T.C.
UNIVERSITY OF GAZİANTEP
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF BUSINESS ADMINISTRATION

THE RELATIONSHIP BETWEEN FINANCIAL DEVELOPMENT AND RENEWABLE ENERGY PRODUCTION: THE CASE OF G20 COUNTRIES

MASTER'S THESIS

Ahmet Fatih TAHİROĞLU

Supervisor: Asst. Prof. Dr. Şükriye Gül REİS

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AHMET FATİH TAHİROĞLU

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Approval of the Graduate School of Social Sciences

Assoc. Prof. Dr. Zekiye ANTAKYALIOĞLU
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master's of Art.

Prof. Dr. H. Mustafa PAKSOY
Head of Department

This is to certify that I(we) has(have) read this thesis and that in my(our) opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master's of Art.

Asst. Prof. Dr. Şükriye Gül REİS
Supervisor

This is to certify that we have read this thesis and that in our opinion it is fully adequate by unanimous vote, in scope and quality, as a thesis for the degree of Master's of Art.

Examining Committee Members:

Asst. Prof. Dr. Şükriye Gül REİS (Chair) ____________________

Asst. Prof. Dr. Yunus KILIÇ ____________________

Asst. Prof. Dr. Mehmet Akif DESTEK ____________________

T.C.
GAZİANTEP ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İŞLETME ANA BİLİM DALI

Finansal Gelişme İle Yenilenebilir Enerji Üretimi Arasındaki İlişki: G20 Ülkeleri Örneği

AHMET FATİH TAHİROĞLU

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Doç. Dr. Zekiye ANTAKYALIOĞLU
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Tez Danışmanı

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Jüri Üyeleri:

Dr. Öğr. Üy. Şükriye Gül REİS (Jüri Başkanı) ____________________

Dr. Öğr. Üy. Yunus KILIÇ ____________________

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Ahmet Fatih TAHİROĞLU

05.08.2019

ABSTRACT

THE RELATIONSHIP BETWEEN FINANCIAL DEVELOPMENT AND RENEWABLE ENERGY PRODUCTION: THE CASE OF G20 COUNTRIES

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Advisor: Dr. Şükriye Gül REİS
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The requirements of the increasing population of our world are being fulfilled by the economic growth of the countries. Providing the energy demand with sensitive to environment by being sensitive to the environment is one of the basic conditions in terms of sustainability. The main purpose of this study is to reveal the relationship between the renewable energy production of countries and the symbols of their financial development and economic growth. In the 20th century, when the countries began to be managed as companies in terms of effective and efficient use of energy and financial resources, the increasing need for energy increased with the tendency towards fossil fuels and nuclear energy, while increasing pollution became a source of concern. The Kyoto Protocol, which was signed in 1997, is an important milestone that directs countries to renewable energy sources against increasing pollution. In this study, G20 countries which represent a significant part of the world population and economy are examined. The relationship between domestic credits to private sector, gross domestic product amounts which are one of the important cause and effect indicators of financial development and renewable energy production, were examined for the period between 2001 and 2016. Findings obtained from the research, cointegration between the variables was clearly seen. However, no causal relationship was found between the studied variables.

Key words: GDP, Financial Development, Renewable Energy, G20

ÖZET

FİNANSAL GELİŞME İLE YENİLENEBİLİR ENERJİ ÜRETİMİ ARASINDAKİ İLİŞKİ: G20 ÜLKELERİ ÖRNEĞİ

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Dünyamızın artan nüfusunun ihtiyaçları ülkelerin ekonomik olarak büyümesi ile karşılanmaya çalışılmaktadır. Büyüme sonucu artan enerji ihtiyacının çevreye duyarlı kalınarak sağlanması sürdürülebilirlik açısından temel şartlardandır. Bu çalışmanın temel amacı ülkelerin yenilenebilir enerji üretimleri ile ülkelerin finansal gelişimleri ile birlikte ekonomik büyümelerinin simgeleri arasındaki ilişkinin ortaya konmasıdır. Enerji ve finans kaynaklarının efektif ve verimli kullanılması noktasında ülkelerin birer şirket gibi yönetilmeye başlandığı 20. yüzyılda hızlı sanayileşme ile artan enerji ihtiyacı fosil yakıtlara ve nükleer enerjiye olan eğilimi artırmışken, artan kirlilik bir endişe kaynağı olmuştur. 1997 yılında imzalanan Kyoto Protokol'ü artan kirliliğe karşı ülkeleri yenilenebilir enerji kaynaklarına yönlendiren önemli bir dönüm noktasıdır. Bu çalışmada dünya nüfusunun ve ekonomisinin önemli bir kısmını temsil eden G20 ülkeleri incelenmiştir. Finansal gelişimin önemli neden ve sonuç işaretçilerinden olan yurt içi özel sektör kredileri ile gayri safi yurt içi hasıla miktarları ile yenilenebilir enerji üretimleri arasındaki ilişki 2001-2016 yılları arasındaki dönem için incelenmiştir. Araştırmadan elde edilen bulgularda değişkenler arasındaki eş bütünleşme net bir şekilde görülmüştür. Ancak, incelenen değişkenler arasında herhangi bir nedensellik ilişkisi bulunamamıştır.

Anahtar kelimeler: GSMH, Finansal Gelişme, Yenilenebilir Enerji, G20

DEDICATION

...to my family

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First of all I want to thank to Allah, the only one creator of universe.

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PREFACE

As countries are growing economically, they have to increase their energy production as their energy consumption increases. As the energy resources of the countries are different, the ratio of resources used in energy production is different. Oil and gas-rich countries do not need much renewable energy resources. However, these countries should know that fossil resources are limited and their current position is not sustainable. In the long term, sustainable economic growth is only possible with sustainable environmental policies.

The main point in this study is the relationship between the countries' orientation towards renewable energy against changes in their gross domestic product and domestic credits to private sector, which are the most important indicators of the financial development and the economic growth of these countries. In this study, the data of G20 countries are examined and it is a pluralist sample group of developed and developing countries.

It is very difficult to determine in which country the source is consumed because electricity is also traded in electricity lines as well as energy source exports. Therefore, renewable energy production selected instead of renewable energy consumption. However, much longer time intervals could be selected in the panel data study, the data of all G20 countries could only be reached between 2001 and 2016.

As a result of cointegration tests with panel data analysis, it has been found that there is co-integration between renewable energy, gross domestic product and domestic credits to private sector. In addition, the causality tests showed a there is no causality. The reason why the causality cannot be determined may be that the relationship between the variables is much more complicated and includes different variables. This could be the subject of a new research.

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SYMBOLS AND ABBREVIATIONS

G20	Group 20 Countries
GDP	Annual Gross Domestic Product
DCP	Domestic Credits to Private Sector
RNW	Annual Renewable Energy Generation
USD	United States Dollar
KToe	Thousand Tonne of Oil Equivalent
GWh	Giga Watt Hour
TWh	Terra Watt Hour
MW	Mega Watt
HEPP	Hydro Electric Power Plant
SPP	Solar Power Plant
WPP	Wind Power Plant
TPP	Thermal Power Plant
CO	Carbon Monoxide Gas
EU	European Union
COP1	Conference of Parties, Berlin
COP3	Conference of Parties, Kyoto Protocol
COP21	Conference of Parties, Paris Protocol
UNFCC	United Nations Framework Convention on Climate Change
DF	Dickey-Fuller
ADF	Advanced Dickey-Fuller
Prob.	Probability

CHAPTER I

INTRODUCTION

1.1. INTRODUCTION

Energy is one of the main requirements for human life. From past to present most of wars have been done for capturing energy sources. After industrial revolution, from the beginning of twentieth century, oil and electricity become more important. Because of the main source of generating electricity, fossil fuels turn into indispensable source. The main reason for the first and second world wars was to have places where fossil fuels were found by colonialism. For this reason, the Middle East and South America, where the main fossil fuels were, was the scene of the power demonstrations of the imperial powers.

It is seen that the countries rich in energy resources are enriched in this way. On the other hand, it is seen that the energy needs of the enriched countries also increased. This shows that there is an undeniable relationship between energy production or consumption and economic wealth.

There are many studies on the relationship between energy and economic growth. Almost all of these studies reveal the relationship between economic growth and energy consumption. The most decisive factor in economic growth of a country is energy (Şengelen, 2016:1). There is bidirectional relationship between energy and economic growth (Ballı, 2018:773-778).

The sources obtained by using different methods in economic terms energy sources, and these sources classified in different types. These sources are examined as primary and secondary energy sources according to their convertibility energy sources renewable and non-renewable energy sources. Non-renewable energy sources are at risk of short-term extinction (Koç and Şenel, 2013: 33).

Before 18th century, renewable energy has no alternative. Energy production based on fossil or nuclear resources has been continuing for the last two centuries. The fact that energy production from fossil or nuclear sources is easier has gradually increased energy production from these sources. At the beginning of the 21st century, 80% of the world's energy production comes from nuclear or fossil fuels such as oil and natural gas. (Sorensen, 1991:125).

Thermal Power Plants (TPP) use fossil fuels and unleash intensive carbon monoxide gas (CO) to atmosphere. Industrial plants, motor vehicles, ships and many other machines pollute our world by releasing carbon monoxide every day. The other waste gases and CO have caused air pollution and global warming. In this context, it is an undeniable reality that countries are turning to renewable energy sources by reducing carbon emissions in other areas such as electricity generation and motor vehicles.

Renewable energy investments support the economic independence of the countries as they lead to domestic resources. Although the dependence on fossil fuels is currently high, renewable energy usage rates are increasing gradually over the years. There are a number of basic factors that affect countries' orientation towards renewable energy. These are;

- Sufficient financial power for the country to invest in renewable energy.
- Sufficient technological infrastructure for the country to invest in renewable energy.
- Sensitivity of country administrations on renewable energy.

Since renewable energy is an issue for the future of our world, countries a series of conferences and conventions has been done in the international arena. With the UNFCC Congresses; COP1 (1995, Berlin), COP3 (1997, Kyoto) and COP21 (2015, Paris) more than 185 countries has committed to limit greenhouse gas emission. But the main goal for why governments and businesses are willing to renewable energies as soon as possible is that fossil fuels are a finite resource. With evolution of technology alternative energy sources started to be searched.

The Kyoto Protocol was held in December 1997 in Kyoto, Japan. The conference was attended by approximately 10,000 delegates, observers and journalists. The Kyoto Protocol was signed on 16 March 1998. It is planned to enter into force 90 days after the approval of 55 countries. In the Kyoto protocol, the parties pledged to reduce greenhouse gas emissions by 5% by 2008 compared to 1990(Alkan and Olsson, 2012:1-30).

Renewable energy technology has been started to develop after 1960. But the rapid technology development has started after 2000s. Especially solar and wind power plant capacities are increased considerably. Figure 1.1 shows the global electricity generation from renewable energy over the long-term.

