-term relationship, when using with panel data, there are different tests. To obtain effective and robust results in study, cointegration test should be detected properly. For this aim,

Table 2. The descriptive statistics

Variables	Observation	Mean	Standard Deviation	Minimum Value	Maximum Value
FDI	**253**	**2.186**	**2.019**	**-7.392**	**11.743**
LCO2	**253**	**2.195**	**0.504**	**1.119**	**3.395**

when analyzing with panel data, firstly, the existence of cross section dependence among units should be investigated. While the second generation cointegration tests are used in cases where there is cross section dependence, otherwise, the first generation cointegration tests are used. Therefore, determining of the cross-section dependence has a significant role in detecting of the cointegration test to be employed.

When employing with panel data, unit root analysis has been done as in time series. The results of the cross-section dependence test also play a role critical for the unit root analysis. After testing the existence of the cross-section dependence for the model and each variable, if there is cross section dependence, the second generation unit root tests should be employed. Otherwise, using of the first generation unit roots test is decided. For instance, if the Fisher ADF test which is one of the first generation unit root tests is employed for a variable which has cross-section dependence, it will not be possible to make a correct decision regarding the stationarity of the variable. Hence, firstly, cross-section dependence should be investigated in the study. In our study, Pesaran (2004) CD test and $_{\text{CD LMadj}}$ test proposed by Pesaran et al. (2008) has been employed as cross section dependence test because of T=20 and N=23 (N >T). Pesaran (2004) CD LM test is as follows (Pesaran, 2004: 5-6);

$$CD = \sqrt{\frac{2T}{N\left(N-1\right)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right). \tag{1}$$

where $\hat{\rho}_{ii}$ .denotes the sample estimate of the pair-wise correlation of the residuals (Pesaran, 2004: 4). Moreover, for general model, we used $_{\text{CD LMadj which is developed by}}$ Pesaran et al. (2008). The test statistic is

$$CD\,LM_{adj} = \sqrt{\frac{2}{N\left(N-1\right)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\frac{\left(T-k\right)\hat{\rho}_{ij}^{2}-\mu_{Tij}}{v_{Tij}}. \tag{2}$$

where first $T \to \infty$ .then $N \to \infty$. $CD\,LM_{adj} \to d\,N\left(0,1\right)$.(Pesaran et al., 2008: 108). Accordingly, for the cross-section dependence tests, while the null hypothesis is that $\hat{\rho}_{ii}$ .equals zero, the alternative hypothesis is that $\hat{\rho}_{ii}$ .does not equal zero. When CD test statistic value is bigger than the value of table, the null hypothesis is rejected. Hence, we can say that the cross-section dependence is valid.

In case which the cross-section dependence is valid, we should use one of the second generation unit root tests such as Pesaran (2007) CADF unit root test. According the simple dynamic linear heterogeneous panel data model (Pesaran, 2007: 268),

$$Y_{it} = \left(1-\varphi_i\right)\omega_i + \varphi_i Y_{i,t-1} + \psi_{it}. \tag{3}$$

where $i = 1,\ldots,N; t = 1,\ldots,T$. ψ_{it} . denotes the error term and Y_{it} .indicates initial value.

$$\psi_{it} = \vartheta_i \xi_t + \tau_{it} . \tag{4}$$

in which ξ_t .denotes the unobserved common effect. τ_{it} .is also the individual-specific error. Equation 6 can be obtained by using Equation 3 and 4.

$$\Delta Y_{it} = \gamma_i + \beta_i Y_{i,t-1} + \vartheta_i \xi_t + \tau_{it} . \tag{5}$$

in which $\gamma_i = (1-\varphi_i)\omega_i$ .and $\beta_i = -(1-\varphi_i)$. $\Delta Y_{it} = Y_{it} - Y_{i,t-1}$. The unit root test hypothesis of interest, $\varphi_i = 1$. can be predicated as

$$H_0 : \beta_i = 0 \text{ . for all } i . \tag{6}$$

$$H_1 : \beta_i < 0 . \tag{7}$$

In this study, to test the long-run relationship between variables, we employed Westerlund panel cointegration test. Four panel cointegration tests that are based on structural rather than residual dynamics are developed by Westerlund (2007). Hence, they do not impose any common-factor restriction (Persyn & Westerlund, 2008: 232). On the basis of these tests, the existence of cointegration is tested by deciding whether each unit has its own error correction. In the study, the long-term relationship is explored within the framework of the model below.

$$LCO2 = f(FDI) . \tag{8}$$

EMPIRICAL FINDINGS

As mentioned in the previous section, firstly, to test whether there is the cross-section dependence, we employed the cross-section dependence tests for all model and each variable. Table 1 displays the results of the cross-section dependence.

According to the obtained results from Table 3, the cross-section dependence is valid for the all model. Hence, we applied Pesaran (2007) CADF unit root test from the second generation unit root tests. Table 4 demonstrates the result of Pesaran (2007) CADF unit root test.

As is seen in Table 4, all variables are not stationary in the models with both constant and constant and trend. When taken the first difference of all variables, they are stationary. Hence, to explore the long-run connection between variables, we applied Westerlund (2007) panel cointegration test. The obtained results are shown in Table 5.

