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Analysis of Past, Present & Future Developments in Green Technology: Renewable Energy Sources (RES) field of Kazakhstan

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The following thesis conducts a research on understanding Kazakhstan's potential of reaching its target indicators in renewable energy sources (RES) field. One of the future ambitious aim of Kazakhstan in developing the concept of "Green Economy" is to reach renewable energy consumption level in electricity to 3% (solar and wind) by 2020, 10% by 2030 and 50% (alternative and renewable energy sources) by 2050.

The author was interested in studying the presence of Kazakhstan in developing RES field, which affects the economy of the country and well-being of the citizens as well as achieving its goal of being amongst 30 most developed countries in the world according to Kazakhstan 2050 Strategy. The author aims to understand whether it is high or low probability for Kazakhstan to achieve its goals in RES field, by making detailed exploratory research as well as based on analysis of numerical data. Additionally, through the participation in official meetings and international events the author gathered valuable insights in understanding and elaborating the topic.

The entire investigation of the thesis is fundamentally based on the analysis / assessment of past, present and future developments of Kazakhstan in RES field. This approach enables to fully understand the topic from the past to the future to seek for patterns and progress of Kazakhstan, and finally provide reasonable conclusion for the research, which eventually explains that Kazakhstan is showing high probability in reaching its nearest targets in RES field.

Keywords	Kazakhstan, Renewable Energy Sources (RES), Energy, Targets, Green Economy, Ministry of Energy

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Definitions of Key Abbreviations

AIFC – Astana International Financial Center

AREK – Association of Renewable Energy of Kazakhstan

ADB – Asian Development Bank

CRNMPC – Committee for Regulation of Natural Monopolies, Protection of Competition and Consumer Rights

CFI – Council of Foreign Investors

DBK – Development Bank of Kazakhstan

EBRD – European Bank of Reconstruction & Development

EDB – Eurasian Development Bank

EXPO – A large international exhibition

FSC LLP – Financial Settlements Center (limited liability partnership)

GDP – Gross Domestic Product

IGTIC – International Green Technologies & Investment Center

IEA – International Energy Agency

IFIs – International Financial Institutions

IRENA – International Renewable Energy National Agency

KZT – Kazakhstan National Currency

KEGOC JSC – Kazakhstan Electricity Grid Operating Company (joint-stock company)

MERK – Ministry of Energy of the Republic of Kazakhstan

OECD – Organisation for Economic Cooperation and Development

PPA – Power Purchasing Agreement

QFTC – Qazaq Finnish Technology Center

RK – Republic of Kazakhstan

RES – Renewable Energy Sources

Measurements

Mtoe – Million tonnes of oil equivalent

MWt / MW – Megawatt

TWh – Terawatt hour(s)

GWh – Gigawatt hour(s)

KWh – Kilowatt hour(s)

1 MW = 1000 KWh

1 Introduction

1.1 Description & Objectives

At the moment, Kazakhstan is considered as one of the rapidly growing countries in the world. (WorldBankData 2018) Therefore, the focus of the author was to identify important features that can influence positively development of Kazakhstan. Despite huge reserves of natural resources in Kazakhstan, the Kazakh elite decided to implement a "Green Economy National Concept" to improve the welfare of people & create sustainable economy. As one of the main solutions is to make a smooth shift in developing green technology sector and one of the main fields within this sector - is development of renewable energy sources (RES) field in the country.

The topic is important, since development of green technology and specifically renewable energy field (RES) in Kazakhstan will directly affect the sustainable development of economy in the country, and its future objective of being amongst the 30 most developed countries in the world by 2050 according to the "Strategy Kazakhstan 2050". Apart from a global meaning of this topic against global warming, another idea is that a country with the newest technologies will win the competition against the country with large reserves of natural resources.

The main point is that renewable energy will inevitably be the main source of energy in the long run, because mankind cannot use finite resources of energy indefinitely. The fossil fuel is the main source of energy in the world and one of the main causes of environmental problems. The potential behind the natural flows of energy in our planet of earth is far beyond what mankind is exploiting. The solar energy emitted by the sun heats the planet, which generates the wind. While wind itself creates waves and the sun also makes the evapotranspiration cycle that gives a possibility of generating power by water with hydro technologies, which is currently the largest electricity utilized from renewable sources. (Council 2016: 8) Also, the photosynthesize process of plants results with a chemical storage of solar energy, which is called as biomass products such as wood fuel to rapeseed, that can be utilized for the generation of

heat, electricity and liquid fuels. Thus, renewable energy sources and generally green technology development will affect the sustainability of economy in the 21st century.

The renewable energy sources (RES), as one of the main fields in green technology, as well as other important fields, such as waste to energy and water treatment will solve the issues with energy supply and climate change, as well as create future sustainable economy. (Council 2016: 11) Therefore, for Kazakhstan as the 9th largest country in the world (territory) with all the natural elements available in the territory according to the Mendeleev periodic table, is a great chance to realize its potentiality for future sustainable climate and economy in the whole Eurasian continent.

In the sector of green technologies and specifically in RES, the future ambitious aim of Kazakhstan is to reach renewable energy consumption level in electricity to 3% (solar and wind) by 2020, 10% by 2030 and 50% (alternative and renewable energy sources) by 2050. As well as reduction of GHGs by unconditional 15% in 2030 and unconditional 25% depending on the international investment and reduction of the energy intensity of GDP by 25% in 2020 according to the established "National concept for transition of the Republic of Kazakhstan to Green Economy" on May 30, 2013. (MERK 2013: 6-8) The success of the RES development will directly determine the achievement of the latter targets.

The main research question the author attempts to answer is **"To what extent the past, present & future developments of Kazakhstan in renewable energy sources (RES) field explain the country's probability in achieving its targets?"**. Will RES field be a success story of Kazakhstan? Considering that currently the electricity generated from renewable sources of energy is around 1% in Kazakhstan and the country still uses out-of-date technologies, which unnecessarily pollute the air and causes environmental problems. One of the essential topics is the creation and presence of international centers, communities, financial institutions & businesses for green technologies, which are powerful instruments for Kazakhstan that can stimulate the development of green technologies and RES within the country and outside of it. The recent development in this regard is the International Astana EXPO-2017 event held in the capital of Kazakhstan during the summer of 2017, with a topic of "Future Energy". The exhibition Astana EXPO-2017 involved more than 100

countries' pavilions sharing its best practices and expertise in innovative technologies as well as more than 5 million visitors from all over the world.

As a heritage and continuation of Astana EXPO-2017, the "International Green Technologies & Investment Center" (IGTIC) was launched in May 2018 in Astana. As noted by the chairman of the center Rapil Zhoshybayev, a solid foundation in the project is laid down by a number of "green" initiatives of the Head of State Nursultan Nazarbayev, such as the earlier mentioned "International Specialized Exhibition Astana EXPO-2017", "the National Concept of Kazakhstan's transition to a Green Economy", "Astana International Financial Center (AIFC)" the "Green Bridge" Partnership Program, the "Global Energy and Environmental Strategy" & others.

1.2 Research Question & Methodology

The thesis aims to investigate the main research question throughout the thesis to find most reasonable answer. Specifically, renewable energy sources field (RES) form the main analysis of the thesis.

The author investigates the main research question, which states **"To what extent the past, present & future developments of Kazakhstan in renewable energy sources (RES) field explain the country's probability in achieving its targets?".** Therefore, the author determines the answer to this question based on the analysis / assessment of past, present and future developments in green technology: more specifically in RES field of Kazakhstan by involving explanation of separate individual topics. An answer to the main research question is not given as an exact numerical data, but the answer is based on high or low probability according to the analysis conducted.

To answer to the main research question, the following structure of analysis was chosen. **First,** the initial section of the thesis gives comprehensive overview about Kazakhstan. **Second,** then starts the main body, which explains the recent developments in green technology sector: renewable energy sources field of Kazakhstan. **Third,** 2018 and future developments in RES field of Kazakhstan is elaborated. **Fourth,** this part of the thesis involves detailed research about energy sector and RES field of Kazakhstan, which gives a detailed content regarding

Kazakhstan's energy sector situation and overview about RES field. **Fifth section** is devoted to the investigation of real case scenarios of achieving RES targets adopted by the Ministry of Energy, which clearly show certain road maps Kazakhstan can implement to reach its target indicators. **Sixth section** provides analysis of the main barriers in Kazakhstan's renewable energy development and generally in green technology sector. **The last but not least,** the author formulated and gathered certain future recommendations for the players in RES development of Kazakhstan. **Thus,** all the topics mentioned sum up the main content of the research and analysis, which affords to objectively answer to the main research question in the conclusion.

The following thesis has the structure of inductive method, whereby specific interconnected topics were analysed to finalise with a general view or statement. First, the author conducted a literature review of the most important topics using qualitative secondary sources and explained the patterns in each topic. Second, with help of the literature review, the further analysis was conducted about more specific topics, namely 2018 and future RES developments, overview of energy and RES field, scenarios, finding out the barriers and future recommendations. As a result, the conclusion is given with certain statements as answers for the main research question.

On the other hand, the research itself is based on qualitative exploratory research such as secondary research and quantitative research with numerical data. The reviews are the based on the national programs, concepts and reports developed by the government of Kazakhstan, international institutions, books, articles and websites. The tables, graphs and pictures are used to illustrate the findings of the reviews and make it easier to read.

Also, important to note that the author developed this thesis topic for a Finnish company Kaukointernational Oy. Therefore, the author took the responsibility of ensuring the right quality of the research as the provided analysis can have an influence on the decisions of the managers from the company. The findings of the thesis are essential for Kaukointernational, because it is closely linked to the potential activities of newly established non-commercial Qazaq Finnish Technology Center (QFTC) by Kaukointernational. QFTC has an aim of bridging the technological gap between Kazakhstan and Finland. One of the focus areas of QFTC might be RES field

of Kazakhstan, and therefore, the analysis provided by this thesis is an important additional measure for the company to make further decisions. Also, Kaukointernational gave an opportunity for the author to participate in different workshops, meetings and international events connected to RES and generally green technology development in Kazakhstan. These were valuable ways of collecting updated right quality data with new ideas for the thesis development. All the information sources used are cited and listed as references.

1.3 Limitations

The topic is relatively new and actively developing in Kazakhstan and therefore, there are always new updates and developments in this topic. This means that the current thesis has to be updated on a regular base in order to make it more relevant. At the same time, since Kazakhstan is a young country and started developing green technology and RES relatively recently, the amount of needed information might be less than required to have a sufficient analysis. The early stage development of Kazakhstan in this topic limits to have more definite answer to the main research question, which in this case could be in the form of approximate percentage or number.

1.4 Recommendations

The main recommendation for this thesis is to keep analysing the development of Kazakhstan in green technology and specifically in RES field. This will help to better answer the research question and further develop the analysis. Conducting interviews from local or international experts, who have direct or indirect relation to the research or surveys from a certain number of participants can be also carried in order to increase the value of the research and to conclude with more concrete answer.

