

Towards Achieving Energy Efficiency in Kazakhstan

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Abstract—Kazakhstan is currently one of the dynamically developing states in its region. The stable growth in all sectors of the economy leads to a corresponding increase in energy consumption. Thus country consumes significant amount of energy due to the high level of industrialisation and the presence of energy-intensive manufacturing such as mining and metallurgy which in turn leads to low energy efficiency. With allowance for this the Government has set several priorities to adopt a transition of Republic of Kazakhstan to a “green economy”. This article provides an overview of Kazakhstan’s energy efficiency situation in for the period of 1991-2014. First, the dynamics of production and consumption of conventional energy resources are given. Second, the potential of renewable energy sources is summarised followed by the description of GHG emissions trends in the country. Third, Kazakhstan’ national initiatives, policies and locally implemented projects in the field of energy efficiency are described.

Keywords—Energy efficiency in Kazakhstan, greenhouse gases, renewable energy, sustainable development.

I. INTRODUCTION

KAZAKHSTAN, the ninth largest and the biggest landlocked country in the world, is located in the centre of Eurasian continent. In December 1991 it gained its independence from the Soviet Union, and the transition period was characterised by economic decline. Since 1992 Kazakhstan successfully adopted a national economic reform aimed at establishing a free market economy through supporting privatisation of state enterprises. However, the main driving force of economic growth in the country was foreign investments generally to oil and gas industries. Since independence has Kazakhstan received more than 30 billion US dollars of foreign direct investment.

Nowadays, Kazakhstan is a major producer and exporter of coal, oil, gas, and uranium ore as well as the largest greenhouse gas (GHG) emitter in the Central Asia region. The domestic demand in energy, mostly in electricity, is rising in the country. The major challenge and urgent need is to diversify Kazakhstan’s energy base and reduce GHG emissions by improving energy efficiency in all economy sectors.

The country will benefit from implementing energy

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efficiency measures in many different ways. It will achieve economic gains by decreasing of electricity and heat bills, meet climate change targets by reducing GHG emissions, create new jobs in green technologies and services, as well as having a social impact by changing humans’ perception and habits towards energy and planet conservation.

II. CONVENTIONAL ENERGY RESOURCES

Kazakhstan has a strong base of natural energy resources such as coal, oil, gas, and uranium. The country possesses 3% of the world’s raw materials. Although the country is rich in energy resources, the energy production and consumption was not high for a certain period of time. The common trend after the declaration of independence from the former Soviet Union in 1991, and as a result of economic crises, the development of all industries in Kazakhstan was suspended. The production together with consumption of energy sources vastly declined. However, in the new century Kazakhstan managed to grow faster than other post-Soviet countries and performed a steady progress in many fields. In 2000-2005 the growth of GDP output was about 10% per annum. Today, the economy of Kazakhstan is 12% as energy intensive as Russian economy and twice more intensive than OECD economy [1].

A. Coal

Central Asia’s largest recoverable coal reserves are concentrated in Kazakhstan. According to BP Statistical Review of World Energy the total number of proved coal reserves in Kazakhstan is 33 600 million tonnes, which is 3,8% of total world’s reserves [2]. The country has more than 400 coal deposits of which a third is classified as brown coal or lignite deposits. 64% of all reserves in Kazakhstan is anthracite and bituminous and the remaining 34% - sub-bituminous (lignite and brown coal). Most of the estimated deposits are in Karaganda coal basin with 2 000 km² carbon coal-content area occupation and Ekibastuz coal basin with 63 km² coal content sediments recovery. These basins are responsible for nearly 95% of total coal production in the country [3].

