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Promoting a Clean Power Industry in the Kazakhstan framework of Green Economy

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아크보타 아만타이의 박사학위논문을 인준함

2020 년 2 월

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Abstract

This study aims to analyze the electricity sector within the conceptual framework of the "Green Economy" in Kazakhstan. The electricity sector in the Republic of Kazakhstan plays a significant role in contributing to environmental pollution, especially through the availability of coal, oil, and gas. In accordance with the Concept of a "Green Economy"- Kazakhstan plans to modernize its electricity sector over the next 30 years in order to reduce CO_2 emissions, gasify some regions, and increase the share of renewable energy. The main objective of this study was to examine three questions:

The first essay, "The Environmental Consequences of Growth: Empirical Evidence from the Republic of Kazakhstan," concerns the impact of economic growth on CO_2 emissions in Kazakhstan, controlling for energy consumption, in the autoregressive distributed lag (ARDL) cointegration framework. The results show that the environmental Kuznets curve (EKC) hypothesis is confirmed, energy consumption increases CO_2 emissions, and that government policy which was interpreted in estimation by dummy variable (D07), has negative significance in CO_2 emissions. This also means that the CO_2 emissions reduction policy is working.

The second essay, is the "Decomposition Analysis of CO_2 Emissions from Electricity Generation by using Coal and Gas fuels in Kazakhstan", performs an analysis of the past patterns of CO_2 emissions from electricity generation, while also analyzing the driving factors, based on index decomposition analysis (LMDI) over three periods: 1990-2000, 2000-2008 and 2008-2016. The economic activity effect ΔGDP increased CO_2 from -0.72 Mt during the first period to 0.00 Mt and, the electricity intensity effect ΔEI from -0.26Mt to 0.33Mt. while, the electricity generation efficiency effect ΔEGEF has decreased from at 0.66Mt during the first period to 0.04 Mt. The thermal power structure effect ΔSEG increased from the -0.65Mt during the first period to 0.10Mt, while the changes in the electricity structure effect ΔSTPG increased from -0.23Mt to 0.45 by the last period.

Third essay is "Analysis of barriers to renewable energy development in Kazakhstan". We determined 16 (four main criteria and 12 sub-criteria) barriers from previous studies, articles and papers, as well as through interactions with experts in energy fields from two groups (private and government experts).We used the analytical hierarchical process (AHP) methodology to identify the importance ranks of barriers regarding renewable energy. The results show that for government experts, economic barriers, and for private experts, technical barriers are the most important. Overall, in terms of these barriers, government experts rank low levels of investment as the most important factor, while private experts rank the lack of infrastructure and transmission system sub-criterion as the most important factor.

Key words: ARDL approach, Analytical Hierarchy Process (AHP), LMDI, Republic of Kazakhstan, Renewable energy sources, CO_2 emissions, Electricity, Green economy.

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Chapter 1

Introduction

1.1. Background

Environmental problems are now impacting the world on a global scale. In connection with the emergence of this crisis, and seeking to bring together financial, economic, and environmental concerns, regarding this situation, a new trend of changing life for the better, the “Green Economy,” has emerged. This concept, incorporates many factors, from improving the environment to the development of new technologies.

The transition toward a Green Economy is an inevitable direction of development, but one which requires intense efforts in order to improve the environmental friendliness of the global economy. In this regard, it is important to determine the similarities and differences regarding national legislation around the world in terms of, the development and adoption of policies governing carbon emissions. It should be noted that the transition toward "green" growth should be, conducted by taking into account the national interests and opportunities of individual economies. It is impossible to achieve high indicators for which the country is not ready, especially if there is a strong dependence on energy resources that do the most damage to the environment.

The Briefing document “What do we mean by Green economy?” by D. Fedrigo-Fazio et. al. (2012) mentioned that the global financial crisis of 2008 triggered questioning regarding the soundness of economic models and policies as they had developed over past decades. Through this approach, they highlight the terms “green growth” and “green economy” as tools that will help countries to overcome future economic crises. During the economic recovery periods of developed countries resulting from the external pressures created by global crises, most international organizations and world research institutes began to contribute to the justification and disclosure of the terms "Green Economy" or "green growth", specifically to improve the situation globally. It should be noted that the two above terms mean primarily refer to a country's low-carbon development (Barbier, 2012).

Kazakhstan's adopted strategy, “ Kazakhstan-2050,” represents a new political course of an established state ” and sets clear guidelines or rules for building a sustainable and effective economic model, based on the country's transition toward a “ green ” path of development. In Kazakhstan's case, the term "Green economy" refers to an economy with a high quality of life for the population, with careful and rational use of natural resources for the benefit of both present and future generations. This should be done in accordance with the country's international environmental views and obligations, including the Rio principles, the Agenda for XXI century, the Johannesburg Plan, and the Millennium Declaration. From this, we can understand that the Green Economy has become one of the important tools for ensuring sustainable development, while it is also a popular trend in the current development of many countries globally. (Egorova M.et al, 2014).

Kazakhstan's blueprint for transitioning toward "Green economy" aims to ensure that the country realizes its goal of becoming one of the 30 most developed nations in the world. To me, this seems to be a very ambitious plan that will require enormous costs, primarily in terms of the development of the country's industrial sector. In accordance with the established goals and, calculations regarding the development of the country's economy by 2050, transformations within the framework of the Green Economy will make it possible to further increase GDP by 3%, generate more than 500,000 new jobs, create new industries and services, and ensure high quality of life standards for the population. In general, the volume of investment required for such a transition is about 1% of GDP annually, which is equivalent to 3-4 billion US dollars per year. At the same time, changes brought about by transitioning to a Green Economy can make the most significant contribution to Kazakhstan's development. (Akhmetyanova S. 2013). The strategy to bring about this transition includes water issues, urgent environmental issues, energy efficiency, heat and power generation, desertification, developing green energy, urban planning, regional development, restoration and modernization of agriculture, reduction of environmental pollution, macroeconomic indicators, and institutional development. In other words, almost every sector of the country requires some form of modernization.

In this regard, the following activities are envisaged:

- Diversification of economic activities and energy: building regional “green” clusters, diversifying energy sources.
- Stimulating the growth of well-being and reducing environmental pollution: reducing air, soil, and water pollution, ensuring the protection of the most important ecosystems and national objects.

- It is necessary to provide measures to support changes that will both impact, the fundamental aspects of the electricity sector, and stimulate its technological aspects in order to ensure that the sector is prepared for the challenges of the future.

At the same time, the government has also identified several aspects that embody the energy strategy within the framework of the Green Economy concept:

- A change in the share of electricity consumption in the country is needed, which indicates a change in trends that is required more generally.
- It is necessary to stimulate investment for improving the infrastructure of the electricity sector.
- A more integrated and consistent approach is needed regarding the development of a regulatory framework in the electricity sector.

Consequently, the state should clearly realize that the regulatory process of the electricity sector, should be guided by realistic forecasts regarding the sector’s development, as potential investors and analysts need better access to information and data. In fact, this implies some kind of update, as well as the use of various tools, in order to improve economic performance.

In essence, the modernization of the economy represents the key objective of the established, ambitious goals that have been set for ensuring Kazakhstan's energy security. Considering that a significant proportion of Kazakhstan’s power plants are relatively old, inefficient, coal-fired, and base-oriented, future energy generation will certainly present certain difficulties. This, means it is necessary to encourage investment in improving efficiency and maneuverability within the existing infrastructure.

The implementation of these tasks aims to both expand and improve these industries, and this study will analyze the electricity industry on a sector-by-sector basis within the framework of the green economy. In doing so, the dynamics of development, the impact on the environment, the issues presented by reducing emissions, and the development of renewable energy in Kazakhstan will all be revealed. This dissertation consists of six chapters and contains three research essays.

This analysis will provide an advantageous contribution, for improving state policies in the electric power and environment sectors, as well as analysis of the goals set in the development of these sectors. It will examine the extent to which the state has chosen the right path, the extent to which the target indicators are achievable, and whether there is a likelihood of improving the current situation as a whole.

1.2. Purpose of study

According to Kazakhstan's "Concept of Transition to the “Green Economy,” the government has adopted a plan for the development of the electric power industry until 2050 (Table 1.1).

"The transition to" green "energy and, the introduction of " green " technologies is a growing vector of the global economy. Despite the presence of enormous natural resources, including hydrocarbons, Kazakhstan intends to actively develop renewable energy sources to improve the current situation by using new technology in order to transition toward a low-carbon economy. Through the " Kazakhstan-2050 " strategy, such tasks have been set,” according to the First President of Kazakhstan Nursultan Nazarbayev, who defined the vector of energy development.

Since, the existing state of the industry is characterized by both considerable wear on the generating and networking equipment, the dominant position of coal fuel generation, and the lack of the necessary reserves to cover peak load periods, the government decided to implement some reforms designed to improve the country's electric power industry in the following ways:

1. To gasify certain regions of the country, which can lead to an improvement in atmospheric air.
2. To reduce CO_2 emissions.
3. To develop renewable energy.

Table 1.1. Goals of the "green economy" in the electric power industry[1]

Sector	**Description of target**	**2020**	**2030**	**2050**
Electric power industry	The use of alternative sources for electricity generation	Solar and wind: no less than 3% by 2020	30%	50%
	Increase the gas fired power plants for electricity generation	20%	25%	30%

[1] The concept of the transition of the Republic of Kazakhstan to the "Green Economy", approved by the Decree of the President of the Republic of Kazakhstan, May 30, 2013 No. 577

	Gasification of regions	Akmola and Karaganda regions	Northern and Eastern regions	
	Reducing the current level of carbon dioxide emissions in the power sector	Level in 2012	-15%	-40%

Based on the goals of the "Green Economy" concept of Kazakhstan (2013) in the electric power engineering sector, this dissertation takes into consideration three research questions:

1) The Environmental Consequences of Growth: Empirical Evidence from the Republic of Kazakhstan.
2) Decomposition Analysis of CO_2 emissions from Electricity Generation by using Coal and Gas fuels in Kazakhstan.
3) Analysis of barriers to renewable energy development in Kazakhstan.

The first of these essays came from the goal of reducing the current level of carbon emissions in the power sector. Kazakhstan is one of the largest GHG emitters in Europe and Central Asia, with annual national emissions of more than 300 million tons of CO_2 emissions. The energy sector accounts for about 85% of the country's total greenhouse gas emissions, followed by agriculture (9%) and industrial processes (6.5%). Therefore, this study aimed to analyze Kazakhstan's dependence of carbon dioxide emissions from economic growth and coal consumption, since 80% of its power plants use coal to generate electricity. To this end, we used time series analysis with variables that can be related to increases in CO_2 emission. The first essay of the dissertation, named “The Environmental Consequences of Growth: Empirical Evidence from the Republic of Kazakhstan," will address these issues.

The second essay was developed based on the goals of increasing gas power plants for electricity generation and shifting the production of the power plants from coal to gas. This analysis aims to verify the correct public policy approach taken by the government within the "Green Economy" framework. Decomposition analysis has shown how CO_2 emissions are changing due to certain economic factors regarding the shift from coal to gas. The second essay, which addresses these issues, is named “Decomposition Analysis of CO2 emissions from Electricity Generation by using Coal and Gas fuels in Kazakhstan."

The third essay of the dissertation focuses on the development of renewable energy in Kazakhstan. While the development of renewable energy is the main goal of the "Green Economy" in most countries that have adopted it as a policy, this trend may pose difficulties for countries which depend on traditional energy sources due to a lack innovation and new technology and price concerns regarding renewable energy. However, the results of the Analytical Hierarchy Process (hereinafter AHP) methodology, which determined the barriers posed by different criterions, offers important contributions regarding Kazakhstan's policy of implementing RES projects. Consequently, the third essay examines the barriers impacting the development of renewable energy in Kazakhstan.

1.3. Dissertation structure

The dissertation is formed of six chapters (Table 1.2). The first chapter provides an introduction and background information regarding the study, while the second chapter offers a description of research questions and the purpose of this study. The third chapter is the empirical analysis of the impact of country's economic development on both carbon dioxide emissions and energy consumption, as well as forecasts for the future. The fourth chapter is the second dissertation essay, providing analysis of carbon dioxide CO_2 emissions from electricity generation developed through the use of coal and gas. This chapter also highlights changes in economic factors when changing fuel and how much the transition from coal to gas affects the existing indicators of CO_2 emissions. The fifth chapter is the third essay, concerning the development of renewable energy and what exactly hinders this development, as well as detailing what factors the government should pay attention to when choosing to make reforms in this sector.

More detailed descriptions of each of these sections are provided in each chapter of the dissertation:

Chapter 1 has three sections: background, purpose of study, and dissertation structure. This chapter presents a general introduction and background information regarding the framework of the dissertation title, as well as an explanation of the three essays and a discussion regarding the purpose of study.

Chapter 2 has three sections, including a discussion of the current status of the electricity sector in Kazakhstan, a description of the period of formation and development of the electricity sector, and a discussion of the electricity sector according to the concept of the "Green Economy."

Chapter 3 is the first essay of the dissertation. It features eight sections, all of which relate to the essay topic.

Chapter 4 has 11 sections, including analysis of the second essay and decomposition analysis of CO_2 emissions from electricity. It also provides a full description of the coal and gas industries and how these fuel types have affected the country's environment.

Chapter 5 consists of 19 sections, which analyze the barriers facing renewable energy development in Kazakhstan. This section features an introduction to the renewable energy sector in general and government policy within it, as well as the results from the AHP methodology and recommendations for this sector.

Chapter 6 provides a description of the policy implications of the findings and an overall conclusion regarding both the three essays and the dissertation in general.

Table 1.2. Structure of the dissertation

Chapter	Title	Description
Chapter 1	Background of analysis	Brief overview of analysis point, purpose of study and background of research.
Chapter 2	The Current Status of the Electricity Industry in Kazakhstan	Description of electricity sector in Kazakhstan, and Green Economy concept goals in this field.
Chapter 3	First essay: The Environmental Consequences of Growth: Empirical Evidence from the Republic of Kazakhstan.	This chapter is first essay of dissertation, analysis of CO_2 emissions from energy consumption and checking the EKC hypothesis in Kazakhstan.
Chapter 4	Second essay: Decomposition Analysis of CO_2 Emissions from Electricity Generation by using Coal and Gas fuels in Kazakhstan.	This chapter is study about CO_2 emissions from electricity generation. We analyzing economic factors changes while the power plants using coal and gas fuels for the production of electricity and how it's affecting on CO_2 emissions.
Chapter 5	Third essay: Barriers of renewable energy development in the context of Kazakhstan.	This study about the determination of RES development barriers in Kazakhstan according to the analysis of the survey (questionnaire) of experts in this fields in conformity with AHP methodology. Description of the current situation, legislation framework and government policy of the country.
Chapter 6	Overall conclusion	There is a policy implication from the three essays of this study.

Chapter 2

The Current Status of the Electricity Industry in Kazakhstan

2.1. Electricity industry in Kazakhstan

The power industry is one of the main sector of the economy and plays an important role in the political, economic and social spheres of any state. In the next ten years, major structural and technological changes are coming in the global electricity sector, which will be related with a big investment in the development of RES new technologies and effective energy conservation policies. The power industry of the Republic of Kazakhstan includes the following sectors:

- Electricity generation;
- Distribution of electrical energy;
- Electric power supply;
- Consumption of electrical energy;
- Other activities in the field of electricity.

Electricity generation

Nowadays in Kazakhstan functions 138 power plants with a different types of ownership forms, and not only ownership forms, Kazakhstan's power plants are divided accordance they importance for country, namely power plants for industrial use and power plants for regional use and power plants of national importance.

Distribution of electrical energy.

The Republic of Kazakhstan has a set of substations, switchgears and power transmission lines connecting them with a voltage of 0.4–1150 kWh, intended for the transmission and distribution of electrical energy.

The backbone network in the Unified Energy System (UPS) of the Republic of Kazakhstan is a national electricity network (NEG), which serves as an electrical connection between the regions of the Republic of Kazakhstan and the energy systems of neighboring countries, such as the Russian Federation, the Kyrgyz Republic and the Republic of Uzbekistan, and also performs the functions of electric energy distribution at power plants and makes it possible to transfer electricity to wholesale consumers. At the same time, substations, switchgears, inter-regional and interstate power lines generating electricity of power plants with a voltage of 220 kW and above, which are part of the NEG, are on the balance sheet of KEGOC[2].

Electric power supply

The power supply sector of the electricity market of the Republic of Kazakhstan consists of energy supplying organizations (ESO), which purchase electricity from energy producing organizations or they are centralize tenders and then sell it to final retail consumers. Part of the ESO performs the function of "guaranteeing suppliers" of electricity.

Consumption of electrical energy

Electricity consumption is directly related to the functionality of the electricity market in the country itself. The electric power market is divided into wholesale and retail, the heat energy market is represented only by the retail market.

The system operator, REC (regional electric grid companies) and other organizations that own electric grids provide free access to the electric power market for all participants in the manner established by the state body exercising leadership in the fields of natural monopolies and in regulated markets. Any relationships in the market of electricity, between consumers, producers or transmission companies regulated by agreements.

Consumers in the decentralized market of electric energy in conclude contracts for the sale and purchase of electric energy at prices, volumes and terms of supply. Consumers of electric energy participate in the wholesale market of electric energy when the following some conditions as for example to purchases on the wholesale electricity market in the amount of not less than 1 mWh of average daily (base) capacity. Electricity consumers connected to the national electrical network, access to the national electrical network is provided in the presence of contracts with the System Operator.

[2] Kazakhstan's power industry: key facts. Information was taken from the KEGOK JSC official website. https://www.kegoc.kz/ru/elektroenergetika/elektroenergetika-kazahstana-klyuchevye-fakty

System operator

According to the Law of Electric Power Industry, KEGOC is the government owned company, who is responsible for the transmission of electricity and over the 500-220 kWh networks - that is, the system operator, which implementing general control and management of the electric power system of Kazakhstan.

We can see the structure of power industry of Kazakhstan system in Figure 2.1.

Nowadays we can highlight some main problems in power industry of Kazakhstan:

1. Development of the park resource of generating equipment (75% at thermal power plants and 90% at hydroelectric power plants);
2. Fuel consumption is very high and low efficiency of stations;
3. The lack of convenient sources to cover peak loads.
4. Depreciation of the main electric networks, more than 60%;
5. The trunk losses about 5.7% and distribution networks losses about 13.0%;
6. Environmental impact from electricity sector is high.

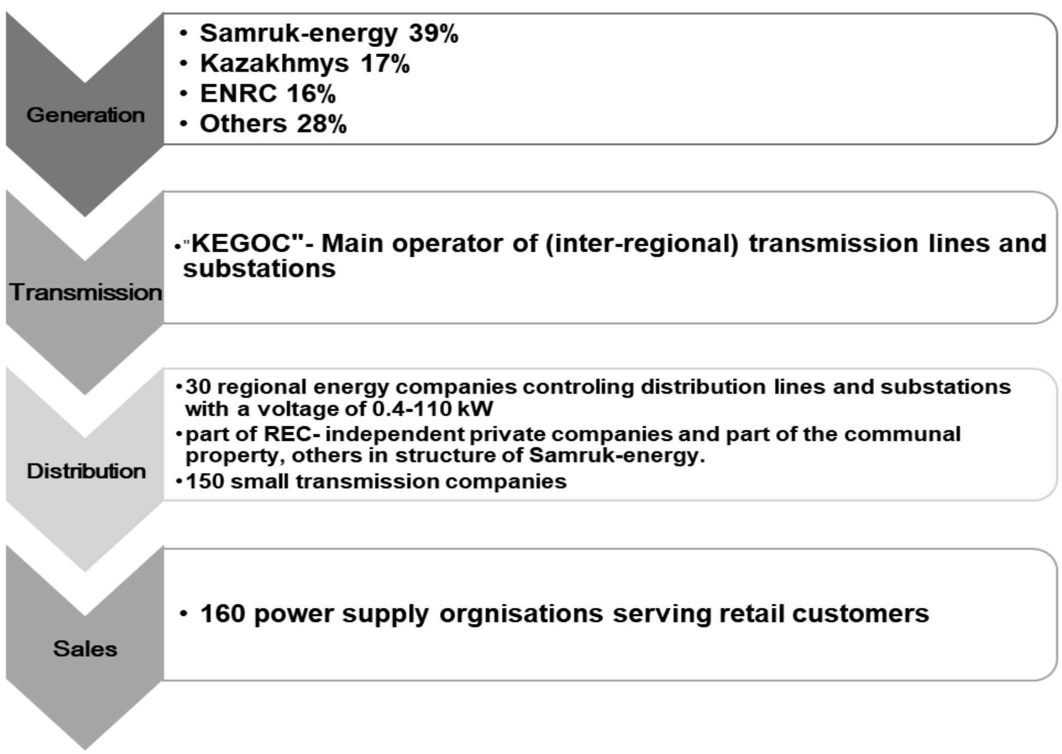

Figure 2.1. Structure of electricity industry in Kazakhstan

Source: Overview of coal mining and coal power engineering in Kazakhstan. (Center for the introduction of new environmentally sound technologies (CINEST), 2017)

2.2.Current situation

The national electric power system of Kazakhstan, which covers a vast area of 2,717,300 km^2 includes three energy zones, North, South and Western energy zones. As we know Kazakhstan's territory is very big, and before it was part of Soviet Union, two of this North and South energy zones are interconnected by electricity network, but the third one Western Energy Zone works a quit isolated. At the end of 2018, the electric power potential of the Republic of Kazakhstan is comprised of the production of electric energy in Kazakhstan by 118 electric stations of various forms of ownership.

Nowadays, the total share of electricity production in 2018 amounted to 106.797.8 billion kWh.(Fig.2.2).

It should be noted, that comparing with another countries energy conversion efficiency of power plants in Kazakhstan has low level. Thus, energy conversion efficiency of coal-fired condensing power plants in Kazakhstan is on average 32%, while in advanced foreign countries - 42%.

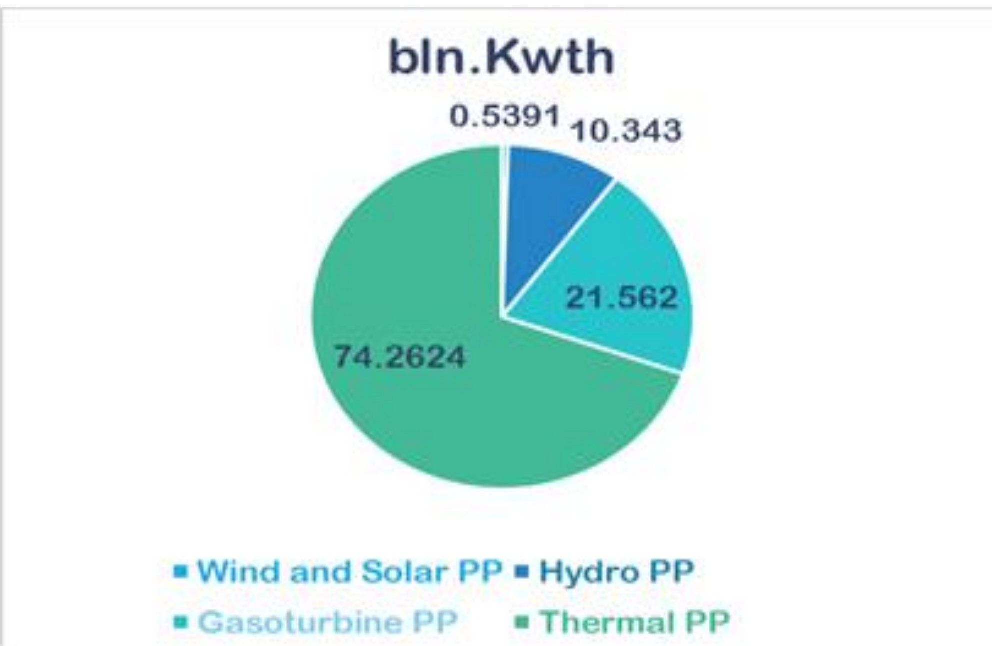

Figure 2.2. Electricity generation by power plants in 2018

Source: (annual report from Ministry energy)

It is also important to discuss of the current status of relations formed between the CIS countries. Thus, a brief overview of the status of the Eurasian Economic Union formed from the general electricity market.

According to the plan on the formation of the EAEU (Common Electricity Market (hereinafter CEM) of the Eurasian Economic Union (EAEU)), was needs to develop relevant documents on the formation of the EAEU CEM. In accordance with the Treaty on the Eurasian Economic Union of May 29, 2014, the EAEU member states must conclude an international agreement on the formation of the EAEU common electricity market and ensure its entry into force no later than July 1, 2019. The international treaty has been prepared in the form of a Protocol amending the EAEU Treaty regarding the formation of a common EAEU electricity market and will become an annex to it.

The draft protocol defines the legal framework and principles for the formation, functioning and development of a common electric power Union, establishes the areas that will be regulated by the rules for the functioning of the common electric power market of the Union, and also empowers the Eurasian Intergovernmental Council and the Council of the Commission to approve acts regulating the common electric power market of the EAEU. At the same time, the draft protocol defines the bodies and organizations that manage and ensure the functioning of the common electric power market of the Union, the participants and infrastructural organizations of the general electric power market of the Union, as well as the methods for trading electric energy on it.

Today, the Eurasian Economic Union (EAEU) of the Republic of Armenia, the Republic of Belarus, the Republic of Kazakhstan, the Republic of Kyrgyzstan and the Russian Federation is the single platform of the post-Soviet countries. The integration of countries with common historical, climatic, geographic, transport and economic foundations will help achieve the intended goals and get the intended benefits. A single commodity market is already functioning within the EAEU. Cooperation of electric power sector between these countries, we can see visually in Fig.2.3 where it is shown that Kazakhstan is self-sufficient, with the exception of the deficit zone, where electric power industry is imported from the Russian Federation and Kyrgyzstan. At the same time, during the 1990s Kazakhstan largely relied on the import of electricity from Russia and Central Asia. This mode of operation was established during the Soviet Union and was quite natural, since the energy systems of our states were originally designed for parallel operation. And electricity flows between Russia and Central Asia were still convenient for balancing purposes. Currently, electricity trade between Russia and Kazakhstan amounts to modest volumes annually. (Annual report of "KEGOC" company, 2018).

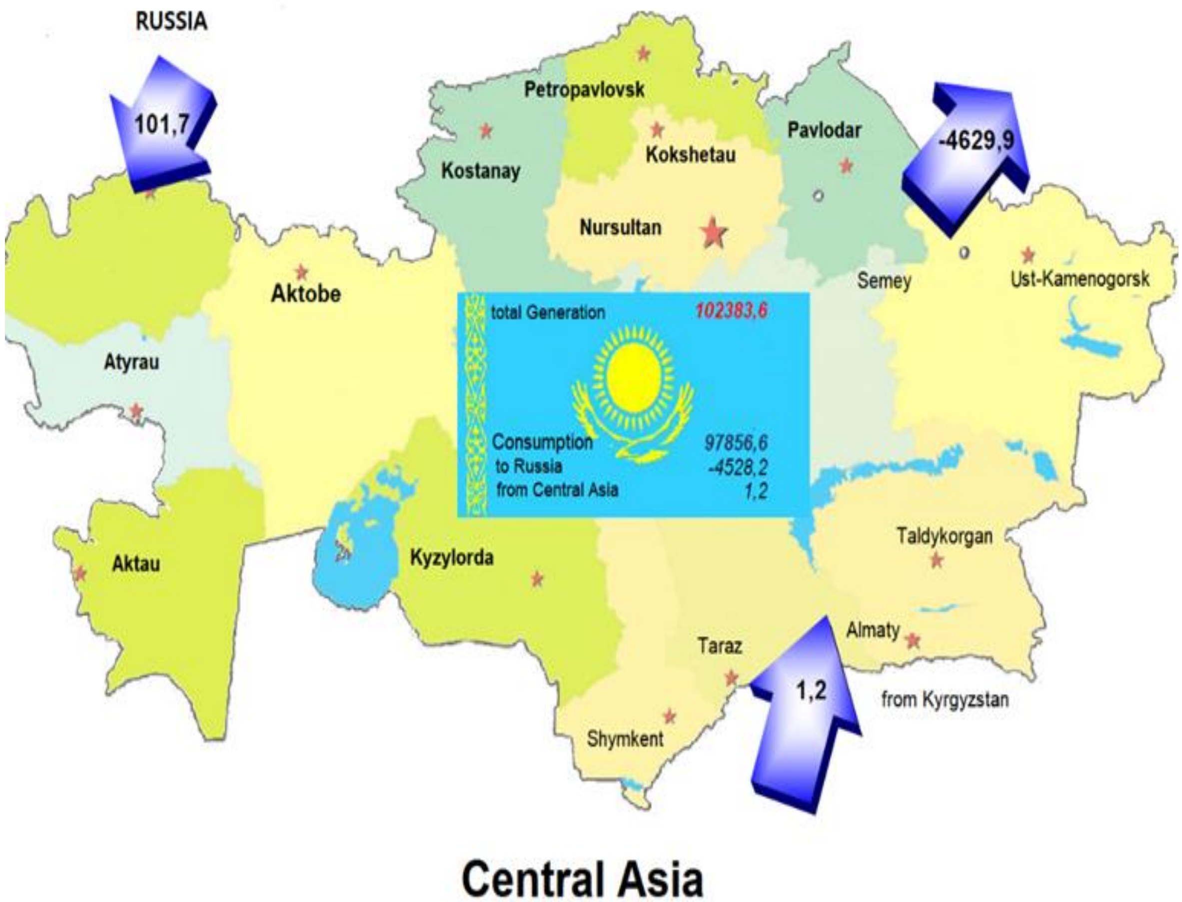

Figure 2.3. Electricity flow balance in 2017

Source: annual report 2018, "KEGOC" company

2.3.Green Economy as a way to develop sustainable power industry.

The concept of a country's transition to a Green Economy implies "the maximum extension of the service life of existing coal and gas stations and hydroelectric power plants, while the main reason is that this solution is capable of providing the lowest cost of electricity." In addition, "it is planned to install dust and gas cleaning equipment as part of the modernization of existing coal-fired plants to improve the quality of atmospheric air and meet environmental standards." The concept provides for three scenarios for the development of the electric power industry - Basic, Green with “expensive” gas, and Green with “cheap” gas. Accordingly, the base scenario provides for a significant increase in coal generation up to 2050 (by 80% from the current level relative to 2012). The green scenario with “expensive” gas provides for a moderate increase in coal generation by 2030 (by 40% from the current level of relative to 2012) And also, the Green scenario with “cheap” gas implies the preservation of coal generation up to 2030 at the level of 2012, and a decrease after 2030 due to the withdrawal of old capacities.

The Concept in any scenarios considering of construction the nuclear power plants 1.5 gWh capacities by 2030 and 2 GW by 2050”. Also the Concept of Green economy adopted rates for the renewable energy development, namely: “Entering 4.6 GW of a wind power station and 0.5 GW of a solar power station by 2030”. Since the gas is the more harmless energy resource, one of the ways to switch to gas generation will be through “modernization of CHP in big regions, to the gas. At the same time, according to the Concept of "Green economy" there will be commissions of new capacities for balancing renewable energy”.

How power industry going to develop in a framework of Green Economy Concept?

Since the situation in the electricity sector has some drawbacks, the Concept has aimed at improving the sector through the elimination of problems. So, today the electric power industry is characterized by considerable wear of generating and network equipment, while the coal generation dominates and there are no necessary reserves to cover the peak load. The concept provides for some figures on the development of the economy and the implementation of energy efficiency measures, implying an increase in energy consumption by 2.3% per year by 2030 to 136 billion kWh. And by 1.2% per year by 2050, up to 172 billion kWh. At the same time, the energy intensity of the country's GDP will decrease by 50% relative to the level of 2010.

At the same time, the demand for electricity will also grow until 2050, based on a particular scenario that will require significant construction of new capacities.

In general, the concept identifies several main factors on which the development of the energy sector of Kazakhstan will depend:

1. Reduce energy consumption by adopting energy efficiency measures.

2. Modernization of current capacity.

3. The competitiveness of various power generation technologies in terms of current costs, as well as the evolution of traditional and renewable technologies in the future

4. The degree of interest of Kazakhstan in the implementation of projects to reduce CO_2 emissions and the price level of CO_2 emissions.

5. The availability of gas for the production of electricity and its price.

Scenarios for the development of the energy sector.

According to the Concept, there are three scenarios of development of the energy sector.

Factors that are giving a description for all of these three scenarios.

1. Reducing electricity consumption by adopting measures to improve energy efficiency (taking into account the basic and "green" scenarios for the development of electricity demand, described earlier in this section, according to which total electricity demand will be 136-145 billion kWh in 2030 and 186-206 billion kWh in 2050);2. The price of gas for the power industry (lower prices correspond to greater availability of gas);

2. We have two options for the development of new types of generation: the first is when the share of alternative and RES (including hydropower plants, WPPs, SESs, and NPPs) is between 20% by 2050 (partial achievement of goals), the second is 50% (complete achievement of Strategy objectives - 2050);

3. The maximum extension of the service life of existing coal, gas stations and hydroelectric power plants, because this giving low price for electricity, the government planned to install dust and gas treatment equipment as part of the modernization of existing coal-fired plants to improve the quality of atmospheric air and meet environmental standards;

4. Forecast data for installed capacity in 2030: 4.6 gWh for WPP and 0.5 gWh for SES;

5. Construction of nuclear power plant will be implemented according to the national plan: total installed capacity is 1.5 gWh in 2030 and 2.0 gWh in 2050.

6. All Thermal power plants will be changed from using coal to gas for increase of quality of atmospheric air.

So we have three possible implementation of scenarios:

The base scenario is the demand for electricity in the baseline scenario, the gasification of Akmola and Karaganda regions, the preservation of the current low gas prices, 30% the share of alternative sources in electricity generation in 2050;

The “green” scenario with expensive gas: the demand for electricity in meeting the goals of the “green economy”, gasification of the Akmola and Karaganda regions, high gas prices, 50% the share of alternative sources in electricity generation in 2050;

The “green” scenario is cheap gas: the demand for electricity in meeting the goals of the green economy, gasification of Akmola, Karaganda, Pavlodar and Eastern regions, low gas prices, 50% share of alternative sources in electricity production in 2050.

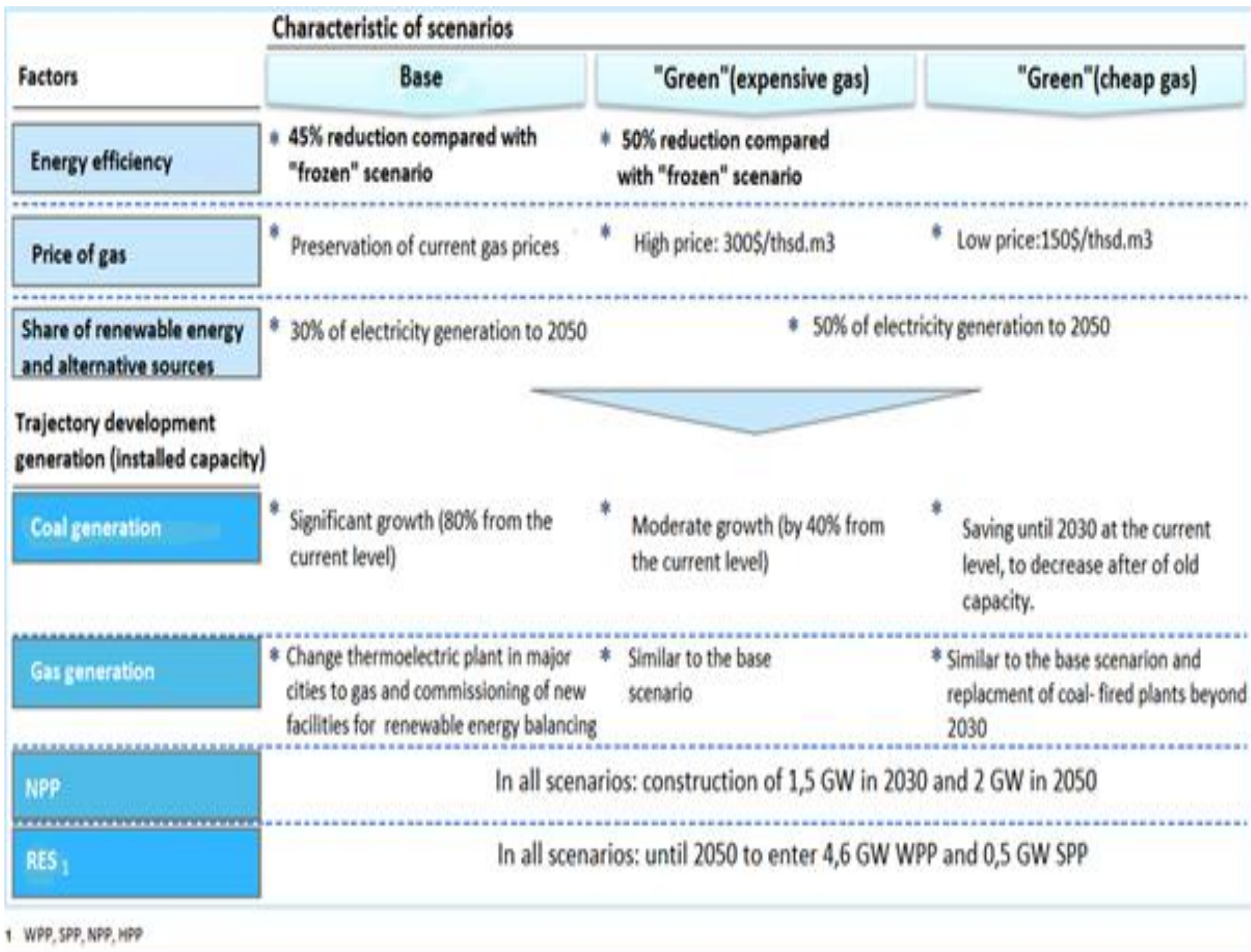

Figure 2.4. Scenario for the development of power industry

Source: Green Economy concept (2013)

The main technical changes, should be as:

1. By existing stations: to inspect an audit of the technical condition and checking all existing power plants by 2020 to determine the modernization schedule and the remaining lifetime of

the generating assets, also modernization of existing coal-fired power plants, which in aggregate will amount to 8.3 gWh of capacity by 2020.

2. New thermal power plants need to be constructed in accordance with the best world technologies in terms of fuel efficiency and environmental parameters.

3. It is necessary to gradually replace the existing old coal capacities with new modern coal-fired power plants, with the exception of big cities, where energy generation will be transferred to gas, if it is available in terms of volumes and price, provided that: be carried out taking into account the achievement of the maximum recovery rate of hydrocarbons; The government will take measures to implement a long-term pricing policy in the domestic market that will increase gas consumption;

4. To start develop of RES with the achievement of 3% share of wind power plant (hereinafter- WPP) and solar power plant (hereinafter – SPP) in the total electricity production by 2020;

With the achievement of 10% of the share of WPP and SES in the total volume of electricity production by 2030;Transition to full-scale introduction of renewable energy after they reach an acceptable level of competitiveness compared to traditional sources, which is expected between 2020 and 2030;

Achievement of 50% of the share of RES, including wind, solar, hydro and nuclear power plants in the total electricity production;

5. The government planned to provide diversification of the energy sector by investing in nuclear energy to create competition in the sector and ensure the competitiveness of the uranium mining industry, the total installed capacity of nuclear power plants will be 1.5 gWh in 2030 with its growth to 2.0 gWh to 2050

6. The necessary investments in the development of the national infrastructure, namely, the transfer of CHP from coal to gas will reduce the level of local emissions, improve the quality of air, as well as increase the reserve capacity to support unstable RES.

For developing the gas infrastructure needs to set a goal for gas facilities to achieve a certain share in the structure of the energy balance by 2020 in order to stimulate investments in gas power plants and in the necessary auxiliary gas infrastructure. The priority for the government in making a decision on the construction of the necessary infrastructure will be considered as issues of ensuring the environmental and social attractiveness of projects, even if the economic efficiency of the projects is low;

7. For electricity generation to shift from coal to gas of thermal power plants in a main cities of Kazakhstan, Almaty, Astana and Karaganda, also needs to build new power plants on gas type until 2020 for improve ecological situation in the cities.

Chapter 3

First essay: The Environmental Consequences of Growth Empirical Evidence from the Republic of Kazakhstan.

3.1. Introduction

Today, in Kazakhstan, as in the whole world, the implementation of a Green Economy is being carried out, and this trend is aimed primarily at improving the quality of life of people. At the same time, one of the most important principles of a Green Economy is to reduce the carbon intensity of GDP. Not an easy task, because the largest segments of the country's economy is energy and most often this sector, has accused of a huge “contribution” to environmental pollution.

This chapter examines the effect the economic growth has on CO_2 emissions and to make a study to determine the relationship between of country’s GDP and CO_2 emissions in Kazakhstan. We tried to identify and examine the environmental Kuznets curve hypothesis for Kazakhstan according to the energy consumption and GDP in the short- and long-run for the period 1991 to 2018. The bounds testing approach are used to test the interrelationships of the variables. The results confirmed the negative and significant impact of GDP on CO_2 emissions in short and long – run. It means the positive role of GDP in reducing environmental impact. Furthermore, as it expected energy consumption has a positive and significant impact on CO_2 emissions. The inverted-U shaped relationship between GDP and CO_2 emissions was confirmed in the case of Kazakhstan (the validity of EKC). Moreover, the environmental measure, which has been taken by government in 2007 onward, worked well in controlling environmental degradation.

Many studies have analyzed the relationship between environmental degradation and economic development which is of great relevance to making policy. (Lin-Sea Lau and et al. 2014). In last ten years, some studies have tried to establish the connection between pollution and economic activity (Pearson P.J.G.1994; Stern et. al, 1996; Dinda, 2004). As a result they got an inverse-U-shaped relationship between economic activity as economic growth and environmental quality as CO_2 emissions, in which environmental quality worsens at low levels of income, and then improves as income increases. It should be noted, that CO_2 emissions has a global impact on climate change, and it’s one of the reason that the Green Economy Concept became a worldwide trend.

In 2013, a strategic document for the Kazakhstan was adopted - "the Concept on the transition of the Republic of Kazakhstan to a green economy". The Concept identifies the main sectors that account for the main emissions: electric power industry using fossil fuels - coal, processing and mining industries, and transportation. Also, it has been noted that the main greenhouse gases in Kazakhstan are: carbon dioxide (CO_2) - 78.23%, methane (CH4) - 17.72%, nitrous oxide (N2O) - 3.26%. Hydro fluorocarbons (HFCs) and per fluorocarbons (PFCs) in total GHG emissions are together 0.84%. As you can see, the main volume of greenhouse gases is CO_2 emissions, which is one of the confirmations of the relevance of this study.

3.2. Policy of reducing CO_2 emissions in Kazakhstan.

The burning of natural energy sources such as coal, natural gas, oil, leads to the release of CO_2emissions in huge quantities, which ultimately harm the environment. Despite t the relative decrease in energy intensity over the 1990s, CO_2 emissions still increasing.

It is obvious that only a radical improvement in energy efficiency will help country reduce energy consumption, save energy resources, decrease the cost of RES, reduce carbon dioxide emissions, and slow down the rise in electricity prices for the population and industrial needs. Therefore, a key role in energy supply within the framework of a Green Economy implies a clear policy based on RES, taking into account the policy of decarbonization of the country's economy. Currently, more than 15 of the largest carbon-producing countries have start to develop decarbonization strategies. Kazakhstan supports these initiatives. In this regard, we believe that there is an urgent needs to develop strategy of country for decarbonization economy, with the large-scale introduction of low-carbon technologies.

Kazakhstan has been actively involved in processes aimed at reducing the environmental impact and climate change since independence.

Kazakhstan’s most important steps towards reducing harmful emissions:

- In 1993, the Law “On natural environmental protection” was adopted by government.
- In 1995, the United Nations Framework Convention on Climate Change was ratified.
- In 1997, some laws were passed "On the protection of the environment", on specially protected natural territories, on ecological expertise.
- In 1998 Kazakhstan joined the international agreements on the protection of the ozone layer. Work has been carried out to reduce the use of ozone-depleting substances (ODS) and

remove them from circulation, the introduction of new technologies with the use of substances that do not destroy the ozone layer.

- In 1999 the Kyoto Protocol to the Convention on Climate Changes was signed.
- In 2001 was ratified the Marrakesh Agreement (Marrakesh, Morocco, 2001) which was identified Kazakhstan as a country of Annex A of the Kyoto Protocol, which gives the right to participate in joint implementation projects and clean development mechanisms;
- In 2002 the law on the protection of atmospheric air.
- In 2003 was adopted of the Concept of environmental safety of the Republic of Kazakhstan for 2004-2015.

Ensuring an optimal level of environmental safety with the achievement of regulatory indicators of the state of the environment consisted of the phased implementation of the provisions of Concept.

Table 3.1. The context of the Concept of environmental safety 2004-2015 [3]

Stages	Implementations
2004-2007 first stage	An environmental protection program for 2005-2007 was adopted and implemented, legislative acts aimed at regulating environmental protection, environmental insurance, production and consumption waste, environmental auditing were developed, and a unified system for monitoring the environment and natural resources was created.
2008-2010 second stage	Through the implementation of the environmental protection program for 2008-2010, the process of creating an environmental protection system that is consistent with the principles of sustainable development and which ensures the qualitative improvement of the state environment with the beginning of the third stage should be completed.
2011-2015 third stage	As a result of the completion of all the planned programs, normative indicators of the quality of environmental objects

[3] The concept of Environmental safety of the Republic of Kazakhstan for 2004-2015, was adopted at 2003

	and a favorable level of environmentally sustainable development of society should be achieved, a reduction in the environmental impact should be ensured, and an environmental quality management system is formed.

- In 2004, the rates of payment for environmental pollution were revised, the amount of which should be established on the basis of the volumes and types of pollutants. For rates of payment for pollution of the environment when a source of pollution is found in or near protected areas, multiplying factors are applied.
- In 2006 was ratified Nairobi Agreement (Nairobi, Kenya, 2006) which set the base year for the country - 1992 year regarding that emissions to the environment should be reduced.
- In 2007 was adopted of the Ecological Code of the Republic of Kazakhstan. The adoption of this regulatory act allowed to ensure its compliance with international standards and harmonize the principles applied by Kazakhstan with the best international experience. In order to further improve the existing environmental legislation, a radical update of the entire sub-legal base was carried out. A special chapter of the environmental code provides for the regulation of emissions and absorption of greenhouse gases. According to the code, legal entities having certain emission sources were required to conduct an annual inventory of greenhouse gas emissions and removals with further inclusion of data into the state inventory of greenhouse gases. The accounting system for greenhouse gas emissions at the level of individual industrial installations was introduced with the intention to create a national market for quotas and emissions of greenhouse gases in the country. This market mechanism has been seen as a key tool for limiting and reducing greenhouse gas emissions.
- In 2007 was adopted Technical Regulations "Requirements for emissions to the environment during the combustion of various types of fuel in the boiler installations of thermal power plants" and Adoption of the Environmental Code on January 9, 2007, with special chapter, which was addresses regulatory issues greenhouse gas emissions and removals.
- In 2008 by Government of Kazakhstan was adopted the Program of “Environmental Protection of the Republic of Kazakhstan for 2008-2010”.

- In 2008 was ratified Poznan Agreement (Poznan, Poland, 2008) which was approved voluntary quantitative commitments for Kazakhstan, do not exceed the 1992 emissions.
- In 2009, Kazakhstan ratified the Kyoto Protocol to the UN Framework Convention on Climate Change, joining the global movement to prevent global warming, and declared the decision to reduce greenhouse gas emissions by 15% by 2020 and by 25% by 2050 from the base year 1992.
- In 2010 started the formation of a national emissions trading system for greenhouse gas emissions with the participation of international experts in the field of climate change. It should be noted that an attempt to create a quota system and trade in greenhouse gas emissions was undertaken by Kazakhstan back in 2008 which comes with adopted Ecological Code in 2007.
- In 2010 was adopted the program “Zhasyl Damu” (translation of Zhasyl Damu from Kazakh to English is “Green development”) - for the conservation and restoration of natural ecosystem of Kazakhstan. This program was adopted in the framework of the implementation of sustainable development policies and the improvement of the environmental management system.
- In 2011 at the 66th session of the General Assembly of the United Nations, the Republic of Kazakhstan initiated the "Green Bridge" Partnership Program which was accepted by all states at the United Nations Conference on Sustainable Development. This interregional initiative was suggested as a sustainable development, which can be built on voluntary principles and open to all partners. Before that, Kazakhstan has adopted The Green Bridge initiative in 2010, is the development of regional, interregional and intersectoral cooperation, and the creation of the environment for the introduction of "Green economy" principles between Europe, Asia and the Pacific, between business and environment, developed and developing countries, science and practice, economy growth and conservation of natural resources, intellectual property and general accessibility to them.
- In 2011, a bill was approved to amend and supplement a number of existing laws, including the Environmental Code. This document laid down some of the foundations for a national quota system and greenhouse gas emissions trading, which are necessary for the development and adoption of more detailed regulatory provisions and procedures at the level of secondary legislation.

