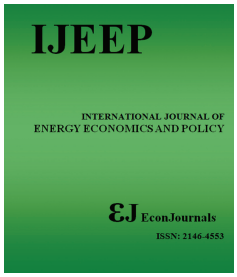
Movkebayeva, Galiya; Aktymbayeva, Aliya; Tyurina, Yuliya et al.

Article

Energy security and sustainability in Eurasian Economic Union in the terms of economic growth : the case of Kazakhstan's energy sector up to 2040 perspectives

Reference: Movkebayeva, Galiya/Aktymbayeva, Aliya et. al. (2020). Energy security and sustainability in Eurasian Economic Union in the terms of economic growth : the case of Kazakhstan's energy sector up to 2040 perspectives. In: International Journal of Energy Economics and Policy 10 (2), S. 497 - 503. https://www.econjournals.com/index.php/ijeep/article/download/9073/4929. doi:10.32479/ijeep.9073.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2020, 10(2), 497-503.

Energy Security and Sustainability in Eurasian Economic Union in the Terms of Economic Growth: The Case of Kazakhstan's Energy Sector up to 2040 Perspectives

Galiya Movkebayeva[1]*, Aliya Aktymbayeva[1], Yuliya Tyurina[2], Nurken Baikadamov[3], Kamar Beketova[4], Marija Troyanskaya[5], Sholpan Smagulova[6], Aizhan Imangaliyeva[7]

[1]Al-Farabi Kazakh National University, Almaty, Kazaksthan, [2]Financial University under the Government of the Russian Federation, Moscow, Russia, [3]Z. Aldamzhar Kostanay Social-Technical University, Kostanay, Kazaksthan, [4]Korkyt Ata Kyzylorda State University, Kazaksthan, [5]Orenburg State University, Russia, [6]Narxoz University, Almaty, Kazaksthan, [7]Tynyshpayev Kazakh Academy of Transport and Communication, Almaty, Kazaksthan. *Email: Movkebayeva@kaznu.kz

Received: 10 October 2019 **Accepted:** 29 December 2019 **DOI:** https://doi.org/10.32479/ijeep.9073

ABSTRACT

The economy of Kazakhstan is the first economy in Central Asia and the second among Eurasian Economic Union (EAEU) countries after Russia. On rates of hydrocarbon raw materials extraction Kazakhstan is included into first ten countries of the world. Kazakhstani economy is based on heavy industry, ferrous and non-ferrous metals, and oil and gas. And it allows Kazakhstan is being on the road of economic growth. With economic growth, the energy production and consumption are also increasing rapidly, resulting first of all, on harmful carbon emissions. Thus, the purpose of this research is to carry out a comparative assessment in the energy sector development and to submit forecast of its demand and its environmental impact in terms of Kazakhstani economic growth up to 2040. First scenario (base case) assumes conventional development pattern together with neither significant changes in the patterns of energy supply and demand nor extensively changed policies and measures. The second one (Mitigation) assumes a technological improvement, regulation and industrial development policies and additional policies which have been designed to promote energy efficiency and reduce emissions across the economy. The simulations are applied until the year 2040, while 2015 is set as the base year. The findings suggest in both scenarios Kazakhstan will continue to pursue its economic development driving energy demand and carbon emissions will also raise. However, under Mitigation Scenario, emission intensity will be lower insignificantly.

Keywords: Kazakhstan, Energy, Carbon Dioxide, Economic Growth
JEL Classifications: 0130, Q400, Q430

1. INTRODUCTION

Kazakhstan has significant oil and gas reserves and abundant mineral resources, including copper, lead, zinc, iron ore, manganese, titanium, chromium, and uranium (Karatayev and Clarke, 2014). This fact allows Kazakhstan has a stable national income and to be on a road of rapid growth in economy. The country ranks 53rd place in the world according to gross domestic product (GDP) (World Bank, 2019). However industrial sector is high energy intensive, due this fact, CO_2 emissions are on the rise in Kazakhstan (Aldayarov et al., 2017). As a consequence of this development Kazakhstan has become large CO_2 emitter in the world. The country ranks 25th place in the world according to carbon dioxide emissions (BP, 2018). In addition, process of industrialization and a lack of government attention to environment have resulted in large scale environment degradation. Among serious environmental problems are the shrinking of the Aral Sea and the steadily rising of water level of Caspian Sea (Valeyev et al., 2019), nuclear waste (Stawkowski, 2016), soil and water pollution (Karatayev et al., 2017; Medetov et al., 2018).

