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ANKARA YILDIRIM BEYAZIT UNIVERSITY

THE INSTITUTE OF SOCIAL SCIENCES

EMPIRICAL ANALYSIS OF RENEWABLE ENERGY AND ECONOMIC GROWTH RELATIONSHIP: A STUDY OF TURKEY AND D-8 COUNTRIES

MASTER THESIS

SÜMEYRA AVCI

DEPARTMENT OF ECONOMİCS

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Doç. Dr. Seyfullah YILDIRIM

Manage of Institute

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science of Economics

Prof. Dr. Murat Aslan

Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science of Economics.

Assoc. Dr. Fatih Cemil Özbuğday

Co-Supervisor

Supervisor

Examining Committee Members

Dr. Zeynep Burcu UĞUR (ASBÜ)

Assoc. Dr. Fatih Cemil Özbuğday (YBU)

Dr. Koray GÖKSAL (YBU)

I hereby declare that all information in this thesis has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work; otherwise I accept all legal responsibility.

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ABSTRACT

EMPIRICAL ANALYSIS OF RENEWABLE ENERGY AND ECONOMIC GROWTH RELATIONSHIP: A STUDY OF TURKEY AND D-8 COUNTRIES

AVCI, SÜMEYRA

Department of Economics

Supervisor: Assoc. Dr. Fatih Cemil Özbuğday

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Today, the demand for energy is growing exponentially. In the global world, countries and various powers focus on various challenges for this strategic input. This struggle with energy acquisition plays a vital role in shaping world politics. Although fossil fuels are widely used to meet the increasing energy demand, they hurt limited environmental resources. The interest in renewable energy sources is increasing day by day. Even though these sources have certain costs, and these costs are continuously decreasing.

Turkey is also a member of D-8 countries that still meet the demand for energy with fossil fuels. In recent years, the focus on clean energy sources in the climate summits has reached a consensus in this group of countries.In this thesis, the relationship between renewable energy use and economic growth is examined for D-8 countries, including Turkey using data for the 1980- 2015 period. Two models were established for the analysis. According to the analysis results, In model 1, GDP and renewable energy are moving together in the long run, but there is no causal relationship between them.

In model 2, there is a long-term relationship between renewable energy and its determinant variables (CO_2, GDP, ENU, UPO, ENI, NRE). On the other hand, no causal relationship between GDP and renewable energy could be determined.

Keywords: Energy, Renewable Energy, Economic Growth, Turkish Economy, D-8 Countries

ÖZET

YENİLENEBİLİR ENERJİ VE EKONOMİK BÜYÜME İLİŞKİLERİNİN EMPİRİK ANALİZİ: TÜRKİYE VE D-8 ÜLKELERİ ÇALIŞMASI

AVCI, SÜMEYRA

Ekonomi Bölümü, Yüksek Lisans

Danışman: Doç. Dr. Fatih Cemil Özbuğday

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Günümüzde enerjiye olan talep katlanarak artmaktadır. Küresel dünyada ülkeler ve çeşitli güç odakları bu stratejik girdi için türlü mücadelelere girişmektedirler. Enerjiyi elde etmek üzerinde oluşan bu mücadele dünya politikasının şekillenmesinde önemli rol oynamaktadır. Artan enerji talebini karşılamak için büyük bir oranda fosil yakıtlardan faydalanılsa da hem maliyetleri çevreye verdiği zararlar ve sınırlı kaynaklar olması gibi nedenlerle dünyada yenilenebilir enerji kaynaklarına olan ilgi her geçen gün artmaktadır. Ancak bu kaynaklarında belli maliyetleri söz konusudur ve bu maliyetlerin her geçen gün azaldığı gözlemlenmektedir.

Türkiye’nin de içinde bulunduğu D-8 grubu ülkelerde yine fosil yakıtlarla enerji taleplerini karşılamaktadır. Ancak son yıllarda yapılan iklim zirveleriyle temiz enerji kaynaklarına yönelme bu grup ülkelerinde de dikkate değer olduğu noktasında görüş birliğine varılmıştır. 1980-2015 dönemini kapsayan bu çalışmamızda Türkiye ve D-8 grubu ülkelerde yenilenebilir enerji kaynakları kullanımı, belirleyicileri ve ekonomik gelişme arasındaki ilişki incelenmiştir. Analiz için 2 model kurulmuştur. Analiz sonucuna göre, model 1 de GSYİH ile yenilenebilir enerji uzun süre birlikte hareket edilir, aralarında herhengi bir nedensellik ilişkisi bulunmamıştır. Model 2'de yenilenebilir enerji ile onun belirleyici değişkenleri (CO_2, GSYİH, ENU, UPO, ENI, NRE) arasında uzun vadeli bir ilişki vardır. Öte yandan, GSYİH ile yenilenebilir enerji arasında nedensel bir ilişki tespit edilememiştir.

Anahtar Kelimeler: Enerji, D-8 Ülkeleri ,Ekonomik Büyüme, Yenilenebilir Enerji

To My Children

Halil, Ayşe Berra, Elif Selen

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TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

LIST OF ABBREVIATIONS AND SIMILARS

EU	European Union
BOTAŞ	Pipelines and Petroleum Transportation Inc.
BTEP	Thousand Petroleum Equivalent
DEKTMK	World Energy Council Turkish National Committee
DMİ	General Directorate of State Meteorology Affairs
ADF	Augmented Dickey-Fuller Test
DF	Dickey-Fuller Test
EJ	Exa Joule
MENR	Ministry of Energy and Natural Resources
GJ	GigaJoule
GNP	Gross National Product
GDP	Gross Domestic Product
GWh	Gigawatt hour
HEPP	Hydroelectric Power Plant
IEA	International Energy Agency
ISE	Istanbul Stock Exchange
KW	Kilowatt
KWh	Kilowatt-hour
MTEP	Million Ton Equivalent Oil
MW	Megawatt
MWh	Megawatt-hour
D-8	Countries of the D-8
TEP	Tons Equivalent Oil
TMMO	Chamber of Mechanical Engineers of Turkey
TURKSTAT	Turkish Statistical Institue
TWh	Terrawat-hour
GES	Solar power plant
WEF	World Economic Forum
GEPA	Solar Energy Potential Atlas

IRENA	International Renewable Energy Agency
TÜREB	Turkey Wind Energy Association
CIS	The Commonwealth of Independent States

CHAPTER I

INTRODUCTION

Humankind needed the energy to sustain life and meet various needs from past to present. It has made various inventions and discoveries to meet the energy need. Since the industrial revolution in the 18th century, industrialized countries have ruthless aggression to obtain the underground fossil energy of our planet. With advancing technology, the use of energy has increased even further, and the energy need has become a significant problem. For the solution of the problem, countries have developed various strategies.

On the other hand, carbon dioxide (CO_2) and other greenhouse gas emissions that arise from the use of fossil fuels such as oil, gas, and coal causes a rise in average surface temperature. This, inevitably, leads to a decrease in biodiversity and a change in the climate. For this reason, new disasters can occur on a global scale. Therefore, it is vital for countries to come up with strategies and policies that will meet the country's energy needs most efficiently while creating reliable, sustainable, clean, and cheap energy. By encouraging the use of local, clean, and non-exhausting renewable energy sources instead of environmentally-harmful and exhausting fossil fuels, governments can provide essential energy inputs to their citizens.

International studies aimed at preventing global warming suggest supporting and enhancing the use of renewable energy resources (hydroelectric, geothermal, solar, tide, wind, biomass, and biofuel), which are considered to be "clean." Similar policy suggestions can also be made for Turkey and other Islamic countries in the world. In line with these suggestions, at the 9th summit of the Developing Eight (D-8) Organization, member countries agreed on principles such as more efficient use of energy, acceleration in the renewable energy deployment, and the creation of D-8 energy database that will functin as a platform for sharing experience.

In this respect, the member countries will increase their joint research and development activities in the field of renewable energy and energy efficiency in line with the international commitments they have made.

In this thesis, an empirical analysis of the relationship between renewable energy and economic growth is provided for the D-8 countries and Turkey to examine the potential effect of renewable energy on economic growth. In this context, the first part explain the importance of energy and the scope of our work. The second part describes various energy sources. The foolowing part presents the D-8's renewable and non-renewable energy outlook and policies, and their impact on economic growth and development. Chapter four provides a summary of the literature review and empirical analyses are performed on the relationship between renewable energy and economic growth for the D-8 countries and Turkey using time series analysis and causality tests. Lastly, in the final chapter is presented the conclusions of study.

CHAPTER II

ENERGY RESOURCES AND ENERGY USE IN THE WORLD

This chapter examines energy as a concept and variety and reviews the energy resources and their uses in the world.

2.1 Energy Concept

Energy is a Greek word, and it consists of the words “en” (inner) and “ergon” (work). The dictionary describes it as the power that exists in the matter, and that arises in the form of heat and light. Energy was a basic input for almost all goods and services sectors.It ıs an indispensable resource that increases the standard of living and accelerates development with the most basic benefits of lighting and heating; but at the same time, if interrupted it can be threatened by life and development that will result in a safe risk and it is an environmental risk that excessive use could endanger the lives of future generations. (Erdal, 2011). Energy can be in many different forms, such as hydraulic energy, fossil energy, heat energy. The word has gained a social character later on, and it was used synonymously with the ability to produce work, dynamism, force, power, and activity. The industrial revolution led energy to be the most important input of production, and this energy need has increased exponentially. In this context, it is very important to have cheap, quality, reliable, and sufficient resources economically (Erdal and Karakaya, 2012).

Some of the forms of energy are listed below :

Mechanical Energy: It is motion energy that can make useful work. Motion energy (kinetic energy) emerges as mechanical energy when a transformation is made in the form of water turbine bombardment in power plants (Altınay and Karagöl, 2005). With the mechanical energy obtained, any work can be done, and electric energy can be produced.

Thermal Energy: The combustion of fuels such as coal, petroleum, lignite, natural gas generates heat energy.
The heat energy obtained can be first converted to electrical energy by the help of mechanical energy using turbines and then by generators.
Chemical Energy: Chemical energy emerges as a result of a chemical reaction. The batteries used in daily life and the chemicals convert the chemical energy into electrical energy (Apergis and Payne, 2010). The storage of electric energy in batteries is done by chemical methods.

Nuclear Energy: Partitioning of heavy atoms such as uranium, plutonium, or the combination of light nuclei such as helium, hydrogen, and lithium generates nuclear energy. Today, many countries make use of nuclear energy to obtain electricity.

Gravity Energy: For example, when a flowing river dam falls by gravity, it slams into the turbine blades, causing the turbine to turn and provides electrical energy.

Electric Energy*:* It is electric power generated by the movement of electrons in the atomic structure of objects. Electricity is a property of matter. It is invisible but felt by the effect.

When energy is used, some form of energy turns into another form. For example, the gravity energy of water falling in dams is converted into mechanical energy when the turbine is turned (Ayres and Nair, 1984). This mechanical energy is converted into electrical energy in the generator at the end of the rotating turbine.

2.2. Energy Resources

We can describe sources of energy as the materials or structures necessary for the emergence of energy that humans use actively for various activities. The development of energy resources is a basic input to facilitate human life.
In general, energy sources are economically produced with different technologies.

There are some criteria when classifying energy sources. For example, the classification of renewable and non-renewable energy sources, which is the most common classification, takes the process and characteristics of energy resources into consideration (Table 1). Today, especially the use rates of fossil fuels that we consider to be renewable are very high. However, their reserves in the world are limited, and there is a danger of extinction in some time. For this reason, more attention is paid to renewable resources today in terms of sustainability of economies.

Table 1: Classification of Energy Resources

Energy Sources

According to their use	**According to their convertibility**
A)Non- Renewable	**A) Primary**
a) Fossil source - Coal - Oil - Naturel gas b) Core welded -Uranium -Thorium	Coal Oil Natural gas Nuclear Biomass Hydraulic Sun Wind Waves, tides
B) Renewable	**B) Secondary**
Biomass Hydraulic Sun Wind waves, tides Geothermal Hydrogen	Electricity, Gasoline, diesel, Secondary coal, Coke, petroleum coke, Air gas Liquefied petroleum gas

Source: Koç and Şenel, 2013

Energy sources can also be classified as primary or secondary energy sources according to the formation of the resource (Adıyaman,2012). Primary energy sources are available in nature. Therefore, these resources are also called natural energy sources. Some examples are solar, wind (also renewable sources), fossil fuels, and nuclear fuels (also non-renewable sources). The primary energy is converted to secondary energy sources with the help of power plants.