2 Overview about Kazakhstan

2.1 History

According to the statistics Kazakhstan is the ninth largest country and largest landlocked country in the world according to the land area, which is based in Central Asia. (Gilmanova 2017) Kazakhstan declared its independence on 16th of December in 1991, after the collapse of the Soviet Union. Despite relatively young age of the country, the history of Kazakh people stretches back more than five centuries, and the history of Kazakhs who were part of the nomads of the Eurasian steppe goes back even further to the first centuries. The most important years were during Soviet years when the first movements to the independence were made. (Fast 2004: 14) For example, in the 1960s Dinmukhamed Konaev became the first secretary of the Kazakh SSR, and then in 1989 Nursultan Nazarbayev also became the first secretary of the Kazakh SSR. As a result, after a collapse of Soviet Union in 1991 Nursultan Nazarbayev was chosen as the first president of Kazakhstan and announced the independence of the state. Generally, before the independence Kazakh people experienced tough centuries with the high cost, measured in human lives, as well as great improvements during especially Soviet years in developed health care, higher education and industrialization. Most importantly, during the period after gaining an independence until this moment, Kazakhstan reached significant results in its economic and political sides and gained a reputation as a petroleum powerhouse and as the leader within Central Asian republics. (Fast 2004: 15)

2.2 Geography and demography

Kazakhstan is located in the north of Central Asia and has 5 bordering countries, namely Russian Federation in the north, China in the east and south-east, Kyrgyzstan and Uzbekistan in the south, the Caspian Sea and Turkmenistan in the west (Figure 1). The land area is 2 717 300 km2 with around 1894 km of shore on the Caspian Sea, which makes Kazakhstan as the 9th largest country in the world according to the territory. Since Kazakhstan is the largest landlocked country having rare rainfall with average number of rivers and lakes, water is a key recourse in Kazakhstan. The country is sparsely populated with around 18 million people and current capital city is

Astana. Kazakhstan is a multinational republic, with the 2nd largest nationality being Russians, then Kyrgyzs, Germans, Uzbeks and others. (Fast 2004: 18)

Figure 1. The map of Kazakhstan (Fast 2004)

2.3 Economy

The economy of Kazakhstan is structured on petroleum and mining industries. The first international investments to extract and process its natural resources played an important role to the growth of economy in the country. The first major investment was from Chevron to Tengiz oil field, which was signed in 1993 for US $20 billion for the period of 40 years. The following main projects were the Karachaganak gas-condensate field, Caspian pipeline, the East Kashagan oil field and others. Kazakhstan also has large reserves of hard minerals such as coal, iron, copper, zinc, lead, chromium, gold silver and others. During the Soviet years, the focus was on heavy industry. In the last decade, there was a change to oil and gas, food processing and professional services. There was also a shift from state ownership to private ownership, with about two thirds of GDP now in private hands. According to the World Bank Data, the recent 2017 GDP (current US$) was 159.407 billion with a GDP per capita being around 8,000 US$. (DataWorldBank 2018) On the other hand, agriculture also plays an important role in the economy, with the largest share as an exporter of

grain along the region. In addition, the transport and logistics sector development in Kazakhstan is significant since the country has high potential of being the main international trade corridor between Europe and Asia. (Fast 2004: 20)

3 Recent developments in renewable energy field (RES)

3.1 "Green Economy" National Development Programme

Kazakhstan is the first country in Central Asia, which adopted institutional base in support of "Green Economy" concept. The first tangible step was the approval of Ecological Code in 2007, and a law in support of utilizing Renewable Energy Sources (RES) in 2009. Afterwards, in 2013 May, the President of Kazakhstan Nursultan Nazarbayev declared the concept for transition of the Kazakhstan to "Green Economy", which plays an important role in the adopted strategy "Kazakhstan 2050". The idea behind "Green Economy" is an economy that has high living standards with the right utilization of natural resources, considering the interests of present and future generations, as well as in consideration with international environmental obligations. (MERK 2013: 2-6)

The "Green Economy" concept is an instrument for the nation's sustainable development. The future targeted results after the implementation of a "Green Economy" plan will be the increase of GDP by 3%, creation of 500,000 new jobs, development of new industries and services, availability of higher living standards all over the country by 2050. (MERK 2013: 3) The estimated investments needed to make a transition to a "Green Economy" will be around 1% of GDP per annum, which is equivalent to USD of 3 to 4 billion. There are many important targets set for the future such as reduction of GHGs by unconditional 15% in 2030 and unconditional 25% depending on the international investment, access to the mechanism of low-carbon technology transfer and green climate funds. In energy efficiency, the task is to reduce the energy intensity of GDP by 25% in 2020. (MERK 2013: 7)

One of the main targets is also in power sector, whereby Kazakhstan aims to reach a share of renewable energy sources in electricity production by 3% (solar and wind) in 2020, by 30% (20% alternative and 10% renewable energy sources) in 2030, by 50% (alternative and renewable energy sources) in 2050. As one of the general approaches

of transition to "Green Economy" is a development of new green technologies in the energy sector. The expected investments in the energy sector is around USD 50 billion by 2030 and around USD 100 billion by 2050. Up to 50% of these investments will be towards renewable and alternative energy sources, which will create employment opportunities in the high-tech renewable energy field. (MERK 2013: 6)

Table 1 gives a brief description of some of the targets set in "Green Economy" national concept.

Table 1. Main examples of the targets set in "Green Economy" concept

"Green Economy" National Concept	
Main Fields	**Targets**
Renewable Energy Sources (RES)	To reach a share of renewable energy sources in electricity production by 3% (solar and wind) in 2020, by 30% (20% alternative and 10% renewable energy sources) in 2030, by 50% (alternative and renewable energy sources) in 2050.
Energy Efficiency	To reduce the energy intensity of GDP by 25% in 2020
Air quality	To reduce GHGs emissions by unconditional 15% in 2030 and unconditional 25% depending on the international investment

Since Kazakhstan's economy is oriented in natural resources extraction, the transition to a "Green Economy" will take decades. Therefore, the "Green Economy" concept will be implemented during three stages:

1) **2013-2020:** During this current period government's main goal is to optimize resource use and increase the efficiency of the environment protection activities. At the same time, to establish green infrastructure.

2) **2020-2030:** The transformation of the national economy will start during this period within created green infrastructure. Developments will be such as rational water use, stimulation of development and implementation of

renewable energy technologies. Also, construction of highly energy efficient facilities.

3) **2030-2050:** Develop the national economy based on the standards of Third Industrial Revolution, whereby natural resources should be used according to the conditions of renewability and sustainability. (MERK 2013: 30-55)

3.2 Analysis of renewable energy field in Kazakhstan

The economy of Kazakhstan mainly benefits from its natural resources such as oil, gas, coal and uranium, heavy industry (ferrous and non-ferrous metals) and agricultural sectors. In 2010 33% of GDP was shared with the petroleum and mining industries, which accounted for 82% of exports. From 1999 to 2013 the GDP showed a rapid growth from 16.9 billion USD to 224.4 billion USD. This type of economic growth positively affected the wellbeing of citizens, which decreased the poverty of total population from 47% in 2001 to 3% in 2013. (MERK 2013: 3-4)

Along with the rapid economic development the demand in electricity consumption has also increased, which led to power shortages during the winter periods. Particularly, in 1999 the energy consumption was 26.92 Mtoe, which has risen to 82.03 Mtoe in 2013. While the annual power generation doubled its amount from 45 TWh in 1999 to 91 TWh in 2013. The 10% of power is generated from hydroelectric power stations located near the Irtysh River, while thermal-powered plants amounts to 90% of power generated. The main problem is that renewable energy sources (RES) in Kazakhstan shares less than 1% of total energy consumed with wind, solar, hydro and bioenergy sources. (Karatayev & Michele L. 2016: 2)

However, the government plans to increase the renewable energy consumption in electricity by (Figure 2.) 3% (solar and wind) in 2020, 10% in 2030 and 50% (alternative: nuclear plants and renewable energy sources) by 2050, which are very ambitious and challenging objectives to achieve. As well as reduction of GHGs (greenhouse gas emissions) by unconditional 15% in 2030 and unconditional 25% depending on the international investment and reduction of the energy intensity of GDP by 25% in 2020. (MERK 2013: 6-7)

Figure 2 below shows an illustration of the targets set in Kazakhstan's "Green Economy" concept in RES field. (see next page.)

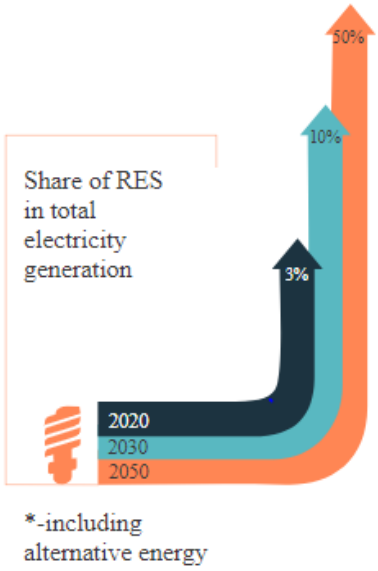


Figure 2. Share of RES in total electricity generation (KazEnergy 2015)

To enhance the development of renewable energy, feed-in tariffs for wind and solar energy were created in August 2013 within a new law on supporting the use of renewable energy sources and with support from the European Bank for Reconstruction and Development (EBRD). The Wind Power Development Programme by 2030 was also established to prioritize the development directions in RES. (IEA 2014: 13)

According to the conference organised by Ministry of Energy of Kazakhstan in 23rd of February 2018, the results in energy sector of 2017 and targets to the following years were discussed. In 2017, the energy produced from RES was accounted for 1.1 billion KW per hour, which is 22% more than in 2016. The plan for 2018 is 1.7 billion KW per hour, which is 54.5% more than in 2017. In 2017, 5 renewable energy sources were established, while the plan for 2018 is to construct 10 technologies of RES with a total capacity of 123 MW per hour. (Energy 2018)

During Astana world EXPO-2017 Exhibition in 21st June 2017, conference in energy sector development of Kazakhstan was held in Astana, whereby important agreements were signed between the Ministry of Energy of Kazakhstan (MERK), financial institutions and investors. For instance, the support to the construction of solar wind

power plants in Kazakhstan was given through the signed agreement with the European Bank for Reconstruction and Development (EBRD) to allocate $200 million from the Global Climate Facility. This agreement will stimulate around $480 million dollars from other financial institutions, as explained by the Minister of Energy of the Republic of Kazakhstan K. Bozumbayev. (RK 2017)

As a result, in the next 2-3 years the total capacity of around 500 MW will be financed in RES projects. For example, during the conference financing agreement on the project "Construction of the wind power plant Astana Expo 2017" (100 MW capacity in Akmola region) was signed between LLP CATEC Green Energy, Development Bank of Kazakhstan and JSC "BRK-Leasing". As noted by K. Bozumbayev, all the signed agreements accumulate to average renewable capacity of 700 MW. In comparison during, recent years the established renewable energy sources were 300 MW, from which 150 MW was introduced last year in 2017. Thus, the task of MERK is to implement all the signed agreements and reach the nearest target of the share of renewable energy sources in electricity consumption by 3% in 2020, which is fixed in the National Concept of developing "Green Economy". (RK 2017)

In 22nd of June 2017, the President of Kazakhstan Nursultan Nazarbayev gave a speech at the 30th plenary meeting of the Council of Foreign Investors (CFI), whereby he explained the key facts, strategies and future targets of Kazakhstan in "Green Economy" and RES. The main directions of development in RES as mentioned by the President are:

1) "First, there is a legally established system of fixed tariffs and guaranteed purchase of electricity from RES"; "The next stage is the transition to the auction system, which is successfully implemented in many countries";" "It will allow to choose and implement the most effective RES projects using the best "green technologies"."