Climate change in Kazakhstan is another environmental concern. More than 60% of the whole Kazakhstani territory is subject to soil degradation, desertification, and water shortages, all of which would be exacerbated by climate change (Salnikov et al., 2015). Kazakhstan has already today suffered from climate change. Most likely that climate change reveals itself through: temperature increase; changeable nature of precipitation; aridity increase; and more frequent cases of extreme weather conditions. All this has been accompanied, in particular, by more frequent cases and intensity of floods, droughts, mud flows, glacier melting and mudslide. As a participator of Kyoto protocol and Paris agreement, Kazakhstan is under a pressure to reduce negative impact on environment and cut carbon emissions (Sabyr et al., 2019). Therefore, Kazakhstan has declared its acceptance of voluntary quantified commitments for the period of post-Kyoto and Paris Agreement - to reduce greenhouse gas emissions for 35% by 2040 compare to 1992 and by 40% at 2050 (Diyar et al., 2014; Bekturganova et al., 2019). The country has significant renewable energy potential including bioenergy potential, and bioenergy is viewed in national strategies as important tool for many sectors and mitigation perspectives as well as from the perspective of developmental goals such as energy security and rural development of Kazakhstan (Koshim et al., 2018). However, the current conurbation of renewable energy sources is about 1% (Rivotti et al., 2019).

2. SCENARIOS METHODOLOGY

The study uses scenario-based modelling tool proposed by Cai et al. (2007) and Karatayev et al. (2019) to assess the CO_2 emission mitigation potential of Kazakhstan's energy sector. In order to collect data authors used primary and secondary sources, at a national level, like the National Energy Balance statistics, Ministry of Environmental protection, Ministry of oil and gas, Ministry of industry and energy, Kazakhstan Electricity Grid Company and the Kazakhstani national GHG inventory, made by the UNDP Kazakhstan, and at international level as well, like the World Bank annual statistics and International Energy Agency.

Additionally, in order to create scenarios authors have studied the long term strategic plans: Development programs of industries of RK up to 2015-2030; Development Program of Kazakhstan until 2030; The scheme of development and location of productive forces of the Republic of Kazakhstan for the period until 2050, which was developed in 2008 by the Economic Research Institute supported by the grant of Ministry of Economics and Budget Planning of RK; The Strategy of Industrial Innovation Development of Kazakhstan for 2010-2030, Ministry of Economics and Budget Planning; Energy Sector Development Program until 2040 (including Programme for the Development of the Electricity Sector up to 2040); National Concept on the Transition of Kazakhstan to Sustainable Development for 2015-2050; National Strategy Kazakhstan – 2050 (Bekturganova et al., 2019).

Based on these data authors developed two scenarios and these results were discussed and verified with local experts (e.g., Kazakhstan Institute of Strategic Research, Institute of Economic Research, Research Institute of Geography, Ministry of Economics and Budget Planning, Local government representatives in sphere of Environmental protection from Aktau, Atyrau, East-Kazakhstan and North Kazakhstan provinces).

3. DEMOGRAPHIC TRENDS

In 2015 the population of Kazakhstan was 16.8 million. Population density was 5.7 people per square meter, which was one of the lowest in the world. According to our projections to 2040 the population of 16 million in 2015 is expected to increase to 22.4 million by 2030 (Sayimova et al., 2017). The result of population projection is presented below in Table 1 "Expected demographic trends."

4. ECONOMIC GROWTH

Since 2001, GDP growth has been among the highest in the world. In 2008 the global financial crisis took a significant toll on Kazakhstan's economy, it has rebounded well. Rising commodity prices have helped revive Kazakhstan's economy, which registered roughly 4-5% growth in 2015-2018. This link and dependency on oil exports will remain the same as long as the Kazakhstani industry and economy does not develop in other areas, like agriculture and manufacture, mid or high technology and service-oriented sector among others and the development of these sectors will take time (Saiymova et al., 2018; Saparaliyev et al., 2019a). Based on this assumption, for the long term the research assumed that the Kazakhstani GDP growth rate will remain linked to world prices for oils and gas, metals and cool, while for the long term (between 2015 and 2040).

Comparing the export concentration index of the Eurasian Economic Union (EAEU) countries, Kazakhstan and Russia show the highest values of this indicator −0.651 and 0.377, respectively, and in Belarus and Armenia - respectively 0.248 and 0.215, which brings them closer to the average for developing countries (0.130), however, significantly exceeding it, not to mention the value for developed countries (0.065). High indicators of export concentration, especially in Russia and Kazakhstan, indicate a low level of diversification of their economies in general, as well as low competitiveness of non-primary products in the world market (World Bank, 2019). Differences in the concentration index of the export of EAEU countries constitute the basis for the influence of external factors on their economies, the spread of the economic crisis, primarily in Russia and Kazakhstan as oil-exporting countries, through a fall in export earnings, as well as a decrease in access to external financing schemes.