2.2.1 Non-renewable Energy Resources

The hydrogen and carbon molecules contained in living things are decomposed under heat pressure and form hydrocarbons. These resources are known as fossil fuels. However, these resources have been utilized for centuries, and they are prone to depletion. Today, resources such as oil, coal, natural gas, and boron are used as non-renewable energy sources. The most important reason for choosing these energy sources is that they can be obtained more easily than renewable energy sources, and they give higher energy in comparison to other sources. Fossil fuels, such as coal oil and natural gas, have been used to meet the need for intense energy along with industrialization in the 20th and 21st century. These became critical inputs for economic growth for the countries. The fossil energy sources are broadly used in the industrial field. They are also heavily used in households, commercial sectors, heat generation, transportation sector, and electric energy production .

As shown in Figure 1, approximately 80% of the world's energy needs are met by fossil energy sources, such as oil, natural gas, and coal. As of 2012, 31 percent of energy demand is supplied from oil, and 29 percent of energy demand is met from coal.

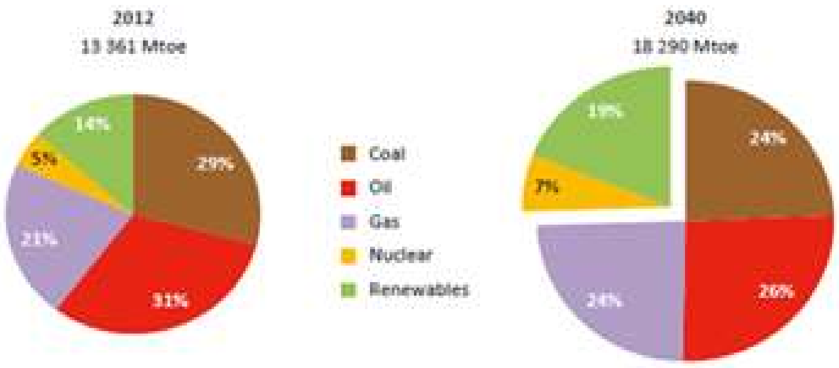


Figure 1: Fuel Shares in World Primary Energy Demand in the New Policies Scenario
Source: World Energy Outlook 2014

As of 2040, 26 percent and 24 percent of energy demand are expected to be met by oil and coal, respectively. According to these figures, the use of fossil fuels is at the peak (Figure1), but future projections show that coal and oil consumption is expected to decline by 2040. As of the end of 2016, primary energy consumption was the leading oil with 33 percent in terms of resources. (TMMOB, Champer of Mechanical Engineers, Engineer and Machinery, 2018). Throughout the world, petroleum is expected to maintain its strategic position for many years. The decline in coal continues for many years and will leave its place to natural gas after 2025.

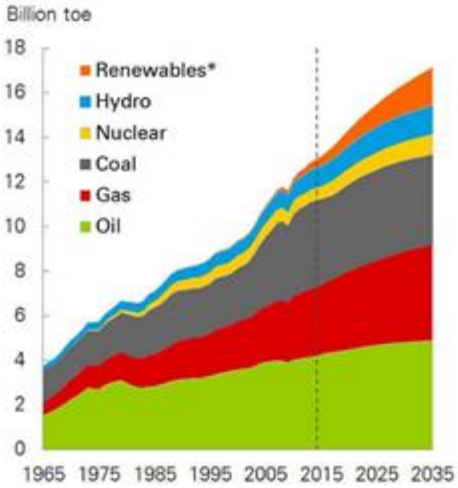


Figure 2: Primary Energy Consumption by Fuel

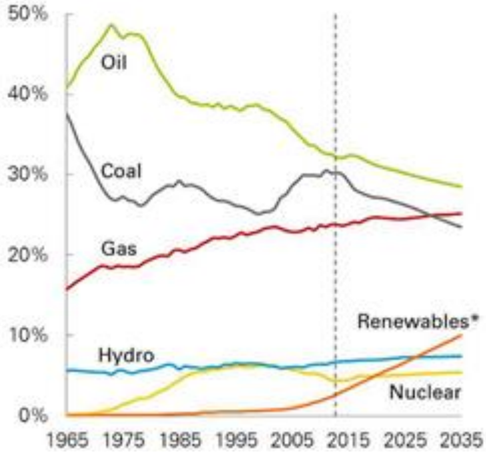


Figure 3: Shares of Primary Energy

Source: BP Energy Outlook, 2017

In addition, the relative mixture of coal, oil, and natural gas in total consumption may vary by country. In China, for example, coal constitutes more than 70% of fossil fuel consumption.

The share of fossil fuels in electricity generation is high all around the world. As Table 2 shows, many industrial countries in the world prefer fossil fuels for electricity generation. For instance, China provides about 72% of the total electricity generation from coal (Table2).

Table 2: Shares of Sources in Electricity Generation for Some Countries

Country	**Coal(%)**	**Oil(%)**	**Natural gas(%)**	**Nuclear (%)**	**Renewable energy(%)**	**Other(%)**
France	2.1	0.3	2.3	77.6	17.5	0.2
Germany	45.4	0.9	9.9	15.5	28.0	0.3
ABD	39.5	0.9	26.8	19.1	13.6	0.1
Canada	9.9	1.2	9.3	16.4	62.8	0.3
China	72.5	0.2	2.0	2.3	23.0	0.0
India	75.1	1.8	4.9	2.8	15.5	0.0
Russia	14.9	1.0	50.1	17.0	17.0	0.0
World	40.6	4.3	21.6	10.6	22.9	0.1

Source: World Energy Outlook 2016, EIA

Despite their prominence, fossil fuels give destructive damage to the environment and the atmosphere.As seen in Table 3, fossil energy sources give serious damage to living things. For example, the monetary value of the damage of oil to humans is 2.83 dollars per GJ, while the corresponding number for coal is 3.48. The monetary value of the damage of oil on air pollution is 0.79 dollars per GJ. On the other hand, natural gas is the fossil fuel with the least harmful effects in all categories. Because of these visible harmful effects, the use of renewable energy resources is essential.

Table 3: Environmental Damages of Fossil Fuels (Dollars / GJ)

Type of damage	Coal	Oil	Natural Gas
Influence on people	3.48	2.83	2.09
Influence on animals	0.51	0.42	0,30s
Effect on plants and forests	1.35	1.09	0.81
Life in the sea	0.18	1.05	0.11
Built structures	1.12	0.90	0.67
Air pollution	0.98	0.79	0.59
Climatic changes	1.49	1.13	0.84
Effects on mining	0.49	-	-
Sea level effects	0.32	1.13	0.19

Source: Barbir and Veziroglu, 1991

2.2.1.1 Oil

The main components of oil and natural gas are hydrogen and carbon, which are also called hydrocarbons. However, oil also contains a small amount of nitrogen, oxygen, and sulfur. All natural hydrocarbons are derived from the decomposition of the organics. Oil has become more effective and strategic in terms of economic development than any other energy source. Petroleum is not only an energy source, but it is also a raw material from which the main inputs of industries such as paint, plastic, cosmetics, iron and steel, pharmaceuticals, and aluminum are produced. This situation causes the value of oil to increase and its areas of influence to expand.

The oil extraction process was first carried out by primitive methods for producing asphalt. The first oil well was opened in France in 1745, and in 1847 the first petroleum products were processed in Scotland. In 1848 the first modern oil well was drilled in Asia by the Russian engineer FN Semyenov on the Aspheron Peninsula in northeastern Baku. The first well for oil production was established in Pennsylvania (San Joaquin Valley Geology, history of oil industry,Geology and history articles).

The main objective of the oil exploration activities is to determine the oil traps. Well-drilling is the process of opening the well for the possible trapping of oil. Costs are higher in seas than in drilling works done in lands. Oil reserves and oil resources have different meanings. While the on-site reserve is the amount of oil and gas that is known in certain reservoirs, it is not possible to produce the vast majority of it. The part that can be produced on-site is the producible reserve (Hatemoğlu, 2008).

In 2009, 64.9% of the world's known oil reserves were located in the Middle East (Ayhan, 2009: 58). This share fell to 47.6% as of 2017. At end 2017, The Middle East has the largest share of total proved reserves with 47,6% is followed by Central and South America (19.5%), North America (13.3%), Eurasia (8.5%), Africa (7.5%), Asia Pacific (2.8%) and Europe (0.8%). In the Middle East, Saudi Arabia has the largest oil reserves in the region with 266.2 thousand million barrels and a 15.7% share. Venezuela is the world's largest reserve country with a total of 303.2 thousand million barrels and a 17.9% share (British Petroleum statistical Review of world energy [BP], 2018).

It seems that oil consumption is more directly proportional to economic development. As of 2018, Middle East is again the leader in production with 33.8%, followed by North America with 20.9%. 13% of total oil and petroleum products production in the world took place in the United States in 2017. Furthermore, the most significant increases of pruduction in regions were in the Asia Pacific (3.3%) and Eurasia (1.9%) (British Petroleum, 2018). In terms of consumption, United States (913.3 Million tonnes oil equivalent) was the first with 19.8%, followed by China with 13.2% (BP, 2018).

2.2.1.2 Natural Gas

Natural gas is a mixture of combustible, colorless and odorless gases from the fossil source inside the Earth's crust. It is an oil-derivative gas lighter than air. The majority of natural gas (70-90%) consists of a combination of hydrocarbons called methane gas. Other components are ethane, propane, butane gases. It contains trace amounts of carbon dioxide, nitrogen, helium, and hydrogen sulfide. It is usually found in the underground, along with petroleum or gas reservoirs. Natural gas, which can be used without any process, can be transported by pipelines or by liquefied tankers (Ministry of Energy and Natural Resources [MENR], 2018).

Natural gas was previously seen as a useless waste that emerged during oil production in the past and was burnt off in oil production facilities. The history of natural gas dates back hundreds of years. Historical sources indicate that natural gas was first introduced in China in BC. 900. The widespread use of natural gas, which is easy to transport, process and stockpile, began in England in 1790.

Today, it is often used in homes and industries as a valuable and strategic energy source. In addition, natural gas can be transported in pressurized tanks in liquefied forms. However, the obligation of liquefied natural gas (LNG) to be kept at very high pressure and low temperatures during transport makes this method more inefficient than the pipeline method. Natural gas is produced on all continents except Antarctica. Due to its simple chemical structure, the combustion process is very easy, and full combustion is achieved. It is an environmentally friendly energy source that burns ash during burning and burns without slag. There is no storage problem, and more importantly, it does not emit sulfur dioxide and carbon dioxide gases that pollute the air as a result of combustion.

Natural gas reserves will be sufficient for the market for 52.6 years. However, with discoveries and developing technologies, more production will take place. As of 2018, gross natural gas reserves are estimated to be 7,124 trillion cubic feet (TCF) worldwide (U.S. Energy Information administration [EIA],2018). 40.9% of the world's natural gas reserves (Handbook of Alternative Fuel Technologies) in the Middle East, followed by Eurasia (30.6%), Asia Pacific (10%), Africa (7.1%), North America (5.6%), Central and South America (4.2%), and Europe (1.5%) (BP,2018).

The country with the largest natural gas reserves is Russia with a reserve of 35.0 trillion m3 as of 2017. Russia is followed by Iran (33.2 trillion m3) and Qatar (24.9 trillion m3) (Table 4). Regarding natural gas production by region, we see that North America is the leader with 25.9%.

Table 4: Countries in the First Ten Countries in Terms of Natural Gas Reserves and Production in 2017

Countries with natural gas reserves	Natural gas reserve (trillion cubic meters)	Natural gas producing countries	Produce amount (billion cubic meters)
Russia	35	ABD	734.5
Iran	33.2	Russia	635.6
Qatar	24.9	Iran	223.9
Turkmenistan	19.5	Canada	176.6
ABD	8.7	Qatar	175.7
Saudi Arabia	8	Chına	149.2
Venezuela	6.4	Norway	123.2
United Arab Emirates	5.9	Australia	113.5
China	5.5	Saudi Arabia	111.4
Iraq	3.5	Algeria	91.2

Source: BP , 2018

CIS (22%), Middle East (17.9%), Asia Pacific (16.5%), Europe (6.6%, respectively) Africa (6.1%), S.and Cent. America (4.9%) follows the regions. he largest share of natural gas consumption belongs to North America (25.7%), followed by Asia Pacific (21%), CIS (15.7%), Middle East (14.6%), Europe (14.5%). , S. & Cent. America (4,7%) and Africa (3,9%) follow the regions. The country with the largest natural gas production at the end 2017 is the USA with 734.5 billion m3. Thus, almost 20 percent of the natural gas sold worldwide is produced by the US. And Russia follows it (17.3%). Also America ranks first with a share of 20% in consumption (635,8 million tonnes oil equivalent) , followed by Rusia with 11.6% (BP, 2018).

2.2.1.3 Coal

Coal is a sedimentary organic rock that can burn. It consists of a combination of elements such as carbon, hydrogen, and oxygen, and has been the result of heat, pressure, and microbiological effects for a long time (millions of years). There are many forms of coal, such as lignite, sub-bituminous coal, bituminous coal, and anthracite coal. While it contains mostly carbon, it can occasionally be inorganic. However, the inorganic matter is undesirable in terms of coal quality.