Table 3. The results of the cross-section dependence test

Models	LM_{adj}
$LCO2 = f(FDI)$	51.26*** (0.000)
Variables	**CD test**
LCO2	11.048*** (0.000)
FDI	8.51*** (0.000)
Notes: *, ** and * show the significance level at 1%, 5% and 10%, respectively. LMadj (Peseran et al., 2008) is test of cross-section dependence.**	

Table 4. The results of Pesaran (2007) CADF unit root test

Variables	Constant		Constant and Trend	
	Statistic	p-value	Statistic	p-value
LCO2	1.700	0.897	-1.818	0.971
Δ ***LCO2***	-2.605***	0.001	-2.926**	0.019
FDI	2.610	0.997	-2.384	0.298
Δ ***FDI***	-3.304***	0.000	-3.060***	0.006
Notes: Δ denotes the first-difference for variables. Akaike information criteria was used for the optimal lag. The maximum lag length was selected 3. *, ** and * show the significance level at 1%, 5% and 10%, respectively.**				

According to the obtained empirical findings in Table 4, that there is no the long-term connection between LCO2 and FDI for three cointegration tests (Ga, Pt, and Pa). Moreover, the presence of this relationship between these variables is only detected in Gt test at 10 percent significance level. When these results are considered as a whole, it can be said that there is no the long-term connection between

Table 5. The results of Westerlund (2007) panel cointegration test

$LCO2 = f(FDI)$		
	Statistic	**Robust-value**
Gt	**-4.788**	**0.059***
Ga	**-7.922**	**0.632**
Pt	**-7.781**	**0.776**
Pa	**-5.071**	**0.753**
Notes: **Akaike information criteria were used for the optimal lag. The maximum lag length was selected 4. ***, **, and * show the significance level at 1%, 5%, and 10%, respectively.**		

these variables. These findings are in harmony with Kearsley and Riddel (2010), Rasit and Aralas (2017), and Destek and Okumus (2019). Accordingly, we can say that NH is valid for developing countries.

SOLUTIONS AND RECOMMENDATIONS

Industrialization and higher living standard have been some of the most leading objectives in developing countries. However, various deficiencies such as low domestic savings, lower research, and development activities, more inadequate management skills, insufficient technological capacities experienced in these countries can prevent achieving these objectives. These bottlenecks have been overcome by the policies aiming to attract FDI. On the other hand, various studies confirm that the developed countries use the developing countries to prevent strict environmental regulations in developed countries. Additionally, non-renewable energy sources are also the most used energy factors. The PHH and the detrimental impacts of the non-renewable energy sources on the environment will create an obstacle to sustain and increase economic activities because countries' environment and natural resources are important production factors. The developing countries should implement policies to create incentives for FDI based on allowing technology transfer, environmentally friendly and high-tech which increase the technological capacities and do not pollute the environment. Besides, the developing countries based on energy importing should diversify energy sources through renewable energy sources along with established more specific FDI policies to decrease environmental degradation.

FUTURE RESEARCH DIRECTIONS

Environment degradation has been one of the leading problems around the world, and there are various indicators used for detecting the level of environmental degradations. It is recommended for further research to consider other environmental degradation indicators as well as CO2 emission to achieve more robust information concerning the existence of the pollution haven hypothesis. Furthermore, investigation of this topic for individual level for each country will contribute to the literature.

CONCLUSION

Investments have always had an important place in the economy in order to achieve important goals such as the development of countries and ensuring social and social welfare. These investments can be made by the public and private sectors within the country, as well as by investors abroad. The investments made from abroad can be made directly or indirectly. In general, it is thought that FDI further contributes to the economy of the country as it affects directly the level of production and employment of the country. As far as the effects of these investments on the economy are important, their effects on the environment undoubtedly have an important place.

In the recent years, many researchers have investigated the impact of FDI on the environmental pollution for different country groups. In the results of these studies, three different hypotheses have appeared. The first is PHH which bases on that the penetration of FDI on EP is positive. The second is PHHH which grounds on that the influence of FDI on environment pollution is negative. The last is NH which bases on the non-existence of the penetration of FDI on EP. In our study, these hypotheses were tested for 23 developing countries after Global Crisis. For this aim, we used annual dataset covering the period 2009-2019. According to the empirical result of Westerlund (2007) panel cointegration test, there is no the long term connection between FDI and CO2 for 23 developing countries after Global Crisis. It means that NH is valid for 23developing countries. In addition, the result is line with with Kearsley and Riddel (2010), Rasit and Aralas (2017), and Destek and Okumus (2019).

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KEY TERMS AND DEFINITIONS

NH: Pollution haven hypothesis.
PHH: Pollution haven hypothesis.
PHHH: Pollution halo hypothesis.

ENDNOTE

[1] Algeria, Argentina, Brazil, Chile, Colombia, Ecuador, Egypt, India, Indonesia, Kuwait, Malaysia, Mexico, Morocco, Oman, Pakistan, Peru, Philippines, Saudi Arabia, South Africa, Sri Lanka, Thailand, Trinidad & Tobago, and Turkey.

Chapter 20
Relationship Between the Use of Renewable Energy, Carbon Dioxide Emission, and Economic Growth:
An Empirical Application on Turkey

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ABSTRACT

The study aims to examine the relationship between the use of renewable energy, CO2, and GDP per capita. In this study that has been carried out on Turkey for the period 1990-2018, time series analysis is used. The long-term relationship between variables is revealed by the cointegration test. The periodic changes of the variables are examined by the variance decomposition and impulse-response function. Finally, with the causality test, the relationship between variables and the direction of this relationship are revealed. Findings show that there is a cointegrated relationship between the variables. According to variance decomposition in the period of 10 lags, the renewable energy variance is 96% due to itself, 2.74% to CO2, and 0.50% to shocks in per capita GDP. As for impact-response functions, while the response of renewable energy to the GDP per capita variable is negative in the first two periods, it increase slightly in the following period, and after the sixth period, the effect of the shock diminished.