2) "Second, we continue the work in improving the business climate. Reduced administrative barriers, I hope you noticed it, investment risks, as well as the costs of implementing projects in the RES field."

3) "Third, at the previous 29th meeting of the CFI the task was to develop "green finance". We are working in developing a Concept for the Development of a Green Financial System." "We encourage you to participate in developing this concept. To do this, you can use the platform of the Astana International Financial Center, which is created in the sight of Astana EXPO-2017. Amendments to the Constitution have been adopted, an English law has been approved, and English will be the main operating language."

4) "Fifth, we need to develop our own scientific and technical potential, create conditions for scientific and applied research, and train specialists in the field of new energy. This should be actively pursued by the relevant ministries, universities and the International Green Technologies and Investments Center (IGTIC)" (Nazarbayev 2017)

3.3 Significance of Astana EXPO 2017 "Future Energy" Global Exhibition

The capital city of Kazakhstan, Astana organised an International EXPO Exhibition in 2017 with a theme of "Future Energy". The event was one of the biggest events in the history of Kazakhstan, which involved more than 100 country representatives and more than 5 million visitors from around the world in sharing the expertise and knowledge about future energy developments and technologies. The organisation of EXPO-2017 International Event in Astana shows Kazakhstan's clear vision in green technology development.

As a continuation of the international event, over 55 new technologies were agreed to be implemented from EXPO-2017 in Kazakhstan. This was discussed at the conference organised by the Republic of Kazakhstan (RK) Government and the Prime Minister Bakytzhan Sagintaev. According to the Ministry of Energy Kanat Bozumbayev, the expert group from the Ministry selected 105 foreign and 28 national technologies, which were presented at the EXPO Event. The selected technologies were made in 4 sectors: 1) oil and gas – 27 technologies, 2) coal industry – 7 technologies, 3) electric power, energy saving and RES – 63 technologies, 4) ecology such as waste management, water treatment and air quality – 36 technologies. This list of technologies was directed to national and private companies, and the regional

administrations for understanding the economic feasibility of their implementation throughout the country.

For example, at the time of the conference administrations selected 40 technologies to implement, four of which were planned to be finished in 2018. National companies selected 15 technologies, from which 2 was planned to be implemented in 2018. Specifically, as an example in oil and gas sector, 7 technologies were chosen from Russia, USA, China and Finland. In the sector of ecology, the administrations decided to implement 10 technologies in treatment of domestic and industrial liquid waste, as well as the control of air quality and systems of waste management. Thus, these recent developments clearly explain that Kazakhstan is moving forward to achieve its targets in "Green Economy" concept, and respectively, RES (green technology sector). (EXPO-2017 2017)

3.4 The heritage of Astana EXPO-2017 - AIFC

As a logical step towards integration Kazakhstan established Astana International Financial Centre (AIFC) by the beginning of 2018 in territory of EXPO-2017, initiated by the President of the Republic of Kazakhstan, which aims to be a regional hub and important financial platform for Central Asia, the Caucasus, EAEU, the Middle East, West China, Mongolia and Europe. The law of the AIFC is based on principles and norms of England and Wales's law, as well as standards of the leading international financial centers. (AIFC 2018)

One of the main strategic directions of AIFC is creating the conditions for the integration of green products and financial services in the country. In this regard, the AIFC presented a concept of "Green Financial System" in Kazakhstan during the conference called as "Strategy of ensuring regional leadership of AIFC in the sphere of green finance" held in Astana on 4th of September 2017. As explained by the General Director, Kairat Kelimbetov in his speech, AIFC with the EBRD worked on this concept, which will eventually provide financial instruments such as green bonds, green loans, green insurance and green purchases, that will enable the implementation of social and environmental projects. The Managing Director of AIFC, Aidar Kazybayev said that an example of this concept is that, if an investor wishes to fund environmental

projects, energy efficiency, waste disposal, green transport, then an investor can issue or become an investor of green bonds. (AIFC 2017)

The author had a great opportunity to participate in the official opening ceremony of the AIFC in the capital city Astana on 5th of July with a participation of the Kazakhstan's President, Nursultan Nazarbayev. The author also took participation in the conferences held for the establishment of AIFC, such as "Green Energy and Waste Recycling Forum" (GEWR). As a result, it can be stated that the establishment of AIFC will have a significant positive effect on the development of green technologies, and in this case specifically in renewable energy field with help of the professional ecosystem AIFC created and financial instruments such as green bonds.

3.5 New institution - International Green Technologies & Investment Center (IGTIC)

During the beginning of Astana EXPO-2017 on 11th of June 2017, the Ministerial Conference "Ensuring Sustainable Energy Development" was organised by the Ministry of Energy of the Republic of Kazakhstan (MERK), the Association KazENERGY and the secretariat of the Economic Commission for Europe (UNECE), which decided to establish the International Green Technologies and Investment Center (IGTIC) "Future Energy" in Astana, as a logical continuation of Astana EXPO-2017 heritage. Originally, the initiative to establish IGTIC Center was put forward by President Nursultan Nazarbayev at the 70th session of the UN General Assembly in 2015. (MFA 2017)

The IGTIC is a renamed version of the "Institute for the Development of Electric Power and Energy Saving (Kazakh energy expertise)". As noted by MERK, the functions of the IGTIC are the following: 1) an educational function (familiarization with green technologies in the post exhibition period, the organization of educational seminars / courses / programs for training "green" innovations and technologies; 2) localisation of "green" technologies in the climatic conditions of Central Asia, taking into account the needs of local enterprises; 3) participation in the trading quotas. The IGTIC Center will be located in one of the territories of Astana EXPO-2017, which is a special economic zone administered by Astana International Financial Center (AIFC). (MFA 2017)
IGTIC Center's plans will be implemented primarily in Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan) Iran, Afghanistan, Mongolia and

Azerbaijan. Along with this, the IGTIC Center will cooperate with industrialised countries of OECD, the European Union, India, China and Latin America.

To ensure long-term and sustainable development, the national holdings and development institutions will be actively involved in the work of the IGTIC in order to attract resources and jointly implement "green" projects. The list includes national holdings and institutions such as: 1) The National Welfare Fund Samruk Kazyna, 2) the KazEnergy Association, the National Management Holding "Bayterek", 3) "Almaty TechGarden", 4) the Entrepreneurship Development Fund "Damu", 5) Development Bank of Kazakhstan & etc. Considering that the IGTIC's content is related to "Green Economy", energy efficiency and low-carbon technologies, the Center will be coordinated by the Ministry of Energy on behalf of the Government of the Republic of Kazakhstan. Other state bodies, such as the Ministry of Foreign Affairs and the Ministry of Investments and Development etc. can become members of the Governing Board of the IGTIC. Additionally, in January 2018 the Commissioner of the International Exhibition Astana EXPO-2017 R.S Zhoshybaev was appointed to the post of the Chairman of the Board of the IGTIC. (MFA 2017)

Thus, as explained by deputy director of department of "Green Economy" in MERK, Anar Bulzhanova, the aim of the center is to transfer green technologies to the central asian region. The center will conduct scientific research, carry out expertise of green technologies, monitor green technologies globally. IGTIC will be working within seven main areas, including the transformation of energy sector, sustainable urban development, introduction of renewable energy sources, green business and financing and adaptation of green technologies and best practices. Also, the Center will work on the effective waste and water management. As a result, IGTIC will drive the green technologies development process both in Kazakhstan and Central Asian countries, which should have a tangible influence in reaching the targets in RES. (Kazakh 2018)

4 2018 & future developments in renewable energy field (RES)

4.1 Main developments in RES field of Kazakhstan in 2018

According to the information adapted by the Ministry of Energy of the Republic of Kazakhstan (MERK) the primary energy reserve of Kazakhstan oil equals to 32 billion tons in oil equivalent, which accounts for 3.6% of world primary energy reserves. Kazakhstan is No.1 in uranium mining in the world accounting to 40% of world uranium mining. In "Doing Business Rating" Kazakhstan is 36th out of 180 countries with improved positions by criteria in business registration, grid connection, property registration and enforcement of contracts. The renewable energy investments are significantly growing in this area and potential in each area is: 1) wind energy 920 billion KWh/year, 2) hydro energy 62 billion KWh/year, 3) solar energy 3 thousand solar hours/year. (MERK 2017: 7)

The 2017 RES results show that there are 50 operating RES facilities with a total capacity of 336 MW. As shown in the Figure 3 (next page) the share of wind power plants was 107 MW, hydro stations 171 MW, solar plants 58 MW and bio gas stations of 0.35 MW in 2017. The RES development indicators in electricity production are 3% by 2020, 10% by 2030 and 50% (alternative and RES) by 2050. Eventually, the closest **2020 aim** is to reach 103 operating RES facilities with a total capacity of 2000 MW. The results should be as shown in the Figure 4 (next page) 23 wind plants of 960 MW, 13 hydro plants of 290 MW, and 17 solar plants of 960 MW power. (MERK 2017: 8-11)

In terms of the **law** there is an official document called "On support of the use of renewable energy sources", which defines the "The scheme of purchase and sale of RES electric energy with financial settlement centre", "15-year PPA standard form by auction price and in national currency (KZT)", and "Standard form of RES facility grid connection agreement".

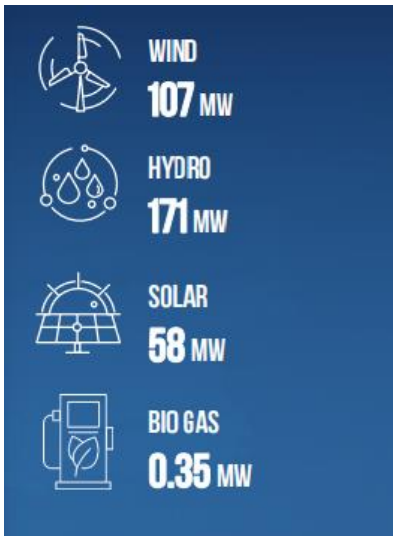


Figure 3. 2017 RE Results

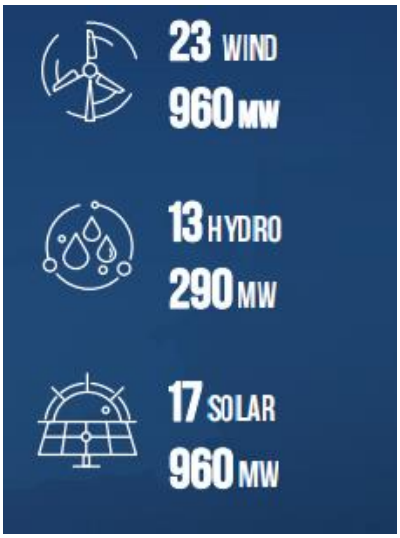


Figure 4. 2020 RE Results (EnergyMinistry 2018)