Coal is the most-abundant low-cost fossil fuel found in the world. It is produced in more than fifty countries around the world. Also, it is the safest fossil fuel in terms of storage and transportation. As of 2018, Asia Pacific became the leader in total coal reserves by region with 41 percent, while North America (25%), CIS (21.6%), Europe (9.7%), S. & Central America with 1.4% and Middle East & Africa. Asia Pacific is the leader in coal production with 71.7%, followed by North America (10.8%), CIS with 7.2% and Africa with 4.2%. The highest coal production was 46.4% on a country-by-country basis from Asia Pacific countries, China (1747.2 Million tonnes oil equivalent). Asia Pacific is the leader in coal consumption with 74.5%, followed by North America (9.7%), Europe with 7.9%, CIS with 4.2% and Africa with 2.5% and Middle East with 0.2%. The highest coal consumption with 50.7% worldwide belongs to China (1892.6 Million tonnes oil equivalent) from the Asian Pacific countries (BP, 2018).

2.2.2 Renewable Energy Sources

Renewable energy is defined as “the energy source that can replenish itself evenly or at a rate faster than the depletion rate of the source” (Akaydın, 2005). Renewable resources are sources that do not change their properties within the natural conditions of the environment. These resources are divided into two subgroups: sources that are affected or unaffected by people. Some of the renewable resources can be affected by human activities, while others are not affected. Renewable resources affected by humans can be reduced or eliminated, depending on human use. Unlike fossil energy reserves, renewable energy sources are inexhaustible sources as they can renew themselves continuously. Renewable energy can be described as “the energy source that can exist exactly the next day in nature’s own evolution.” (Uyar, 2004).

Renewable energy has an important place in terms of reducing dependence on foreign sources by meeting the energy needs of the countries with domestic sources, providing sustainable energy use by diversifying the resources, and minimizing the environmental losses as a result of energy consumption.. In the current situation, although dependence on fossil fuels is high, the rates of use of renewable energy are increasing by years.

Renewable energy sources are geothermal, solar, wind, wave, tidal, wind, rain, and other natural phenomena such as sun movements, cosmic events in the atmosphere, waves in the sea, winds and precipitation, hydrogen, hydroelectric and biomass energy. The fact that renewable energy sources are inexpensive and do not harm the environment is a great advantage in terms of its use. However, there are some obstacles, such as the cost of the technologies and the lack of state subsidies, which prevents the expansion of the use of renewable energy.Approximately one-fifth of the energy consumed in the world is supplied from renewable sources (Renewables global status report [REN21], 2018). Renewable energy has an important place in the production of electricity in the world, too. By 2017, 25% of global electricity production is derived from renewable sources (EIA,2018). In 2030, approximately 50% of electricity needs are expected to be covered by renewable energy sources.

When we examine the investments in renewable energy around the world, record investments were realized in 2015. In 2017, however, investments in renewable energy (333 billion US dollars) increased by 3% compared to the previous year. China has taken the lead in these investments and is followed by the United States, Japan, the United Kingdom, and India.

Finally, it seems unlikely that the energy generated from renewable energy sources can compete with fossil fuels in terms of pricing. In this respect, it is estimated that it will take time to increase the share of renewable energy in total energy consumption. However, countries around the world are making government policies towards increasing the use of renewable energy and improving technologies in this field.

2.2.2.1. Geothermal Energy

Water reaching the Earth in the form of snow and rain penetrates through cracks in the Earth’s crust and reaches the rocks where the magma is heated. Hot water reaching the rocks and warming up in different regions in the form of geyser emerges on Earth. The temperature of this water is usually 150°C. This hot water coming out of the ground is converted into electrical energy through some steam turbines. This is called geothermal energy.

Geothermal energy is a clean source of energy. Geothermal power plants produce only one-sixth of a natural gas-powered power plant. Compared to renewable energy sources such as wind or solar, geothermal energy is continuous. The natural energy source is heat energy. In studies on the environmental impacts of geothermal systems, a number of classifications are made that are essentially the same. Some of those; environmental impacts according to the characteristics of the geothermal field and intended use, and the preparation of the geothermal field, environmental impacts on well drilling and testing in the operation (Bustamente, 2000).

The geothermal energy obtained in this way comes from a clean, efficient, and inexhaustible energy source. Until the beginning of the 20^{th} century, the usage areas of geothermal resources were cooking food and health. Today, geothermal energy is used for electricity generation, heating (greenhouse and housing), health tourism, and industrial mineral production. The first geothermal energy was produced in 1904 in Larderello, Italy. Today, geothermal energy is produced in more than 20 countries. The United States is the world's largest producer, and the largest geothermal development in geysers is in California. Most of the buildings in Iceland and even the swimming pools are heated by geothermal hot water.

Geothermal energy is obtained without burning fossil fuel. It is also relatively cheap; savings from direct use can be up to 80% compared to fossil fuels (National Geographic web site). The fluid obtained from high-temperature fields can be used in other fields as well as integrated electricity production.

The total installed capacity of geothermal energy has increased by 4.3% (600 MW) in 2017 and reached 14,369 MW worldwide. As we can see in figure 4, the United States is the leading country in capacity. Increasing geothermal energy production plants in countries such as Indonesia and Turkey is drawing attention.

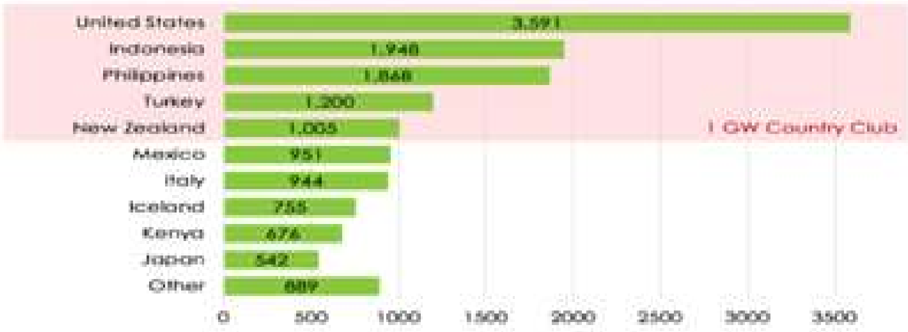


Figure 4: Top 10 Geothermal Countries, Installed Capacity-MW (October 2018)-14,369MW in Total

Source: ThinkGeoEnergy,2018

2.2.2.2. Solar Energy

The sun, which consists of very hot gases and is the energy source of our world, is one of the hundred trillion stars in the Milky Way galaxy. It is approximately 150 million km away from the world, and its diameter is 1.39 million km. Solar energy is the energy of radiation emitted by the fusion process in the nucleus of the sun, resulting from the fusion process in which the hydrogen gas in the sun is converted to helium. Even a small portion of this energy is many times more than the current energy consumption of humanity. Thus, solar energy is the greatest energy source.

The use of solar energy as solar-powered hot water systems is more preferred from the standpoint of simplicity and cheapness. This heat can be used directly or can be used in electricity generation. Low-temperature applications (20-100° C) are used in areas such as obtaining domestic water, drying of agricultural products, seawater treatment, salt production, solar cookers, solar chimneys, and solar ponds. Medium heat applications (100-300°C) are systems applied through solar vacuum collectors.(Kim et al. 2013)

In the direct conversion of light into electricity, photovoltaic systems are used. Some materials exhibit a feature known as the photoelectric effect. This effect absorbs photons and releases electrons, thus generating electrical energy. The first photovoltaic module was established in Bell Laboratory in 1954. Especially with the oil crisis, photovoltaic technology has been seen as a common energy source (Goetzberger et al., 2003).

Solar power generation is becoming more widespread day by day. This type of energy, which continuously shows seasonal fluctuations in some regions throughout the year, can save the countries where it is abundant from dependence on energy (Karadaş, 2008).

Globally, Germany uses the largest share of all solar energy capacity. Germany, one of the countries that makes the most investment in solar energy, has established photovoltaic systems and established scientific institutions to carry out studies on this subject throughout the country. In this regard, although the number of sunny days in Germany, it is a country that sells what it produces with advanced technology to the world. In 2017, China, United States, India, Japan, and Turkey accounted for about 84% of new power capacity increases in solar energy. The next five are Germany, Australia, the Republic of Korea, the United Kingdom, and Brazil (Ren 21, 2018).

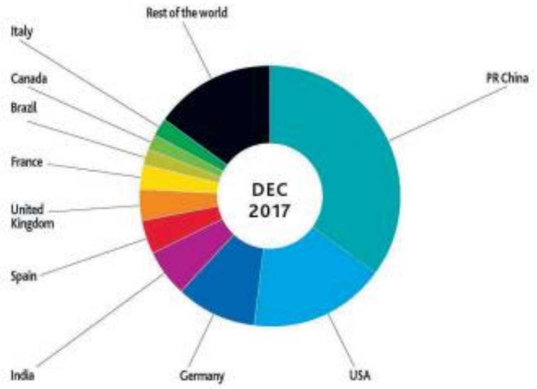
2.2.2.3. Wind Energy

Wind energy is caused by temperature and pressure differences caused by the sun. Wind energy systems produce electrical energy by converting the kinetic energy obtained by the wind into mechanical energy. It is a renewable, clean, environmentally-friendly energy source, abundant and free in the atmosphere. There is no risk of exhaustion. The raw material is completely local and does not create foreign dependence. Its technology and operation are simple, and its costs can compete with other energy sources (MENR,2018). It does not cause the formation of gases that will result in the greenhouse effect as it does not release carbon. Wind turbines can be installed almost anywhere. Wind power plants do not cover a lot of lands, as solar power plants do.

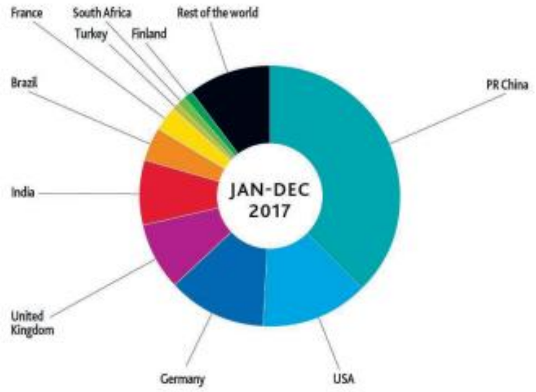
However, they have also some disadvantages. The wind needs to blow at the optimum level to generate electricity by wind turbines. If this condition is not satisfied, the turbines will not work. Furthermore, winds cause serious problems for the migrating birds. If the wind farms are too large in an area, they can disturb the cellular phone and television signals. It also makes a lot of noise. Therefore, they need to be built away from settlements. However, the degree of noise is significantly reduced with new technologies.

As shown in Figure 5 and 6, China produces 35% of the electricity produced from wind power in the world, but this represents only a small fraction of its energy needs.

China, which is also the leader in additional capacity increases, is followed by the USA and Germany, respectively.



Country	MW	% Share
PR China	188,392	35
USA	89,077	17
Germany	56,132	10
India	32,848	6
Spain	23,170	4
United Kingdom	18,872	4
France	13,759	3
Brazil	12,763	2
Canada	12,239	2
Italy	9,479	2
Rest of the world	82,391	15
Total TO P10	**456,732**	**85**
World Total	**539,123**	**100**



Country	MW	% Share
PR China	19,660	37
USA	7,017	13
Germany	6,581	12
United Kingdom	4,270	8
India	4,148	8
Brazil	2,022	4
France	1,694	3
Turkey	766	1
South Africa	618	1
Finland	535	1
Rest of the world	5,182	10
Total TOP 10	**47,310**	**90**
World Total	**52,492**	**100**

Figure 5: Top 10 cumulatıve capacity **Figure 6:** Top 10 New Installed Capacity

Source: Global wind Energy Council (GWEC),2018

Denmark is currently the country that takes the most advantage of wind energy in the world. This country covers a wide area of wind turbines along both the coasts and the open land. According to the data of 2017, wind power plants in the country produced 43.4% of total electricity consumption (The Local [Denmark Englısh news cite]). In 2017, the amount of electricity produced by wind power plants was 104% of the country’s current electricity demand. In addition to providing all the energy needs from wind turbines, Denmark also exports energy to countries such as Sweden, Norway, and Germany.

2.2.2.4. Hydraulic Energy

As the global water cycle is an ongoing process, hydraulic energy is considered a renewable energy source. Hydroelectric power plants, also referred to as HEPP, utilize the energy gained from their flow of water to obtain electricity. These power plants, which can be installed on rivers in general, are installed with high reinforced concrete structures in certain parts of the water.
When the dams that are positioned in front of the accumulated water are opened, the water starts to flow violently, and the potential energy is converted to electrical energy by running the turbine.