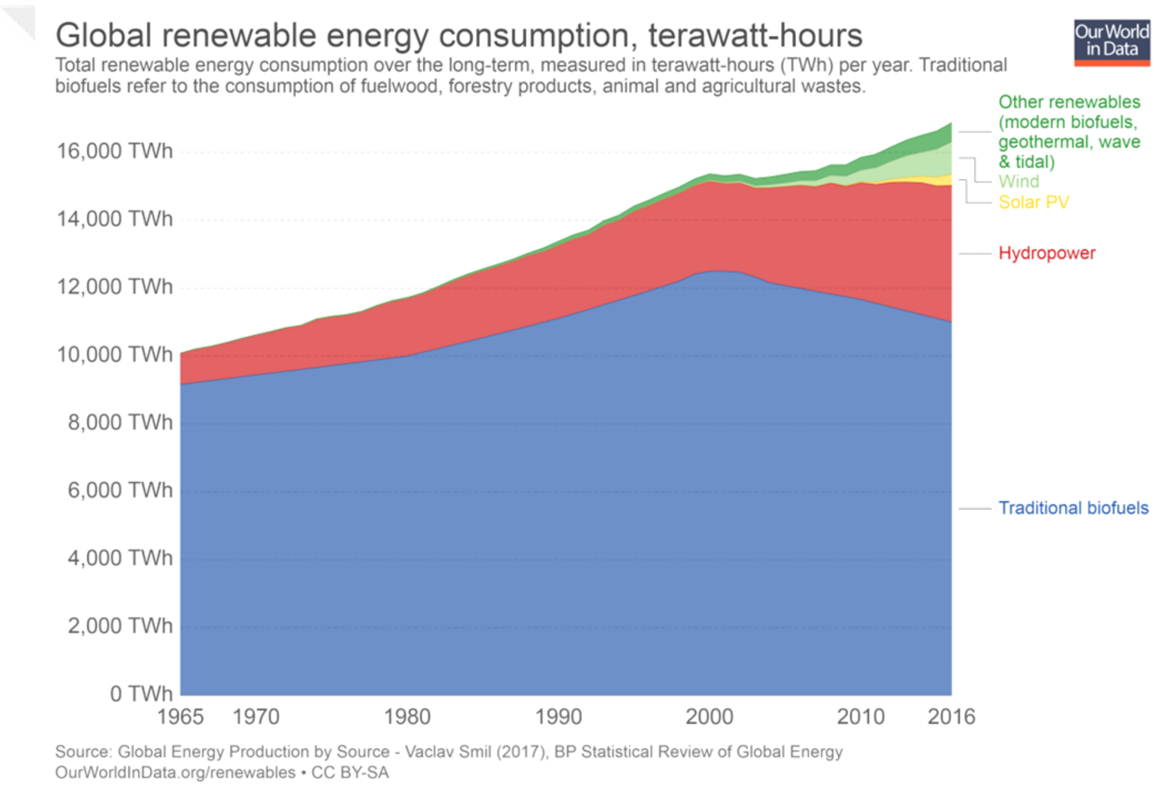

Figure 1.1 Global Renewable Energy Consumption (Ourworldindata.org, 2018)

Innovation in renewable technology includes hydropower, wind, solar and geothermal electricity generation capacity. Renewable energy technologies are fresh sources of energy that have a much lower environmental impact than the other technologies. However, although it is based on renewable energy, serious damage to the environment can be caused during the construction of these power plants.

Renewable energy sources accounted for nearly 20 percent of global energy at the beginning of the 21st century. By 2015 about 16 percent of the world's total electricity came from large hydroelectric power plants, whereas other types of renewable energy (Ritchie, 2018).

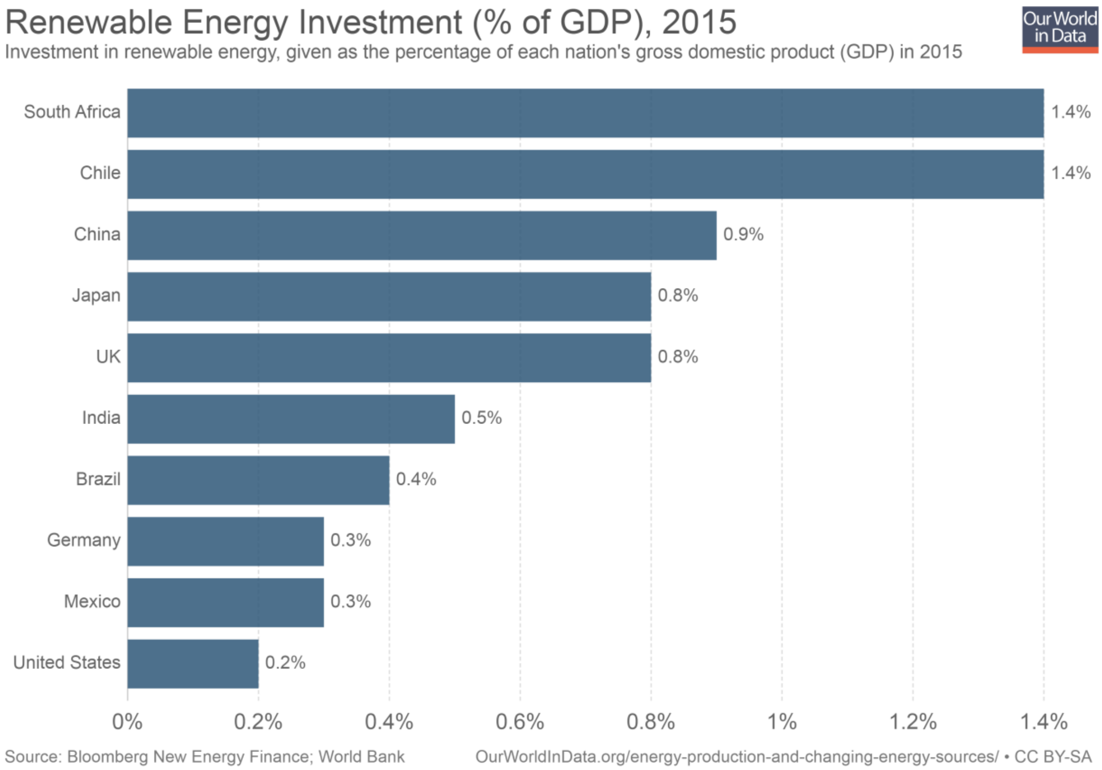

Figure 1.2 Renewable Energy Investment Ratio in 2015 (Ourworldindata.org, 2018)

As can be seen from Figure 1.2, many countries use less than 1% of their GDP for renewable energy investments. It is interesting to note that developed countries, such as the United States, have made much less renewable energy investments for at least 2015 (Figure 1.2:ourworldindata.org) (Ritchie, 2018).

The first United Nations Climate Change Conference called COP1 had been done 1995 in Berlin. In this conference countries decided to do something to bad trajectory of world environment and climate. One of the decisions is improving renewable energy production and decreasing carbon emission. But some countries are not very much willing to do this when some of them are loyal to their signatures.

Energy is never effortlessly obtained. There is a cost to produce and consume energy. Therefore, energy is an economic asset. It is an undeniable fact that this economic asset is associated with economic growth. As well as being a cost of generating energy, energy-producing plants are also economic investment instruments and need large sources of financing. For this reason, the relationship between financial development and energy is worth considering. The relationship between renewable energy and financial development of energy resources is a more specific research topic.

As the financial development and renewable energy production of G20 countries are examined within the scope of this research, it is interesting to examine the countries in question as a single country on a graph. In Figure 1.3, Green colour represents RNW(Annual renewable energy production), blue represents DCP(Annual Domestic Credits to Private Sector) and red represents GDP(Gross domestic product) in the Figure 1.3. The terms in the Figure 1.3; RNW unit is kToe when in the graphics GDP unit is 100 Million USD and DCP unit is also 100 Million USD to show the parallel relationship better. If we think of G20 countries as a single country, we see a picture. Figure 1.3 shows us during the 24 years, GDP and RNW has been increased linear and parallel. And DCP is near to them. This graph actually demonstrates the expression of this study using only a single graph without using different research methods to reveal the relationship between GDP, DCP and RNW.

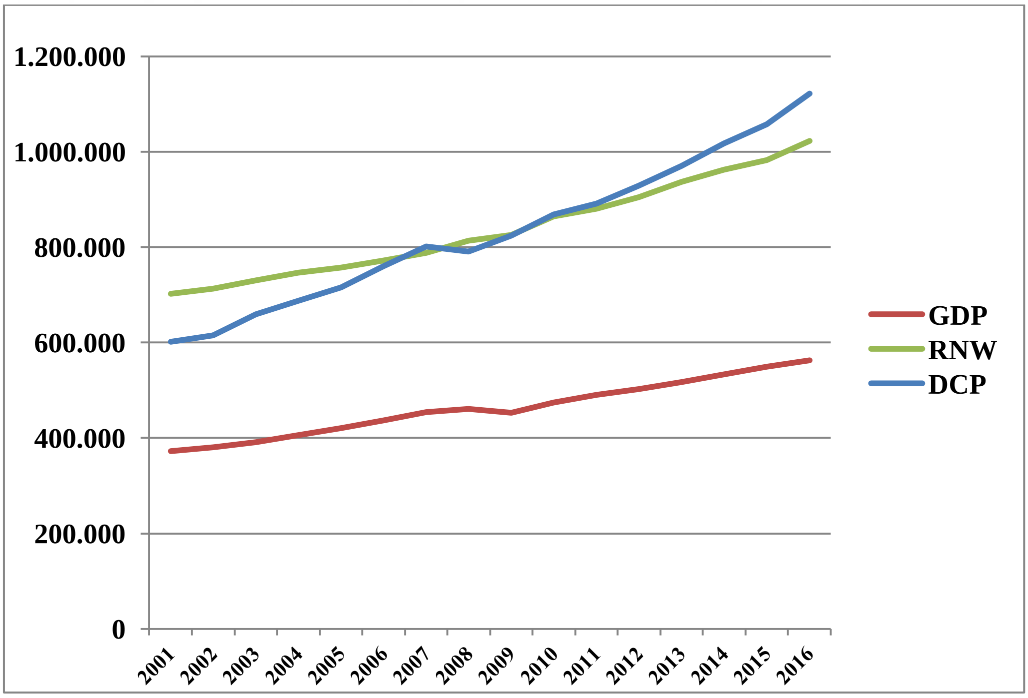

Figure 1.3 RNW-GDP-DCP Graphic

Despite the decline in GDP between 2008 and 2010, the continuation of the upward trend in RNW was an interesting issue. This can be studied that although renewable energy investments in the world decreased between 2008 and 2010, renewable energy production continues to increase. Due to the economic contraction, the falling income of countries may have removed those countries from oil as an energy source. In this case, they may have used the capacity of the RNW installed in their hand more. This topic can be a different and important research topic. To see countries' positions, the table below is more understandable. Figure 1.4 and Figure 1.5 show country standings due to renewable energy production in the year 2016.

Figure 1.4 G20 Countries' RNW Production in 2016 (Australia Gov. Portal, 2018)

Figure 1.5 G20 Countries' GDP in 2016 (Australia Gov. Portal, 2018)

The effects of the world globally or the individual effects of the countries are reflected in the graphics. As can be seen, renewable energy production of G20 countries has increased continuously. The impact of the global economic crisis on DCP and GDP in 2008 is clearly evident. In 2008 world economic crisis and global recession effect G20 countries DCP and GDP values as it seem in the graphics. There is a horizontal period after 2008 world economic crisis, but after 2010 all parameters increased continuously.

In all parts of the world, companies in all sectors have turned to clean energy and in 2004, they increased their investments from 33 billion USD to 155 billion dollars in 2008. Nevertheless, the upturn in the second half of 2008 was at a standstill. The biggest decline was experienced in the first quarter of 2009 when the investments in clean energy decreased by 50% compared to a year ago. (Albayrak, 2011:26)

The change in countries' renewable energy investments according to gross domestic product or Domestic Credits to Private Sector does not show their interest in direct renewable energy. The main determinants of this problem are whether countries have renewable or non-renewable energy resources or the lifetime of their existing investments. Therefore, a long-term exam will lead to more realistic results. The aim of this study is to determine whether there is only a cointegration or causality relationship.