In order to achieve the aforementioned targets the Ministry of Energy of Kazakhstan decided to organise the first international auction in May-June 2018 to select the most cost effective projects in RES with a total capacity of 1 GW. This also signifies that Kazakhstan is following the world trends of transitioning to renewbale energy (RE) auctions mechanism instead of feed-in tariffs in determining the market price for renewable energy. At the same time, the strategy of the Ministry of Energy of Kazakhstan is to implement a simple to understand renewable energy (RE) auctions mechanism, which should attract Kazakhstan's and foreign investers in development of RES. Therefore, in this way the process of selecting projects and investors become transparent and more understandble. One of the final results set to be minimising the price on end-users' tariffs. (FSC 2018)

The main functions of the auction mechanism in RES projects from 2018 are the following:

1) Transparent and clear process of projects and investors selection
2) Selection of technologies and projects having the least effect on the tariffs of end consumers
3) Clear responsibilities of market participants in generation, transmission and consumption of electric energy (EnergyMinistry 2018: 13)

Important preferences for RES producers are the following:

1) Tariffs are subject to annual indexation considering inflation and exchange difference between KZT and USD
2) Investment preferences on the basis of contract signed between the government of the republic of Kazakhstan and legal entity, which implements investment projects.
3) Exemption from payment for energy transmission services
4) Priority dispatching of electric energy (EnergyMinistry 2018: 12)

Selection of RES projects for auctions is based on:

1) Readiness of infrastructure and demand in energy
2) RES facilities location plan considering the target indicators
3) Maximum permissible installed capacity by zones of unified power system
4) RES potential (EnergyMinistry 2018: 15)

The company winning the auction will be included in the list of energy producing organisations and sign power purchase agreement (PPA) with the Financial Settlement Center (FSC) of renewable energy for 15 years. The PPA is a power purchase agreement or contract, which enables the purchase of electricity from an energy producing company that uses RES. The prices are signed during the auctions between the Financial Settlement Center and an organisation that produces energy using RES. (MERK 2017: 1-8)

On the other hand, the Financial Settlement Center of Renewable Energy LLP (FSC) was created to increase investment in renewable energy field as well as to increase the share of RES in total energy production. The main advantage of FSC is that it guarantees centralised purchase of all RES produced electricity by government. The FSC of renewable energy was established by the System Operator – KEGOC JSC, based on the Law of Kazakhstan No. 128-V of July 4, 2013 "On Amendments and Additions to Certain Ligislative Acts of the Republic of Kazakhstan on support of renewable energy sources". Specifically, the responsibility of FSC is to organise centralised purchase and sale of electricity generated by RES and supply it to electric grid of the unified electric power system of Kazakhstan. (Kegoc 2018)

It is important to note that investor must place a bid bond to implement RES project as stated by MERK. In May and June 2018 MERK will organise the first 3-hour session of auctions, whereby most effective RES projects win and sign PPA. There is an internet platform created for these auctions and according to the approved data the selection of projects in 2018 will have the total capacity of 1000 MW. The plan for the auctions of 2018 in the power stations are the following: 1) solar power stations – 290 MW, 2) wind power stations – 620 MW, 3) hydroelectric power stations – 75 MW, 4) bioelectric stations – 15 MW. (MERK 2017: 4-10)

4.2 Results of the first spring auction system.

The results of the first spring auctions are already available, which was organized from May 23rd to June 7th . Investors were invited to participate in the auctions with the following RES opportunities: 1) wind power stations – 140 MW, 2) solar power stations – 80 MW, 3) small hydroelectric power stations – 20 MW, 4) bioelectric stations – 5 MW. As a result, participants proposed bids with a total installed capacity of 959.7 MW, which exceeds demand (245 MW) almost 4 times. 53 Kazakhstani organisations and foreign companies from China, Russia, Turkey, the United Arab Emirates, France and Bulgaria participated in the spring auctions. (MinistryofEnergy 2018)

The results of the spring auctions are the following:

1) 4 solar power plants with a total capacity of 68 MW will implemented within the next 2 years in Almaty and Kyzylorda regions. Total investment is around 23 billion tenge.
2) 10 wind and 1 biogas power plants will be built with a total capacity of 105.85 MW within the next 3 years in Akmola, Almaty, East Kazakhstan, Kostanay, Mangystau, East and North Kazakhstan. Total investment is around 36 billion tenge.
3) 4 hydroelectric power plants will be built with a total capacity of 20.6 MW in the next 4 years in Almaty region. Total investment is about 7 billion tenge. (Energy, 2018)

Most importantly, the first spring auctions decreased tariffs of wind power stations by 20%, small hydropower plants by 23%, solar stations by 25.5%. 19 companies already have an opportunity to sign contracts with a single electricity purchaser of renewable energy for 15 years with a total capacity of 194.45 MW. (Energy 2018)

5 Detailed research about energy sector of Kazakhstan & the share of RES

The fossil fuel resources are the main wealth of Kazakhstan, which makes Kazakhstan as the largest energy producers in Central Asia. According to the results of 2013 in crude oil resources Kazakhstan is ranked as the 8th highest and 12th highest in crude oil reserves. The reserve of natural gas is ranked as 18th in the world. (IEA 2015: 165) Figure 5 shows the energy production by each source in the timeline of 1990-2012. In 2012, the total energy production was 164.4 million tonnes of oil equivalent (Mtoe), 80.4% increase since 2002. In 2013, the crude oil production was 83.1 Mtoe which is almost half of energy produced. The production of natural gas was tripled in one-year transition from about 10.7 billion cubic meters (bcm) in 2002 to 33 bcm in 2013, which shared 17.3% in 2012. Over the decade, the coal production increased by around 62% to 2012, and its share in energy production is about 32%. Renewable energy sources, namely hydro, wind and biofuels contributed less than 1% of energy production. (IEA 2014: 13-14)

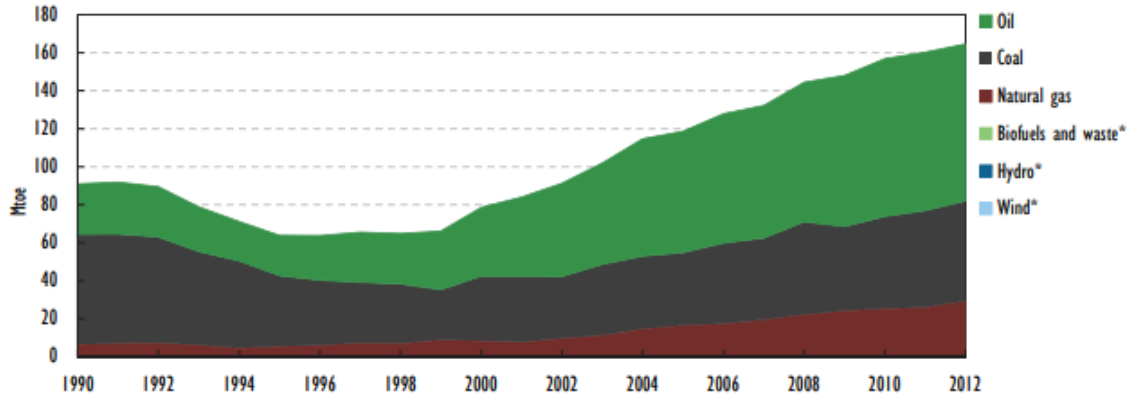


Figure 5. Energy Production by source, Kazakhstan, 1990-2012 (IEA 2014a)

Table 2 below represents an approximate estimation of Kazakhstan's total capacity in natural resources. Uranium has the largest world share being 20% with 1.69 mln. tons of proven reserves and depletion year in 2150. Then coal has 38.6 billion tons of reserves with the depletion year in 2160. The crude oil has proven reserves of 4.8 billion tons and natural gas 3.5-4 trillion m3 proven reserves and both resources have

a depletion year by 2050. Thus, Kazakhstan's targets in renewable energy and green technology sector are logical and right steps towards a new economy.

Table 2. Kazakhstan's proven resources (Karatayev & Hall 2016)

Resources	Proven reserves	World share	Depletion year
Crude Oil	4.8 billion tons	3.2%	2050
Natural Gas	3.5-4 trillion m^3	1.7%	2050
Coal	38.6 billion tons	3.6%	2160
Uranium	1.69 mln. tons	20%	2150

Table 3 below shows the production capacities per energy source evaluated by World Data statistical database. It clearly shows that the development of natural and renewable sources of energy are significantly different while comparing two regions such as Kazakhstan and Europe. The production capacity of Kazakhstan in fossil fuel is 86,1% (9,349 kWh per capita), which two times smaller in Europe accounting to 48,9% (7,993.04 kWh per capita) in Europe. The production capacity of Kazakhstan in Renewable energy is 0,8% (86,87 kWh per capita), which is around 16 times less than in Europe being 16,2% (2,654.74 kWh per capita). There is no nuclear power production capacity in Kazakhstan while in Europe it is 7,2% (1,185.60 kWh per capita). Also, the water power production capacity is around two times more in Europe 23,4% (3,829.04 kWh per capita) and in Kazakhstan it is 13.3% (1,444.15 kWh per capita). (WorldData 2018)

Table 3. Production capacities per energy source (WorldData 2018)

Energy source	Total in Kazakhstan	percentage in Kazakhstan	percentage in Europe	per capita in Kazakhstan	per capita in Europe
Fossil fuels	166.38 bn kWh	86,1 %	48,9 %	9,349.00 kWh	7,993.04 kWh
Nuclear power	0.00 kWh	0,0 %	7,2 %	0.00 kWh	1,185.60 kWh
Water power	25.70 bn kWh	13,3 %	23,4 %	1,444.15 kWh	3,829.04 kWh
Renewable energy	1.55 bn kWh	0,8 %	16,2 %	86.87 kWh	2,654.74 kWh
Total production capacity	193.25 bn kWh	100,0 %	100,0 %	10,858.30 kWh	16,358.42 kWh

Figure 6 (next page) clearly depicts that natural resources occupy almost the whole final energy consumption in Kazakhstan with oil products being the largest. Therefore, the utilization of renewable energy sources and development of green technologies in energy production is an important aspect to focus and develop for Kazakhstan in the near future. (Karatayev & Hall 2016: 1-23)

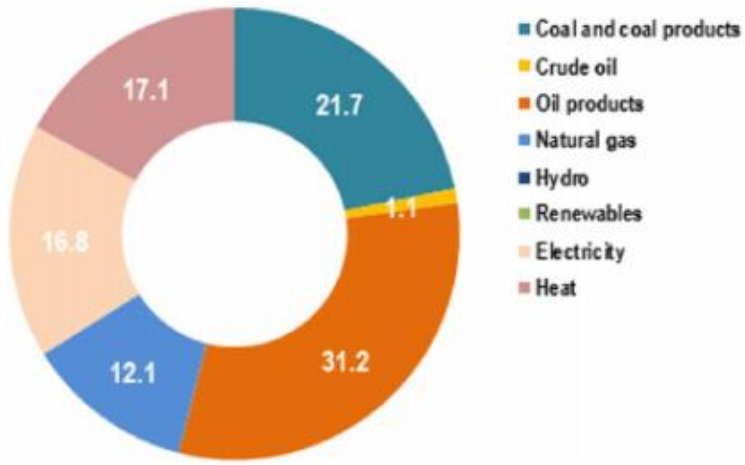


Figure 6. Final energy consumption by resources (Karatayev & Hall 2016)