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INTRODUCTION

The term "renewable energy" is energy from a wide range of sources, all based on self-regenerating energy sources such as wind, sunlight, running water, earth's internal heat, and biomass such as agricultural, energy crops and industrial waste and municipal waste (Bull, 2001; Demirbaş, 2006). Renewable energy (RE) sources can be utilized in many areas such as electricity, transportation and heating for various economic sectors all over the world.

Economic and social problems related to energy security and global warming increase awareness on the need for RE consumption day by day (Sadorsky, 2009b). Many countries face a serious challenge of growing their economies without disrupting the environment, and it is important to consider environmental quality as a key factor in development strategies to achieve this goal (Hoang Phong et al., 2018). Studies reveal that non-RE consumption increases carbon dioxide emissions (CO2-E), while RE consumption reduces CO2-E. In this context, good renewable energy is also a good substitute (Shafiei & Salim, 2014; Zoundi, 2017). Strategically, governments should provide necessary incentives for using RE for CO2-E, as well as increasing public awareness on climate change and CO2 (Xu et al., 2019).

There are many opinions on the relationship between RE, economic growth (EG) and CO2. The general view is that RE positively affects EG (Bakırtaş & Çetin, 2016; Çınar & Yılmazer, 2015; Emir & Bekun, 2019; Koçak & Şarkgüneşi, 2017; Ntanos et al., 2018; Rahman & Velayutham, 2020). It is also stated that there is a positive relationship between RE consumption and economic development (Özşahin et al., 2016). The use of RE has proved to be effective in reducing CO2-E (Apergis et al., 2010; Menyah & Wolde-Rufael, 2010; Qi et al., 2014). However, whether it is at the desired level is still a matter of debate (Menyah & Wolde-Rufael, 2010). In some studies, it is stated that there is no long or short term causality between CO2-E and RE consumption (Lin & Moubarak, 2014). It is also claimed that CO2 emission increases per capita RE consumption (Sadorsky, 2009a). RE is important for EG and likewise encourages greater use of RE resources in EG (Apergis & Payne, 2014). At the same time, the increase in per capita GDP grows the consumption of RE. In this context, it is stated that as per capita income raises, more RE is needed (Sadorsky, 2009a).

Globally, energy consumption increased by 2.3% in 2018, almost twice the average growth rate since 2010, due to a strong global economy as well as higher cooling and heating requirements in some region of the world. As a result of high energy consumption the world, CO2-E increased by 1.7% to 33.1 Gt CO2. Coal-fired electricity output continues to be the single biggest emitter, accounting for 30% of all energy-related CO2. As a result of high energy consumption, CO2-E increased by 1.7% last year and reached a new record (*Global Energy & CO2 Status Report, 2019*). When it comes to Turkey, a reduction in CO2 of 0.5% compared to 2017 was observed. However, when the period of 1990-2018 is examined in general, an increase of 176.7% was seen in CO2-E. In 2018, the biggest share in CO2-E was energy-related emissions with 71.6%, followed by industrial processes and product use with 12.5%, agricultural activities with 12.5% and waste with 3.4% (TUIK, 2020). Greenhouse gas per capita is approximately 6 million tons in Turkey. So significant investments in RE over the last 10 years took place in Turkey while it was understood that the case was of vital importance for Turkey in RE sources. According to TUIK data, that the proportion of RE from waste and electricity production in 2019 rose 43.9 percent from 26.4 percent in 2010 is an important outcome for Turkey.

This study is intended to examine the relationship between RE, EG and CO2-E in Turkey. For this purpose, firstly the literature was examined, then econometric methods were determined and applied, and finally, the findings were discussed. Energy, CO2-E and growth adventure were analyzed using data between the years 1990-2018. Cointegration analysis was done under the time series econometrically. Finally, the causality test revealed the relationship between variables and the direction of this relationship. Findings show that a cointegrated relationship was found between the variables.

LITERATURE REVIEW

Table 1 contains different studies/contexts related to RE; relationship between RE and its effects, CO2-E and RE, effects of RE on EG, pollutant emission and nuclear energy, CO2-E of RE, industrial value-added, service value-added, RE fossil fuel prices emissions, sustainable development and EKC.