According to the projected data (Table 2) - active carrying out of an industrial policy will provide economy growth rates not less than on 7.8-8.5% in a year. It will allow to increase by 2040 in comparison with 2010 gross national product volume approximately at 3.5-3.8 time, to lead mid-annual increase rates in manufacturing industry to 8-8.4%, to rise labor productivity growth by 2040 in comparison with 2015 not less than in 3 times. Dynamical GDP growth per capita which is predicted by 2015 at a rate of 678.9 thousand tenge will proceed that on 27.7% exceeds level of 2015, in 2040 this indicator will make 8.5 times. On the basis of it the further growth of monthly average incomes of the population will be provided. Manufacture goods growth in gross national product occurs, first of all, at the expense of increase in volumes of the added

Table 1: Expected demographic trends

Population growth	2000	2006	2015	2020	2025	2030	2035	2040
Population, thousands	14865.6	15310.3	16884.9	17712.7	18588.2	20423.5	21635.1	22401.7

Table 2: The major economic indicators of Kazakhstan

Economic indicators	2015	2020	2025	2030	2035	2040
GDP in the current prices, billion tenge	10139.5	10739.1	15472.0	21050.9	27723.1	35906.6
In % by corresponding period of previous year	110.6	105.9	144.1	136.1	131.7	129.5
Gross national product per capita, thousand tenge	662.4	678.9	879.9	1055.2	1201.9	1312.4
Gross national product per capita, US dollars/the people	5253.5	5853	7855.9	10050.1	11900.8	13392.7
Real change of gross national product per capita, in % to previous year	109.0	107.0	106.4	105.7	104.5	103.7
Industrial output, billion tenge	6432.4	6988.3	9905.9	11823.6	15741.2	18658.9
In % by corresponding period of previous year	107	108.6	107.4	106.5	107.3	105.4
The mining industry, billion tenge	3726.8	3819.1	4754.1	6788.8	8023.7	10558.6
In % by corresponding period of previous year	107	108.5	107.4	106.7	105.4	104.7
Manufacturing industry, billion tenge	2358.9	3123.5	3359.8	4596.1	5832.4	6068.7
In % by corresponding period of previous year	107.3	107.5	105.6	104.9	104.5	103.7
Manufacture and distribution of energy, gas and water, billion tenge	346.7	365.7	492.2	538.7	685.2	731.7
In % by corresponding period of previous year	103.6	104.5	103.7	103.4	102.3	101.5
Investments into fixed capital, billion tenge	2810.3	3108.1	3930	4751,9	6573.8	7395.8
In % by corresponding period of previous year	110.6	112.3	110.4	113.5	114.6	112.5
Foreign trade turnover, mln. dollars of the US	61927.2	64774.8	74253.4	83732	101210.6	142689.2
In % by corresponding period of previous year	137	133	125	132	125	124
Export turnover, mln. dollars of the US	38250.3	42324.8	56817.7	72310.5	86803.4	108296.2
In % by corresponding period of previous year	137.3	134.5	126.7	123.5	117.7	115.7
Import, mln. dollars of the US	23676.9	27449.9	34435.7	42421.5	57407.2	72393
In % by corresponding period of previous year	136.4	131.5	125.7	130.4	123.5	119.7
Tenge course to US dollar (average for the period)	126.09	116	112	105	101	98
Index of labor productivity occupied in economy (under gross national product), % to previous year	108.5	107.7	105.6	106.5	104.6	103.6

Table 3: Kazakhstan expected extraction mineral resources

Resources	Reserve	World share (%)	Rate of extraction	Depletion year
Crude oil	39.8 billion barrels	3.2	83 billion tons	2100
Natural gas	3.3 trillion м³	1.7	35 billion м³	2085
Coal	31.7 billion tons	3.6	120 million tons	2160
Uranium	1.69 mln. ton	20	17.8 thousand tons	2150

Table 4: Kazakhstani expected extraction mineral resources

Resources	2010	2015	2020	2025	2030	2035	2040
Crude oil, thousand tons	25943.8	35316.8	65003	128000	135600	143000	155000
Natural gas, bln. м³	20.1	45.9	35.4	55.6	70.6	95.5	120.3
Uranium, thousand tons	1270	1870	4500	19500	22000	25000	30000

cost in the industry. A considerable impact will render the volume increasing in export of oil and improvement of the structure of exported goods towards extension share of finished goods on a share size of pure goods export and services in GDP (Saparaliyev et al., 2019b). It is supposed that export will keep high dependence on term of a fuel and energy complex. Almost half of that is made in the country, is exported, and more than half which is consumed in the country, imported. These are typical macroeconomic proportions of underdeveloped country with raw economy orientation.

5. ENERGY SECTOR

As it was described earlier, Kazakhstan is very rich by mineral resources (Karatayev et al., 2016). Stocks of coal make 30-35 billion tons (BP, 2018). Kazakhstan possesses 3.6% of world reserves of the coal, about 910 billion tone (Table 3).