There are major characteristics of why countries invest Renewables much more or not. For example Saudi Arabia has rich oil researches and they thought that they does not need to renewables. Or Germany has no oil resources and does not want to be dependent to other countries, so Germany has invested to renewables much more. Therefore countries need to be evaluated separately. The G20 Countries Standing in terms of Renewable sources in total Electricity Generation in 2017 is below: (2018, Global Energy Statistics Yearbook)

Standing	COUNTRY	(2017) (%) Renewable Sources / Total Electricity Generation
1	Brazil	79,7
2	Canada	64,7
3	Italy	35,7
4	Germany	34,0
5	United Kingdom of Britain	30,2
6	Turkey	29,5
7	Argentina	28,0
8	China	26,0
9	United States of America	18,4
10	Japan	17,8
11	France	17,6
12	Russia	17,5
13	Mexico	16,6
14	India	16,3
15	Australia	14,9
16	Indonesia	12,3
17	South Africa	4,2
18	South Korea	3,4
19	Saudi Arabia	Less than 0,1

Table 1.1 G20 Renewable Source Ratio in Total Electricity Production (2018, Global Energy Statistics Yearbook)

1.2. RENEWABLE ENERGY TYPES

1.2.1. Solar Energy

Mankind has been using solar energy for thousands of years for many purposes. The sun has been sending its energy to us for a long time and it is actually the only source for all the energy sources and fuels we use today. People dried their grains and other foods using sunlight and prevented them from deteriorating. As technology evolved, human beings began to use solar rays to generate electrical energy. Today, we use the sun's rays with many techniques to heat the places where we live and work (Shinn, 2018).

Photovoltaic cell systems that make up the solar panels are made of silicon compound materials which can convert the sunlight directly to electricity. Solar cells, photovoltaic cells, are semiconductor circuit elements that can convert solar rays directly into electrical energy. The surface area of solar cells, generally with an area of around 100-120 cm^2 and a mounting thickness of 0.2-0.4 mm, is in the form of polygons such as circular, square or rectangular. When solar rays fall on the solar cells, electrical voltage is generated at the end of the cells. Solar energy can be converted to electrical energy with an efficiency ratio of 4% to 25%. The solar cells are connected in parallel or in series within the circuit and are integrated in a panel. Thus, the solar cell module system or the so-called photovoltaic module system is obtained and the power output is increased (EIA, 2018)

Solar systems generate electricity locally for homes and industry. Solar Power Plants (SPP) can generate power for thousands of homes, using mirrors to concentrate sunlight across acres of solar cells. Solar energy systems don’t produce greenhouse gases most solar panels have few environmental impacts during the manufacturing process. Figure 1.3 shows that, after 2010, the rate of increase in solar power capacity in the world has increased considerably and became competitive with the capacity of the wind power plant.

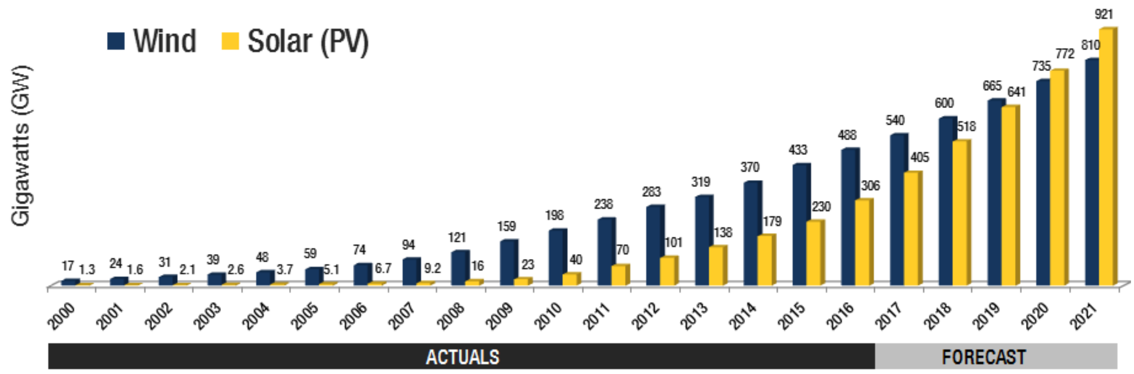

Figure 1.6 Solar and Wind Installed Capacity (fi-powerweb.com, 2019)

1.2.2. Wind Energy

Throughout the history of humanity, wind energy has been used in the movement of sails, corn and wheat in grinding and irrigation. Nowadays, wind energy is used in electricity generation. Water pumping windmills were once used throughout the World and some still operate on farms and ranches, mainly to supply water for livestock. Wind energy is an energy source that does not cause environmental pollution, provides energy security, has no fuel costs and has no risk of resource depletion. Wind energy is a domestic and always available resource that avoids dependence on other countries in terms of economic, political and supply risks, without any risk of fuel costs (Topçu and Türtük Yünsel, 2012;14-20).

Wind energy turns a turbine's blades, which shafted to an electric generator and produces electricity. Wind is caused by heating of the earth's surface by the sun. Because the earth's surface is made up of different types of land and water, it absorbs the sun's heat at different rates. One example of this uneven heating is the daily wind cycle. Some countries have installed wind turbines in Wind Power Plants (WPP) in the sea as called off-shore wind power plants.

Installed capacity of wind energy has been increased rapidly during the years after 2001 to 2017 in all over the world. Figure 1.4 shows this situation clearly. At the end of 2017 World total wind energy capacity has reached 539,581 MW. Some countries dominate this increase. 90% of this capacity has been installed by these 16 Countries. Table 1.1 shows us these top 16 countries wind energy installed capacity in terms of MW. With the development of technology, the decrease in the initial investment costs increased the amount of investment in wind energy.

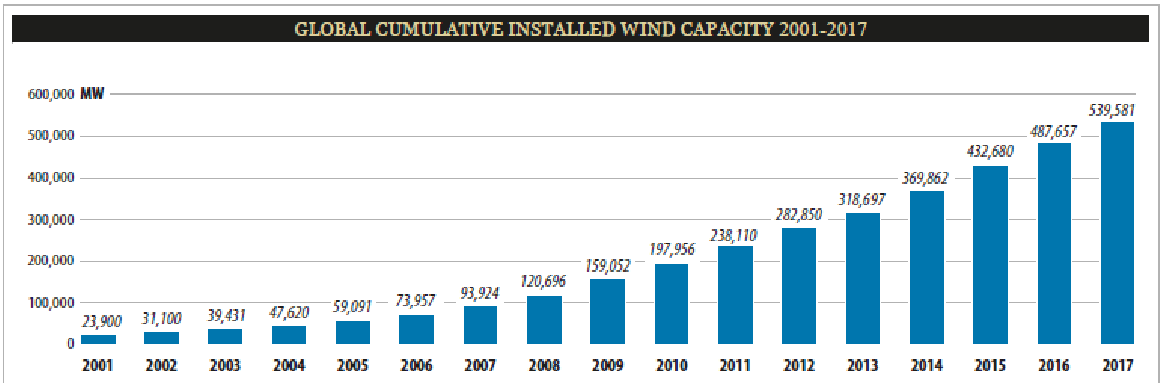

Figure 1.7 Global Installed Wind Energy Capacity 2001 to 2017 (Gwec 2017, 2019)

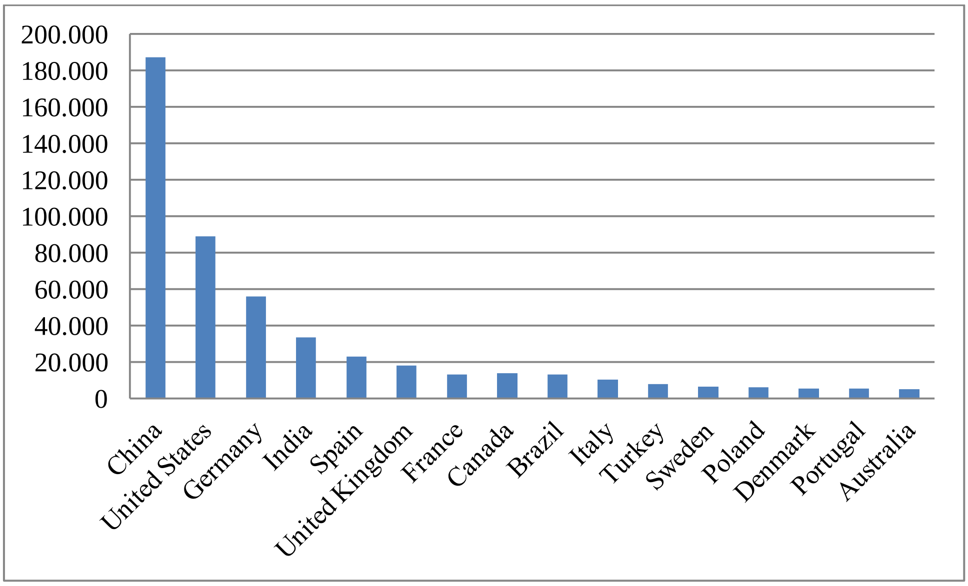

Figure 1.8 Installed Wind Energy Capacity at the end of 2017 (Wwindea.org, 2018)

1.2.3. Hydroelectric Energy

World has a long history of using the hydro power in streams and rivers to produce mechanical energy. Hydropower was one of the first sources of energy used for generating electricity in the World. Hydropower is theoretically the largest renewable energy source for the generation of electricity in the world, but the potential of wind energy is close to hydroelectric in this respect. It is based on hydroelectric water cycle. In a large river, the rapidly moving water, or the water falling rapidly from a high point, turns the blades of a turbine and the power transferred to the shaft is converted into electricity in the generator. In some classifications, large hydroelectric power plants (HEPPs) are sometimes considered as non-renewable energy sources. Very large-scale dams direct or reduce natural flows by restricting their access to plant, animal and human habitats using rivers. In contrast, small hydroelectric power plants (generally under 10MW installed power), which are referred to as river-type, if they are carefully managed, tend to minimize damage to environmental impact ratings, as they only drive a certain amount of flow. (EIA, 2018).

Understanding the water cycle is important to understanding hydropower. The water cycle has three steps:

- The sun's rays heat the water on the surface of lakes, seas and rivers, causing water to evaporate.
- Water vapour rises and condenses in the atmosphere and falls to the earth as rain and snow.
- The rains gather in rivers that discharge into the oceans and lakes. Then the loop continues.

The amount of precipitation flowing into rivers and streams in a water basin constitutes the amount of water available for potential hydroelectric power generation. Seasonal changes in precipitation are the main factors determining the amount of hydroelectric power generation.

The world's first hydroelectric power plant was installed in Northumberland, England, in 1878. After the year 1900, hundreds of small hydropower plants were in operation as the emerging technology spread across the world. Parallel to the developing technology in the middle of the 20th century, hydroelectric installed capacity increased rapidly in the world (Iha, 2019).

Since the end of the 20th century and the beginning of the 21st century, the uses of a significant portion of the feasible hydroelectric potential and developments in wind and solar energy technologies have slowed the increase in hydroelectric power installed power. Figure 1.5 show increase in the hydroelectric capacity all over the world.

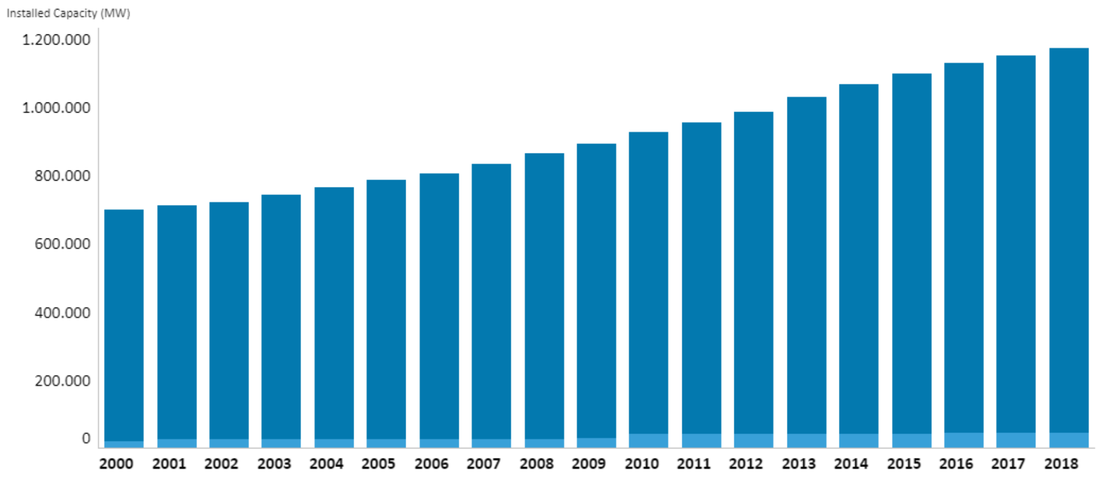

Figure 1.9 Hydroelectric Installed Capacity (irena.com, 2019)

1.2.4. Biomass Energy

Although Biomass energy is not a widely used type of energy, fossil fuels are becoming increasingly important. Biomass is organic material that comes from animals and plants, and it is a renewable source of energy. Biomass includes stored energy from the sun. Plants absorb the sun's energy in photosynthesis. When biomass is burned, the chemical energy in biomass is released as heat energy. Biomass could be burned directly or converted to liquid bio fuels or biogas that could be burned as fuels.