- In 2012, at the "Rio + 20" World Summit, by the First President of the Republic of Kazakhstan, N. Nazarbayev was forward an initiative launched - the Green Bridge Partnership Program and the Global Energy and Environmental Strategy, which was offered to make joint and practical mechanisms for the transition to a green economy. The Green Bridge initiative is focused on technology transfer and best practices for managing low carbon development.
- In 2012, some aspects of the introduced national quota system and greenhouse gas emissions trading received more detailed regulation. About 30 by-laws were adopted regulating the following aspects in the field of emissions and absorption of greenhouse gases:

✓ quoting of greenhouse gas emissions;

✓ monitoring, reporting and verification of greenhouse gas emissions;

✓ greenhouse gas emission reduction and absorption projects;

✓ trade and other operations with carbon units.

- In 2012 December, a government decree was adopted the first National Quota Allocation Plan of greenhouse gas emissions, which entered into force on January 1, 2013
- In 2013, by the Presidential Decree was proved the Concept for the transition of the Republic of Kazakhstan to the “Green economy”, and for the implementation, Government was adopted an "Action Plan for the implementation of the Concept to the transition of the Republic of Kazakhstan to the Green Economy for 2013–2020".
- In 2014 The National Plan for the Allocation of Quotas for Greenhouse Gas Emissions for 2014 – 2015, came into force from 1 of January 2014 and was adopted by government in 2013.
- In 2014 by Presidential Decree No. 823 of May 26 was established the Council for the Transition to a Green Economy which was under the President authority of the Republic of Kazakhstan.
- At the end of 2015, 14 countries (Kazakhstan, Russia, Kyrgyzstan, Georgia, Germany, Mongolia, Belarus, Montenegro, Latvia, Albania, Finland, Hungary, Bulgaria, Sweden) and 12 non-governmental organizations participated in the Charter on the Green Bridge Partnership Program. (Association “Finnish Water Forum”, Association of Legal Entities “Association“ G-Global International Secretariat ”, Association of Legal Entities“ Coalition for Green Economy and Development G-GLOBAL ”, Establishment-club“ ZANATAU ”,

Public Foundation“ GREEN BRIDGE & G-GLOBAL ", Public Association “KazAlliance”, “German Kazakhstan Society” (Germany), PF “UNISON” (Kyrgyz Republic), LLC “Scientific and Production Association“ Green Peak ”(Russian Federation), OEO“ Fund for Support of Civil Initiatives ”(Republic of Tajikistan) , “Green PIK in Turkey” (Turkey), “MTU Rohiline sild” (Republic of Estonia)).

- In September 2015 was opened Center for the dissemination of knowledge on the "Green Economy" and replication of "Green" practices and technologies "People's Academy of Green Technologies" took place. More than 15 "Green" technologies (solar collectors, wells, LED lamps, pyrolysis furnaces, etc.) successfully operate on the basis of the Center.
- In August 2015, the International Organization “Partnership Program “Green Bridge” was created, on the basis of which, within the framework of international commitments of Kazakhstan, the international office of the Partnership Program “Green Bridge in Astana” begins to function.
- In 2017 the rules for allocation of quotas for greenhouse gas emission were clarified and adopted with new changes and these new rules which were included in addition to the distribution of quotas have the formation of reserves of the established number and volume of quotas of the National Plan greenhouse gas emission allocations.

Nowadays, the action plan has covered all important areas, such as water use, the development of sustainable and high-performance agriculture, energy conservation and energy efficiency, power industry development, improved waste management and air pollution reduction.

In the beginning of independent Kazakhstan ratified the Convention on Climate Change UN Framework and then the Kyoto Protocol in 2009 and last stage initiative was the Paris Agreement in 2016.

The Paris Agreement will be implemented from 2020 and then will adopted for an indefinite period. Kazakhstan presented they nationally determined contribution for reduce greenhouse gas emissions (ONRA) under the Paris Agreement to the Secretariat of the UN Framework Convention on Climate Change, which provides for a 15% reduction in greenhouse gas emissions by 2030 relative to 1990 emissions. The main advantage which the ONRA has reached is the Greenhouse Gas Emissions Trading System (hereinafter - ETS), along with the development of RES and energy efficiency. ETS has been at the national level since 2013. Although the only quotable greenhouse gas, carbon dioxide (CO_2), is not a pollutant, a reduction in greenhouse gas emissions is usually accompanied by a reduction in pollutants such as SO_2, NOx, particulate matter, heavy metals, etc.

From January 1, 2018, a new stage of operation of ETS started, which includes 225 installations of 129 enterprises from the electricity, oil and gas, mining, metallurgical, chemical and manufacturing sectors.

The volume of distributed quotas amounted to 485 million tons of CO_2 emissions for 3 years. At the same time, a reserve of the National Plan is provided, which amounted to 35 million tons of CO_2emissions. This reserve is intended for issuing additional quotas, in case of increasing capacity, issuing quotas to new installations, as well as for selling quotas on auction terms. The main objective of the market mechanism for regulating greenhouse gas emissions is to encourage enterprises to use “green” technologies and increase their own efficiency.

3.3.Purpose of study

Most of the countries considering a transition from issues concerning the depletion of natural resources into current issues concerning either the sustainability of economic growth or the necessity of economic growth to overcome environmental degradation. (D. Kaika and et a, 2013)

In 1992 the “World Development Report” had a conclusion that some environmental problems are increasing by the economic activity growth and the opposite they might be connected with the stuck of economic development (Ekins, 1993). There was a proposal to create the way of rapidly development of income to achieve the higher world output and more safety environmental protection.(Ekins, 1993). This proposal gave a new issue for analysis as of the so-called Environmental Kuznets Curve literature, which appears in the early 1990s. (D. Kaika and et al, 2013).

The Environmental Kuznets Curve (hereinafter EKC) is used to explain that when the economy are growing, the environment suffers but in the end of the point or another words in the end of considering period the relationship between the environment and the economic growth going to improve, which means that there is a positive relationship between two variables, for example growth domestic products and CO_2 emissions (environmental degradation). The EKC hypothesis was first proposed by Simon Kuznets in the 1950. The Curve is represented by an inverted U shape.

The graph's Y-axis is labeled as inequality, while time or per-capita income is depicted by the X-axis.

Under the Green Economy concept, Kazakhstan has an ambitious nationally determined contribution (NDC) target to reduce CO_2 emissions by 15–40% by 2050 compared with 2012 levels. (Table 1.1). More specifically, despite a twofold increase in electricity production, it is expected that CO_2 emissions will decrease from 90 million tons per year to 75 million tons per year by 2030, mainly due to the development of nuclear, alternative energy and an increase in the share of gas in the structure electricity production. If we talk about the goals of the government to change or improve climate policy in Kazakhstan, we can also note the introduction of changes to the environmental code on environmental standards, the introduction of the best available technologies and strategic environmental payments, as well as the transition to the target nature of collecting environmental payments.

Until now there have been only a few studies that analyzed historical trends in CO_2 emissions in Kazakhstan: (J. H. Bae et al, 2016) has to determinate of CO_2 emissions for post-Soviet Union independent countries include of Kazakhstan, Analysis of Environmental Policy in Kazakhstan (Nugumanova L. 2016) by GTAP standard CGE model based on assumptions of perfect competition and constant returns to scale by introduction of various levels of carbon tax in Kazakhstan is simulated. (Chuanhe X. and et al, 2015) made research namely "The relationship between energy consumption and economic growth and the development strategy of a low-carbon economy in Kazakhstan" by the approximate relationship analysis, a decoupling relationship analysis, and a trend analysis to explore the relationship between energy consumption and economic growth.

It should be noted that Kazakhstan's GDP and energy consumption start to increase rapidly from 2000 and we can determine Kazakhstan as a country with high energy consumption, low energy efficiency and a medium level of income per capita. Since the world trend has the goal of countries worldwide to address climate change, reduce carbon dioxide emissions, and implement sustainable development strategies, Kazakhstan according to the Green Economy concept also on the way of a low-carbon economy and this is the best strategic choice for the country.

Based on foregoing, there is a reason to make a contribution in academic research of CO_2 emissions in Kazakhstan, until nowadays, there have been no studies that have provided an in-depth analysis of CO_2 emissions trends or examined the effects of energy sector activities and the economic growth on CO_2 emissions in Kazakhstan, which can confirm or reject EKC theory.

3.4. Literature review

Today, in the world there are striking examples of active industrial development of the economies of some countries and the steady degradation of its ecological system. In particular, China, with its high rate of economic growth, which occupies a leading position especially in terms of polluting industries. The author of the article "China's economic boom and environmental threat" (Boubacar Badian , 2009) in his study came to the conclusion that the environmental problem in China acquires a "pass-through" nature, permeating all aspects of Chinese society, all spheres - economic and political, cultural and social, giving them growing influence. In this case, the issue of increasing CO_2 emissions, together with an increase in GDP in China is a serious concern.

However, in some countries, any generalization and correlation of economic growth indicators and CO_2 emissions have a very weak character and dynamics of the growth of almost not changed over the years. For example, researchers at Cambridge University, (Michael Grubb and et al, 2004) analyzed directly the question, "On the relationship between CO_2 emissions and economic growth in OECD countries" and came to the conclusion that, to a greater extent since 1980, the link between emissions and GDP looks very weak, and it has not changed in the period of stability of energy prices (1990+). Consequently, there is no clear link between more rapid economic growth and increasing CO_2 emissions.

Another strategically important partner of Kazakhstan is the Russian Federation. It is clear that any fluctuations in the economy of the Russian Federation in one way or another affect the economy of Kazakhstan, if only because of the share of Russia in the country structure of the total foreign trade turnover of Kazakhstan It is the main trading partner. Russia is in fourth place in terms of reducing CO_2 emissions in the CIS, in doing so, the country's policy is based more on efficiency than on the decarbonization of its energy sector. To considering the impact of energy consumption to GDP and an increase in CO_2 emissions in Russia, there a long-run relationship between emissions, energy use and real output, as well as in the long-run relationship, emissions to be energy use elastic and GDP inelastic. This elasticity means a high energy use replies on changes in emissions (Pao H.T. et al., 2014).

Examining the effect growth has on a country's environment has long been a popular subject of empirical research. Based on modeling approach, the existing research can be classified into three groups. The first group generally includes early papers that have adopted cross-sectional or panel data in determining the effect of growth on the environment (e.g., Shafik & Bandyopadhyay, 1992; Panayotou, 1993; Holtz-Eakin & Selden, 1995; Moomaw & Unruh 1997; Roberts & Grimes, 1997; List & Gallet, 1999; Heil and Selden, 2001; Harbaugh et al., 2002; Perman & Stern, 2003; Martonez-Zarzoso & Bengochea-Morancho, 2004; Liu, 2005; Frankel & Rose, 2005). Holtz-Eakin & Selden (1995), for example, use panel data of 130 countries for the years 1951 to 1986 when examining the growth-environment nexus; they find that growth improves the environment.

The second group claims that, since any beneficial growth effect on the environment in one country may be outweighed by an adverse growth impacts in other countries, or vice versa, the results of the first group are likely to suffer from the so-called aggregation bias of data. To avoid the shortcoming, therefore, this group employs individual country level data and time series methods in tackling the issue (e.g., Soytas & Sari, 2009; Jalil & Mahmud, 2009; Halicioglu, 2009; Iwata et al., 2010; Baek & Kim, 2011 and 2013; Akpan &Akpan, 2012; Shahbaz et al., 2013; Baek, 2015; Tutulmaz, 2015; Ibrahiem, 2016). Baek (2015), for example, analyzes the growth-environment nexus using a time series dataset of seven Arctic countries in a dynamic cointegration framework he finds that growth has a beneficial effect on the environment only in some Arctic countries.

The third group of the literature review can be highlighted in connection with the attempt to the explanation by authors of the changes in CO_2 emissions, by adding other variables, in other words, the variables which has affected for increasing or decreasing of CO_2 emissions during long-run and short-run perspective. (e.g., Jalil & Mahmud, 2009; Farhani et al. 2014; Kohler, 2013; Ozturk & Acaravci, 2013; Halicioglu, 2009; Pao & Tsai, 2011).

Most of studies which were mentioned before focusing on EKC hypothesis, which is coming from the analyzing of CO_2 emissions and GDP and GDP^2, in other words, the standard EKC equation suggests that the environmental degradation depends on GDP and square of GDP. The EKC is named for Simon Kuznets, who hypothesized that income inequality first rises and then falls as economic development proceeds.

Since one of contribution of this study is confirmed EKC hypothesis in Kazakhstan by using ARDL approach, it's necessary to determine the summary of some papers which has same analysis. (Table 3.1)

Table 3.2. Summary of literature review

Author	Period	Country/ region	Methodology	Variables	EKC hypothesis
Usama Al-Mulali Sakiru Adebola Solarin Ilhan Ozturk (2015)	1980–2012	Kenya	ARDL approach	CO_2 emission per capita, GDP per capita (constant 2005 US$), GDP^2 electricity generated from renewable sources, electricity generated from fossil fuel sources (such as coal, oil, and natural gas), financial development, trade openness, urban population ratio	EKC confirmed
Lau et. al (2014)	1970–2008	Malaysia	ARDL approach and VECM Granger causality	CO_2 emissions and GDP	EKC- confirmed
Kohler (2013)	1960–2009	South Africa	ARDL approach and Pair-wise Granger causality	CO_2 emissions, GDP, financial development, trade openness, and coal consumption	EKC - confirmed
Al-Mulali et al. (2015)	1981–2011	Vietnam	ARDL approach and	CO_2 emissions, labor, capital, GDP, export,	EKC- not confirmed

			VECM Granger causality	imports, and renewable and non-renewable energy consumption	
Kivyiro and Arminen (2014)	1971–2009	Sub-Saharan African countries	ARDL approach and VECM Granger causality	CO_2 emissions, energy consumption, foreign direct investment, and GDP	EKC – confirmed
Shahbaz et al. (2012)	1971–2009	Pakistan	ARDL approach and VECM Granger causality	CO_2 emissions, energy consumption, trade openness, and GDP	EKC - confirmed
Shahbaz et al. (2013)	1970–2010	Turkey	ARDL approach and VECM Granger causality	CO_2 emissions, GDP, energy consumption, and globalization	EKC- confirmed
Akpan and Akpan (2012)	1970 - 2008	Nigeria	ARDL approach and VECM Granger causality	CO_2 emissions, electricity consumption, GDP per capita, GDP^2	EKC- not confirmed
Jungho Baek (2015)	1960–2010	Arctic countries	ARDL approach	CO_2 emissions per capita, GDP per capita, energy consumption	For Iceland, Norway and U.S. EKC- confirmed

Onur Tutulmaz (2015)	1968–2007	Turkey	ARDL approach	CO_2 emissions per capita, GDP per capita, GDP^2 per capita	EKC- not confirmed
Dalia M. Ibrahiem (2016)	1980–2010	Egypt	Vector Autoregression (VAR) model and Johansen cointegration approach	CO_2 emissions per capita, real economic growth per capita, energy consumption, trade openness and population	EKC- not confirmed
Abdul Jalil et al, (2009)	1975–2005	China	ARDL approach VAR Granger casualty test	CO_2 emissions per capita, commercial energy use per capita, per capita real income, square of per capita real income, trade openness.	EKC- confirmed
Farhani et al. (2014)	1971–2008	Tunisia	ARDL bounds testing and VECM Granger causality.	CO_2 emissions, GDP, GDP square, energy consumption, trade openness.	EKC- confirmed
Shahbaz et al. (2014)	1975–2011	United Arab Emirates	ARDL bounds testing and VECM Granger causality.	CO_2 emissions, electricity consumption, GDP, and GDP square, urbanization, and exports.	EKC- confirmed
Jayanthakumaran	1971–2007	China and India	ARDL approach	CO_2 emissions, GDP, GDP square, Energy	EKC- confirmed

et al. (2010)				consumption, and trade openness	
Pao et al. (2011)	1990–2007	Russia	Johansen–Jusellius cointegration, VECM Granger causality.	CO_2 emissions, GDP, GDP square, and energy consumption.	EKC - confirmed

When Grossmann and Krueger (1991, 1993, 1995), who was found an inverted U-shaped relationship between GDP and some emission indicators at the beginning of 1990s, together with the rapid increase of environmental problems, this topic has been growing fast in the research literature. According to Table 3.1. we can observe the relationship between income and environmental pollution has been studied for groups of countries and for individual countries.

Most of researchers used models in which the relationship between environmental destruction and growth is are generally criticized because of the omitted variable and the estimations are assumed to be biased. Actually this is the rule of academicals findings and contribution in science should be improved from study to study. For example, Richmond and Kaufmann (2006) authors in their paper had included energy consumption variable in order not to be exposed to the undesirable effects of the omitted variable and they determined a positive relationship. Another authors had searched for the Granger type causal relationship between GDP and CO_2 emissions. (Soyta et al. 2007, Lau et al, 2014) but in general, the emission of greenhouse gas is directly related to energy consumption, which is the basic factor for production and consumption.

Most of the papers which were mentioned used economic indicators which have significant in long-run short-run relationships and have exist or not exist of EKC hypothesis. Furthermore, most of them who investigated the EKC hypothesis used GDP and the square of GDP together in a single equation, which may generate multicollinearity problems and usually this calls large standard errors and wide confidence intervals. To avoid this kind of issue we followed another group of researchers as Al-Mulali, 2016 and used it through the Narayan and Narayan's (2010) approach which also examines whether environmental degradation quality improves overtime as the economy grows. According the Narayan and Narayan's (2010) approach we have to compare the short- and long-run elasticity's. If the coefficient of GDP in the short run is bigger than the coefficient of GDP in the long run relationship, it means that, over time, more income will lead to less carbon dioxide emission. At the same time, in case if our result will confirm the Inverted-U shaped of EKC in considering period, we are adding an advance a dummy variable with meaning(the year where was formed a quotas system for the emission) which presenting a year (2007) when government start a radical policy to affect for the reduction of CO_2 emissions. If to be exactly in 2007 was adopted Environmental Code with special chapter, which was addresses for regulatory issues greenhouse gas emissions and removals. According to the code, legal entities with certain sources of emissions were required to conduct an annual inventory of emissions and removals of greenhouse gases with further inclusion of data in the state greenhouse gas inventory.

The system of accounting for greenhouse gas emissions at the level of individual industrial plants was introduced with the intention of creating a national market for quoting and trading in greenhouse gas emissions in the country. This market mechanism was seen as key tools to limit and reduce greenhouse gas emissions include CO_2 emissions.

3.5. Research question

What is the effect of economic growth on CO_2 emissions in Kazakhstan, controlling for total energy consumption? In other words, we are going to check the validity of Environmental Kuznets curve hypothesis in case of Kazakhstan considering energy consumption and population as controlling variables.

3.6. Model and Methodology

The Environmental Kuznets Curve (EKC) hypothesis investigates the relationship between environmental pollution and economic growth of the country at different stages of development. According to this theory, the pollution increases along with the economic growth in the early stage of growth, then stabilize at a certain threshold and finally decreases. It means that there is an inverted U-shape relationship between two variables studied. In other words, over time a country shifts from an agricultural-based economy with low environmental impacts to an industrial-based one with high environmental impact and lastly moves to the clean economy (Cosmas, 2019). Therefore, on this study followed by seminal work of Grossman and Krueger (1991), who extended the model developed by Kuznets (1955), to examine the interaction between income growth and environmental degradation (sulfur dioxide and dark-matter concentrations), the validity of the EKC hypothesis is tested in Kazakhstan. In the general form of EKC, environmental degradation is a quadratic function of income (per capita) (Eq.3-1):

$$CO2_t = \beta_0 + \beta_1\ Y_t + \beta_2\, Y_t^2 + +\mu_{it} \tag{3-1}$$

Where, CO_{2t} is environmental impact, and Y_t indicates income. However, to overcome the co-linearity or multi-collinearity problems that may arise between income and it's squared; the alternative method was proposed to test the validity of the EKC hypothesis in developing countries. The method acted based on comparing the long and short-run elasticities of income into CO_2 emissions (Narayan and Narayan 2010). The smaller long-run income elasticities than the short-run confirms the existence of the EKC hypothesis. It means that over time income leads to less carbon dioxide emissions. So, the equation (3-1) could be rewritten as the equation (3-2):

$$CO_{2t} = \beta_0 + \beta_1\ Y_t + \mu_{it} \tag{3-2}$$

Therefore, to investigate the environmental impact of energy consumption in Kazakhstan, followed by (Narayan and Narayan 2010), (Bölük and Mert 2015), (Sugiawan and Managi 2016), (Zoundi 2017), and (Zambrano-Monserrate et al. 2018), the Equation (1-3) is estimated.

$$CO_{2t} = \beta_0\ +\ \beta_1\ y_t +\ \beta_2\, EC + \beta_3\, Pop + u_t + D_{07} \tag{3-3}$$

In this analysis we are going to show the validity of EKC in Kazakhstan during the period of 1991-2018, CO_2 emissions denote the carbon emission (million tons), GDP, energy consumption, population (the population is added to the model as a control variable) and one dummy variable for determine affect which are might to increase or decrease of CO_2 emissions by policy of Government. All variables we are considering in a logarithmic form. Yearly data covers the period between 1991 and 2018 based on the last data availability. The data analyzed is retrieved from world development indicators. Moreover, to investigate the impact of support environmental policy by the government the dummy variable D_{07} is incorporated into the model.

Followed by Pesaran, Shin, and Smith (2001), the Autoregressive Distributed Lag (ARDL) bounds testing is applied to achieve the goal. To check the existence of long-run linkages among variables investigated, the Wald F-statistic proposed by Pesaran, Shin, and Smith (2001), is employed. This statistic provides upper and lower bound test. The null hypothesis shows the existence of long-run relationship. There are three possible options, depends on the critical value and F-statistic as shown in Table 3.2.

Table 3.3. Checking the existence of long-run relationship among variables

Description	Null hypothesis	Remarks
F-statistic>upper bound	Can be rejected	Confirms the existence of long-run relationship
F-statistic < lower bound	Cannot be rejected	No evidence of existing long-run linkages
Lower bound < F-statistic<upper bound	-	Inclusive result

In this regard, to conduct F-bound testing the Unconditional Correction Model (ULCM) is applied as Equation (3-4)

$$\triangle Logc_t = \alpha_0 + \sum_{i=1}^{n} b_i \triangle Logc_{t-i} + \sum_{i=1}^{n} c_i \triangle LogY_{t-i} + \sum_{i=1}^{n} e_i \triangle LogEC_{t-i} + \sum_{i=1}^{n} d_i \triangle LogPop_{t-i} + \delta_0 Logc_{t-1} + \delta_1 LogY_{t-1} + \delta_2 LogEC_{t-1} + \delta_3 LogPop_{t-1} + D_{07} + \mu_{1t} \quad (3\text{-}4)$$

Based on this study needs long-run and short –run analysis, by ARDL approach, it has to be checked the stationarity features of variables concerning CO_2 emissions, in other words, we need to define whether series are stationary in order to avoid the problem of spurious regression.

The estimation (3-4) include the time trend variable to capture the autonomous time-related changes and dummy variable, denoted by D_{07}, to capture the effects of any structural change procedures detected (estimated by the Lee and Strazicich method (2003, 2004)).

At the same time, we need the F- test to understand how in long-run relationship existed among the variables by testing the significance of the lagged level of the variables. The parameters$\triangle_i$, where i=1, 2, 3, 4, 5 and 6 are the corresponding long-run multipliers, where the parameters b_i $c_i d_i g_i$ are the short-run dynamic coefficients of the underlying ARDL model. In Eq. (3-1) for Kazakhstan, the null hypothesis of no cointegration amongst the variables is $H_0\colon \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ tested against the alternative $H_1 = \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$

The asymptotic distributions of the F-statistics are non-standard under the null hypothesis, and two sets of asymptotic critical values are provided by Pesaran and Pesaran (2009). The first set assumes that all variables are I(0); while the second set assumes that all variables are I(1). The null hypothesis of no cointegration was rejected if the calculated F-statistic was greater than the upper bound critical value. If the computed F-statistics is less than the lower bound critical value, then we cannot reject the null of no cointegration (long-run relationship) among the variables. At the same time, we can conclude that, the result is inconclusive if the counted F-statistic falls within the upper and lower bound critical values. (Table 3.2)

As we mentioned before, most papers using to investigate the EKC hypothesis used GDP and the square of GDP together in a single equation, which may generate multi-collinearity problems and usually this calls large standard errors and wide confidence intervals. To confirm a right a way of our analysis we have checked correlation between variables and in our case it is 0.99. (Table 3.3)

At the same time, to check accurate data for this analyzes we made correlation test and we can see that electricity generation and electricity consumption has high correlation between GDP, more than 50%, that's why we decide to stop on energy consumption which is showing correlation less than 50% (0.36).

Table 3.4. Correlation coefficient matrix

	CO_2	EC	EG	EL_C	GDP	GDP2	Pop
CO_2	1						
EC	0.94	1					
EG	0.78	0.60	1				

EL_C	0.95	0.85	0.89	1			
GDP	0.55	**0.36**	**0.87**	**0.71**	1		
GDP2	0.55	0.38	0.84	0.71	0.99	1	
POP	0.85	**0.82**	0.76	**0.88**	**0.73**	0.78	1

The investigated data were sourced from World Bank database (World Development Indicators), which covered 1991-2016, in case of Kazakhstan. GDP is economic growth, which measured in constant 2010 US$, CO_2 emissions, that measured in metric tons, energy consumption in million tons of oil equivalent (MTOE).

3.7. Analysis and results

As the first step in time series model, the variable stationary should be checked. In this respect, there are several unit root tests including Augmented Dickey Fuller (ADF), Philips Perron (PP), and so on. In this study the ADF is applied. The results are summarized in Table 3.4.

Table 3.5. Unit root test (at 5% level)

Variable	Coefficient	Result
Log CO_2	-2.06	-
Log GDP	-4.13**	I (0)
Log EC	-2.17	-
Log POP	-4.600**	I (0)
Log D(CO_2)	-3.86**	I (1)
Log D (EC)	-3.61**	I(1)

From Table 3.4, the dependent variable (Log CO_2) is stationary at the first difference (I (1)) and independent and control variables are stationary mutually at level (I (0)) or fist difference (I

((1)). It means that none of the variables studied are stationary at the second difference and the ARDL model could be applied.

Long-run co-integration

Determining the optimal lag length is the next step before investigating the existence of the co-integration relation. There are several methods to select the lag values such as Akaike information criterion (AIC), the Schwarz information criterion (SIC), the Hannan–Quinn information criteria, Adjusted R-squared. It worthwhile to noted that the models with the minimum criteria value or the maximum value of the R-squared are chosen as the best model. The optimal ARDL model based on the AIC is ARDL (1,1,0,1). The maximum lag 1 is selected for the dependent variable (Log CO_2) and maximum lag 1, 0, and 1 is selected for Log GDP, Log POP, and Log EC, respectively. The results from Wald F-statistic are provided in Table 3.5.

Table 3.6. ARDL Bounds Test Results

Test Statistic	Value	Signif.	I(0)	I(1)
		Sample Size: 40		
F-statistic	7.816	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: Eviews Output, Critical values are collected from (Narayan P.K and Smyth R, 2005b).

By comparing the calculated Wald F-statistic value with the lower/upper critical values at 5% level, it is proved that the null hypothesis can be rejected. In other words, existence the long-run relationship between the respective variables is verified. The long-run co-integration vector results are listed in Table 3.6.

Table 3.7. Estimated long-run results

Dependent Variable: Log CO_2	Coefficient	Prob.
Log GDP	-0.019	0.000
Log POP	-0.434	0.000
Log EC	1.034	0.000
C	3.675	0.000
D07	-0.015	0.0013

Source: EViews 10 output

From Table 3.6. variables investigated are statistically significant. Real GDP is connected negatively to the CO_2 emissions at 5% level in long-run. The coefficient of this variable is -0.019, which means that a 10% increase in real GDP decreases the CO_2 emissions by around 0.2 if other things remain same. Furthermore, energy consumption is connected positively to CO_2 emissions and statistically is significant, ceteris paribus. More precisely, a percent increase in energy consumption increases CO_2 emissions more than 1 percent (1.034%) if other things do not change. It implies that among variable studied, energy consumption has the highest impact on CO_2 emissions. Finally, population has a negative and significant environmental impact. A 10% increase in this variable reduces CO2 emissions by 4.3% ceteris paribus. Significance and negative sign of dummy variable confirms the effectiveness of the implemented policies and regulation. The short-run estimation results are presented in Table 3.6.

Table 3.8. ECM regression, Considering CO_2 as dependent variable

Variable	**Coefficient**	**Prob.**
D (Log GDP)	-0.146	0.0002
D (Log EC)	1.095	0.0000
D07	-0.015	0.0000
CointEq(-1)*	-0.752	0.0000

Source: EViews 10 output

The results in Table 3.7. are shown that the coefficient of the error correction term is statistically significant and has a negative sign. The estimate of the lagged ECM is −0.752 indicates that when CO_2 emissions are far away from their equilibrium level, it adjusts by almost 75% within the first period (year). The full convergence to equilibrium level takes about 1.4 periods (years). Comparing the long and short-run elasticities of real income into CO_2 emissions, verified the existence of EKC hypothesis in case of Kazakhstan (the long-run elasticities is smaller than the short-run) Table 3.8. It can be concluded that, over time, more income will lead to less carbon dioxide emission.

Table 3.9. Naryan and Naryan (2010) method of EKC hypothesis

Log GDP	Long-run	Short –run
Coefficient	-0.019	-0.146
P-value	0.000	0.0002

Diagnostic and stability tests

To check the perfection of the model various diagnostic tests were also applied and illustrated in Table 3.9.

Table 3.10. Diagnostic Tests Result

Diagnostic test	Statistic (p-value)
Serial Correlation	1.073 (0.346)
heteroscedasticity	0.609 (0.442)
Normality	1.077 (0.583)

Note: B-G null is no serial correlation, ARCH null is no heteroscedasticity. The numbers in the parenthesis indicate p-value.

Source: calculation based on EViews 10

As it can be seen in Table 3.9. there is no evidence of serial correlation, and heteroscedasticity; the normality of the residuals is confirmed as well.

To test the stability of short-run and long-run coefficient estimates, the cumulative sum (CUSUM), cumulative sum of squares (CUSUMSQ) tests, and recursive coefficient stability tests are applied to the residual of our optimum model (Figure 3.1). Apparently, all estimates are generally stable over the sample period.

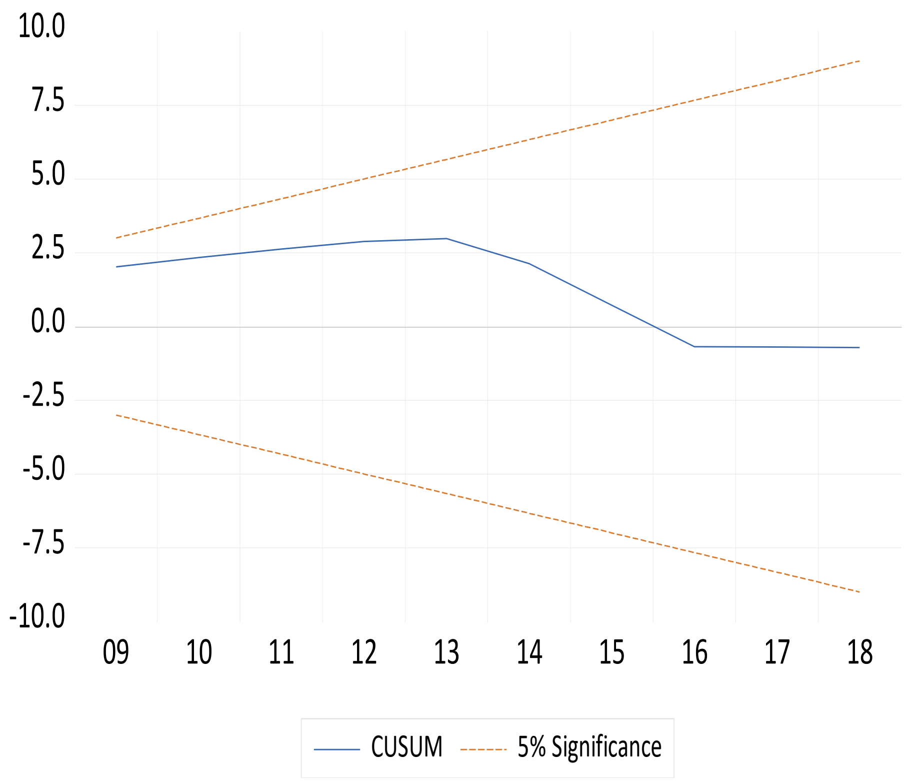

Figure 3.1. Plots of CUSUM, CUSUMSQ test

Figure 3.2. Plots of CUSUM of squares

3.8. Conclusion and Policy implication

Our analysis shown that the effect growth has on CO_2 emissions in Kazakhstan, controlling for total energy consumption, is examined in the autoregressive distributed lag (ARDL) cointegration framework.

Academicals contribution of this study is to apply a country-specific time series method to the growth-environment nexus and to address the problem of aggregation bias drawn from the earlier cross-sectional and panel data studies. Our results show that growth decreases CO_2 emissions which are providing evidence in support of the EKC for CO_2 emissions in Kazakhstan. We found that total energy consumption has an adverse effect on reducing CO_2 emissions.

Policy implication of this study, from our findings is that given the fact that CO_2 emissions decreasing regardless of economic growth which is not common for developing countries, any effort to promote economic growth may cause a corresponding more decrease in CO_2 emissions. For this reason, government measures that need to be taken to reduce CO_2 emissions should be implemented with the policy of reducing CO_2 emissions, to keep developing renewable energy and using new technology in electricity production. In other words these measures include government policies directed more toward a low-fossil-fuel economy through an increase in the use of renewable energy and improved energy efficiency.

All regulatory enforcement of reducing the greenhouse gas emitted which implementing by government happening in industry, transport, and heating sectors, happening through the development of carbon sequestration technologies in power plants with a different ways (different regulatory instruments like legislation or introduction of quotes system, different technologies).

In this regard, we had considered dummy variable, to understand how government measures working on environmental protection. D07 showed a negative coefficient and significance on impact to CO_2 emissions during the considering period, it means that the policy of Kazakhstan doing for the reduction of CO_2 emissions is working well. Recall that D07 is the time when government start to control GHG emission by creating of quotes system for industrial emission, without this companies cannot make any emission during their activity and this was very reasonable step from the government side, as long as air pollution is also associated with the development of old and the development of new hydrocarbon deposits, which leads to an increase in atmospheric pollution with hydrogen sulfide and mercaptans. Flaring of the associated gas is accompanied by the release into the atmosphere of a large number of greenhouse gases, sulfur oxides, and nitrogen increased thermal background is formed around the fields. In general, most of the industry especially which connecting with energy resources (mining or processing) has air emission, if to be clear more than 40% of GHG emissions in Kazakhstan coming from industry.

Another conclusion is that, since energy consumption is mainly driven by continued growth in the industrial sector in Kazakhstan, any industrial policy implemented by the government that aims to promote economic development could offset the positive income impacts on the environment, thereby can also leading decline of CO_2 emissions. At the same time, we have to accept that energy consumption is the main variable which showing the positive significance in CO_2 emissions.

In this regard, we can suggest some policy implication as measures, which can be adopted or considered by government of country, especially in creating the commercial attractiveness possibilities for investments, since the economic growth giving decreases of CO_2 emissions.

- Detail work on legislation for investments opportunity. (Note: From 2007 Ecological Code got changes more than 25 times).
- To develop more flexible opportunities for Private Public Partnership projects, this can lead more investment, especially in infrastructure field. (Note: Mostly investment in Kazakhstan is direct investments)
- Implementation of new-technology projects in regions of country, since in a big cities as Almaty and Astana the environmental situation also depend from transport GHG emission which is more can be controlled by government regulation, as for example special tax for car which were used more than 5 years or free tax for electrical vehicles.
- Introduce special tax treatment or tax incentives to encourage the private sector to manufacture equipment that can be used in the energy sector. At the same time, tax incentives can be applied when using local equipment and technology, which are exempt from VAT and are considered as a justifiable measure to stimulate local investment in production.
- Considering the dynamically developing market and its changes, new studies are needed to improve the energy efficiency of the industrial sector, so far as energy consumption gave more increases of CO_2 emissions, usually it's common for oil export countries, for sure R&D has to be develop.

Chapter 4

Second essay: Decomposition Analysis of CO_2 Emissions from Electricity Generation by using Coal and Gas fuels in Kazakhstan

4.1. Introduction

Electric power industry is one of the basic sectors of an economy. Reliable and efficient functioning of the industry stable supply of consumers with electricity and heat energy is the quality mark which showing stable development of the country's economy and an indispensable factor in ensuring civilized living conditions of the population.

Achieving the goals stipulated by the "Concept of Transition to the Green Economy" requires some changes in the existing development trajectory of the economy of Kazakhstan, as a result of which the country has to be able to restore water and land resources and be equal in average efficiency indicators of using natural capital with another members of OECD countries. (Akhmetyanova S. 2014)

Currently, the main type of fuel used for the production of electricity in Kazakhstan is coal. The share of natural gas is relatively small, but until 2050 the situation will gradually change towards an increase in the share of natural gas, partly due to growth in oil and gas production in western Kazakhstan. So, government has plan geographic shift in economic activity in the country towards the above region, where gas is a natural fuels for power generation.

However, the Concept implies "the maximum extension of the life of existing coal, gas stations and hydroelectric power plants, since this solution is capable of ensuring the lowest cost of electricity." In order to achieve the goals regarding the reduction of greenhouse gas emissions, gas generation will be introduced by "converting Thermal Power plants in major cities to gas and commissioning new capacities for balancing renewable energy", which is not supported by specific quantifiable targets. At the same time, the concept envisages three scenarios for the development of the electric power industry - Basic, Green -"expensive" gas, and Green -"cheap" gas.

According to the Base scenario, provides increase in coal generation up to 2050 is foreseen (by 80% from the level of 2012). The green scenario with "expensive" gas provides for a moderate increase in coal generation by 2030 (by 40% from the level of 2012) And finally, the Green scenario with “cheap” gas implies the preservation of coal generation up to 2030 at the current level, and a decrease after 2030 due to the withdrawal of old capacities.(Green Economy concept, 2013)

This study analyzes changes of some economic factors in electricity generations structure and shows a whole picture of CO_2 emissions fluctuation from using coal and gas for electricity generation during 25 years.

To analyze the past pattern of CO_2 emissions changes in economic factors we choose to check electricity production from coal and gas, for this we choose study which were made Zhang et al. 2013, they were estimated the CO_2 emissions from electricity generation in China and use the Logarithmic Mean Division Index modeling (hereinafter - LMDI) to decompose the change of CO_2 emissions overtime. To make this analysis more contributed we made comparison analysis with two studies Nnaemeka Vincent Emodi, Kyung-Jin Boo (2015) Decomposition Analysis of CO_2 Emissions from Electricity Generation in Nigeria and the second one is Decomposition analysis of CO_2 emissions from electricity generation in China, which were made by Zhang, M., Liu, X., Wang, W., Zhou, M. (2013).

4.2. The role of coal and gas in electricity generation

The origin of the coal industry in Kazakhstan dates back to the middle of the XIX century. In 1855, the development of the Karaganda basin began, from 1869. - Lenger, since 1895. Ekibastuz field. Small deposits were also exploited in the region to meet the needs of the local population, small mines and factories.

Nowadays, electricity is the main consumer of coal. Until 1950, coal occupied a leading position in the global fuel and energy balance (hereinafter- FEB), but share of this FEB gradually decreased. During this period, which was called the “first coal wave”, the coal industry was an industry designed to meet the needs of domestic markets, mainly cooking coal was exported. The specific weight of coal in the global FEB corresponded to the structure of fuel and energy resources, where coal accounts for over 90% of all

reserves.

Today, more than 70% of electricity in Kazakhstan is produced by 40 thermal power plants operating on coal from Ekibastuz, Maikubinsk, Turgai and Karaganda basins (fields). The largest one is Ekibastuz SDPP-1 which was built in Kazakhstan with 8 power units with an installation capacity of 500 MW each, working on brown coal, local coal mines, however, currently the station's available capacity is 2,250 mWh. Aksu (Ermakov's) state district power station has the highest power generation.

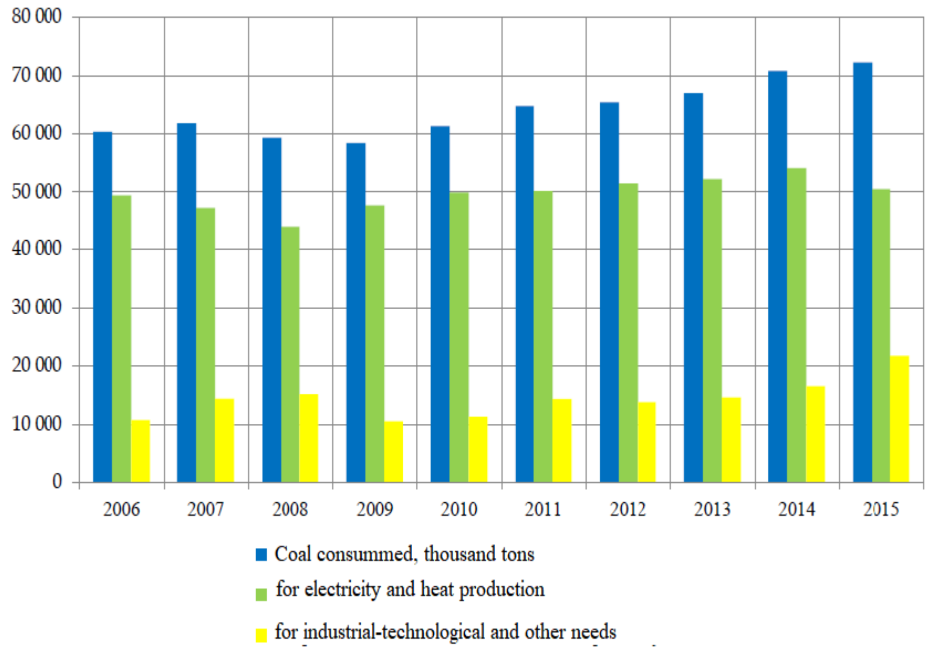

Figure 4.1. Distribution of coal by domestic market of Kazakhstan

Source: Overview of coal mining and coal power engineering in Kazakhstan. (Center for the introduction of new environmentally sound technologies (CINEST), 2017)

The coal industry is one of the most important resource sectors of the Republic of Kazakhstan. In Kazakhstan, all the main segments of the coal industry are represented and extraction and use of steam coal are particularly developed. We have clear understand how government policy can effect on environment or opposite can effect on economy since we are depending from coal in electricity sector. To estimate the impacts of the coal substitution policy ("coal-to-gas" and "coal-to-electricity") on creating energy demand and emissions very important, and this question still analyzing by different authors and researchers, since it has not be fully opened and could help Government policymakers in solving with this drastic energy transformation by evaluating potential social costs and benefits. (Han Chen and et. al. 2019)

Over the past 25 years, the largest volumes of coal production in Kazakhstan were observed in 1990-1992, and, in value terms, these were the lowest figures. At the same time, over the past 10 years there has been an active growth in the volume of coal production as well as its value. In general, the coal industry over the past five years can be characterized by the following factors:

1) the number of operating enterprises engaged in coal mining has decreased by 25%;

2) the share of coal in the total volume of extracted natural resources in Kazakhstan is increasing every year;

3) the share of coal in the composition of exports, on the contrary, decreased;

4) increased coal consumption in the domestic market.

5) the share of coal in the composition of exports decreased.

6) the distribution of coal in the domestic market will increase the consumption of coal for the production and technological needs, the consumption of coal for the production of electricity and heat.

According to the operational information of the Committee on Statistics of the Ministry of national economy of Republic of Kazakhstan in 2017, 106 million tons of hard coal were extracted, which is 2.9% more than in 2016 (103.1 million tons). More than 90% of proven coal reserves are concentrated in the north and in the central part of Kazakhstan.

Coal energy, unfortunately, provides the main pollution of the environment. (Marcos L.S. Oliveira, 2019). Since Ekibastuz Thermal power plant using lignite with a high, more than 30% mineral content, the plume of coal thermal power plant emissions extends to the entire north-east of Kazakhstan, Siberia and Mongolia. Among these mineral substances are many environmentally very harmful and poisonous. For the large-scale development of coal energy, it is necessary to solve problems related both to the ecology and to the wider introduction of new technologies and equipment in the coal industry. This trend in the world energy sector has been called the “second” or “new coal wave”.

Changes in a fossil fuel policy for the future can be implemented step by step, the role of gas in the global energy balance is very high - since the gas is the most environmentally friendly and affordable fuel even quit expensive. At the same time, in the world energy market, we have shale gas, and it also nowadays has many discussions. Nowadays the shale gas in the energy market considered as something new. The last decades in the energy sector have some important to the involve of hydraulic fracturing technologies which might be useful enable the production of previously uneconomic shale gas resources. If these gas production technologies were to be available globally, the energy market could see a large income of economically competitive unconventional gas resources. (Haewon Mc Jeon, 2014).

Over the past 20 years, the consumption of primary energy resources in the world has increased almost 1.5 times, and electricity - by almost 80%. The share of gas in the global fuel and energy balance is about 22%, gas is inferior to both oil and coal.

Nowadays, electricity from natural gas now accounts for about 20% of the use of natural resources for the development of electric power engineering in the country. In addition, Kazakhstan has significant resources of associated gas produced with oil. Combustion gives up to 10% of the country's electricity, making up the bulk of it in the west of Kazakhstan. Although gas-fired power plants are highly ecological, burning such a valuable product for the chemical industry is completely irrational and fully corresponds with the phrase of the great chemist D.I. Mendeleev, who compared this burning as a using banknotes money as fuel.

In addition, it should be noted that, since Kazakhstan had a rapid growth of GHG emissions, any research by academic and other policy-analysis institutions are important within a climate and energy-policy framework. Nowadays most of researches looking the answers how to determine sensitive variables for reducing GHG emissions through the energy saving and emissions reduction systems is a interesting topic in academic research (Shi-Chun Xu and et al., 2015). Our analysis focused on Kazakhstan economic growth and dependency from energy consumption in total and considering energy consumption and population as controlling variables in equation.

4.3. Purpose of study

One of the goals and targets of "Green economy" Concept of Kazakhstan in electricity sector is reduction in CO_2 emissions, increase the share of gas in electricity production and gasification of some regions by changing thermal power plants from coal to gas fuels.

To be more precise, Green Economy Concept in reduction of CO_2 emissions has plan of reducing level of carbon dioxide emission in the power sector in 2030 – 15% and at 2050 – 40% (Table 1.1)

At the same time, power industry of Kazakhstan has not only environmental issue for implement in a green energy, there are also some problems which has to be solved at the initial stage:

1) Mastering of the park resource of generating equipment (75% at thermal power plants and 90% at hydroelectric power plants);

2) High specific consumption of fuel, low efficiency of stations;

3) The lack of maneuverable sources to cover peak loads;

4) Depreciation of fixed assets of electric networks (60%);

5) Significant losses in the trunk (5.7%) and distribution networks (13.0%);

6) High level of environmental impact (high emissions of harmful substances, lack of utilization of ash and slag waste).

Even if the government developing the report on CO_2 emissions or formulating future commitment, it is necessary to know fully changes in countries CO_2 emissions. At the same time, it is necessary to know what factors in recent years are driving these changes to identify quantitatively the relative impact of different factors on the changes in CO_2 emissions. (Wu et al. 2005)

In addition, in accordance with the forecasts of the Concept, the amount of electricity produced by coal -fired power plants will remain on the same level until 2030 of about 60-75 TWh in 2030 compared to 70 TWh in 2012. The volume of annual coal consumption by the energy sector will slightly decrease to 40-50 million tons in 2030 compared to 2012 — more than 50 million tons — mainly due to the increased efficiency of modernized and new coal-fired power plants, as well as the use of gas electricity production will double in comparison with current consumption and reach 8 billion m3 per year in 2030 (10 billion m3 per year in the green gas scenario) compared with about 4 billion m3 per year in 2012.