Oil resources of Kazakhstan are the biggest among the former Soviet republics. Independent experts of the Kazenergy Association. (2017) estimated the confirmed stocks in 39 billion barrels. The previous estimates are given by lower figures: 6.42 billion barrels it agrees with OPEC and 8 billion barrels agree BP (BP, 2018). Recently Kazakhstan finished a new assessment of the oil stocks and estimated the confirmed and possible oil stocks about 35 billion barrels. Considering rich mineral, the Government of Kazakhstan plans to increase considerably level of oil, gas, and coal and uranium production (Table 4).

It is necessary to pay attention to that fact that the current outputs of coal in Kazakhstan exceed demand in the republic (Abdukarimova et al., 2018; Lobova et al., 2019). Export makes 1/3 from the general production of coal. Among CIS countries, the biggest consumer is Russia (63.5% from the general consumption of coal).

After Russia on volume coal consumption there is Ukraine (22.1%) and then Kazakhstan (13.7%). Identical tendency characteristics for oil and gas sector also slightly involved in obtaining energy. More than 80% of the republic oil productions send for export (International Energy Agency, 2017).

At the same time, coal is remaining and will be remain main resources for energy production. For these purposes, Ministry of Industry and new technologies developed the concept of development on the coal industry up to 2030. According to the concept the increase in volume of coal mining from 96.3 million tons in 2006 to 145.6 million tons to 2020 is presupposed (Table 5).

The energy generation is distributed by the type of power plant in a following way: thermal power plants – 87.7%, hydroelectric power stations – 12.3%. Coal is the main source for receiving the electric power in Kazakhstan, and nearly 73% of the electric power are made at coal power plants, 12.3% - from water resources, 10.6% - from gas and 4.9% - from oil (National Energy Report, 2017).

As it was already noted in many references (Karatayev and Clarke, 2014; Rivotti z., 2019), the industry is the biggest consumer of energy. It absorbs a half of final consumption while housing and economic and serving sector consumes about 40%, and transport sector only 10%. It should be noted that such high share of electricity consumption is closely connected with an environment production of the country in such branches, as ferrous and nonferrous metallurgy, the chemical industry, the industry of building materials and so on which usually are considered as the most power-intensive. It should be noted that in sector of the electric power of the industry the main development is the share of coal. Coal is also widely used as a power source and for domestic needs.

The renewable energy resource potential in Kazakhstan is significant but was largely neglected (Karatayev and Clarke, 2016; UNEP and Bloomberg, 2017). The share of renewables is only 1.1% in total primary energy supply. A hydro power capacity of 2000 MW is installed. Most of the hydro stations currently in operation require reconstruction and modernization due to large exploitation period (most of hydro station were in operation for 40-55 years) and depletion of equipment (Teleuyev, 2017). However the potential capacity is estimated to be 10 times higher, i.e., 27 billion kWh/year. Mini-hydro (units of <10 MW), has a significant potential. Based on existing studies, there are at least 453 potential small hydroelectric power projects with 1380 MW of total installed capacity and 6.3 TWh of mean annual production. Kazakhstan has very strong wind potential, largely due to the pervasiveness of wind-intensive areas. The majority of the country's land mass has wind potential of at least 4-5 m/s, with a few coastal areas reaching 6 m/s. The estimated potential amounts to 1.300 TWh. The sheer size of Kazakhstan compared to its Central Asian neighbors gives it a distinct advantage in the development of solar power, since more surface area yields more direct sunlight. The country receives between 2200 and 3000 h of sunlight per year on average. This allows using of the sun batteries, in particular portable photovoltaic applications in the rural area on the cattle farms.

Table 5: Coal mining forecast by 2030 (mln. tones)

Regions	2006	2010	2015	2020	2025	2030
Northern region	91,83	101,7	120,4	137,8	144,0	150,5
Eastern region	4,43	5,5	6,6	6,6	7,6	8,1
Western region	0,03	0,3	0,4	0,4	0,4	0,4
Southern region	0,03	0,8	0,8	0,8	1,0	1,0
Total in RK	96,32	108,3	128,0	145,6	153,0	160,0

According to our projection, perspective levels of electric power production as a whole on the republic were predicted in volume of 110 MTOE by 2040, with a gain for 1.8-2.4%. Agreeing to national long-term programs, development building of new power objects, restoration, capital and maintenance, modernization of power generation facilities, including reconstruction of electric networks and substations is provided. It is supposed that construction input of small hydro-stations and input of wind power stations, which construction to be carried out to 2015-2025. However according our projected scenarios, considering technological capabilities of Kazakhstan, energy will remain to depend on coal and its share in power consumption will grow only. The use of natural gas also will grow up respectively, and also too insignificant growth will be observed at the expense of alternative sources using.