Table 1. Selected studies for renewable energy

Author	Subject	Scope and Period	Methodology	Result
Ben Jebli, Farhani, & Guesmi (2020)	CO2-E, RE, Industrial and Service value added	102 Countries - 1995-2015	Granger Causality, And GMM	This study revealed that RE consumption reduces CO2-E in all countries, except for low-middle-income countries. The findings displayed that RE consumption negatively affected service and industry value added for high-income countries and low-middle-income countries (upper-middle-income countries, respectively).
Chen, Wang, and Zhong (2019)	CO2-E, RE consumption And Foreign Trade	China - 1980-2014	ARDL, VECM And Granger Causality	This article explores the relationship between CO2-E per capita, GDP, renewable, non-RE generation, and foreign trade for China. One finding is that there is a long-term relationship between these variables. Long-term projections show that increasing non-RE and GDP raises CO2-E, while RE and foreign trade have a negative impact on CO2-E.
Hasnisah et al. (2019)	CO2, RE, EKC	13 Asian developing countries - 1980-2014	Panel cointegration, FMOLS and DOLS	This study confirms the existence of the inverted U-shaped EKC hypothesis for estimators that reduce environmental quality with per capita GDP growth and conventional energy consumption. However, empirical evidence suggests that consumption of RE is insignificant in contributing to less pollution related to CO2-E.
Haug and Ucal (2019)	CO2-E, Foreign trade, FDI	Turkey - 1975-2011	Nonlinear ARDL	In this study, foreign trade and FDI is examining the impact on CO2-E in Turkey. As a result, it found significant asymmetric effects of exports, imports and FDI on CO2-E per capita.
Rehman et al. (2019)	RE, Fossil fuel energy, CO2-E, GDP per capita, Electric power consumption	Pakistan - 1990-2017	Johansen cointegration, Granger causality	In this study, overall, the long-run impacts of variables were found to have a stronger effect on GDP per capita than short-run dynamics and this status indicated that the findings were heterogeneous.
Dong et al. (2018)	CO2-E, Nuclear energy, RE consumption, and EKC	China - 1993-2016	ARDL, VECM Granger causality, FMOLS, DOLS	In this research, empirical results validate the existence of EKC for CO2-E in China. In 2028 years, CO2-E were expected to peak. Empirical results also exhibit that, both in the short and long term, nuclear power and RE play an important role in reducing CO2-E, but also a fossil fuel consumption is indeed the dominant culprit in promoting CO2-E.
Pata (2018)	RE consumption, Financial development and Urbanization	Turkey - 1974-2014	ARDL, FMOLS and Canonical cointegration regression	The study supports the EKC hypothesis that establishes an inverted U-shaped relationship between EG and CO2-E. Overall results indicate that environmental pollution to reach Turkey's GDP per capita could reduce the level and showed that there was a solution to reduce CO2-E from consumption of RE.
Ben Mbarek, Saidi, & Amamri (2017)	Pollutant emissions; RE; nuclear energy	18 Developed and Developing Countries - 1980-2013	VECM, Granger causality	This study results show that there is co-integration between variables. The article also examines the linkage using Granger analysis of the VECM, which shows a one-way relationship from GDP per capita to pollutant emissions both developed and developing countries. However, there is a one-way causality from GDP per capita to RE in the short term and long term.
Beşer & Beşer (2017)	RE, Sustainable development and EKC	Turkey - 1960- 2015	ARDL	In this study, the relationship between CO2-E and energy consumption was researched within the framework of EKC (developed by Kuznets). This hypothesis (EKC), for CO2-E in Turkey, was found to be valid. The second conclusion is that GDP suppresses both energy consumption and CO2-E. GDP also supports the protection or feedback hypothesis for the economy.
Ito (2017)	CO2-E RE consumption EG	42 developing countries - 2002-2011	GMM, PMG	In this study, CO2-E, renewable and non-RE consumption and EG are examined. The results show that non-RE consumption has a negative impact on EG for developing countries. Besides, this paper stated that RE consumption contributed positively to EG in the long run.
Mehdi & Slim (2017)	RE, Agriculture, CO2-E	5 North Africa countries - 1980-2011	Panel cointegration, Granger causality	In the short term, Granger tests show the existence of bi-directional causality between CO2-E and agriculture; It is also a one-way causality from agriculture to GDP, from GDP to RE consumption and from RE consumption to agriculture. Long-term parameter estimates reveal that an increase in GDP or RE consumption increases CO2-E, while an increase in agricultural value-added reduces CO2-E.