Thus, for the modernization of the electricity sector, needs some investments for creation of gas infrastructure in the northern, eastern and southern regions of the country. This will make it possible to convert coal-fired power plants to the gas power plants in all major cities of country, with taking into account its availability in terms of volumes and prices. First of all, it will reduce the level of local emissions and improve the quality of atmospheric air, as well as ensure the availability of flexible reserve capacity to support unstable renewable energy.

- To set a goal for facilities to achieve a certain share in the structure of the energy balance by 2020 in order to stimulate investments to the gas power and in general to the necessary auxiliary gas infrastructure.
- To agree with plan for the construction of the necessary infrastructure for ensure the supply of gas to new power plants in the event of economic efficiency and environmental

attractiveness. The priority for Government in deciding on the construction of the necessary infrastructure will be the issues of ensuring the environmental and social attractiveness of projects, even if the economic efficiency of the projects is low.

- Conversion of existing coal-fired power plants to gas, primarily in large cities (Almaty, Astana, Karaganda), as well as the construction of new gas stations by 2020 to improve the environmental situation in these cities.

Consequently, the implementation of the goals set in accordance with the Concept can not only reduce the level of pressure on the environment, but also solve the problem of the full modernization of the power industry of Kazakhstan. Several studies have used LMDI to investigate carbon emissions at regional and national scales. (Liu LC and et al. 2007, Lee K et al, 2006, Hatzigeorgiou E, 2008) and we also following them.

This study will be able to reflect the level of affecting on CO_2 emissions from the production of electricity by fuel type, coal or gas and how economic factors are changing on CO_2 emissions, this will show also analyze of government policy during 1990 to 2016.

4.4. Literature review

The IPCC provides three tiers for estimating CO_2 emissions from the fuel combustion. (IPCC, 2006). The IEA uses the simplest (Tier 1) methodology to estimate CO_2 emissions from fuel combustion based on the IPCC'S 2006 GLs (IEA, 2016). Decomposition analysis is a subject area that has gained in importance in policymaking in the energy field in the last 25 years and the method has been adopted by some national agencies and international organizations.(B.W. Ang, 2004). Many countries such as US, EU, New Zealand, etc., has adopted the Divisia index approach (Lermit and Jollands, 2001; Wade, 2002; ODYSSEE, 1999). Decomposition analysis technique provides analytical tools for studying the underlying factors that cause changes in electricity generation and CO_2 emissions. There are two decomposition analysis techniques which we got through the litreture review: Index Decomposition Analysis (hereinafter-IDA) that uses aggregate data at the sectoral level and Structural Decomposition Analysis (hereinafter-SDA) that uses input–output tables (Malla, 2009). According to Ma and Stern (2008) there are many different indexing methods that can be used in IDA. Ang (2004) recommended LMDI method over other IDA methods, and argued that this method has several desirable advantages such as time independence, ability to handle zero and absolute values and consistency in aggregation. Additionally, this method has a sound theoretical foundation, adaptability, ease of use and result interpretation, along with some other desirable properties in the context of decomposition analysis.

4.5. Contribution of study

There is no a lot of explorations of CO_2 emissions from electricity generation by using LMDI method. In this section we identified several studies that focused on the study of carbon dioxide emission from different sectors including electricity generation. Some authors had analysis in case of one country as this study and some of them focused on several countries (M. Sunil, 2009). Also, most of the authors had study different factors which is giving changes in CO_2 emissions, for example one of them population. (José M. C. et al, 2015), (Qingyou Y. et al, 2016). In case of Republic of Kazakhstan, only few researchers who used LMDI approach for the determine changes in CO_2 emissions through the economic factors. (LI Jiaxiu1et al, 2018), (Kerimray A. et al, 2018), (Akhmetov A., 2015).

Table 4.1. LMDI method for analyze CO_2 emission changes.

Name of paper	Factors of changes in CO_2	Industry sector	Fuel type	Authors
Using LMDI method to analyze the change of **China's** industrial CO_2 emissions from final fuel use: An empirical analysis	Activity effect, Energy intensity effect, Fuel mix effect, Emissions coefficient effect, Structural shift effect.	36 industrial sector	coal, coke, petroleum, natural gas, electricity, and heat	Lan-Cui Liua, Ying Fana, Gang Wua, Yi-Ming Weia,(2007)

Decomposition Analysis of CO_2 Emissions from Electricity Generation in **Nigeria**	CO_2 emissions coefficient of fuel type, the electricity generation efficiency based on fuel type, the share of electricity generation based on fuel type in total thermal power generation, the share of thermal power generation in total electricity generation, electricity intensity.	Electricity generation sector	Diesel oil, natural gas.	Nnaemeka Vincent Emodi, Kyung-Jin Boo (2015)
Driving forces of **Spain's** CO_2 emissions: A LMDI decomposition approach	Carbon Intensity factor (CI), the Energy Intensity factor (EI), the structural composition of Spain's economy (Economy Structure, ES), the Economic Activity factor (EA) and Population (P)	35 industrial sector	All fuel type which producing electricity	José M.Cansinoab Antonio Sánchez-Brazac María L. Rodríguez-Arévalod (2015)
CO_2 emissions from electricity generation in **seven Asia-Pacific and North**	electricity production, electricity generation structure and energy intensity of electricity generation	Electricity generation sector	Gas, Coal, Oil	Sunil Malla (2009)

American countries: A decomposition analysis				
Decomposition analysis of carbon dioxide emissions in **China's** regional thermal electricity generation, 2000-2020	energy structure, CO_2 emissions intensity, Energy efficiency, economic development, and regional population.	Regional China thermal electricity generation.	coal, gasoline, kerosene, diesel oil, fuel oil, and natural gas	Qingyou Yan, Qian Zhang, Xin Zou (2016)
Decomposition analysis of CO_2 emissions from electricity generation in **China**	Changes in the emissions coefficient effect, the changes in the electricity generation efficiency effect, the changes in the thermal power structure effect; changes in the electricity structure effect; the changes in electricity intensity effect; the changes in the economic activity effect.	Electricity generation sector	Coal, coke oven gas, other gas, crude oil, gasoline, kerosene, diesel oil, fuel oil, LPG, refinery gas, other petroleum, natural gas, other energy.	Ming Zhang, Xiao Liu, Wenwen Wang, Min Zhou (2013)
Decomposition analysis of **Philippine** CO_2	Population effect, Activity effect, Intensity effect,	Electricity generation and fuel combustion	Biomass Other Renewables	Ana Karmela Sumabat, Neil Stephen

emissions from fuel combustion and electricity generation	changes to energy Structure.		Geothermal Natural Gas Oil-based Coal	Lopez,⇑, Krista Danielle Yu, Han Hao, Richard Li, Yong Geng, Anthony S.F. Chiu.
Quantitative analysis of the impact factors of conventional energy carbon emissions in **Kazakhstan** based on LMDI decomposition and STIRPAT model	Population effect, economic active effect, energy intensity effect and energy carbon structure effect.	Energy consumption by fuels	coal, oil and natural gas	LI Jiaxiu1, Chen Yaning, LI Zhi1, LIU Zhihui. (2018)
Analysis of the energy intensity of **Kazakhstan**: from data compilation to decomposition analysis	The total change in energy intensity: 'intersectoral structural change', 'energy intensity impact', 'per capita GDP impact' and 'household energy intensity impact'.	power and heat, upstream, commercial and public services, transport and households and agriculture	Energy balance, by using coal, oil and gas	Aiymgul Kerimray, Igor Kolyagin Bakytzhan Suleimenov (2017)
Decomposition analysis of industry sector CO_2 emissions	Changes in activity, industrial output structure, energy intensity, fuel mix,	Power industry, Iron and steel industry, Non-ferrous metals industry, Chemical industry, Coal,	Oil, coal, gas and other.	Almaz Akhmetov (2015)

from fossil fuel combustion in **Kazakhstan**	emission factor.	oil and gas industry, Other industries (machinery, food processing, pulp and paper industry, light industry and other non-specified industries)		

As we see in a Table 4.7 many researchers using LMDI method for analyzing past pattern of CO_2 emissions which is coming from different industries by using different type of fuels. The decomposition analysis for the change in energy field was made by using the LMDI method, which was proposed and applied by Ang (2004, 2015). If to be more precise, this method is a widely used for the analysis of energy consumption, energy intensity and carbon emissions changes by years.

At the same time, according to the EU Consortium of PROMITHEAS – 4 which was supported by the European Commission under the Environment (including climate change), in theme of the 7th Framework Program for Research and technological development was adopted the report with short summary of gaps in development, evaluation of mitigation and adaptation policy portfolios in 12 countries including of Kazakhstan.

Based on studies about climate change impacts, assessments to identify the adaptation needs and the best options to address these needs need to be carried out. We need research which is covering technical, socio-economic, and environmental aspects. Another important gap that there is space for improvement of reporting about fugitive emissions from fuels in the energy sector.

In this regard, it is recommended to do research and develop studies for the climate change impact on each of the most affected sectors.

Therefore, this study fills a gap where shows the environmental impact of the electricity generation, which has the most significant meaning in emissions in Kazakhstan. Moreover, based on had done a search in Google scholar and another scientific sources between all studies in Kazakhstan with the LMDI method it is the first analysis which showing detail changes economical- energy factors in CO_2 emissions from electricity sector which were produced by gas and coal fuels.

4.6. Research question

Through the LMDI model, we can track throughout the entire period under review the changes in factors that are included in the structure of power generation and their impact or affect on CO_2 emissions.

There are 5 given factors, namely:

ΔCEGEF: the changes in the electricity generation efficiency effect.

ΔCSEG: the changes in the thermal power structure effect.

ΔCSTPG: the changes in the electricity structure effect.

ΔCEI: the changes in electricity intensity effect.

ΔCGDP: the changes in the economic activity effect.

Thus, the research question: Dynamics of factors in the structure of electricity production by using gas and coal and their (factors) influences on the changes of CO_2 emissions in Kazakhstan.

4.7. Model and Methodology: LMDI approach

This research can help to understand the past pattern of CO_2 emissions from electricity generation by using coal and gas fuels. Specifically, the study and compare the past pattern of CO_2 emissions in Kazakhstan and the emission driving economic factors based on an index decomposition analysis (specifically the Logarithmic Mean Divisia Index Modeling).

The methodology adopted for this study follows the work of Zhang et al. (2013) and use LMDI (additive) method proposed by (Ang, 2004), and which was used by IEA (2016). The Divisia index is based on the concept of log (i.e. logarithmic) change. The LMDI use a log mean weight function and in the additive case it's ''difference'' change, is decomposed. We apply the study of Zhang et al. (2013) that was referenced by IEA (2016) and therefore we analyze the change in CO_2 emissions from electricity generation over time decomposed into the respective changes of six driving factors. However, the IEA report (2016) considered only 4 driving factors. In general, there are two method of decomposition analysis; one is structural decomposition analysis (SDA) and the other is index decomposition analysis (IDA). According this methods we can also obtain the influence of economic growth, sector and technology changes on a framework of environmental and socioeconomic number. The IDA uses only sector level data (Hoekstra and Van den Bergh, 2003) however even there are many specific decomposition methods can be developed we focused on LMDI.

- *CO_2 Emission Estimation:*

$$\mathrm{CO} = \sum_{\mathrm{ft}} \mathrm{EC_{ft}} \times \mathrm{CEF_{ft}} \times \mathrm{COD_{ft}} \times \mathrm{MWR} \qquad (4-1)$$

Where:

ft: Fuel type

EC_{ft}: the energy consumption based on fuel type ft

CEF_{ft}: the carbon emission factor of the fuel type ft

COD_{ft}: the fraction of the carbon oxidized dioxide from fuel type ft

MWR: the molecular weight ratio of carbon dioxide to carbon (44/12).

The carbon emission factors for diesel coal which is the fuel used in the coal power plants was 20.8 and fractions of carbon oxidized is 0.99. Natural gas which is used in gas plants have the carbon emission factor of 15.3 while its fraction of carbon oxidized is 0.98 (IPCC, 1996).

The next step is decomposition of CO_2 emissions, which is provide fellow estimation:

- *Decomposition of CO_2 Emissions:*

$$\mathrm{CO} = \sum_{\mathrm{ft}} \mathrm{CO_{ft}} = \sum_{\mathrm{ft}} \frac{\mathrm{CO_{ft}}}{\mathrm{EC_{ft}}} \times \frac{\mathrm{EC_{ft}}}{\mathrm{TPG_{ft}}} \times \frac{\mathrm{TPG}_{ft}}{\mathrm{TPG}} \times \frac{\mathrm{TPG}}{\mathrm{TEG}} \times \frac{\mathrm{TPG}}{\mathrm{TEG}} \times \mathrm{GDP}$$

$$= \sum_{\mathrm{ft}} \mathrm{CO_{ft}} = \sum_{\mathrm{ft}} \mathrm{COCF} \times \mathrm{EGEF} \times \mathrm{SEG} \times \mathrm{STPG} \times \mathrm{EI} \times \mathrm{GDP} \qquad (4-2)$$

Where:

CO_{ft} denotes CO_2 emissions based on fuel type ft

TPG_{ft} denotes thermal power generation based on fuel type ft

TPG denotes thermal power generation

TEG denotes total electricity generation

GDP as the gross domestic production

$COCF_{ft}=CO_{ft}/EC_{ft}$ is the CO_2 emissions coefficient of fuel type ft

$EGEF_{ft}=EC_{ft}/TPG_{ft}$ is the electricity generation efficiency based on fuel type ft

$SEG_{ft}=TPG_{ft}/TPG$ is the share of electricity generation based on fuel type ft in total thermal power generation

STPG=TPG/TEG is the share of thermal power generation in total electricity generation

EI=TEG/GDP is the electricity intensity.

$$\Delta C_{COCF} = \log(CO_{ft}^{t}, CO_{ft}^{0}) \ln(\frac{COCF_{ft}^{t}}{COCF_{ft}^{0}}) \quad (4-3)$$

$$\Delta C_{EGEF} = \log(CO_{ft}^{t}, CO_{ft}^{0}) \ln(\frac{EGEF_{ft}^{t}}{EGEF_{ft}^{0}}) \quad (4-4)$$

$$\Delta C_{SEG} = \log(CO_{ft}^{t}, CO_{ft}^{0}) \ln(\frac{SEG_{ft}^{t}}{SEG_{ft}^{0}}) \quad (4-5)$$

$$\Delta C_{STPG} = \log(CO_{ft}^{t}, CO_{ft}^{0}) \ln(\frac{STPG_{ft}^{t}}{STPG_{ft}^{0}}) \quad (4-6)$$

$$\Delta C_{EI} = \log(CO_{ft}^{t}, CO_{ft}^{0}) \ln(\frac{EI_{ft}^{t}}{EI_{ft}^{0}}) \quad (4-7)$$

$$\Delta C_{GDP} = \log(CO_{ft}^{t}, CO_{ft}^{0}) \ln(\frac{GDP_{ft}^{t}}{GDP_{ft}^{0}}) \quad (4-8)$$

$$\Delta C_{Total} = \Delta C_{COCF} + \Delta C_{EGEF} + \Delta C_{SEG} + \Delta C_{STPG} + \Delta C_{EI} + \Delta C_{GDPl} \quad (4-9)$$

$$(\frac{\Delta C_{COCF}}{\Delta_{Total}} + \frac{\Delta C_{EGEF}}{\Delta_{Total}} + \frac{\Delta C_{SEG}}{\Delta_{Total}} + \frac{\Delta C_{STPG}}{\Delta_{Total}} + \frac{\Delta C_{EI}}{\Delta_{Total}} + \frac{\Delta C_{GDP}}{\Delta_{Total}}) \times 100\% = 100\% \quad (4-10)$$

Where:

0: initial year

t: following year

ΔC_{COCF}: the changes in the emissions coefficient effect

ΔC_{EGEF}: the changes in the electricity generation efficiency effect

ΔC_{SEG}: the changes in the thermal power structure effect

ΔC_{STPG}: the changes in the electricity structure effect

ΔC_{EI}: the changes in electricity intensity effect

ΔC_{GDP}: the changes in the economic activity effect

The emissions coefficient effect factor for each of the fossil fuels is assumed to remain unchanged over the study period, ΔCOCF =0 in Eq.(4-3). Hence, analyzing the additive LMDI formulae used in the study for the rest decomposition factors during the considering period. (Sunil

Malla, 2009), In another words, if the emission factor were assumed to be constant, thus the emission factor effect can be regarded as zero. (Ana Karmela Sumabat and et al. 2016)

4.8. Data source

For this analysis, we study the power industry sector of Kazakhstan. CO_2 emissions from electricity generation and preliminary data from Kazakhstan show a rising trend of CO_2 emissions that accompanied economic growth in the last two decades. Kazakhstan is in fact classified among the top emission generating countries in the world. The considering period from 1990 to 2016, 26 years which was analyzed by three periods, 1990-2000, 2000-2008 and 2008-2016 for calculation by decomposition method (LMDI). The main goal of this study is to analyze the impact of economy and policy events during development of independent Kazakhstan on the energy generating sector and CO_2 emissions with the specifically following data:

a) Electricity generation in KWh data as provided by statistic committee of Kazakhstan (Stat.gov.kz);

b) GDP (constant PPP and constant prices, 2010 US$) (World Bank database).

c) Thermal power plant generation, from Electricity market analysis Samruk-Energy, 2017-2018.

d) Coal consumption and Gas consumption from the national inventory report (NIR) and common reporting format (CRF) of all parties included in Annex I to the Convention.

For calculation of CO_2 emissions, we obtain use the emission factor for fuel, the fraction of the carbon oxidized based on fuel type from IPCC (2006).

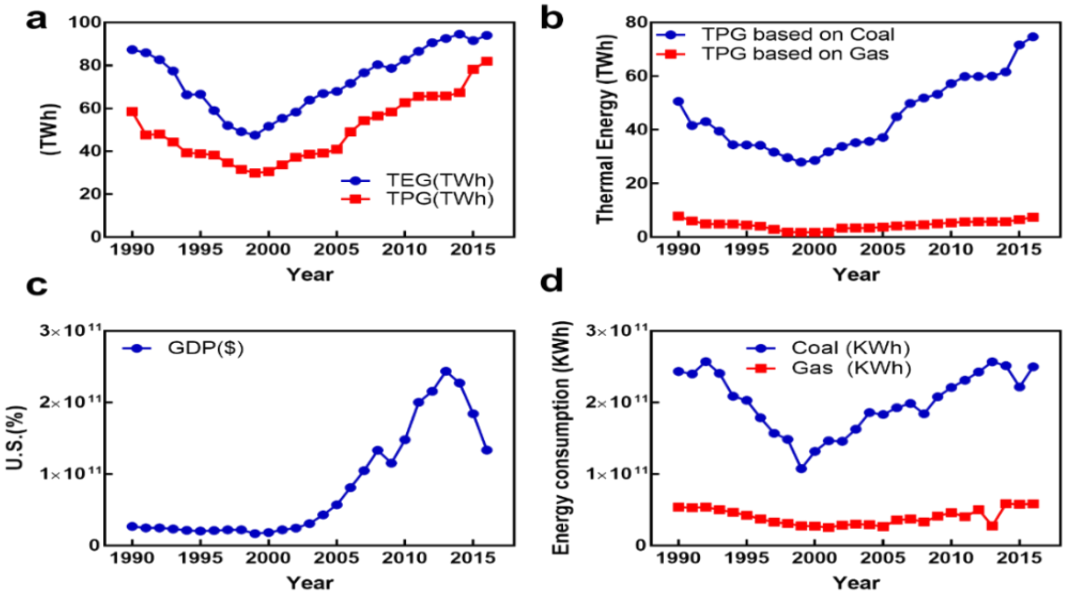

Figure 4.1a: All data's of study in a graph. (a) Total electricity (TEG) and thermal energy (TPG), (b) Thermal energy based on fuel type, (c) Gross-domestic product, and (d) Energy consumption based on fuel type.

4.9. Analysis and result

Since our LMDI methodology has two estimation parts, we divided for two sections as it shown above in section 4.7. First, the analysis of CO2 emissions and the next step is decomposition of CO_2 Emission.

4.9.1. Analysis of CO_2 emissions

The consequential CO_2 emissions from electricity generation in Kazakhstan from 1990 to 2016 are presented in Figure3.2. In general, it should be noted that Kazakhstan regards 1990 as a base year, and the whole policy of reducing the level of CO_2 emissions is repelled precisely from this year.

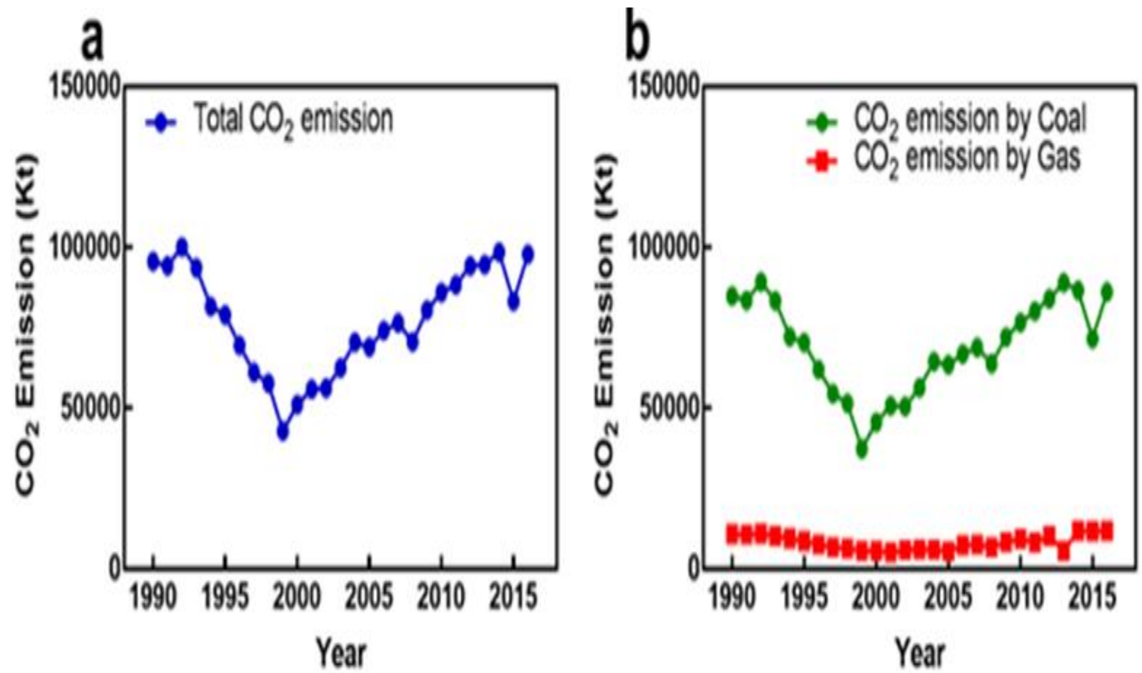

Figure 4.1b: (a) Total CO_2 emissions (CO), (b) CO_2 emissions by fuel types (CO_{ft})

4.9.2. Decomposition analysis

First part of analyzing period from 1990-2000.

First part of considering period can be described as cardinal changes of electricity sector, and one of the reason is the Kazakhstan's independence which were gotten in 1991. Electricity system was function according to the Soviet Union policy, and the country need to create new policy without depending from anybody. There were needs to increase capacity, and new investments in this fields. There have been significant decreases in CO_2 emissions from electricity generation in 1994 from 81609.7 Mt to 42818.12 Mt in 1999 but after this until 2016 year CO_2 emissions growing up actively. In more detail, such a jump down is associated with the reforms in the electricity industry in those years. In fact, these reforms began even earlier than in Russia, exactly in the first half of the 90 decade. Despite the periodic increase in energy tariffs, the state was unable to ensure the modernization of the industry. By the middle of the decade, the depreciation of generating capacity reached 50 percent, accounts receivable and payable grew continuously in the industry, so that by 1994 the power companies were left without working capital, this was a peak that we could not manage. The leadership of the republic did not see any other way out than to listen to the advice of foreign investors and international financial organizations and to begin practical steps to liberalize the industry.

At the same time, from 1993 to 2000, emissions of harmful substances into the atmosphere decreased from 5.1 million tons to 3.2 million tons mainly due to the decline in production. In recent years, under the conditions of economic growth, it was possible to stabilize emissions of harmful substances into the atmosphere at the level of 3.2-3.4 million tons due to the widespread introduction of mandatory state environmental impact assessment and state control in the field of environmental protection.

Table 4.2. Complete decomposition results of CO_2 emissions from 1990-2000.

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	ΔTotal
1990-1991	0,43	-0,05	-0,38	0,13	-0,16	-0,03
1991-1992	0,25	-0,18	0,10	-0,08	0,00	0,09
1992-1993	-0,03	0,05	-0,03	-0,01	-0,12	-0,13
1993-1994	-0,09	0,10	0,07	-0,11	-0,19	-0,22
1994-1995	-0,04	-0,05	-0,03	0,09	-0,08	-0,11
1995-1996	-0,14	-0,08	0,21	-0,30	0,06	-0,25
1996-1997	0,15	-0,20	0,05	-0,35	0,10	-0,25
1997-1998	0,38	-0,30	-0,07	-0,11	0,00	-0,11
1998-1999	-0,35	0,02	-0,04	0,46	-0,53	-0,43
1999-2000	0,17	-0,02	-0,12	0,01	0,16	0,20
1990-2000	**0,66**	**-0,65**	**-0,23**	**-0,26**	**-0,72**	-1,21

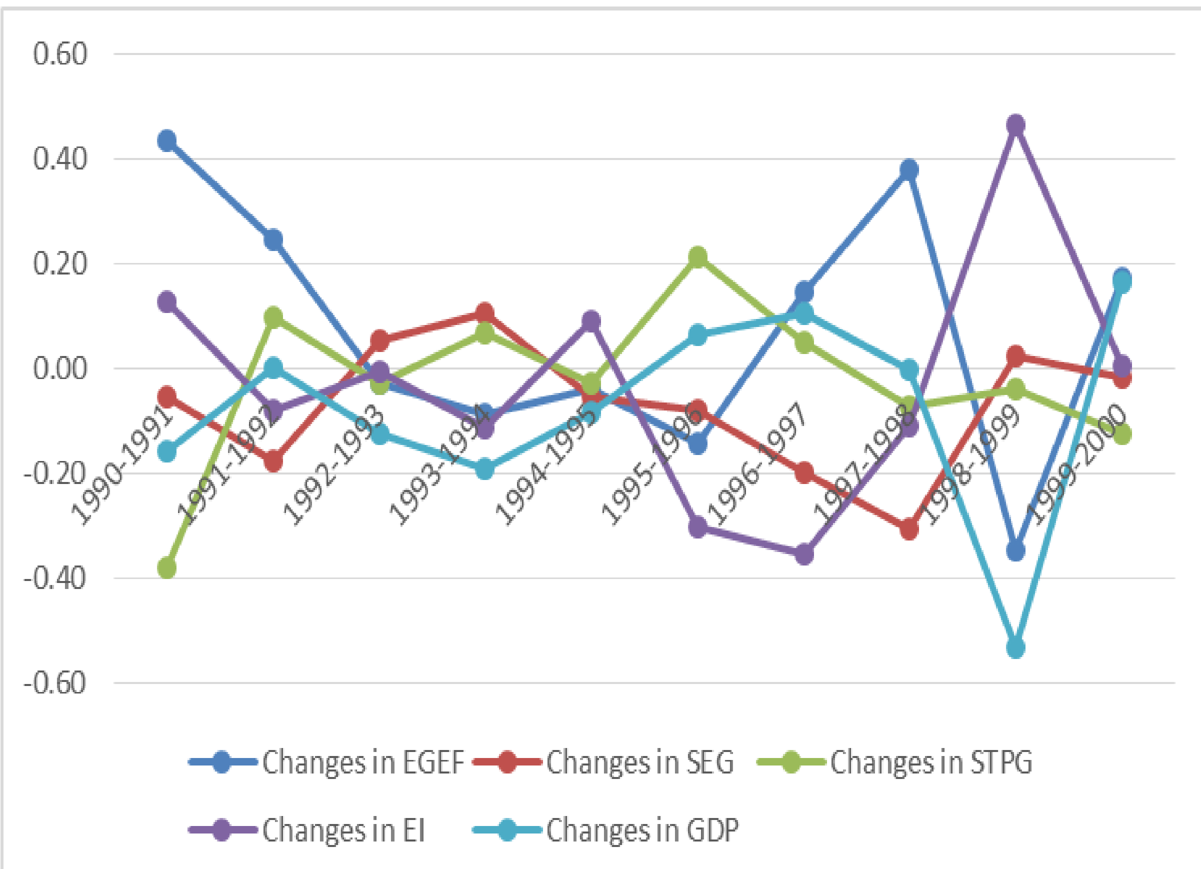

Figure 4.2. Complete decomposition results of CO_2 emissions from 1990-2000.

Table 4.3. Complete decomposition results of CO_2 emissions from 1990 -2000 (%)

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	ΔTotal
1990-1991	-1437,86	175,66	1255,71	-417,75	524,24	100,00
1991-1992	279,04	-199,13	108,78	-91,05	2,36	100,00
1992-1993	21,04	-39,90	21,16	5,42	92,29	100,00
1993-1994	39,54	-47,34	-29,96	51,18	86,58	100,00
1994-1995	34,95	45,86	26,06	-79,88	73,01	100,00
1995-1996	57,16	31,32	-83,48	119,98	-24,98	100,00
1996-1997	-57,09	78,56	-19,89	139,02	-40,59	100,00
1997-1998	-336,07	271,05	65,17	97,41	2,45	100,00
1998-1999	80,19	-5,19	9,59	-107,41	122,83	100,00
1999-2000	86,54	-8,97	-62,74	2,71	82,47	100,00
1990-2000	**-54,89**	**54,10**	**19,36**	**21,54**	**59,89**	**100,00**

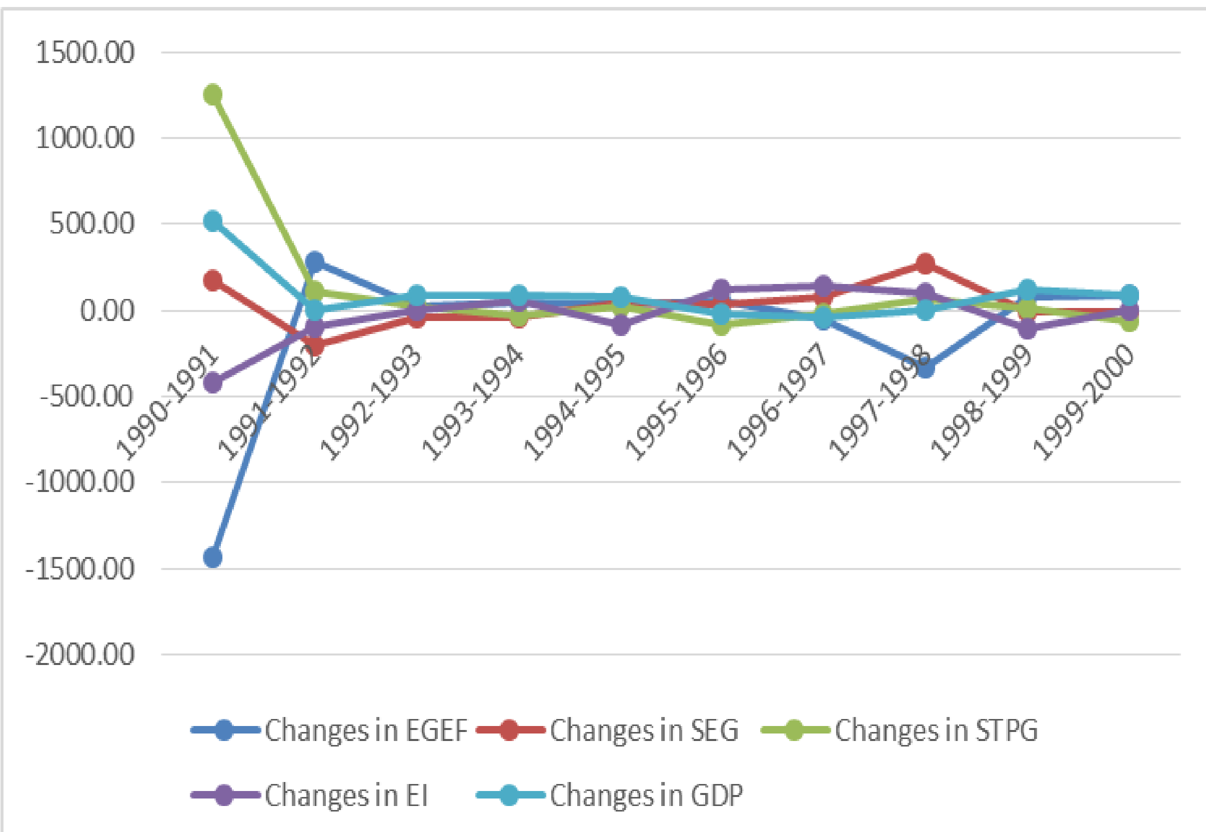

Figure 4.3. Complete decomposition result of CO_2 emissions from 1990-2000 (%)

The tables above showing the result from decomposition calculation in first period in 1990-2000 changes in the **electricity generation efficiency effect EGEF** partially increased the emissions of CO_2. Even there are some negative results in 1992-1993, 1993-1994, 1994-1995, 1995-1996 and in 1998-1999 periods, the accumulated (period-wise) effect leads to increase of CO_2 emissions at 0.66 Mt which accounts in C ΔTotal absolute value as 54.89%. It was mentioned before there have been significant decrease in CO_2 emissions from electricity generation from 1994 -1999 and we can observe that by 1994 the power companies were left without working capital, this was a peak that government could not manage. The leadership of the republic did not see any other way out than to listen to the advice of foreign investors and international financial organizations and to begin practical steps to liberalize the industry.

The **thermal power structure effect changes SEG** has a significant role in a reduction of CO_2 emissions, except 1992-1993, 1993-1994, 1998-1999. The accumulated (period-wise) effect is a decrease of -0.65 Mt which accounts for 54.10% of the C ΔTotal changes in absolute value. The notable period of reduced CO_2 emissions 1990-1991, 1992-1993, 1994-1995, 1995-1996, 1996-1997 and 1999-2000 were the period of various power sector reforms in Kazakhstan. This was happened because the power sector has some shortage and it was a period of new formation of industry. As a result of a decrease in solvent demand for electricity, its production in 1996 decreased to 59.3 billion kW / h, in 1997 - to 52.2 billion kW / h, and in 1998 - to 49.215 billion kW/ h. In 1995 the number of unprofitable enterprises in electricity reached 40%.

Under the observation period, **the electricity structure effect STPG** also reduced CO_2 emissions except for 1991-1992, 1993-1994, 1995-1996 and 1996-1997 with accumulated (period-wise) effect of

-0.23 Mt which accounts for 19.36% in the CΔTotal changes in absolute value. As we see it is a small decrease in a total value and it is related not with a using of coal fuel type it is more explaining the weak capacity which has fluctuation.

The next factor which is played role of reduction of CO_2 emissions is changes in **electricity intensity effect EI**. In whole period there is a decreasing except 1990-1991, 1994-1995, 1998-1999 and 1999-2000. The accumulated (period-wise) is a decrease of -0.26 Mt, which accounts for 21.54% of the C ΔTotal changes in absolute value. What is the electricity intensity in our case, its a total electricity generation/ GDP, in general energy intensity is a measure of the energy inefficiency of an economy. It is calculated as units of energy per unit of GDP, electricity intensity in this case same but its coming from total electricity generation. High energy intensities indicate a high price or cost of converting energy into GDP. Low energy intensity indicates a lower price or cost of converting energy into GDP. According our results electricity intensity giving decrease of CO_2 emissions in total absolute volume of considering period which can be interpret as a low CO_2 emissions from the total electricity generation in GDP equivalent.

The dominant role in CO_2 emissions reduction in considering period is **economic activity effect changes in GDP**. During whole period there were decreases in CO_2 emissions except 1991-1992, 1995-1996, 1996-1997, 1997-1998 and 1999-2000. However the accumulated (period-wise) is a decrease of -0.72 Mt, which accounts as 59.89% of the total changes CΔTotal in absolute value.

The Republic of Kazakhstan was one of the first countries in the post-Soviet space in 1996 to reform the electric power industry. A lot has been done by common efforts over this period. As a result, it can be noted that the cost of electricity in the Republic of Kazakhstan is lower than in the CIS countries. During 10 years was established a new system of electricity sector, new companies which is providing the normal functions in electricity market. The reform ideology provided for the separation of natural monopoly and competitive functions, the privatization of generating assets, the creation of a national power grid company with dispatching management functions - KEGOC JSC, the launch of a trading platform represented by the Kazakhstan electricity and capacity market operator (KOREM JSC). The authors of the reform did not have to discover a new continent, the experience of reforming the power industry in Europe and the USA was taken as a basis. A few years later, the experience of reforming the power industry of Kazakhstan became one of the example models for carrying out similar reforms in the Russian power industry. The reform ideology provided for the separation of natural monopoly and competitive functions, the privatization of generating assets, the creation of a national power grid company with dispatching management functions - KEGOC JSC, the launch of a trading platform represented by the Kazakhstan electricity and capacity market operator (KOREM JSC).

In the end of considering period, at 1999 was the beginning of changes in electricity generation and electricity consumption sectors, the state carried out a number of reforms from 1990 to 1999, which allowed it to stabilize this sector more or less. For example, the maximum level of power consumption in the southern zone of the country was noted in 1990, and between 1991 and 1999 the level of power consumption decreased by almost 3 times, then in the period from 2000 to

2007 electricity consumption was an increase in a 1.67 times and was noted with an average annual growth rate of 7.6%. Next period which we are going analyze is 8 years from 2000-2008.

Second part of analyzing period from 2000-2008

In 2000–2008 years, there was a steady increase in power consumption with a dynamics on average of about 5% per year. During considering period the main factors that give some value in CO_2 emissions are economic activity, and in fact it is worth to note that the country's GDP for 25 years of independence has grown very actively, while the industry of the country as a whole also grew, and electricity consumption had both recession and growth. So much the less, if we decompose obtained the results by years, then we have the following development.

In 2000-2007 The country's economic growth rates were among the highest in the world - more than 10%. The index of physical volume of GDP in 2007 compared with 1991 increased by 154.1%. Economic growth was mainly associated with the development of oil and gas fields and the development of the associated production and infrastructure base, while it should be noted that the inflow of money was from foreign investment. The government was also concerned about the weak intersectoral and interregional integration of the economy, the underdeveloped domestic market for consumer goods and services, insufficient development of logistics and social infrastructure, aging of fixed assets (except for oil and gas and mining and metallurgical industries), and low innovativeness of the economy. Electricity generation increasing very low only 5% per year, but mostly consumption were consumed by industrial sector and in the end of period electricity consumption in the country amounted to 76.4 billion kW / h. that period was global economy crisis, the decline economic led to negative changes in the work of power engineers.

At the same time, this was the period of the first stage of modernization of the national electricity network, and according to the plan, the implementation of this project was from 2000-2009, the project was aimed at replacing obsolete high-voltage equipment at 46 substations (out of 74 available).

In other hands, it was time where government sent all their efforts for developing the capital of Kazakhstan to Astana (nowadays the name of capital changed as Nursultan). Given the high pace of construction of the capital and the high growth trends in the population of the city where therefore the increasing demand for heat and electricity, the Government decided to solve the development of the city's infrastructure at a faster pace. The main base for achieving the goals is an effective economy, the formation of which involves investing in sectors of the economy that can become sources of growth of the GDP, if to be clear it's about building a new or reconstructing and modernizing existing enterprises including industrial sector.

Table 4.4. Complete decomposition results of CO_2 emissions from 2000-2008

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	ΔTotal
2000-2001	-0,08	-0,09	0,06	-0,24	0,38	0,03
2001-2002	-0,53	0,46	0,09	-0,11	0,21	0,12
2002-2003	0,10	-0,02	-0,11	-0,27	0,45	0,16
2003-2004	0,10	-0,01	-0,07	-0,58	0,68	0,11
2004-2005	-0,24	0,04	0,06	-0,53	0,56	-0,11
2005-2006	0,05	-0,07	0,26	-0,60	0,71	0,36
2006-2007	-0,09	-0,05	0,07	-0,38	0,52	0,07
2007-2008	-0,28	0,01	-0,01	-0,38	0,48	-0,19
2000-2008	**-1,00**	**0,27**	**0,36**	**-3,17**	**4,08**	**0,54**

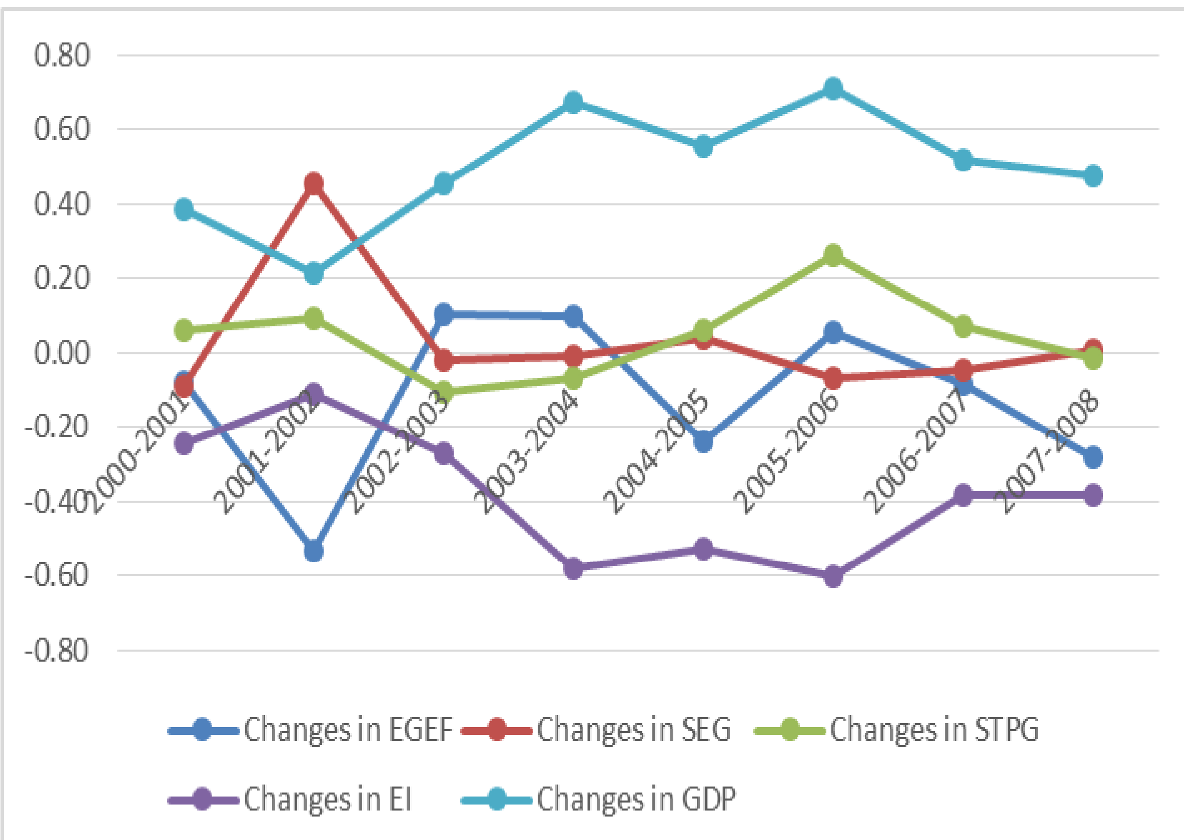

Figure 4.4. Complete decomposition results of CO_2 emissions from 2000-2008

Table 4.5. Complete decomposition results of CO_2 emissions from 2000 to 2008 (%)

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	ΔTotal
2000-2001	-269,2	-302,7	202,8	-812,6	1281,7	100,0
2001-2002	-435,5	374,0	75,9	-89,8	175,3	100,0
2002-2003	64,7	-11,5	-66,4	-166,8	279,9	100,0
2003-2004	84,3	-8,1	-59,0	-508,7	591,4	100,0
2004-2005	213,1	-35,1	-52,5	468,4	-493,9	100,0
2005-2006	15,0	-18,5	72,8	-168,6	199,3	100,0
2006-2007	-121,9	-66,5	97,7	-545,7	736,5	100,0
2007-2008	145,5	-3,8	7,1	198,9	-247,7	100,0
2000-2008	**-183,0**	**50,3**	**65,8**	**-583,1**	**750,0**	**100,0**

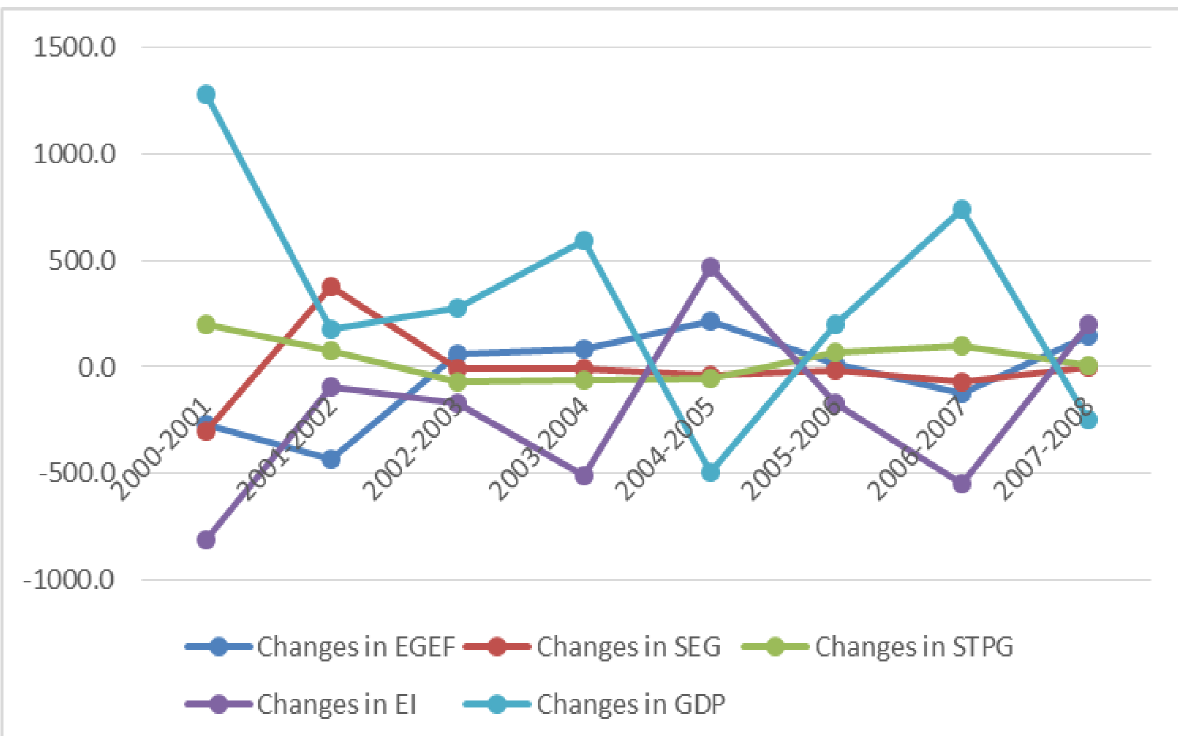

Figure 4.5.Complete decomposition result of CO_2 emissions from 2000 to 2008 (%)

The changes in the **electricity generation efficiency effect EGEF** has brought some decrease in CO_2 emissions from 2000-2001 at -0.08 (%-2.69) and in 2001-2002 it's giving more negative changes in CO_2 emissions at -0.53(in %-4.35). Next two years from 2002-2003 it's 0.10(%0.65) and 2003-2004 shown as 0.10(%0.84), which means that EGEF factor has an increasing effect in CO_2 emission, and in the last two years of considering period the numbers were decreased again, but if we are looking in the graph of result that we've got, the line which showing EGEF factor almost smooth without radical fluctuation. The accumulated period leads decrease at -1.0 Mt and in CΔTotal absolute value is decrease at 183.0%.