The evolution of the modern hydroelectric turbine began in the mid-1700s when French engineer Bernard Forest de Bélidor studied horizontal and vertical axis turbines. In 1882, the first hydroelectric plant began to operate in Appleton, Wisconsin in the United States. The first hydroelectric power plants can convert only 5% of the mechanical energy of water to electricity, but today this rate reaches 90% (Wolfson, 2012). About 20% of the electricity produced in the world comes from hydraulic energy.

Although hydraulic energy is clean, local, and it gives no harm to the environment, it might pose some problems. For instance, fish species may be adversely affected by dams if they cannot pass the reservoir dam during migration to spawning areas or return to the ocean. Fish ladders or fish lifts can be used to facilitate the passage of fish from the dam, or fish flocks can be compressed and transported by trucks. Furthermore, HEPPs that are largely dependent on rainfall do not work when there is no water. Besides, their construction is opposed because it damages the natural environment. Nevertheless, HEPPs, which require serious cost and time, make up for these disadvantages with their efficiency.

When we look at the renewable energy indicators, the hydraulic energy capacity is about 50% of the total global renewable capacity. According to the Ren21, 2018 report, the total capacity reached approximately 1,114 GWh in 2017, with 19 GWh global additions to the hydroelectric capacity. Approximately 63% of this capacity is registered in China, Brazil, Canada, the United States, the Russian Federation, India, and Norway. China is the leader of global capacity with 28%, followed by Brazil, Canada, and the United States.

Hydropower is a very important source of renewable electricity, with a share of 16%–17% of the total world electricity generation. Hydropower is by far the largest source of renewable electricity, in 2016 with more than twice the contribution from all other renewables combined (Killingtveit,A., 2019).

Albania, Bhutan, Lesotho, and Paraguay meet almost all of their electricity needs from hydroelectric power. Also, 15 countries around the world consume approximately 90% of their electricity from hydroelectric power.

2.2.2.5. Biomass Energy

Biomass is the source of organic matter that materializes as a result of the storage of green plants by converting solar energy into chemical energy through photosynthesis. It can be defined as all organic substances that can be renewed in less than a century, including plants growing on land and in water, animal wastes, food industry, forest products and urban wastes (Illeez, 2004; Olgun and Tiris, 2001, Tüplek, 2011). Approximately 90% of the biomass in the world consists of forests, branches, leaves, debris, animals, and microorganisms. Biomass is an inexhaustible resource, and it can be cultivated everywhere.

Biomass energy is one of the sources that can supply the rapidly increasing energy demand of the world with its increasing population without damaging the environment. Biomass fuels are derived from biomass sources such as biofuel, solid, liquid, or gas. Agricultural plants and wastes, industrial wood and timber wastes, livestock waste and local organic wastes are also biomass resources. Biomass can be converted into three main types of electrical/heat energy,transport fuel, chemical feedstock (McKendry, P.,2002).

Biomass is the fourth largest energy source in the world. Many developed countries regard bio-energy as the main energy source of the future. For example; 16% of Sweden's energy is derived from biomass. Similarly, while Austria provides 13% of its energy from biomass, Finland also benefits from biomass energy (Karayilmazlar et al., 2011). In the coming years, besides the new developments in these technologies, the construction of large thermal power plants which are only working with biomass sources is planned. In countries such as Sweden and Finland, electricity is produced with regional biomass power plants, and new power plants are under construction.

Bioenergy, including traditional biomass use, contributed approximately 12.8% (46.4 ECJ) to total final energy consumption in 2016. Modern bioenergy (excluding traditional biomass use) has contributed 5% to final energy consumption (including traditional biomass wood and wood charcoal, as well as manure and various agricultural waste incineration. In addition, modern bioenergy encounters about 4% of the heat demand in buildings, 6% in industry, 2% of global electricity generation and 3% of transport needs (Ren21,2018).

Largest modern bio-heat consumer is Europe. The EU has used an estimated 3.6 EJ bio-heat in 2016, a large part of which is solid biomass. 80% of all biofuel is produced and consumed in the USA, Brazil, and the EU. In bioelectrical production, China has taken its lead from the United States by 2017. China and the United States are followed by Brazil, Germany, Japan, UK, and India (Ren 21,2018).

2.2.2.6. Nuclear Energy

Nuclear energy is the energy released by the breakdown of large atoms (uranium, plutonium) or the fusion of small atoms (hydrogen). Nowadays, nuclear power plants are the sources of electricity that countries prefer because of their unique characteristics. The need for a more eco-friendly, reliable, inexpensive, sustainable, and accessible energy source brings nuclear power plants to the forefront according to other alternatives. The reasons for the preference of nuclear power plants include ease of accessibility, lack of greenhouse gas effect, low operating cost, high utilization capacity, fuel prices stability, energy-intensive production, long life of power plants (Dujardin, 2004).

As of July 2018, 453 nuclear reactors are built in 31 countries and 57 nuclear reactors in 17 countries. The electricity produced in nuclear power plants corresponds to 11% of the world’s electricity supply. The European Union and the United States receive about 30% and 20% of their electricity demand from nuclear energy, respectively (MENR,Nuclear Page,2018). More than half of the nuclear power plants are concentrated in North America and Europe, although there is a decrease in the number of reactors in Europe. The number of reactors in the Far East is increasing steadily. It has been proven that a 100 MW nuclear power plant in the world today saves approximately 2 million tons of oil each year, preventing approximately 2.5 million tons of carbon dioxide (CO_2) emissions from this savings. However, the resulting nuclear waste storage is a significant problem that needs to be solved.

In the analyses carried out by the International Energy Agency for the period up to 2030, attention is drawn to the fact that there is a noticeable decline in the use of nuclear energy in the light of the available data. Nuclear energy technology is serving humanity with the production of some isotopes that are used in medical and industrial branches while meeting 11 percent of the world's electricity needs. Today, nuclear power plants in the world, which have an installed capacity of 353 GW (Ren21,2018), produce about 10 thousand tons of used fuel, or "nuclear waste" per year. Today, the accumulated amount of nuclear waste has exceeded 250 thousand tons. In countries with nuclear facilities, the urgency of storing used fuels is a growing problem. If these problems cannot be solved, some reactors may have to be closed down for this reason. However, nuclear energy consumption around the world is expected to increase 1.5 times in the period 2018-2040 and projected to be the second fastest growing energy source in the world.

CHAPTER III

ENERGY OVERVIEW AND POLICIES FOR D-8 COUNTRIES

This chapter allows us to recognize the organization d8 and its objectives. It also provides information about the organization's energy outlook and policies in the world.

3.1 D-8 Organization and Energy Overview

D-8 (eight developing countries) is an international organization formed by Turkey, Egypt, Iran, Pakistan, Bangladesh, Malaysia, Indonesia, and Nigeria. The purpose of the organization is to create new opportunities in trade relations between the eight countries, an international organization that promotes economic and commercial cooperation among the member countries at the decision-making level, and to increase the participation of developing countries in the process to strengthen their position in the world economy.

The foundations of D-8 were launched in October 1996 at the Cooperation in Development Conference held in Istanbul with the invitation of the then Prime Minister Necmettin Erbakan and the representatives of these countries., Erbakan, the founder of the organization which is also a member of the Islamic Union, argued that a new world order should be established after the Cold War and that Muslim countries could play a more important role in this order. Turkey hosted the organization's most recent ninth summit in 2017. D-8 was also granted observer status at the United Nations General Assembly in 2014. The membership of D-8 member states has no negative impact on bilateral and multilateral commitments to regional and international organizations (Republıc of Turkey Ministry of Foreign Affairs, [MFA] 2019). D-8 consists of three main organs: the Summit (the president of the member states), the Council (political decision-making body) and the Commission (the executive body).
The six stars in the D-8’s flag symbolize the organization’s six basic principles. These are:

- Not war, but peace
- Not conflict, dialogue

- No double standard, fairness
- Not superiority, equality
- Collaboration, not exploitation
- Not oppression and domination, but human rights, freedom, and democracy (MFA,2019)

In addition, in some areas, joint projects were decided to be carried out between member states. It was recommended to establish an international marketing and trade company, to carry out teamwork to reduce poverty, to establish information network between the members in the field of technology and industry, and to implement projects such as Islamic Banking. As of July 2016, the D-8 Preferential Trade Agreement between Iran, Pakistan, Malaysia, Indonesia, Nigeria, and Turkey envisages improving the position of developing Muslim countries in the world economy.

Since energy is a priority sector for D-8 countries, they have been assertive to build the energy infrastructure, to increase energy efficiency, and to build the necessary financing mechanisms. As of 2013, more than 85% of the total primary energy production in the world comes from fossil fuel sources, while 95% of the total primary energy production in D-8 countries comes from fossil fuels (Figure 7).

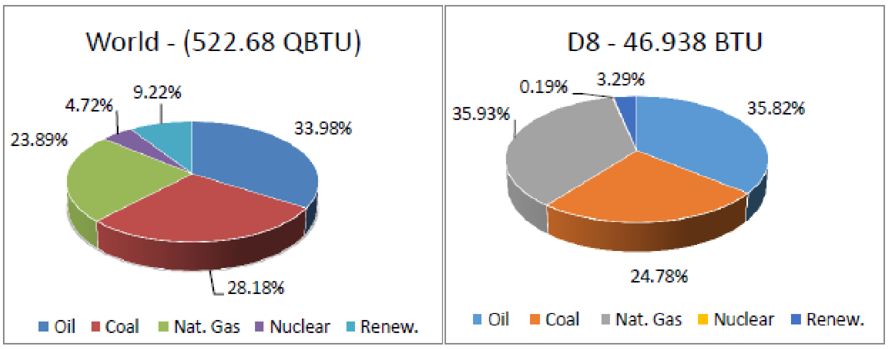


Figure 7: Shares of Primary Energy Sources in Total Primary Energy Production, 2013
Source: SESRIC,2016

Also, unlike the world's oil-intensive trend, the D-8 countries have the highest share of natural gas in the energy mix (35%). However, while renewable energy sources meet 9% of the world total primary energy production, D-8 countries' share is only 3.5% (Statistical, Economic and Social Research and Training Centre for Islamic Countries, [SESRIC],2016 State of Energy Sector in D-8 Countries).

The D-8 has a trading volume of 1,720 billion dollars and a share of 4.68% in world trade. The share of the organization in world imports is 4.83% while the share of world exports is 4.54%. In D-8 countries, as of 2013, total primary energy production has the highest utilization rate of natural gas on the basis of resources. The coal ranks 3rd , while it follows the oil with a slight difference (Figure 7).

The highest and lowest volumes of trade among D-8 are for Malaysia and Bangladesh, respectively. Malaysia is the twenty-fifth largest exporting country in the world. Indonesia and Turkey are following Malaysia in exports.

Table 5: The Place of D-8 Organization in World Trading (2013-Million Dollars)

Countries	**Trade volume**		**Export**		**Imports**	
	Value	**Share in the World (%)**	**Value**	**Share in the World (%)**	**Value**	**Share in the World (%)**
Malaysia	434,290	1.18	228,276	1.21	206,014	1.09
Turkey	403,437	1.09	151,787	0.81	251,650	1.33
Indonesia	370,638	1.00	183,344	0.97	187,294	0.99
Nigeria	159,000	0.43	103,000	0.55	56,000	0.30
Iranian	131,000	0.35	82,000	0.44	49,000	0.26
Egypt	86,787	0.23	28,492	0.15	58,295	0.31
Pakistan	69,848	0.19	25,150	0.13	44,698	0.24
Bangladesh	65,491	0.17	29,114	0.15	36,377	0.19
Total (D-8)	1,720,491	4.68	831,163	4.54	889,328	4.83

Source: Doğan, A.,2015 from World Trade Report 2014

Among D-8 members, Turkey imports are the most. Turkey is the nineteenth largest importing country in the world, followed by Malaysia and Indonesia.The country with the highest foreign trade surplus is Nigeria, while the country with the highest foreign trade deficit is Turkey.

According to the Global Competitiveness Index 2014-2015 Report published by the World Economic Forum (WEF), Malaysia ranked 20th among 144 countries with the highest competitiveness level among D-8 countries.