continued on following page

Table 1. Continued

Author	Subject	Scope and Period	Methodology	Result
York & McGee (2017)	RE, CO2-E	128 Country - 1960-2012	Panel Regression Models	In this study, how renewable electricity generation interacts with CO2-E per capita and GDP per capita has been assessed. They find an interaction effect between the amount of RE and GDP per capita. As a result, more closely linked to emissions in countries that have the majority of their electricity from renewable sources, and the growth of renewable electricity has a smaller suppressing impact on emissions in more affluent countries.
Bilgili, Koçak, & Bulut (2016)	EKC, CO2-E RE consumption	OECD countries - 1997-2010	DOLS	This article discusses a revised EKC hypothesis with the potential impact of RE consumption on environmental quality. As a result, the article highlights that countries can contribute to tackling the global warming problem as they come up with policies for fair and easy access to electricity from renewable sources, and implement policies to increase RE supply through the improvement of RE technologies and increase their GDP.
Cerdeira Bento & Moutinho (2016)	EKC, RE and International trade	Italy - 1960-2011	ARDL	In this study, the EKC hypothesis was analytically validated because the predictive pollutant model shows that EG causes less pollution over time. Renewable electricity generation reduces CO2-E per capita in both the short and long term, while international trade only positively affects per capita CO2-E in the long run. The findings show that renewable electricity generation is a solution to reducing pollutant emissions by time.
Gökmenoğlu & Taspinar (2016)	EKC hypothesis of relationship in Turkey	Turkey - 1974-2010	ARDL, Toda Yamamoto (1995) causality test	This study shows that CO2-E converge to long-term equilibrium levels, with an adjustable-rate of 49.2% each year, contributed by energy consumption, EG and FDI. The findings, furthermore the scale effect, proves evidence for the validity of EKC in Pollution Haven Hypothesis and Turkey sample.
Magazzino (2016)	CO2-E, EG, Energy	South Caucasus area And Turkey	Panel VAR	The purpose of this article, the South Caucasus region in 1992-2013 years, and EG for Turkey is to examine the relationship between energy use and CO2-E. Results demonstrate that the response of CO2-E to energy use is negative and statistically significant.
Öztürk & Öz (2016)	Energy Consumption, EG, FDI, CO2-E	Turkey - 1974-2014	Maki Cointegration and Grange causality	The study revealed that there is a long-term relationship between variables. The results also indicate that Turkey supported the EKC hypothesis in both short and long term. Also, foreign direct investment, which means pollution halo hypothesis that positive environmental effects, dual causal relationship between FDI inflows CO2-E and is also available in the short and long term, for Turkey as FDI negative coefficients.
Saidi & Ben Mbarek (2016)	Nuclear energy consumption, CO2-E, RE consumption And EG	9 developed countries 1990-2012	DOLS and FMOLS	The results of the study conducted on 9 developed countries reveal that GDP has a positive effect on RE and has a positive effect on GDP in RE. In addition, this research stated that RE reduces CO2-E. This means that policies aimed at promoting RE consumption are effective in protecting the environment.
Begum et al. (2015)	CO2-E, Energy, consumption and EG	Malaysia - 1970-2009	ARDL And DOLS	This study examines the profound effects of GDP growth, energy consumption and population growth on CO2-E by using econometric approaches for Malaysia. CO2-E per capita diminished by raising GDP per capita (EG) between the years 1970 and 1980; however, from 1980 to 2009, per capita, CO2-E grew distictly with further increase in GDP per capita. EKC is not valid.
Bölük & Mert (2015)	RE, Sustainable development, EKC	Turkey - 1961–2010	ARDL	This study research the potential of RE sources in Turkey in reducing the impact of greenhouse gas emissions. The results show that renewable electricity generation will contribute to the improvement of the environment with a delay of one year. Besides, the finding also shows that there is a U-shaped (EKC) relationship between greenhouse gas per capita and income.
Apergis & Payne (2014)	RE Fossil fuel prices Emissions	Seven Central American countries 1980-2010	Panel FMOLS, Regime-wise Granger-causality Tests	In this study, the authors found that there is a statistically significant positive coefficient long-term co-integrated relationship between RE consumption per capita, real GDP per capita, CO2-E per capita, real coal prices and real oil prices.
Bozkurt & Akan (2014)	CO2-E, Energy Consumption, And EG	Turkey - 1960-2010	Cointegration Test	In this study, EG in Turkey, CO2-E and energy consumption relationship are examined by using the cointegration test. Empirical results obtained from this article display that CO2-E negatively affect EG and energy consumption positively.
Erataş & Uysal (2014)	Environmental Pollution and EKC	Brazil, Russia, India, China and Turkey- 1992-2010	Panel Cointegration Test and Breitung Two-stage OLS	According to the findings, the EKC approach is valid in the countries subject to the analysis.
Silva, Soares, & Pinho (2012)	RE Sources, EG, and CO2-E	USA, Denmark, Spain, Portugal. - 1960-2004	Structural Vector Autoregressive (SVAR)	This study examines the profound effects of GDP growth, energy consumption and population growth on CO2-E by using econometric approaches for Malaysia. CO2-E per capita diminished by raising GDP per capita (EG) between the years 1970 and 1980; however, from 1980 to 2009, per capita, CO2 emissions grew distictly with further increase in GDP per capita. EKC is not valid.
Ozturk & Acaravci (2010)	CO2 emission, Energy consumption, and EG	Turkey - 1968–2005	ARDL, Granger causality	The EKC hypothesis of a causal theoretical using a logarithmic linear model does not apply in the case of Turkey. Overall results of the rationalization of energy consumption and CO2-E are not controlled, such as energy-saving policies, which shows that Turkey cannot have a negative impact on real output growth.

As seen in Table 1, the first theme in the literature review for RE literature is whether RE has an impact on CO2 emission and growth in the long run. EKC has been generally accepted in studies on developing countries. It is emphasized here that the CO2 emission of developing countries will increase with growth and that the increase in income per capita will decrease when it reaches a certain level. Other important highlights are the impact of FDI on RE and CO2-E. Besides, the role of international trade in this effect has been tried to be measured.

METHODOLOGY AND DATA SET

The relationship between RE, GDP per capita and CO2-E are examined in this study in which analysis was carried out on Turkey. Time-series analysis covering the period 1990-2018 was used to examine the relationship between variables. In the application part, firstly the descriptive statistics of the variables were given and then, unit root tests were made to determine stationaries. Besides, the long-term relationship between variables has been tried to be revealed by the cointegration test. Also, with the FMOLS-DOLS tests, the coefficients of the variables were interpreted, and the periodic changes of the variables were examined by the IRF and variance decomposition. Finally, through the causality test, the relationship between variables and the direction of this relationship was revealed. The equation (1) that was created for the analysis is as follows:

$$\Delta Renewable\ Energy_t = \beta_0 + \sum_{i=1}^{p}\beta_{1i}\Delta LNPCNI_{t-i} + \sum_{i=1}^{q}\beta_{1i}\Delta CO2_{t-i} + \sum_{i=1}^{r}\beta_{1i}\Delta Renewable\ Energy_{t-i} + \psi_1 + \mu_{1t} \quad (1).$$

Table 2. Definition and sources of variables

Variables	Explanation	Source of Data
Renewable	Renewable energy use (% of total energy demand)	World Bank, International Energy Agency
LNPCNI	Real GDP per capita, $	World Bank
CO_2	Carbon Dioxide Emission, Million Tons	BP-Stats-Review

Table 3. Descriptive statistics of variables included in the model

Variables	Mean	Std. Dev.	Coefficient of Variation	Kurtosis	Skewness	Jarque-Bera	Observation
Renewable	17.089	4.602	0.269	1.660	0.383	2.880	29
LNPCNI	8.675	0.596	0.068	1.350	-0.101	3.337	29
CO_2	240.008	78.790	0.328	1.991	0.433	2.135	29

Note: If the Skewness value is <0; skewed to the left, if the Skewness value> 0; skewed to the right. If kurtosis value <3; flattened, if the kurtosis value> 3; is upright.