Next factor is a **thermal power structure effect SEG**, in a whole considering period giving increased effect in CO_2 emissions, at 0.27 Mt (50.3%), during a whole period there is significant increase in 2001-2002 period 0.46 Mt(374.0%), then two next periods small decreased as -0.02(% -0.11) and -0.01(%-0.08) and its giving small fluctuation. In general it might be different reasons for this kind of indicators in SEG effect, if consider 2002 year, then that time in Kazakhstan's accordance with forecast estimates, there were certain concerns in energy production and its consumption, thus the Government tried to consolidate these indicators with the national plan, and it was the production plan until 2015 which was built at the level of 2002. As we see, changes in SEG factor effect at 2002 giving the most increase in CO_2 emissions, which is more likely In total that it may not be on a deficit of electricity generating because annual growth at that time was no more than 5%, but rather it was on the positive dynamics of the country's power plants works. At the same time, it was planned that the electricity consumption in Kazakhstan in the medium term will increase by 2005 to 62.5 - 67 billion kWh (min. Option - max. Option), by 2010 - to 75 - 82 billion kWh, and by 2015 electricity consumption will increase to 86 - 95 billion kWh. To cover the indicated growth in energy consumption, it will be required until 2015 increase electricity production by existing and newly constructed power plants in Kazakhstan by 1.5-1.65 times, compared with the level of 2002.

The highest significant effect in CO_2 emissions are giving the **changes electricity structure effect - STPG**, in a whole considering period this factors was decreased only during two years from 2002-2004, in 2002-2003 is giving -0.11(%-0.66) and in 2003-2004 is small changes as 0.07(%-0.58), CΔTotal absolute value of considering 10 years analysis 1990-2000, there are increases in CO_2 emissions as 0.36 (% 65.8) Mt.

During the study period the **electricity intensity effect changes in EI** giving dominant CO_2 emissions decreased at -3.17(%-583.1)Mt, and also if we considering each period separately we can recognize that a whole period there is negative numbers which is indicating in a positive effect on reducing CO_2 emissions. The downward trend in the intensity of electricity, which has a diminishing effect on CO_2 emissions, means that due to the period in question, the industry has seen some updates in new processes, new technologies and new equipment, which have been accompanied by widespread use of energy-saving technologies and improved management levels. It might be also consider as a reason of **the changes in ∆GDP economic activity effect** has the most increase significant affect on CO_2 emissions at 4.08 and in a C∆Total absolute value (%750.0).

Apart from the fact, that the result gives a certain picture of the development of CO_2 emissions from 2000–2008, we are giving some review about the development of electricity data's, since this analysis is directly related to the electricity industry which we can clearly see in Figure 4.1a.

With annual GDP by 9%, the average increase in domestic energy consumption in 2007 was at least 5–6%. The maximum amount of electricity generation at that time industries conditions of the equipment of the operating power plants in Kazakhstan was limited to 73–74 billion kWh / year. There were needs for new capacity. This period general was quite active for Kazakhstan, to ensure diversification of economic development was supposed to concentrate efforts on the implementation of service-infrastructure clusters, production with high technological redistribution, as well as on the creation of new industries. The programs of technological development of the republic until 2015 and the development of science for 2007–2012 were adopted. All these numerous events required considerable financial resources. It is no coincidence that in 2007 Kazakhstan began to clearly feel the onset of the global financial crisis.

Third part of analyzing period is 2008-2016

After the global economic crisis of 2008, the global economy until 2013 experienced recovery growth. Everywhere there was a policy of quantitative easing, many economies were growing.

This period can be described as a period of implementation some long-term Government plans in electricity sector. For example, introduction of the marginal tariff mechanism (“tariff-for-investment”), which has been in force since 2009, has allowed for five years to increase investment in the power industry of fivefold more, to build 1,700 MWh of additional electrical capacity and to upgrade another 5,000 MWh.

As we can see in a Table 4.5 and 4.6., it's a period from 2008-2016, 8 years of electricity development with using coal and gas fuels has a most highest significance in the electricity structure effect STPG of CO_2 emissions at 0.45 Mt and 49.30% in CΔTotal absolute value. At the time of 2008, the assessment of the country's electric power sector was not the best, since for a long time sufficient investments in the electricity sector were not made. Until 2015, the Government planned to modernize and reconstruct existing and construct new energy facilities in the amount of 2.8 trillion tenge. It was also obvious that it was impossible to solve this problem only at the expense of electricity tariffs. An important problem was the lack of credit resources. It should be noted the inertia of the development of the energy industry, associated with long construction and payback periods. Banks preferred to lend to the trading business and the construction sector, while domestic banks were not able to provide credit at reasonable rates, and Western banks were not particularly active.

Environmental issues in Kazakhstan during this period were within the competence of the Ministry of Environmental Protection (MEP). The government of Kazakhstan has issued a number of laws and regulations relating to environmental aspects. Despite the environmental orientation of the legal framework, poor compliance with laws, especially at the local level, was still a problem at that time, and duplicate legal documents were a big problem for improving environmental protection. Strategic Plan of the Republic of Kazakhstan for 2011-2015 was the basis for the development of strategic environmental plans for ministries and departments, national companies and regions.

Table 4.6. Complete decomposition results of CO_2 emissions from 2008-2016

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	ΔTotal
2008-2009	0,23	0,05	0,11	0,26	-0,30	0,35
2009-2010	0,04	-0,01	0,05	-0,41	0,50	0,17
2010-2011	-0,19	0,01	0,00	-0,51	0,60	-0,09
2011-2012	0,26	0,01	-0,09	-0,06	0,15	0,27
2012-2013	-0,50	0,00	-0,04	-0,19	0,24	-0,50
2013-2014	0,76	-0,02	0,01	0,19	-0,14	0,79
2014-2015	-0,41	-0,02	0,36	0,35	-0,42	-0,14
2015-2016	0,03	0,07	0,04	0,70	-0,65	0,20
2008-2016	**0,04**	**0,10**	**0,45**	**0,33**	**0,00**	**0,91**

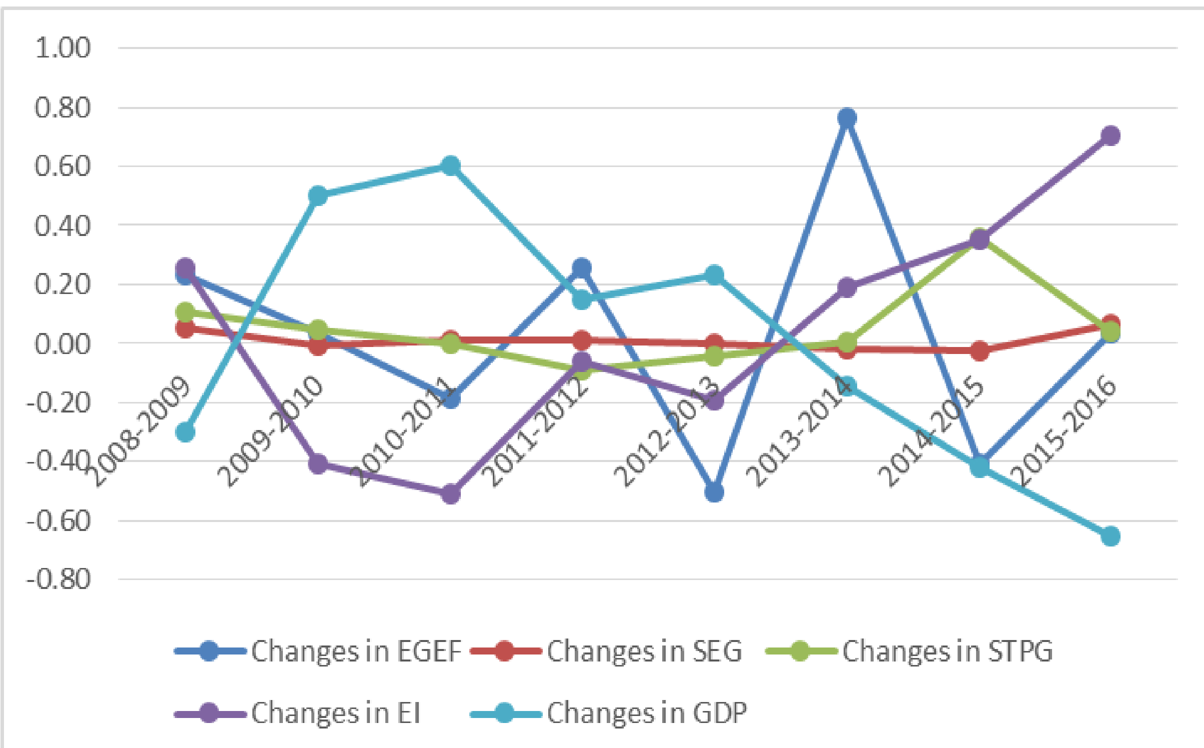

Figure 4.6. Complete decomposition result of CO_2 emissions from 2008-2016

Table 4.7. Complete decomposition results of CO_2 emissions from 2008-2016 (%)

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	ΔTotal
2008-2009	66,53	14,96	30,41	73,51	-85,41	100,00
2009-2010	20,64	-3,97	27,11	-233,10	289,32	100,00
2010-2011	219,35	-13,83	3,13	597,65	-706,30	100,00
2011-2012	95,05	4,03	-32,95	-21,70	55,57	100,00
2012-2013	100,53	0,12	7,83	38,63	-47,10	100,00
2013-2014	96,16	-2,54	0,68	23,96	-18,26	100,00
2014-2015	295,09	17,68	-258,76	-254,00	299,99	100,00
2015-2016	17,31	34,09	22,20	350,60	-324,21	100,00
2008-2016	**3,91**	**10,68**	**49,30**	**35,74**	**0,37**	**100,00**

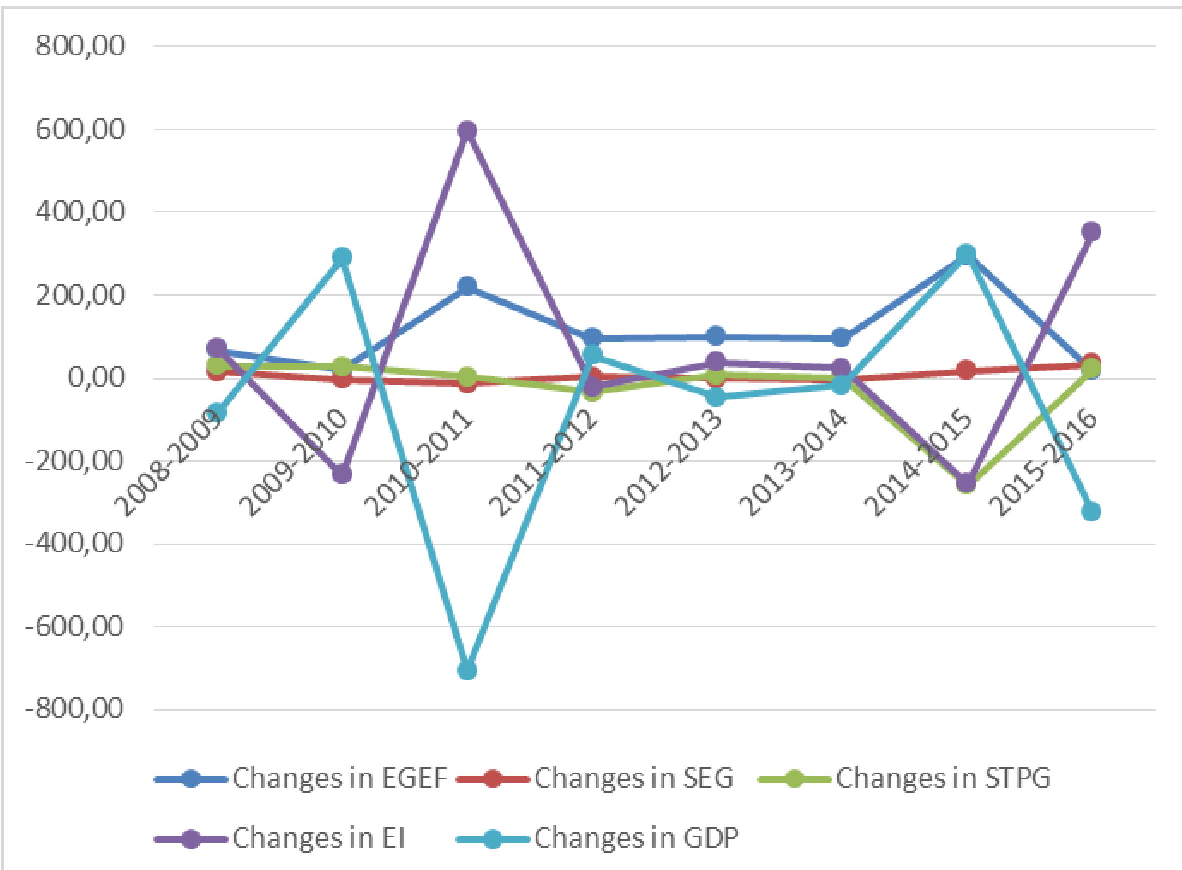

Figure 4.7. Complete decomposition result of CO_2 emissions from 2008-2016 (%)

The changes in the **electricity generation efficiency effect EGEF** has increases in CO_2 emissions on total absolute value at 0.04 Mt (% 3.91) but during 2010-2011 period it has decrease in CO_2 emission at from 0.04(20.64) in 2009-2010 to -0.19 (%219.35) in 2010-2011 and the same fluctuation from 2012-2013 which is decrease at -0.50(%100.53) and in 2013-2014 increase at 0.76 (96.16) level, after this there is decrease again at -0.41(%295.09) and at 2015-2016 going down 0.03(17.31). So as we see, this factor going up and down during the whole considering period and it should be noted that this period in Kazakhstan is characterized by the introduction of new capacities with transmission line for 500 kWh in a North- south as Northen – Aktobe region. Also there were some government reforms as privatization power plants, if we are evaluating whole period it was recession.

Next factor is the changes in **the thermal power structure effect SEG** has also increase in CO_2 emissions, its more than previous factor, and during whole period its almost giving in upper rate except 2009-2010, 2013-2014 and in 2014-2015. In total of considering period it shows at 0.10 Mt (10.16%). In this period Kazakhstan start new reform in power industry field, in 2010 the government adopted a new program for the development of the country's power industry for 2010–2014, which envisages bringing the electricity production in 2014 to 97.9 billion kWh, while the estimated consumption(forecast) was 96.8 billion kWh And this was due primarily to the fact that until 2010 and after 2013, Kazakhstan was a net exporter of electricity, and in the period 2010 - 2013 was a net importer, that is, consumed more electricity than produced. In ΔCTotal of absolute value SEG factor giving increase in CO_2 emissions.

Under the observation period, the **electricity structure effect STPG** did not reduce CO_2 emissions except for 2011-2012, 2012-2013 with accumulated (period-wise) effect of 0.45Mt which accounts for 49.30% in the total CO_2 emissions change ΔCTotal in absolute value and actually its dominant rate in increasing of CO_2 emissions. This may be due to the long reliance of the Kazakhstan power sector on thermal power plants not changing. In Kazakhstan case we can also assume that the gas which we are using for electricity generation has small amount which is not giving any positive result in environmental situation.

The results for **electricity intensity effect EI** showed that electricity intensity played role as one of the highest factor which is increasing of CO_2 emissions except for 2009-2010, 2010-2011, 2011-2012, 2012-2013 where was some reduction of CO_2 emission. The accumulated (period-wise) is a decrease of 0.33 Mt, which accounts for 35.74% of the change ΔCTotal change in absolute value.

Next factor is **economic activity, changes in GDP** have almost no changes and low fluctuation which is going down in third period (Table. 4.5) with 0.00 Mt and in ΔCTotal changes absolute value has 0.37%. Actually, this kind of result might indicate that growth in GDP reducing CO_2 emissions and we have to give attention to the policy of country economic growth, since apparently it was a downturn in the economy.

As we mentioned before, it was period when the Government start some implementation of plans in electricity sector, regarding this the implementation of the following projects was completed:

The project "Construction of a second 500 kWh transmission line for North-South Kazakhstan transit", worth 43.7 billion tenge. The project "Construction of an inter-regional power line 500 kWh" Northern Kazakhstan - Aktobe region ", worth 19.9 billion tenge. In 2009, 135.2 MW of new generating capacity were commissioned. In 2010, the government adopted a new program for the development of the country's electric power industry for 2010–2014, which envisaged to bring electricity production in 2014 to 97.9 billion kWh, with a forecast consumption of 96.8 billion kWh.

In 2011, the production of electricity in Kazakhstan is carried out by 46 energy-producing organizations of various forms of ownership at 65 power plants with a total installed capacity of about 19.8 GW and available capacity of about 15.7 GW. In 2011, the level of electricity production reached highest level - more than 86 billion kWh, which was comparable to the level of electricity generation in the early 1990s.

As we can see the capacity of electricity production was grow as electricity consumption. The Government choose more modern technology as gas fuels in power plants, which might effect on reduction of CO_2 emissions. According our results we can observe that the government increase capacity and tried to change of structure of power plants while the economic activity factor had small changes in CO_2 emission.

Since there were a lot of power plant modernization, based on the annual Ministry of Energy report the number of emergency shutdowns of large power plants decreased from 131 in 2008 to 39 in 2013, which ensured a reduction in the time of emergency shutdown of stations from 3200 to 900 hours per year.

Consequently, we can analyze this emission reduction based on the development of the electric power industry itself in the country. However, in the first half of the 2000s, when the country's economy demonstrated intensive recovery growth, the physical volume of electricity consumption grew by four to five percent per year, and the calculations of the departmental organization predicted an acute shortage of electrical capacity faced by the energy sector in 2015-2016 years.

4.10. Comparison analysis

This study was made based on the analysis of two studies Nnaemeka Vincent Emodi, (2015) Decomposition Analysis of CO_2 Emissions from Electricity Generation in Nigeria and Zhang et al. (2013) Decomposition analysis of CO_2 emissions from electricity generation in China. Nigerian case had considered two types of fuels in electricity production as oil diesel and natural gas. In turn, China's study was analysis electricity generation by using in power plants all possible fuels, as gasoline, coal, oil diesel, kerosene, oil and natural gas. However, we using the same method for analyzing impact to environment degradation from electricity generation, we stopped on the five factors which are giving more significant meaning in CO_2 emissions from electricity generation in Kazakhstan case, hence and comparative analysis focused on this five factors. Both of these authors have considered about 20 years and more. In case of China it is 19 years from 1991–2009 and in case of Nigeria it is 21 years from 1990 to 2011, regarding of this fact we decompose all 26 years of study period in Kazakhstan which means it is from 1990-20016 without dividing in a three parts.

4.10.1. Decomposition analysis for Kazakhstan in 1990-2016 years

Using the decomposition methodology from Zhang et al. (2013), we got the results in Tables 4.8 and 4.9 in the results in percentage. Modernization of electricity sector in Kazakhstan implies to reduce of CO_2 emissions but at the same time, this improvement will require more electricity which is vital for socioeconomic growth. The complete decomposition of CO_2 emissions change from 1990 to 2016 is shown in Figures 4.8. and 4.9.

Table 4.8. Complete decomposition results of CO_2 emissions 1990-2016

Year	ΔEGEF	ΔSEG	ΔSTPG	ΔEI	Δ GDP	ΔTotal
1990-1991	0,43	-0,05	-0,38	0,13	-0,16	-0,03
1991-1992	0,25	-0,18	0,10	-0,08	0,00	0,09
1992-1993	-0,03	0,05	-0,03	-0,01	-0,12	-0,13
1993-1994	-0,09	0,10	0,07	-0,11	-0,19	-0,22
1994-1995	-0,04	-0,05	-0,03	0,09	-0,08	-0,11
1995-1996	-0,14	-0,08	0,21	-0,30	0,06	-0,25
1996-1997	0,15	-0,20	0,05	-0,35	0,10	-0,25
1997-1998	0,38	-0,30	-0,07	-0,11	0,00	-0,11
1998-1999	-0,35	0,02	-0,04	0,46	-0,53	-0,43
1999-2000	0,17	-0,02	-0,12	0,01	0,16	0,20
2000-2001	-0,08	-0,09	0,06	-0,24	0,38	0,03
2001-2002	-0,53	0,46	0,09	-0,11	0,21	0,12
2002-2003	0,10	-0,02	-0,11	-0,27	0,45	0,16
2003-2004	0,10	-0,01	-0,07	-0,58	0,68	0,11
2004-2005	-0,24	0,04	0,06	-0,53	0,56	-0,11
2005-2006	0,05	-0,07	0,26	-0,60	0,71	0,36
2006-2007	-0,09	-0,05	0,07	-0,38	0,52	0,07
2007-2008	-0,28	0,01	-0,01	-0,38	0,48	-0,19
2008-2009	0,23	0,05	0,11	0,26	-0,30	0,35
2009-2010	0,04	-0,01	0,05	-0,41	0,50	0,17
2010-2011	-0,19	0,01	0,00	-0,51	0,60	-0,09
2011-2012	0,26	0,01	-0,09	-0,06	0,15	0,27
2012-2013	-0,50	0,00	-0,04	-0,19	0,24	-0,50
2013-2014	0,76	-0,02	0,01	0,19	-0,14	0,79
2014-2015	-0,41	-0,02	0,36	0,35	-0,42	-0,14
2015-2016	0,03	0,07	0,04	0,70	-0,65	0,20
1990-2016	**-0,22**	**-0,35**	**0,53**	**-3,07**	**3,22**	**0,11**

Table 4.9. Complete decomposition results of CO_2 emissions 1990-2016 (%)

Year	ΔEGEF	ΔSEG	ΔSTPG	ΔEI	Δ GDP	ΔTotal
1990-1991	-14,38	1,76	12,56	-4,18	5,24	100,00
1991-1992	2,79	-1,99	1,09	-0,91	0,02	100,00
1992-1993	0,21	-0,40	0,21	0,05	0,92	100,00
1993-1994	0,40	-0,47	-0,30	0,51	0,87	100,00
1994-1995	0,35	0,46	0,26	-0,80	0,73	100,00
1995-1996	0,57	0,31	-0,83	1,20	-0,25	100,00
1996-1997	-0,57	0,79	-0,20	1,39	-0,41	100,00
1997-1998	-3,36	2,71	0,65	0,97	0,02	100,00
1998-1999	0,80	-0,05	0,10	-1,07	1,23	100,00
1999-2000	0,87	-0,09	-0,63	0,03	0,82	100,00
2000-2001	-2,69	-3,03	2,03	-8,13	12,82	100,00
2001-2002	-4,35	3,74	0,76	-0,90	1,75	100,00
2002-2003	0,65	-0,11	-0,66	-1,67	2,80	100,00
2003-2004	0,84	-0,08	-0,59	-5,09	5,91	100,00
2004-2005	2,13	-0,35	-0,52	4,68	-4,94	100,00
2005-2006	0,15	-0,18	0,73	-1,69	1,99	100,00
2006-2007	-1,22	-0,66	0,98	-5,46	7,36	100,00
2007-2008	1,45	-0,04	0,07	1,99	-2,48	100,00
2008-2009	0,67	0,15	0,30	0,74	-0,85	100,00
2009-2010	0,21	-0,04	0,27	-2,33	2,89	100,00
2010-2011	2,19	-0,14	0,03	5,98	-7,06	100,00
2011-2012	0,95	0,04	-0,33	-0,22	0,56	100,00
2012-2013	1,01	0,00	0,08	0,39	-0,47	100,00
2013-2014	0,96	-0,03	0,01	0,24	-0,18	100,00
2014-2015	2,95	0,18	-2,59	-2,54	3,00	100,00
2015-2016	0,17	0,34	0,22	3,51	-3,24	100,00
1990-2016	**-2,09**	**-3,30**	**4,99**	**-28,83**	**30,22**	**100,00**

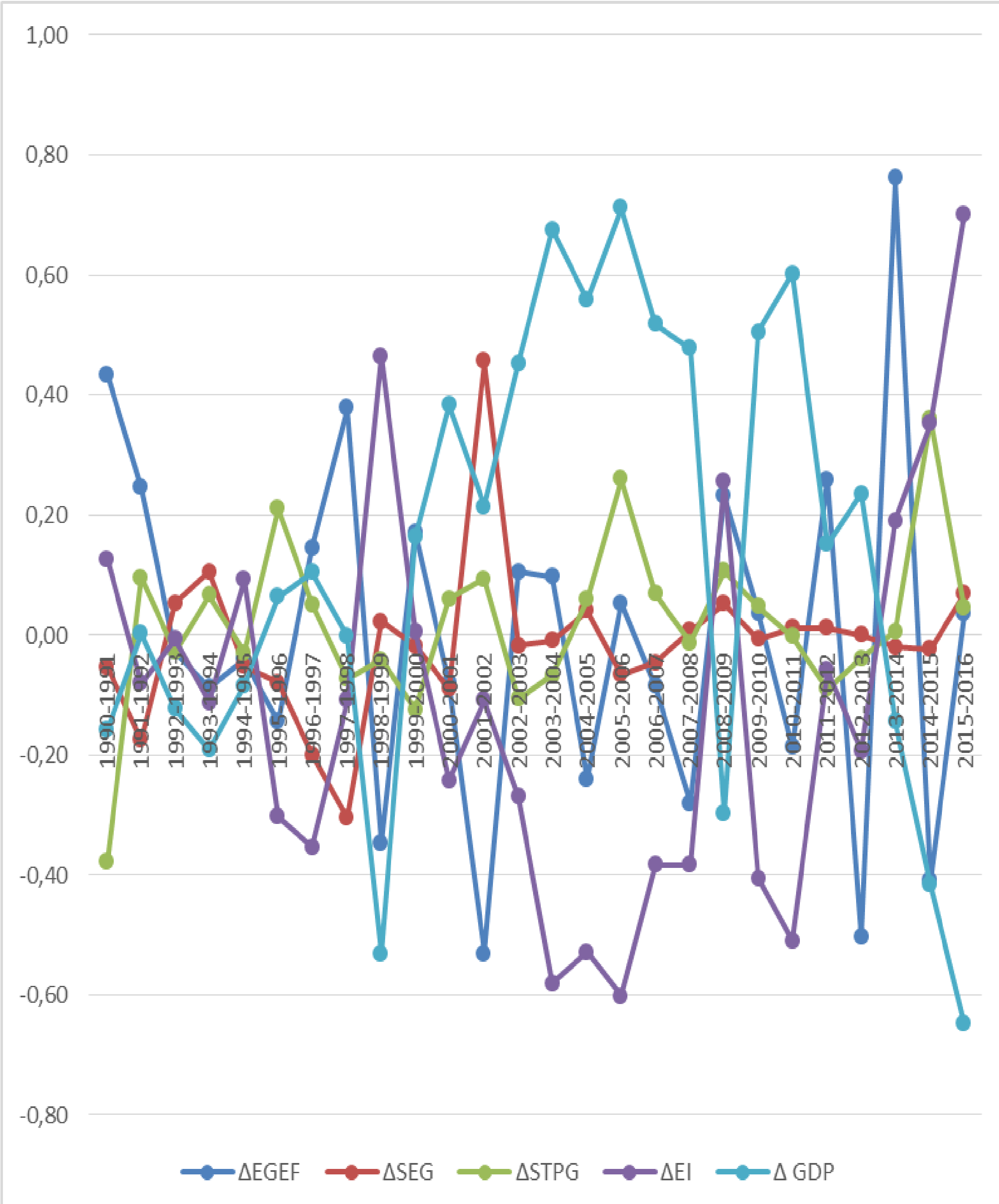

Figure 4.8. Complete decomposition of CO_2 emissions change (absolute).

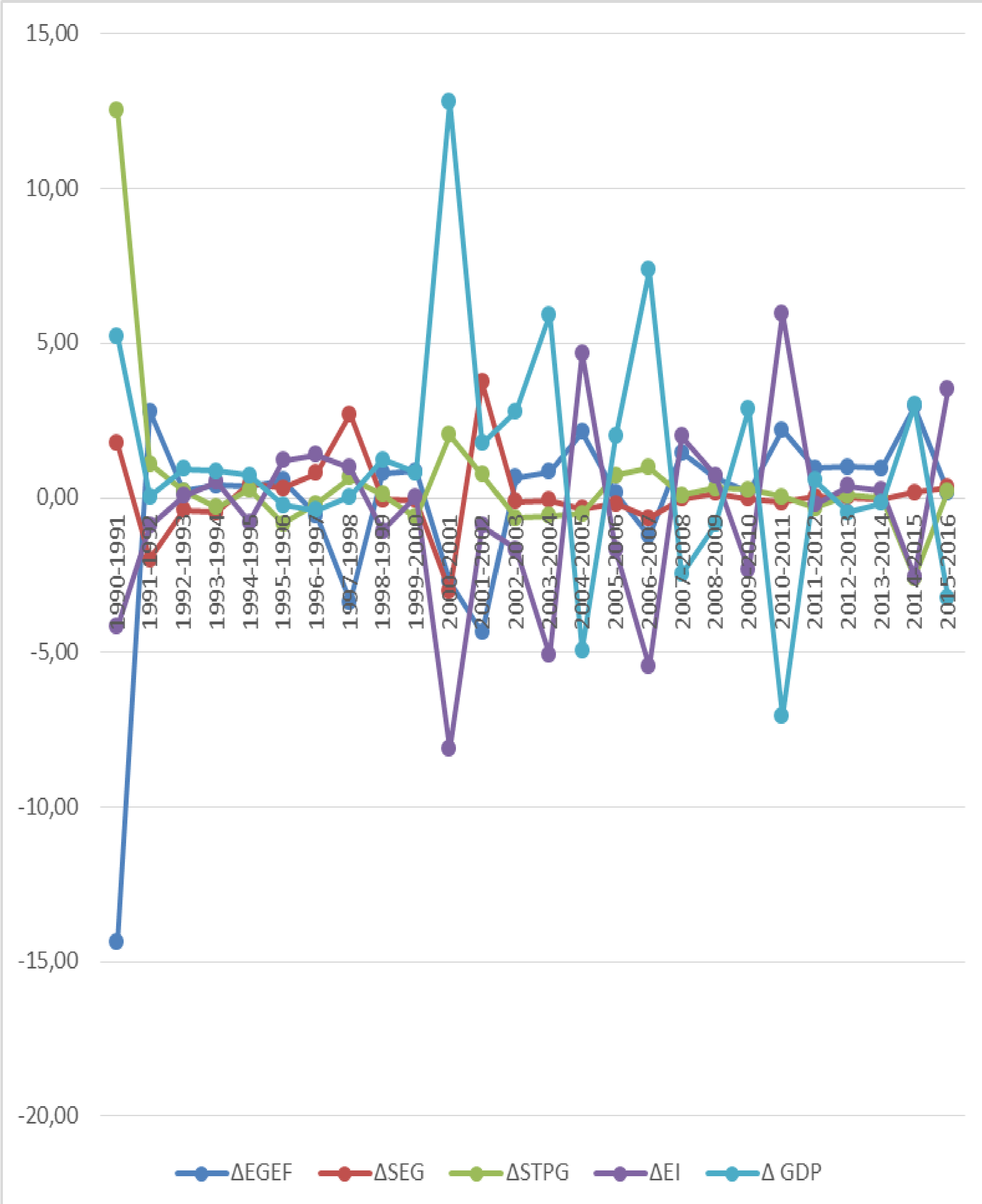

Figure 4.9. Complete decomposition of CO_2 emissions change (%)

Result from analysis the △EGEF factor in considering period of study showing that **generation efficiency effect** in CO_2 emissions is fluctuating from decrease to increase condition, and we can explain this by active reform which was conducted by government, and the total number showing decreasing -0.22 while in percentage -2.09 of the total change (ΔCTotal) in absolute value.

The **thermal power structure effect** △SEG has decrease in CO_2 emissions. The accumulated (period-wise) effect is a decrease of -0.35 Mt which accounts for 3.30 % of the total change (ΔCTotal) in absolute value.

The changes in the **electricity structure effect** △STPG in CO_2 emissions has positive result, it should be noted, that this factor has to be significant, because we analyzed this sector as a reason of calling GHG emission. This factor also has changes as increase and decrease, for example 1997-2000 is decreasing then two more years is increasing and then decreasing again, but in a total it's giving 0.53Mt and in total change (ΔCTotal) in absolute value is 4.99%.

The changes in **electricity intensity effect** △EI is the lowest significance in CO_2 emissions, which is -3.07 and in percentage absolute value is -28.83%, regarding this we can conclude that this factor has decreasing effect of CO_2 emissions and played a dominant role.

The changes in the economic activity effect ΔGDP has the highest significant impact in CO_2 emissions, as we know from 2000-2010 the country's economic growth rates were among the highest in the world - more than 10%, the index of physical volume of GDP in 2007 compared with 1991 increased by 154.1%. Therefore, 1% increase in real GDP in Kazakhstan leads to approximately 0.5% increase in electricity consumption. This factor in CO_2 emissions in total rank is 3.22 and total electricity change (ΔCTotal) in absolute value is 30.22%.

Next step of this analysis is the comparison with other studies which we can observe in Table 4.10. We choose two studies were authors (Nnaemeka Vincent Emodi, Kyung-Jin Boo, 2015 and Zhang, M., Liu, X., Wang, W., Zhou, M. 2013) used LMDI methodology and made analysis of CO_2 emissions from electricity generation factors from different type of fuels.

Table 4.10. Decomposition result (accumulated) from Kazakhstan, Nigeria and China

Factors	**Kazakhstan**	**China**	**Nigeria**
Changes in electricity generation efficiency	The accumulated effect leads to decrease in CO_2 emissions 0.22 Mt (2.09%)	The accumulated effect leads to decrease in CO_2 emissions 303.55 Mt (16.31%) dominant effect	The accumulated effect lead to a decrease in CO_2 emissions to 2.33 Mt (32.29%)
Changes in thermal power structure effect	The accumulated effect leads decrease in CO_2 emissions 0.35 Mt (3.30%)	The accumulated effect leads to decrease in CO_2 emissions 41 Mt (2.2%)	The accumulated effect lead to minor increase in CO_2 emissions to 0.48 Mt (6.62%)
Changes in electricity structure effect	The accumulated effect leads to increase in CO_2 emissions 0.53Mt (4.99 %)	The accumulated effect leads to decrease in CO_2 emission 41.0 Mt (2.20%)	The accumulated effect lead to a change in CO_2 emission increase to 3.01 Mt (4the rol1%)
Changes in electricity intensity effect	The accumulated effect leads to decrease in CO_2 emissions 3.07 (28.83%) dominant effect	The accumulated effect leads to decrease in CO_2 emissions 48.56 Mt (2.61%)	The accumulated effect lead to a decrease in CO_2 emissions to 21.85.13 Mt (302.94%) dominant effect
Changes in economic activity effect	The accumulated effect leads to increase in CO_2 emissions 3.22 Mt (30.22%) dominant effect	The accumulated effect leads to increase in CO_2 emission 2256.75 Mt (121%) dominant	The accumulated effect lead to an increase in CO_2 emissions to 28.27 Mt (391.95%) dominant effect

In Zhang et al. (2013) results from the "Decomposition analysis of CO_2 emissions from electricity generation in China", and Nnaemeka Vincent Emodi, (2015) "Decomposition Analysis of CO_2 Emissions from Electricity Generation in Nigeria" we can observe that a lot of factors has a significant contributed to the reduction in CO_2 emissions. China actually has 52 coal power plants and 7 nuclear plant as compared to Nigeria's 20 gas power plants (SCGT and CCGT) and 2 oil power plants in terms of thermal power generations. In Kazakhstan case there are 59 thermal power plants and most of them for produce electricity using coal, gas and oil. Comparing Kazakhstan with China and Nigeria, we have to note big differences between countries, as a population (consumers), which is very small and territory which is very big, hence the changes in considering factors giving totally different numbers.

The electricity generation efficiency effect has a decrease in CO_2 emissions at -0.22 Mt (accumulated) in Kazakhstan and played a significance meaning in CO_2 emissions reduction at 303.55 Mt (accumulated) in case of China and Nigeria, it was given at 2.33 Mt and this means that electricity efficiency measures provide to the reduction of CO_2 emissions in last considering both countries but not dominant in Kazakhstan case. Nowadays China also trying to convert some of its coal plants to CCGT and this giving high-efficiency which were recorded in Zhang et al. (2013).

The thermal power structure effect played a decrease in CO_2 emissions at 0.35 Mt in Kazakhstan and has minor role in increasing CO_2 emissions from generation of electricity plants in China and decreased at 1.92 Mt (accumulated) in Nigeria. The results from Nigeria study showed little change as it recorded 0.48 Mt (accumulated) of CO_2 emissions change and also a minor role in Kazakhstan

The electricity structure effect in Kazakhstan has increase in CO_2 emission to 0.53Mt (accumulated) and in China has decreased CO_2 emissions to 41.00 Mt (accumulated) but Nigeria showed no reduction and just a change of 3.01 Mt (accumulated) as compared to China it's quite different result, since the Chine is the country with big population and has huge number of power plants and renewable energy generation source (hydro power and wind). In this regard Nigeria has hydro power and thermal power plants throughout the considering period and same as Nigeria, Kazakhstan depending from thermal power plant too.

The electricity intensity effect from Zhang et al. (2013) results showed that an accumulated effect in China decrease in CO_2 emissions to 48.56 Mt and in the Nigerian results showed 21.85 Mt decrease. In Kazakhstan case there is also reduction effect of CO_2 emissions and it is dominant. Nigeria's authors mentioned that in their case this means that new process and new technologies and new equipment which can be used by electricity generating facilities assist in the reduction of the CO2 emissions. We can assume that Nigeria use less amount of electricity to develop its economic growth which we reject to accept as explained in the Decomposition result.

The economic activity effect ΔGDP in Kazakhstan increase in CO_2 emission at 3.22 Mt (accumulated) and China increased the emission of CO_2 emissions to 2256.75 Mt (accumulated) while Nigeria recorded 28.27 Mt (accumulated). This implies that CO_2 emissions and electricity generation is closely linked to economic development in China but not in Nigeria since the supply of electricity from the national utility grid is not sufficient to foster economic growth which has caused both the manufacturing, service and residential sectors to depend heavily on private generating plants. Table 3.7 gives a summary of the comparison between Kazakhstan, Nigeria and China by showing the highest effect in these countries.

4.11. Conclusion and Policy Implication

The purpose of this study comes from the goal of electricity development which is adopted by government and had provided in Green Economy concept. The analysis of past pattern of CO_2 emissions from power industry giving us opportunity to see exactly activities in the past which we can avoid in the future.

Since, considering period was divided for three parts, and aimed more clear description of each period and factors which affected to CO_2 emissions decreases or increases.

In first period the highest decrease giving economic activity GDP and the highest increases giving electricity generation efficiency effect EGEF which is means that this period had some economic downturn and there are needs in an electricity capacity. At the same time, it was our formation of the country, and almost all power plants was built in the country during Soviet Union, because only after 2008 year Kazakhstan start actively to introduce new capacity of electricity with more newest technology in power industry.

The second period, has the highest decrease is electricity intensity and the highest increase was economic activity, in this case we can conclude that since economic growth as a rule plays a role in CO_2 emissions, then the government has to be attentive to use the leverage for reducing CO_2 emissions, even the electricity intensity not giving high importance.

In a third period all factors have increased in CO_2 emissions, which means that this period more focused on quantities achievement of economic factors the development of the electricity industry than qualities indicators of this sector, but it might be only assumption, since this period also has some effort from the Government as a creating plans for modernization of many power plants with increasing of capacity.

Table 4.11. Decomposition analysis from all three period (accumulated)

Three Parts	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP
1990-2000	**↑0.66**	**↓-0.65**	**↓-0.23**	**↓-0.26**	**↓-0.72**
2000-2008	**↓-1.00**	**↑0.27**	**↑0.36**	**↓-3.17**	**↑4.08**
2008-2016	**0.04↑**	**0.10↑**	**0.45↑**	**0.33↑**	**↑0.00**

If compare all three periods as summary of this result, we can observe that electricity intensity effect **ΔEI** has initial decreases into two periods from 1990–2000 and from 2000–2008, both considered periods shown a reduction in CO_2 emissions, but we cannot say that this is also associated with the use of new technologies as in a Nigeria and China cases, and the transition of some power plants to gas, although cannot give this kind of result in Kazakhstan case. Regarding this result we can assume that before 2000 there were decreases in electricity consumption and production, and from 2000 until 2008 there was a steady increase in electricity consumption with dynamics on average 5% per year. At the same time, an annual GDP growth of 9%, and the average increase in domestic energy consumption was at least 5– 6% and the maximum amount of electricity generation at that time of power plants equipment's operating capacity in Kazakhstan was on the contrary limited to 73–74 billion kWh / year, that means that electricity intensity has a small amount and it gave small changes in CO_2 increases. Also the new capacities were introduced after 2008 which is might affect as increases in CO_2 emissions in Kazakhstan, which can explain the increases of electricity intensity effect in CO_2 emissions in third considering period.

At the same time, the economic activity factor changes effect **ΔGDP** has the highest decreases at -0.72 of CO_2 emissions in a first period and the highest increases 4.08 in a second period but in the last period there is no significant value. As we know, CO_2 emissions from electricity sector is closely connected to economic growth, which might affect on more electricity consumption and it is driving some increases of new capacity, and commissioning new power plants but its depend also from the electricity generation structure. This kind of result not a common for developed countries, according their economic situation, they can achieve more electricity without any harmful affect into environment.

The thermal power structure effect **ΔSEG** has small changes of increasing in CO_2 emissions in a last two considering period, and this amount showing even we have big dependency from coal. However, Green Economy concept, considering to use coal fuel type as long as we can. Some policy implication in government should be more strictly in case of using coal fuel, or at least to change to the gas has to be by force and more attentive. If the government will keep providing to develop Green Economy in Kazakhstan, then it is necessary to learn commercially technology for the production of liquid fuel from coal and gasification by the underground method, to introduce environmentally friendly coal combustion in the electric power industry, and also to learn new ways of transporting coal over long distances, including sea transport. Technological convergence of the physical and technical characteristics of coal and liquid fuels will contribute to the creation of coal-oil or coal-water pulp, which can be transported and burned like oil. We can also to suggest to start use coal an efficient way through increasing share of raw washed coal and promote domestic use of coal briquette might be the more harmless way for reducing CO2 emissions from electricity generation. At the same time, to popularization a shift of economic structure to the less electricity intensive services and a change of product mix toward high value-added products might be helpful for reduction of CO2 emissions.

To determine more specific measures and recommendations, based on the results obtained, the following can be identified:

- It is necessary to identify promising areas for the development of low-carbon technologies for the energy production and the energy consumption sector.
- Solving the problems of reducing emissions from coal-fired TPPs requires an integrated approach that combines the introduction of energy-saving technologies, the use of highly efficient technologies for producing electric energy at coal-fired TPPs, as well as the

widespread use of carbon dioxide capture and storage technologies at power plants - CCS technologies.

- 80% of worn-out electrical networks is a threat that makes energy supply unpredictable. Reconstruction of electric networks is necessary, since a high level of wear of electric networks is an increase in accident rate and the inability to connect new subscribers. This is the damage that sooner or later will hit the pockets of consumers and the state budget, which is able to correct the situation before it is too late.

Our results, in turn, are based on the generation of electricity by coal and gas, and unfortunately the transition to gas may not give the desired result, since a change in various factors of the economic structure of the electric power industry in one way or another gives more increases of CO_2 emissions than reduction. Since CO_2 emissions per unit of coal energy used are several times higher than for natural gas and fuel oil, large-scale development of coal energy will make a major contribution to the growth of global carbon emissions. Over a 60-year operation period, new coal-fired power plants can emit as much CO_2 emissions into the atmosphere as was released during the combustion of coal since the start of the industrial revolution.

Chapter 5

Third essay: Analysis of Barriers to Renewable Energy Development in Kazakhstan

5.1. Introduction

Today, renewable energy is being actively developed in the Republic of Kazakhstan. It should be noted that even before gaining independence, Kazakhstan knew about hydroelectric power plants and even if the percentage of energy produced is negligible even today, we were among the first to show initiative in the development of green energy on the world market. However, a country with a huge potential for renewable energy also has huge energy reserves, which will be destructive for our economy. In pursuit of the trend and preservation of the environment, we can upset the existing balance in our sustainable development. Nevertheless, the development of renewable energy is a long-term perspective, to which Kazakhstan is ready up to 2050. What is Kazakhstan preparing for, why we set such ambitious goals and what barriers the country faces for the development of the renewable energy sector, these are the questions that will be studied in this section of the dissertation through the AHP making decision methodology. This essay consists of 10 sections. From 5.1 - 5.2 contain information on the current state of the renewable energy sector in Kazakhstan. From 5.3- 5.8 is purpose of study, research question and methodology and sections from 5.9 - 5.10 is the results of this study and conclusion of research.

5.2. Renewable energy in Kazakhstan

Needs for the formation of a new energy model, diversification of power industry technology base and fills the energy deficit or to find solution of environmental problems caused the development and improvement of renewable energy in Kazakhstan. Many of the alternative energy sources are the complex of energy components that let you receive and non-fuel products, widely used in chemicals, building industry, agriculture, metallurgy, and others. The resources of these types of energy are great. The main superiority of renewable energy - inexhaustible and ecological clean energy. Their use does not bring the energy imbalance of the planet. This characteristic caused the rapid development of renewable energy resources and has positive forecasts of their growth in the next decade. Renewable energy has a role in solving an important three huge targets which are facing humanity nowadays: energy, environment, and food.

Factors contributing to the development of renewable energy are:

- Energy security;
- Preserving the environment and ensuring ecological safety;
- The conquest of the world's renewable energy markets, particularly in developing countries.
- Preservation of stocks of own energy resources for the future generations.

The development of renewable energy in Kazakhstan is important because there is a huge potential in the geographical and meteorological point of view, in particular, hydropower and wind power. But, unfortunately, the potential is not yet fully harnessed. In 2017 renewable energy represent only about 1% of the energy balance of Kazakhstan, nowadays it’s about 2%. One of the target indicators "green economy" in the energy sector is a growth in the share of alternative sources of electricity production.

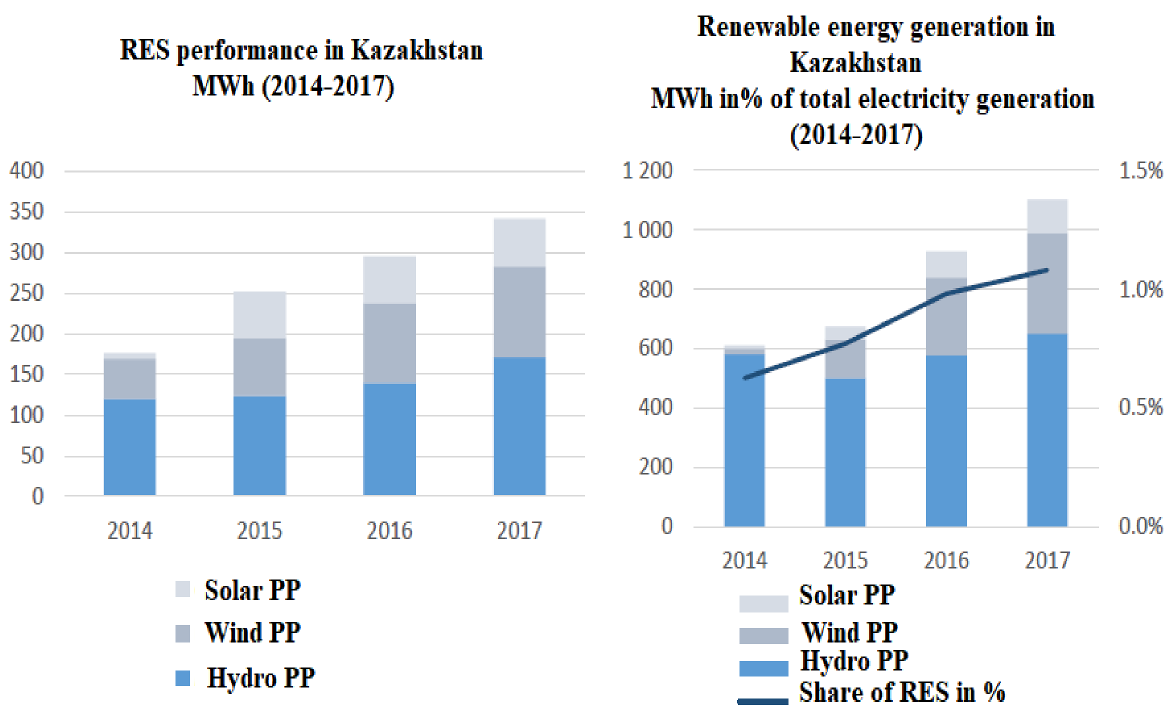

Figure 5.1. Share of RES in Kazakhstan

Source: Annual report from Ministry of energy (2017)

Today, in the Kazakhstan of strengthening legislative support for renewable energy development. According to enforcement of the 2013 Law "On the support of renewable sources of energy" from July 9, 2009 the renewable energy sector received new impetus in its development. System measures of state support of RES in Kazakhstan aimed at improving the legal environment for investors, enhancing the attractiveness of the sector, and implemented through the development and improvement of the regulatory framework. In 2014 was established Settlement and Financial Center (hereinafter SFC) to support renewable energy in Kazakhstan, ensuring the centralized purchase and sale of electrical energy produced by the use of renewable energy facilities. Each year, an increasing number of renewable energy facilities, in addition, Kazakhstan has ratified the statute of the International Renewable Energy Agency (IRENA), thus becoming a full member of this organization**.**

Kazakhstan, as a country aiming at joining 30 developed countries of the world, adopted the program “Strategy Kazakhstan-2050”, where the first President Nazarbayev N.A. took the task for develop RES, which by 2050 should account for at least half of the total energy consumption”.