The RES had a 2% share out of the total energy production in 2002, and after the boom in fossil fuel production its contribution decreased to 1%, whereby the main sources are hydro and biofuel, with wind power just entering the energy mix. Nevertheless, the RES had a significant development in the timeline of 2010-2018. One of the reasons to develop RES can be seen from the Figure 7 below, whereby in 2012 Kazakhstan was in one of the least positioned countries in total share of RE in energy balances. (IEA 2015: 169)

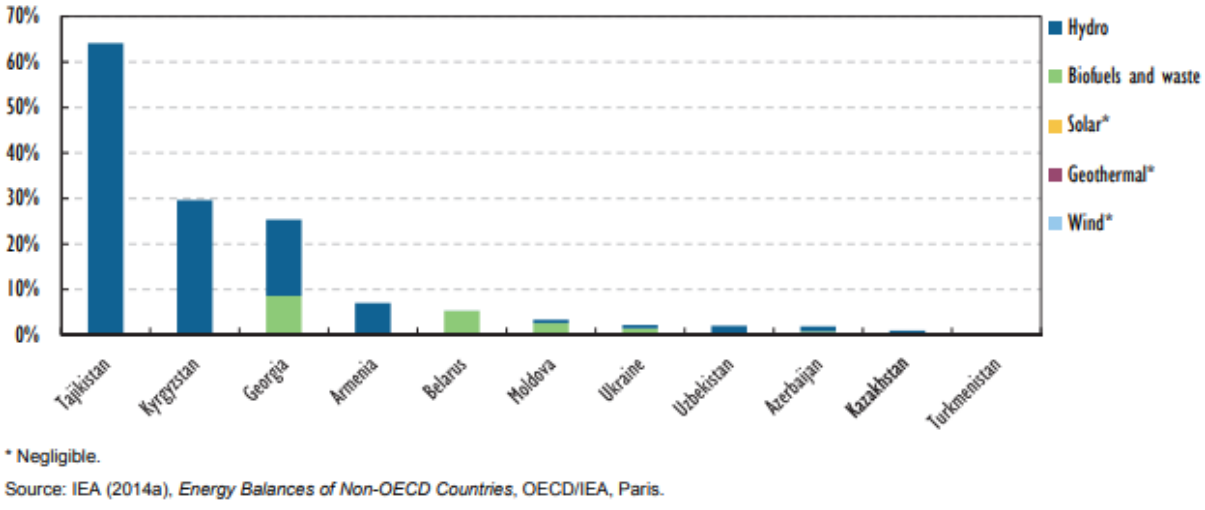


Figure 7. Renewable Energy as a percentage of TPES in Kazakhstan and other EECCA countries, 2012 (IEA 2014a)

6 Detailed research about renewable energy field (RES) in Kazakhstan

The following part elaborates in detail the institutions, overview, potential behind each RE field of Kazakhstan and their potential to contribute in achieving the targeted results by important timelines of 2020, 2030 and 2050.

6.1 Institutions

- **The Ministry of Energy of the Republic of Kazakhstan (MERK)** was created in August 2014 which is the central executive entity that is responsible for the energy policy and governance. It coordinates the management process of the fields such as oil and gas, production of petroleum products, electric power industry, environmental protection, "Green Economy" concept and all other this type of areas. (IEA 2015: 171-172)

- **The Committee for Regulation of Natural Monopolies and Protection of Competition (CRNMPC)** is a state-owned body under the Ministry of National Economy, which controls important activities such as protecting the rights of entrepreneurs or creating legislative acts of the Republic of Kazakhstan on the transitions to a "Green Economy".

- **The Committee on Statistics** is an entity which also operates under the Ministry of National Economy and manages the regulations in methodology of statistics, data gathering and forming relevant policy measures.

- **The Sovereign Wealth Fund Samruk-Kazyna** is a state-owned fund, which was formed in 2008 by the decree of the President, Nursultan Nazarbayev to act as an investment holding to increase the national welfare of Kazakhstan and support the modernization of national economy. Portfolio of Samruk-Kazyna includes the main companies of Kazakhstan in the fields such as oil and gas, transport and logistics, mining and real estate. (IEA 2015: 171-172)

Figure 8 below depicts the visualization of certain institutions mentioned above.

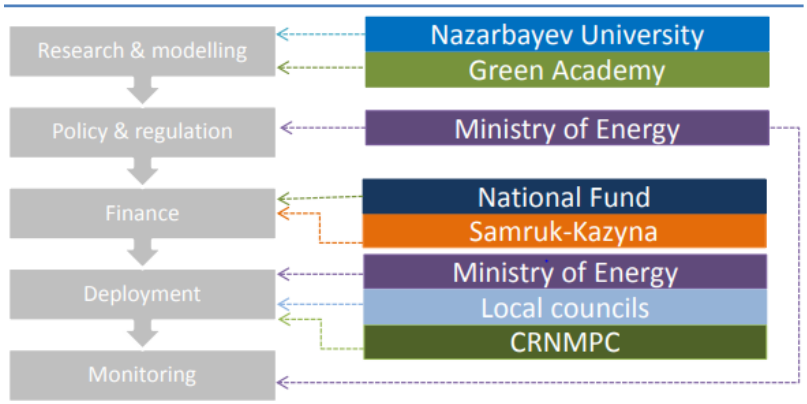


Figure 8. Institutional framework for renewables development, Kazakhstan (Energy 2018)

Table 4 below illustrates the levels of RES in Kazakhstan in 2015-2016. It can be concluded that large and small hydro plants are the main source of electricity and energy in RES of Kazakhstan with a capacity being 2535 MW. The wind and solar fields are the main development areas at the moment. The other RE sources such as biomass, biogas and geothermal play also an important role in energy sector, especially biomass utilization, which is also under careful development at this current time. (Karatayev & Hall 2016: 2-6)

Table 4. Current RET capacity levels in Kazakhstan. (Karatayev & Hall 2016)

Renewable energy source	Capacity MW
Biomass (wood, waste and agricultural)	..
Wind	70
Biogas	0.4
Small hydro	125
Large hydro	2 535
Solar	57
Geothermal	..
Total*	**2 787.4***

6.2 Hydro Power

According to the results of 2014, Kazakhstan's hydropower equals to around 13% out of the total electricity generating capacity, which comprises of 15 large hydropower stations delivering approximately 7.78 TWh with a maximum capacity of 2.248 GW. The main large hydro power plants are the following:

1) Bukhtyrma – 750 MW
2) Shulbinsk – 702 MW
3) Ust-Kamenogorsk – 315 MW (Irtysh River)
4) Kapshagai – 364 MW (Ili River)
5) Moinak – 300 MW (Charyn River)
6) Shardarinskaya – 104 MW (Syrdarya River) (Karatayev & Michele L. 2016: 6-8)

Apart from large hydro power plants, small 1-10 MW and medium-scale (10-50 MW) are also popular because they require low cost and are more reliable. In 2016, there were 7 small version of hydropower plants (10 MW) with a maximum capacity of 78 MW. Table 5 below shows an estimated potential in hydro power with the key locations being east and south Kazakhstan and the provinces such as Zhambyl and Almaty. As a result, the production potential is around 13 TWh with a capacity of 2707 MW.

Table 5. Small hydropower projects in Kazakhstan (Karatayev & Michele L. 2016)

Regions	Number of projects	Projected installed capacity (MW)	Annual production (GWh)
East Kazakhstan	68	349	1700
Almaty province	n.a.	1762	8700
Southern Kazakhstan	112	421	1800
Zhambyl province	77	175	700
Total	257	2707	12900

Figure 9 (next page) depicts the water resources of Kazakhstan that can be deployed in hydropower field. It is clearly shown there are areas, which have a shortage of water, especially in the central and northern regions of Kazakhstan. The purple coloured zones on the map are the three main districts: Irtysh River (tributaries: Bukhturma, Uba, Ulba, Kurchum and Kardzhil), the South-eastern zone with Ile River and the Southern zone with river basins of Syrdaria, Talas and Chu. (Lekovic 2016: 20-22)

Source: KazEnergy (2015), "KAZENERGY National Energy Report", presentation, www.kazenergy.com/images/stories/ob_association/national_energy_report_general_director_a_magauov_en.pdf.

Figure 9. Map of hydropower resources in Kazakhstan (KazEnergy 2015)

6.3 Wind Power

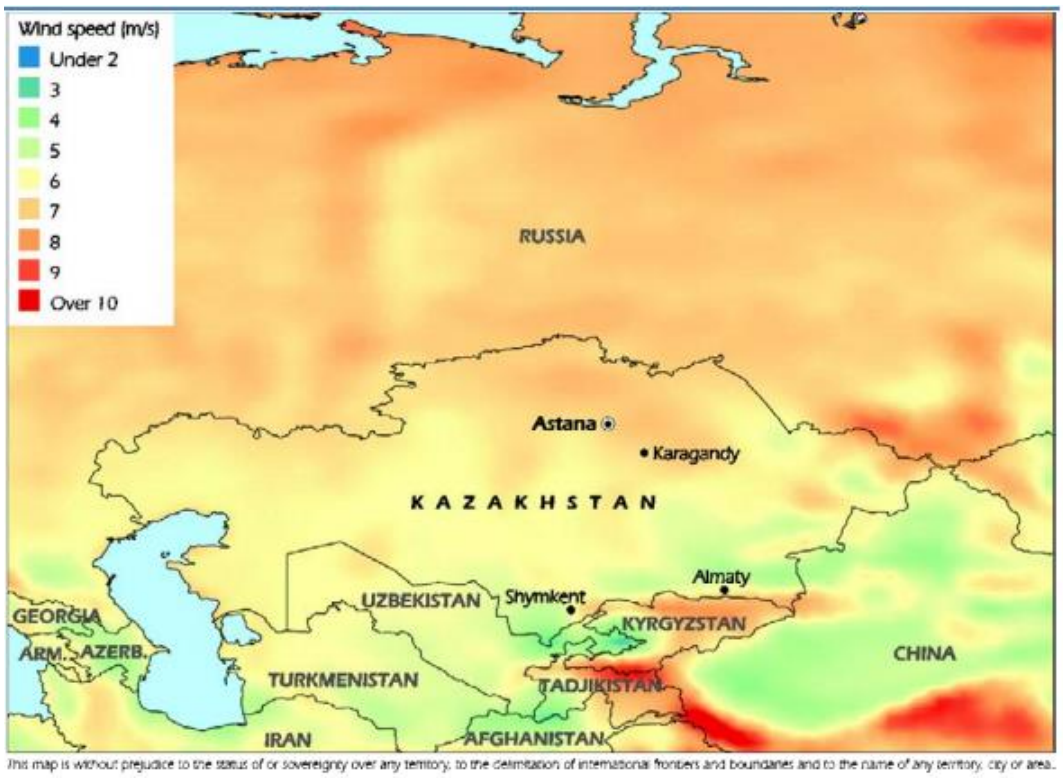
The wind power sector in Kazakhstan has a great potential in the future because of its geography, which fits the wind energy requirements. The potential behind this sector is around 760 GW. According to the statistics of the geography, the highest potential of wind power generation is in the Caspian Sea, central and northern regions, because these regions' structure is comprised of the steppe with average wind speed available for energy production, which is around 60% of Kazakhstan's territory (**Figure 8.**). (Karatayev & Michele L. 2016: 7-10)

Table 6 (next page) represents the sites in Kazakhstan that have potential in wind energy generation. The most cost efficient and high potential sites are located near Almaty region, namely Djungar gates with a capacity of 200 MW and number of wind generators being around 1,100.