Biomass energy is carbon neutral electricity generated from renewable organic waste that would otherwise be dumped in landfills or left as fodder for forest fires. When burned, the energy in biomass is released as heat.

In biomass power plants, wood waste or other waste is burned to produce steam that runs a turbine to make electricity, or that provides heat to industries and homes. Fortunately, new technologies have advanced to the point that any emissions from burning biomass in industrial facilities are generally less than emissions produced when using fossil fuels (coal, natural gas, oil). ReEnergy has included these technologies in their facilities (ReEnergy, 2018).

The amount of biomass energy obtained from biological sources is very low compared to wind, solar and hydroelectric energy. The installed capacity of biomass energy power plants is under 100.000 MW by the year 2017 (Irena, 2019).

1.2.5. Geothermal Energy

Geothermal word comes from the antic Greek words geo (earth) and thermo (heat). Geothermal energy is heat in the earth. Human can use this heat as steam or as hot water to heat buildings or to generate electricity. Heat is continuously produced inside the earth so geothermal energy is a renewable energy source.

Geothermal energy comes from inside the earth. The earth's layer is broken into tectonic plates. Magma comes close to the earth's surface near the edges of these plates, which is where many volcanoes seem. Water absorbs heat from magma deep underground. Water found deeper underground has high temperatures. To generate geothermal-generated electricity wells are drilled into underground reservoirs to tap steam and very hot water that drive turbines linked to electricity generators.

Countries around the world use geothermal energy to heat their homes and to produce electricity by drilling deep wells and pumping the hot underground water or steam to the surface. People can also use warm waters near the surface of the earth to heat buildings. The share of geothermal energy in world energy consumption is very low. As of 2018, the installed capacity of the geothermal plant is 12.000 MW(Irena, 2019).

1.2.6 Other Types of Renewable Energy

Hydrogen energy is generated by the processing and conversion of hydrogen gas. Although not a natural source of energy, they are sustainable energy sources.

Wave energy is a kind of energy produced by taking advantage of sea wave movements. Installation and operating costs are very high compared to other energy types.

Tidal energy is a kind of energy produced by exploiting the seas on the sea due to the movement of the moon around the world.

The use of all these energy types and their use in electricity generation are not much included in the calculation and analysis when they are much lower than a thousandth of the total amount of other energy types.

1.3. PROBLEM STATEMENT AND IMPORTANCE OF RESEARCH

The question of study is: While countries are growing economically and financially, is renewable energy production increasing in coordination with their economic and financial growth? From this question, The aim of this study is to put forth of the relationship between countries' annual gross domestic product and Domestic Credits to Private Sector values against countries' annual electricity generation amount from renewable energy sources. Main importance of this study is showing the countries' precision for earth's future by fronting renewable sources for producing energy. GDP and DCP act the parameters that are useful for showing the prosperity of them. From this study, it will be shown that the countries approach the clean energy sources depending to changes in GDP and DCP.

One of the main factors of production is energy. Energy is using by every products manufacturing stage. So there is a strong correlation between PPP and energy consumption (Figure 1.3) (Sceptic, 2013).

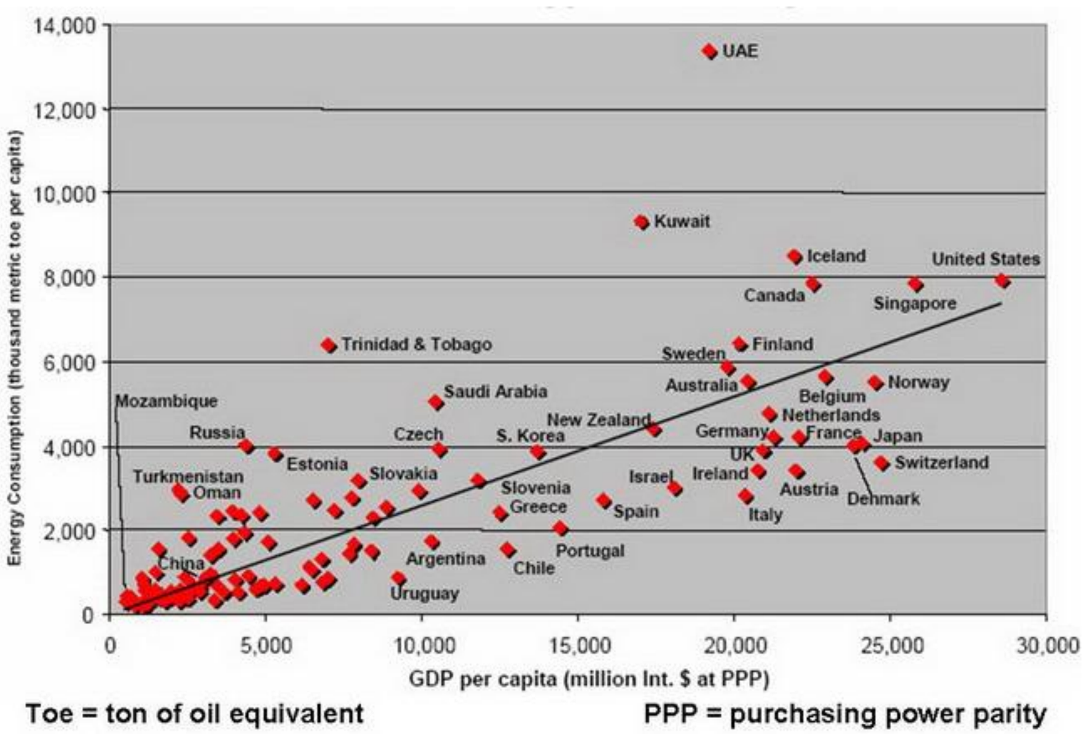

Figure 1.10 PPP vs. Energy Consumption in 2013 (EIA, 2018)

Group 20 (G20) Countries are the most effective countries on the world economic policy. Which are, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States and the European Union.

There is a clear relationship between prosperity and GDP. Also there is high level correlation between GDP and energy consumption. In this study it is studied that relationship between GDP and renewable energy production. The question is: While countries are growing economically, is renewable energy production increasing in coordination with their economic growth? The major indicator of economic growth is GDP and increase in GDP causes energy consumption. Does renewable energy production increase when energy consumption increasing? Or energy requirement is provided from fossil fuels (Narayan, 2008:2331-2341).

Main importance of this study is showing the countries' precision for earth's future by fronting renewable sources for producing energy. There is needed a second parameter that GDP is useful for showing the prosperity of them. Renewable energy technologies rapidly upgraded in last thirty years. From this study, it will be shown that the countries approach the clean energy sources depending to changes in GDP.

The relationship between renewable energy and GDP has received attention by policymakers. Using renewable energy will reduce carbon dioxide emissions and prevents depletion of natural resources. Renewable energy is expected to provide a good solution for global warming and climate change. Renewable energy deployment brings economic growth and sustainable development. Development of Renewables means clean energy supply while supporting GDP growth and improving trade balances.

G20 countries fulfil 90% of global economic output. (g20.org, 2018) These countries have much more facilities than the others. Studying this research undeveloped countries such as Ethiopia or Bangladesh will not be reliable. Because their facilities are so limited and they have no more chance to produce energy. So to increase reliability the study will be done on G20 countries. In G20 countries there are some big differences between countries such as Saudi Arabia has large petrol reserves when Turkey has a few petrol reserves. It is supposed that these differences dominate radical changes. But in panel data analysis it will be fused.

1.4. LIMITATIONS OF RESEARCH

The data of the research were obtained from OECD and World Bank websites. While the sources that the data can be taken correctly and up-to-date were unfortunately, the data were not published until March 2019 when the last part of the research was prepared. However, until the same date, the renewable energy generation of seven countries, which were members of the G20, had not been published. Back from 2001, many countries are missing data from DCP, RNW and GDP. Also Canada and the Russian Federation could not be included in the research because of the lack of data. Because of all these reasons the data range was obtained from the years between 2001 and 2016 from seventeen G20 Countries.

CHAPTER II

LITERATURE REVIEW

2.1. FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH

There is no single concept that defines financial development. Many economists have described financial development in similar but different ways. Many of these studies argue that there is a very strong cointegration and bi-directional causal relationship between economic growth and financial development. For this reason, macroeconomic data showing economic growth are often used as parameters for financial development.

The relationship between financial development and economic growth is one of the main concerns of economists. Although many studies have found a strong relationship between financial and economic development, there is no consensus on the direction of the interaction between these two elements. In the empirical studies, conclusions supporting both opinions were obtained. However, although it is generally accepted that financial development has an impact on economic development, it is accepted that financial development is also affected by economic growth, that is to say, there are bidirectional causality (Akçoraoğlu, 2000:12).

Financial development is the changes in the financial structure. Therefore, in order to examine financial development, it is necessary to examine the changes in financial structure in the short and long term process (Goldsmith, 1969:37). The factors that reveal the financial structure of a country are the outlook, characteristics and relative dimensions of the financial instruments and institutions in that country. Because it is the combination of financial instruments and institutions in the economy that shape the financial structure (Goldsmith, 1969:26).

Financial development is the increase in the number and diversity of these instruments and institutions that make up the financial structure. Financial development refers to the change experienced by the financial system both in size and structure. This view, pioneered by E. Shaw, explains this development in the financial system with the concept of financial deepening (Öcal, 1999:272).

The success of developing countries in the development process is related to their ability to increase savings and investments. Lack of resources is one of the most important problems for these countries. Therefore, the full and effective use of the funds of the country is decisive for this process. The development of the financial markets to which the funds are transferred means the better performance of the functions undertaken by the financial system, ie the more efficient transfer of funds. Therefore, financial development and economic development are intertwined. While the fact that there is a relationship between these two concepts in the economic literature is indisputable, the direction of this relationship is highly debated. The question discussed in the final analysis is which is the result and which is the cause (Ergeç, 2004:53).

Economic growth and economic development are different terms. Economic growth means the rise in the capacity of manufacturing of goods and services in an economy (Parasız, 1997:4). Economic development is more inclusive terms that covers economic growth. Economic development includes economic growth, and qualitative changes in production. Economic development is also the welfare of the country’s population and is the process of raising the standard of living (Hogerdam, 1992:16).

Development in general, the realizations that will occur in these expectations it reflects. Increased importance and protection of advanced ecological balance co existence was raised. More emphasis and protection of ecological balance measures for sustainable development if a more sustainable environment rises.

Ecosystem resources are limited. Sustainability of economic development should calculate these natural resources. Sustainability has four major components (Basiago, 1995:109-119). These are;

- Futurity: Take into account the needs of the future.

- Equity: Fair social distribution of economic benefits between generations
- Global Environmentalism: It covers the using of natural sources globally.
- Biodiversity: Conservation of ecological system biodiversity.

Sustainable economic growth needs sustainable development. Sustainable development needs fulfilling the criteria of sustainability: Futurity, equity, global environmentalism and biodiversity.

2.2. PREVIOUS STUDIES ABOUT THE RESEARCH TOPIC

Studies on the relationship between energy and economic development are based on four main hypotheses. These hypotheses are conservation, growth, feedback, and neutrality hypotheses. The growth hypothesis argues that energy is one of the causes of economic growth. The Conservation hypothesis, unlike the Growth hypothesis, claims that economic growth is one of the causes of energy. The feedback hypothesis assumes that this relationship has bidirectional causality. Neutrality hypothesis argues that there is no causal relationship between these two concepts.