Table 6: Global Competitiveness of D-8 Members

Country	**Global Competitiveness Index 2014-2015**		**Global Competitiveness Index 2013-2014**		**Global Competitiveness Index 2012-2013**	
	Ranking	**Value**	**Ranking**	**Value**	**Ranking**	**Value**
Malaysia	20	5.16	24	5.03	25	5.06
Indonesia	34	4.57	38	4.53	50	4.40
Turkey	45	4.46	44	4.45	43	4.45
Iranian	83	4.03	82	4.07	66	4.22
Bangladesh	109	3.72	110	3.71	118	3.65
Egypt	119	3.60	118	3.63	107	3.73
Nigeria	127	3.44	120	3.57	115	3.67
Pakistan	129	3.42	133	3.41	124	3.52

Source: World Economic Forum (WEF) report-2014-2015

If we draw a framework for evaluating D-8 countries in terms of macro-economic indicators, per capita income is the first indicator of welfare level or economic development that comes to mind. The two countries with the highest welfare level among D-8 countries are Malaysia ($11,528) and Turkey ($10,546) as of 2017. In addition, when D-8 countries are evaluated in terms of unemployment rates, it is seen that Turkey (11.14%) ranks the third led by Egypt (11.83%) and Iran (12.37%). Malaysia is the country with the lowest unemployment rate (3.35%) (D-8 organisation for economic corporation,Developing8 [D-8], 2018).

The volume of trade among member states at the time the organization was established was 20 billion dollars. Today the volume of trade between member states is around 120 billion dollars. D-8 member Iran, which has the highest number of exports and imports, has a share in Turkey's total exports and imports of 2.7% and 4.1% respectively (Doğan, A., 2015). Both geographical proximity and cultural ties are used, and the development of the image of the Turkish goods in the market is one of the most effective factors leading to this situation.

3.1.1 Oil

D-8 countries are responsible for only 9% of the world's total primary energy production). While the world's total oil reserves are about 1.6 trillion barrels, the D-8 countries' reserves are 207 billion barrels, which corresponds to 12.9% of the world's oil reserves (SESRIC,2016).

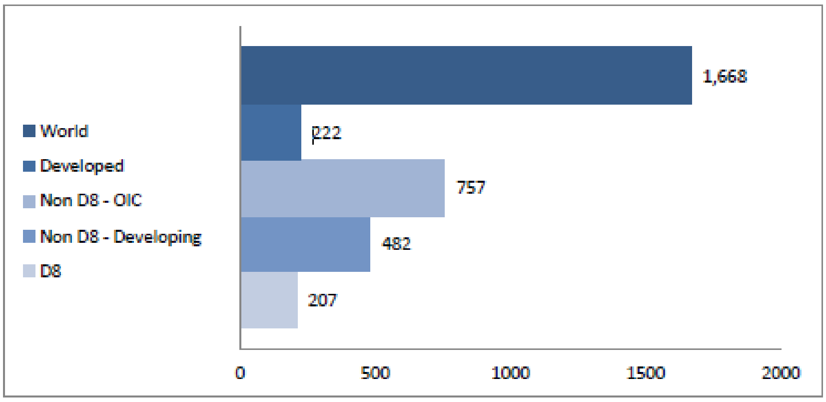


Figure 8: Proved Crude Oil Reserves for Selected Country Groups, 2014 (billion barrels)
Source: SESRIC,2016

3.1.2 Coal

Coal is the largest source of energy for electricity production worldwide. However, the level of coal production in D-8 countries is significantly lower than in other developing countries. Indonesia produces most of the group's coal production (85%). This country is the third largest producer of coal in the world after China and India (BP, 2018).

3.1.3 Natural gas

Natural gas, which is a cleaner energy source than petroleum and coal, emits 50% less carbon dioxide for the same amount of energy produced (Haktanir, 2004). In D-8 countries, the rate of use of natural gas is higher than in the world. Iran has the leading share (70%) of the proven natural gas reserves among D-8 countries. Besides, the group's reserves are higher than the developed and developing countries (Figure 19). On the other hand, dry natural gas production of the D-8 group is less than the production level of other country groups due to the lack of extraction capacity (SESRIC,2016)

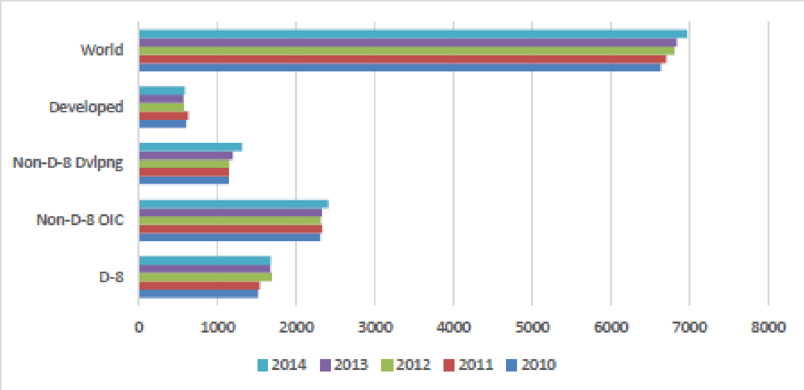


Figure 9: Total Proved Reserves of Natural Gas for Selected Country Groups, 2010-2014 (trillion cubic feet)
Source: SESRIC,2016

3.1.4. Renewable Energy in D-8

Renewable energy sources are critical for sustainable economic development. However, in D-8 countries, the interest in renewable energy is not high due to the use of fossil fuels, which are abundant, easily accessible, and less costly. Renewable energy investments, installation costs, and technological deficiencies, as well as the availability of fossil-based natural resources, leave these investments back in D-8 countries.

Table 7: Total Renewable Energy in D-8 (Renewable Energy Capacity Statistics 2019 (MW))

Egypt	3354	3483	3503	3503	3503	3503	3713	3736	3857	4813
Nigeria	2087	2089	2119	2134	2136	2138	2140	2143	2143	2143
Bangladesh	251	266	267	291	330	358	382	393	438	439
Indonesia	6702	6856	7147	7489	8261	8417	8514	870	9142	9471
Malaysia	2836	2801	3899	4245	5674	6367	7568	7938	7999	8157
Pakistan	6929	7012	7024	7141	7563	7913	8089	8623	9304	13049
Iran	7808	8588	8850	9858	10380	10955	11452	11824	12263	12675
Turkey	15 529	17 369	19 086	22 186	25 551	27 940	31 516	34 446	38 746	42 215

Source: IRENA, International Renewable Energy Agency ,2019

D-8 countries' total renewable energy supply is low compared to that of other developing and developing countries (SESRIC,2016). On the other hand, as shown in Table 7, Turkey ranks first among D-8 countries with a renewable capacity of 42,215 MW as of 2018, followed by Pakistan, Iran, Indonesia, and Malaysia, respectively.

3.1.4.1. Hydroelectric

The D-8 countries have 7% of the total hydropower supply as of 2012. They have achieved an impressive growth rate of around 30% between 2008 and 2012 for hydropower capacity. Turkey has a 40% share of the hydroelectric supply of D-8 countries.As shown in Figure 10, more than half of global hydroelectric production comes from non-D-8 developing countries.

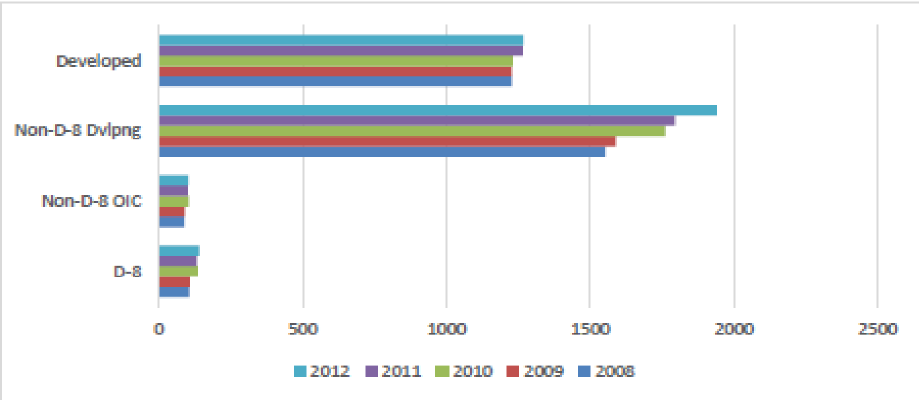


Figure 10: Total Hydroelectricity Net Generation for Selected Country Groups, 2008-2012 (Billion kWh)
Source: SESRIC,2016

3.1.4.2. Wind Energy

More than 60% of the world's total wind energy production is carried out by developed countries. In recent years, despite significant growth, the level of wind energy production in D-8 countries is low. As of 2012, the group's worldwide share of production is approximately 1.5% (7.4 billion kWh). Turkey has by far the largest share in wind energy production in D-8 countries (80%) followed by Egypt (17%). Malaysia and Nigeria are two D-8 countries that do not produce wind energy (SESRIC,2016)

3.1.4.3 Solar Energy

According to 2016 data, approximately 0.66% of the total solar energy capacity comes from D-8 countries. As in wind energy, Turkey has the largest solar energy capacity, with a 42% share among D-8 countries. Pakistan is following Turkey with a 21% share (IRENA, 2017).

3.1.4.4. Geothermal Energy

In terms of resource utilization and net electricity generation from geothermal energy, developed countries lead the way, while D-8 countries have a share of approximately 15%. In D-8 countries, 90% of the total electricity produced from geothermal resources comes from Indonesia. It also performs 10% of total production in the world (SESRIC,2016).

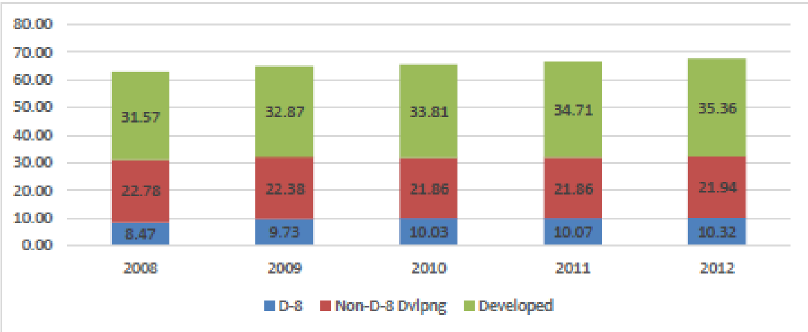


Figure 11: Total Geothermal Net Electricity Generation for Selected Country Groups, 2008-2012 (Billion kWh)
Source: SESRIC,2016

3.1.4.5. Nuclear energy

Iran and Pakistan are the two utilizers of nuclear energy in D-8 countries. Iran's only nuclear reactor has been active since 2011 and has met 1.5% of the electricity produced in the country. On the other hand, Pakistan has three nuclear power reactors, and the first reactor has been in operation since 1971. With an output capacity of with 1355 MW, Pakistan produces 6% of total electricity from nuclear energy (World Nuclear Assocıatıon, 2018).

3.2. Emission and Energy Density

In the last 30 years, total world CO_2 emissions have increased by 75%. On an annual basis, the average growth rate of emissions is 2.2%. However, the average annual increase in the D-8 group was recorded at around 10.8%. There is a lesser increase in the absolute levels of carbon dioxide emissions for the D-8 group compared to developed countries. For the D-8 group, the largest share in emissions belongs to oil, with a share of 62% (SESRIC,2016).

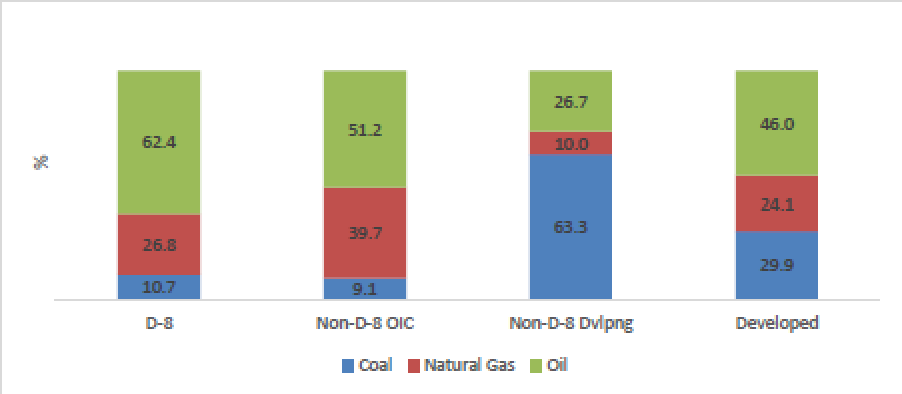


Figure 12: Shares of Fossil Fuels in Total Carbon Dioxide Emissions for Selected Country Groups, 2012 (%)
Source: SESRIC,2016

Energy density is the total primary energy consumption per GDP dollar. According to 2011 data (SESRIC,2016), energy density was calculated as an average of 905 Btu in the world. Compared to other group countries, the D-8 group has the highest energy density with 17,874 Btu. Developed countries are far below the world average . This is also a negative environmental situation for D-8 countries.