RE and CO2-E variables in the analysis were used at the level value, while the real GDP per capita variable was used by taking its logarithm. The reason for taking logarithms is that when the logarithm of the series that shows an exponential growth at the level is taken, the growth becomes linear. By taking the logarithm of the variable, the variance is stabilized, and the effects of outlier observations are reduced (Türe & Akdi, 2005).

The standard deviation value is used to express the volatility value. While this value has been determined for the most CO2 emission, the lowest value was determined for GDP per capita. The coefficient of variation is obtained by dividing the standard deviation by the mean. The variable with the highest value for the obtained coefficients causes more effects in the series. This value is again the highest in CO2 emission. The Skewness value shows the asymmetric value of the variables. While the variable of RE and CO2 emission is skewed to the right, the variable of GDP per capita is skewed to the left. Kurtosis value reflects the tail distribution of the variables. This value is found to be kurtosis for all variables.

ADF and PP Tests

İf it works with times series data, it's must be stationary. Unit root tests are performed to determine the stationary of the variables. When the series is expressed as Y_t, the regression equation for the unit root is represented as (2):

$$Y_t = pY_{t-1} + \mu_t \tag{2}$$

If the parameter p in the equation is equal to 1, it is understood that the series is not stationary. In this case the created equation is expressed as (3):

$$\Delta Y_t = \left(p-1\right) Y_{t-1} + \mu t \tag{3}$$

$$= \delta Y_{t-1} + \mu t \, .$$

In this situation, the search parameter becomes δ the parameter. The equality of this parameter value to zero is tested. In this context, the model is constructed as follows equations (4) – (6):

$$\Delta Y_t = \delta Y_{t-1} + \mu t \tag{4}$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \mu t \, . \tag{5}$$

$$\Delta Y_t = \beta_1 + \beta_{1t} + \delta Y_{t-1} + \mu t \tag{6}$$

The first of the above equations that equation (1), expresses only the delayed value. Equation (2) represents the autonomous parameter. In equation (3), it shows that both the autonomous parameter and deterministic trend are included in the model. The variables absence of stationary leads to some problems in series. In order to avoid problems in series, it is stabilized by unit root tests. Actually, the variables are not stationary causes of some problems in the series. To avoid problems, the series is making a stationary with the help of unit root tests. The ADF test adds the lagged value of the dependent variable in the model to avoid the autocorrelation problem that may occur between variables. In such a case, the equation is formed as in equation (7) in its most general form (Güriş, 2008):

$$\Delta Y_t = \beta_1 + \beta_{1t} + \delta Y_{t-1} + \alpha \sum_{i=1}^{m} \Delta Y_{t-i} + e_i \tag{7}$$

Dickey-Fuller test argues that error terms are without autocorrelated. However, many time series contradict these assumptions and show both a more or less dependent and inhomogeneous structure. Accordingly, Phillips and Perron developed the PP test by taking these into consideration (Gujarati and Porter, 2012).

The distribution theory, which supports Dickey-Fuller tests in unit root tests, basically argued that errors are statistically independent. It also predicts that the errors have a continuous variance. At the same time, it predicts that the errors have a continuous variance. Phillips and Perron (1988) put forward a generalization allowing for fairly light assumptions about the distribution of errors of the Dickey-Fuller test in the unit root test they developed. They also stated that the expected value of the error term in the unit root test is equal to zero. As a result, a time series created by { y_t . is represented as the equation (8):

$$y_t = \alpha y_{t-1} + \mu t \tag{8}$$

(t = 1, 2, ...), α= 1.

The equation is initially constructed concerning t = 0. The y0 distribution is determined as fixed. The test is expressed equally as in the following equations (9) – (10) (Phillips and Perron, 1988):

$$y_t = \hat{\mu} + \hat{\alpha} y_{t-1} + \hat{u}_t . \tag{9}$$

$$y_t = \tilde{\mu} + \tilde{\beta}\left(t - \frac{1}{2}T\right) + \tilde{\alpha} y_{t-1} + \hat{u}_t . \tag{10}$$

According to the results in Table 4, the unit root test performed to determine the stationarity of the variables it was seen that all variables became stationary at the same level. It has been determined that all variables are not stationary at the I(O) level value; therefore, the first difference of variables is taken. It's seen that all variables have become stationary at the I(1) level.

Table 4. ADF and PP unit root results of variables

	I(0)				I(1)			
Variables	**Intercept**		**Intercept+Trend**		**Intercept**		**Intercept+Trend**	
	ADF Value	**Prob**	**ADF Value**	**Prob**	**ADF Value**	**Prob**	**ADF Value**	**Prob**
Renewable	-1.058	0.717	-2.247	0.446	-6.499	0.000***	-5.500	0.000***
LNPCNI	-1.034	0.726	-1.590	0.770	-5.536	0.000***	-5.509	0.000***
CO_2	0.993	0.995	-1.966	0.593	-5.992	0.000***	-6.456	0.000***
Phillips-Perron (PP)								
Variables	**Intercept**		**Intercept+Trend**		**Intercept**		**Intercept+Trend**	
	PP Value	**Prob**	**PP Value**	**Prob**	**PP Value**	**Prob**	**PP Value**	**Prob**
Renewable	-1.019	0.732	-2.198	0.471	-7.091	0.000***	-9.944	0.000***
LNPCNI	-1.016	0.733	-1.731	0.710	-5.535	0.000***	-5.509	0.000***
CO_2	2.503	0.999	-1.966	0.593	-6.063	0.000***	-11.064	0.000***

Note: The *** sign in the table indicates % 1 meaning level.