In general, the development of renewable energy is based primarily on the principle of sustainable development of the government. Sustainable development of society is based on the production of consumer goods and their means of production for sustainable and affordable goals. The increase in the production of such goods leads to an increase in the welfare of society. Production of better and qualitative goods and services, then the demand of market becoming greater , which allows such industries not only to create economic benefits, but also to create jobs and bring profit to shareholders and investors. Thus, sustainable development plays an important social and economic role as a source of maintenance and enhancement of material and social capital, allowing to successfully increase the human capital of society to fully meet current needs, without compromising the standard of living and ensuring the needs of future generations.

Sustainable development based on using of RES and alternative energy. Kazakhstan can achieve sustainability of economic development not only by producing clean electricity, which is a consumer product with high added value, but also to create permanent and highly skilled jobs in the construction, electrical, engineering and energy industries. The great potential of RES, located in Kazakhstan, will not only provide clean and renewable energy to the resource-deficient regions of the country, but also send its surplus to diversify exports with non-commodity mass goods.

If mass production of renewable energy is achieved at affordable prices, the following beneficial effects will be achieved:

1) Sustainable sales at affordable and stable prices,

2) Favorable effect for the social and economic development of the country,

3) Generation of sustainable profits,

4) Creation of new jobs and industries,

5) Preservation of the purity of the environment,

6) Conservation of non-renewable energy sources for the needs of future generations.

5.2.1. Strategy and target indicators of RES development.

In 2012, the Government of the Republic of Kazakhstan adopted the Strategy "Kazakhstan-2050", which sets a policy direction of long-term economic development in the country. In May 2013, the “Concept for the transition of the Republic of Kazakhstan to a“ Green economy” was adopted with scale goals, according to which by 2050 the structure of generating capacity by 50% should be consist of alternative energy sources against coal and oil, but including gas, nuclear and RES. The Government of the Republic of Kazakhstan plans to achieve this by phasing out aging infrastructure, expanding the use of “alternative” fuels, installing energy-efficient equipment, and adhering to strict environmental standards. Thus, the Concept of the transition to a "Green economy" sets the following strategic goals for the development of renewable energy in Kazakhstan:

✓ 3% share of RES in the total electricity production by 2020;

✓ 30% share of RES in total electricity production by 2030;

✓ 50% share of low carbon alternative and RES.

According to the strategic plan development of the Republic of Kazakhstan until 2025, which was approved by Decree of the first President of the Republic of Kazakhstan and dated February 15, 2018 № 636, set a target indicator to achieve a 6% share in renewable energy from the total electricity production by 2025. The Order of the Minister of Energy of the Republic of Kazakhstan dated of November 7, 2016, № 478 was approved the Target Indicators of the RES sector development until 2020, with the overall goal to increase of the total installed capacity of facilities of RES to 1,700 MW by 2020 (3%).

Table 5.1. Target indicators of RES development

№	The name of indicators	Number of indicators
1	The share of electricity generated by facilities for the use of renewable energy in the total volume of electricity generation until 2020.	3%
2	The total installed capacity of facilities for the use of RES until 2020, including:	1700 MWT
3	Wind power plant	933 MWT
4	Solar power plants using photovoltaic solar energy converters	467 MWT
5	Hydro power plants	290 MWT
6	Biogas plants	10 MWT

In order to successfully develop renewable energy in Kazakhstan, According to the plan, for develop RES in Kazakhstan in the light of international experience, in 2013, amendments and additions were made to the Law of the Republic of Kazakhstan on support for renewable energy. We have to note that Kazakhstan open for discussing any problems regarding to get success in this sector and making changes in a legislation has to bring they must bear fruit. Thus, in accordance with the Law of the Republic of Kazakhstan dated July 4, 2013 № 128-V "On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on Supporting the Use of RES" the purchase and sale of electric energy produced by facilities for the use of RES and supplied to the electrical networks of the unified electric power system of the Republic of Kazakhstan. Later, by the Resolution of the Government of the Republic of Kazakhstan № 1281 dated November 29, 2013, the FSC was determined as a SFC for the support of RES. Decree №. 645 of the Government of the Republic of Kazakhstan of June 12, 2014 fixed tariffs for a period of 15 years. In July 2017, the

Law on Supporting Renewables was amended and the auction bidding mechanism for the selection of renewable energy projects was introduced. Marginal auction prices for auction trading were set at fixed rates.

5.2.2. Definition of Renewable energy

According to the article 1 of the Law of the Republic of Kazakhstan “On Support of renewable energy”, the renewable energy sources are energy sources that are continuously renewed due to naturally occurring natural processes, including the following types: solar energy, wind energy, hydrodynamic water energy; geothermal energy: heat of the soil, groundwater, rivers, reservoirs, as well as anthropogenic sources of primary energy resources: biomass, biogas and other fuels from organic waste used for the production of electrical and (or) thermal energy.

Wind Energy

In Kazakhstan, has a most significant wind potential among the all RES. About 50% of the territory of Kazakhstan has a wind speed of 4-5 m / s at an altitude of 30 m. The highest wind potential exists in the Caspian Sea region, where the Atyrau and Mangistau regions, as well as in North and South Kazakhstan. According to the concept of the development of the fuel and energy complex of the Republic of Kazakhstan until 2030, Kazakhstan’s wind potential is 1,820 billion kWh per year. According of this analyze which was made by UNDP as part of the GEF project in 2007, an Atlas of wind resources of Kazakhstan was developed.

Hydropower

Hydropower is the second largest source of electricity production in Kazakhstan, which, according to 2017, accounts for about 10.9% of Kazakhstan’s total generating capacity. Among the CIS countries in absolute terms of potential hydro resources Kazakhstan taking the third rank. The hydropower potential of Kazakhstan is counted at about 170 billion kWh per year, technically feasible – 62 billion kWh. The hydraulic potential of medium and large rivers is 55 billion kWh, small rivers - 7.6 billion kWh per year. Meanwhile, technically possible to use the potential of small hydropower plants is about 8 billion kWh. Hydropower resources are distributed throughout the country, but among them there are three particularly large areas: the Irtysh River Basin with major tributaries (Bukhtarma, Uba, Ulba, Kurchum, Karzhil), the Southeast Zone with the Ili River Basin and the South Zone - Syrdarya River Basins, Talas and Chu. According to data for 2017, electricity generation from small hydropower plants amounted to 649 million kWh.

Solar energy

Solar energy has great potential in Kazakhstan. According to the Concept of development of the fuel and energy complex of the Republic of Kazakhstan until 2030, the potential of solar energy is about 2.5 billion kWh per year, the number of sundials is 2,200–3,000 hours per year (2,500–3,000 hours per year in the southern regions) of 8,760.

Geothermal sources

Kazakhstan is also potentially rich in geothermal resources. The reserves of hydro - geothermal resources in Kazakhstan with temperatures ranging from 40 ° C to more than 100 ° C are estimated to be 10.275 billion m^3 of water and 680 billion GCal of heat, which is equivalent to 97 billion tons of fuel equivalent or 2.8 billion TJ, which is comparable with the resources of traditional fuel sources of heat. For comparison: the forecasted reserves of hydrocarbon raw materials in Kazakhstan are about 12 billion tons of oil and condensate (17.2 billion tons of fuel equivalent) and about 6-8 trillion cubic meters of gas (7-9.2 billion tons of fuel equivalent). The total geological reserves and projected coal resources in the republic are estimated at 150 billion tons (101.0 billion tons of fuel equivalent). Geothermal sources are mainly located in Western Kazakhstan - 75.9%, in South Kazakhstan they are 15.6%, and in Central Kazakhstan - 5.3%. The most promising for the recovery of thermal energy groundwater with mineralization up to 3 g / dm3 with temperatures up to 70-100 °C are artesian basins of South and South-East Kazakhstan: Arys, Almaty and Zharkent.

Biomass

Kazakhstan is a major producer of grain and other agricultural products, which indicates a significant amount of waste and residues produced, and therefore, Kazakhstan has significant amounts of waste available, especially for crops, manure and municipal solid waste. The largest volumes of mixed types of agricultural waste are available in Almaty, East Kazakhstan, Zhambyl, Kostanay, Akmola and Karaganda regions. A stable source of biomass for energy production in Kazakhstan is animal waste products. However, data on total and available waste volumes and their geographical location are not available, waste and residues are rarely used productively, for example, as a raw material for bioenergy projects. Currently, the European Bank for Reconstruction and Development is implementing a project on bioenergy potential assessment.

Table 5.2. Potential of RES in Kazakhstan

RES type	kWh/year
Wind energy	920 billion kWh / year;
Hydro energy	62 billion kWh / year;
Solar energy	2,5 billion kWh / year;
Thermal potential of geothermal waters	4.3 GW[4].

5.2.3. Government support to investment in the development of renewable energy

In order to attract private investment in the renewable energy sector in the Republic of Kazakhstan, the Law on Supporting Renewables provides for the following investor support measures:

- ✓ The single purchaser of electricity from RES is the FSC established at the Kazakhstan Electricity Grid Operating Company KEGOC JSC;
- ✓ Investors are guaranteed the purchase of the whole amount of renewable energy at auction prices for 15 years when concluding a purchase agreement with SFC for support of renewable energy sources;

[4] Government Decree of the Republic of Kazakhstan dated June 28, 2014 No. 724 “On approval of the Concept for the development of the fuel and energy complex of the Republic of Kazakhstan until 2030”

- ✓ Auction prices are subject to annual indexation, starting from the second year of electricity generation: 70% of the change in the exchange rate of the national currency to convertible currencies and 30% on the consumer price index;
- ✓ Producers of renewable energy are exempt from payment of services for the transmission of electricity from renewable energy;
- ✓ Financial settlement of imbalances from RES is carried out by the SFC;
- ✓ RES producers are provided with priority dispatching when transmitting electrical energy;
- ✓ The energy transfer organization does not have the right to refuse to connect the RES facility due to the unavailability of the network;
- ✓ Expenses for reconstruction and expansion of the network are borne by the energy transfer organization;
- ✓ Land plots and grid connection points are reserved for conducting auctions for the selection of renewable energy projects;
- ✓ Legislation provides investment preferences.

Investment preferences

The State investment support questions are regulated by the Ministry of Investment and Development of the Republic of Kazakhstan. The issues of state support stimulate investment in the creation of new, increases and renewal of current situation in industry is to make a acceptable investment climate for the development of the economy and using modern technologies and advanced training for experts in energy field. Government support for investment is to ensure state preferences. Investment preferences are the ensure of a targeted nature provided regarding legislation of the Republic of Kazakhstan to legal entities of the Republic of Kazakhstan implementing an investment project and leasing companies importing technological equipment's based of a financial leasing agreement for a legal entity of the Republic of Kazakhstan which are implementing an investment project. Investment preferences provides of categories of investment projects according to the Business Code of the Republic of Kazakhstan. In this regard, provides preferences for the following categories of investment projects are investment project, investment priority project and special investment project.

The investment project is a activities set of involving investments in the creation of new or expansion and (or) renewal of existing industries, including created and expanded and (or) updated during the implementation of a public-private partnership projects and concession project.

Investment priority project has same definition as investment project. So, there are two explanations about the investment projects:

1. New productions providing for a legal entity to invest in the construction of new production facilities (factory, workshop) in the amount of at least two million times the monthly calculated indicator established by the law on the republican budget and valid at the date of application for investment preferences;
2. Expansion and (or) updating of existing operations, providing for a legal entity to make investments in the amount of at least five million times the monthly calculated indicator established according to the legislation on the republican budget and valid on the date of filing application to get investment preferences to change fixed assets, including renewal (renovation, reconstruction, modernization) of existing production facilities that produce products.

The investment priority project for the creation of new industries or the expansion and (or) updating of existing industries is carried out by a legal entity for certain priority activities, the list of which is accepted by the Government of the Republic of Kazakhstan. A special investment project is an investment project implemented by a legal entity of the Republic of Kazakhstan registered as a member of a special economic zone or a free warehouse owner in accordance with the customs legislation of the Republic of Kazakhstan. Also it might be a project which is implemented by a legal entity of the Republic of Kazakhstan that has entered industrial assembly of motor vehicles. The types of investment preferences according to the article 283 of the Business Code of the Republic of Kazakhstan, there are:

Investment project (including an investment priority project) includes an exemption from customs duties, value added tax on imports and State in-kind grants - the maximum size of the state in-kind grant is no more than 30% of the volume of investments in fixed assets (land, buildings, structures, cars and equipment, computer equipment, measuring and regulating devices, vehicles (except for passenger cars), production and household equipment).

Investment priority project: we have a tax preferences (corporate income tax, land tax and property tax), exemption from customs duties and state in-kind grants.

Special investment project we have preferences as tax exemption (corporate income tax, land tax, property tax).

In investment projects, investors must specify the entire list of imported equipment. In accordance with the Decree of the Government of the Republic of Kazakhstan dated January 14, 2016 No. 13, the production of electricity and gaseous fuel is included in the List of priority activities for the implementation of investment projects. In this regard, renewable energy projects fall under the category of investment projects, within the framework of which investors are granted the following investment preferences:

- Exemption from customs duties means that importing technological equipment and its components for the term of the investment contract, but not more than 5 years from the date of registration of the investment contract and when importing spare parts for process equipment, raw materials and supplies for a period of up to 5 years, depending on the volume of investments in fixed assets and in case the investment project complies with the list of priority activities;
- Exemption from value added tax on imports, provided that, raw materials and supplies which going to use according investment projects included in the Order of the Minister for Investments and Development of the Republic of Kazakhstan of February 27, 2018 No. 140. import of raw materials and supplies is documented by the customs legislation of the Eurasian Economic Union and / or customs legislation of the Republic of Kazakhstan and imported raw materials and / or supplies will be used exclusively in the implementation of activities under the investment contract;
- State in-kind grants (land, buildings, structures, cars and equipment, computers, measuring and regulating devices, vehicles). The size of the state in-kind grant should not exceed 30% of the volume of investments in fixed assets;

In order to receive investment preferences, a legal entity of the Republic of Kazakhstan submits to the Ministry of the foreign affairs Republic of Kazakhstan and to the Investment Committee of the Ministry for Investments an application for the provision of investment preferences.

Auction bidding

The auction bidding mechanism for the selection of renewable energy projects was introduced by the Law of the Republic of Kazakhstan No. 89-VI 3PK dated 07.11.2017 "On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on Electric Power Issues", through which norms on auctions were introduced into the Law of the Republic of

Kazakhstan about supporting renewable energy. The main purpose of implementing the auction mechanism is the selection of the most efficient renewable energy projects and the formation of market competitive prices for electricity generation by renewable energy facilities. Auction bidding is a process which organized and conducted by the bidding organizer in an electronic system based on an auction and aimed at selecting projects for the construction of renewable energy facilities and determining the auction prices of electrical energy, taking into account of the plan for the deployment of renewable energy facilities. The main objectives of the auction system for supporting renewable energy in Kazakhstan are:

✓ achievement of target indicators for the development of renewable energy;

✓ reducing the impact of the RES sector on the growth of end-user tariffs;

✓ ensuring of planned development of the renewable energy sector, taking into account the capabilities of the unified power system of the Republic of Kazakhstan;

✓ transparent procedure for the selection of renewable energy projects.

In 2017 of December, by the command No. 466 of the Minister of Energy of the Republic of Kazakhstan was approved "The Rules for the organization and conduct of auction bidding, including qualification requirements for auction participants, the content and procedure for submitting an application, types of financial security for applications for participation in the auction and conditions for their entry and return order of summing up and determining the winners".

5.2.4. Legislative framework

Considering Kazakhstan’s plans for the development of renewable energy in the long term period, renewable energy of electricity should be a substitute for natural resources, as well as provide a reduction in the cost of energy supply, transportation of energy and the resolution of environmental problems.

In accordance with the legislation of the Republic of Kazakhstan, RES include, inter alia, wind and solar energy, hydrodynamic energy of water, geothermal energy (ground heat, groundwater, rivers, reservoirs), and anthropogenic sources of major primary energy resources and etc. From the point of view of security, the most suitable types of alternative energy sources necessary conditions for its production are wind, solar and hydropower. With this promise

Kazakhstan has formation on a new political course on the country's transition to a “green” path of development.

One of the priorities for the development of a “Green Economy” is the development of renewable energy and by 2020 it was entrusted to provide a 3% share in the total electricity, which is still an ambitious task. In this regard, a number of regulations were adopted, aimed at imparting a certain order in the field of energy supply using RES.

At the same time, many of the existing legal acts contain significant flaws of a legal technical and conceptual nature, and also do not take into account the accumulated successful experience of foreign countries. At the same time, legal regulation has also made positive changes through legislative changes, for example, the abolition of licensing for such activities as production, transmission and distribution of electric and thermal energy, operation of power plants, power grids and substations, and the use of RES.

As previously mentioned, in 2009 Kazakhstan adopted first legislation initiatives for the supporting of renewable energy development. In 2009 was approved the law “On Supporting the Use of RES”, aimed at supporting the use of renewable sources in the production of heat and electricity. Some questions in the field of renewable energy use are regulated by other legislation such as the Land Code, the Water Code, the Code of Administrative Offences and the Law on Natural Monopolies. A separate law regulates issues arising in the field of biofuel production and trafficking. In addition, there are some regulations that govern certain questions on the use of renewable energy.

In 2013, the mechanism of government support for the renewable energy sector was launched, which is based on a centralized guaranteed purchase of all electricity which is produced by RES at fixed tariffs. However, as a result, the government changed this strategy in favor of holding an auction(bidding mechanism), that was accepted and starting from 2017, there is a form of bidding mechanism, when the government announce generation capacities that the general power system is ready to accept from renewable sources, and investors offer their tariffs and the desired location of projects. As a result, a first auction was held, where the government determines itself where to build RES, and all participants compete in the offer of a smaller tariff at a particular site.

Nowadays Kazakhstan has several legislations in renewable energy sector which are regulating all relations between participants of renewable energy projects:

- **№165 2009.07.04** The Law of the Republic of Kazakhstan "On Supporting the Use of

Renewable Energy Sources".

- **№271 2014.03.27** Government decree "On approval of the Rules for determining fixed tariffs and marginal auction prices".
- **№645 2014.06.12** Government Decree of the Republic of Kazakhstan "On approval of fixed tariffs".
- **№419 2014.04.29** Government Decree of the Republic of Kazakhstan "On approval of tariffs not exceeding the level of the selling price which are established in the approved and agreed with the authorized local executive organization of the feasibility proofs of the project construction of a facility on RES using, and validity of term accordance to the feasibility proofs organizations which using of RES".
- **№644 2014.06.12** Government Decree "On Approval of a Fixed Tariff for Solar Power Plants Projects Using Kazakhstan Silicon Photovoltaic Modules (Kaz PV) to Transform Solar Energy".
- **№478 2016.11.07** Order of the Minister of Energy of the Republic of Kazakhstan "On approval of target indicators for the development of the renewable energy sector".

Table 5.3. Order defines targets for the development of the RES sector

No.	The name of indicators	Indicators
1	The share of electricity generated by facilities for the use of renewable energy sources in the total electricity production until 2020.	3%
2	The total installed capacity of facilities for the use of renewable energy sources until 2020, including:	1700 MWt
I.	Wind Power plants	933 MWt
II.	Solar power plants using photovoltaic solar energy converters	467 MWt
III.	Hydro Power plants	290 MWt
IV.	Biogas plants	10 MWt

- **№466 2017.12.21** Order of the Minister of Energy "On approval of the Rules for the organization and conduct of auction bidding, including qualification requirements for auction participants, the content and procedure for submitting an application, types of financial security for an application for participation in the auction and conditions for their entry and return, procedure for summing up and determining the winners”.
- **№345 2016.07.27** Order of the Acting Minister of Energy "On approval of the Rules for the formation of a plan for the placement of objects for the use of renewable energy sources."
- **№343 2016.07.27** Order of the Acting Minister of Energy "On approval of a model agreement on the connection of objects for the use of renewable energy sources, as well as the rules for its conclusion."
- **№482 2016.11.09** Order of the Minister of Energy "On approval of the Rules for the formation of the list of energy-producing organizations using renewable energy sources".
- **№361 2016.07.29** Order of the Acting Minister of Energy "On approval of the Rules for the formation and use of the reserve fund."
- **№164 2015.03.02** Order of the Minister of Energy “On Approval of the Rules of Centralized Purchase and Sale of electricity by the Financial Settlement Center (hereinafter FSC) which is produced by Objects of Renewable Energy Sources, Recalculation and Redistribution of FSC of the Eligible Share of Electricity to the Qualified Conditional Consumer by the End of the Calendar Year”.
- **№480 2017.12.28** Order of the Minister of Energy "On approval of standard forms of contracts of a FSC with energy producing organizations using renewable energy sources, with consumers and qualified conditional consumers"
- **№117 2015.02.20** Order of the Minister of Energy “On Approval of the Rules for Determining the Nearest Point of Connection to Electric or Thermal Networks and Connection of Facilities for the Use of Renewable Energy Sources”.
- **№210 2014.12.18** Order of the Minister of Energy "On approval of Grid rules"
- **№309 2016.07.08** Order of the Minister of Energy of the Republic of Kazakhstan "On approval of the Rules for the sale and purchase of electricity from net consumers".
- **№161 2014.11.28** Order of the Minister of Energy "On approval of the Rules for providing targeted assistance to individual consumers."
- **№247 2015.03.30** Order of the Minister of Energy of the Republic of Kazakhstan "On

approval of the Rules for the technical operation of power plants and networks."

- **№ 118 2015.02.20** Order of the Minister of Energy "On approval of the rules for determining the tariff for support of renewable energy sources."
- **№ 588 2004.07.09** The Law of the Republic of Kazakhstan “On Electric Power Industry”.

5.3. Purpose of study

In accordance with the Order of the Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan for the period from 2017–2021, dated December 28, 2016 No. 571, RES has priority for development. In this connection, the Ministry of Energy of Kazakhstan in order to ensure the planned development of renewable energy and eliminate the risks of oversaturation of renewable energy in the country considers it necessary to take restrictive measures in terms of renewable energy development in the long term in an amount not exceeding 3% in the total electricity production by 2020 % by 2030 in accordance with the Concept on the transition of the Republic of Kazakhstan to a "green economy", including by types of RES, and taking into account the integration of RES without damage to the sustainable work of the Unified Energy System of Kazakhstan. Based on this order, it is clear that there are clear measures that should not be achieved by more than 3% by 2020. However, there is a need to stimulate the development of the renewable energy sector through the development of additional legislative support measures that can positively affect the investment attractiveness of projects in renewables and to attract foreign investment. In addition, during the transition of the Republic of Kazakhstan to a low-carbon development and "green economy", when choosing a low-carbon development path, the initial national conditions should be taken into account, gradually combining them with global development trends. According to the Ministry of Energy, low-carbon development should be considered as part of the national strategic goals of socio-economic development in relation to improving energy efficiency and energy saving and as the essence of medium-term and long-term development. This should gradually lead from a reduction in the growth rate of greenhouse gas emissions, to their gradual reduction, while maintaining a high economic growth rate. However, some experts believe that the share of renewable energy should not exceed 40% in the total energy balance of the country, while it is necessary to clearly define the location of each source, otherwise you need to build very large backup capacities network. Developing countries still in a stage of considering RES as a new technology, in our case except hydro energy which was start to develop during Soviet Union era.

Development of renewable energy has been focused in developed nations, however, in under developing countries the RES still considered as a new technology.

The motivation of this research is to determine the main reason for the develop of renewable energy, to help make decision in this field and to plan more accurate ongoing steps for policy makers or investors, since even Kazakhstan is the developing country, we have a huge potential and dependence from the natural source which affecting for the GHG emission.

At the same time, government planning to implement RES projects with a small rank, because country's technical opportunity still in low condition. We have a lot of problem as economy, small market with small population (customers).

Previous researchers which had used AHP methodology for identified of countries opportunities in renewable energy fields and determined a lot of different barriers to renewable energy development has considered them individually for the issuance of specific recommendations. As such, this study combined all the identified relevant barriers and ranked them based on the results of the calculation of their meanings in terms of the degree to which they hinder renewable energy development.

Although, this study will help to fill the research gap by listing the identified barriers to renewable energy development in the context of Kazakhstan, considering goals as to identify barriers to renewable energy development in Kazakhstan and to find a general recommendations and policy suggestions for overcoming the major barriers to the development of renewable energy, to ensure the success of the development efforts.

5.4. Research questions

The objective of this research was to the identified barriers of the development renewable energy technologies in Kazakhstan and then to understand what should pay attention to? AHP methodology was the tool that was used for ranking the barriers. The ranking was established by analyzing the views of renewable energy experts that were obtained through a survey. This research assigned meanings to the barriers based on the expert respondents, and coming up with a systematic hierarchy structure.

Based on this motivation and objectives, the following main research questions were adopted in this study.

What are the ranks and weights of criteria and sub-criteria for the development of renewable energy?

Which criterion and sub-criterion might be considered by government for improving policy of renewable energy development?

To obtain the aforementioned objectives of this research, the AHP framework MCDM was used. This approach is a popular for decision-making tool based on subjective judgments. Finally, we can understand what exactly might be solve, what for attention government should pay more carefully during the policy making process in renewable energy field and what exactly we can change in the future to get better results for developing renewable energy and implement renewable energy projects.

5.5. Literature review

Association of Chartered Certified Accountants has given some analysis about the probability of Renewable energy in Kazakhstan. They identified following aspects which is requiring some improvement for development of renewable energy:

- ✓ Securing Capital Security and Respecting Intellectual Property Rights;
- ✓ The lack of technological and design experience for the development and implementation of new technologies;
- ✓ Relations with equipment suppliers;
- ✓ Coordination and planning of risks that may lead to delays in construction and installation;
- ✓ Operation and maintenance in a highly continental climate;
- ✓ Weather and climate risks;
- ✓ The need to enter new markets;
- ✓ Lack of developed infrastructure of power lines;
- ✓ Regulatory risks.

Some of researchers conducted the analysis and identified barriers for the development of renewable energy in Kazakhstan. Nowadays, studies in energy sector in Kazakhstan context are growing. According AHP model we have to identify barriers of Renewable energy developing by search of Literature review and analyze of current situation of renewable energy sector in Kazakhstan. One of the base which is giving opportunity to develop for any sector is the legislation base. The main task of the renewable energy legislation is creation of complex conditions of green technologies development but in Kazakhstan legislators does not always consider the main mechanisms necessary for development of this technology. (Galym B. and et al, 2017)

At the same time, in 2016 almost all renewable energy projects was stopped, and one of the reason is the process of giving the land for foreign company for the construction of power plant, That time the legislation wasn't consider foreigner(non-resident) as owners or tenants of land, and this problem was blocked investors steps. (E. Grinstein, 2017).

However, another problem which investors was noted is not enough capacity in generation network. In accordance with the principle of the KEGOC operator, the network is necessary for the smooth operation of permanent sources, but it is worth noting that the electricity industry of the Republic of Kazakhstan operates on the basis of power industry facilities built in the Soviet Union years.

Next problem which investors are considering, as well as the creditworthiness of the FSC to support RES, in case the of a shortage of money. (World Bank, 2018). In general Kazakhstan trying to create good opportunity for the investors by investment preferences and subsidies and government incentives for companies to invest in renewable technologies range from feed-in tariffs, to investment subsidies, tax credits, portfolio requirements and certificate systems. (Reuter W.H. et al, 2012). How it's working we can realize it only on practice. That's why we chose AHP method to identify barriers from first sources as a policymakers and experts who directly involved in the implementation of renewable energy projects. At the same time some of researcher as (Meixner, 2009) distinguish that this kind analysis it is scientific mainstream within decision making, of qualified MCDM methods going back to Zadeh's argumentation concerning fuzzy sets, first published in 1965 (Zadeh, 1965). One of the popular used method which can handle both group decisions and fuzziness – is the AHP (Saaty, 1980).

Any mechanism which is going to implement might has a lot of difficulties, especially in developing countries and renewable energy not an expectation, it is also new technology which required some awareness in this field.

5.5.1. Literature review of studies based on AHP method

AHP is a popular method in making decision process, another authors considered they are own criteria according of problems in their analyzing of countries sector. Examples which shown in a Table 5.4 or somehow was reviewed gave us some base for our study to use AHP methodology. As we can see different authors have got different academically contribution. S. Ahmad and R. Mat Tahar in (2014) used AHP to analyze various renewable resources potential and for priority renewable options in Malaysia. They considered four major resources, hydropower, solar, wind, biomass (including biogas and municipal solid waste) and based on the analytic hierarchy process (hereinafter, AHP) employs four main criteria, technical, economical, social and environmental aspects, and twelve sub-criteria.

Presented the effective framework and their procedures to create and improve of GSI for renewable energy systems. For deal with the not clear of human cognitive processes in the development of GSI, the AHP method is combined with the fuzzy sets theory. In the AHP questioner users are important to state whether he/she is indifferent to the two attributes or whether he/she has a weak, strict, strong, or very strong preference for one of the considering meanings. Therefore, in generally suggested considering the nine-point intensity scale for pair-wise comparison for express the degrees of preference between three elements.

Table 5.4. Summary of empirical evidence on renewable energy barriers by determine AHP methodology and academically contribution

Name of paper and authors	Main criteria	Sub-criteria (factors/dimensions)	Contribution of study
Analysis of the assessment factors for renewable energy	Technological	Superiority of technology, Completeness of technology, Reliability of technology and operation, Possibility of acquiring original technology.	For the additional to establishing an effective dissemination program of renewable energy technology, for
	Market	Domestic market size and competitiveness Global market size and competitiveness Competitive power of domestic technology	

dissemination program evaluation using fuzzy AHP E. Heo, J.Kima, Kyung-Jin Boo In case of South **Korea** (2010)	Economic	Supply capability, Economic feasibility, Supply durability	which were established the criteria and factors.
	Environmental	Reduction of greenhouse gas and pollutants, Requirement of resources, Acceptability of local residents	
	Policy	Contribution to achieve dissemination goal, Spillover effect, Linkage with R&D program, Influence of existing social system.	
Recognition and prioritization of challenges in growth of solar energy using analytical hierarchy process: **Indian** outlook Sonal Punia Sindhu et. al. (2016)	Institutional	Legislative failures, Lack of coordination between agencies, Lack of R&D culture, Lack of local infrastructure, Uncertain government policies, Lack of specialized courses on RET engineering,	There were identified the main barriers which are found to be the most influential challenge in the growth of solar energy. The sensitivity analysis was performed in order to examine the rank stability of challenges faced by solar industry.
	Technical	Lack of proper standards, Lack of entrepreneur and innovations, Lack of skilled personnel and training institutes, Performance constraint and technology risk, Storage issues, Design and ease of operation	
	Political and Regulatory	Multi tired government approval, Lack of strong political will, Political instability, Lack of experts at decision and policy making level, Regulatory issues.	
	Marketing	Lack of competition, Poor market infrastructure, Small market size, Partnership issues, Lack of solar radiation measuring centers, Splitting of incentives	

	Social Cultural and Behavioral	Lack of awareness, Resistance to new technology, Perceptional problem, Low affordability of weaker sections of the society,	Recommendations for the eradication of the barriers are also suggested.
	Finance	Lack of access to credit/capital, Lack of financing institutions, Budgetary constraints, Lack of financial literacy	
	High Cost of Capital.	High payback period, Solar manufacturing challenges, Cost of balance of system components, O&M (operation and maintenance) cost	
Evaluating the Best Renewable Energy Technology for Sustainable Energy Planning Ozgur Demirtas (2013) Turkey	Technical	Energy Production Capacity, Technological Maturity, Reliability, Safety	The aim of this study is to determine the best renewable energy technology for sustainable energy planning.
	Economical	Investment Cost, Operation and Maintenance Cost, Service Life, Payback Period	
	Environmental	Impact on Ecosystem CO_2 Emissions	
	Social	Social Benefits, Social Acceptability	
Renewable energy technology uptake in **Kazakhstan:**	Market Failure	Highly controlled energy sector; Restricted access to technology; Lack of competition; High transaction costs; Missing market infrastructure; High investment requirements; Fossil fuel subsidies; Trade barriers.	Deploying an AHP methodology to identify the most significant

Policy drivers and barriers in a transitional economy M. Karatayev, et al. (2016)	Economic and Financial	High payback period; Lack of access to capital; Market size small; Lack of access to credit to consumers; Low electricity tariffs; High discount rates; High up-front capital costs for investors; Lack of investor interest from the private sector; Lack of investor interest from the public sector; Lack of financial resources; Lack of instruments.	barriers to uptake of renewable energy in the context of the electricity sector.
	Institutional	Lack of involvement of stakeholders in decision making; Lack of private sector participation; Lack of a legal and regulatory framework; Problems in realizing financial incentives; Long and complicated bureaucratic procedures regarding the issuance of building permits; Lack of expertise and awareness within authorities, especially at the local level; Lack of a stable institutional framework.	
	Technical	Lack of infrastructure; Lack of specialized technology for the needs of Kazakhstan's market; Lack of domestic manufacturing industry PVs/ Wind turbines; Lack of skilled personnel/ raining facilities; Lack of entrepreneurs; Lack of R&D culture; Product not reliable; Inefficient technologies; Lack of experience.	
	Social	Lack of consumer acceptance of the product; Lack of social acceptance for some RETs; Low consumer awareness.	
Selection among renewable energy	Quality of the Energy Source	Sustainability, Durability, Distance to user	The purpose of this work is to develop a selection
	Socio-political	Government policy, Labor impact, Social acceptance	

alternatives based on a fuzzy analytic hierarchy process in **Indonesia** Adek Tasri et. al. (2014)	Economic	Implementation cost, Economic value, Affordability.	methodology and to determine the most appropriate renewable energy sources for electricity generation for Indonesia.
	Technological	Continuity and predictability of the performance, Risk, Local technical knowledge.	
	Environmental	Pollutant emission, Land requirement, Requirement for waste disposal.	
An analysis on barriers to renewable energy development in the context of **Nepal** using AHP Laxman Prasad Ghimire, Yeonbae Kim (2018)	Social Barriers	Lack of Public Awareness, Lack of Consumer Paying Capacity, Lack of Social Acceptance	Estimating and ranking the barriers of renewable energy development in Nepal
	Political and Policy Barriers	Lack of Transparency in Decision Process, Political Instability, Absence of Coherent Renewable, Energy Policy	
	Technical Barriers	Lack of R&D Facility, Unreliable Supply, Risk and Uncertainty, Absence of Grid Connection, Mechanism	
	Economic Barriers	High Capital Cost, Lack of Credit Access, Lack of Sufficient Market Size (Small Market Size), Lack of End Use, Lack of Subsidies/Funds	
	Administrative Barriers	Lack of Skilled Manpower (Human Resource), Lack of Coordination between Authorities, Lack of Institutional Capacity, Delivery Mechanism Complexity	
	Geographical Barriers	Transportation Problem, Scattered Households	
Barriers to renewable/sustainable energy	Economical & Financial	High initial capital cost, Lack of financing mechanism Transmission & distribution losses, Inefficient technology, Lack of subsidies.	Barriers to renewable/sustainable energy

technologies adoption: **Indian** perspective Sunil Luthra et al.(2015)	Market	Lack of consumer awareness to technology, Lack of sufficient market base, Unable to meet electricity power demand alone, Lack of paying capacity.	technologies and investigate the priority ranking stability of barriers to adopt renewable/sustainable technologies in the Indian context.
	Awareness & Information	Need for backup or storage device, Unavailability of solar radiation data, Lack of IT enablement.	
	Technical	Lack of awareness of technology, Less efficiency, Technology complexity, Lack of research & development work, Lack of trained people & training institutes, Lack of local infrastructure, Lack of national infrastructure.	
	Ecological & Geographical	Scarcity of natural & renewable resources, Geographic conditions, Ecological issues.	
	Cultural & Behavioral	Lack of experience, Rehabilitation controversies, Faith & Beliefs.	
	Political & Government Issues	Lack of political commitment, Lack of adequate government policies, Lack of public interest litigations.	
Multi-criteria evaluation of renewable and nuclear resources for electricity generation in **Kazakhstan** Salman Ahmad et. al. (2017)	Technical	Technical maturity, Efficiency, Lead time, Resource availability, grid connectivity,	What is the most appropriate criteria for the non-fossil fuel's energy for Kazakhstan
	Economic	Capital Cost, operational cost, Financial cost,	
	Social	Public acceptance, lob creation,	
	Environmental	Emission. Impact on environment, Land requirement.	

Table 5.4. showing that some authors used the AHP approach to determine most of the suitable meaning in the issues of the study of renewable energy development. In our case, we are considering Kazakhstan context, analyzing current condition for the renewable energy development, and identifying barriers which are affecting on this sector. Until now we have a few studies on the renewable energy field, one of them mentioned in Table 5.4., that was made by Salman Ahmad et. al. (2017). The author analyzed the most important criteria for the non-fossil fuel's energy in Kazakhstan, to find more clear reasons of weak position of renewable energy, we are going to determine the main barriers which are making stuck this sector to develop rapidly.

5.6. Barriers to deployment of renewable energy in Kazakhstan

The current situation of the electricity sector has a lot of weak points, even the World Bank at the end of February 2017[5], had published an analysis of the electricity sector in Kazakhstan. In that report analysis explicitly stated regress of reforms in this industry. They also noted that the Kazakhstan government is not fulfilling its own plans in this direction.

Some experts counted that the Paris agreement has promoted the RES but it just affects on reduction of emissions, not more than this. Thus global trend of the Green Economy is a reduction of emissions, but not the development of renewable energy as a whole or as one of the ways to contribute a reduction of emissions. Since Kazakhstan has a large number of energy reserves, it should be clear that the country's policy is aimed more at engineering solutions for filtering and implementing environmental measures and technologies, upgrading or replacing coal capacities, including through the capacity market mechanism. Of course, the government contribution to the RES sector can lead more significant results, but hardly more beneficial in this situation.

This study is aimed at identifying existing problems in this sector, including identifying specific barriers that are highlighted by experts in the country's energy sector. Previously, we selected a number of criteria based on the literature review and found confirmation of them in others researcher's study, where they considered the same barriers of RES development. (Table 5.5)

[5]M.Aldayarov, I.Dobozi and T.Nikolakakis "Stuck in Transition, Reform Experiences and Challenges Ahead in the Kazakhstan Power Sector", Worldbank Group, 2017.

Table 5.5. Criteria and sub-criteria as barriers of renewable energy development in Kazakhstan and references.

Criteria	Sub- Criteria	References
Socio – Political	Resources Availability	(Nigim et al., 2004; Rumbayan and Nagasaka, 2012)
	Government policy	(Darmani et al., 2014; Gurung et al., 2012; Luthra, Sanjay Kumar, et al., 2015; Singh, 2013; Surendra et al., 2011)
	Social acceptance	(Chatzimouratidis & Pilavachi, 2008; Darmani et al., 2014; J.P. Painuly, 2001; Wang, Jing, Zhang, & Zhao, 2009), L. Prasad Ghimire, Yeonbae Kim 2018
Technical	Lack of infrastructure and transmission system	(Elina Grinshtein, 2017), (S. Luthra, Sanjay Kumar, Dixit Garg , Abid Haleem 2013)
	Lack of sufficient skilled workers	(Amer & Daim, 2011; Brown, 2001; Darmani et al., 2014; Deepak Kumar, 2014; Dulal et al., 2013; Kahraman et al., 2009; Luthra, Sanjay Kumar, et al., 2015; J.P. Painuly, 2001; Singh, 2013; Yadoo & Cruickshank, 2012)
	Unreliable supply and Energy conservation	(Kahraman et al., 2009; Wang et al., 2009), (L. Prasad Ghimire, Yeonbae Kim 2018)
Economic	Commercial incompetitiveness	(Elena Grinshtein, 2017), (S. Luthra, S. Kumar, D. Garg, A. Haleem ,2015)
	Low level of investment	(Wolf Heinrich Reuter, Jana Szolgayová, Sabine Fussa, Michael Obersteinera, 2012) (Gangol, 2014)
	Contractual market	(M. Aldayarov, I. Dobozi, and T. Nikolakakis, 2018)
Rregulative	Unstable legislation	(Galym B. Teleuyev.,2017, Elina Grinshtein, 2017)
	Investment preferences	(K.Govindan, M. Kaliyan, D. Kannan, A.N.Haq, 2014)
	Bidding mechanism	(Malte Gephart., 2017), (Lucy Butler, Karsten Neuhoff 2007),

Table 5.6. Barriers of Renewable Energy Development – Context of Kazakhstan.

Criteria	Sub-criteria's	Description
Socio – Political	Resources Availability	Kazakhstan is among the top ten countries which has a lot of hydrocarbons and mineral resources. It might be reason for the stuck in development of renewable energy. Dependency from energy source means there is no need to develop renewable energy since we have cheaper way to have electricity.
	Government policy	Too ambitious goals for develop renewable energy for the country, which has huge reserves of natural energy resources. The main load on purchasing electricity government put on a coal-fired power plant.
	Social acceptance	Low environmental awareness of the population and lack of consumer acceptance of renewable energy technologies.
Technical	Lack of infrastructure and transmission system	Low developed or deteriorating infrastructure leads to high costs and losses, especially in transmission of electricity.
	Lack of sufficient workers	There is a shortage of qualified personnel and a lack of competence on the part of the authorities;
	Unreliable supply and Energy conservation (Storage issue)	Unstable nature of work is the main problem of RES, that's why the RES might disrupt the operation of power system and call imbalance in supply of electricity.
Economic	Commercial incompetitiveness	Green" energy is expensive compared to traditional energy, and it develops only from government support.
	Low level of investment	During 2020-2024 The annual investment will be required about 1.8% of total GDP.
	Contractual market	According of legislation only one consumer will buy all energy from the RES, it's like a guarantee from the

		government but how come one company financially can handle all sellers.
Rregulative	Unstable legislation	Low legislation and regulatory framework which required to promote renewable energy
	Investment preferences	Subsidies and other incentive tools should be revised to reach more investors and projects
	Bidding mechanism	According to the literature review which are supported by empirical renewable electricity auction examples, some factors can affect the success of an auction and nowadays there is no good or exact examples of auction design.

5.7. Methodology

Analytic Hierarchy Process

The Analytic Hierarchy Process is a structured method which can provide for organizing and analyzing complex decisions and giving the opportunity to determine the relative weights of the decision criteria and the relative priorities of alternatives. We can compare qualitative and quantitative information by using informed judgments to derive weights and priorities.

Nowadays the AHP model is one of the method decision-making analysis, which is developed to overcome of this issue and for to find a compromise decision. Many researchers has used this model because it's simple to use and it has versatility for various fields of study in incorporating various criteria and factors both in quantitative and qualitative data (Sangwook, 2016). First time the AHP method was introduced by (Saaty, 1980) as an effective method for sorting out a complicated decision-making process, through the evaluation of the priority scale of each indicator in order to generate the best way. We can also consider this model as basic methodology for subjective evaluation. Through the AHP we have opportunity to determine the weights through the pairwise comparison of certain criteria. (Ghimire, 2016). At the same time, the AHP method can evaluate criteria and another alternative options.

After to identify all your criteria which has to be analyzed need to work on it step by step.

However from the table below we can understand that AHP model has some weakness point. (Kumar A. et al, 2017)

Table 5.7. AHP description

Methods	**Area of application**	**Steps**	**Weakness**
Analytical hierarchy process (AHP)	1. Determination of objective into a hierarchical tree. 2. Determination of weight of each criterion. 3. Considering of alternative the criteria and calculating a score. 4. Calculation overall score of each alternative criteria.	1. Flexible adoption 2.Easy mathematics 3.Regarding hierarchical structure and each criteria can be more focused and transparent.	1.Interdependency between objectives and alternatives leads to hazardous results. 2. In accordance with the number of respondents, the task of determining the weight of the criterion can be complicated. 3.knowledge of the respondents is needed based on experience.

As some authors like Chatzimouratidis & Pilavachi (2008) has mentioned in AHP model has some importance which has to be considered. It doesn't matter if the hierarchy is going in top-down or bottom-up approach, because the validity of the results depends from availability of information's and the knowledge of level from each of the respondent toward the criteria, factors and alternatives. The evaluation is implementing through the pair-wise comparison, and the elements in the same hierarchical level are compared relative to their importance or contribution to certain criteria.

The first step is to create hierarchical tree structure, in case of Kazakhstan and identified 4 main criteria with 12 sub-criteria, which one are have more importance value we will see in the section of results and discussion.

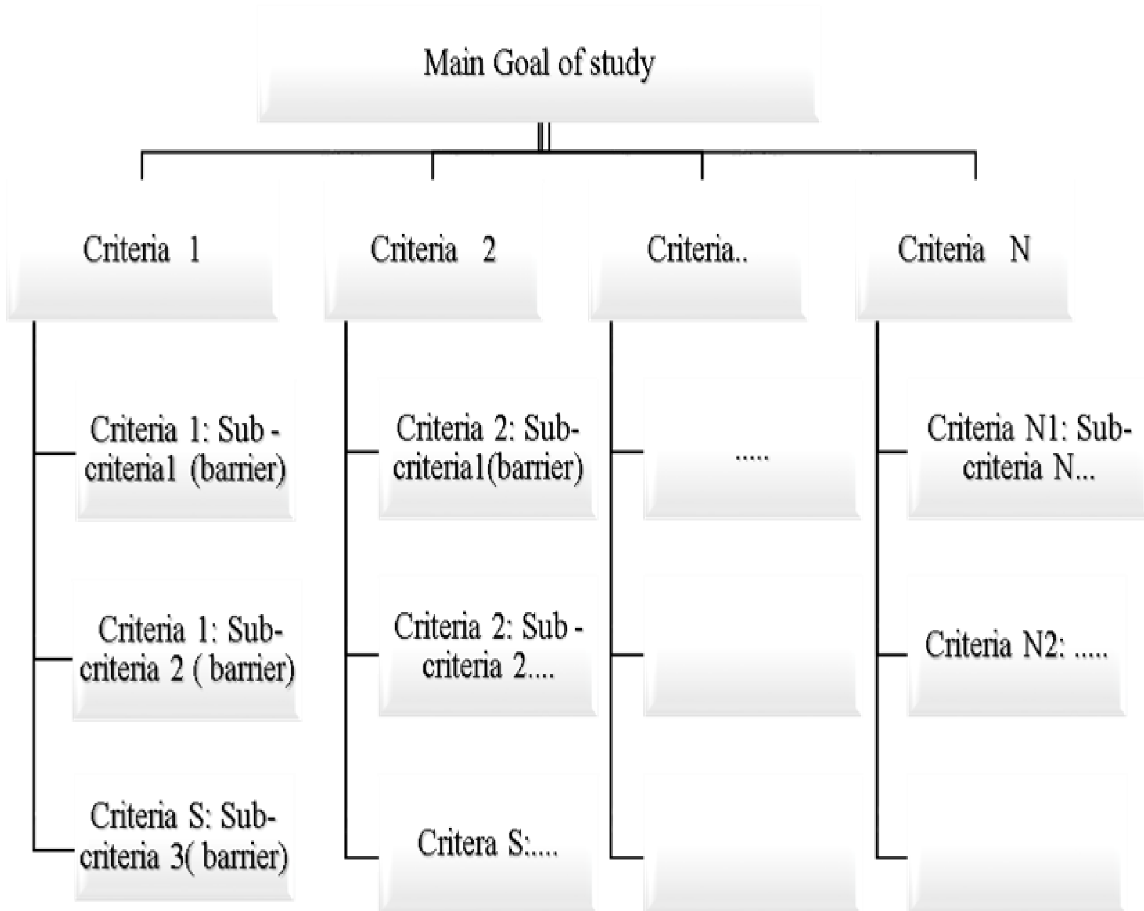

Figure 5.2. Example of formulation of hierarchical tree/Structure

Sources: Reference from (R. W. Saaty,1987; Saaty, 1986, 1990, 1994, 2008; Wind & Saaty, 1980)

Levels of hierarchy structure could be defined as below.

Level 1: Main goal of research is lines in level 1.

Level 2: Based on the goal, number of criteria can be identified. So criteria of barriers of renewable energy development could be listed in level 2.