3.3. Energy Trilemma Index

The Energy Trilemma Index is calculated by the World Energy Council and ranks countries in three dimensions of energy: energy security, energy equity, and environmental sustainability. "*Since last year's Paris Agreement on climate change, almost every country in the world has been aware of the need to meet the challenge of the energy trilemmas*," said Sir Philip Lowe (WEC, Chairman of the board, Energy Trilemma, World Energy Council).

As shown in Figure 13, at each country level, the best trilemma index score worldwide was recorded for Switzerland (9.48) while the best score of the D-8 countries belonged to Malaysia (6.79). On the other hand, the lowest score among developed countries is for Estonia (4.57). Among D-8 countries, the lowest score is for Bangladesh (1.99). In general, D-8 countries perform similar to other developing countries, but their performance seems to be very low in comparison to developed countries.

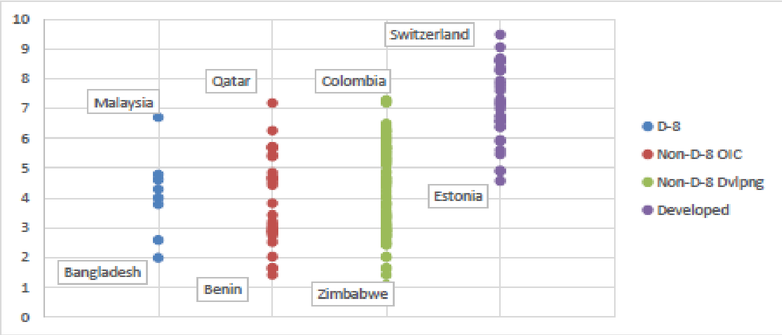


Figure 13: Energy Trilemma Index for Selected Country Groups, 2014
Source: WEC, 2014 report

CHAPTER IV

LITERATURE REVIEW AND EMPIRICAL ANALYSIS OF RENEWABLE ENERGY AND ECONOMIC GROWTH RELATIONSHIP: A STUDY OF TURKEY AND D-8 COUNTRIES

In this chapter, between renewable energy and economic development in d-8 countries is examined as an empirical analysis. Firstly, studies on the subject in the literature have been put forward and then analysis is presented with ıts method, findings, results and recommendations.

4.1. Literature review

Until today many scientific studies have been carried out to study the link between energy consumption and economic growth. Energy is undoubtedly one of the most interesting topics. Scientists base their work on this subject in four different hypotheses. The first of these hypotheses is the feedback hypothesis. According to this hypothesis, the causality relation between variables is bidirectional. It can be interpreted that the country is dependent on energy to grow, and the growing economy will increase energy consumption. (Apergis and Payne, 2010; Li, 2011; Salim and Rafiq, 2012). Another hypothesis is the growth hypothesis. This hypothesis refers to the one-way causality relation from energy consumption to the economy. Accordingly, the country is dependent on growing energy. So energy saving policies will affect negative growth (Bildirici, 2013; Akinlo, 2009; Sari and Soytas, 2007; Shahbaz, 2011).

Another is the conservation hypothesis, claiming causality to energy consumption from economic growth. This hypothesis argues that the country is less dependent on the energy needed to grow and that saving policies will have little or no adverse effect on the economy. (Kraft and Kraft, 1978; Sarı et al., 2008). The fourth and final hypothesis is the neutrality hypothesis. The hypothesis that there is no causal relationship between economic growth and energy consumption. In other words, policies regarding energy can be implemented without forgoing economic growth (Menegaki, 2011; Soytas and Sari, 2007).

It is possible to examine the scientific studies in this subject with regards to supply and demand. In the supply-side approach, the growth effect of natural resources used for energy production is explored through traditional production function. Just like labor and capital, energy is also an important production factor. In the demand-side approach, the determinants of renewable energy consumption are searched. For example, variables examined are the use of renewable energy, economic growth, CO_2 emissions, the price of substitute products (oil, natural gas, etc.), net energy import, etc.

Thus, the number of studies examining the link between energy consumption and economic growth has increased considerably in recent years. The causality relation between these two factors has been studied by using different models and different country samples.

Given the hypotheses mentioned above, various results were obtained in the studies carried out. For instance, Neroyan and Symith (2008), Lee (2005), Lise and Monfort (2007), Soytaş (2001), Wolde-Rufael (2010) found a one-way causality relation to economic growth from energy use. Similarly, Imran and Sıddıqui (2010) conducted a panel cointegration and Granger causality test for Bangladesh, India, and Pakistan for the 1971-2008 period, and found no one-way relationship in short-run, while verifying a long-run one-way relationship from energy consumption to economic growth.

However, many studies supporting the conservation hypothesis exist in the literature (e.g., Mehrara, 2007; Islam at al., 2011; Al-Iriani, 2006; Sadorsky, 2010; Altinay and Karagöl, 2005; Kraft and Kraft, 1978; Kwakwa, 2012; Sari et al., 2008). These studies found that there is one-way causality relation to energy consumption from economic growth.

On the other hand, there is a considerable number of studies which detect a bi-directional causality relationship is in the literature (e.g., Shahbaz, 2010; Apergis and Payne, 2010; Apergis and Payne, 2011a; Tuğcu et al., 2012; Anis Omri, 2013). Finally, as mentioned in the neutrality hypothesis, some studies find no causality relationship between energy consumption and economic growth (e.g., Menegaki, 2011).

The number of studies on the relationship between renewable energy consumption and economic growth has increased recently (e.g., Apergis and Payne, 2010; Apergis and Payne, 2011; Pao and Fu Johansen, 2013; Bloch, 2015; Büyükyılmaz and Mert, 2010; Ibrahiem, 2015; Bayraktutan et al., 2011; Chien and Hu, 2007; Chien and Hu, 2008; Özşahin et al., 2006; Bhattacharya et al., 2016; Shahbaz, 2011; Shahbaz et al., 2015; Salim and Rafiq, 2012;

Ocal and Aslan, 2013; Dogan, 2015; Dogan, 2016). As in the literature for economic growth-energy consumption nexus, all four hypotheses have found support in these studies on the link between renewable energy use and economic growth. Potential explanations for these contradictory findings might be the use of different samples, the use of different control variables, the implementation of different econometric techniques or the distinction between short-run and long-run. However, the most common finding is that there is a two-way relationship between economic growth and renewable energy consumption.

On the other hand, demand-side studies focus on macro-level determinants of the use of renewable energy sources. In the related literature, these determinants are subsidies and incentives (Bowden and Payne, 2009), population (Islam at al., 2013), energy imports and CO_2 emissions (Aquire and Ibukunle, 2014).

4.2. Data set

The data set of the study covers D-8 countries (Turkey, Iran, Pakistan, Bangladesh, Malaysia, Indonesia, Egypt, and Nigeria). The data for these countries cover 1980-2015 period. The variables used are gross domestic product (GDP), renewable energy consumption, nonrenewable energy consumption, carbon dioxide emissions, real gross fixed capital, labor, net energy imports, energy use per capita, and annual urban population growth rate.The data sets used in the study are compiled from the World Bank data sets (World Development Indicators, [WDI], 2018). Table 8 shows the definitions of the variables used in the study. Analyses were carried out with the help of Eviews-9 and Stata 14 econometric package programs.

Table 8 : Description of the Data Set

Variable	Explanation	Abbreviation
Renewable Energy Production	Hydroelectric, Geothermal, Solar, Tidal, wind, biomass, and biofuels), the Electricity Production (kwh)	RE
Nonrenewable Energy Production	Coal, Natural Gas, Oil) Production of Electricity (kwh)	NRE
Gross domestic product	with constant real GDP in US dollars from the 2010 price	GDP
Carbon Dioxide Emissions	CO2 emissions (metric tons per capita)	CO2
Real Gross Fixed Capital	Gross capital formation	RGC

Labor	The total labor force participation	L
Net Energy Imports		ENI
Energy use per capita	Energy use (kg oil equivalent per capita)	ENU
Urban Population Growth Rate	Urban population growth (annual%)	UPO

Among the variables used in the study, since NRE, RE, GDP, CO2, BRS, L, ENU variables are numerically large, they are added to the models by taking their natural logarithms. Since the UPO variable is expressed as a percentage, the logarithm was not taken. Similarly, the logarithm of ENU was not taken since the variable was not numerically large.

The models used in the study are as follows;

Model 1: $GDP_{it} = a_0 + \beta_1 LNNRE_{it} + \beta_2 LNRE_{it} + \beta_3 LNL_{it} + \beta_4 LN\ RGC_{it} + \mu_{it}$

Model 2: $LNRE_{it} = a_0 + \beta_1 LNGDP_{it} + \beta_2 LNCO2_{it} + \beta_3 LNNRE_{it} + \beta_4 LNENU_{it} + \beta_5 UPO_{it} + \beta_6\ ENI_{it} + \mu_{it}$

4.3 Methodology

To obtain reliable results from the models created within the scope of the study, it is important to test the cross-section dependence in the models. The reason for the cross-section dependency test is countries in the sample might be affected by a shock coming to any country in the panel. Due to the rise of globalization, the level of international trade, the degree of financial integration, an economic shock in any country, a global financial crisis as in 2008, countries can be exposed to common shocks. Therefore, it is necessary to test whether there is a cross-section dependency between the series before starting the analysis. Otherwise, the results obtained in the analyses without considering cross-section dependency will be inconsistent (Mercan, 2014; Menyah et al., 2014). If the presence of cross-sectional dependence is not rejected, it means that other countries are affected by a shock to any country in the panel, and the use of analyses taking into account the cross-sectional dependence in such a case gives more reliable results. In the literature, to test cross-section dependence; Breusch-Pagan CD_{LM1} (1980), Pesaran (2006) CD_{LM}, Pesaran (2004) CD_{LM2} and Pesaran et al. (2008) LM_{adj} tests have been developed.

The Breusch-pagan CD_{LM1} (1980) test is the first test in this field, and the test is described in equation (1):

$$LM = T\sum_{i=1}^{N-1} . \sum_{J=i+1}^{N} \dot{p}_{ij^2} \tag{1}$$

In equation (1) ṗ is a dual correlation estimation, and the main hypothesis in the Breusch-Pagan CD_{LM1} (1980) test is that there is no cross-sectional relationship. If T→∞ and N is fixed, it is assumed that it has a chi-square asymptotic distribution with the degree of freedom $\frac{N(N-1)}{2}$ (Güloğlu and Ivrendi, 2010).

In Equation 2, the Peseran (2004) CD_{LM2} test assumes that both the time dimension and the cross-sectional dimension can be used:

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} . \sum_{J=i+1}^{N} \quad \dot{p}_{ij^2} - 1 \tag{2}$$

In the case of N>T, the Peseran (2004) CD_{LM} test shows major biases in level. Biases increase as N grows. Therefore, Pesaran (2006) developed the CD test for cases where it was N>T. This test, which is in Equation 3, is used when N is greater than T (N>T).

$$CD_{LM} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} . \sum_{J=i+1}^{N} \quad \dot{p}_{ij} \tag{3}$$

Pesaran (2006) is based on the sum of the correlation coefficients between the sectional residuals in CD_{LM} test.

One of the horizontal cross-section dependency tests is shown in Equation 4 and Pesaran et al. (2008) was developed by the corrected LMadj test.

$$LM_{adj} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} . \sum_{J=i+1}^{N} \quad T\,\dot{p}_{ij} \qquad \frac{T-k \quad \dot{p}_{ij^2 - uT_{ij}}}{\sqrt{\frac{v^2}{T_{ij}}}} \tag{4}$$

In the study, stationarity of variables was also analyzed by Im, Pesaran, and Shin (IPS) test. The most important feature of the IPS test is the consolidation of data and the application of individual unit root tests to time series for all units. The IPS panel unit root test statistic is the average of all individual ADF test statistics. The null hypothesis of the test is that at least one unit has unit root in the panel while the alternative hypothesis is that all units in the panel do not have unit roots. Panel unit root analysis aims to determine the stationarity order of the variables and to select the appropriate analysis method. In addition, if regression analysis is performed with non-stationary data, spurious regression results are obtained.

When determining the stationarity order of the variables, the length of the lag is determined automatically by the program, and the t-statistic which gives more reliable results is chosen instead of the information criteria for calculating the stationarity order.

In the study, Pedroni (1999, 2004) cointegration analysis is used to examine the cointegration relationship. In Pedroni cointegration analysis, the null hypothesis consists of seven cointegration tests based on the absence of cointegration. Four of these tests are panel statistics, and the other three are group statistics. The first test of panel statistics is a variance ratio type. The second is similar to Phillips Peron (PP) (Rho) statistics, the third is similar to PP t-statistics, and the fourth is a parametric statistic similar to Augmented Dickey-Fuller (ADF) t-Statistics. In cross-group statistics, cointegration statistics are based on the assumption of group averages. The first test in this group is similar to the PP (Rho) statistics, while the other two are similar to the PP t- and ADF t-statistics (Güvenek and Alptekin, 2010). In the analysis of Pedroni co-integration, it is requested that the time dimension is large and the unit size is medium.