6. EMISSIONS AND TRENDS

According to the world development indicators, the total CO_2 emissions were estimated at 261.3 mln. tons in the year 1992. The economic collapse in Kazakhstan from 1990 up to 2000 has resulted in the consequent decline of the energy consumption and the corresponding CO_2 emissions (USAID, 2018). In 2000, the overall CO_2 emission constituted 140.8 mln. tons, or 53% less than the level in 1992. Due to the high energy intensity of the economy and the prevailing use of coal in energy production, it was expected, however, that the recovery of the economy has resulted in rapid increase of CO_2 emissions. Despite the remaining growth of CO_2 emissions from 2000, total CO_2 emissions in 2015 remain below 1992-year level (203 mln. tons of CO_2). However Kazakhstan has globally position as the largest emitter of greenhouse gases in post-Soviet countries. Also, Kazakhstan belongs to the countries with the highest CO_2 emissions per capita.

In accordance to a share in total CO_2 emissions energy sector emissions prevail – in 1990 and 2015 their share came to 83% and 87% correspondingly. Agricultural sector is on the second place of share, which contribution slightly reduced from 11% in 1990 to 8.08% in 2015, and share of CO_2 emissions from the other category during the concerned period has been in the limits of 1.6-2.13% correspondingly. As mentioned before coal is the main resource for energy sector Kazakhstan. Thus, coal used by Kazakhstan gave off an estimated 155 and 124 million metric tons of CO_2 in 1992 and 2015. In 2015, 73% of CO_2 emissions from fuel combustion were produced from coal.

7. SCENARIOS DEVELOPMENT

7.1. Base Case Scenario

This scenario assumes the future economic development along the conventional path. New policies are put in place to encourage energy efficiency, renewable energy, or other emissions abatement but limited actions due to number of different barriers. This means neither significant changes in the patterns of energy supply and demand nor extensively changed policies and measures. In principle it is prolongation of perceivable trends. In such a scenario global demand for energy resources would remain fairly strong in the post-crisis recovery stage. High earnings from exports of oil and gas are capable of maintaining the Kazakhstani economy as a whole. It is therefore possible that neither the state nor big business will implement a serious reduction CO_2 emissions policy. This could lead to: Kazakhstani energy efficiency remaining less than half that of developed countries; Slower progress towards energy efficiency in Kazakhstan during the coming decade and increased export of energy-intensive commodities with low levels of processing (metals, other resources materials etc.); Continued dominance of coal as the feedstock to fuel-fired power stations; Continued low levels of oil product export (3-5.5 times less than exports of crude oil by volume); Government energy priorities remain focused on increase of oil and gas industry.

The transition to a low-carbon economy is a priority for Kazakhstan, as outlined in the Kazakhstan-2050 strategy (Karatayev and Hall, 2017). The main ways to achieve the goal are energy efficiency, energy saving, transition to alternative and renewable forms of energy. By 2030, it is planned to reduce the energy intensity of GDP by 25%. Currently, the specific energy consumption per unit of GDP is 1.9, i.e., is one of the highest in the world. However, country faces a number of barriers in policy implementation. The high energy intensity of the economy is one of the negative factors for its development, due to the fact that it reduces the competitiveness of manufactured goods and pollutes the environment to a great extent. According to the projected data of the Base case scenario, CO_2 emissions could increase from 203 $MtCO_2$ in 2015 to 253 in 2025, 359 in 2030, and 435 in 2040 (Table 6). The threshold of 261 $MtCO_2$ 1992 will be reached in 2025. Emissions increases due to the fact that raises the total national consumption of energy without changes in use as a primary resource – coal. The share of coal in total energy consumption will only increase.

7.2. Mitigation Scenario

Which incorporates a range of additional policies designed reduces emissions across the economy; improve energy and electricity efficiency and development of a renewable electricity programme and instruments to support it. Good institutional environment is created for development of other economic sectors (in addition to the fuel and energy sector). These factors in combination could have the following consequences: Shift of government and private investments from extensive development of the fuel and energy sector to its modernization. Achievement of greater refining depth and increase of oil product export volumes towards the level of crude oil exports; Energy efficiency innovations and much greater use of existing mechanisms for energy saving; Targeting of competitive advantages in new energy (alternative energies); Government energy policy becomes focused on competitiveness of other industries and investments into fixed capital in metallurgy and chemical branch, in mining, in mechanical engineering, in fuel and energy complex.