Level 3: Within each of sub-criteria of barriers, specific barriers could be listed up to n number in each criterion. In each criterion number of barriers may be different. Specific barriers within each criterion may list level 3.

The next stage of analysis in AHP, is the creation of pair-wise questionnaire for Kazakhstan experts in energy/ electricity field to provide their judgments according on the 9 point scale.

Table 5.8. Saaty's scale of relative importance

Scale	Numerical Rating
Extremely Preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1
Intermediate Values	2,4,6,8

According to Saaty (1980) explanation to make qualitative information to the quantitative information is expressed in the numbers of 1 – 9 and literature review of study this methodology shown that Saaty's numerical scale is the most appropriate scale to represent the preference between two alternatives, based on its validity as well as the robustness of the results.(Saaty, 1980, 1991)

After we get the results of these pair-wise comparisons we have to arrange in a comparison matrix. This comparison matrix has the results of all pairwise comparisons between all criteria. The main rule of this matrix is the reciprocal system, and all numbers which are in Table 5.9 have to match the scale of relative importance in Table 5.8.

Table 5.9. Reciprocal system

Criterion	**C1**	**C2**	**C3**	**CN**
C1	1	1/3	3	1
C2	3	1	3	3
C3	1/3	1/3	1	1/3
CN	1	1/3	3	1
SUM	5.33	2	10	5.33

This is how we can obtain the normalized-comparison matrix by using the formula in Eq. (5-1) to make summation each in the matrix to have an amount of 1.

$$\overline{a_{Jk}}=\frac{a_{jk}}{\sum_{l=1}^{m} a_{lk}} \ldots\ldots\ldots\ldots\ldots\ldots.(5-1)$$

Table 5.10. Reciprocal system

Criterion	C1	C2	C3	CN
C1	0.1875	0.1666	0.3000	0.1875
C2	0.5625	0.5000	0.3000	0.5625
C3	0.0625	0.1666	0.1000	0.0625
CN	0.1875	0.1666	0.3000	0.1875
SUM	1	1	1	1

Afterward, we need calculate the normalized eigenvector for each row by using the formula expressed in Eq. (5-2). This normalized eigenvector represents final relative weights of each criterion with respect to the main problem, and final relative weights of each criterion with respect to the following sub-criteria (Saaty, 1980).

$$W_j = \frac{\sum_{l=1}^{m} \overline{a}_{jl}}{m} \qquad (5\text{-}2)$$

Table 5.11. Normalized Eigenvector

Criterion	Normalized Eigenvector or Priority Vector
C1	0.2104
C2	0.4813
C3	0.0979
CN	0.2104
SUM	1

When we get normalized eigenvector we can conclude that within the hierarchy structure that we have, criterion C2 is the most important criterion and has the greatest impact to determine the main problem. At the same time, we can arrange a ranking system on the scale of importance for all given criteria: (1) criterion C2; (2) criterion C1, and criterion C3; and (3) criterion C4.

As Saaty (1989) had considered AHP methodology can also be applied to group decision problems, in wider applications and more complex issues. So we will use, the geometric mean method (GMM), which averaging every individual opinion in a comparison matrix to compute group priorities.

Also we need to aggregating individual opinions into group opinion. The GMM implemented for aggregation of group opinions to maintain the reciprocal system. For example, if participant A gives the comparison scale of 3 and person B gives the comparison scale of 1/3, then the GMM determines the consensus as: $\sqrt{(3 * 1/3)} = 1$, which corresponds to mathematical logic. But if we use the weighted average method (WAM), the group consensus will be determined as: $(3 + 1/3)/2 = 1.667$, which is incompatible with mathematical logic. For this reason, the GMM will be used in this study for aggregating individual opinions into a group opinion.

AHP method not a perfect, and we can accept that this study in a framework of this method has some inconsistency. For example, if we got results from one respondents as C1 is more important than C2 ratio scale 2 and C2 important than C3, ratio scale is 3, then consistency requires that C1 is more important than C3 with ratio scale 6. Anyway there is some acceptable consistency ratio if it’s not more than 0.10.

So, to determine of Consistency Ratio, we must first determine:

1. Calculate the Consistency Index (CI);
2. Determine the Random Index (RI);
3. Calculate consistency ratio (CR)

For Consistency Index (CI) we can obtain it by equation:

$$CI = \frac{x - m}{m - 1} \qquad (5\text{-}3)$$

For obtain the Random Index (RI) we have to refer Saaty (1980) RI table:

Table 5.12. Random consistency index

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

For obtain the Consistency Ration we have to follow next equation:

$$CR = \frac{CI}{RI} < 0.1 \tag{5-4}$$

5.8. Methodological Framework

The AHP model that is used in this study has some parts, first is a literature review, then we had create the main criteria in Kazakhstan context and established sub-criteria which are affecting and connecting with a developing RES fields in country and in the end we had a group them in hierarchical structure and finally to analyze through pairwise comparison and the survey results.

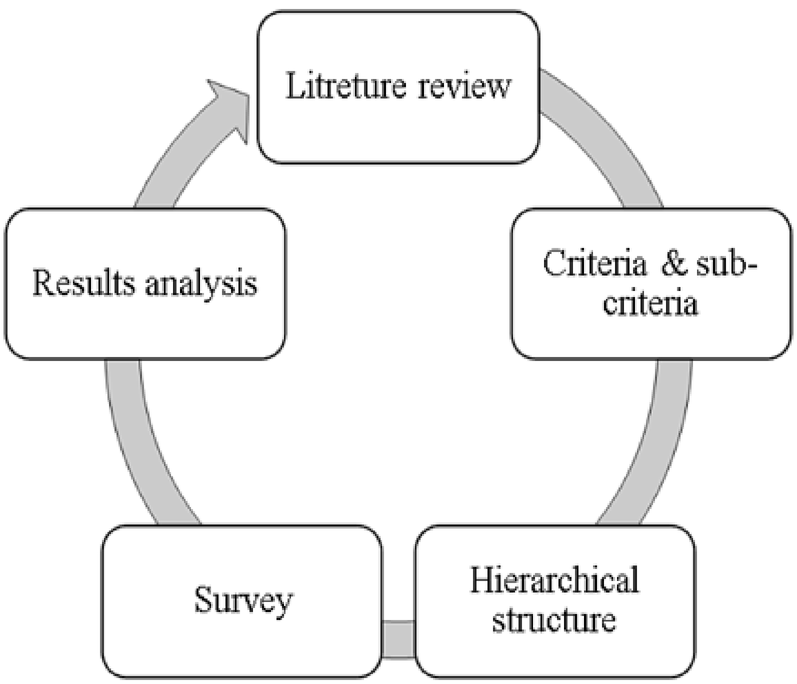

Figure 5.3. Steps in AHP analyzing

According to the literature review we identified 4 (four) criteria and 12 (twelve) sub-criteria in hierarchical structure.

At the same time, Saaty (1980) had determined four steps that need to be implemented in order to produce results and priorities:

1. Determine the goal of the decision-making process;

2. Establish a hierarchy structure that describes every related criteria, factors and alternatives;

3. Make a set of pairwise matrix comparisons;

4. Evaluate the calculations that obtained from the pairwise comparison matrices to weigh the priority, and do this for each level. The process of analyzing research questions by AHP methodology will be explained in the next section of dissertation.

In AHP model we have 5 steps and additional step is a literature review which has a one of main role in structure of this study. According literature review we can determine our criteria, to give the opportunity to the experts to choose main idea between others criteria.

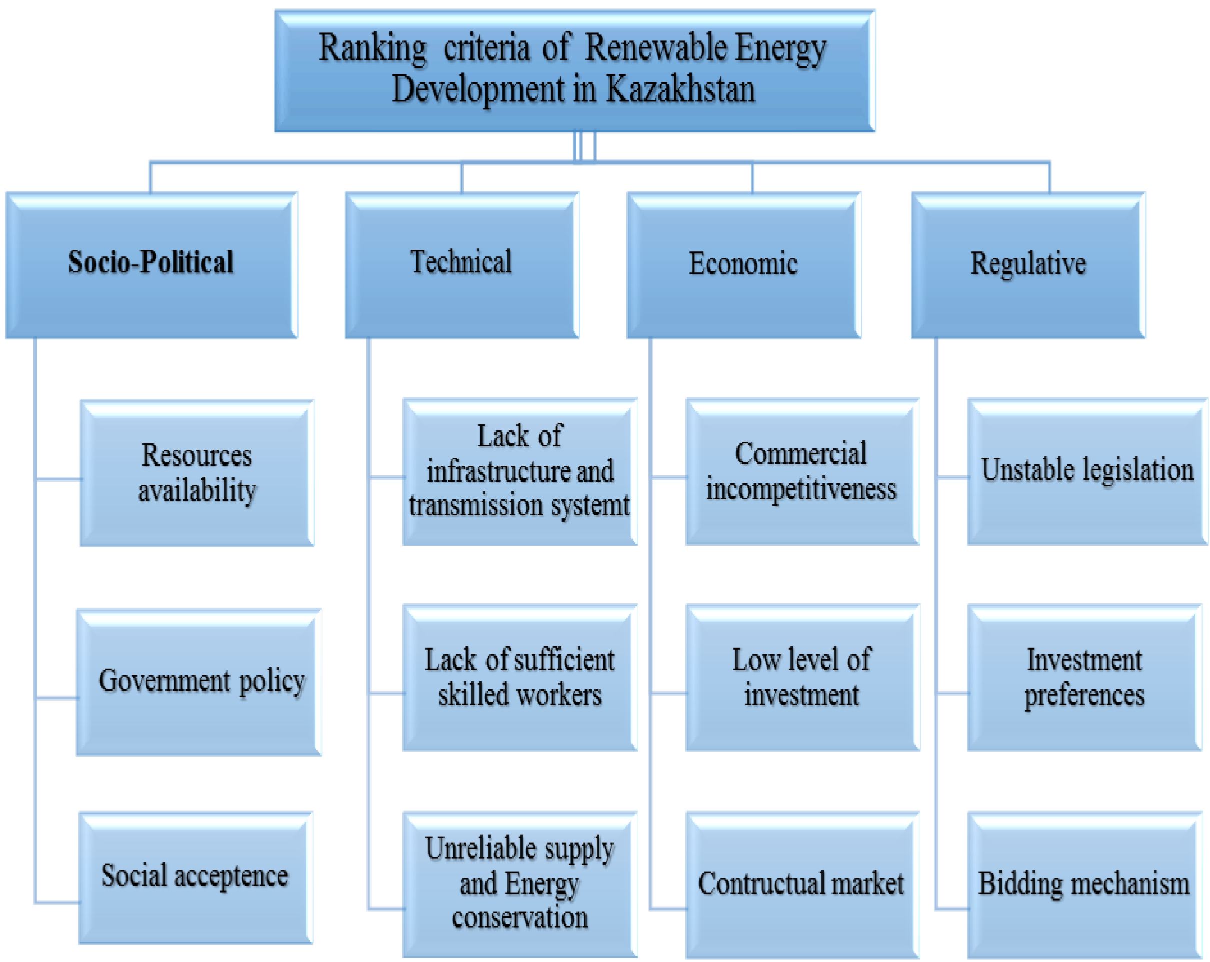

Figure 5.4. Hierarchical Structure of Research

5.8.1. Criteria description in Hierarchical Structure

- **A Socio-Political Barriers**

The criterion used to determine the social and political barriers which affecting for develop of renewable energy. Socio-Political criterion includes three sub-criteria, as Resource availability, Government policy and Social acceptance.

Resources availability

Kazakhstan is among the top ten countries exporting hydrocarbons and mineral resources. At the same time, realizing the responsibility in front for the world community and future generations, the republic is introducing the principles of a Green Economy into the system of government strategic development, but even in a Green Economy concept Government is trying to keep using coal in electricity generation as much as possible. In 2015, after two years of the Green Economy concept was released, the annual Kazenergy National Report noted that despite the Government's desire to realize Kazakhstan's potential for renewable energy development (by creating favorable conditions for attracting investments in the segment), the share of RES in the overall structure of Kazakhstan's electricity generation should remain relatively small. Thus, due to the availability of substantial reserves of cheap coal and the developed infrastructure of large coal-fired power plants, over the next two decades, electricity generation on coal will remain dominant in the balance of Kazakhstan's electricity generation.

At the same time, in 2019, Kazenergy Association has analyzed that despite a significant increase in renewable energy capacities, a long-term development of the industry is at risk, since the main financial burden will be on traditional power plants. Simply put, if the costs of traditional power plants for the purchase of renewable energy with target indicators for achieving renewable energy in 2021 will be 15-30% of the total costs plus an increase of fuel costs and other expenses which can lead to a critical financial situation for traditional energy. According to the current legislation, traditional power plants are obliged to buy renewable energy through the SFC. Hence, the possible increase in non-payments for the purchase of renewable energy and the general financial instability of the electricity sector. Therefore, the Resource availability criterion in this study was taken on the current policy of RES developing within the electric power industry policy, the last is based on energy resource availability in country. The government cannot increase the share of renewable energy more than the current plan, even existing the number of renewable energy share, it can lead to instability in this sector.

Government policy

This barrier is directly the way of development of RES which Government taking and it is very important to analyze because it might cost the government the reaction of producers if it's not uncertainty in the political and regulatory framework.(W. H. Reuter and et al., 2012) The country's leadership has set a task to increase the share of renewable energy in the total volume of electricity production to 3% in 2020, to 10% in 2030. Currently, the total installed capacity of renewable energy excluding large hydropower plants has reached 632 MW, which is approximately 2.4%. World experience shows that the growth of renewable energy sources is mainly due to government support, and without this such kind of stations are not competitive compared to traditional ones, however, in the world practice where purchase of electricity is entrusted to the final consumer, in Kazakhstan the responsibility for the implementation of renewable energy sources was entrusted to traditional power plants which have a critical way.

In general, the policy is aimed at attracting investors, but as practice shows, to the detriment of traditional electricity, therefore, traditional power plants will also attract investors for modernization, because they still occupy the bulk of the total electricity generation in the country.

Also, renewable energy facilities still remain less profitable and much more capital-intensive compared to traditional ones and using of renewable energy is rather skeptical of private business, including due to lack of awareness and lack of experience and their use. This necessitates a selective approach to their implementation and emphasizes government support for the sector.

Social acceptance

Today in Kazakhstan there is no private use of RES, but this is one of the goals that the government intends to achieve. In general, social acceptance in a particular industry is one of the factors for its further development. It is the society has to take initiative to preserve the environment, since any consequences from the manufacturing industry may affect many generations ahead. In addition, renewable energy can be a good basis for solving problems in the regions, and perhaps the living population does not have large financial income compared to the population in large cities, and here their consent to the use of still expensive electricity is necessary. In this regard, the government should establish vigilant market monitoring and effective control over the market in the sector’s value chain. Develop appropriate social protection mechanisms (for example, tariffs for low-income consumers), based on best experience, to manage the social implications of tariff rebalancing.

However, in developed countries during the development of renewable energy, the population takes its direct part and even is a shareholder of such power plants. For Kazakhstan, this practice is not available yet, at least because renewable energy is developing with the money of investors.

- **Technical Barriers**

This criterion used to evaluate the technical aspects of the technologies which needs for the smooth operation of power plants and needs some requirements like human source with technical knowledge in this field. We have 3 sub –criteria in this fields:

Lack of infrastructure and transmission system

There are certain problems in Kazakhstan regarding power transmission issues, and despite the development of the power grid infrastructure, the some tasks have not been completed this days yet.

By 2050, the share of RES will be about 50% of the installed capacity. The infrastructure of the power grid system, which consists of transformers, substations, power lines, is highly susceptible to fluctuations, but it is necessary for stable electricity generation, since only in these cases the network can operate normally without harming infrastructure. Racing at a substation is fraught with damage to equipment, wiring, burnout, transformers and other side effects.

Current legislation for the renewable electricity provides for guaranteed network connection, renewable energy producers should only pay for connecting their installation to the "closest connection point". In practice, however, significant issues arise in connecting Kazakhstan renewable energy producers. Despite of the fact that the shallow price principle costs that are necessary for upgrading should be recovered from the network tariff and renewable energy producers, in real this cannot be affected by the network company because of the current regulatory requirements. For connection need connection agreement, and the PPA (Power purchase agreement) does not include the right to connect. There are no specific technical rules for renewable energy in the Grid Code, thus giving an opportunity for the network companies to make some issue impossible requirements.

At the same time, according to the last annual national report of Kazenergy JCS, there are some issues which were suggested to solve for government:

1. There are no direct electrical connections at a voltage of 500 square meters in three regions of the southern energy zone (Kyzylorda, Turkestan, Zhambyl) with the UES of the Republic of Kazakhstan.
2. There are no direct connections between the Western energy zone and the Unified Electric Power System of the Republic of Kazakhstan (hereinafter referred to as the UES of Kazakhstan).
3. A high degree of wear of the main equipment of the Energy Transmission Organization (hereinafter - ETO).

Lack of sufficient skilled workers

According to the Ministry of Energy of the Republic of Kazakhstan, the implementation of renewable energy projects will unambiguously contribute to the creation of jobs for the period of construction and operation (technical and support staff). Today, training of specialists in the field of renewable energy is carried out in the framework of the specialty "electric power industry". At the same time, taking into account the process of digitization and automation of industries, in the future there might be a need for training specialists in the field of IT technologies, design, etc. In addition, further engineers working in grid companies will need to be trained in integration objects of renewable energy in a single power system of the Republic of Kazakhstan.

Unreliable supply and energy conservation

Nowadays renewable energy still are not a reliable source of energy, we know that the renewable energy can satisfy only part of the electricity needs. It is necessary to build reserve capacities that will produce more energy than renewable energy. It is also important to build reserve capacity in order to meet peak demand at those times when neither solar or wind power plants can produce anything.

Thus, arises question about advantages which solar and wind energy does provide for us. When we are using the gas or coal-fired power plants as reserve capacity, then we can save fuels but gas and coal-fired power plants must be connected to the grid and shut down very quickly to compensate for the variability of renewable energy. Hence, everything ends up because gas and coal are consumed less efficiently, and at the same time when they are used inefficiently, greenhouse gas volumes greatly increase.

We choose this criterion as a barrier of developing of RES in Kazakhstan because RES technology has some imperfection, and in this study, we call it unreliable supply, because reliability of renewable energy technology might be determine as opportunity of a system to produce energy according to designed capacity throughout the life. (J.-J. Wang and et al, 2009). For example, solar photovoltaic technology can produce electricity only in the daytime, while the sun is up and the same situation with varying wind speed which can cause power generation to fluctuate. In 2016 KEGOC JSC operator which transports electricity had announced that they cannot create stable conditions for renewable sources that generate electricity unevenly. They (KEGOC) network is configured for permanent sources. For example, TPP-2 in Almaty gives 510 MW, and TPP-1 in Ekibastuz - 3,000 MW. KEGOC already knows this clearly. And suddenly some kind of source appears, which, let's say, fluctuates - it gives electricity, then no, this calling instability of function in electricity grid balance in general. Regarding the "energy conservation" part of the technology sub-criterion as an imperfection of RES technology, we can say that RES technology has a weak energy storage system in general. The renewable energy technology has some intermittency; it means there’s a high needs for energy storage. Even nowadays, there are new storage technologies available, it might be expensive, especially for large-scale renewable energy plants. It should be noted that energy storage capacity is growing; giving new opportunities for storage and batteries are becoming more available and can be used for a long time.

- **Economic Barriers**

The criterion used to determine the economic cost-and-benefit value which should be considered by government in plan for the steps on “green economy” in develop of RES.

Low level of investment

Nowadays, all projects in the field of renewable energy projects in Kazakhstan are implemented at the expense of own and loan funds of investors and are not funded from the government budget. Certainly, Government giving support to investors and RES producers through the buying of the entire volume of RES energy at fixed tariffs or prices which were fixed by auction and giving some exemption from payment for the transportation of renewable electricity and one more is the investment preferences which were established by Business Code of Republic of Kazakhstan. Since the adoption of the Law of the Republic of Kazakhstan on Supporting the Use of Renewable Energy Sources in 2009, the total investment in the renewable energy sector amounted to about 58.5 billion tenge. To achieve the goals set, namely 3% by 2020, up to 30% - in 2030 and up to 50% in 2050, according to the Concept of Green Economy, the total annually amount of investments which needs for implement all projects until 2050, on average will be 3-4 billion US dollars. The largest annual investment approximately 1.8% of GDP in the period from 2020 to 2024, and on average until 2050, investment will be about 1% of GDP. Also, the bulk of investments will be attracted at the expense of private investors.

Commercial incompetitiveness

The basis of the specialization that allows creating competitive world-class industries in the country is the presence of the following factors:

1) Conditions;

2) The market;

3) Related and supporting industries;

4) The strategy and structure for achieving sustainable competitiveness.

The analysis of these factors indicates the possibility of creating a world-class green energy industry in Kazakhstan, integrating all the production stages - from design and research and experimental work to manufacturing, construction and operation of electricity generating facilities based on renewable energy.

The potential of RES is particularly rich in the south-east of Kazakhstan. Due of this remoteness from traditional sources of energy, such as coal, oil and gas, the energy supply of this region requires transportation for many hundreds of kilometers, which is associated with significant costs and losses. At the same time, huge RES are practically not developed. One of the main reasons is the lack of electrical and machine-building production in the country, which does not allow attracting investments or building wind and solar energy facilities, small and medium hydropower plants on the Zailiysky and Dzhungarian Alatau mountain rivers. Meanwhile, the own production of electrical equipment and turbines would make the construction and production of energy cheaper and affordable for the end user.

Thus, the successful production of renewable energy in Kazakhstan might possible with the development of its own related industries and technologies. First we need to achieve its competitiveness in price and performance with traditional energy sources.

Contractual market

The organizational and contractual arrangement of Kazakhstan's renewable energy electricity sales has a little bit different mechanism from that of its wholesale market. According to the law, all sells should be organized through a single buyer, the FSC. So, all companies who produce renewable electricity has guaranteed that FSC must buy all power from renewable energy operators under 15-year power purchase arrangements. The FSC then mixing the renewable energy electricity to sell to conventional generators (conditional consumers). If any of these consumers will cancel renewable energy payments to the FSC must be redistributed among the remaining conditional consumers for the entire amount of the renewable energy needed. To achieve a fair and equal distribution of costs for all customers, the conditional consumers would on-sell the renewable energy electricity to large consumers and ESOs, together with their own energy. Given the tariff cap regulation for conventional generators, the transfer cost to the final consumer must be assured by taking into account additional costs, although this is currently not explicitly required by the regulators. The sale and purchase of renewable energy electricity through a single buyer is not an unusual practice; it takes place regularly to form market pools. In Kazakhstan, however, two factors make the contractual structure atypical and, to a certain extent, somewhat a challenge:

1) The FSC is a structure that will purchase renewable energy and, unlike other renewable energy single buyers— it is a weak entity without a history and is not adequately integrated into the market framework. The FSC does not have the required short- and long-term creditworthiness necessary for long-term PPAs with international banks.

2) The involvement of conditional consumers (that is, conventional generators) in the payment chain and planning, scheduling, and balancing phases of renewable energy is unprecedented at the global level.

3) Consideration should be given to implementing additional measures for market integration, reviewing the legal setup of the FSC, or providing additional guarantees.

- **Regulative Barriers**

The criterion used to analyze, what should be improved by government for regulation green energy system by RES.

Investment preferences

Since RES are building at the expense of investors, the state should create the most convenient and transparent conditions for this, otherwise there will be no inflow. In addition, there should be a research institute in the country to analyze any decisions taken by the government regarding any subsidies and investment preferences and agreements between investors. One of the unsuccessful examples of a large project that was not implemented was the Balkhash TPP, where investors ultimately decided to leave the project, considering it unprofitable. Also, Government involvement is necessary to provide financial aid and/or tax compensation in the promotion of RES. The governments play a key role in the commercialization of RES to the market and investment preferences has a direct effect to enter to this market. (Hui-Ming Weea et al, 2012)

Investment Law provides investment preferences which are giving according to investment agreement. This agreement signed between investor and the Ministry for Investment and Development (MID) according to the list of priority activities or the list of strategic investment projects approved by the Government of the Republic of Kazakhstan..

Priority activities qualified for investment preferences, among others, include the production, transmission, and distribution of electricity. The investor may be granted exemption from customs duties and from government in-kind grants. Also for the “investment priority project”, there are preferences as a tax preference and investment subsidy. At the same time, since January 1, 2015, the rule came into force that the investment subsidy will be paid after production is fully commissioned by the investment contract, according to results of one year, that the subject to the investor’s fulfillment of production load obligations. If the investor fails to comply with the annual indicator established in the work program for the production load, for the investor will be paid a subsidy amount proportional to the percentage of the performance of this indicator.

Unstable legislation

Renewable energy is a relatively new trend, which developing with even greater activity. Since the presence of this technology in the country can improve not only the economy, but also the state of the environment, a number of measures are necessary that need to be regulated through the legislation. Nowadays, the application of any legislation requires compliance with certain hierarchical structures. The task of the legislation is to regulate the difficult conditions for the development of green technologies. Unfortunately, the legislative framework may miss some mechanisms necessary for the development of this technology. In addition, especially at the initial stage, RES legislation has a large number of standards that impede their application. There are incentive measures for renewable energy sources, but there are no clear instructions and standards that could affect its development. For example, the standards of economic stimulation for the RES investors, the standards of support for the consumers, energy-producing organizations and energy-distributing companies. Regarding this, In order to increase the energy efficiency and development of renewable energy in Kazakhstan needs to formed current legislation the legal standards according to the following aspects:

• Special tools for credit provision (renewable funds; credit lines);

•Third parties participation and findings;

• Tax concessions for investment activities;

• Integrated approach to the application of energy certification;

• Needs on programs and companies regarding informing, education and training.

Bidding mechanism

Auctions can also be negatively aim at increasing cost-effectiveness of renewable electricity support, which may be influenced by some main factors: first is the level of competition in the auction; second is the mitigation of speculative over- or under-bidding. So, Auction in Kazakhstan started from 2018 and the ending results of this new issue we will see later.

5.9. Survey of pairwise comparison

The implementation of AHP methodology requires the pairwise comparisons, which are organized in a questionnaire and through the survey the data was Collected for expert opinion in the energy field (Wind et al, 1980). The AHP methodology is chosen as one of the best MCDA procedure for establishing the assessment framework for energy planning in Kazakhstan, therefore the hierarchy structure in Figure 4.3 is the basis for the pairwise comparisons that are presented in the questionnaire. Also, AHP model considering demands data were collected based only on experience. The questionnaire has 5 sections and 18 questions. The Survey on AHP Pairwise Comparisons was established according to the Hierarchical Structure, which was considered by specialists who are working in energy fields, government officials from Ministry energy of Kazakhstan and experts in energy sector from the different companies.

The main goal of questionnaire is to identify main barriers and rank, according to the importance. Questionnaire includes pairwise comparison questions all response to this survey is confidential and used only for this doctoral dissertation.

To make it more clearly, questionnaire has example which is describing how to answer the questions. This explanations are shown below.

Example: You have to compare the relative importance between Socio-Political and Technical criteria for develop RES in Kazakhstan and to answer this question, you can choose ONLY ONE OPTION among all nine options, which strongly represents your view of it.

Options A	**Extremely**		**Very Strongly**		**Strongly**		**Moderately**		**Equally**		**Moderately**		**Strongly**		**Very Strongly**		**Extremely**	**Options B**
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Technical**
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Economic**

1. It shows option A (Socio-Political) and Option B (Technical) are equally important criteria of renewable energy development.
2. It shows Option A (Socio-Political) Very strong criteria in comparison with Option B (Economic).

First section is section of pairwise comparison of main criteria, and other four sections has an option of pairwise comparison of each sub- criteria which is considering as a barriers of renewable energy development in Kazakhstan.

5.10. Data collection and result of analysis

This research conducted the survey based collection of experts opinions through request from email. A set of questionnaire had been sent to 80 respondents and got survey answers from 75 participant’s experts from Kazakhstan companies in energy field and from Ministry of energy. Out of 75 data collection 13 filled-out questionnaire were considered invalid because of incomplete survey and the rest of result respondents gave inconsistence numbers. As survey questionnaire had complete 50 experts of the total respondents. For complete exactly 50 consistency data we asked some respondents to change their answers, because the inconsistency rate was unacceptable. The experts are chosen for this survey are classified two groups: the first group is governmental program implementation experts, second group is private experts from national companies who are also considered as producers and investors in electricity sector in Kazakhstan.

Table 5.13. Experts work fields

Government experts from Ministry of energy	**Number of respondents**	**Private experts[6]**	**Number of respondents**
Department of RES	7	LLM "PSA"	10
Department of development gas industry	6	LLM Samruk-energy	9
Department of green economy	4	LLM "KazMorTransflot"	7
Department of Environmental Monitoring and Information	5	National company "Kazakh Invest"	7
Department of the implementation of the state policy in the field of electricity	3	The "Erementau Wind Power" JSC	3
Law department	6	The JSC "KazTransGaz Aimak"	4
Total	**31**	**Total**	**40**

As defined in methodology part, AHP model can be implemented and described in five stages. According to our model AHP, hierarchical structure was formed for the further calculation, all pair-wise comparison data provided by experts have calculated according the formula which was

[6] Employees of companies engaged in the implementation of State policy in the field of energy and electric power industry.

mentioned in section before. At the final stage of calculation, researcher synthesized the results based on the all data estimated and combined them for the total estimation of ranking. The aggregation was calculated by the arithmetic mean of global weight of all two groups of respondents.

Table 5.14. Consistency Ratio

Groups	Group 1: Government Experts		Group 2: Companies Experts	
Experts respondent	25	6	25	15
Inconsistency	CI≥0.10	CI≤0.10	CI≥0.10	CI≤0.10

It should be noted, that the consistency ratio have been developed in order to discover contradictory judgments and correct them (Ishizaka & Lusti 2004; Wang, Chin et al. 2009). Which means when the number of experts opinions are too different or scattered inconsistency or variation meaningful information to the researchers.

However, inconsistencies in the subjective judgment of respondents can still be tolerated if the Consistency Ratio (CR) is less than or equal to 0.10.

5.10.1. Weights of main criteria

This section presents the overall results of our study based on the findings from AHP methodology. In Table 4.11 we can see the weights of each main criteria and the synthesized results on Figure 4.5, the overall aggregated results from group 1 (government experts) experts shows that the Economic criteriion (0.536) has the greatest weight as a barrier of the renewable energy development in the context of Kazakhstan. Socio-Political criterion staying on a second place (0.243), next one is Regulative criterion (0.126), the last one is Technical criteria (0.095) which is on the lowest rank of importance among all considering criteria.

The second group of experts represents the private sector in energy field has different aggregate results. For them, main problem is Technical criteria takes the highest weight (0.436), then next follow Regulative (0.348), the third takes Socio-political criterion (0.139) and in the lowest weight has Economic criterion (0.077).

Such kind of differences in opinions can be explained, that two of these groups has different goals and tasks in implementing renewable energy policy and projects. One group has imperative nature of authority, they are creating rules and looking for answer the question “How it should be?” Policymakers working on creation of possibilities for investors and producers, while the other side are looking answer to the question of “How it’s possible to implement?” The second group of experts focused more on a daily problem arising during on implementation of RES projects. They are investors and producers of electricity in Kazakhstan.

Economic criterion for private experts in the lowest rank, in Economic criterion we considering three sub-criteria’s, commercial incompetitiveness, contractual market, low level of investment, which describes the opportunity of RES in a market of Kazakhstan, and to change this situation almost impossible in a short- term. In other hands for government experts, these criterion has the highest rank, and this can be explained that the RES as a commodity has some necessary measures to implement and it has political meanings as a sector of the country than commodity which can be sell with a good price.

After economic criterion for government experts the second rank weight of importance tis taken by *Socio –political criterion*, this criterion includes a definition of current situation of country, and they considering this criterion as one of the main of barrier. All policy in energy sector was built according to this social-political situation in the country, but for private sector it’s like a step on nothing, this criterion doesn’t have really big value for them, because it's like a condition of RES market which cannot be changed right now, anyhow for the second group Socio-political criterion takes the third rank among four main criterion as a barrier to develop of RES. Private sector has a conviction in two obvious facts, the country with a lot of energy resources has difficulties for further development of any alternative energy, except traditional one. It's not easy to change state and consumers' minds to refuse for example use coal and to transit to the RES. If to be clearer, only government policy can promote this awareness for consumers and promote clean energy.

The last main criterion is *Regulative* which is staying in a third rank for government experts and it's expectable result because all sub-criteria’s of Regulative criterion had created by the government. The regulation system has to be adopted very accurate otherwise it can bring more questions and consequences. For private experts Regulative criterion has high meaning and high significance as barriers of RES, because it's a real problem that can stuck they work and money during the implementation of projects

Government experts are representatives of organization which controlling and implementing a policy of RES according to international standards, they are policymakers, therefore technical characteristic of technology not considered by them in a first. Although, for experts from private sector, Technical criterion considered as a barrier which is a disturbance and has no enough attention by the government side, for example during creating regulative legislation and this will be countable for any investors who are going to input investment in RES sector in Kazakhstan. As we see in Figure 5.5 Technical criterion for the private experts in a first rank and for the government experts this criterion in the last rank, the weights of criteria for two groups are opposite. The next section is a discussion of each sub-criteria and their weights in the rank of barriers of renewable energy development in Kazakhstan.

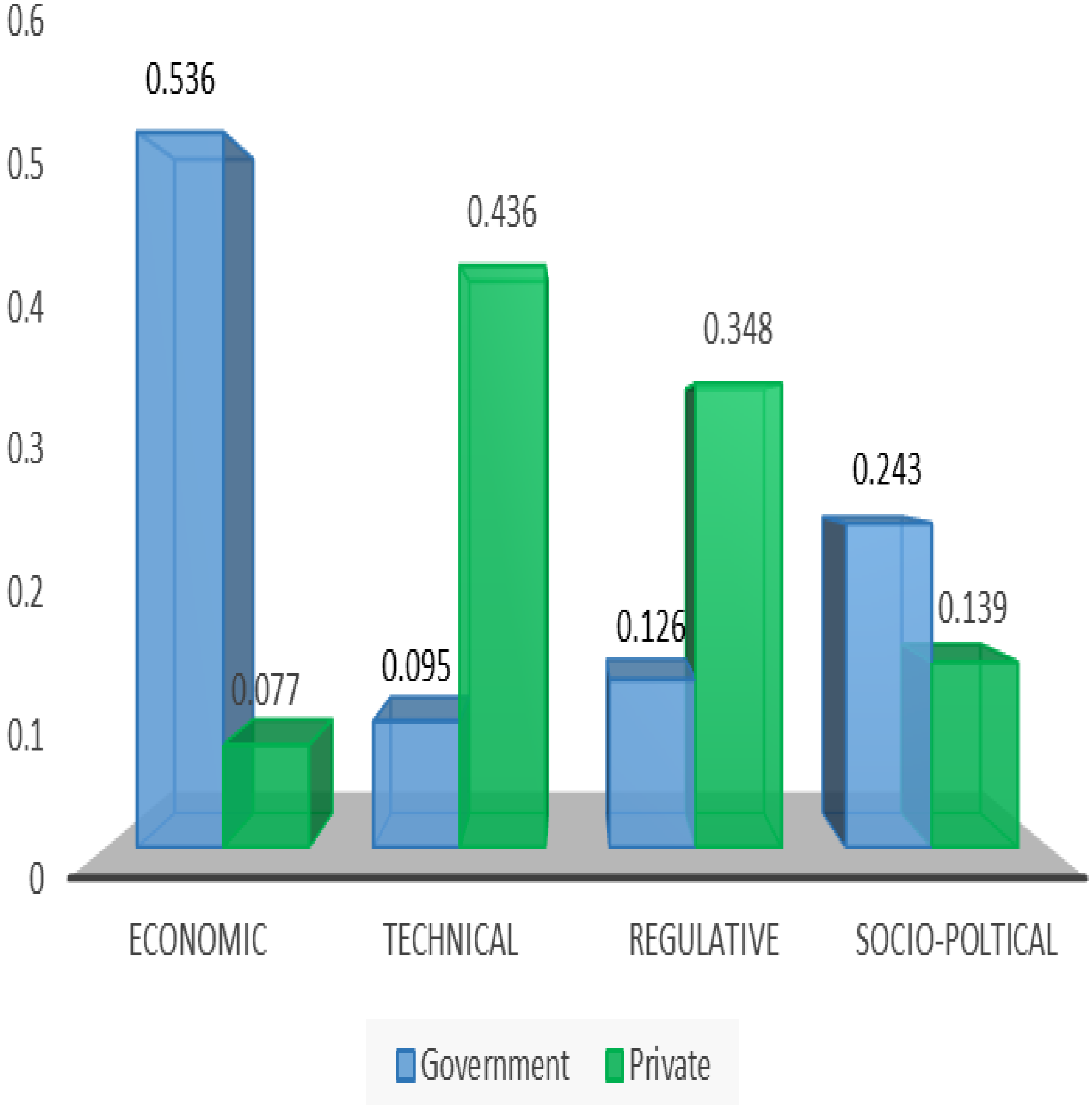

Figure 5.5. Main Criteria

Table 5.15. Calculated weights of Main criteria for Government experts

Criteria	Priority weight	Share	Rank
Economic	0,536	53.6%	1
Socio-Political	0.243	24.3%	2
Regulative	0.126	11.8%	3
Technical	0,095	8.5%	4

Table 5.16. Calculated weights of Main criteria for Private experts

Criteria	Priority weight	Share	Rank
Technical	0,436	43.6%	1
Regulative	0,348	34.8%	2
Socio-Political	0,139	13.9%	3
Economic	0,077	7.7%	4

5.10.2. Weights of Sub- criteria

According the results, the **Economic** sub-criterion has next aggregate value:

For the first group (government experts) the main criteria are the Low level of investment (0.704) Commercial incompetitiveness (0.152) and Contractual market (0.144).

Low level of investment sub-criteria takes the first rank for this group of experts. In fact, the reason for the low investment flow in the renewable energy sector has many meanings. Kazakhstan, after the Paris Agreement, is one of the several countries which was attracted investments in the development of renewable energy, but there are still fossil fuel subsidies to this day, hence this is also of barrier for increasing the share of investments in renewable energy. At the same time, if to choose between Contractual market and Low investment it is obviously that government experts won't consider contractual market as a bad way for RES development, because for government the *Contractual market* (0.144) is a tool which was created by them as convenient deal for both of side and this is profitable tool to involve investors in a RES projects, that's why Contractual market doesn't have a big value as a barrier for government experts.

As a regard of Commercial incompetitiveness, our conclusion based on that fact, that renewable energy cannot compete with traditional electricity from fossil fuels. Government can only support this sector and give some preferences and flexible condition for all participants of the RES market, but it doesn't mean that it's going to work easily. Government considering this also as a weak point of the sector.

For the private sector group first rank takes Commercial incompetitiveness (0.606), second rank Low level of investment (0.293) and last place in a rank takes the Contractual market (0.101).

Commercial incompetitiveness has also high significance as for a first group of experts, because to develop a product (service) which has the low opportunity in a market it's not efficient. The money which they are investing to this sector has difficulties with payback and this we determined as a commercial incompetitiveness, because of the RES position in a market not in demand needs.

Low level of investment takes the second rank for the second group of expert and we can explain this position that this sub-criteria sensitive subject for them, they are investing money according to their opportunity and both of the side of investment agreement trying to satisfied each other, but if we are comparing this chosen with a rank of *Contractual market* which is staying in the last rank for private sector, we can tell that the main reason of this, is that all electricity which produced by renewable energy will be purchased only by one consumer as FSC, and the main problem, that the government cannot guarantee that SFC can handle all amounts of all sellers of renewable electricity. It might be some another problem which will demand some additional regulation in case if SFC doesn't have enough money.

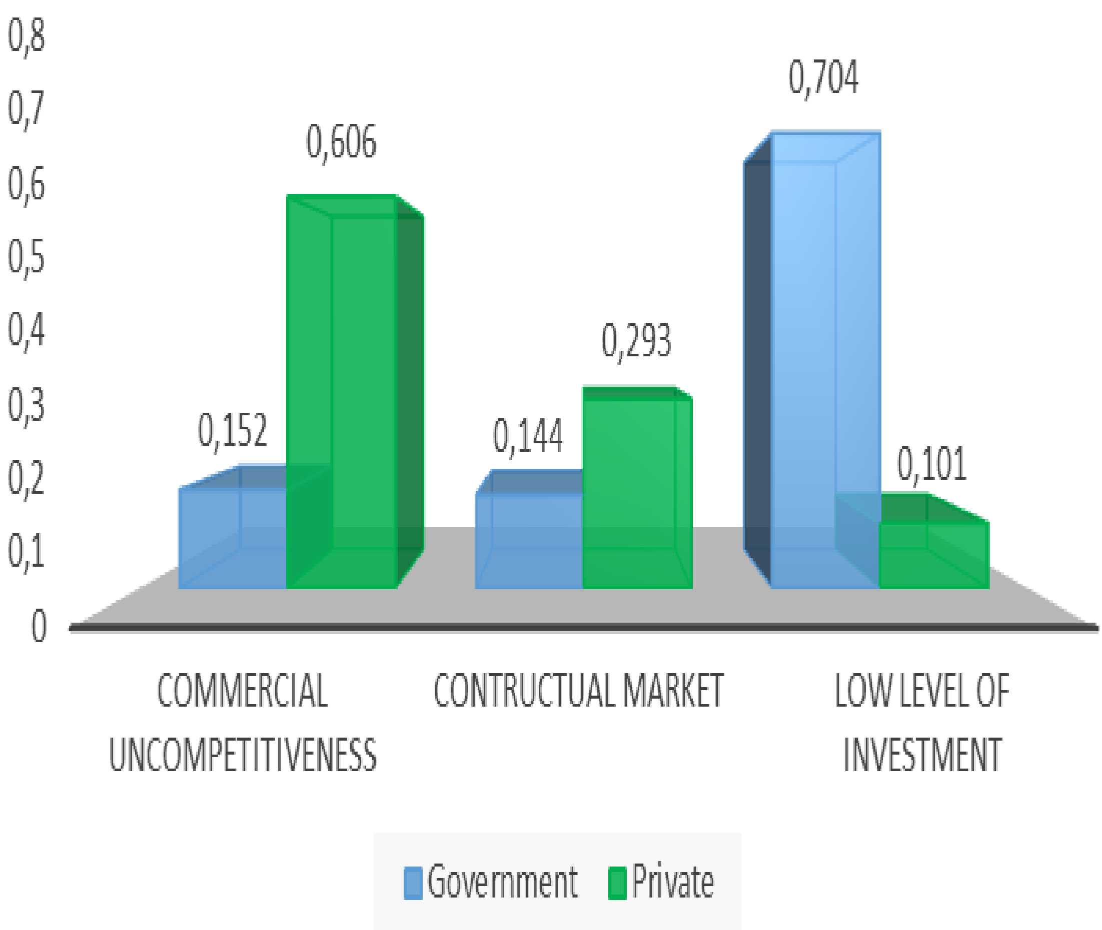

Figure 5.6: Economic Sub-criteria

Table 5.17. Calculated weights of Economic sub- criteria for Government experts

Sub-criteria	Priority weight	Share	Rank
Low level of investment	0,704	70.4%	1
Commercial incompetitiveness	0.152	15.2%	2
Contractual market	0.144	14.4%	3

Table 5.18. Calculated weights of Economic sub- criteria for Private experts

Sub-criteria	Priority weight	Share	Rank
Commercial incompetitiveness	0.606	60.6%	1
Low level of investment	0.293	29.3%	2
Contractual market	0.101	10.1%	3

The main criterion on my opinion which has more significance for policymakers is **Technical** criterion, it seems like all policy in electricity sector circling around this three sub-criteria.

Technical criterion have also three sub- criteria: Lack of infrastructure and transmission system, Unreliable supply and energy conservation, and a third one Lack of sufficient skilled workers. For the first group of experts: Unreliable supply and energy conservation (0.683), Lack of infrastructure and transmission system (0.174), Lack of sufficient skilled workers (0.143).

Government experts, in first rank considering *Unreliable supply and energy conservation* criterion. This sub-criterion is the barrier which is coming from RES technology, this is the weakness of technology and off course, and it has some significant role as a barrier, since it can impact on reliable quality of electricity supply. As long as we trying to develop RES in Kazakhstan, this kind of barriers will be considered with the both side. Government experts while the creating policy, more focusing in general information, they can make decision based on features of particular technology, but description of technological features, usually the task of investors and manufacturers. Government has worry about smooth operation of electricity industries, which is the main goal.

Luck of infrastructure and transmission system (0.174) even if it's one of the reason which is blocking increases in electricity capacity it's taking only second place in rank of barriers for the Government expert, off course it's not the end of analyzing, later we will see which rank it's taking in all 12 sub- criteria. In this case Government has to create some airbag, otherwise it might come with moreover request of money flow. When government announcing about any needs of increasing of electricity capacity, they have to make decision based on this rank of criterion and consider this as possibilities for development of RES.

Lack of sufficient skilled workers taking last place in rank of importance for the government experts. Kazakhstan as a developing countries need professional sufficient skills in renewable energy sector, and if we considering this from the government side its might be some shortage of labor, with a good experience and knowledge, also this sector requires a special engineering skills and we considering RES as a new technology field.

For private sector experts the Technical sub-criterion has next aggregate value: Unreliable supply and energy conservation (0.573), Lack of infrastructure and transmission system (0.300), Lack of sufficient skilled human resource (0.127).

Unreliable supply and energy conservation as we said, in the beginning, this sub-criteria present the weakness of technology, which the investors and producers of electricity for sure has to count the price of this imperfection which can, in the end, bring some negative changes on electricity balance, for sure this criterion has a warning character which must be countable in long-term investments.

Lack of infrastructure and transmission system is sub-criteria which has equal rank for both experts of group. Private experts agree that this depends not only from investment because for modernizing and build infrastructure Government should require and plan step by step and to consider these issues as solutions as the problem arises is not working in this case.

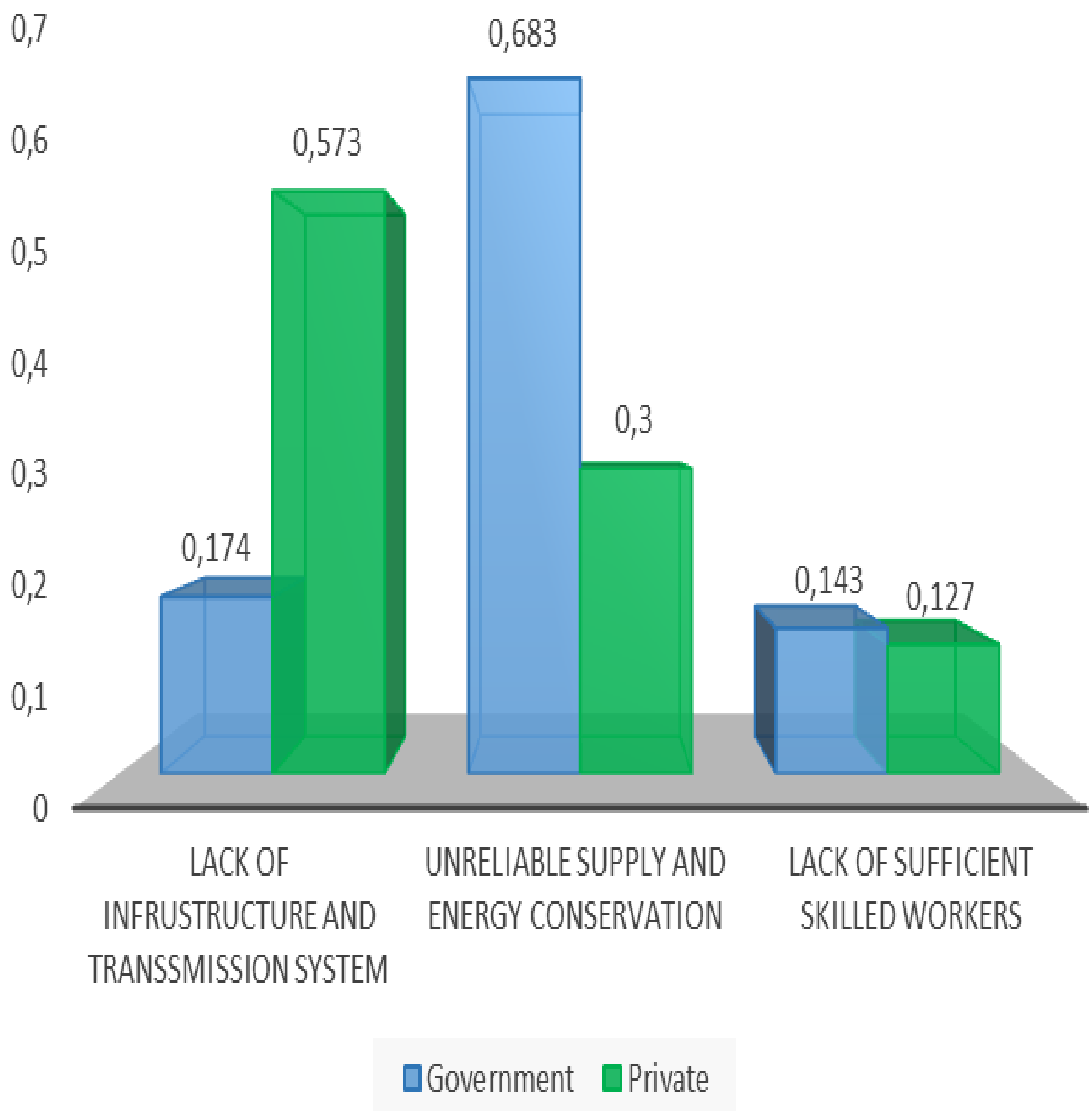

Figure 5.7. Technical Sub-criteria

Table 5.19. Calculated weights of Technical sub- criteria for Government experts

Sub-criteria	Priority weight	Share	Rank
Unreliable supply and energy conservation	0.683	68.3%	1
Lack of infrastructure and transmission system	0.174	17.4%	2
Lack of sufficient skilled workers	0.143	14.3%	3

Table 5.20. Calculated weights of Technical sub- criteria Private experts

Sub-criteria	Priority weight	Share	Rank
Lack of infrastructure and transmission system	0.573	57.3%	1
Unreliable supply and energy conservation	0.300	30%	2
Lack of sufficient skilled workers	0.127	12.7%	3

Next criterion is **Regulative** criterion. The Regulative criterion has three sub-criteria and from the government expert's survey result has next importance rank: Unstable legislation (0.627), Investment preferences (0.203), and bidding mechanism (0.170).