Table 9: Group and panel statistics

	Group statistics	Panel statistics
ρ statistic	$TN^{-\frac{1}{2}}Z_{\rho N,T^{-1}} \equiv TN^{-\frac{1}{2}} \sum_{i=1}^{N} \frac{\sum_{t=1}^{T} u_{it-1}\Delta u_{it} - \lambda_i}{\sum_{t=1}^{T} u_{it-1}^{2}}^{-1}$	$T\sqrt{N}Z_{\rho NT-1} \equiv T\sqrt{N}\frac{\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2} u_{it-1}\Delta u_{it} - \lambda_i}{\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}u_{it-1}^{2}}$
t statistic nonparametric	$N^{-\frac{1}{2}}Z_{tN,T} \equiv N^{-\frac{1}{2}} \sum_{i=1}^{N} \frac{\sum_{t=1}^{T} u_{it-1}\Delta u_{it} - \lambda_i}{\sigma_i^{2} \sum_{t=1}^{T} u_{it-1}^{2}}^{-\frac{1}{2}}$	$Z_{tNT} \equiv \frac{\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2} u_{it-1}\Delta u_{it} - \lambda_i}{\sigma_{NT} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}u_{it-1}^{2}}$
t statistic parametric	$N^{-\frac{1}{2}}Z^{*}_{tN,T} \equiv N^{-\frac{1}{2}} \sum_{i=1}^{N} \frac{\sum_{t=1}^{T} u^{*}_{it-1}\Delta u^{*}_{it}}{\sum_{t=1}^{T} s_i^{*2}u_{it-1}^{*2}}^{-\frac{1}{2}}$	$Z^{*}_{tNT} \equiv \frac{\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2} u^{*}_{it-1}\Delta u^{*}_{it}}{s_{NT}^{*2} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}u_{it-1}^{2}}$
v statistic		$T^{2}N^{3}Z_{eNT} \equiv T^{2}N^{\frac{3}{2}}\frac{1}{\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}u_{it-1}^{2}}$

Source: Selim et al. (2014: 97)

Consider the following regression:

$$Y_{it} = a_i + \delta_i t + \beta_i X_{it} + u_{it} \qquad (5)$$

Here, a_i ve δ_i show the fixed effects and parameters of the deterministic unit-specific trend, respectively. The slope parameter is allowed to be considered unit-specific so that the co-integration model can be heterogeneous across the units of the panel.

For nonparametric statistics, the $\hat{u}_{it} = \hat{y}_i\hat{u}_{it}-1 + \hat{e}it$ regression is estimated, and residuals are used to estimate the unit-specific long-term variance of $\hat{e}_{it}$. Parametric statistics are used to estimate $\hat{u}_{it} = \hat{y}\hat{u}_{it-1} \sum_{k=1}^{K} \hat{y}_{ik}\Delta\hat{u}_{it-1}$.

In the study, the group average panel DOLS (Dynamic least squares) estimator proposed by Pedroni (2001) is used as the co-integration coefficient estimator. According to Stock and Watson (1993), this method eliminates the problem of ignoring small data sets and dynamic structures that occur in the least squares estimator (OLS). Panel DOLS is a robust approach and eliminates the problem of endogeneity by taking a lag and forward value of the arguments. On the other hand, the panel DOLS autocorrelation problem is eliminated by the Generalized Least Squares (GLS) method. The purpose of this analysis is to determine the direction, strength, and significance of the effect of the independent variable on the dependent variable in the presence of cointegration relationship.

In this study, the causality relationship between variables will be examined with the analysis of Dumitrescu and Hurlin (2012). The most important advantages of this method are that it can be used both in the presence and in the absence of cross-section dependency, and it can yield effects when the time dimension is larger than the unit size (Dumitrescu and Hurlin, 2012). In this test, the causality relationship between Y and X is analyzed using a linear model:

$$y_{it} = a_i + \sum_{k=1}^{K} y^{(k)} \; y_{it-1} + \sum_{k=1}^{K} \beta_1{}^{(k)} \; y_{it-1} + \varepsilon_{it} \tag{6}$$

Here, K is the optimal lag length, and the most important limitation of this model is the homogeneity and the stationarity of the series.

Dumitrescu and Hurlin (2012) calculate individual Wald statistics ($W_{i,T}$) for each cross-section to test the null hypothesis based on the assumption that there is no causality, and then reach the panel's Wald statistics ($W_{N,T}{}^{HNC}$) by taking their arithmetic mean. Dumitrescu and Hurlin (2012) recommend the use of test statistics with asymptotic distribution when T> N, and use the test statistics with semi-asymptotic distribution ($Z_N{}^{HNC}$) when T <N. Dumitrescu and Hurlin (2012) calculate test statistics and probability values of statistics using Monte-Carlo simulation. The purpose of this analysis is to determine whether a shock in one variable affects another variable or not.

4.4 Findings

To test cross-section dependency in panel data; Breusch-Pagan CD_{LM1} (1980), Pesaran (2004) CD_{LM}, Pesaran (2006) CD_{LM2} and Peseran et al. (2004) LM_{adj} tests statistics are calculated.

According to the results of the cross-sectional dependence test, H_0 could not be rejected. In other words, no cross-section dependence is found on the models.

Table 10: Cross Section Dependency Test Results

Model 1	**Statistic**	**Prob.**

Breusch-Pagan CDLM1	28.31869	0.4477
Pesaran scaled CDLM	-1.026458	0.3047
Bias-corrected scaled LM(LMadj)	-1.147671	0.2511
Pesaran CDlm2	0.817984	0.4134
Model 2		
Breusch-Pagan CDLM1	39.89642	0.0675
Pesaran scaled CDLM	0.520681	0.6026
Bias-corrected scaled LM(LMadj)	0.354014	0.7233
Pesaran CDlm2	1.942722	0.0520

In this context, we can proceed with the first generation panel unit root tests and cointegration analysis, that yield more reliable results.

Table 11: IPS (2003) Panel Unit Root Test Results for Model 1

Variables	I(0)	I(1)
LNGDP	4.928	-4.640***
LNRE	0.327	-12.696***
LNNRE	-1.068	-6.306***
LNCO2	0.470	-12.684***
LNL	1.756	-3.450***
UPO	4.417***	-
LNENU	1.180	-7.784***
LNRGC	3.220	-7.910***
ENI	-1.312	-8.536***

Note: ***, **, *, Indicates that the variables are respectively stationary at 1%, 5% and 10% significance levels

According to Im, Pesaran, and Shin (2003) panel unit root test results, which is among the first generation panel unit root tests, all variables except the UPO variable are stationary at the first difference. On the other hand, the UPO variable was found to be stationary at the basic level.

According to Pedroni cointegration test results (Panel PP-Statistic, Panel ADF-Statistic, Group PP-Statistic, Group ADF-Statistic), it is determined that there is co-integration for model 1 (Table 12).

Table 12: Pedroni Co-Integration Test Results for Model 1

Model 1	Statistic	Prob.	Weighted	Prob.

			Statistic	
Panel v-Statistic	1.049543	0.1470	0.551701	0.2906
Panel rho-Statistic	0.251352	0.5992	0.291141	0.6145
Panel PP-Statistic	-1.640073	0.0505	-1.403744	0.0802 *
Panel ADF-Statistic	-1.646606	0.0498	-1.431311	0.0762 *
Alternative hypothesis: individual AR coefficients (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	1.275550	0.8989		
Group PP-Statistic	-1.488220	0.0683*		
Group ADF-Statistic	-1.411609	0.0790*		

Note: *, indicates that co-integration at a 10% significance level**.**

Thus, renewable energy, non-renewable energy, labor, and capital formation are co-integrated in the long run. Since there is cointegration in model 1, cointegration coefficients should be found in the second step. In this context, the panel DOLS estimator is used as the cointegration coefficient estimator (Table 13).

Table 13: Panel DOLS Co-Integration Estimator Results for Model 1

Variable	**Coefficient**	**Std. Error**	**Prob.**
LNRE	0.057012	0.060232	0.3469
LNNRE	0.236000	0.049666	0.0000***
LNL	0.437428	0.160094	0.0078***
LNRGC	0.270287	0.050365	0.0000***
R-squared	0.996		
Adjusted R-squared	0.992		

Note: ***, indicates significance at a 1% level of importance

According to panel DOLS co-integration coefficient estimator results; only the renewable energy variable is found to be statistically insignificant.

Accordingly, a 1% increase in non-renewable energy production causes a 0.24% increase in GDP, a 1% increase in labor force causes 0.44% increase in GDP, and a 1% increase in the capital formation increases GDP by 0.27%. In this case, the determinants of economic growth are non-renewable energy, labor, and capital formation In addition, 99% of the explanatory power of the model is an important finding.Regarding the insignificant effect of renewable energy on GDP, it is thought that the amount of renewable energy produced in the studied countries is insufficient. In the table below, co-integration coefficients for each country are examined separately.

Table 14: Co-integration Coefficient Estimator Results for D-8 Countries for Model 1

Turkey	**Coefficient**	**Std. error**	**Prob.**
LNRE	0.003	0.020	0.859
LNNRE	0.072	0.031	0.022**
LNL	0.575	0.908	0.000***
LNRGC	0.315	0.027	0.000***
Constant	-11.396	1.970	0.000***
Bangladesh	**Coefficient**	**Std. error**	**Prob.**
LNRE	-0.012	0.012	0.310
LNNRE	0.126	0.047	0.008***
LNL	-0.567	0.109	0.000***
LNRGC	0.631	0.075	0.000***
Constant	0.334	1.324	0.808
Indonesia	**Coefficient**	**Std. error**	**Prob.**
LNRE	0.307	0.052	0.566
LNNRE	0.076	0.107	0.475
LNL	0.443	0.235	0.060*
LNRGC	0.422	0.046	0.000***
Constant	-12.361	4.400	0.005***
Iran	**Coefficient**	**Std. error**	**Prob.**
LNRE	0.316	0.019	0.100*
LNNRE	0.152	0.139	0.475
LNL	0.096	0.171	0.573
LNRGC	0.257	0.033	0.000***
Constant	-2.188	2.145	0.308
Malaysia	**Coefficient**	**Std. error**	**Prob.**
LNRE	-0.009	0.034	0.787

Table 14 (Continue)

LNNRE	0.336	0.047	0.000***
LNL	0.226	0.309	0.465
LNRGC	0.127	0.031	0.000***
Constant	-2.331	5.138	0.650
Nigeria	**Coefficient**	**Std. error**	**Prob.**
LNRE	0.018	0.092	0.843

LNNRE	0.332	0.113	0.003***
LNL	-0.015	0.661	0.981
LNRGC	0.188	0.049	0.000***
Constant	0.657	11.429	0.954
Pakistan	**Coefficient**	**Std. error**	**Prob.**
LNRE	0.018	0.030	0.206
LNNRE	0.051	0.053	0.328
LNL	0.375	0.194	0.053*
LNRGC	0.022	0.021	0.291
Constant	-1.541	2.987	0.606
Egypt	**Coefficient**	**Std.error**	**Prob.**
LNRE	0.094	0.033	0.005***
LNNRE	0.346	0.242	0.153
LNL	0.120	0.027	0.000***
LNRGC	0.595	0.143	0.000***
Constant	-1.362	3.698	0.363

Note: ***, **, * Indicates significance at 1%, 5% and 10% importance levels, respectively**.**

When the model is examined for Turkey; all variables positively affected GDP, but the renewable energy variable was found to be statistically insignificant. According to these results, 1% increase in LNNRE variable increases GDP by 0.072%, 1% increase in LNL variable increases GDP by 0.575%, 1% increase in LNRBS variable increases GDP by 0.315%. For Bangladesh, while there is no statistically significant relationship between GDP and LNRE, it is found that the LNL variable negatively affects GDP, and LNNRE and LNRGC variables positively affect GDP. LNRE and LNNRE variables are statistically insignificant for Indonesia, whereas LNL and LNRGC variables are positive and statistically significant. LNRE and LNRGC are positive and statistically significant for Iran, whereas LNNRE and LNL are statistically insignificant. For Malaysia and Nigeria, LNNRE and LNRGC are statistically significant and positive, whereas LNRE and LNL are statistically insignificant. While only LNL is statistically significant and positive for Pakistan, all variables except for LNNRE are statistically significant. The coefficients of all variables are positive for Egypt.