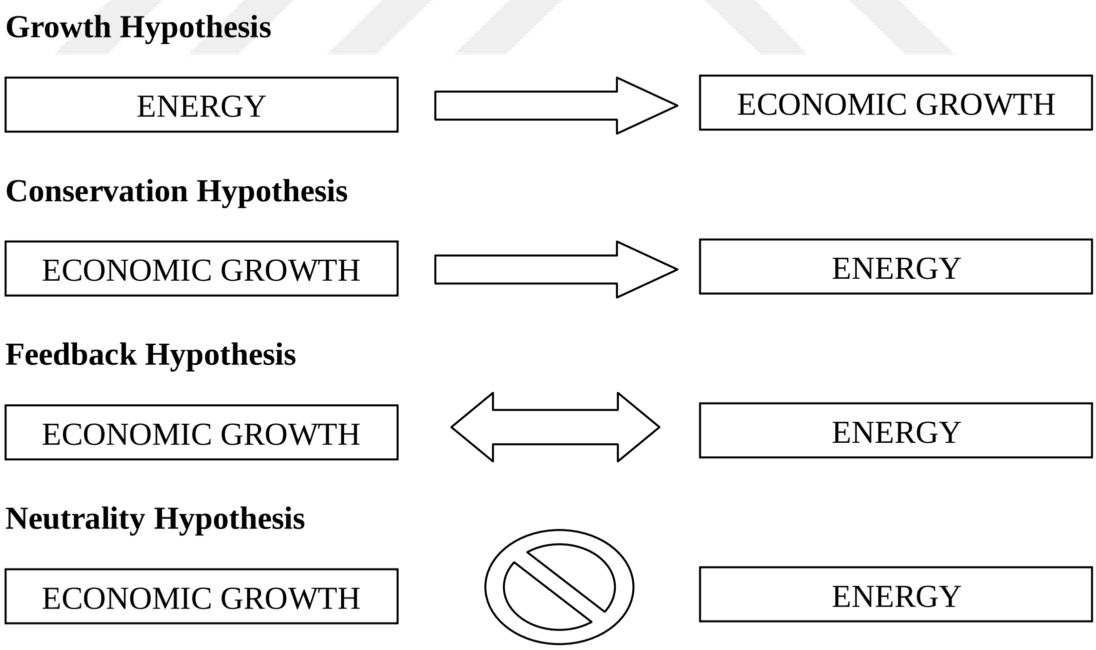

Figure 2.1 Energy & Growth Hypotheses

Of all these four hypotheses, the most widely accepted feedback hypothesis is the feedback hypothesis. So, it is easy to say; there is strong relationship between energy consumption and gross domestic product. Strong causality from GDP to energy consumption was recently showed by Baranzini et al. (2013), Azlina & Mustapha (2012), Adom (2011), Jamil & Ahmad (2010). Bi-directional causality corresponds to the feedback hypothesis, which suggests that energy consumption and real GDP affect each other simultaneously.

The most important indicator to show enrichment of a country is gross domestic product (GDP). GDP is the value of all the finished services and goods manufactured within a country in a time period. The nationality of manufacturers is not important. Although they are foreign investors their finished products have to include to GDP. Rising GDP is an indication of a strong economy. When GDP is rising we are all earning more and we are all spending more and more.

There are many studies examining the long-term relationship between renewable energy and gross domestic product. Most of the studies in the literature examined the long-term relationship between the two variables mentioned above using panel data and time series analysis techniques. The studies summarized at the section 2.2.

Numerous studies have investigate the relationship between renewable energy production or consumption and economic growth by using multi-country sample and time series. Chien and Hu (Chien, 2008:3063-3076) have analyzed the relationship between GDP, capital formation, trade balance, energy imports, re-newable energy consumption for 116 countries by applying Structural Equation Modelling (SEM). The result shows that there is a positive relationship between renewable energy and GDP through the path of increasing capital formation.

Another multi-country time series analyses, there is another group of studies (Fang, 2011; Tiwari, 2011; Pao & Fu, 2013) dealing with single country time series. For the US, Sarı (2008:2302-2313) use distributed lag approach to indicate integration between industrial production, employment, fossils fuels, conventional hydroelectric-power, solar energy, wind energy, natural gas, wood and waste consumption over 2001:1-2005:6 period. The results show that in the long run output and labour are the key determinants of fossil fuel, conventional hydroelectric power, solar, waste and wind energy consumption. Fang (2011:5120-5128) analyzes the period of 1978-2008 employing multivariate OLS and finds that 1% increase in renewable energy consumption increases real GDP by 0.120%, GDP per capita by 0.162% in China.

In 2009, Sadorsky examined the relationship between renewable energy consumption and revenue of 18 developing countries between 1994 and 2003 with panel data analysis method. In the long run, it was concluded that 1% increase in renewable energy consumption increased the real income in the period by 3.5%.

Uçak (2010) studied on OECD countries for the period of 1980-2007 economic growth and electricity generation from renewable sources in using panel-data method. Uçak finds that there is a long term positive relationship between economic growth and renewable electricity generation. An increase in electricity generation from renewable sources dominates sustainable development, as well as long-term growth performance.

Apergis (2014) found in 20 OECD countries that renewable energy positively affects growth with labor and capital in the period 1985-2005. Apergis and Payne (2010) analyzed the Panel Cointegration Model for 13 Asian countries between 1992 and 2007 and found a bi-directional causality relationship for both short-term and long-term. Apergis did similar studies in this field and achieved similar results.

Bayraktutan and Yılgör (2011), in their research on OECD countries between 1980 and 2007, found a positive and bidirectional relationship between economic growth and electricity generation based on renewable energy sources.

Şengelen's (2016) scopes of the study, annual data for the period of 1995-2014 of 27 European Union member states were used. He reached that there is a long-run co integration relationship between economic growth and renewable energy consumption.

In 2012, Silva conducted a very long-term regression analysis on the examples of USA, Denmark, Spain and Portugal between the years 1960 and 2004. This analysis shows that the increase in renewable energy production increases the GDP.

Tugcu (2012) 1980-2009 Following the ARDL test in G7 countries, it was concluded that renewable and non-renewable energy consumption are important determinants of economic growth.

Panel ARDL and Granger Causality analysis done by Salim and Rafiq (2012), the six emerging markets during the 1980-2005 period Long-term income and pollution of renewable energy consumption in the economy The emission is determined by the short term renewable energy and income-directional causality between and between renewable energy and pollution emissions highlighted.

In the study prepared by Çınar in 2015, he studied the RNW and GDP data of G8 countries between 1990 and 2013 with panel data analysis method and determined that there is cointegration. Further, Brazil, Russia, India, China and South Africa consisting of the BRICS countries engaged in working with countries and Turkey, has identified a long-term relationship between on panel data analysis with GDP and RNW.

In 2017, Armeanu examined the GDP and RNW values of 28 European Union member countries between 2003 and 2014. In this study, renewable energy production was selected as an independent variable and the effect of granger causality and RNW on GDP was shown. Another study that identified Granger causality between GDP and Renewable Energy is the study of Şen in 2010 covering the years of Spain in the years 1980 to 2006. Also, in a study conducted by Ntanos in 2018, it was reported that there was a high correlation between the GDP and renewable energy data of the 28 European Union countries. Similarly, Neitzel (2017) conducted a survey of OECD member countries in 2017 and found Granger causality among RNW and GDP.

In a study prepared in 2016, Kimiagari conducted a study for a set of 22 years period on 34 OECD member countries and found that renewable energy production had a direct impact on gross domestic product. In the study conducted by Marinas on Eastern European countries in 2018, the countries were examined separately and different findings were found in terms of the relationship between GDP and RNW. However, unlike many other researches, there are also studies that concluded that there is no relationship between renewable energy and GDP. One of them is York's study in 2017. In York's study, data from 128 countries between

1960 and 2012 were measured by panel data analysis. Among the reasons for the lack of any relationship between GDP and RNW, there may be periodic and regional effects due to the fact that the period is too long as well as the number of samples are too much.

The overall result obtained from all these researches had revealed there is a significant relationship between Renewable Energy production/consumption and GDP. But researches give us different forms of this relationship. In this study, research periods and sample groups in the literature were taken into consideration. In this context, the sample group and period that were never studied together were preferred.

In their research conducted in 2017, Çağlar and Kubar examined the relationship and causality between financial development and renewable and non-renewable energy. In a study conducted between 1964 and 2014 on a sample of Turkey financial system deposits to GDP, deposit money bank assets to GDP, private credit to GDP, liquid liabilities to GDP rates and energy consumption values studied. As a result of the study, while there is no causality relationship between renewable energy and financial development, one-way causality relationship from financial development to non-renewable energy was found.

In 2017, Burakov and Freidin found a two-way causal relationship between economic growth and financial development in their study on the Russian Federation between 1990 and 2014. However, they found that there is no causal relationship between these concepts and renewable energy.

Hassine and Harrathi found that RNW causes economic and financial growth for GCC countries in their research in 2017.

In this study, 24 years between 1993 and 2016, Domestic Credits to Private Sector, Gross Domestic Product and Renewable Energy Production of G20 Countries' will be examined.

Some of the studies in the literature are listed chronologically with their results.

Author	Name	Data	Period	Sample	Method	Result
Soava G.	(2008 Article) Impact Of Renewable Energy Consumption On Economic Growth: Evidence From European Union Countries	RNW and Total Energy Consumption	1995-2015	28 EU Members	Panel Data	RNW improves Total Energy Consumption
Chien T.	(2008 Article) Renewable energy: An efficient mechanism to improve GDP	GDP and Renewables	2003	116 Countries	Structural Equation Model (SEM)	There is cointegration between GDP and RNW
Şen A.	(2010 Master Thesis) Relationship Between Renewable Energy Consumption And Economic Growth: The Spanish Case	GDP and Renewables	1980-2006	Spain	Enger-Granger and Johansen Co-integration	There is bidirectional Granger causality between RNW and GDP
Uçak S.	(2010 PhD Thesis) On the Base of Sustainable Development the Relationship Between Alternative Energy and Economical Growth	GDP Growth Rate and Renewables	1980-2007	30 OECD Countries	Panel Data	There is bidirectional relationship between GDP and RNW
Silva S.	(2012 Article) The Impact of Renewable Energy Sources on Economic Growth and CO2 Emissions	GDP and Renewables Per Capita	1960-2004	USA, Denmark, Spain, Portugal	SVAR	RNW improves GDP (Except USA)
Apergis N.	(2014 Article) Renewable Energy and Economic Growth: Evidence from the Sign of Panel Long-Run Causality	Stock of Capital, Labor, GDP and Renewables Per Capita	1990-2012	80 Countries	Panel Data	There is Granger causality from RNW to GDP
Çınar S.	(2015 Article) Determinants of Renewable Energy Resources and Their Relationship Between Economic Growth	GDP and Renewables	1990-2013	G8 Countries	Panel Data	There is causality form GDP to RNW
Şengelen H.	(2016 Master Thesis) Research into Relationship between Renewable Energy Sources and Economic Growth with Panel Data Analysis	GDP and Renewables Per Capita	1995-2014	27 EU Members	Panel Data (FMOLS Model)	There is long term co-integration relationship between RNW and GDP