Table 6. Prospective regions for wind power development in Kazakhstan. (Karatayev & Michele L, 2016)

Location of potential wind farms	Region	No. wind generators	Projected installed capacity [MW]	Annual production [billion kWh]
Mangystau mountains	West	8,000	210	0.4
Peak Karatau	South	7,800	190	0.23
Chu-Ili mountains	South	6,800	180	0.27
Mount Ulutau	Central	3,400	90	0.13
Yerementau mountains	Central	2,100	50	0.01
Mugojary mountains	West	400	10	0.01
Djungar gates	South	1,100	200	0.66
Total		29,600	930	1.71

Figure 10 clearly shows that minimum wind speed is 4 m/s ranging to a maximum of 8 m/s across the whole territory of Kazakhstan, which is enough for the operation of wind turbine technologies.



Source: Rife, D. L., J. O. Pinto, A. J. Monaghan, C. A. Davis, and J. R. Hannan (2014), *NCAR Global Climate Four-Dimensional Data Assimilation (CFDDA) Hourly 40 km Reanalysis*, Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory, dx.doi.org/10.5065/D6M32STK, accessed on 30 June.

Figure 10. Background zoning of average annual wind speed, Kazakhstan (Rife & Pinto 2014)

6.4 Solar Energy

The Solar Power in Kazakhstan also has high potential since the insulation in most of the regions and especially in the south of the country is high, whereby the sunlight emission is in between 2200 and 3000 hours of sunlight per year that can produce 1200-1700 kW/m2 energy annually. Currently, the Almaty region has 2 MW solar PV plant nearby and 6 solar PV plants in progress inside the Zhambyl province in southern Kazakhstan with a total energy capacity of 300 MW. On the other hand, solar thermal is new source of renewable energy for Kazakhstan that is more cost-efficient since it does not require water for its operation and can be placed in desert or semi-desert areas. In solar thermal sector, Kazakhstan government plans to establish 1.04 GW of renewable energy by 2020. Figure 11 illustrates the mean annual solar radiation, which is mostly at an average rate (160-172 W/m2) across the territory that enables the installation and full operation of solar PV plants. (Karatayev & Michele L. 2016: 6-15)

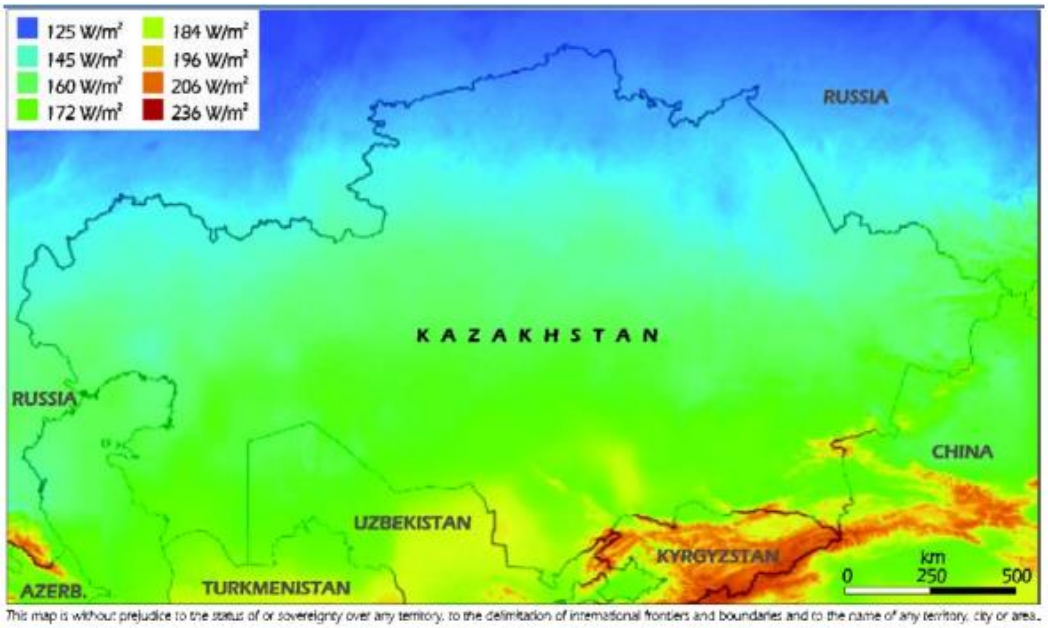


Figure 11. Horizontal solar radiation on the territory of Kazakhstan (IRENA 2016)

6.5 Bioenergy

The Kazakhstan's land territory provides large amount of biomass wastes and residues from its 76.5 Mha (mega hectare = hectare multiplied by 10^6) agricultural land, 10 Mha forest and 185 Mha steppe grasslands. The yearly biomass wastes are around 12-14 Mt (metric tonne), which is not properly exploited and out of the total residues only 10% is utilized. The potential behind biomass electricity production is high with yearly estimation of 35 billion kWh per year as well as heat production of 44 million Geal per year. At the moment, there is only one large biogas unit located in Vostok village in the Kostanai region with a power of 360 kWe (kilowatt - electrical) biogas unit. The capacity of this biogas unit has two digesters of 2400 m^3 with a result of 40 tonnes per day of sheep, cow and camel manure, grain residues and slaughterhouse waste of 1 tonne per day. (Karatayev & Michele L. 2016: 8)

7 Real case scenarios for achieving RES targets

7.1 Scenario for RES development for 2013-2020 timeline

In order to increase the development of RE, a national strategy for Kazakhstan was created for the timeline of 2013-2020. Table 7 below shows an action plan in RES development for 2013-2020 and Figure 12 depicts a visualisation of the same action plan. It can be concluded that most of the projects are being implemented in small hydro, wind and solar power plants, with bio-power plants being the least.

Table 7. An action plan for the development of renewable energy in Kazakhstan for 2013-2020 (Karatayev & Hall, 2016)

	Number of projects	Technical capacity, MW
Wind power plants	34	1787
Solar power plants	28	713,5
Small hydro power	41	539
Bio-power plants	3	15,05
Total RES projects	106	3054,55

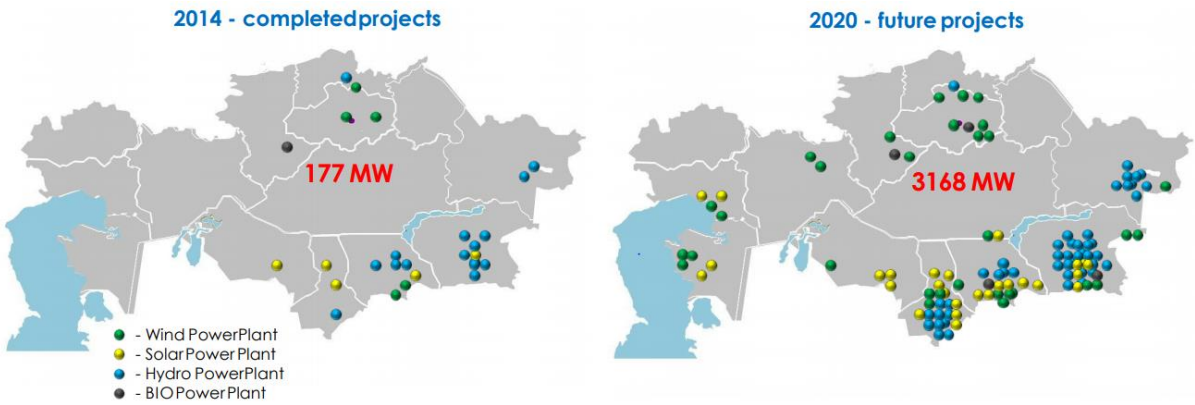


Figure 12. The visualization of an action plan for the development of renewable energy in Kazakhstan for 2013-2020 (Kashkinbekov 2017)

7.2 Brief descriptions of the scenarios

On the other hand, the Government of Kazakhstan created three integrated scenarios for power sector development in the 2013 "National Concept for Transition to a Green Economy up to 2050".

Base-case scenario: called as "Business as usual" electricity demand, gasification of Astana and Karaganda regions, current low gas prices, 30% alternative (20%) and renewable (10%) energy share in generation in 2050.

Green scenario – expensive gas: "Green" electricity demand, gasification of Astana and Karaganda regions, high gas prices, 50% alternative and renewable energy share in generation in 2050.

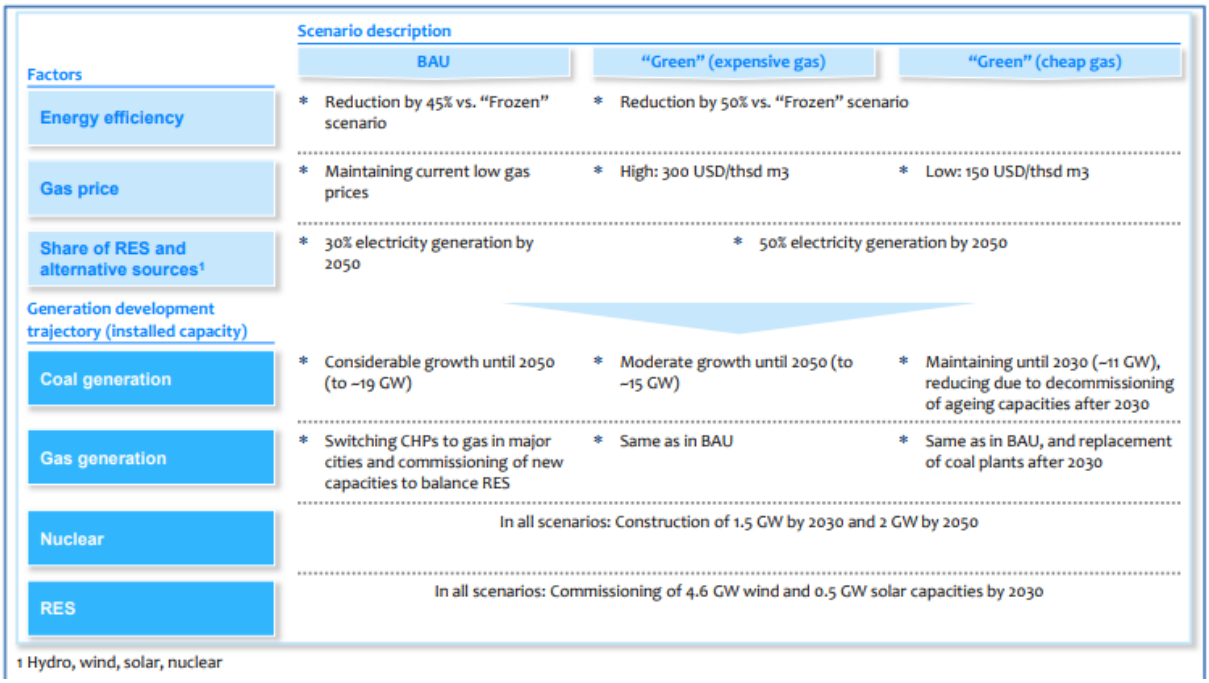
Green scenario – cheap gas: "Green" electricity demand, gasification of Astana, Karaganda, Pavlodar and Eastern regions, cheap gas prices, 50% alternative and renewable energy share in generation in 2050. (MERK 2013: 30-33)