Table 15: Dumitrescu-Hurlin Panel Causality Tests for Model 1

Null Hypothesis:	**W-Stat.**	**Zbar-Stat.**	**Prob.**

DLNNRE does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DLNNRE	3.39339 3.13812	0.04083 -0.18794	0.9674 0.8509
DLNRE does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DLNRE	3.64952 2.61154	0.27038 -0.65986	0.7869 0.5093
DLNL does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DLNL	3.09575 6.08538	-0.30352 2.17719	0.7615 0.0295**
DLNRGC does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DLNRGC	2.13357 7.13647	-1.09059 3.35060	0.2755 0.0008***
DLNRE does not homogeneously cause DLNNRE DLNNRE does not homogeneously cause DLNRE	2.09308 2.78385	-1.11492 -0.45542	0.2649 0.6488
DLNL does not homogeneously cause DLNNRE DLNNRE does not homogeneously cause DLNL	3.20251 6.64615	-0.21494 2.64250	0.8298 0.0082**
DLNRGC does not homogeneously cause DLNNRE DLNNRE does not homogeneously cause DLNRGC	2.79182 3.73905	-0.46026 0.43060	0.6453 0.6668
DLNL does not homogeneously cause DLNRE DLNRE does not homogeneously cause DLNL	2.69427 5.63394	-0.63666 1.80259	0.5243 0.0715*
DLNRGC does not homogeneously cause DLNRE DLNRE does not homogeneously cause DLNRGC	2.27134 2.68575	-0.94977 -0.56002	0.3422 0.5755
DLNRGC does not homogeneously cause DLNL DLNL does not homogeneously cause DLNRGC	3.42454 2.54074	-0.03070 -0.76405	0.9755 0.4448

Note: ***, **, * means causality at the level of %1, %5, and %10, respectively.

According to Dumitrescu and Hurlin (2012) panel causality analysis (Table15), one-way causal relationship from GDP to the labor force and capital formation, and a one-way causal relationship from non-renewable energy and renewable energy to the labor force are detected. However, no causality is detected among other variables. In the table below, cointegration analysis for model 2 is reported.

According to Pedroni cointegration test results , it is determined that there is co-integration for model 2 (Table 16).

Table 16: Pedroni Co-integration Results for Model 2

Model 2	Statistic	Prob.	Weighted	Prob.

			Statistic	
Panel v-Statistic	0.061781	0.4754	-0.355550	0.6389
Panel rho-Statistic	1.673314	0.9529	1.019232	0.8460
Panel PP-Statistic	-0.039576	0.4842	-1.846686	0.0324**
Panel ADF-Statistic	-1.202145	0.1147	-2.189455	0.0143*
Alternative hypothesis: individual AR coefficients (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	2.144146	0.9840		
Group PP-Statistic	-1.561095	0.0593*		
Group ADF-Statistic	-1.396404	0.0813*		

Note: **,*, indicates the presence of cointegration at 5% and 10% significance levels, respectively.

According to this, there is a long-term relationship between renewable energy and CO2, GDP, ENU, UPO, ENI, NRE. Since model 2 has co-integration, the second step is to calculate co-integration coefficients. In this context, the panel DOLS estimator is used as the cointegration coefficient estimator.

Table 17: Panel DOLS Estimator for Model 2

Variable	Coefficient	Std. Error	Prob.
LNGDP	0.890561	0.325211	0.0067***
LNCO2	-0.121970	0.309868	0.0694*
LNNRE	-0.277670	0.153536	0.0719*
LNENU	0.607202	0.354235	0.0879*
UPO	-0.215615	0.040323	0.0000***
ENI	0.018302	0.020008	0.3614
R-squared	0.98		
Adjusted R-squared	0.97		

Note: ***, **, * represent significance at 1%, 5% and 10% significance levels, respectively.

According to panel DOLS co-integration coefficient estimator results (Table 17), all variables are statistically significant except net energy imports. A 1% increase in CO_2 emissions reduces renewable energy by 0.121%. A 1% increase in GDP increases renewable energy by 0.890%. A 1% increase in urban population decreases renewable energy by 0.215%, and 1% increase in non-renewable energy decreases renewable energy by 0.277%.

Table 18: D-8 Countries Co-Integration Coefficient Estimator Results for Model 2

Turkey	Coefficient	Std. Error	Prob.
LNGDP	0.948	0.565	0.094*
LNCO2	-1.296	1.434	0.396
LNNRE	-0.612	0.184	0.001***
LNENU	2.641	1.887	0.162
UPO	-0.116	0.039	0.003***
ENI	0.106	0.143	0.455
Constant	-4.806	6.077	0.429
Bangladesh	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	0.254	1.712	0.882
LNCO2	-0.232	0.691	0.737
LNNRE	-0.175	0.668	0.793
LNENU	-1.133	1.536	0.461
UPO	0.237	0.103	0.021**
ENI	0	0	0
Constant	3.276	5.206	0.529
Indonesia	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	0.266	0.433	0.538
LNCO2	-0.250	1.277	0.366
LNNRE	0.212	0.303	0.484
LNENU	0.407	0.420	0.332
UPO	-0.044	0.066	0.497
ENI	6.188	20.255	0.760
Constant	-0.559	2.356	0.812
Iran	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	3.752	0.878	0.000***
LNCO2	-1.143	1.125	0.057*
LNNRE	-3.095	0.922	0.001***
LNENU	1.498	1.026	0.147
UPO	-0.007	0.160	0.964
ENI	-0.068	0.022	0.003***
Constant	1.263	11.287	0.000***
Malaysia	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	3.481	0.797	0.000***
LNCO2	-0.927	0.516	0.072*
LNNRE	-1.355	0.373	0.000***
LNENU	-0.567	0.792	0.474
UPO	0.107	0.079	0.177
ENI	0.154	0.054	0.005***
Constant	-0.113	3.919	0.977
Nigeria	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	-0.791	0.228	0.001***
LNCO2	0.084	0.138	0.541

Table 18 (Continue)

LNNRE	0.076	0.327	0.816
LNENU	2.425	1.236	0.050**
UPO	-0.085	0.071	0.233
ENI	-0.001	0.901	0.999
Constant	-11.649	7.205	0.106
Pakistan	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	-0.578	0.983	0.953
LNCO2	-0.499	0.845	0.595

LNNRE	-0.599	0.252	0.018**
LNENU	2.224	1.192	0.062*
UPO	-0.455	0.323	0.163
ENI	1.412	0.977	0.149
Constant	-2.249	5.721	0.694
Egypt	**Coefficient**	**Std. Error**	**Prob.**
LNGDP	1.256	0.597	0.036**
LNCO2	0.437	0.313	0.163
LNNRE	-0.787	0.415	0.058*
LNENU	-0.406	0.311	0.193
UPO	-0.131	0.084	0.107*
ENI	0.023	0.060	0.706
Constant	-4.982	2.595	0.055*

Note: ***, **, * Indicates significance at 1%, 5% and 10% significance levels, respectively.

When the results of the global panel are analyzed (Table 18), the LNGDP, LNNRE, and UPO variables for Turkey are statistically significant, while the CO2, ENI, and LNENU variables are statistically insignificant. According to these results, a 1% increase in LNGDP increases LNRE by 0.948%. A 1% increase in LNNRE reduces LNRE by 0.612%. A 1% increase in UPO decreases LNRE by 0.116%. All variables except UPO are statistically significant for Bangladesh. However, the ENI variable is not calculated for Bangladesh due to insufficient data. The UPO variable has a positive effect on the LNRE. All variables for Indonesia are statistically insignificant. For Iran and Malaysia, all variables except the LNENU and UPO variables are statistically significant and positive. For Nigeria, the LNGDP and LNENU variables are statistically significant and positive. The LNNRE and LNENU variables for Pakistan are statistically significant and positive. For Egypt, the LNGDP, LNNRE, and UPO variables are positive and statistically significant.

Table 19: Dumitrescu-Hurlin Panel Causality Tests for Model 2

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
DLNGDP does not homogeneously cause DLNNRE	2.08507	-0.12999	0.8966
DLNNRE does not homogeneously cause DLNGDP	2.51460	0.37071	0.7109
DLNCO2 does not homogeneously cause DLNNRE	3.29126	1.36721	0.1716
DLNNRE does not homogeneously cause DLNCO2	2.17750	0.02115	0.9831

DLNRE does not homogeneously cause DLNNRE DLNNRE does not homogeneously cause DLNRE	2.17478 3.66772	0.02545 1.84055	0.9797 0.0657*
DUPO does not homogeneously cause DLNNRE DLNNRE does not homogeneously cause DUPO	1.82352 2.61528	-0.40160 0.56100	0.6880 0.5748
DLNCO2 does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DLNCO2	4.22592 2.17020	2.32934 -0.04253	0.0198** 0.9661
DLNRE does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DLNRE	3.07514 1.50318	1.02411 -0.80828	0.3058 0.4189
DUPO does not homogeneously cause DLNGDP DLNGDP does not homogeneously cause DUPO	2.55888 1.14340	0.42233 -1.22766	0.6728 0.2196
DLNRE does not homogeneously cause DLNCO2 DLNCO2 does not homogeneously cause DLNRE	5.02678 1.63204	3.46472 -0.63808	0.0005*** 0.5234
DUPO does not homogeneously cause DLNCO2 DLNCO2 does not homogeneously cause DUPO	1.84874 4.18599	-0.37619 2.44856	0.7068 0.0143**
DUPO does not homogeneously cause DLNRE DLNRE does not homogeneously cause DUPO	1.96366 1.40418	-0.23123 -0.91144	0.8171 0.3621

Note: ***, **, * represent causality at a significance level of 1%, 5% and 10%, respectively.

According to panel causality analysis results (Table 19), a unidirectional causality from non-renewable energy sources to renewable energy sources, a one-way causality from CO_2 to GDP, a one-way causality from renewable energy to CO_2, and a one-way causality from CO_2 to the urban population are detected. On the other hand, no causal relationship between GDP and non-renewable energy, between CO_2 and non-renewable energy, between population and non-renewable energy, between GDP and renewable energy, between GDP and population, between population and renewable energy could be determined.

CHAPTER V

CONCLUSIONS

Fossil fuels, a very important input for the world economy, are in danger of being depleted rapidly. In addition, efforts to reduce the amount of use as much as possible due to environmental damage occupy an important place on the world agenda. At this point, renewable energy is both a local and a clean alternative. Besides being clean and harmless, renewable energy sources, which contribute to the decrease of dependence on foreign sources and increase in employment since they are domestic resources, have become one of the important elements for economic growth. The fact that the increase in energy demand is mainly met by external sources causes the problem of energy scarcity and security.

In the D-8 organization, which has important potential in the world economy, it is remarkable that this issue is brought to the agenda with importance. The adoption of the "D-8 Istanbul Action Plan" at the ninth Summit of the D-8 Economic Cooperation Organization in 2017 is proof of this. The D-8 countries, which correspond to 16% of the world as a population and 65% of the Islamic world, have a working group formed according to the plan, and the countries have positive intentions to increase the share of renewable energy. However, at this stage, the interest in renewable energy sources used in the D-8 group countries is not sufficient. According to the literature, it is possible to grow with renewable energy sources, which is a production factor with low carbon emissions. However, in D-8 countries, the interest in renewable energy is not desirable due to reasons such as the use of fossil fuels.

In the first part of the study, to compare the energy concept and usage rates in the world, the potential of renewable and non-renewable energy sources in the world, their use, have been discussed in detail. In the second part, the energy outlook of the D-8 organization has been extensively studied. In the third and final part of the study, the relationship between renewable energy and economic growth of the D-8 countries (Turkey, Iran, Pakistan, Bangladesh, Malaysia, Indonesia, Egypt, and Nigeria) for the 1980-2015 period and the determinant factors of this relationship are studied. To this end, GDP, renewable energy, non-renewable energy, carbon dioxide emissions, real gross fixed capital, labor force, net energy imports, per capita energy use, urban population growth rate variables from the World Bank data sets are compiled.

In the analysis, cross-section dependency test, Im, Pesaran, and Shin (2003) panel unit root test, Pedroni co-integration test, Dumitrescu and Hurlin (2012) panel causality test are implemented. The second model explores the factors that affect the use of renewable energy and the direction of the relationship while investigating the factors that affect economic growth. Based on the established models, analyses are performed both for whole D-8 organization and individual countries.

In the analysis for model 1, it is seen that GDP and renewable energy, non-renewable energy, labor, and capital formation co-integrate in the long run. In the results of the panel DOLS cointegration coefficient estimator, the renewable energy variable is found to be statistically insignificant, and this finding is attributed to the insufficient level of renewable energy use in D-8 countries. In the causality analysis, no causality between GDP and renewable energy could be determined. In the analysis made with Model 2, a long-term relationship is found between renewable energy and CO2, GDP, ENU, UPO, EIM, NRE variables. However, net energy imports are not statistically significant in coefficient estimates. On the other hand, according to causality analyses, no causality between economic growth and renewable energy could be determined. However, according to the panel DOLS estimator, economic growth has a positive impact on the amount of non-renewable energy.

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