Gregory-Hansen Cointegration Test

The Gregory-Hansen Cointegration test was developed in 1996 by Allan W. Gregory and Bruce E. Hansen. The Gregory-Hansen Cointegration test was developed in 1996 by Allan W. Gregory and Bruce E. Hansen. In this test that allows a single structural break, three models were created: Level shift (C), change in both level and trend (Level shift and trend (C / T)) and regime shift (C / S). These models are respectively expressed as follows equations (11, 12, 13, 14):

$y_{1t} = \mu + x^{T}{}_{\cdot 2t} + e_t$, t=1, ..., n (Standart Cointegration) (11)

$y_{1t} = \mu_1 + \mu 2\,¢t_{\tau +}\ \alpha^{T}.2t_{+}$ et, t=1, ..., n (Level shift) (12)

$y1_t = \mu 1 + \mu 2¢_t\tau_{+\beta}t + x^{T}.2t_{+}$ et, $_t$=1, ..., n (Level shift and trend) (13)

$y1t_{=}\ \mu 1_{+}\ \mu 2¢t_{\tau + x1}T\ y2_t + {}_{\alpha 2}Ty2t^{¢}t_{\tau} + {}_{et,}$ t=1, ..., n (Regime shift) (14)

In the equations stated that $\mu 1$ is the constant before the break, $\mu 2$ is the constant at the time of the break, $\alpha 1$ is the slope coefficient before the break, and $\alpha 2$ is the slope coefficient after the regime change (Gregory and Hansen, 1996: 102-103). As a result, the cointegration test was used to determine the long-term relationship between variables that became stationary at the same level. Analysis results are shown in Table 5.

Table 5. Gregory-Hansen cointegration test

Models	t-stat	Break	%1	%5	%10
1 C					
Renewable- LNPCNI	-3.850	1996	-5.13	-4.61	-4.34
Renewable- CO_2	-3.409	2000	-5.13	-4.61	-4.34
2 C/T					
Renewable- LNPCNI	-4.998	2009	-5.13	-4.61**	-4.34*
Renewable- CO_2	-4.443	2010	-5.13	-4.61	-4.34*
3 C/S					
Renewable- LNPCNI	-4.576	1999	-5.13	-4.61	-4.34*
Renewable- CO_2	-4.320	2002	-5.13	-4.61	-4.34

Note: The *** sign in the table indicates% 1, **% 5, * sign% 10 meaning level.

With the Gregory-Hansen cointegration analysis, it was investigated whether there was a cointegration relationship for all three models. It has been determined that there is no long-term relationship between RE and GDP per capita for both independent variables for Model 1. Since the test statistic is smaller than the absolute value of the critical values, no relationship was found. For Model 2, it is seen that there is a relationship between RE and GDP per capita at both 5% and 10% level. It was determined that there is a long-term relationship between RE and CO2 emission at 10% significance level for Model 2. For Model 3, only a significant relationship of 10% was found between RE and GDP per capita.

FMOLS-DOLS Tests

FMOLS-DOLS tests are used to predict long-term relationships between variables. Here, the Fully Corrected Least Squares Method (FMOLS) proposed by Phillips and Hansen (1990), and then the Dynamic Least Squares Method (DOLS) proposed by Saikkonen (1991) and Stock and Watson (1993), the coefficients of the variables can be interpreted. FMOLS refers to non-parametric and DOLS refers to coefficients considering parametric endogeneity (Cergibozan, Çevik, & Demir 2017).

When the FMOLS results in Table 6 are examined, it is seen that the coefficient of the CO2 variable is negative, and the probability value is at the threshold value. The results are statistically and theoretically significant. The results are statistically significant variable for the GDP per capita and exhibit a negative influence for Turkey. For DOLS, the CO2 variable is statistically insignificant.

Table 6. FMOLS and DOLS test results

Variables	FMOLS			DOLS		
	Coefficient	t-Statistic	Prob	Coefficient	t-Statistic	Prob
LNPCNI	-4.896	-3.082	0.004***	-5.540	-2.130	0.048**
CO_2	-0.021	-1.798	0.084*	-0.015	-0.637	0.532

Note: The *** sign in the table indicates % 1, ** % 5, * sign % 10 meaning level.

Variance Decomposition

VAR analysis shows how the variables that are thought to affect each other act together. The variance decomposition method separates the changes in one of the variables and the variable itself into the analysis, and separates them into separate shocks affecting all variables. With the variance decomposition test, it is possible to interpret the effects of variables on each other as percentages (Lebe & Bayat, 2011). Variance decomposition separates the change in one of the internal variables as separate shocks affecting all internal variables. Also, it provides information about the dynamic structure of the system. The main purpose of variance decomposition is to reveal the effect of each random shock on the error variance of the forecast for future periods. The error variance of the prediction for the variance decomposition can be expressed as the contribution of each variable to the error variance for a period of length. Afterwards, each variance obtained in this way is proportioned to the total variance and has a relative weight as a percentage (Öz, 2004). The results of the variance decomposition of the variables that used in the model are shown in Table 7.