Figures 13 and 14 (page 33) show scenarios in electricity production from different sources of energy, namely: RES and alternative sources, coal, gas, nuclear. The renewable energy field will be developed mainly through wind and solar power plants with help of:

- Achieving 3 percent share of wind and solar power stations in the total capacity of electricity generation by 2020.
- Achieving 10 percent share of RES in the total capacity of electricity generation by 2030.
- Full-scale RES implementation after RES becomes cost competitive with the prices of traditional energy sources and this shift is expected between 2020 and 2030.
- Achieving a 50 percent share of alternative and RES (including wind, solar, hydro and nuclear plants) in the total capacity of electricity generation by 2050. (MERK 2013: 36)

According to the Figures 13 and 14 (next page) the key assumptions in each of the scenarios are:

1) The range of electricity demand is from 136 TWh to 145 TWh in 2030, and from 172 TWh to 188 TWh in 2050.
2) The availability of gas will be greater, leading to a lower price of gas in power generation
3) Extending the lifetime of existing coal, gas and hydro capacity with maximum possibility
4) Renewable energy installed capacity in 2030: wind accounting to 4.6 GW and 0.5 GW for solar
5) The total nuclear capacity installed is estimated to be 1.5 GW by 2030 and 2.0 GW by 2050. Nuclear power plants will be developed according to the national plan
6) In order to improve the quality of local air, the major cities will be gasified by a transition from coal to gas. (Lekovic 2016)



Factors	Scenario description: BAU	"Green" (expensive gas)	"Green" (cheap gas)
Energy efficiency	* Reduction by 45% vs. "Frozen" scenario	* Reduction by 50% vs. "Frozen" scenario	
Gas price	* Maintaining current low gas prices	* High: 300 USD/thsd m3	* Low: 150 USD/thsd m3
Share of RES and alternative sources[1]	* 30% electricity generation by 2050	* 50% electricity generation by 2050	
Generation development trajectory (installed capacity)			
Coal generation	* Considerable growth until 2050 (to ~19 GW)	* Moderate growth until 2050 (to ~15 GW)	* Maintaining until 2030 (~11 GW), reducing due to decommissioning of ageing capacities after 2030
Gas generation	* Switching CHPs to gas in major cities and commissioning of new capacities to balance RES	* Same as in BAU	* Same as in BAU, and replacement of coal plants after 2030
Nuclear	In all scenarios: Construction of 1.5 GW by 2030 and 2 GW by 2050		
RES	In all scenarios: Commissioning of 4.6 GW wind and 0.5 GW solar capacities by 2030		

1 Hydro, wind, solar, nuclear

Figure 13. Power Sector Development Scenarios (MERK 2013)

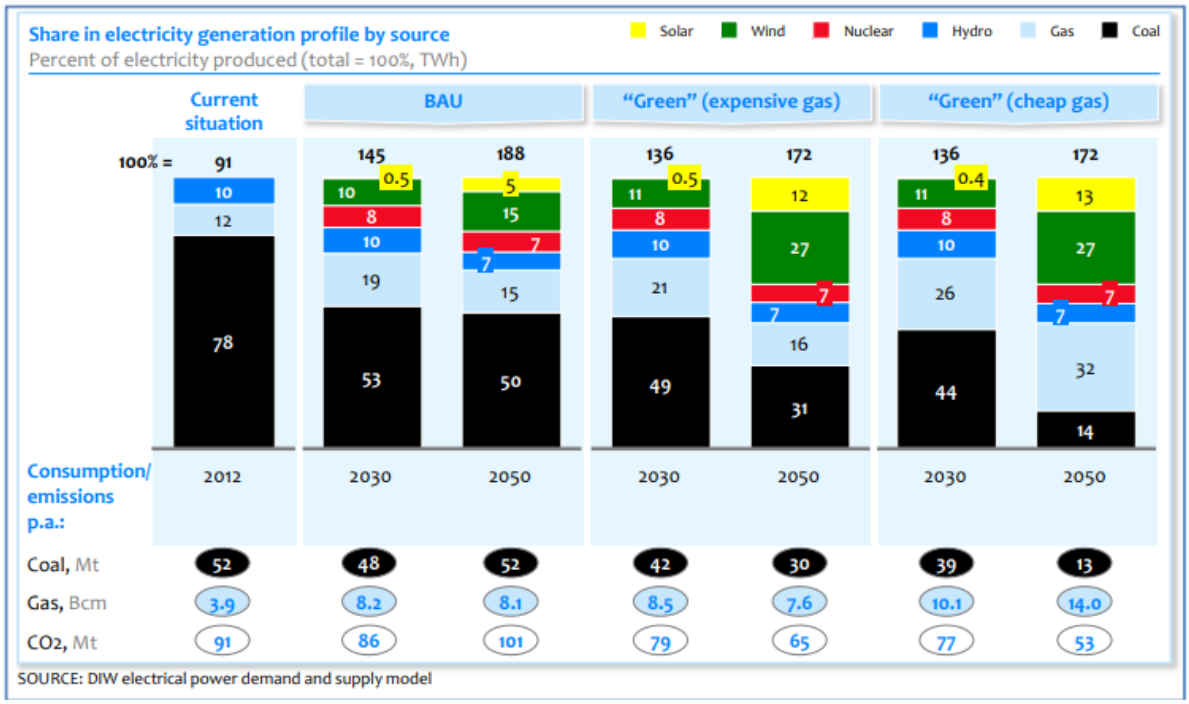


Figure 14. Share of electricity generation in the scenarios (MERK 2013)

(Continue in next page)

7.3 Analysis of the scenarios considering RES

Figure 13 shows the results that should be achieved through each scenario in different energy sectors by 2020, 2030 and 2050. The energy sector section on the table includes the main important energy fields such as Energy Efficiency, RES, coal and gas generation, which have the specific target indicators in "Green Economy" National Concept of Kazakhstan. The major assumptions in all scenarios are the rapid development of gas generation in the country and increase of RES share in electricity production. All three scenarios show a plan of switching CHPs to gas in major cities such as Astana and Almaty. On the other hand, in BAU scenario RES share in electricity production plans to be 30% by 2050, whereas in scenarios "Green" (expensive and cheap gas) the share of RES in electricity consumption plans to meet the target indicator of 50%.

Figure 14 depicts the share of the energy resources in electricity generation of Kazakhstan according to three different scenarios. The energy sector situation in 2012 shows that around 78% of electricity production was out of coal natural resource, 12% gas power plants, 10% hydro power stations. After a careful analysis, the author concludes that third scenario "Green" (cheap gas) show results that would enable Kazakhstan to achieve its targets in energy sector. Since "Green" (cheap gas) significantly reduces the energy production out of harmful natural resources and instead expands the share of more environmentally friendly and renewable energy sources in electricity production by 2030 and 2050. As it can be seen, from the section of "Green" (cheap gas) scenario in 2030 the share of coal reduces until 44%, gas increases until 36%, nuclear power plant increases to 8% and total share of electricity from RES increases to 21.4%. These results in third scenario by 2030 is similar compared to other two scenarios with a certain degree of better results.

More importantly, the cheap gas scenario eventually should enable Kazakhstan to build more sustainable and strong developed energy sector. Because the results by 2050 in cheap scenario should lead to 14% share of coal, 32% share of gas, 7% share of nuclear power plant, and 47% share of renewable energy sources in electricity production of Kazakhstan. These results are what the government of Kazakhstan, and specifically the Ministry of Energy is seeking for, as it helps to reach the main energy related target indicators within the National Concept of Kazakhstan in transition to

"Green Economy". Thus, the author concludes that "Green" (cheap gas) scenario is a possible and best road map for Kazakhstan to implement, to achieve the targets set in Energy Sector, in this case, specifically in renewable energy sources (RES) field by strategic 2020, 2030 & 2050 years.

Table 8 below was published by the Ministry of Energy of Kazakhstan, which shows the results of 2017 in regard to the share of RES in electricity production in each area.

Table 8. RES in electricity production for 2017 (EnergoGovKZ 2018)

Indicators	**Measurements**	**2017 Results**
Total power generated	**MWt**	**342,3**
Wind power stations	MWt	112,4
Small hydro power stations	MWt	170,8
Solar power stations	MWt	58,8
Bio power stations	MWt	0,3
Total electricity generated	kWh (million)	**1102,4**
Wind power stations	kWh (million)	339
Small hydro power stations	kWh (million)	649,1
Solar power stations	kWh (million)	114,3
Bio power stations	kWh (million)	0,06
The RE share of produced electricity out of the total electricity produced	%	**1,08**
Conclusion: the use of Renewable Energy in electricity production has increased by 15,8% in 2017 compared to 2016.		

8 The barriers in Kazakhstan's renewable energy development

8.1 Instability of the regulatory legislation

The regulatory legislation in RES of Kazakhstan is not stable. The system of fixed tariffs lasted 3-4 years and a new approach to auctions for new projects is being introduced. Therefore, the results of the first auction systems will determine the future development of RES in Kazakhstan. In this case, the first objective should be to attract strategic investors and support Kazakhstan's business stability for the next 10+ years. (MERK 2018)

8.2 Low interest rates at national currency "Tenge"

There is an issue of large-scale financing in national currency – tenge. Banks of the second level (BTB) – the main player of the financial market – are not interested in RES. The European Bank for Reconstruction and Development (EBRD), the Eurasian Development Bank (EDB), and the Development Bank of Kazakhstan (DBK) are still the main institutions that lend to new projects in "Tenge" at low interest rates.
The solution in this case is a state financial program that would, at the country level, determine the available resources. The goal is to replicate the best practices from this filed and implement it in Kazakhstan realities. (MERK 2018)

At the same time, the issue with the currency risk "Tenge" is being addressed by the Ministry of Energy of the Republic of Kazakhstan (MERK), which works on the elimination of currency risk, the reform of the electricity purchase agreement (PPA), the financial sustainability of the Settlement and Finance Center for the Support of Renewable Energy Sources. (MERK 2018)

8.3 Low electricity tariffs

In electricity consumption of Kazakhstan, there is not enough support for the development of renewable energy field. The structure of electricity consumption in Kazakhstan contains two parts. 1) industrial companies consume a minimum of 750 kW, 2) the rest of the regular consumers. The large industrial and regional energy companies purchase electricity from the producers itself in the wholesale market and the price includes generation and regulated transmission tariffs. While other energy

consumers purchase electricity from regional energy companies by paying the access fee for the distribution system plus the generation and transmission tariffs. The regular consumers also pay a value-added tax and a low excise tax. As a result, the average price of the electricity is around 2.3 US cents per kWh and maximum of 3.5 US cents per kWh in certain locations of the country. This amount is relatively low since the Soviet-era power plants are still in use and large reserves of cheap coal are available. The old power plants pollute the air and creates environmental problems. The problem is that the transition to a renewable electricity production would lead to higher prices (higher electricity tariffs) as it is more expensive to produce. Therefore, this price difference makes it harder to support renewable energy generation considering that future wholesale price for electricity is expected to grow every year. However, according to the MERK the costs for the development of RE technologies will decrease starting 2020 and it is estimated that by 2030 the price of electricity produced from renewable energy sources will be less compared to traditional energy sources. (Karatayev & Michele L. 2016: 9)