According to the Mitigation scenario, CO_2 emissions could increase from 203 $MtCO_2$ in 2015 to 200 in 2025, 251 in 2030, and 361 in 2040. The threshold of 261 $MtCO_2$ 1992 will be achieved in 2030 (Table 7), despite the insignificant measures taken from

Table 6: Forecasting summary emissions CO_2 from energy sector (base case scenario, $MtCO_{2e}$)

Year	Total CO_2	Energy sector	Coal	Oil	Gas
2015	202546.5	180094.6	117740.2	33389.0	28965.4
2020	196208.0	170966.7	121939.0	32447.0	16580.7
2021	203400.7	170924.6	122447.2	31486.4	16991.0
2022	208470.1	177199.6	127583.7	31895.9	17720.0
2023	225813.0	188941.1	130519.9	34549.4	23871.7
2024	234110.5	205217.2	144212.1	37083.1	23922.1
2025	252875.2	222001.4	158401.0	39600.3	24000.1
2026	272210.3	236823.0	165776.1	42628.1	28418.8
2027	290905.8	258906.2	181234.3	46603.1	31068.7
2028	310977.7	286770.2	199274.5	49818.6	37677.0
2029	332233.1	299009.8	203326.7	53821.8	41861.4
2030	359854.9	315876.7	217172.4	55057.8	43646.4
2031	365488.7	330975.2	228942.1	57235.5	44797.5
2032	378133.1	348975.8	240152.3	59215.6	49607.8
2033	383600.4	344896.3	234226.4	59381.3	51288.6
2034	387951.2	353517.5	239637.5	60753.2	53126.9
2035	393461.7	370246.3	252759.8	62324.3	55162.2
2036	410188.0	378659.8	258008.3	62758.8	57892.8
2037	415970.1	388734.3	264723.4	64392.2	59618.7
2038	421697.3	403876.7	275157.5	66037.8	62681.4
2039	429193.0	407689.8	275713.6	67984.2	63992.1
2040	435741.2	425809.7	290857.3	69805.7	65146.7

Table 7: Forecasting summary emissions CO_2 from energy sector (Mitigation scenario, $MtCO_{2e}$)

Year	Total CO_2	Energy sector	Coal	Oil	Gas
2015	202546.5	180094.6	117740.2	33389.7	28965.4
2020	194974.2	170322.6	112967.3	32009.3	25346
2021	201881.3	165987.1	112004.9	31674.1	22308.1
2022	200852.1	163227.9	110948.4	31088.4	21191.1
2023	190842.7	154810.2	110307.1	30172.2	14330.9
2024	195734.1	158289.9	111470.6	29947.3	16872.9
2025	199360.9	156669.3	111841.5	29824.4	15003.1
2026	204327.7	172770.9	117733.6	31559.6	23477.6
2027	210248	183701.7	129336.8	32365.6	21998.8
2028	219800.1	185233.8	132868.3	33647.3	18718.5
2029	242269.3	199433.6	136712.6	37906.6	24814.4
2030	251264.2	205921.9	138823.5	40297.9	26800.7
2031	266654.6	220440.8	146713.4	45438.1	28288.6
2032	272609.8	237272.2	151134.9	49218.6	36918.7
2033	285800.7	249034.3	158933.8	52935.8	37164.4
2034	292628.4	252549.4	160301.8	54447.3	37800.2
2035	321146.9	276786.6	179071.3	56717.8	40997.7
2036	335484.5	281279.2	181564.2	56893.5	42822.2
2037	341216.1	286293.7	185178.5	56513.2	44601.9
2038	349489.2	286846.5	183132.3	57122.4	46591.8
2039	355907.7	294333.3	186495.6	58667.3	49170.2
2040	361176.9	301841.8	192146.1	58667.4	51028.3

Figure 1: Forecasting summary emissions CO_2 from energy sector (under Mittigation scenario, $MtCO_{2e}$)

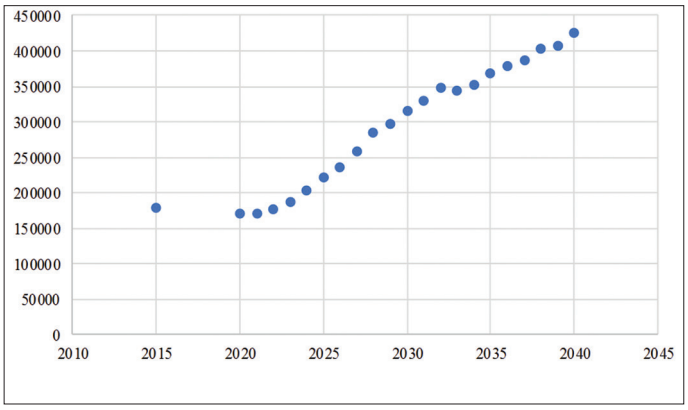
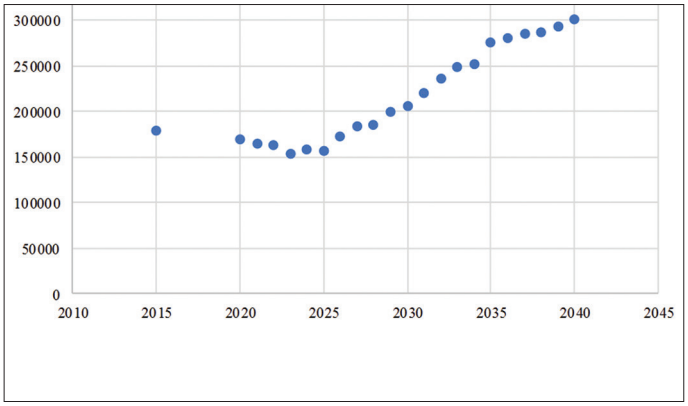