Investment preferences have a different functions and role for each organization of government administration systems. This sub-criterion has general information which is include tax, subsidies, guarantee and investment policy, representing effort in a making policy from another part of administration as a Ministry of Industry and Infrastructure Development or Ministry of economy.

Next important sub-criterion is *Unstable legislation* which has also high significance for government experts. First of all, we had collected answers from the government workers in ministry energy of Republic of Kazakhstan, the policy makers has long procedure to implement all concept from government administration. In section of Legislation we considered more than 20 low and legislation acts which are regulating relationship between sides of this sectors.

For private experts the results are almost same, *Investment preferences* (0.696), *unstable legislation* (0.215), and *bidding mechanism* (0.089).

Investment preferences has a high significant meanings for private sector as much they are on the side who is implementing of RES projects, they are facing a lot of problems during that and this sub –criteria is one of the part, which cannot satisfy they needs.

The second criterion which we are considering is *Unstable legislation*, we considered this criterion from the source of experiences of investors who faced this problem in Kazakhstan. Since Government control has imperative mood, all legislation building on this principle. They are giving some opportunity for implement RES projects by one preference, like the state consents to certain steps from investors, while the other side might be restricted. So, for example, there was a question of allocating land for the construction of renewable energy facilities. In accordance with the land code, foreign persons has no right to get the land plot in ownership, and the lease right was allocated only after the purchase of lease right and this rule does have some difficulties, to get this lease right takes long time and this choosing land by investors should be in a special line of lands for constructions of RES facilities. Today, the issue of land is solved at the level of the auction for renewable energy projects in Kazakhstan. For the private sector, no need to forget that legislation base in Kazakhstan has imperative principle.

Third criterion which has lowest importance for both experts a *Bidding mechanism,* this innovation starts only from the end of 2018, and there are a lot of experts who doesn't believe on this mechanism until now. However, the system of fixed tariffs existed for 3-4 years, after it has failed the government create new approach as auction system for the new project.

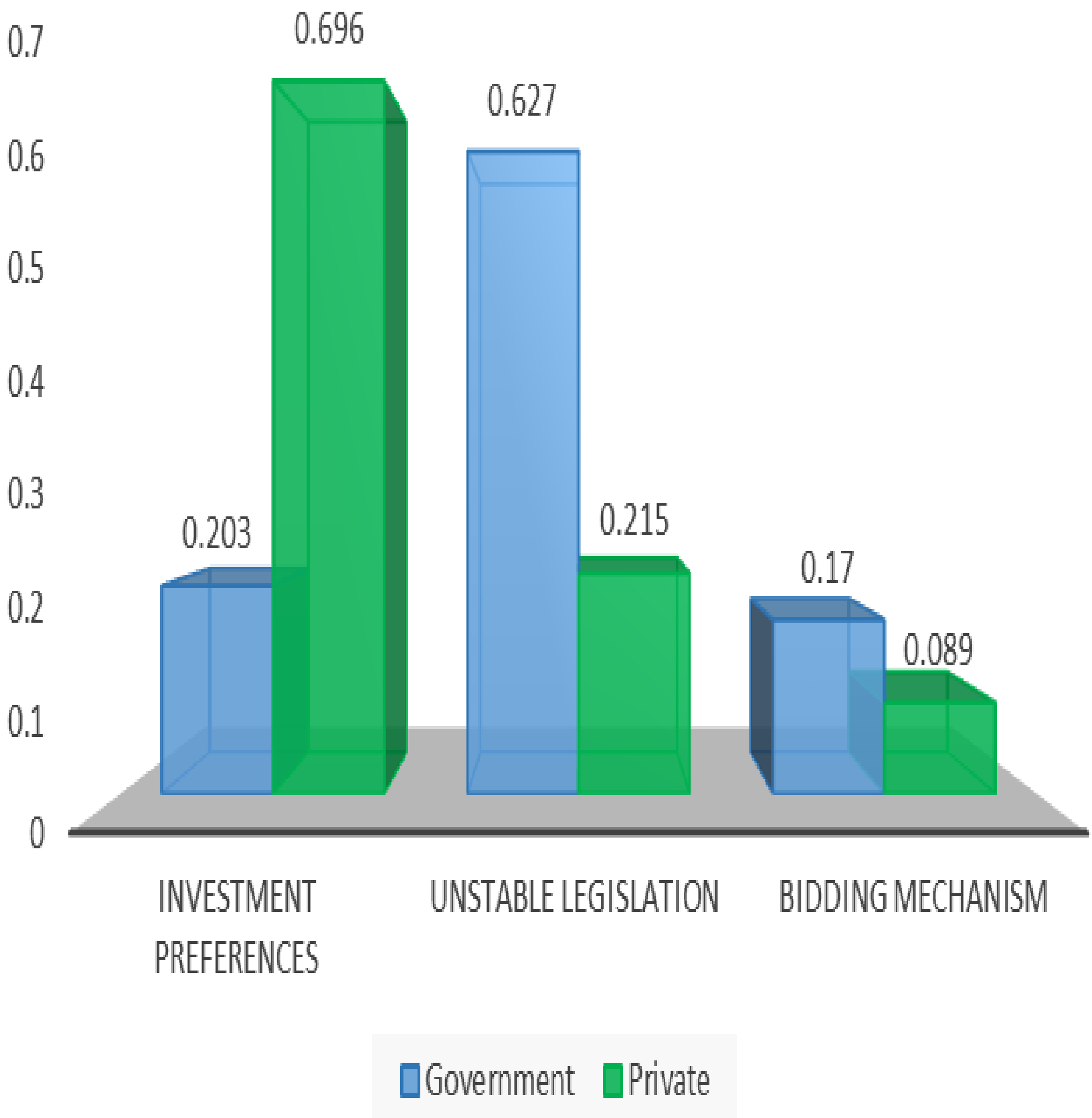

Figure 5.8. Regulative Sub-criteria

Table 5.21: Calculated weights of Regulative sub- criteria from Government experts

Sub-criteria	**Priority weight**	**Share**	**Rank**
Unstable legislation	0.0.627	62.7%	1
Investment preferences	0.203	20.3%	2
Bidding mechanism	0.170	17%	3

Table 5.22. Calculated weights of Regulative sub- criteria from Private experts

Sub-criteria	**Priority weight**	**Share**	**Rank**
Investment preferences	0.696	69.6%	1
Unstable legislation	0.215	21.5%	2
Bidding mechanism	0.089	8.9%	3

The last criterion which we are considering in this study is **Socio –political** sub-criteria.

For government experts: Resource availability (0.659), *Government policy* (0.171), and *Social acceptance* (0.17).

Resource availability criterion has a high rank among government experts, and we can assume that Government building all policy according this fact. On the other hand, for the private experts, this criterion takes last rank priority, and we can assume that the main reason of taking this criterion importance in a lowest rank, it's fact which social and private side are considering this as a factor which cannot be change in sort–term perspectives. It's a condition of country development, it's a country opportunity in energy sector and social acceptable rank, in other words, this is the country ideas or view about renewable energy.

The *Government policy criterion* takes the second rank of importance for government experts and *Social acceptance* criterion takes third rank of importance. So, this all three sub-criteria have significance from the country capabilities, namely the availability of energy resource, therefore the government policy and social acceptance criteria importance coming also from the first sub-criteria. For example, the price of traditional energy has a lower than renewable energy electricity, which is taking time for regulation and creation opportunity for price policy. At the same time, "green economy" concept has a plan to use fossil fuels in the electricity sector as much as it's possible because it might keep the price of electricity in a stable range and Kazakhstan has more opportunity to develop and upgrade this field than to develop RES in a higher position.

For private experts: Resource availability (0.644), Government policy (0.164), and Social acceptance (0.192).

Resource availability criterion has a political character. For countries that exporting fuels and subsidizes domestic prices, the development of RES can minimize domestic fuel consumption and maximize the amount exported, which is ideal. However, we must not forget that not everyone succeeds in realizing such plans. In Kazakhstan, more than 50% of GDP consists of oil exports, but if we are talking about the electric power industry, then this is coal, the cheapest of energy resources. If Kazakhstan trying to transit from coal to Gas only if gas price will be not high it means that we are choosing the way which more profitably.

Government policy is sub-criteria which staying in a second rank for private sector, and as we discussed before, Government acts has imperative character, which means they are creating rules and giving assignment for private sector. Regarding results that we got, both groups of experts has same result about this sub-criteria.

Social acceptance sub-criteria also very important for renewable energy develop. The main meaning of this sub-criteria it's a social or almost civil position of population about climate change problem /environmental problem but also acceptance for developing technology which they can buy in this case its electricity from RES even it will be expensive.

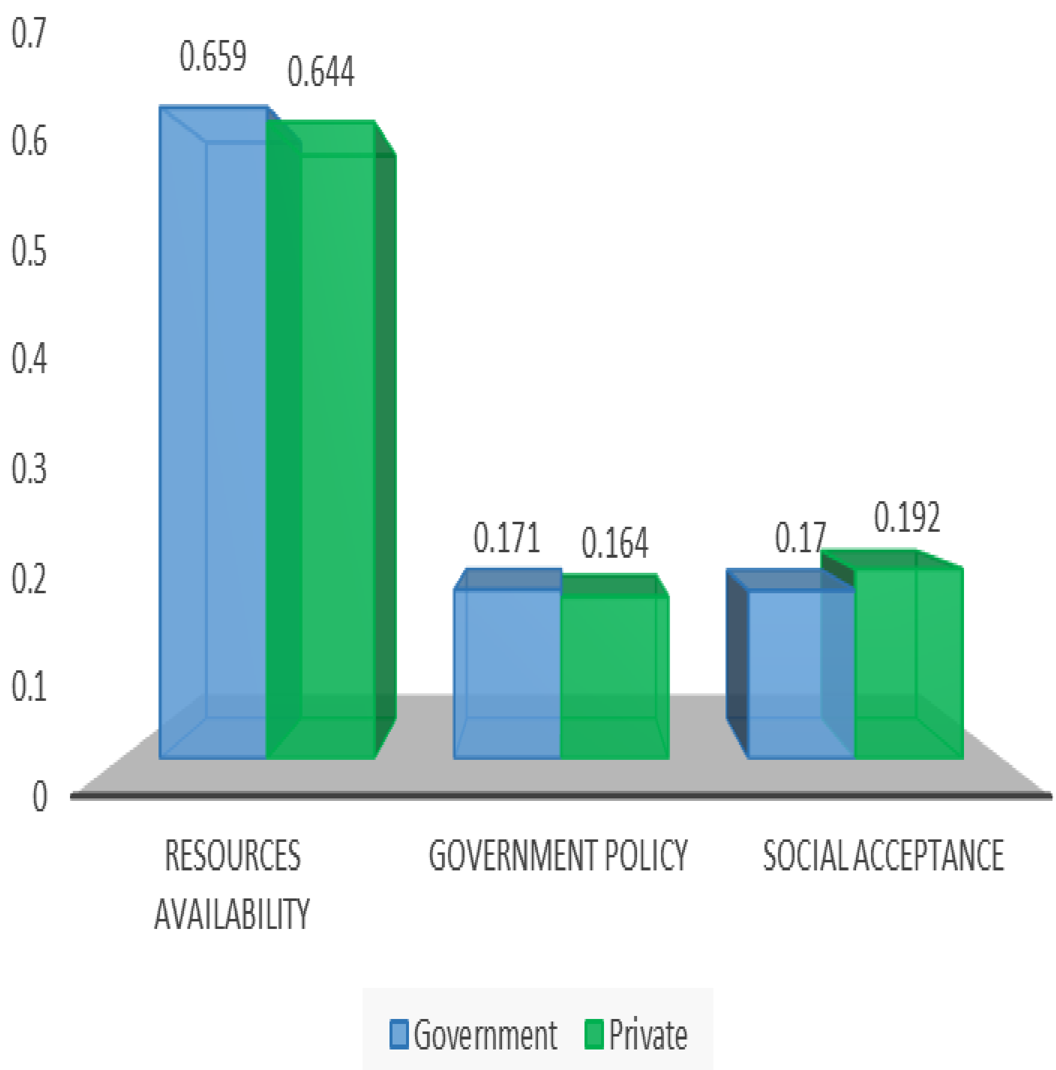

Figure 5.9. Socio-Political Sub-criteria

Table 5.23. Calculated weights of Socio-Political sub- criteria from Government experts

Sub-criteria	Priority weight	Share	Rank
Resources availability	0.659	65.9%	1
Government policy	0.155	17.1%	2
Social acceptance	0.170	17%	3

Table 5.24. Calculated weights of Socio-Political sub- criteria from Private experts

Sub-criteria	Priority weight	Share	Rank
Resources availability	0.644	64.4%	1
Government policy	0.164	16.4%	2
Social acceptance	0.192	19.2%	3

5.10.3. Results of Overall weights Ranking of Criteria

According to the AHP model we create the hierarchy tree based on the 4 criteria and 12 sub-criteria which were found in related papers and articles. This section will show the overall ranking weight of all criteria. It is a last step of calculation in AHP analysis, we need to get the overall weights of barriers that are affecting the development of RES in Kazakhstan by multiplying the weight of each sub-criteria by the weight of main criteria to which they belong.

Table 5.25. Criteria and Sub-criteria of RES development barriers from the hierarchy tree

Criteria	Sub-criteria
1 Socio-political	Resource availability
	Government policy
	Social acceptance
2 Technical	Lack of infrastructure and transmission system
	Unreliable supply and energy conservation
	Lack of sufficient skilled workers
3 Economic	Commercial incompetitiveness
	Low level of investment
	Contractual market
4 Regulative	Investment preferences
	Unstable legislation
	Bidding mechanism

Overall weights of criteria for the Government experts.

In this study we have 4 criteria and 12 sub- criteria from the hierarchy tree and our result shown in a previous section, now let's consider the overall ranking criteria from government employees. In the first rank we got **Low level of investment** 37.8%. This sub-criterion might be considered actually as a result of wrong policy, but for government experts it's a reason why condition for the RES development has some problem for implementation. **Resource availability** is the one of the reason why government still have subsidies for the development project with fossil fuels and has 16%. **Commercial incompetitiveness**

8.2%, this barrier more fits producers, that's why Government trying to create all possible opportunities for develop this sector. Fourth rank takes the **Unstable legislation** in Kazakhstan and this barrier has among the all variables shown obvious experience of government reforms, where they using a method of "trial and error", because every 5 years they are making changes in legislation, it's depend from the updating of new program, new policy, from the applications that they received from investors, producers and etc. **Contractual market** takes the fifth rank in overall weights of barriers and has 7.7% of share and considered by government as relief for producers. Next is **Unreliable supply and energy conservation in a sixth rank with 6.5% share**, actually this barrier has RES and considered as a weak point of technology which not depend from the government experts. **Government policy**, has seventh rank and 4.1% share, among the barriers, and off course all improvement should be started from here. **Social acceptance** has 4.1% share of overall weights and on eighth rank, it's one of the reason how growing demand of RES in Kazakhstan, as we see significance is low. Next is **Investment preferences** with 2.6% share and on the ninth rank, has general information of main support from government which might be improved. **Bidding mechanism**, for government is a support but they are not considering this part as a hinder, rather the opposite, and this barrier on the tenth rank with 2.2% of share. **Lack of infrastructure and transmission system**, has 1.6% of share and on eleventh rank of barriers, this criterion has a technical meaning and is very important for smooth operation. The last of barrier is **Lack of sufficient skilled workers** 1.3% and very low significance.

Table 5.26. Calculated weights of overall ranking of criteria from Government experts

Barriers	Weight	Share %	Rank
Low level of investment	0.378	37.8	1
Resource availability	0.16	16	2
Commercial incompetitiveness	0.082	8.2	3
Unstable legislation	0.079	7.9	4
Contractual market	0.077	7.7	5
Unreliable supply and energy conservation	0.065	6.5	6
Government policy	0.041	4.1	7
Social acceptance	0.041	4.1	8

Investment preferences	0.026	2.6	9
Bidding mechanism	0.022	2.2	10
Lack of infrastructure and transmission system	0.016	1.6	11
Lack of sufficient skilled workers	0.013	1.3	12

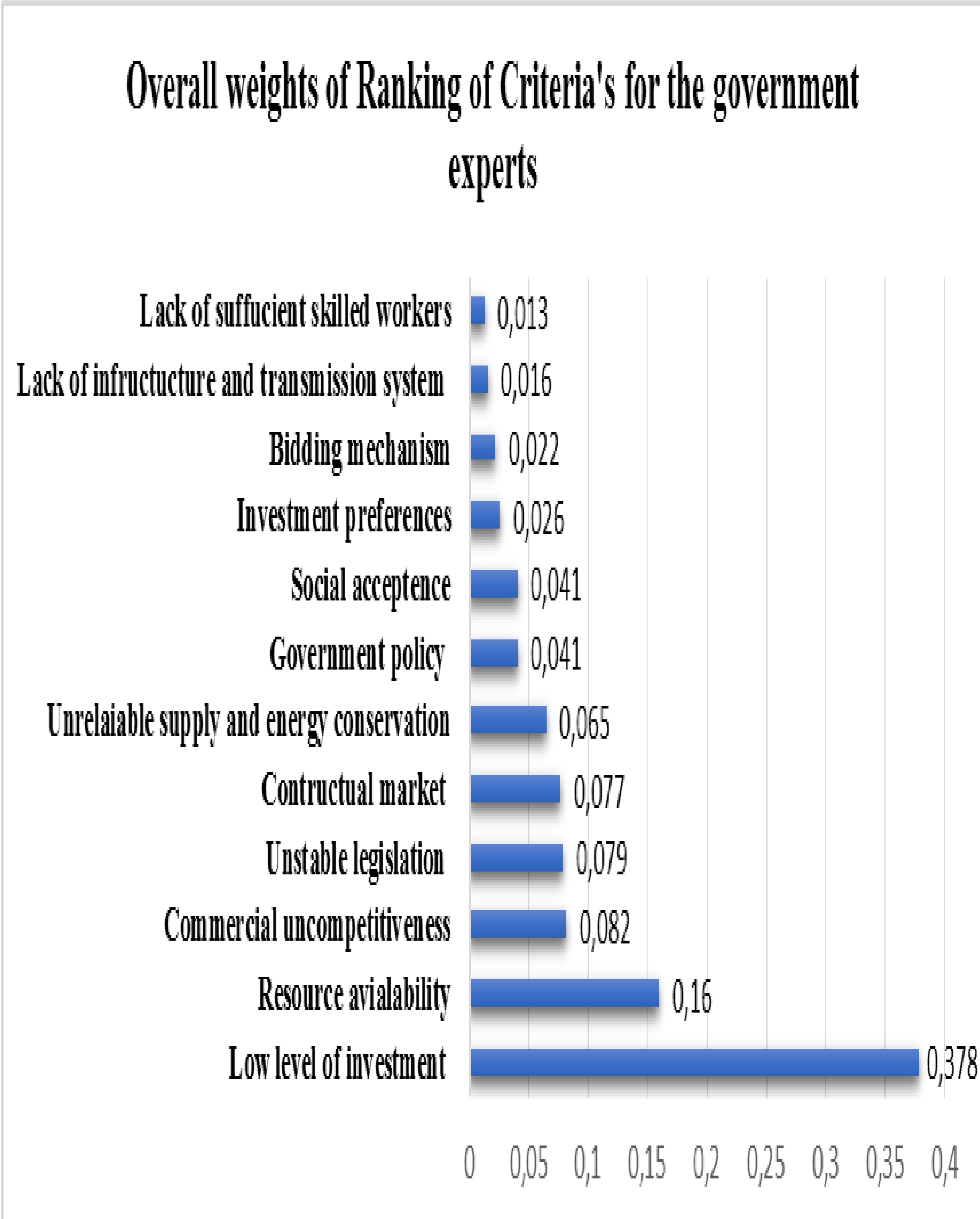

Figure 5.10. Overall weights of ranking of criteria's for the Government experts.

Overall weights of criteria for the Private experts.

For private experts weights of criteria has a different meanings. As we see in a Table 5.27 first rank takes **Lack of infrastructure and transmission system** criterion (25% of share). This criterion describing a technical situation of electricity sector in Kazakhstan, as we mentioned before, the current state of the electricity industry characterized by a significant deterioration of generating and network equipment.

Investment preferences criterion on a second rank of importance and has 24.2% of share. This criterion connected with no satisfaction of the government support of renewable energy sector. Since the implementation of such kind of projects will bring benefit not only for country but also for population and has important environmental aspects, all producers of RES and investors certainly want maximum convenient condition from the state. For example, the price of renewable energy still expensive.

The third rank takes **Unreliable supply and energy conservation** with 13.1% of share. This criterion coming from the weak point of renewable energy technology and has importance which might cost for producers additional spending.

Resource availability criterion has significant position with 9% of share, because government will never reject from the natural energy resource, fossil fuels is the main opportunity of Kazakhstan and off course experts from the private sector can understand that this fact, might affect on slowly development. It can affect in economy of sector in general.

Unstable legislation criterion takes fifth rank among all barriers with 7.5% of share. Unfortunately, even government trying to be open for the investors on this problem, changes in legislation can means that government not doing their job well. Every time when RES sector has some stock, for analyzing and changing the regulation takes time, so we can assume that this barrier has affection which are making some stuck of RES project for the further implementation.

Lack of sufficient skilled workers criterion has some significance for the renewable energy producers and investors and shortages of professional workers usually are compensated by foreign specialists. This barrier takes 6 ranks with 5.5% of share. There are no specialties in the system of Kazakhstani higher education in which renewable energy engineers are trained. Currently, only general energy engineers are trained at universities.

The current composition of specialists were studied in practice, somewhere special courses took place. However, we must admit that we need to release personnel. The transition to a green economy needs to start with education, we need to cultivate a generation that can understands, why this is all done.

Commercial incompetitiveness criterion in seventh ranks and has 4.7% of share. The renewable energy demand is still very low, there are only some needs in a remote areas where renewable energy could solve demand of small communities. Renewable energy for some countries has been considered as one of the strong contenders to improve plight of people, mostly in rural areas, without access to modern forms of energy. (J.P. Painuly, 2001).

The **Bidding** mechanism criterion takes eighth in importance and has 3.1% share, this barrier considered as an instruments which start work during this last 2-3 years, and besides distrust the Financial Settlement Center (FSC), no other negative consequences have yet arisen.

Social acceptance criterion in a ninth place of rank importance and has a small significance with 2.7% of share. Actually we can consider this criterion as an opportunity of calling interests from population, this might to increase the share of RES.

Government policy is almost acceptable for the private experts it takes tenth place in a rank of importance with 2.3% of share in overall weights of barriers.

Contractual market has same rank as a government policy, 2.3% of share and we can conclude that this barrier as a support from government which has some doubt but not more than this.

The lowest importance rank takes **Low level of investment** criterion, it has a monetary value for the private sector who is implementing RES projects. Low level of investment might be explained with different reason but this actually characterized not a perfect investment management system.

Table 5.27. Calculated weights of overall ranking of criteria from Private experts

Barriers	Weight	Share %	Rank
Lack of infrastructure and transmission system	0.25	25	1
Investment preferences	0.242	24.2	2
Unreliable supply and energy conservation	0.131	13.1	3
Resource availability	0.09	9	4
Unstable legislation	0.075	7.5	5
Lack of sufficient skilled workers	0.055	5.5	6
Commercial incompetitiveness	0.047	4.7	7
Bidding mechanism	0.031	3.1	8
Social acceptance	0.027	2.7	9
Government policy	0.023	2.3	10
Contractual market	0.023	2.3	11
Low level of investment	0.008	0.8	12

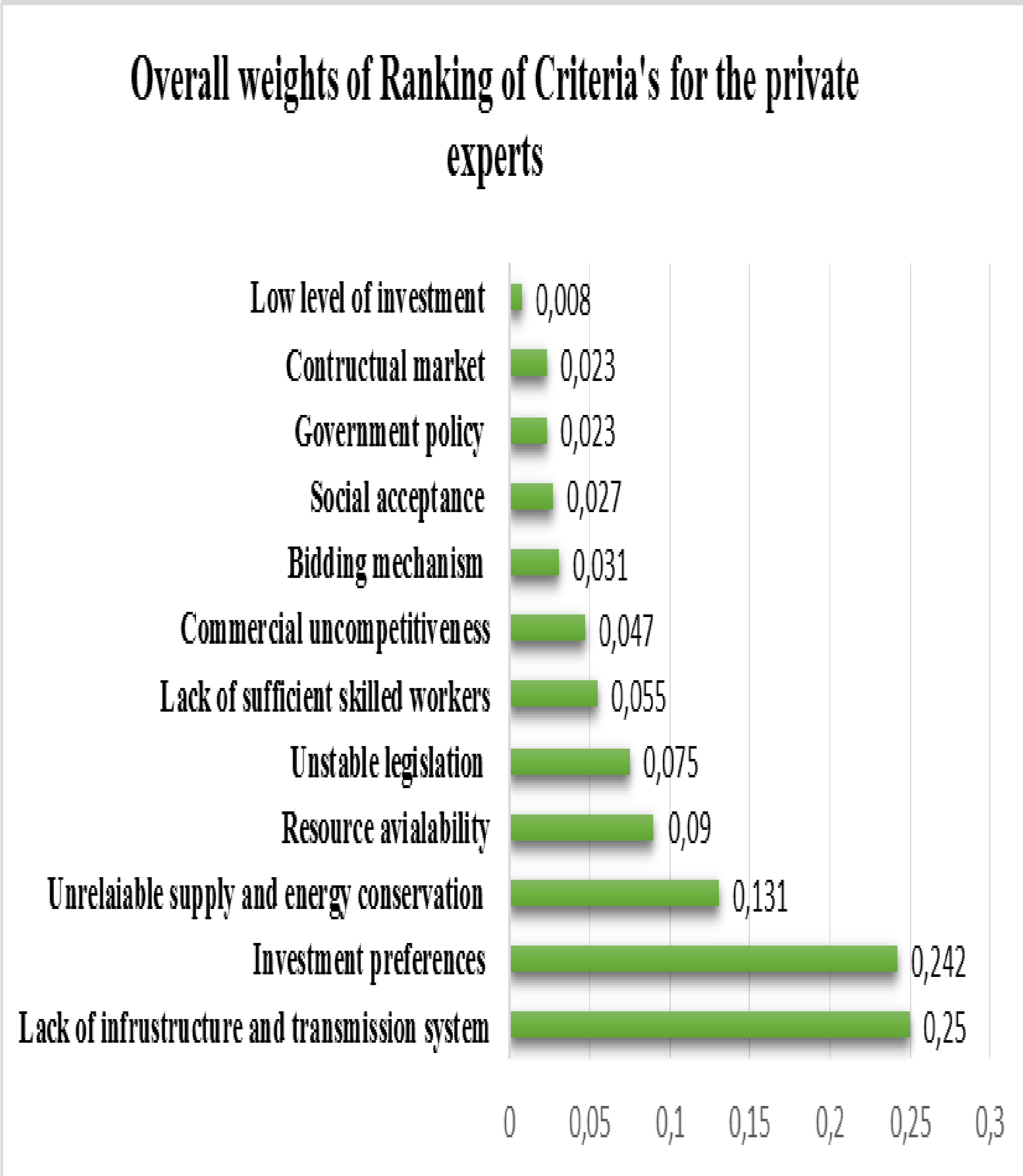

Figure 5.11. Overall weights of ranking of criteria for the Private experts.

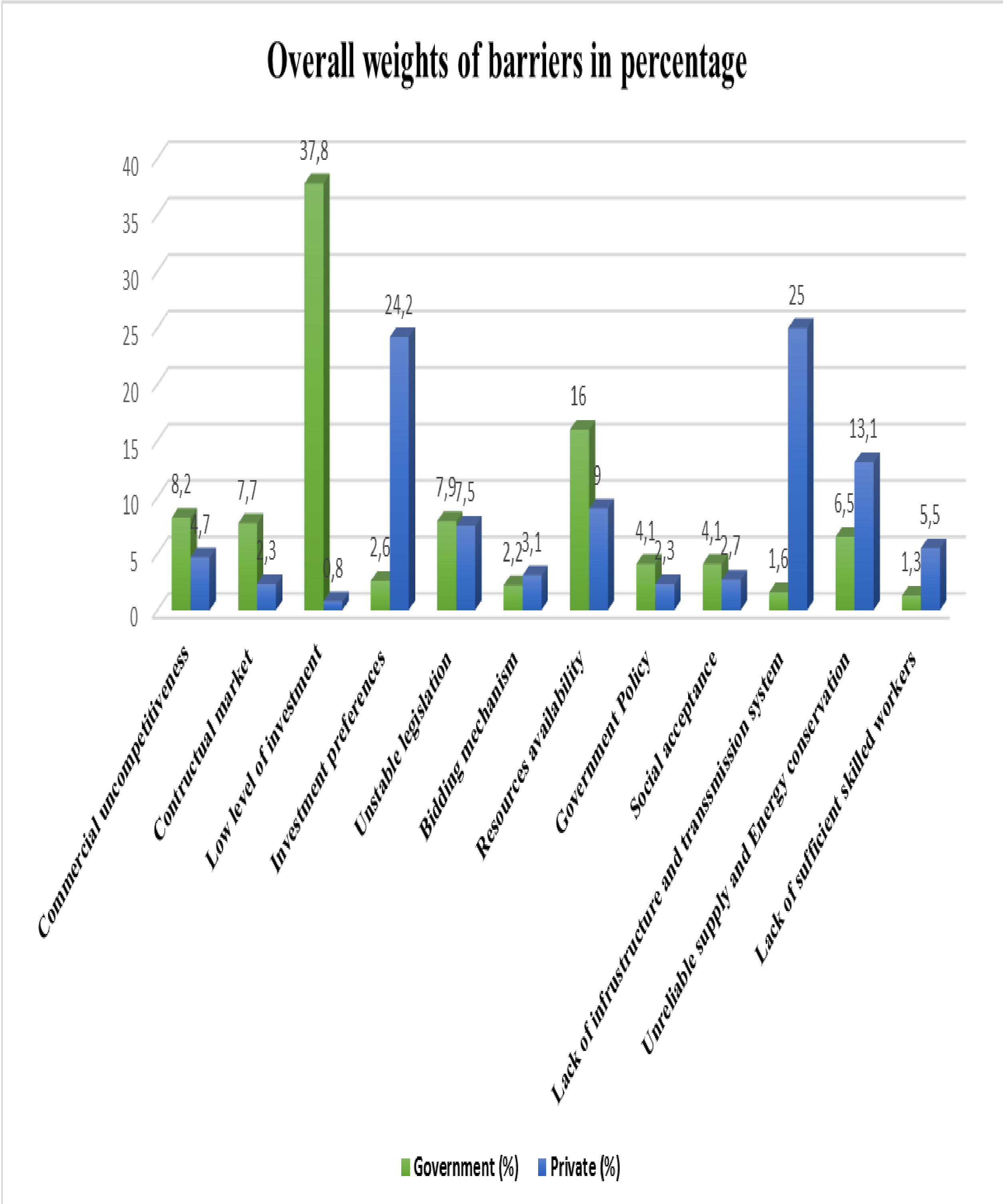

Figure 5.12. Overall weights of barriers

5.11. Conclusion and Policy implication

Kazakhstan has a large number of energy resources, nevertheless made a commitment to reduce carbon dioxide and develop renewable energy. Thus, developing "Green Technologies", introducing innovations and creating more energy-efficient production is very important for our country, albeit not yet quite efficiently.

The state of the power system has a significant impact on the life of any country. Problems in the basic industry impede the development of the economy and threaten the life support systems of citizens and the state as a whole. While reliable and dynamically developing electric power industry allows the country to live comfortably in the present and confidently plan for the future, developing energy-intensive production, which, coupled with its own electric power industry, significantly improves the competitiveness of the economy and favors long-term investments.

Kazakhstan has significant priorities of the government to develop new technologies and use of renewable energy. The various kinds of barriers to renewable energy development were identified based on literature review and experts opinions who directly works on policy of renewable energy development and makes the decisions about this. Regarding, of the nature of the identified barriers to renewable energy development, we classified into 4 main criteria, namely the socio-political, technical, economic and regulative which includes 12 sub-criteria's were listed, and each of these was explained thoroughly. According to the AHP model we got the results where each of considering criteria has a rank on priority, this might give for the policymakers some direction to make some improvements in renewable energy sector in Kazakhstan.

We can conclude that both group working on one direction with different views. For example, the Lack of infrastructure and transmission system criterion for the Private experts taking first rank in overall weights, it's connected with deterioration of generating capacities.

The increase in energy consumption in the country over the past 10 years amounted to 28%. It should be expected that in the future this trend will continue due to ambitious plans for the growth of the national economy. Therefore, it seems necessary to improve the quality of the forecast analysis of the provision of the growing demand of the economy in the electric power industry, taking into account the disposal of generating capacities by the service life and functioning of the capacity market. Another problem that is associated with this criterion is that, the reception of electricity to the region from the West Kazakhstan Region is limited by the capacity of the Uralsk - Atyrau power line. When the value of 130 mWh is reached, emergency control is triggered - an automatic load shedding system. We know that the creation of new renewable energy facilities will increase the generation of electricity, the existence of new technologies with old and worn-out capacities will be unacceptable over time. Therefore, to solve this problem, according to experts from government agencies, investments are needed, and the amount of investment in electricity sector has different numbers, until 2030 ranges from 5.5 to 54 billion dollars. Seems that it's a huge investments are needed to maintain the industry in good condition. However, government funds will not be enough. It is necessary to attract private investment. For this reason, for experts from the Ministry of Energy in the first place is the criterion of Low level of investment.

Another interesting conclusion that we got about different views of two groups is the second rank criteria in overall weights for government experts it's Resource availability criterion and for private experts it's Investment preferences.

Nowadays, Kazakhstan is systematically developing the renewable energy sector, if to be clear the goal is to reach 3% of all production in 2020 and 10% by 2030. One of the reasons for this dilatory way of development is the cost of tariffs. Some experts noting that the price should be equalizing with time, for traditional and green energy. However, it happens in developed countries because the traditional energy, the former was originally expensive. For example, if the latter auctions were held in the fall of 2018 and according to its results for solar energy, the tariffs of the winners were from 18 to 22.9 tenge per kilowatt hour, for wind - from 20.9 tenge and above, unfortunately the price is still high because the price of electricity that offers coal- fired power plants at the wholesale market is from 6 to 9 tenge.

This is due primarily to the presence of coal resource in the country. If we talk about developed countries, then traditional energy there is much more expensive, in the range of 30-50 tenge per kWh, and the cost in our wholesale market as we mentioned is from 6 to 9 tenge. Thus, traditional electricity in developed countries has been historically expensive, and its cost may rise further. Therefore, there it is a question of economic feasibility. The high cost of renewable energy in Kazakhstan is associated, with the need to attract borrowed funds for the implementation of projects. As it turned out, long-term financing in tenge for renewable energy sources is not available in Kazakhstan. If in developed countries the financing of green energy projects goes long-term at 1-3%, then our loan rate exceeds 10%. Considering that the payback of renewable energy facilities reaches 10-15 years, investments at such interest rates are very expensive, here’s the answer to the question why some experts see the problem in insufficiently good or affordable investment preferences, while others assume that the country still needs energy resources and is more accessible, and it’s much more beneficial to build policies based on Resource availability, since it's more profitable for the state and for citizens.

In this regard, we need create some policy implication which will be more reliable for the both side and we cannot reject the fact that renewable energy is the way for develop clean energy which can safe environment for future, it is a measure which can lead safety of health and life of country citizens. The main goal is to find more flexible way for renewable energy development, not a satisfied the group of experts. At the same time, we cannot consider different results from two groups as contradictions but as we can see we have reasonable explanation for these different views, at least regarding of two examples which we discussed before.

Policy actions should be taken by the Kazakhstan government to encourage investors to develop more renewable energy opportunities to maximize share of RES more rapidly and without a large burden on the population and medium and small business.

To develop renewable energy sources in Kazakhstan we need cooperation between government and private business. Business is not able to independently switch to the use of renewable energy sources, and the government without entrepreneurship interest in this field will not achieve much success either. To work on the implementation of RES development policy, should be in the long-run perspective and systemically planed by government. In this regard It’s important to highlight some important moments. Collaboration with business and private sector through the support of the electricity sector happening suddenly as a help and government scare to lose this support. This is what happened in West Kazakhstan region(hereinafter- WKO).

Certainly, coordinated work of business and government is necessary, as is happening today in western Kazakhstan. As was mentioned above, the WKO has a small deficit of electricity due to wear and tear of generating capacities and weather conditions. Last year, due to the abnormally hot weather in the Atyrau region (West Kazakhstan region-WKO), the consumption of electric energy increased sharply. The main source of electric energy generation, Atyrau Thermal Power Plant JSC, operates in the mode of maximum possible power output, the reception of electricity to the region by the WKO is limited by the capacity of the Uralsk-Atyrau power line. When the value of 130 mWh is reached, emergency control is triggered - an automatic load shedding system. The actual volume of electricity generation is 740 MW and the region lacks 200-300 MW. In this connection, the region municipality has to ask for help from industrial enterprises that have their own power plants and generate energy for production needs. In this regard Government can support that kind of Industries Company as partnership and regulate some issues in this case.

The Government needs to consider small-scale renewable energy projects that are implemented on the basis of the general state policy of the Republic of Kazakhstan in relation to all renewable energy projects and unfortunately do not have separate regulatory and incentive mechanisms, with some exceptions. According to the current legislation, when installing a small-scale renewable energy facility, an investor can count on direct subsidies and a scheme for own consumption.

In Kazakhstan, direct subsidies as support are provided to autonomous renewable plants with a capacity of up to 5 kW. The mechanism covers up to 50% of investment costs, provided that the equipment was manufactured in Kazakhstan. However, today in Kazakhstan, the local equipment manufacturing industry is in its infancy and the purchase of local equipment (if any) may be unprofitable due to the high cost. Despite the availability of direct support, there are a number of other obstacles in view of the fact that support is paid in reimbursement only after the installation of the plant. Lastly, limiting the power to 5 kWh means that the mechanism is intended for investment only by households or very small enterprises.

In this case we can suggest:

- Based on international practice, the main lever for starting stimulation of small renewable energy sources is direct support of direct investments (direct subsidizing or subsidized loans). In Kazakhstan direct investment more popular than for example Private public Partnership. This type of renewable energy support is suitable both for objects operating in the network and outside it. Direct support can be combined with stimulation of the own consumption scheme (including storage subsidies) through the net revenue method, in which the renewable energy producer for his own consumption receives a cash loan for excess electricity supplied to the network.
- Tax incentives, can also be used as a support small renewable energy projects, hence as in the electricity sector, the exemptions can be applied for using local equipment and technology, which are exempted from Value added tax (hereinafter - VAT) and considered as a measure to stimulate local investment in production.

At the same time, we have to accept that in general medium and small business which can implement renewable energy projects can be happened only in regions, regarding this:

- The regional administration needs more active participation in development electricity sector, Government has to required, creating high strategy which has to be planned for some years, setting clear goals and timely development of legislative initiatives aimed at achieving the goals set in the strategies.

The state should consider the renewable energy development policy in a comprehensive manner, it will be better to include all barriers or criteria that were considered in this study. For example, in India, on the implementation of renewable energy, both issues of increasing interest to a population from the environment and improving the legislative framework or technical issues such as accelerated depreciation for energy efficiency and air pollution control. (Luthra S. et al, 2015) When the RES projects starting implementation it should be included some even insignificant questions for state experts, but having values for the population.

Nowadays in electricity sector needs the global analysis every issues, if it will help to avoid any affect the load for population from environmental and safety of health and life of population. This might be on shoulder of renewable energy association or on Legal Entities namely, "Kazakhstan Electric Energy Association" (KEA). It is a non-governmental and non-profit organization which plays a connecting role in the dialogue between industry representatives and government bodies. They have a Renewable Energy Committee has been established under the Association.

- It is necessary to give them more initiative as in Kazenergy JCS Association or the National Chamber of Entrepreneurs of Atameken, which can be more effective in creating R&D part of electricity sector and effectively participate in policy making process in Kazakhstan.

As a note, KAZENERGY Association was established on November 2, 2005 to support the development of entrepreneurship in the oil and gas sector. For more than 10-year history, the Association has united over 80 major players in the oil and gas and energy sectors, including mining and transport, service and geophysical, uranium and other transnational companies. Working closely with government agencies, business representatives and public structures, it contributes to the sustainable development of the oil and gas and energy complexes of the Republic of Kazakhstan.[7]

[7] Kazenergy JSC officially information on website. http://www.kazenergy.com/en/association/about-on/

National Chamber of Entrepreneurs of Kazakhstan "Atameken" is a non-profit organization. NPP "Atameken" created to strengthen the negotiating power of business with the Government of the Republic of Kazakhstan and government agencies. The Chamber of Entrepreneurs represents the interests of small, medium and large businesses, covering all areas of business, including domestic and foreign trade.

At the same time, when making changes or additions to existing legislative acts of the Republic of Kazakhstan, they all has to be agree with the above organizations, this procedure allows businesses to somehow participate in government regulation of the interests of a particular industry. This kind of powers are stipulated in a charter of Kazenergy Association accreditation by Government, participation with the right to vote in interdepartmental commission on legislative activity, and also by official there is attraction of similar functions which implemening the "Atameken" National Chamber of Entrepreneurs of the Republic of Kazakhstan in the oil-gas and energy sectors.

Another criterion that we considered is the Contractual Market, as we mentioned here the main role is financial status of the SFC, from one side this guarantee very helpful for attraction investment but in other hand is being questioned. Since 2013, the KEGOC subsidiary, the SFC for the Support of Renewable Energy Sources, began to centrally purchase electricity from renewable energy stations at fixed marginal tariffs. In fact, the SFC offered off-take contracts to alternative energy companies that chose this support scheme for themselves.

In 2018, the scheme changed - the SFC continues to carry out guaranteed procurement, but instead of the mechanism of marginal tariffs for renewable energy facilities - the so-called “tariff in exchange for investments”, the Republic of Kazakhstan switched to lower auctions to select projects for placement. The winner is the investor who offers the lowest cost of the tariff for 1 kWh (the starting point is the marginal tariffs). The winner receives the right to build a power plant in pre-designated areas. Such a scheme was introduced in order to reduce the cost of alternative energy. Indeed, the initial cost of wind and solar energy was reduced, but the issue of financing the SFC is still open. In this connection we have proposal:

- The government needs to consider all the risks of insolvency of a single purchaser of electricity, it is this guarantee that may prompt investors to offer attractive prices for electricity at renewable energy auctions, which will positively affect the impact of renewable energy on the economy of Kazakhstan. - For this reason, the Government of Kazakhstan needs to develop a specific mechanism to ensure the long-term sustainability of the SFC.

Chapter 6

Overall Conclusion and Policy Implication

At the heart of the specialization that allows you to create competitive world-class industries domestically is the presence of certain factors that have been mentioned previously. These are conditions that facilitate development, such as market conditions that support industries and offer strategies for achieving sustainable competitiveness. The analysis of these factors indicates that it is possible to create a world-class green energy industry in Kazakhstan that integrates all production stages, from designing the research and experimental work to the manufacturing, construction, and operation of electricity generating facilities based on renewable energy.

This study provides some understanding of national policy in terms of the environmental safety and electricity development policies of Kazakhstan according to the concept of the "Green Economy." This was done through three essays:

1) The Environmental Consequences of Growth: Empirical Evidence from the Republic of Kazakhstan.

2) Decomposition Analysis of CO_2 Emissions from Electricity Generation by using Coal and Gas fuels in Kazakhstan.

3) Analysis of barriers to renewable energy development in Kazakhstan.

The three studies of this dissertation came out Kazakhstan's established goals regarding electricity development until 2050, which were established through the introduction of the "Green Economy" concept of Kazakhstan in 2013. These goals, regarding the development of the electricity sector were based primarily on the decarbonization of the economy. Strategies such as reducing emissions, the gasification of regions by switching power plants from coal to gas, as well as the development of RES, represent the main tasks that will lead Kazakhstan to a higher level of development by 2050. In addition, the availability of energy resources does not necessarily make it easier to achieve these goals. For example, completing the gasification of other regions of the country, is very costly, as carrying gas from one region of the country to another requires many kilometers of pipes to be laid through huge investments, the presence of knowledgeable specialists, and constant supervision and subsequent technical support. In other words, for countries with economies that are in transition, and taking into account the decisive role of public spending on the formation of a Green Economy, it is essential for governments to develop immediate, medium, and long-term objectives in respective regions to ensure the successful implementation of sustainable development. This is especially true in the event of sudden changes in key financial factors, such as growth, interest rates, and income and expenses.

If we summarize all the problems discussed above regarding the electric power industry, we can distinguish three main issues that are both extensive and, unfortunately, cannot be resolved prohibitively. These include the following:

1) The economy of Kazakhstan is extremely energy-intensive, which is due to both objective and subjective circumstances. Difficult natural conditions and huge areas with extremely low population density predetermine significant fuel costs for the transport of passengers and goods.
2) Kazakhstan's power industry is characterized by the deterioration of a significant number of fixed assets. Depreciation of the power supply network equipment accounts for 60–80% of this process.
3) Intensive production of oil, gas, and coal, as well as the functioning and the development of the fuel and energy complex, have an extremely large and destabilizing effect on both the reproduction of natural resources and the environment.

One of the main ways to solve the above problems, as well as to satisfy the population's electrical energy needs, is the use renewable energy sources. While renewable energy has undergone various reforms, experts in this field still have complaints. However, the main reason for the slowdown in development is dissatisfaction in terms of simulating development of the RES sector. For some countries, the decision to transition toward alternative energy sources or to renewable energy was based on the desire of these countries to reduce their dependency on countries that are large exporters of gas or oil. Kazakhstan is lucky in this regard in that we have huge reserves of various energy resources, including gas, coal, and oil. However, whether it will be possible to live peacefully without harming the environment depends purely on us. Hence, we can assume that the main reason for the transition toward the Green Economy is concern for the environmental.

The First essay of this dissertation aimed to study the CO2 emissions produced by the energy sector. We chose annual data from the years 1991 to 2018, while also using time-series analysis via an ARDL approach. Our results showed that economic growth decreases CO2 emissions in both short-run and long-run relationships, and that both of these estimation results were of negative significance in terms of CO2 emissions and reductions in GDP. We also checked the EKC hypothesis in the context of Kazakhstan to ensure that our results comply with the hypothesis. At the same time, we tried to confirm the right approach the government should take in terms of policies regarding environmental safety measures, which also showed a negative significant contribution to CO2 emissions. Furthermore, we also found that total energy consumption has an adverse effect on reducing CO2 emissions. This result gave us the right to assume that, first of all, government policies on the reduction of CO2 emissions are working well, and that the country continues to both develop renewable energy and use new forms of technology in the energy sector. In other words, the measures included in government policies aim to move Kazakhstan toward a low-fossil-fuel economy through an increase in the use of renewable energy and improved energy efficiency. Another conclusion is that, since energy consumption is mainly driven by continued growth in Kazakhstan's industrial sector, any industrial policy implemented by the government that aims to promote economic development could also offset positive income impacts on the environment, thereby leading to a decline in CO2 emissions.