Table 2.1a Literature Table

Author	Name	Data	Period	Sample	Method	Result
Kimiagari A.	(2016 Article) Analysis of the simultaneous effects of renewable energy consumption and GDP, using Dynamic Panel Data	GDP and Renewable Energy Consumption	1990-2012	34 OECD Countries	Dynamic Panel Data	RNW and Non-RNW Dominates GDP
Hassine M.B. & Harrathi N.	The Causal Links between Economic Growth, Renewable Energy, Financial Development and Foreign Trade in Gulf Cooperation Council Countries	GDP, Renewable Energy Consumption, Capital Stock, Number of Labour Forces	1980-2012	GCC Countries	Panel Data	RNW Causes Economic Growth
Neitzel D.	(2017 PhD Thesis) Examining Renewable Energy and Economic Growth: Evidence from 22 OECD Countries	RNW, GDP, Capital, Non-RNW	1995-2012	22 OECD Members	Panel Data	There is bidirectional Granger causality between RNW and GDP
Burakov D. & Freidin M.	(2017 Article) Financial Development, Economic Growth and Renewable Energy Consumption in Russia: A Vector Error Correction Approach	Share of bank loans to national GDP, Renewable Energy Consumption	1990-2014	Russia Federation	Panel Data	There is no causality between Financial & Economic Development and Renewable Energy
York R.	(2017 Article) Does Renewable Energy Development Decouple Economic Growth from CO2 Emissions?	GDP, CO2 and Renewables Per Capita	1960-2012	128 Countries	Panel Data	GDP improves CO2 but no Relationship between GDP and RNW
Armeanu D.	(2017 Article) Does Renewable Energy Drive Sustainable Economic Growth? Multivariate Panel Data Evidence for EU-28 Countries	GDP and Renewables	2003-2014	28 EU Members	Panel Data	There is bidirectional Granger causality between RNW and GDP
Marinas M.	(2018 Article) Renewable energy consumption and economic growth. Causality relationship in Central and Eastern European countries	GDP and Renewable Energy Consumption	1990-2014	Eastern EU Members	Panel Data	GDP and RNW are independent in Romania and Bulgaria, while in Hungary, Lithuania and Slovenia an increasing RNW improves GDP
Ntanos S.	(2018 Article) Renewable Energy and Economic Growth: Evidence from European Countries	GDP and Renewable Energy Consumption	2007-2016	25 EU Members	Panel Data (ARDL)	There is a higher correlation between Renewable Energy Consumption and GDP

Table 2.1b Literature Table

CHAPTER – III

APPLICATION

3.1. DATA TYPES AND METHOD OF DATA COLLECTION

Energy is one of the main requirements for sustainable development. Sustainable development also needs to use sources efficient and effectively. It means planet's sources such as air, soil and water should be fresh and clean when human produces more energy. So, relationship between renewable energy consumption and gross domestic product shows countries' sensitivity on sustainable development up to the future.

Environmental and economic relations have begun to emerge from the end of the 20th century. These prominent relationships have been the subject of many researches. The correct selection and use of parameters is very important in these studies. In this study, completely measured and objective values were studied. While economic growth was a subjective concept, subjectivity was eliminated by using GDP, which is the most important indicator in this field. While there is no need to explain the relationship between energy and GDP, the relationship between renewable energy and DCP is still an interesting field for research. Renewable energy production is an objective measure that can be measured as GDP or DCP. The use of the data banks of international institutions such as the World Bank and OECD in the collection of these data stands out in terms of ease of access and accuracy.

DATA	SOURCE	DESCRIPTION
GDP	World Bank Web Site	Gross Domestic Product of Every Country
DCP	World Bank Web Site	Domestic Credits to Private Sector
RNW	OECD Web Site	Renewable Energy Production of Every Country

Table 3.1 Data Table

3.1.1. Gross Domestic Product

Economic growth is a measurable value. The most important indicator to measure this value is Gross Domestic Product (GDP). GDP is the total value of everything produced in the country. It is not important that if it's produced by are citizens or foreigners. If they are located within the country's boundaries, their production is included in GDP.

A country's gross domestic product can be calculated using the following formula: **GDP = C + G + I + NX.** C is equal to all private consumption, or consumer spending, in a nation's economy, G is the sum of government spending, I is the sum of all the country's investment, including businesses capital expenditures and NX is the nation's total net exports, calculated as total exports minus total imports (NX = Exports – Imports) (Investopedia, 2018).

Annual GDP data received from the site of World Bank. We use the GDP series data which calculated with constant value. Because current series are influenced by the effect of price inflation. World Bank uses constant 2010 US Dollars Currency for calculating GDP for all countries.

3.1.2. Domestic Credits to Private Sector

In order to define financial development, first of all, when measured as the level of financial development, the internal credit provided by the private sector banking institutions is important for the level of financial development. (Fisman and Love, 2004:2287)

Domestic credits to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For all these reasons, Domestic Credits to Private Sector (DCP) are considered as one of the most important indicators that provide and protect financial development. Domestic Credits to Private Sector data has been taken from World Bank web site.

3.1.3. Renewable Energy Generation

Renewable energy is defined as the contribution of Renewables to total primary energy supply Renewables include the primary energy equivalent of hydro (excluding pumped storage), geothermal, solar, wind, and wave sources. Energy generated from solid biofuels, bio gasoline, biodiesels, other liquid biofuels, biogases and the renewable fraction of municipal waste are also included.

Annual Renewable Energy Generation (RNW) data received from web site of The Organisation for Economic Co-operation & Development (OECD). This indicator is measured in thousand toe (tonne of oil equivalent). It means that the energy total output of one tonne of oil equals to “1 toe”. Toe was selected instead of kWh (kilowatt-hour) because toe is more universal unity in all over the world. 1 Toe is equal to 11.630 kWh. It means that 1 kToe is equal to 11.630.000 kWh or equal to 11,6 GWh.

3.1.4. G20 Countries

Group 20 Countries (G20) has a capacity of; 85% of global economic output, 66% of World population, 75% of international trade and 80% of global investment. (G20 Web Site, 2018) So, if we want to study on a global research, G20 is very useful sample. G20 Members are Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, United States and European Union. They are shown at below. G20 covers Group 7 Countries which are Canada, France, Germany, Italy, Japan, United Kingdom and United States. Figure 3.1 shows G20 Countries around the World (Australia Government Portal, 2018).

Figure 3.1 G20 Countries (Australia Government Portal, 2018)

In this study, sample group are 19 G20 Countries except European Union. European Union excluded to block repeated data for some European Countries. There are some radical varieties between 19 countries. Such as India and China has large population than others or Saudi Arabia has rich petrol reserves. These diversities effect the relationship between GDP, DCP and RNW. By the development of renewable energy technology renewable energy plants started to be more efficient and effective. So quantity feasible renewable energy projects are increased.

3.2. HYPOTHESIS OF THE RESEARCH

In this research, the hypothesis claims that there is co-integration between Gross Domestic Product and Renewable Energy Production. Also the hypothesis claims that the changes in Gross Domestic Product affect Renewable Energy Production. Therefore, a one-way causality relationship is proposed in which the independent variable is GDP and the dependent variable is RNW. The hypotheses are;

H_1 : There is co-integration between Renewable Energy Production, Gross Domestic Product and Domestic Credits to Private Sector.

H_2 : There is bidirectional causal relationship between Renewable Energy Production, Gross Domestic Product and Domestic Credits to Private Sector.

3.3. RESEARCH MODEL AND METHODOLOGY

Panel data analysis can be defined as the method for estimating economic relations by using the horizontal cross-series series with the most general sense of time (Green, 2003:19).

Although panel data analysis is successful in solving some problems that a time series or section analysis cannot independently overcome, it cannot solve every problem. The disadvantages of panel data analysis can be specified as follows:

- Design and data collection problems; there may be difficulties in collecting data related to this survey and the management of this data and research.
- Disorders related to measurement errors; such errors may arise due to the inaccuracy of the answers given to the data collector, the inaccuracy of the answers given, the inaccuracy or deliberate misrepresentation, the misrepresentation of the answers or the data obtained.
- Excessive amount of data may result in increased measurement error.
- Macro panels covering a long time dimension with regard to a country or region may have problems with data collection and some misleading results may occur. (Baltagi, 2005;305)

In this analysis, time series and horizontal section series are combined and a data set with time and section size is formed.

3.3.1. Panel Data Analysis

Panel Data is a set of data generated by compiling various values of the same units within a certain time interval. Panel data can be named differently. These are cross-sectional data, enriched data, pooled data, mixed data, and long-section data due to time-dependent monitoring of a variable, due to combining horizontal section variables and time series (Tarı, 2011).

Panel data analysis is a method of estimating economic relations by using the cross - sectional data of time dimension. Studies using the panel data set have many advantages over other studies. These advantages are;

- Since the panel data provides for the use of a combination of horizontal section and time series data, it allows for better measurement of effects that cannot be observed only in the time series or only in the section series.
- Panel data allows us to work on complex models.
- The panel data combine the time series of horizontal cross-section observations to provide more relevant data, greater variability, less linearity among variables, a more efficient model (Gujarati, 2001:637-638).

In cases where only time-series or only horizontal-cross-sectional data is not sufficient, the panel allows the data to work with both data types. The word unit, used in the models estimated by the panel data can represent the person, company, household, sector, region or country. In this respect, the concept of panel data implies combining cross-sectional observations over a period of time (Baltagi, 2005:29).

Like this study, many researchers have demonstrated the advantages of panel data models. Unlike time series and cross-sectional data, the fact that a large number of countries can be included in the analysis is the first. The second advantage is that the panel data are more successful in detecting and measuring unpredictable effects in pure section data or pure time series analysis. A third advantage of panel data analysis is that panel data analysis is more successful in setting up and testing complex behavioural models than time series data or cross-sectional data. In addition, one of the most important advantages of panel data analysis is the modelling of behavioural changes in individuals more flexibility.

In addition, panel data analysis can be used to control individual heterogeneity, unlike other analysis techniques. On the other hand, in panel data analysis better results can be obtained with regard to dynamic regulations. Some other important advantages related to panel data analysis can be seen by obtaining more enlightening information through this analysis technique, achieving more probability, decreasing the linear connection between the variables, increasing the degree of freedom and obtaining more effective results. (Hsiao, 2003; Baltagi, 2005; Greene, 2012).

Among the descriptive variables, panel data models that do not have lagged values of dependent or independent variables are called static models. In static panel data analysis, pooled panel data (POLS), fixed effects (FE) and random effects (RE) model estimators are used. The pooled panel data model estimator is preferred when the cross-sectional data is homogeneous, but the fixed effects model is assumed when the units in the data set are specific or have specific effects specific to the time. The analysis will be carried out with the help of coincidental effects model estimator, on the other hand, when units or time-specific effects are included in the model as a component of the error term is used (Baltagi, 2005:139).

Various data types are used in econometric research. Each data type is used only with models that are appropriate for that data type. The simple functional form of the panel data regression is as follows;

$$y_{it} = \alpha + \beta_1 x_{1it} + ... + \beta_K x_{Kit} + u_{it}$$

i = 1,2.....N (number of samples) *t = 1,2......T (time)*

In this model, parameter α is a common scalar of all units. The β parameter shows that, the common effects of each illustrative variable on all units. As a result, it is predicted that both parameters do not change between units and over time (Baltagi, 2005;82).

3.3.2. Unit Root Tests

In the panel data, information about both units and time can be included in the analysis. In addition to the cross-sectional dimension of the data, the change in time series of the series is important because the time dimension is included in the analysis. The concept of stationary is a concept that needs to be examined in time series analysis and the types of analysis in which this series is found. In time series analysis, mean and variance are independent of time and covariance is called stationary series (Güriş, 2015;203).

Dickey Fuller (1979) and Advanced Dickey Fuller (ADF) are based on test approaches. The first-generation panel unit root tests are Levin, Lin (1992) test, Im, Pesaran and Shin (1997) test, Harris and Tzavalis (1999) test, Mandala and Wu (1999) test, Breitung (2000) test, Hadri (2000) test, Choi (2001) test, Levin, Lin and Chu (2002) test and Im, Pesaran and Shin (2003) tests (Güriş, 2015;204).