Table 7. Variance decomposition of variables used in the Var system (for RE)

Dependent Variable	Variance Period	Renewable	LNPCNI	CO_2
Renewable Energy	1	100.000	0.000	0.000
	2	95.281	0.201	4.516
	3	95.929	0.223	3.846
	4	96.323	0.198	3.477
	5	96.662	0.190	3.146
	6	96.957	0.198	2.843
	7	97.153	0.225	2.620
	8	97.203	0.280	2.515
	9	97.072	0.372	2.554
	10	96.744	0.508	2.746

According to the result of the variance decomposition up to ten periods, it is understood that the one-unit change in the dependent variable originates entirely from itself in the first period. In the process, other variables have an effect on the dependent variable. However, this effect occurs at a low level. In the period of ten lags, the RE variance is 96% due to itself, 2.74% to CO2-E and 0.50% to shocks in per capita GDP (Table 7).

Impulse-Response Functions (IRF)

IRF show the effect of a standard deviation shock in one of the random error terms on the present and future values of the internal variables. IRF in VAR analysis are used to determine the dynamic interaction and symmetrical relationships between variables examined. The most effective variable on a macroeconomic size is determined by the decomposition of variance. Whether this variable, which is found to be effective after variance decomposition, can be used as a policy tool is determined by IRF (Öz, 2004).

According to our model's IRF, while the response of RE to shocks with a standard error caused by itself is positive, this effect decreases in the following periods with a negative trend. While the response of RE to the GDP per capita variable was negative in the first two periods, it increased slightly in the following period, and after the sixth period, the effect of the shock diminished. Whereas the reaction of RE to shocks in CO2 emission was positive and significant in the first two periods, the effect of the shock was diminished in the following period.

Toda-Yamamoto Causality Test

Toda-Yamamoto (1995) causality test is a test that allows examining the causality relationship between series that are both stationary in level values and stationary in first difference values. In the application phase of the test, it is necessary to know the maximum integration degree (d_{max} . of the series calculated by the VAR method at the beginning. When it comes to the last part of the test, $p + d_{max}$ .is estimated by the Least Squares method on the original values of the series for the delay (Toda & Yamamoto 1995). The test is shown in equations (15) and (16):

$$Y_t = \bar{w} + \sum_{i=1}^{m} \alpha_{1i} X_{t-i} + \sum_{i=1}^{m} \beta_{1i} Y_{t-i} + \sum_{j=m+1}^{d_{\max}} \delta_{1i} X_{t-i} + \sum_{j=m+1}^{d_{\max}} \theta_{1i} Y_{t-i} + \varepsilon_{1t} . \tag{15}$$

$$X_t = \partial + \sum_{i=1}^{m} \alpha_{2i} X_{t-i} + \sum_{i=1}^{m} \beta_{2i} Y_{t-i} + \sum_{j=m+1}^{d_{max}} \delta_{2i} X_{t-i} + \sum_{j=m+1}^{d_{max}} \theta_{2i} Y_{t-i} + \varepsilon_{2t} . \tag{16}$$

"m" indicated in the equations is the appropriate lag length, d_{max} indicates the maximum degree of integration. The means of the error terms ε_{1t} .and ε_{2t} .re assumed to be zero and the covariance matrix to be constant. $H_0:\alpha_{1i}=0$ and $H_0:\alpha_{2i}=0$ basic hypotheses are used to test the causality between variables. The specified hypotheses are tested with the help of WALD test statistics, and the basic hypothesis is rejected when the obtained test statistic value is bigger than the critical value (Gazel 2017).

Table 8. Causality test consequences

Variables	MWald	df	Prob.
Renewable-LNPCNI	0.327	2	0.954
LNPCNI- Renewable	9.079	2	0.028**
Renewable-CO_2	2.420	2	0.298
CO_2-Renewable	1.499	2	0.472

Note: ** demonstrates that the variable is significant at the5%level.

As a result of the causality analysis, it has been determined that there is a relationship at the level of 5% from GDP per capita to RE. Besides, between the other variables, causality has not been found at the 5% significance level.

SOLUTIONS AND RECOMMENDATIONS

Results indicate that there is a negative relationship between GDP per capita in Turkey with the use of RE. Another important result is RE's response to a standard error shock. In this context, CO2-E and per capita GDP, albeit low, in the long run, are responsive to shocks.

FUTURE RESEARCH DIRECTIONS

This study examines the relationship between RE, CO2-E and GDP per capita. During the analysis process, cointegration and causality analyzes were taken into account. In this field, many aspects of the relationship have been tried to be revealed by using many methods and in this context, it has been tried to contribute to the literature. Turkey's investments in the field of energy should be increased, it is understood that the base of the increase in GDP should spread. In this context, it can be prevented again from society turning to fuels that cause greenhouse gases.

CONCLUSION

It has been revealed that there is a cointegrated relationship between RE and GDP per capita at both 5% and 10% level. It was determined that there is a long-term relationship between RE and CO2 emission at a 10% significance level. The structural breaks between EG, CO2-E and RE, the existence of a cointegration relationship explains that the structural changes experienced over time are important in the model "both in level and trend change model". According to FMOLS results on the use of RE and CO2-E GDP per capita in Turkey, it was found to have a negative effect. In addition, the DOLS estimate supports this in terms of GDP per capita. According to the result of the variance decomposition up to ten periods, the one-unit change in the dependent variable is entirely due to itself in the first period. In the future, other variables affect the dependent variable. However, this effect occurs at a low level. In the period of ten lags, the RE variance is 96% due to itself, 2.74% to CO2-E and 0.50% to shocks in GDP per capita. While the response of RE to the GDP per capita variable was negative in the first two periods, it increased slightly in the following period, and after the sixth period, the effect of the shock diminished. While the reaction of RE to shocks in CO2 emission was positive and significant in the first two periods, the effect of the shock diminished in the following period.

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