Figure 2: Forecasting summary emissions CO_2 from energy sector (under Base Case scenario, $MtCO_{2e}$)



the state level and national projects. All the long-term national projects are aiming to economic growth and exploitation of natural resources. In addition, oil and gas and energy sector of the country claim to increase capacity and performance. Therefore, even under Mitigation scenario CO_2 emissions will rise.

In 2040, the model results estimate that both scenarios show that based on primary energy demand by energy sources, total CO_2 emissions are projected to increase. The resulting Base Case Scenario emissions nonetheless will be substantially higher than current levels, and significantly higher than Kazakhstan's voluntary target of 15% reduction relative to 1992 levels in the period to 2040 (Figure 1). However, under the Mitigation Scenario, environmental pressures from energy production and consumption are also likely to mitigate insignificantly. Under Mitigation Scenario target 2040 reduction CO_2 emissions by 35% perhaps would be achievable with significant efforts (Figure 2).

8. CONCLUSION

The results imply that energy demand and associated CO_2 emissions in Kazakhstan will raise in both scenarios in terms of the economic growth until 2040. According to the international obligations of Kazakhstan must reduce emissions at 35% by 2040 compare to 1992 and by 40% at 2050. In this case, our analysis suggests that Kazakhstan can meet the 2040 target with the Mitigation Scenario aiming to improving energy efficiency, energy technology and service sector. However, with the projected continued growth across emissions-intensive sectors, emissions are on an upward trajectory even in this scenario.

Choice of fuel in the power sector is a major determinant of future emissions trajectory in Kazakhstan, because the power and heat sector based on coal already accounts for a very significant proportion of emissions. Kazakhstan's reliance on coal across most sectors results in a significant increase in emissions over time. Limiting the use of coal would therefore substantially reduce emissions. For such a scenario to be feasible, however, the government would need to significantly increase its efforts to modernize power plant and industry sector which required additional significant investments.

9. ACKNOWLEDGMENT

This manuscript was written under grant from Kazakhstan Ministry of Education and Science №AP05135081 "The problem of energy security within EAEU of energy policy-making framework" coordinated by Prof. Dr Galiya Movkebayeva (Al-Farabi Kazakh National University).

REFERENCES

Abdukarimova, Z., Bitemirov, K., Bizhan, N., Esenaliyev, A., Poshanov, N., Kalkanova, Z. (2018), Features of compensation for damage caused to natural resources in Kazakhstan. Journal of Advanced Research in Law and Economics, 9(4), 1169-1175.

Aldayarov, M., Dobozi, I., Nikolakakis, T. (2017), Stuck in Transition: Reform Experiences and Challenges Ahead in the Kazakhstan Power Sector. Directions in Development. Washington, DC: World Bank.

Bekturganova, M., Satybaldin, A., Yessekina, B. (2019), Conceptual framework for the formation of low-carbon development: Kazakhstan's experience. International Journal of Energy Economics and Policy, 9(1), 48-56.

BP. (2018), Statistical Review of World Energy. 67th ed. New York: Energy Council.

Cai, W., Wang, C., Wang, K., Zhang, Y., Chen, J. (2007), Scenario analysis on CO_2 emissions reduction potential in China's electricity sector. Energy Policy, 35(12), 6445-6456.

Diyar, S., Akparova, A., Toktabayev, A., Tyutunnikova, M. (2014), Green economy-innovation-based development of Kazakhstan. Procedia Social and Behavioral Sciences, 140, 695-699.

International Energy Agency. (2017), World Energy Statistics and Balances Data Service. Available from: http://www.iea.org/statistics. [Last accessed on 2019 Aug 20].

Karatayev, M., Clarke, M.L. (2014), Current energy resources in Kazakhstan and the future potential of renewables: A review. Energy Procedia, 59, 97-104.

Karatayev, M., Clarke, M.L. (2016), A review of current energy systems and green energy potential in Kazakhstan. Renewable and Sustainable Energy Reviews, 55, 491-504.

Karatayev, M., Hall, S. (2017), Integration of wind and solar power in Kazakhstan: Incentives and barriers. In: Sustainable Energy in Kazakhstan. Abingdon: Routledge. p65-89.

Karatayev, M., Hall, S., Kalyuzhnova, Y., Clarke, M.L. (2016), Renewable energy technology uptake in Kazakhstan: Policy drivers and barriers in a transitional economy. Renewable and Sustainable Energy Reviews, 66, 120-136.