3.3.3. Co-integration Tests

The tests used to determine the existence of a long-term relationship between non-stationary panel data series are commonly referred to as cointegration tests. Empirical studies have shown that the majority of macroeconomic time series are non-stationary series. Various methods have been proposed to find a solution to this problem because of the problem of counterfeit regression between these series containing unit root. One of them is to take the differences of the series and regression them. However, in this case, a new problem is faced. This method leads to the loss of information that is important for the long-term balance. Because when we use the first differences, it is not possible to see the long-term relationship between these variables. This was the exit point of the cointegration analysis. The theory of cointegration is an analysis method which allows predicting the existence of the equilibrium relationship implied in economic theory and is used to find out whether there is a long-term equilibrium relationship between variables (Uçak, 2010;121).

McCoskey and Kao (1998) Test, Kao (1999) Test, Pedroni (1999) Test, and Westerlund (2007) Test are major co-integration models.

The cointegration test tries to determine whether two or more variables are integrated. If the variables are integrated, they will be moved over time and the disturbances in the short term are corrected. In this case, it is stated that the series will approach each other in the long run and the difference between them will remain constant. If the two variables are not integrated, they will be seen and the confusion will not be corrected (Güvenek and Alptekin, 2010: 181).

For assuming assumptions, transformation of variables approach is widely used. Conversion to variables has three main objectives, such as linearizing, normalizing and stabilizing constant variance (Albayrak, 2006:80).

Because of Heteroskedasticity problem Co-integration tests which are resistant to the changing variable problem should be applied. Therefore, in order to find the relations between RNW and GDP, co-integration tests which require differentiation of the Heteroskedasticity from the cointegration tests will be required. In 1997, 1999, 2000 and 2004, Pedroni put forward several test proposals to allow for heterogeneity in cointegration analysis. (Asteriou and Hall, 2007: 373)

Pedroni panel cointegration method, which allows the study of the long-term relationship for each unit separately and together with a resistance against it, and Kao cointegration method which is resistant to changing variance problem will be used. Pedroni's approach differs from Kao's approaches in the context of a hypothesis of zero assumption and no hypothesis that there is no cointegration. Pedroni tests allow multiple explanatory variables. It also allows differentiation along different parts of the cointegration panel. This allows the heterogeneity of errors throughout the section units. In Pedroni test, six different cointegration tests were presented to cover within and between effects on the panel and these tests were divided into two different categories. The first category includes four tests pooled within the "within" dimension. The second category includes three other tests. These test will be shown as below; (Asteriou and Hall, 2007: 374).

Kao (1999) has prepared a co-integration test for panel data using with Dickey-Fuller and Advanced Dickey-Fuller. According to Kao, model is shown below:(Baltagi, 2005:252).

$Y_{it} = \alpha_i + \beta X_{it} + u_{it}$

And the co-integration test now includes the residual equation:

$u_{i,t} = \rho u_{i,t} + \Sigma \Phi \Delta U_{i,t} + v_{it}$

Kao also suggests an ADF test expressed as follows.

$u_{i,t} = \rho u_{i,t} + \Sigma \Phi \Delta U_{i,t-1} + v_{it}$

3.3.4. Causality Tests

Statistically, causality is that the future predicted values of a time series variable are derived from the previous period values of itself or another related time series variable. Causality analysis is used to find the direction and presence of a causal relationship between two variables. This relationship may also be a one-way or two-way causality relationship. If there is co-integration between the series, it is expected to have a causal relationship in at least one direction (Engle and Granger, 1987;251-276).

The most common used causality test is Granger Causality Test. Tado-Yamomoto and ARDL tests are also used by researchers. But, because of its ease in empirical studies, the most preferred test is granger causality test.

The definition of causality by Granger is based on the following assumptions;

- The future cannot be the cause of the past. Definitive causality is only possible if the past causes the present or future. The reason always occurs before the result. This necessitates a time delay between the cause and the result.
- Causality can only be determined for a group of stochastic processes. It is not possible to know the causality between two deterministic processes (Işığıçok, 1994;81).

According to Granger, if the prediction of Y is more successful when X's past values are used than when X's past values are not used (while other terms do not change), X is the reason of Y's Granger. The Granger causality test is highly sensitive to the number of delays and the direction of causality may vary depending on the number of delayed terms. In studies based on some annual analyzes, the number of delays should be taken as 1, 2 or 3 (Takım, 2010;327).

3.3.5. Auto Correlation and Heterocedascity Problems

In the case of a relationship between the error terms in a time series model, this problem is called the auto correlation problem. One of the basic assumptions in regression is that there is no relationship between error terms. In the case of auto correlation, the estimator of the variance of the error term should be deviated and therefore the variance of the parameters would be deviated. If there is autocorrelation, the deviation is negative. As a result, the value of the test statistic is large. This increases the likelihood of a meaningless coefficient being significant and increases the R^2 value. The LM(Lagrange Multiple) test, most commonly found by Breusch (1978) and Godfrey (1978), is used to determine the autocorrelation problem (Yamak and Köseoğlu, 2009; 86).

Heteroskedasticity is the case that the variances of the error errors in a statistical model are not fixed for different observations. It is the opposite of Homoskedasticity. There are several statistical tests used to determine the variance problem in the literature. These tests are: Graphical method, Park test, Goldfeld-Quandt test, Glejser test, Spearman rank correlation test, Breusch-Pagan-Godfrey test and White nR-square test. The most common-use test is White nR-square test (Albayrak, 2008:115).

Most common tests for Heteroskedasticity is the White test and Breusch-Pagan tests. White test allows Heteroskedasticity process to be a function of independent variables. It is like to Breusch-Pagan test, but the White test advantage is; which allows independent variable to make an interactive and nonlinear effect on the error variance (Pedace, 2013:347).

3.3.6. Research Model of Study

GDP arises from production, production needs energy, energy needs energy sources and Renewables are the most important energy sources. It shows us the flow direction is from GDP to RNW. So GDP is chosen independent value when RNW is chosen dependent value. The panel data regression model shown as;

$RNW_{it} = (\beta_1 GDP_{it}) + (\beta_1 DCP_{it}) + Ʊ_{it}$

RNW : Renewable Energy Production as dependent value

GDP : Gross Domestic Product as independent value

DCP : Domestic Credits to Private Sector as independent value

β_1 : Slope Coefficient

β_2 : Slope Coefficient

$Ʊ_{it}$: Error Coefficient

it : Number of observations

In this study, the stationary of our data set will be tested first. If the data set is not stationary, first difference or logarithm will be taken and the station will be stabilized. In our data set, we will test whether there is auto correlation and heterogeneity problem. As a result of the test, as in most of the long-term panel datasets, heterocedascity problem is expected. In 1997, 1999, 2000 and 2004, Pedroni proposed several test proposals that allowed for heterogeneity in cointegration analysis. So, Pedroni co-integration test, which is resistant to the heterocedascity problem will be performed. Pedroni cointegration test results will also be checked by Kao cointegration test. Finally, if a co-integration is detected, it will be investigated whether there is a bidirectional or one-way causality relationship between the Dumitrescu Hurlin Causality Test for RNW and GDP & DCP.

Methodology of research shown with a flow chart in Table 3.2;

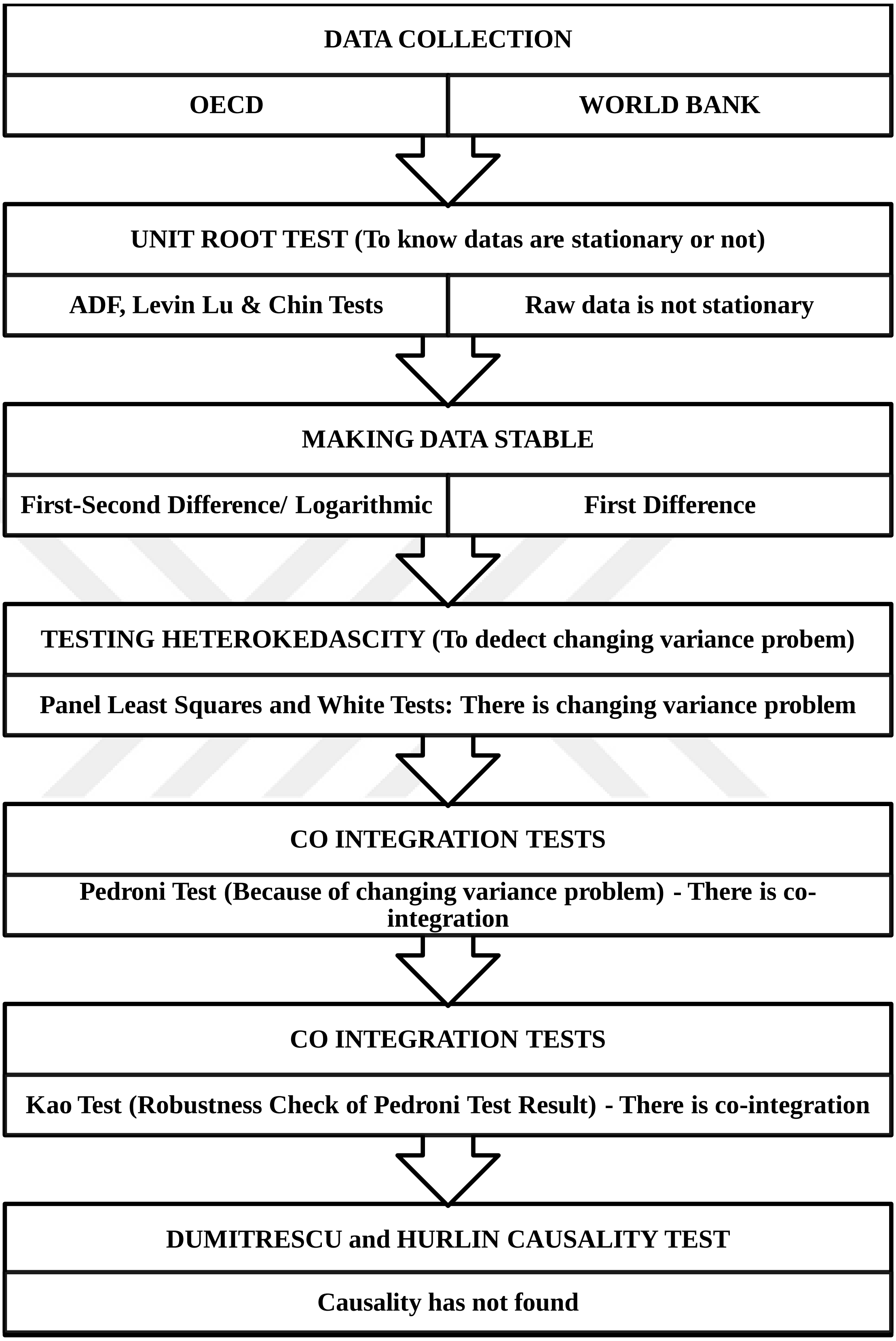

Table 3.2 Methodology Flow Chart

3.4. FINDINGS

The econometric methodology applied in this research is described in Table 3.2 as a flow chart.

3.4.1. Unit Root Test Results

If a time series is stationary, its mean, variance and covariance do not change over time. Macroeconomic time series are generally not stationary. The series having this feature are stabilized by taking their first or second differences or logarithms. The unit root tests are; Levin, Lin and Chu(2002), Harris and Tzavalis (1999), Breitung (2000), Hadri (2000), Fisher ADF (Maddala and Wu, 1999), Fisher Philips and Perron (Choi, 2001). Im, Peseran ve Shin (IPS, 2003). First of all, we must ensure that the series are stationary or not.