8.4 The losses in the transmission and inefficient technologies

Kazakhstan Electricity Grid Operating Company (KEGOC) is a government owned main supplier and operator of the transmission system in Kazakhstan, which ranges in the capacity from 110 KW to 1150 KW, including all the substations and transformers. The network of electricity transmission and distribution have losses because of inefficiencies, which is around 15%. For example, thermal power plants in Kazakhstan are much less efficient compared to other national energy systems. The net efficiency of coal-fired electric power plant of 1000 MW is 27%, an electricity generation efficiency of around 18%-21%. Respectively, the total efficiency sums up to 49%-68%. On the other hand, gas fired heating plants have a net efficiency of 60%-65% and an electricity generation efficiency of 24%-26% with a total efficiency of 71%-81%. Thus, the same type of problems can exist in renewable energy technologies, which is why the problem of the inefficiency of the electric power system and losses need to be carefully addressed. The geography of the country has to be analysed appropriately in order to place availability and generation of electricity closer to the point of consumption, which can lead to low transmission and distribution losses. (Karatayev & Michele L. 2016: 9-10)

8.5 Possible issues in business environment

In the last 25 years, along with economy and political development Kazakhstan showed a rapid progress in establishing favourable conditions for foreign investments. The World Bank in its report of 2013 called as "Doing Business" ranked Kazakhstan 36th in the list of 190 countries. Nevertheless, there are certain weak areas that are significant for the development of renewable energy in Kazakhstan. Kazakhstan's ranking in the category of "Trading Across Borders" is 123rd, 77th in "Getting Credit", 70th in "Getting Electricity". These areas play an important role for national and international investors while making the decisions on whether to invest or not. (WorldBank 2018: 4) Also, the corruption is one of the main problems in the political structure of Kazakhstan, which was ranked by Transparency International's "Corruption Perceptions Index" as 122nd out of 180 countries. The political indicators such as corruption, rule of law, effectivity, regulatory quality and voice accountability are in average or below the average level, which can negatively affect the investments in renewable energy field of Kazakhstan. (International, 2018) In addition to this, as one of the reasons for the transition to Green Economy is an inadequate system of tariffs and pricing for energy sources discourages industrial technology improvements. (Karatayev & Michele L. 2016: 11)

9 Future recommendations for the players in RES development of Kazakhstan

9.1 Future prospects in RES of Kazakhstan

The prospects for the development of the renewable energy field in Kazakhstan are large. The potential of solar, wind, water and bioenergy is measured in Terawatt hours. As a result of the last 2017, the share of RES was about 1%, which means that out country is in a state of start-up. (RK 2017) This gives its advantages over the outside world. In particular, the ability to avoid mistakes of other countries and choose its successful development path. An appropriate solution to this is to replicate advanced international experience of other countries that have already passed this path.

Kazakhstan aims at becoming one of the 30 most developed countries in the world by 2050. Therefore, it is necessary to renew the country's energy policy, which is the locomotive of economic growth. RES is able to create the energy of the future and ensure the country's energy security.

9.2 Small RES facilities at the household level

The next task is to develop small generation at the household level and support for Kazakhstan content in large projects. By small generation, it is meant to say the generation of electricity by individual users with the ability to sell surpluses to a network, which also performs battery functions (that is, the storage and transmission of electricity produced). Thus, a large part of the population will have the opportunity to earn extra money and familiarize themselves with new technologies and innovation. This path was passed by many leading countries and can be replicated in Kazakhstan. (EXPO-2017 2017)

9.3 Future tasks for the RES field in Kazakhstan and its prospects

Kazakhstan has to develop a state wide-scale program for the development of the industry, which includes technological, financial, administrative and other resources necessary for the industry. Pilot projects are financed by international and local financial institutions such as the EBRD, EDB and DBK.

In Kazakhstan, as well as all over the world, there is a significant decrease in the cost of turnkey start-up of new renewable energy facilities. Almost 1.6-1.7 time cheaper than the first projects and the cost of solar panels, wind generators and other necessary electrical equipment is falling rapidly every year. (MERK 2018)

While the industry is developing at the expense of IFIs and national companies, Kazakhstan with the authorised bodies such as AREK and Ministry of Energy has to build a convenient ecosystem for the growth of small and medium-sized businesses.

10 Conclusion

At the moment, Kazakhstan is experiencing one of the crucial periods, which is full of modernization, changes and challenges. According to the analysis provided it can be stated that Kazakhstan has proven a significant progress since its independence and has a rapidly growing economy and various energy resources. The largest share of energy is proven to be oil reserves in the Caspian Sea. The gas reserves accounts for 2 trillion cubic metres, the production of which is going to increase substantially in the period to 2030. Kazakhstan has large coal reserves in the northern part of the country and is the leader in producing uranium, currently providing 35% of the global supply. Considering these large reserves of natural resources in the country, it becomes very challenging to imagine the development of RES in Kazakhstan. Moreover, the forecasted energy installed capacity by 2050 is two times more than compared to 2015 (13 TWt). From which the solar and wind power plants will amount to 40%. The value of coal will significantly decrease in electricity production, which will share 22% compared to 85% in 2015. The global generation of electricity will increase by 70% compared to the level of 2015 and will be around 41 TWt per hour in the basic scenario according to the "Foresight-2050. New World of Energy and Kazakhstan's place in it" (Kazinform 2017). Therefore, the Kazakhstani government clearly understands that its natural resources are non-renewable and therefore, finite sources of energy. Hence, the thesis analysed Kazakhstan's past, present and future actions in reaching its targets in renewable energy and generally in green technology sectors, which eventually result in understanding and finding that Kazakhstan has high probability in achieving the closest targets set with certain barriers to overcome. The following paragraphs provide short explanations of the key findings in the thesis.

First, Kazakhstan launched 2050 Strategy in December 2012 to ensure sustainable development of the country, which explains the future development plans of the country, including the importance and future targets in renewable energy sources (RES) field. (MFA, 2012) The main target in this program is to be amongst the 30 world's most developed countries by 2050. As a part of the 2050 "big scale" strategy "The National Concept for transition of the Republic of Kazakhstan to Green Economy" was established in May 2013, and one of the key targets is an ambitious plan of reaching renewable energy sources in electricity production by 3% (solar and wind) in

2020, by 30% (20% alternative and 10% renewable energy) in 2030, by 50% (alternative and renewable energy) in 2050. Also, reduction of GHGs by unconditional 15% in 2030 and unconditional 25% depending on the international investment and reduction of the energy intensity of GDP by 25% in 2020. In order to achieve these targets, the Kazakhstan government provides 3 possible scenarios to implement, which are: 1) Base-case scenario "Business as usual (BAU)", 2) Green scenario "expensive gas", 3) Green scenario "cheap gas". According to the results of each scenario, the author's conclusion is that third scenario "Green" (cheap gas) should be the right option to choose. The reason being is that, the cheap price of gas as well as estimated cheap price of renewable energy sources starting 2020 should eventually result in achieving the main targets such as: 1) Share of RES and alternative sources of energy in electricity production being 30% by 2030 and 50% by 2050; 2) Significant reduction of GHG emissions by decreasing the usage of traditional energy sources such as coal by 2030 and 2050; 3) Significant reduction of energy intensity and therefore, increase of energy efficiency by 2030 and 2050. This is due the fact that renewable energy sources are becoming price competitive compared with traditional sources of energy with considerable changes every year.

Second, in 2017 the capital city Astana held an International Expo 2017 event with a topic of "Future Energy", whereby more than 100 hundred countries presented their projects, green technologies and expertise in the energy sector. One of the main topics of the event was about sharing expertise and best innovations in renewable energy field. As a result, the event stimulated an important development of RES and green technologies in Kazakhstan, whereby the Ministry of Energy selected a considerable amount foreign and national projects in installation of renewable energy sources as well as other green technologies.

As a logical development of Astana EXPO-2017, the International Green Technologies & Investment Center (IGTIC) was established on 5th of July 2018 in the territory of EXPO-2017, which has an aim of transferring the best green technologies in Central Asia. The IGTIC will also closely cooperate with organisations such as the Qazaq Finnish Technology Center (QFTC) launched in 2017, which is a non-profit organisation financed by the governments of Kazakhstan and Finland. The QFTC has an aim of bridging the technological gap between Kazakhstan and Finland to reach sustainable

economic development. At the same time, it is important to note that the whole territory of EXPO-2017 will be administered by the Astana International Financial Center (AIFC), which was also established on 5th of July 2018 with a participation of main players from Kazakhstan and international community. The AIFC has a strategic direction to develop the green financial system and support RES with green financial instruments such as green bonds and insurances. Therefore, these type of large scale events and developments clearly show Kazakhstan's position in sustainable economic development and high probability in achieving the targets set.

Third, the Ministry of Energy of the Republic of Kazakhstan (MERK) also announced that by starting 2020 the prices of producing energy from RES will decrease significantly and eventually by 2030 its price will be less than the price of energy produced from traditional sources of energy, because of mass production. The role of the Ministry of Energy of RK is highly important and it shows clear actions in RES field development of Kazakhstan, with recent development being the implementation of the first international auction mechanism in May 2018, which should stimulate investments and high potential projects in renewable energy field (RES). Also, important to note that with help of the negotiations made by MERK, investments from local and international enterprises were given into the development of RES in Kazakhstan. For example, signed agreement with EBRD in an investment of $200 million from the Global Climate Facility, or the financial support of $21.7 million from World Bank, which assist in consistent fast improvements and expansion of RES and green technology sector in Kazakhstan. (EnergyMinistry, 2018)

Fourth, it can be stated that Kazakhstan is developing its renewable energy sources (RES) field on the right direction and this field should be one of the success stories of Kazakhstan according to the recent successfully organized auction system for RES. (MinistryofEnergy, 2018) However, Kazakhstan has significant barriers such as no single separate national program for the development of RES, which was explained by the Minister of Energy that this field is too small in Kazakhstan, for which a separate state program cannot be created at the moment. Nevertheless, Kazakhstan is showing solid results for instance, the successful completion of first international auction mechanism, which significantly reduced the tariffs for the RES by making it more competitive with traditional sources of energy. (MinistryofEnergy, 2018)

Thus, according to the investigation of the thesis Kazakhstan is generally achieving tangible results in developing green technologies by implementing projects in renewable energy sectors such as wind, solar, hydro and bioenergy power plants. The government of Kazakhstan is actively developing and implementing multiple scenarios for energy sector development and international auction system, which are stimulating the uptake of renewable energy technologies. Thus, the analysis of this thesis states that the future targets set in RES (especially 2020 target) and generally in green technology are highly probable and therefore, realistic for Kazakhstan to achieve according to the past, present and future developments. The author sees RES development as one of the real examples of the Kazakhstan success story. RES field is a breakthrough industry for Kazakhstan, such as fintech, blockchain, IT, robotics that can provide great opportunities for the younger generation of Kazakhstan.

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