Karatayev, M., Kapsalyamova, Z., Spankulova, L., Skakova, A., Movkebayeva, G., Kongyrbay, A. (2017), Priorities and challenges for a sustainable management of water resources in Kazakhstan. Sustainability of Water Quality and Ecology, 9, 115-135.

Karatayev, M., Movkebayeva, G., Bimagambetova, Z. (2019), Increasing utilisation of renewable energy sources: Comparative analysis of scenarios until 2050. In: Koulouri, A., Mouraviev, N., editors. Energy Security: Policy Challenges and Solutions for Resource Efficiency. Cham, Switzerland: Palgrave Macmillan.

Koshim, A., Karatayev, M., Clarke, M.L., Nock, W. (2018), Spatial assessment of the distribution and potential of bioenergy resources in Kazakhstan. Advances in Geosciences, 45, 217-225.

Lobova, S.V.E., Ragulina, J.V., Bogoviz, A.V., Alekseev, A.N. (2019), Energy security performance: A dataset on the member countries of the commonwealth of independent states, 2000-2014. Data in Brief, 26, 104450.

Medetov, A., Bitemirov, K., Yessimkulov, S., Nakypov, B., Sabyr, A. (2018), The legislative and institutional framework for transboundary water resources management in Kazakhstan. Journal of Legal, Ethical and Regulatory Issues, 21(3), 1-6.

National Energy Report. (2017), Kazenergy Association. Available from: http://www.kazenergy.com. [Last accessed on 2019 Aug 20].

Rivotti, P., Karatayev, M., Mourão, Z.S., Shah, N., Clarke, M.L., Konadu, D.D. (2019), Impact of future energy policy on water resources in Kazakhstan. Energy Strategy Reviews, 24, 261-267.

Sabyr, A., Rustemova, G., Koshkinbayeva, A., Bitemirov, K., Bizhanova, A., Medetov, A., Kussainova, L. (2019), The role of international conventions and covenants in achieving economic and environmental justice: A conceptual review. Journal of Legal, Ethical and Regulatory Issues, 22(2), 1-8.

Saiymova, M., Yesbergen, R., Demeuova, G., Bolatova, B., Taskarina, B., Ibrasheva, A., Saparaliyev, D. (2018), The knowledge-based economy and innovation policy in Kazakhstan: Looking at key practical problems. Academy of Strategic Management Journal, 17(6), 1-11.

Salnikov, V., Turulina, G., Polyakova, S., Petrova, Y., Skakova, A. (2015), Climate change in Kazakhstan during the past 70 years. Quaternary International, 358, 77-82.

Saparaliyev, D., Mokin, C., Movkebayeva, G., Saiymova, M., Mustafina, A. (2019b), Review and analysis of imposed European Union and United States international sanctions on Ukrainian crisis and Russia's countermeasures. Journal of Legal, Ethical and Regulatory Issues, 22(2), 1-12.

Saparaliyev, D., Spankulova, L., Zhaxylykova, A., Aldashova, G., Saiymova, M., Akhmetova, G. (2019a), Impact of new technologies, innovations and barriers on the service delivery and financial income of the private business in transitional economies: The case of health centers. Academy of Strategic Management Journal, 18(3), 1-10.

Sayimova, M., Esbergen, R., Baimukasheva, Z., Turganbaev, M., Dzhusibalieva, A. (2017), Features of social and economic development of the small city of Kandyagash. International Journal of Economic Perspectives, 11(4), 125-130.

Stawkowski, M.E. (2016), "I am a radioactive mutant": Emergent biological subjectivities at Kazakhstan's Semipalatinsk nuclear test site. American Ethnologist, 43(1), 144-157.

Teleuyev, G.B. (2017), Problems of legal regulation for use and development of renewable energy sources in the republic of Kazakhstan. International Journal of Energy Economics and Policy, 7(5), 296-301.

UNEP and Bloomberg New Energy Finance. (2017), Global Trends in Renewable Energy Investment. Available from: http://www.fs-unep-centre.org. [Last accessed on 2019 Aug 20].

USAID. (2018), A Guide for Investors on the Implementation of Renewable Energy Projects in Kazakhstan. Available from: http://www.ptfcar.org. [Last accessed on 2019 Aug 20].

Valeyev, A., Karatayev, M., Abitbayeva, A., Uxukbayeva, S., Bektursynova, A., Sharapkhanova, Z. (2019), Monitoring coastline dynamics of Alakol Lake in Kazakhstan using remote sensing data. Geosciences, 9(9), 1-10.

World Bank. (2019), Central Asia Energy-Water Development Program. Washington, DC: World Bank. Available from: http://www.worldbank.org. [Last accessed on 2019 Aug 19].