In this study, the stationary of the data for the variables will be tested using the extended Dickey-Fuller unit root test (ADF), Impesaran and shin and Levin Li & Chu Test Test for GDP;

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	7.49215	1.0000	17	252
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	7.45984	1.0000	17	252
ADF - Fisher Chi-square	8.67002	1.0000	17	252
PP - Fisher Chi-square	10.6927	1.0000	17	255

Table 3.3 GDP Unit Root Test Results

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.81715	0.9654	17	252
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	6.96238	1.0000	17	252
ADF - Fisher Chi-square	11.4171	0.9999	17	252
PP - Fisher Chi-square	12.8707	0.9996	17	255

Table 3.4 RNW Unit Root Test Results

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	4.92476	1.0000	17	249
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	7.66593	1.0000	17	249
ADF - Fisher Chi-square	9.58135	1.0000	17	249
PP - Fisher Chi-square	8.21299	1.0000	17	255

Table 3.5 DCP Unit Root Test Results

The p value of probability value is higher than the 5% significance level and the null hypothesis cannot be rejected. It can be said that they contain unit roots for data and are not stationary. We cannot reject null hypothesis in all tests, so GDP, DCP and RNW 5% significance level. All the data are not stationary. So the first difference of the series will be tested. Test of first difference of GDP;

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-8.51084	0.0000	17	232
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.59333	0.0000	17	232
ADF - Fisher Chi-square	103.933	0.0000	17	232
PP - Fisher Chi-square	133.162	0.0000	17	238

Table 3.6 GDP Unit Root Test Results (First Difference)

Prob. value is under 5%, so first difference of GDP is stationary now. Unit root tests fo the first difference of RNW and DCP;

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.58889	0.0000	17	233
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.41398	0.0000	17	233
ADF - Fisher Chi-square	117.089	0.0000	17	233
PP - Fisher Chi-square	142.914	0.0000	17	238

Table 3.7 RNW Unit Root Test Results (First Difference)

Method	Statistic	Prob.	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.90810	0.0000	17	234
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.31430	0.0005	17	234
ADF - Fisher Chi-square	69.1508	0.0003	17	234
PP - Fisher Chi-square	77.6398	0.0000	17	238

Table 3.8 DCP Unit Root Test Results (First Difference)

RNW's and DCP's Prob. values are also stationary at the first difference. It has been determined that both series have clearly stabilized in the first differences. While the unit root tests were performed, tests were performed by selecting automatic lag length according to Schwarz information criteria. So in cointegration and causality tests, first difference of the series will be used. First differences of raw data gives us stationary data.

3.4.2. Heteroskedasticity Test Results

To find any Heteroskedasticity problem we should do White tests. We will use stationary series with unrestricted vector auto regression. White test results are shown below:

Individual components:

Dependent	R-squared	F(12,208)	Prob.	Chi-sq(12)	Prob.
res1*res1	0.199321	4.314962	0.0000	44.04996	0.0000
res2*res2	0.383985	10.80453	0.0000	84.86078	0.0000
res3*res3	0.309508	7.769530	0.0000	68.40121	0.0000
res2*res1	0.370724	10.21156	0.0000	81.93004	0.0000
res3*res1	0.392009	11.17584	0.0000	86.63390	0.0000
res3*res2	0.224735	5.024619	0.0000	49.66648	0.0000

Table 3.9 Heteroskedasticity Test Results

Null hypothesis of White test is: there is no changing variance problem. Probality values say we should reject the null hypothesis. So there is

Heteroskedasticity problem. So that, cointegration test which resistive to Heteroskedasticity problem is needed.

3.4.3. Kao And Pedroni Co-Integration Tests Results

At first, we use Engle-Granger based Pedroni Cointegration test which is resistive to Heteroskedasticity problem. Stationary data, which are first difference of series, will be used in Pedroni co-integration test. Null hypothesis is: There is no co-integration.

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	1.727048	0.0421	-2.239997	0.9875
Panel rho-Statistic	-3.357890	0.0004	-2.872352	0.0020
Panel PP-Statistic	-7.078593	0.0000	-9.101115	0.0000
Panel ADF-Statistic	-6.606695	0.0000	-8.364306	0.0000
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	-0.865255	0.1934		
Group PP-Statistic	-12.57435	0.0000		
Group ADF-Statistic	-8.842913	0.0000		

Table 3.10 Pedroni Co-integration Test Results

When the values found as a result of the Pedroni co-integration test were examined, null hypothesis was strongly rejected according to under the 1% significance level in five of the seven test-based seven tests.

Panel ADF and group ADF statistics are better than 20 in short periods. Therefore, Panel rho and Panel pp statistics are more important in terms of test result. These results show that there is a co-integration between RNW, GDP and DCP very strongly. However, only panel v-statistic prob. value is higher than 5%. Kao cointegration test will be conducted to strengthen the results.

In Kao co-integration test first difference of the series will be used also. The test will be performed by Newey-West automatic bandwidth selection. The null hypothesis says that there is no co-integration. Pedroni cointegration test results will be provided by kao cointegration test. If two different cointegration tests show the same direction, this will lead to more reliable results. It will be also Robustness check of Pedroni test results.

	t-Statistic	Prob.
ADF	-3.839997	0.0001
Residual variance	31238276	
HAC variance	5054663	

Table 3.11 Kao Co-integration Test Results

Kao test result says that there is a co-integration between RNW, GDP and DCP values.

3.4.4. Dumitrescu And Hurlin Causality Test Results

The Granger Causality test is a causality test found by Granger in 1969. And developed by Dumitrescu and Hurlin (2012), This test can return successful results, even when analyzed along with cross-sectional dependency conditions. The Granger causality test is used to test the existence of a causal relationship between two variables, but also the direction. Granger describes causality as follows: “The prediction of the Y is the cause of X, Y if the past values of X are more successful than when the past values of X are used” (Gujarati, 2004: 699).

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
DIFGDP does not homogeneously cause DIFRNW	2.70357	0.04035	0.9678
DIFRNW does not homogeneously cause DIFGDP	2.99758	0.36179	0.7175
DIFDCP does not homogeneously cause DIFRNW	4.43285	1.93098	0.0535
DIFRNW does not homogeneously cause DIFDCP	2.14410	-0.57133	0.5678
DIFDCP does not homogeneously cause DIFGDP	5.15451	2.71996	0.0065
DIFGDP does not homogeneously cause DIFDCP	3.14009	0.51760	0.6047

Table 3.12 Dumitrescu and Hurlin Causality Test Results

As we see we cannot reject null hypothesis 5 of 6 tests. There is no bi-directional or directional causality between renewable energy production with domestic product and domestic credits to private sector. Only, there is causality between domestic credit to private sector and gross domestic product. The direction is from DCP to GDP. It means DCP causes GDP. But in this study we focused on the relationship between economical data and RNW. So this causality is not important for this study. It is clear that, there is no causality relationship between renewable energy production between gross domestic product and domestic credits to private sector.

CHAPTER – IV

CONCLUSIONS AND SUGGESTIONS

4.1. CONCLUSIONS

The strong relationship between growth and energy is also expected to be between financial development and energy. Therefore, the parallel relationship between financial development and economic growth is expected to be seen with energy production. However, cointegration between financial development and renewable energy is an interesting topic.

In this study, the relationship between financial development and renewable energy has been investigated. Seventeen of G20 Countries' GDP, DCP and RNW data analyzed with panel data analyse method. DCP data of the Russian Federation and Canada were not available for the period 2001-2016, so, these countries were excluded from the study although they were from G20 countries.

Pedroni cointegration test was applied. It is concluded that there is cointegration. Then confirm the cointegration, Kao test was applied. The cointegration relationship was again determined. It was seen in this study that there is a significant relationship between renewable energy production, domestic credits to private sector and gross domestic product of countries. Co-integration test results showed the co-integration between RNW, GDP and DCP. According to this result, it was concluded that the first hypothesis was valid. Thus, it can be expressed easily: There is a cointegration between financial development and renewable energy production.

This meaningful relationship found shows us that there is an overlapping trend between variables. However, it does not mean that there is a directional or bi-directional relationship among these variables. Therefore, causality tests were performed to determine whether there was a causal relationship between the variables. The second hypothesis in this study claims that there is a bi-directional causal relationship between financial development and renewable energy production. The second hypothesis claimed that RNW was the cause of DCP and GDP, and that DCP and GDP were the cause of RNW. The strongest basis of this hypothesis was that a significant portion of renewable energy investments were covered by domestic credits to the private sector. But, there is no causality has been found with RNW and other variables. This result shows that the second hypothesis has collapsed and is not valid.

Similar to most of the studies in the literature, a cointegration was found between financial and economic development and renewable energy. The reason why the causality, which varies significantly according to sample group and period, cannot be found in G20 countries is also a research subject. One of the main reasons for the lack of causality may be the complexity of the relationship between the variables. Increasing the number of correctly identified variables to reduce this complexity may cause causality in new research. In order to identify new variables, the parameters determining the concepts need to be analyzed carefully.

4.2. SUGGESTIONS

The econometric analysis performed in this study revealed the relationship between renewable energy production and financial development. If there was a relationship between financial development and renewable energy consumption, policy recommendations would be made. It is understandable that renewable energy power plants are expensive investments. If a country becomes richer, they do more investments to renewables. However, although there is cointegration, no causal relationship has been found from financial development to renewable energy consumption or vice versa. It is concluded that the first hypothesis, which claims to be cointegration, is valid, but the second hypothesis, which advocates causality, is not valid.

Although there is cointegration between renewable energy production and financial development, the lack of causality is an issue that needs to be studied. This shows that the financial developments of countries do not directly affect renewable energy investments. The fact that renewable energy investments have longer financing and repayment periods may cause loss of causality between the variables. For this reason, new researches covering longer periods can be done instead of annual research.

Capital accumulation is an important problem for developing countries to overcome. Regardless of the development model, the economic development process for each country requires increasing investments. In order to increase the investments, the funds needed to realize these investments must be met. An advanced financial system plays an important role in meeting this need. A healthy financial structure can ensure full and effective use of funds that are necessary and scarce for investments. Therefore, it is necessary for each country to ensure the development of this financial structure (Ergeç, 2004:63).

Excessive consumption that started with the industrial revolution has caused many problems. In this context, environmental problems are due to the secondary growth of the environment according to economic growth. The model that provides economic growth by taking environmental factors into account is expressed as sustainable development. (Uçak, 2010:127).

Research findings show that in G20 countries, which have a significant share in the world population, it is possible to grow financially and economically with renewable energy sources, a production factor with low carbon emissions. Increasing use of renewable energy resources in the production process as a result, an environmentally sensitive financial and economic growth process can be initiated without the need for lower financial and economic growth than the current level.

As a result of this study, although there is a cointegration between financial development and renewable energy, it can be said that G20 countries do not transfer financial resources in proportion to renewable energy.

Initial installation costs are reduced as a result of the development of renewable energy technologies. Therefore, their weight on financing opportunities is decreasing. Renewable energy investments, which facilitate investment opportunities, should therefore be further encouraged. The renewable energy resources of countries should not be a limiting factor. As a matter of fact, the project of some European countries to transport the energy produced from sunlight in the

Sahara desert from under the Mediterranean to the European continent is a concrete example of this.

Since the industrial revolution developed countries are responsible from CO_2 emission and global warming. Most of them tried to reduce CO_2 emission by fronting renewable energy sources instead of fossil fuels. For sustainable development renewable energy is one of the most important requirements. Of course, renewable energy sources of countries are also an important factor at this point. When these two factors, namely oil reserves and renewable energy sources are excluded from the evaluation, it is observed that some countries lacking both sources are more eager than their economic and financial growth in terms of renewable energy. With this study, country administrators should analyze the position of their countries in terms of renewable energy and financial development. A portion of each size that is economically earned to leave a cleaner and more sustainable world for our children must be reserved for renewable energy funds.

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ÖZGEÇMİŞ

İstanbul’da doğdu. İlk ve orta öğrenimini Kahramanmaraş’ta yaptı. Çeşitli kamu kurumlarında çalıştı. Anadolu Üniversitesi İşletme Bölümünü bitirdikten sonra Gaziantep Üniversitesi’nde İngilizce İşletme alanında yüksek lisansa başladı. Evli ve iki çocuk babasıdır. İngilizce bilmektedir.

VITAE

He was born in İstanbul. He completed his primary and secondary education in Kahramanmaraş. He worked in various public institutions. After graduating from Anadolu University, Department of Business Administration, he started his master's degree in Business Administration at Gaziantep University. He is married and has two children. He speaks English.