The second essay of this dissertation was based on analyzes CO_2 emissions from electricity generation via coal and gas fuels. Regarding this study, we can observe past patterns of CO_2 emissions from electricity generation to show how economic factors drive emissions based on an index generated by decomposition analysis (specifically Logarithmic Mean Divisia Index Modelling).

In fact, the decomposition analysis showed that carbon dioxide emissions are growing actively in accordance with increases in the intensity of electricity demand. Furthermore, by using data on the generation of electricity through the use of coal and gas fuels, we concluded that changes in generation efficiency effect ΔEGEF produced an increase CO_2 emissions in the first period under consideration, which covers the 10 years after Kazakhstan gained independence from Soviet Union. This was the highest indicator, whereas the ΔGDP in that period had the opposite effect, producing the highest decreases in CO_2 emissions. This can be explained by the fact that Kazakhstan at this time was still in the process of establishing its electricity sector at this time, and, in order to avoid this kind of fluctuation between two factors, technological innovations which can use gas with lower electricity generation costs, which are still relatively high, should be supported. Meeting this goal requires stable gas prices and implementing the targets that we identified.

At the same time, the results showed that the Kazakhstan electricity structure effect ΔSTPG has the highest effect in increasing CO_2 emissions from electricity generation. The structure of our electricity generation relies heavily on coal dependency, which means that government has to focus on continuing its plan to shift some power plants from coal to gas, while also actively developing renewable energy. It would also be not superfluous improve technology production according international standards, as well as to modernize existing power plants, which will lead to some changes in the environment.

Some of the economic factors which we analyzed in second essay have produced some decreases in CO_2 emissions, which is good. Unfortunately, however, the nature of this decline was associated with a period of weakness in the electricity sector. The economic activity factor changes effect ΔGDP and has the highest decreases (-0.72) of CO_2 emissions over the first period, as well as the highest increases (4.08) in a second period. However, in the last period there is no significant value. As we know, CO_2 emissions from electricity generation are closely linked to economic growth, which depends on more electricity consumption, and which is driving both certain increases in new capacity and the commissioning of new power plants. However, this also depends on the electricity generation structure. In this case, we can assume that the first period saw decreased CO_2 emissions, since it represented the formation of country's economy and the electricity sector was weak. We can therefore consider this result as representing a national opportunity regarding electricity generation. During this period there was a stable but low level of growth and low levels of production, which means that the capacity of electricity generation was lower, therefore reducing CO_2 emissions.

One more factor which will needs to be to mentioned is the thermal power structure effect ΔSEG. This provided some increases in CO_2 emissions in the second and third periods. Even when comparing this factor with others, these amounts are not very high, and this also means that we have a dependency on coal. It is necessary, therefore, to identify alternative technologies that can decrease this dependency. For example, this might involve technology for the production of liquid fuel from coal and gasification via the underground method, or environmentally friendly coal combustion in the electric power industry. At the same time, both promoting a shift in economic structure to less electricity intensive services and shifting product mix toward high value-added products may be useful for reducing CO_2 emissions. IT is for these reasons that the government is trying to shift from coal to gas.

The third essay of the dissertation provided an analysis of the barriers toward developing renewable energy in Kazakhstan. The growth produced by the government depends on the policy which it chooses for us. Analyzing the barriers for the growth of renewable energy provided interesting results, with the experts choosing a less painless way to implement this reform without taking major steps. Through these kinds of mistakes by the government, the plans for developing a Green Economy can appear to be too ambitious. We have a huge stock of resources, we are not going to refuse them, and even if we have technical problems, such as depleting the infrastructure for the smooth transmission of electricity operations, for us it's better to move slowly and solve problems as they arrive. At the same time, according to the answers of both groups of experts, it is clear that they have their own visions but that they are moving according to the policy implications of the country.

The third essay of this study gave us the vision of two groups concerning the barriers facing renewable energy development in Kazakhstan, and the results from two groups are quite different. There were answers according their authority and according to what kind of goals for achievement they have. Both of these groups have their own importance ranks concerning the various barriers they are facing when working to implement renewable energy projects or make policy decisions regarding renewable energy. Among these barriers, the ones that we identified as being most importance are investment preferences for private experts and low levels of investment for the government. In this sense it appears that these groups have totally different views. The criterion Lack of infrastructure and transmission system was connected with the deterioration of generating capacities. The increase in energy consumption in Kazakhstan over the past 10 years amounted to about 28%, and in the future it should be expected that this trend will continue due to the government's ambitious plans for the growth of the national economy. Therefore, since the percentage of energy consumption is growing every year, it is necessary to improve the quality of the forecast analysis regarding the provision of the growing demand of the economy in the electricity sector while simultaneously considering the disposal of generating capacities.

Another problem that is associated with this criterion is that while the creation of new renewable energy facilities will increase the generation of electricity, the existence of new technologies with old and worn-out capacities will become unacceptable over time. Therefore, to solve this problem, according to experts from government agencies, investment is needed because government funds will prove to be insufficient. Renewable energy still is expensive, and this is the main reason for the existing low levels of investment. The government tried to alter this situation by creating new mechanisms, such as bidding mechanism, which addresses some issues regarding the price of electricity, but it still expensive compared to the electricity produced by traditional power plants. At the same time, the market for renewable energy is very weak, and we can call it a Contractual market which relies on the status given it by the SFC. The SFC is the company which can guarantee investors that over a period of 15 years they will buy all of electricity that will be produced, but there are growing doubts that the SFC, like the JSC, is not financially stable and may close the debt obligation in the event of difficulties. One more important criterion that we want to highlight is resource availability, according to which the government is making policy from a position of profitability. Since Kazakhstan has huge reserves of coal and gas, renewable energy will be developed slowly by the government over a 50-year period, subsidizing energy projects with coal and gas.

Based on the three essays results, our suggestions for policy implications and additional measures for implementation of the "Green Economy" concept in Kazakhstan are as follows:

Detailed work on legislation for investment opportunities.

The main problem is the inability of the technical, market rules and the system of standard contracts to consider the characteristics of renewable energy sources. In this regard, it is necessary to comprehensively improve the regulatory system, including the improvement of electric grid rules, the rules for the functioning and balancing of the electricity market, the rules for the provision of services by the system operator, and the rules for the organization and functioning of the wholesale market, taking into account the technological specifics regarding renewable energy facilities.

Developing more flexible opportunities for Private Public Partnership projects.

This can lead to more investment, especially in infrastructure field. Investment in Kazakhstan mostly consists of direct investments, and nowadays we have only one example of the implementation of an energy project via Private Public Partnership: the construction and operation of the inter-regional power transmission line "Northern Kazakhstan - Aktobe region."

Public Private Partnership (PPP) is collaboration between the government and a private partner. PPP is a reciprocally beneficial cooperation between the state and the private sector in industries traditionally related to the sphere of responsibility of the state, based on equality risks, benefits and costs, and rights and obligations defined according to the PPP agreement.

The main goal of PPPs is to develop infrastructure in the public interest by combining the resources and experience of the state and business, implementing socially significant projects with the lowest possible costs and risks, provided that high-quality services are provided to economic entities. The main reason for this is the unsettled aspects related to investor risk.

There are 3 main risks regarding PPP projects:

1) The risk of delay in construction or non-compliance with accepted standards (construction risk);
2) The risk of non-payment of requirements or lack of funds for construction (financial risk);
3) The risk of insufficiency or fluctuations in demand.

Unfortunately, practice shows that the problems of ongoing PPP projects are associated with these risks. In many countries, institutional investors do not participate at all at the riskiest stage of the project - the construction stage. In principle, this is possible to implement in our case. For example, at the construction stage, the Development Bank of Kazakhstan or a consortium of large banks could act as the initial co-investor of the project, and, in the future, after putting the facility into operation, money would be returned to him through the placement of infrastructure bonds. Alternatively, the construction itself could be financed using the state budget. It must be clearly understood that any investor who finances the facility from scratch needs guarantees that if something does not work out in the facility, collateral will be used. This is one of the common truths - loans are granted on a paid, urgent, and repayable basis.

Implementation of new-technology projects in regions across the country.

This also can help to achieve the ambitious goals that Kazakhstan has established. Along with the numerous regions of our country that are rich in natural sources of fuel, we also have regions where it is the development of renewable energy that is the most profitable and appropriate form of energy production. However, even there, without state support, investors will not be able to independently launch a truly serious project based on renewable energy sources. At the same time, in big cities such as Almaty and Astana, the environmental situation also depends on the transport GHG emission, which can be controlled more via government regulation, for example through a special tax for cars which are more than 5 years old or removing taxes for electric vehicles.

The regional administration also requires more active participation in the development of the electricity sector, while the government is required to create a long-term strategy that sets clear goals and establishes the timely development of legislative initiatives aimed at achieving the goals set in the existing strategies.

Introduce special tax treatment or tax incentives.

This will encourage the private sector to manufacture equipment that can be used in the energy sector. At the same time, tax incentives can also be applied when using local equipment and technology, which are exempt from VAT and are considered as justifiable measures for stimulating local investment in production.

Develop R&D in energy sector systemically.

This could involve establishing a plan revolving around exact research questions in this field or to consider some budgeting money which can be set aside to provide opportunities to hire and attract foreign researchers. For example, to analyze how to create a dynamically developing renewable energy market and forecast how it will evolve, new studies are needed to improve the energy efficiency of the industrial sector and reduce CO_2 emissions. This emphasis on R&D is common in oil exporting countries, and may help to avoid a lot of potentially wrong decisions in this sector. This research could be developed in tandem with renewable energy associations or legal entities, namely, "Kazakhstan Electric Energy Association" (KEA), a non-governmental and non-profit organization which plays a connecting role in the dialogue between industry representatives and government bodies. KEA has a Renewable Energy Committee which has been established under the Association.

It is also necessary to identify promising areas for the development of low-carbon technologies for the energy production and the energy consumption sector. In fact, Kazakhstan has already considered and adopted these ideas in legislative form. For example:

Entrepreneurial Code of the Republic of Kazakhstan, article 256.

Tools of the industrial-innovative system:

1) the tools of planning an industrial-innovative system include technological forecasting and a single map of priority goods and services;
2) technological forecasting refers to a set of analytical research aimed at identifying technologies whose development is a prerequisite for sustainable industrial and innovative development states;
3) technological forecasting is carried out by the authorized body in the field of state support for industrial and innovative activities on an ongoing basis, with a debriefing at least once every five years;
4) the process of technological forecasting is provided by the national development institute in the field of technological development by attracting foreign and domestic experts,

conducting surveys and analytical research, the generalization of the data, and the formation of recommendations for summarizing technological forecasting;

5) the results of technological forecasting are taken into account when determining priority areas for the provision of innovative grants, including the implementation of targeted technological programs. [8]

Solving the problems of reducing CO_2 emissions from coal-fired TPPs.

This requires an integrated approach that combines the introduction of energy-saving technologies, the use of highly efficient technologies for producing electric energy at coal-fired TPPs, and the widespread use of carbon dioxide capture and storage technologies at power plants. Carbon Capture and Storage (CCS) is a technology that can capture up to 90% of the carbon dioxide (CO_2) emissions produced via the use of fossil fuels in electricity generation and industrial processes, preventing this carbon dioxide from entering the atmosphere.[9]

Reconstruction of electric networks is necessary.

A high level of wear regarding electric networks increases the accident rate and results in the inability to connect new subscribers. 80% of worn-out electrical networks represent a threat, making energy supply unpredictable. This damage will, sooner or later, hit the pockets of consumers and the state budget, which should correct the situation before it is too late. At the beginning of this year, the Ministry of Energy approved a seven-year forecast balance for 2019-2025. According to this forecast, and taking into account both the withdrawal of old energy capacities and the commissioning of new ones, a surplus of electric energy and power is expected until 2025.

Continue to stimulate investment policies, including for small-scale projects.

Based on international practice, the main lever for beginning to stimulate small renewable energy sources are direct support of direct investments (direct subsidizing or subsidized loans). In Kazakhstan, direct investment is more popular than, for example, Private Public Partnership. This type of renewable energy support is suitable for objects operating both in the network and outside it. Direct support can be combined with a stimulation of the consumption scheme (including storage

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[8] Entrepreneurial Code of the Republic of Kazakhstan. The article 256, www.adilet.zan.kz

[9] What is CCS? Carbon Capture & Storage Association 2011-2020. http://www.ccsassociation.org/what-is-ccs/

subsidies) through the net revenue method, in which the renewable energy producer in charge of his own consumption receives a cash loan for any excess electricity supplied to the network.

To make the status of the SFC as a guarantee as payback for investors more stable.

The government needs to consider all the risks of insolvency that come with having only a single purchaser of electricity. It is this guarantee that may promote investors to suggest attractive prices for electricity at renewable energy auctions, which can lead to a renewable energy having a positive impact on Kazakhstan's economy. In this regard, Kazakhstan needs to develop a specific mechanism to ensure the long-term sustainability of the SFC.

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Appendix

First essay of dissertation

Summary of Unit root test

Source: Eviews Output

At Level: LOG_GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.139290	0.0161
Test critical values:	1% level	-4.356068	
	5% level	-3.595026	
	10% level	-3.233456	

At Level: LOG_CO2

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.061993	0.5427
Test critical values:	1% level	-4.339330	
	5% level	-3.587527	
	10% level	-3.229230	

At 1st difference: D(LOG_CO2)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.867816	0.0286
Test critical values:	1% level	-4.356068	
	5% level	-3.595026	
	10% level	-3.233456	

At Level: LOG_POP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.600043	0.0061
Test critical values:	1% level	-4.374307	
	5% level	-3.603202	
	10% level	-3.238054	

At Level: LOGEC

		t-Statistic	Prob.*
Augmented Dickey-Fuller test stic	-2.176026	0.4830	
Test critical values:	1% level	-4.339330	
	5% level	-3.587527	
	10% level	-3.229230	

At 1st difference:

Null Hypothesis: D(LOGEC) has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3. 61649	0.0434
Test critical values:	1% level	-4.356068	
	5% level	-3.595026	
	10% level	-3.233456	

Summary Table of Long – run test result

Dependent Variable: D(LOG_CO2)

Selected Model: ARDL(1, 1, 0, 1)

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	2.764898	0.630209	4.387269	0.0003
LOGCO2	-0.752246	0.161103	-4.669347	0.0002
LOGGDP	-0.014304	0.017477	-0.818483	0.4232
LOGPOP	-0.326576	0.087987	-3.711653	0.0015
LOGEC	0.778349	0.166261	4.681487	0.0002
DUMMY_2	-0.015992	0.004237	3.774372	0.0013

Summary of ARDL Bounds Test Results

Test Statistic	Value	Signif.	I(0)	I(1)
		Sample Size: 27		
F-statistic	7.8	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: Critical values are collected from

(Narayan P.K and Smyth R, 2005b).

Summary of Short –run test result

(**ARDL Error Correction Regression)**

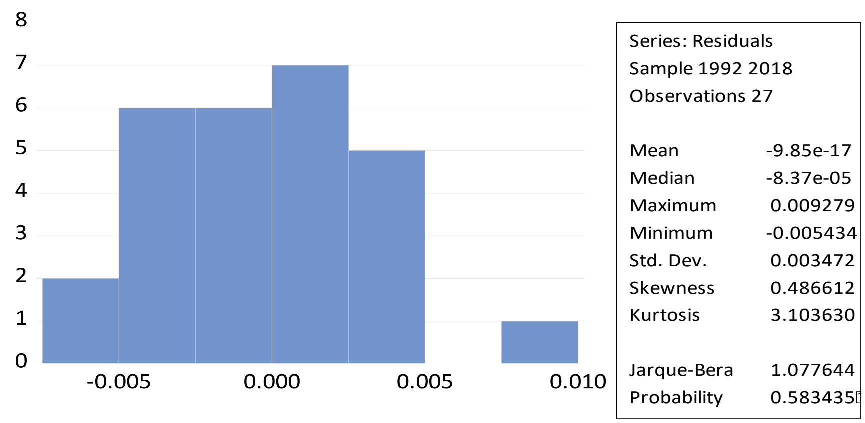
Dependent Variable: D(LOG_CO2)

Selected Model: ARDL(1, 1, 0, 1)

ECM Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_GDP)	-0.146722	0.031519	-4.655101	0.0002
D(LOGEC)	1.095553	0.024864	44.06270	0.0000
DUMMY_2	-0.015992	0.002566	6.231648	0.0000
CointEq(-1)*	-0.752246	0.109366	-6.878241	0.0000

Normality test



Source: Eviews 10 output**.**

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.073222	Prob. F(2,17)	0.3640
Obs*R-squared	3.026881	Prob. Chi-Square(2)	0.2202

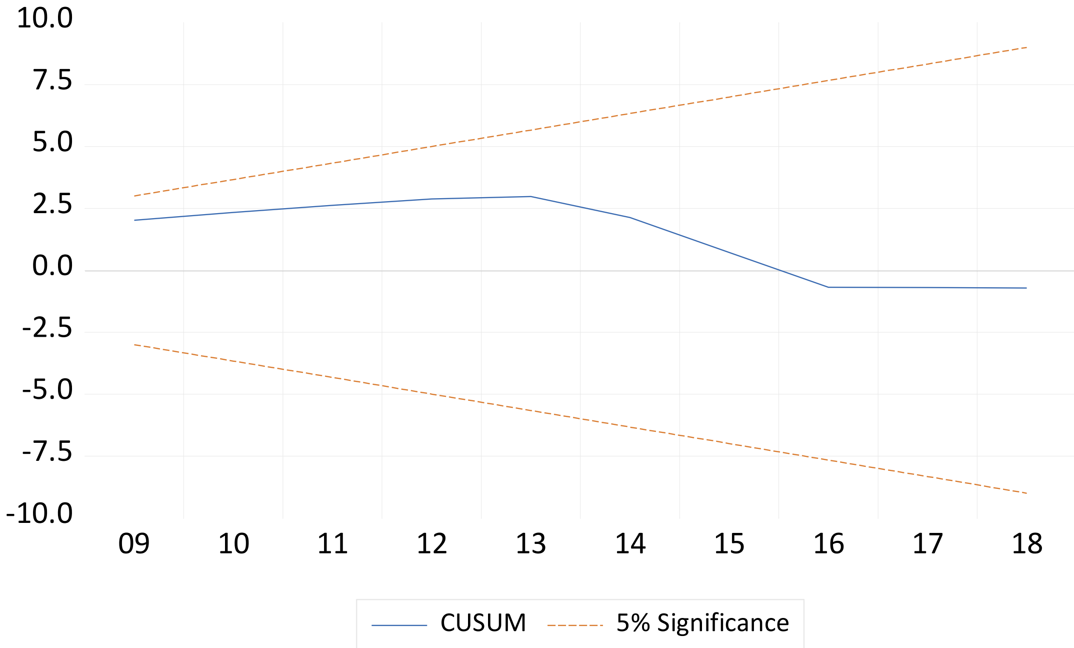
B-G null is no serial correlation.

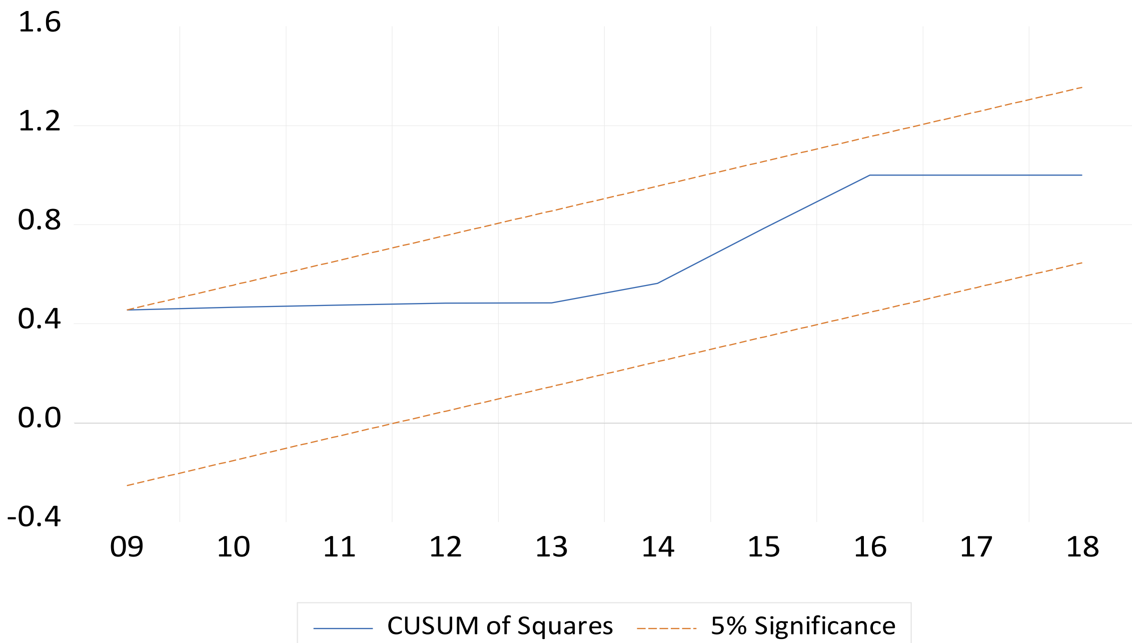
Heteroskedasticity Test: ARCH

F-statistic	0.609631	Prob. F(1,24)	0.4426
Obs*R-squared	0.644073	Prob. Chi-Square(1)	0.4222

ARCH null is no Heteroscedasticity.

Stability test results





Second essay

First period from 1990-2000

Decomposition estimation, from Coal and Gas separately estimations results:

Coal

Gas

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Total
1990	0.18	0.01	-0.19	0.06	-0.08	-0.02
1991	0.04	0.03	0.05	-0.04	0.00	0.07
1992	0.02	-0.01	-0.01	0.00	-0.06	-0.07
1993	-0.01	-0.02	0.03	-0.06	-0.10	-0.14
1994	-0.02	0.01	-0.02	0.05	-0.04	-0.03
1995	-0.12	0.01	0.11	-0.15	0.03	-0.13
1996	-0.05	0.02	0.03	-0.18	0.05	-0.13
1997	0.01	0.03	-0.04	-0.05	0.00	-0.06
1998	-0.26	0.00	-0.02	0.23	-0.26	-0.31
1999	0.18	0.00	-0.06	0.00	0.08	0.21
Total	-0.04	0.08	-0.12	-0.13	-0.37	-0.58

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Total
1990	0.25	-0.06	-0.19	0.06	-0.08	-0.02
1991	0.21	-0.20	0.05	-0.04	0.00	0.02
1992	-0.05	0.06	-0.01	0.00	-0.06	-0.07
1993	-0.08	0.12	0.03	-0.06	-0.10	-0.08
1994	-0.02	-0.06	-0.01	0.05	-0.04	-0.09
1995	-0.02	-0.09	0.11	-0.15	0.03	-0.13
1996	0.20	-0.22	0.03	-0.18	0.05	-0.13
1997	0.37	-0.33	-0.04	-0.05	0.00	-0.06
1998	-0.09	0.02	-0.02	0.23	-0.27	-0.12
1999	-0.01	-0.02	-0.06	0.00	0.08	-0.01
Total	0.71	-0.73	-0.12	-0.13	-0.36	-0.63

Complete decomposition result of CO_2 emissions

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Δtotal
1990-1991	0,43	-0,05	-0,38	0,13	-0,16	-0,03
1991-1992	0,25	-0,18	0,10	-0,08	0,00	0,09
1992-1993	-0,03	0,05	-0,03	-0,01	-0,12	-0,13
1993-1994	-0,09	0,10	0,07	-0,11	-0,19	-0,22
1994-1995	-0,04	-0,05	-0,03	0,09	-0,08	-0,11
1995-1996	-0,14	-0,08	0,21	-0,30	0,06	-0,25
1996-1997	0,15	-0,20	0,05	-0,35	0,10	-0,25
1997-1998	0,38	-0,30	-0,07	-0,11	0,00	-0,11
1998-1999	-0,35	0,02	-0,04	0,46	-0,53	-0,43
1999-2000	0,17	-0,02	-0,12	0,01	0,16	0,20
1990-2000	**0,66**	**-0,65**	**-0,23**	**-0,26**	**-0,72**	-1,21

Complete decomposition result of CO_2 emissions in %

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Δtotal
1990-1991	-1437,86	175,66	1255,71	-417,75	524,24	100,00
1991-1992	279,04	-199,13	108,78	-91,05	2,36	100,00
1992-1993	21,04	-39,90	21,16	5,42	92,29	100,00
1993-1994	39,54	-47,34	-29,96	51,18	86,58	100,00
1994-1995	34,95	45,86	26,06	-79,88	73,01	100,00
1995-1996	57,16	31,32	-83,48	119,98	-24,98	100,00
1996-1997	-57,09	78,56	-19,89	139,02	-40,59	100,00
1997-1998	-336,07	271,05	65,17	97,41	2,45	100,00
1998-1999	80,19	-5,19	9,59	-107,41	122,83	100,00
1999-2000	86,54	-8,97	-62,74	2,71	82,47	100,00
1990-2000	-54,89	54,10	19,36	21,54	59,89	100,00

Second period from 2000-2008

Decomposition estimation, from Coal and Gas separately estimations results:

Coal

Gas

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Total
2000	0.00	0.01	0.03	-0.12	0.19	0.11
2001	-0.07	-0.04	0.05	-0.05	0.11	-0.01
2002	0.07	0.00	-0.05	-0.14	0.23	0.11
2003	0.12	0.00	-0.03	-0.29	0.34	0.13
2004	-0.05	0.00	0.03	-0.27	0.28	-0.01
2005	-0.14	0.01	0.13	-0.30	0.35	0.05
2006	-0.07	0.00	0.03	-0.19	0.26	0.03
2007	-0.11	0.00	-0.01	-0.19	0.24	-0.08
Total	-0.27	-0.02	0.18	-1.59	2.05	0.35

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Total
2000	-0.08	-0.10	0.03	-0.12	0.19	-0.08
2001	-0.47	0.49	0.05	-0.06	0.11	0.13
2002	0.03	-0.02	-0.05	-0.13	0.23	0.05
2003	-0.02	-0.01	-0.03	-0.29	0.34	-0.02
2004	-0.19	0.04	0.03	-0.26	0.28	-0.10
2005	0.19	-0.07	0.13	-0.31	0.36	0.31
2006	-0.01	-0.05	0.03	-0.19	0.26	0.04
2007	-0.17	0.01	-0.01	-0.19	0.24	-0.12
Total	-0.73	0.30	0.18	-1.58	2.03	0.20

Complete decomposition result of CO_2 emissions

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Δtotal
2000-2001	-0.08	-0.09	0.06	-0.24	0.38	0.03
2001-2002	-0.53	0.46	0.09	-0.11	0.21	0.12
2002-2003	0.10	-0.02	-0.11	-0.27	0.45	0.16
2003-2004	0.10	-0.01	-0.07	-0.58	0.68	0.11
2004-2005	-0.24	0.04	0.06	-0.53	0.56	-0.11
2005-2006	0.05	-0.07	0.26	-0.60	0.71	0.36
2006-2007	-0.09	-0.05	0.07	-0.38	0.52	0.07
2007-2008	-0.28	0.01	-0.01	-0.38	0.48	-0.19
2000-2008	-1.00	0.27	0.36	-3.17	4.08	0.54

Complete decomposition result of CO_2 emissions in %

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Δtotal
2000-2001	-269,2	-302,7	202,8	-812,6	1281,7	100,0
2001-2002	-435,5	374,0	75,9	-89,8	175,3	100,0
2002-2003	64,7	-11,5	-66,4	-166,8	279,9	100,0
2003-2004	84,3	-8,1	-59,0	-508,7	591,4	100,0
2004-2005	213,1	-35,1	-52,5	468,4	-493,9	100,0
2005-2006	15,0	-18,5	72,8	-168,6	199,3	100,0
2006-2007	-121,9	-66,5	97,7	-545,7	736,5	100,0
2007-2008	145,5	-3,8	7,1	198,9	-247,7	100,0
2000-2008	-183,0	50,3	65,8	-583,1	750,0	100,0

Third period from 2008-2016

Decomposition estimation, from Coal and Gas separately estimations results:

Coal

Gas

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Total
2008	0.09	-0.01	0.05	0.13	-0.15	0.12
2009	-0.01	0.00	0.02	-0.20	0.25	0.06
2010	0.00	0.00	0.00	-0.26	0.30	0.05
2011	0.05	0.00	-0.04	-0.03	0.07	0.05
2012	0.06	0.00	-0.02	-0.10	0.12	0.06
2013	-0.05	0.00	0.00	0.09	-0.07	-0.02
2014	-0.27	0.00	0.18	0.17	-0.21	-0.12
2015	-0.08	-0.01	0.02	0.35	-0.33	-0.04
Total	-0.06	-0.01	0.22	0.16	0.00	0.31

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Total
2008	0.14	0.06	0.05	0.13	-0.15	0.23
2009	0.05	-0.01	0.02	-0.20	0.25	0.11
2010	-0.19	0.01	0.00	-0.25	0.30	-0.13
2011	0.21	0.01	-0.05	-0.03	0.08	0.22
2012	-0.56	0.00	-0.02	-0.09	0.11	-0.56
2013	0.81	-0.02	0.00	0.10	-0.08	0.81
2014	-0.14	-0.03	0.18	0.18	-0.21	-0.01
2015	0.12	0.08	0.02	0.35	-0.32	0.24
Total	0.10	0.11	0.23	0.17	0.00	0.60

Complete decomposition result of CO_2 emissions from 2008-2016

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Δtotal
2008-2009	0.23	0.05	0.11	0.26	-0.30	0.35
2009-2010	0.04	-0.01	0.05	-0.41	0.50	0.17
2010-2011	-0.19	0.01	0.00	-0.51	0.60	-0.09
2011-2012	0.26	0.01	-0.09	-0.06	0.15	0.27
2012-2013	-0.50	0.00	-0.04	-0.19	0.24	-0.50
2013-2014	0.76	-0.02	0.01	0.19	-0.14	0.79
2014-2015	-0.41	-0.02	0.36	0.35	-0.42	-0.14
2015-2016	0.03	0.07	0.04	0.70	-0.65	0.20
2008-2016	0.04	0.10	0.45	0.33	0.00	0.91

Complete decomposition result of CO_2 emissions in %

Year	Changes in EGEF	Changes in SEG	Changes in STPG	Changes in EI	Changes in GDP	Δtotal
2008-2009	66,53	14,96	30,41	73,51	-85,41	100,00
2009-2010	20,64	-3,97	27,11	-233,10	289,32	100,00
2010-2011	219,35	-13,83	3,13	597,65	-706,30	100,00
2011-2012	95,05	4,03	-32,95	-21,70	55,57	100,00
2012-2013	100,53	0,12	7,83	38,63	-47,10	100,00
2013-2014	96,16	-2,54	0,68	23,96	-18,26	100,00
2014-2015	295,09	17,68	-258,76	-254,00	299,99	100,00
2015-2016	17,31	34,09	22,20	350,60	-324,21	100,00
2008-2016	3,91	10,68	49,30	35,74	0,37	100,00

Third essay

Survey on Barriers to renewable energy sources development.

Ms. Amantay Akbota is performing this research under the supervision of faculty Professor of the International Energy Policy Program (IEPP) Seoul National University, Professor Kyun-Jin Boo. This survey is carrying out with the cooperation of IEPP of Seoul National University, South Korea, in order to study barriers of renewable energy sources development and for the purpose of the ranking barriers in Republic of Kazakhstan.

The main goal of this questionnaire is to identify main barriers and rank the according to the importance. This questionnaire includes pair-wise comparison questions addressed to the government officials and experts in energy sector, to seek their judgments representing the relative influence of pre-identified barrier criteria's and sub criteria's. All your response to this survey will be confidential and used only for academic research purpose. The answers provided by participants will be confidential. The information obtained from the participants will only be for writing a doctoral dissertation.

If you have any comments, suggestions or questions about this survey, do not hesitate to contact me via e-mail aakbota@mail.ru.

Using Analytic Hierarchy Process model (AHP), I will analyze the government officials' opinions and experts in energy sector in Kazakhstan. AHP allows to compare the importance of alternative factors affect on decision making process. Through the questionnaire, the interviewees will express their thoughts about barriers of renewable energy sources development.

Explanation:

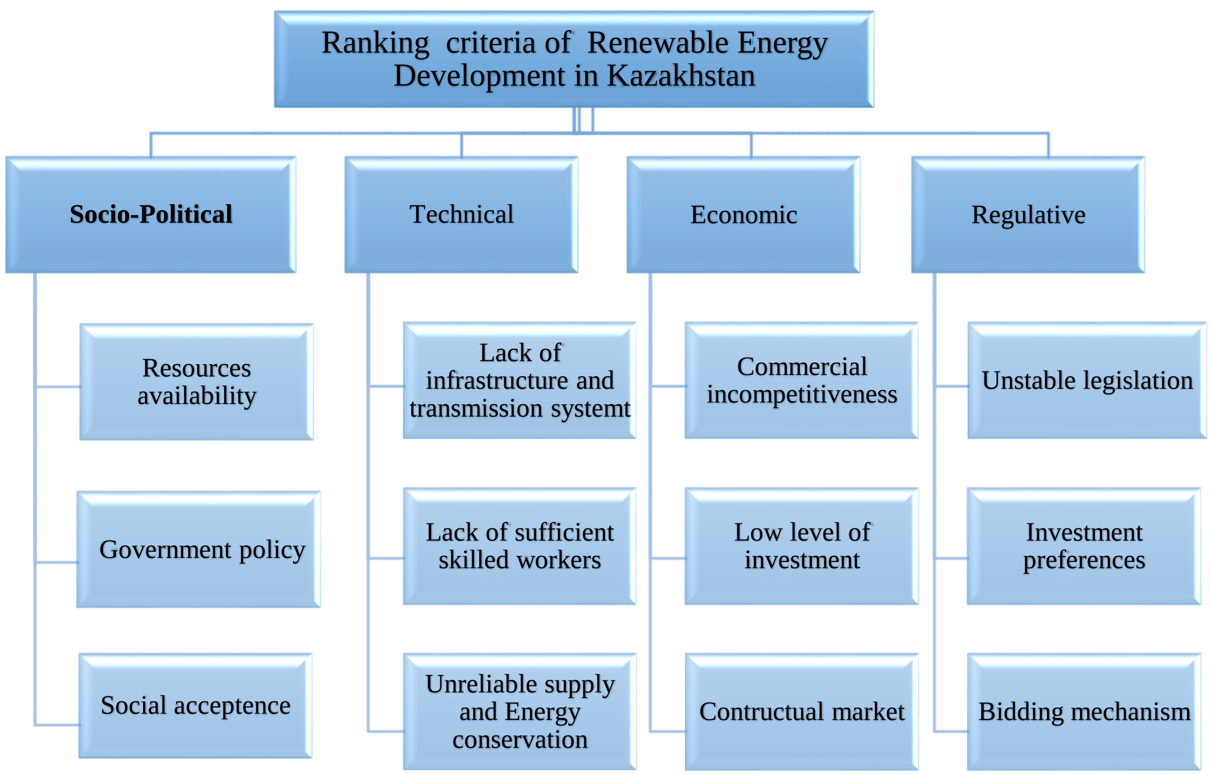
Through a survey questionnaire, we intend to evaluate 4 criteria's by obtaining the views and opinions of experts. For a sub-criteria analysis, Analytic Hierarchy Process (AHP) is employed. The AHP is method designed to help in prioritizing very complex decision alternatives involving multiple stakeholders and multiple goals. Pair-wise comparisons are the fundamental buildings blocks of AHP. By using the questionnaire, the participants compare the relative importance of the criteria and sub criteria's pair-wise with respect to the goal. As shown in below, the first level of hierarchy is the ultimate goal of the project; the second level represents the criteria barriers of which the projects are to be evaluated and, finally, the third level presents the sub-dimensions of barriers.

Table 2. Barriers to Renewable Energy Development –Context of Kazakhstan.

Criteria	**Sub-criteria**	**Description**
Socio – Political Barriers	Resources availability	Kazakhstan is among the top ten countries which has a lot of hydrocarbons and mineral resources. It might be reason for the stuck in development of RES.no need to develop RES since we have cheaper way to have electricity.
	Government policy	Too ambitious goals for develop RES for the country, which has huge reserves of natural energy resources. The main load on purchasing electricity government put on a coal-fired power plants.
	Social acceptance	Low environmental awareness of the population and lack of consumer acceptance of RES technologies in general.
Technical Barriers	Lack of infrastructure and transmission system	Low developed or deteriorating infrastructure leads to high costs and losses, especially in transportation and transmission electricity.
	Lack of sufficient workers	There is a shortage of qualified personnel and a lack of competence on the part of the authorities;
	Unreliable supply and Energy conservation	Unstable nature of work is the main problem of renewable energy sources, that's why the RES might disrupt the operation of power system and call imbalance in supply of electricity.
Economic Barriers	Commercial incompetitiveness	Green" energy is expensive compared to traditional energy, and it can develop only by government support.
	Low level of investment	During 2020-2024 The annual investment will be required about 1.8% of total GDP.
	Contractual market	According of legislation only one consumer will buy all energy from the RES, it's like a guarantee from the government but how come one company financially can handle all sellers.

Regulative barriers	Unstable legislation	Low legislation and regulatory framework which required to promote renewable energy
	Investment preferences	Subsidies and other incentive tools should be revised to reach more investors and projects
	Bidding mechanism	Based on theoretical insights and supported by empirical renewable electricity auction examples, some factors can influence the success of an auction but also shows there is no exact blueprint for a good auction design.

Figure 1. Hierarchical Structure of Research



Example: You have to compare the relative importance between Socio-Political and Technical criteria's for develop renewable energy sources in RK and to answer this question, you can choose ONLY ONE OPTION among all nine options, which strongly represents your view of it.

Options A	Extremely		Very Strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very Strongly		Extremely	Options B
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Technical**
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Economic**

1. It shows option A (Socio-Political) and Option B (Technical) is equally important criteria of renewable energy development.

2. It shows Option A (Socio-Political) Very strong criteria in comparison with Option B (Economic).

More details for each number of meaning:

9: if Socio-Political is EXTREMELY MORE IMPORTANT than Technical

7: if Socio-Political is VERY STRONGLY MORE IMPORTANT than Technical

5: if Socio-Political is STRONGLY MORE IMPORTANT than Technical

3: if Socio-Political is MODERATELY MORE IMPORTANT than Technical

1: if Socio-Political and Technical are EQUALLY IMPORTANT

3: if Technical is MODERATELY MORE IMPORTANT than Socio-Political

5: if Technical is STRONGLY MORE IMPORTANT than Socio-Political

7: if Technical is VERY STRONGLY MORE IMPORTANT than Socio-Political

9: if Technical is EXTREMELY MORE IMPORTANT than Socio-Political

SELECTION OF MAIN CRITERIA

In this section you have to provide your professional judgment in comparing the relative importance between two main criteria.

Description of each main criterion:

a. **Socio-Political**

The criterion used to determine the social and political barriers which affecting for develop of RES.

b. Technical

The criterion used to evaluate the technical aspect of the technologies which needs for the smooth operation of power plants and needs some requirements like human source with technical knowledge in this field.

c. **Economic**

The criterion used to determine the economic cost-and-benefit value which should be considered by government in plan for the steps on "green economy" in develop of RES.

d. **Regulative**

l.Underline or color the relative weighting of your chosen criteria according to the scale shown in the above table

Option A	**Extremely**		**Very strongly**		**Strongly**		**Moderately**		**Equally**		**Moderately**		**Strongly**		**Very strongly**		**Extremely**	**Option B**
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technical
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Economic
Socio-Political	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Regulative
Technical	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Economic
Technical	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Regulative
Economic	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Regulative

SELECTION OF SUB CRITERIA

Since RES fields have to be analyzed, the barriers of RES development should be studied.

Thus, in this section you have to provide your professional judgment in comparing the relative importance criteria's between two sub criteria of Socio-Political Criterion.

Description of each sub criterion in social-political criteria:

a. **Resources availability**

Kazakhstani has mineral and hydrocarbon energy sources

b. **Government policy**

The criterion analyzes the integration of the national energy policy and the suggested renewable energy alternative. Too ambitious goals for develop RES for the country, which has huge reserves of natural energy resources.

c. **Social acceptance**

Option A	**Extremely**		**Very strongly**		**Strongly**		**Moderately**		**Equally**		**Moderately**		**Strongly**		**Very strongly**		**Extremely**	**Option B**
Resource availability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Government policy
Resource availability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social acceptance
Government policy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social acceptance

SELECTION OF SUB CRITERIA

Since RES fields have to be analyzed, the barriers of RES development should be studied.

Thus, in this section you have to provide your professional judgment in comparing the relative importance between two sub criteria of Technical Criterion.

a. Lack of infrastructure and transmission system

This sub- criteria used for analyze of infrastructure for the smooth operation of power plants which can also affect for leads to high costs and losses, especially in transportation and transmission electricity.

b. Lack of sufficient skilled workers

This sub- criteria considering for evaluate ability of workers on RES projects, there is a shortage of qualified personnel and a lack of competence on the part of the authorities;

c. Unreliable supply and Energy conservation

The factor used to express the opportunity of RES. Unstable nature of work is the one of the problem of renewable energy sources, that's why the RES might disrupt the operation of power system and call imbalance in supply of electricity.

Option A	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	Option B
Lack of infrastructure and transmission system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Lack of sufficient skilled workers
Lack of infrastructure and transmission system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Unreliable supply and Energy conservation
Lack of sufficient skilled workers	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Unreliable supply and Energy conservation

SELECTION OF SUB CRITERIA

Since RES fields have to be analyzed, the barriers of RES development should be studied.

Thus, in this section you have to provide your professional judgment in comparing the relative importance between two sub criteria of Economic Criterion.

Commercial incompetitiveness

Green" energy is too expensive compared to traditional energy, and it develops only from government support.

Low level of investment

During 2020-2024 The annual investment will be required about 1.8% of total GDP. All RES project are implementing by investors, to get all goals in a RES development according of Green Economy concept, might be considered as a plan, because to implement this, needs a lot of projects, with a lot of payback, which is very difficult to organize, and call the interest from investors.

Contractual market

Option A	**Extremely**		**Very strongly**		**Strongly**		**Moderately**		**Equally**		**Moderately**		**Strongly**		**Very strongly**		**Extremely**	**Option B**
Commercial incompetitiveness	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Low level of investment
Commercial incompetitiveness	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Contractual market
Low level of investment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Contractual market

SELECTION OF SUB CRITERIA

Since RES fields have to be analyzed, the barriers of RES development should be studied.

Thus, in this section you have to provide your professional judgment in comparing the relative importance criteria's between two sub-criteria's of Regulative Criterion.

Unstable legislation

The applicable law on renewables has a great number of reference standards preventing from proper application of their provisions.

Investment preferences

How is the quality of investors' opportunity for the RES projects now? This issue should be analyzed through experience that we have done already in this fields. Noted, In 2016 almost all projects of RES was stopped.

Bidding mechanism

Auctions also aim at increasing (static) cost-effectiveness of renewable electricity support, which may be influenced by some main factors: first, the level of competition in the auction; second, the mitigation of speculative over- or under-bidding.

Option A	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	Option B
Unstable legislation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Investment preferences
Unstable legislation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bidding mechanism
Investment preferences	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bidding mechanism

(Respondent Demographic and general Information)

Name	
Organization Type	◌ Goverment ◌ NGO/INGO ◌ Private ◌ Development Partner ◌ Other
Position	
Working Experience	Choose an item.

(Years)	
Email and Contact No	

The survey have been sent to the Ministry of energy and for the national companies in energy sector. LLM “PSA”, “Samruk energy”, LLM “KazMorTransflot” of Kazakhstan, National Company Kazakh Invest, Kaztransgas Aimak JCS, Ereymentau Wind Power LLM.

List of acronyms

UPS	Unified Power System
NEG	Electrical network grid
ESO	Energy supplying organizations
REC	Regional electric grid companies
KEGOC	Kazakhstan electric grid operating company
ECE	Energy conversion efficiency
EAEU CEM	Common Electricity Market (CEM) of the Eurasian Economic Union (EAEU)
EPC CIS	Electric Power Council of the Commonwealth of Independent States
Wind PPs	Wind power plants
SESs	Solar electric stations
NPPs	Nuclear power plants
AHP	analytical hierarchy process
HFCs	Hydro fluorocarbons
PFCs	Perfluorocarbons
ODS	Ozone-depleting substances
EKC	Environmental Kuznets Curve
NDC	Nationally determined contribution
MTOE	Million tons of oil equivalent
LMDI	Logarithmic Mean Division Index modeling
FEB	Fuel and energy balance
CRF	Common reporting format
AIC	Akaike information criterion
SIC	Schwarz information criterion
SFC	Settlement and Financial Center

Abstract (Korean)

이 연구는 카자흐스탄 "녹색 경제"의 개념적 틀 내에서 전력 부문을 분석하는 것을 목표로 한다. 카자흐스탄 공화국의 전력 부문은 특히 석탄, 석유 및 가스의 이용으로 인해 환경 오염에 상당한 기여를 한다. "녹색 경제"의 개념에 따라, 카자흐스탄은 향후 30년 동안 전력 부문을 현대화하여 CO2 배출량을 줄이고, 일부 지역을 가스화 하며, 재생 가능 에너지의 비중을 늘릴 계획이다. 본 연구의 주요 목표는 다음 세 가지 질문을 조사하는 것이다.

첫 번째 에세이인 "성장의 환경적 결과: 카자흐스탄 공화국 사례의 실증적 분석"은 에너지 소비를 통제한 상황에서 카자흐스탄의 경제 성장이 CO2 배출량에 미치는 영향을 자기회귀 분산 지연 (ARDL) 통합 프레임 워크를 이용해 분석한다. 분석 결과, 환경 쿠즈네츠 곡선(Environmental Kuznets Curve, EKC) 가설이 확인되었으며, 에너지 소비는 CO2 배출량을 증가 시키고, 더미 변수(D07)를 이용하여 추정된 정부 정책은 CO2 배출량에 부의 영향을 미침을 관찰할 수 있었다. 이는 CO2 배출 저감 정책이 잘 작동하고 있음을 의미한다.

두 번째 에세이인 "카자흐스탄의 석탄 및 가스 발전에서 발생하는 CO2 배출량의 분해 분석"에서는 전력 발전 시 발생했던 과거 이산화탄소 배출 패턴을 분석하는 동시에 지수 분해 분석을 기반으로 한 추진 인자 분석을 1990-2000, 2000-2008, 그리고 2008-2016의 세 기간에 걸쳐 수행하였다. 경제 활동 효과 ΔGDP는 첫 번째 기간 동안 CO2를 -0.72Mt에서 0.00Mt로, 전력 강도 효과 ΔEI를 -0.26Mt에서 0.33Mt로 증가시킨 반면, 발전 효율 효과 ΔEGEF는 같은 기간 동안 0.66Mt에서 0.04Mt로 감소시켰다. 화력 전력 구조 효과 ΔSEG는 첫 번째 기간 동안 -0.65Mt에서 0.10Mt로 증가한 반면, 전력 구조 변화 효과 ΔSTPG는 마지막 기간 동안 -0.23Mt에서 0.45Mt로 증가했다.

세 번째 에세이인 "카자흐스탄의 재생 가능 에너지 개발에 대한 장벽 분석"은 선행 연구 및 두 그룹의 에너지 분야 전문가(민간 및 정부 전문가)와의 상호 작용을 통해 16 개 장벽 요인을 결정하였다 (4 개의 주요 요인 및 12 개의 보조 요인). 우리는 AHP (Analytical Hierarchical Process) 방법론을 사용하여 재생 가능 에너지와 관련된 장벽의 중요도를 식별하였다. 분석 결과, 정부 전문가에게는 경제 장벽이 가장 중요했지만 민간 전문가에게

는 기술 장벽이 가장 중요했다. 전반적으로, 정부 전문가는 여러 장벽 중 낮은 수준의 투자를 가장 중요한 요인으로 평가하고 민간 전문가는 인프라 및 전송 시스템의 부족을 가장 중요한 요소로 평가하였다.

핵심어: ARDL, AHP, LMDI, 카자흐스탄, 신재생에너지, CO_2 배출량, 전기, 녹색 경제

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