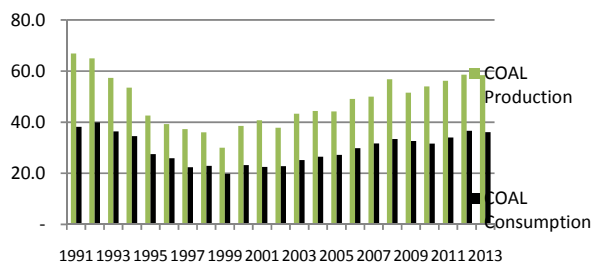


Fig. 1 Coal production and consumption (MToe) [2]

Fig. 1 shows coal production and consumption for the period of 1991-2013. Since independence, Kazakhstan has been characterized by economic decline, which affected all industries. Due to the cut of subsidies and slow adaptation to new economic conditions, coal production in Kazakhstan has significantly dropped from 66,9 Mtoe in 1991 to 30,0 Mtoe in 1999. By 2000 many of coal mining enterprises were restructured and largely privatised by foreign companies. As a result of foreign investments and growing demand, the annual coal production has progressively increased to 58,4 Mtoe in 2013. According to the Ministry of oil and gas of Kazakhstan the country aims to produce 100 Mtoe by 2015 [4]. However, with a new energy orientation under government consideration towards renewable energy resources, the situation of coal industry in Kazakhstan may change in the long-term outlook.

Similar to coal production the consumption index has fallen to the minimum of 19,8 Mtoe in 1999 which is accounted for 52% of coal consumed in 1991 and 55% in 2013. Approximately 30% of Kazakhstan's coal production is exported, mainly to Russia and Ukraine. 80% of electric generating plants are coal-fired, including the largest power generator, Ekibastuz No.1, located in north-central Kazakhstan. Bogatyr Access Komir, LLP is the largest open cast mining company in Kazakhstan.

B. Oil

The first oil was extracted in Kazakhstan on Karashungul oilfield in November 1899. However industrial oil production began since 1911 on Dossor (Atyrau region) oilfield. Nowadays Kazakhstan is one of the largest oil producers in the world and the second largest liquid fuels producer among former Soviet Union republics [3]. By the end of 2013 Kazakhstan accounted for 3.9 million tonnes of both onshore and offshore proven hydrocarbon reserves.

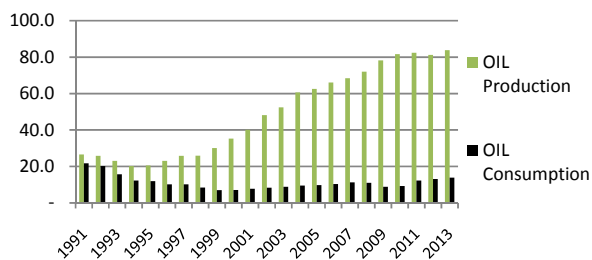


Fig. 2 Oil production and consumption (Mtoe) [2]

As shown in Fig. 2 a rapid increase of oil production in Kazakhstan started in 1995 from 20,6 million tonnes and by 2013 the number has become four times greater. The driven force for becoming Kazakhstan a strong oil actor on international scene was signing several agreements with transnational oil companies such as Chevron in 1993, Agip, British gas and Gazprom in 1995 to exploit oil fields [4]. The largest oil fields are Tengiz and Karachaganak in north-west of Kazakhstan are responsible for a nearly a third of total output. Another significant project of Kazakhstan is a newly started Kashagan oilfield, the fifth world's largest in terms of

reserves, developed by North Caspian Operating Company in 2013 [5] is expected that Kazakhstan will continue enhancing its leading position on international scene over the next decade when Tengiz and Karachaganak oil fields will reach their peak production [6].

Oil consumption is connected to economic activity, consumption patterns, and conservation. In Kazakhstan oil consumption declined throughout the decade after independence (1991-2000) reaching a low of 7.0 million tonnes in 1999. During the next 14 years, the number has been doubled to 13,8 million tonnes. Considering the low demand, significant quantities of oil are available for export.

Diverse export options and appropriate transportation infrastructure are vital to ensure that Kazakhstan oil is sold at competitive prices. In 1996 Kazakhstan, Russia, Oman and foreign oil companies signed Caspian Pipeline Consortium (CPC) and agreed on construction of oil pipeline with capacity of 67 million metric tons on the route Tengiz-Tikhoretsk-Novorossiysk to facilitate oil export. Current infrastructure delivers Kazakhstan oil to world markets westward to the Black Sea via pipelines and rail, northward to Russia via pipeline and rail, southward through the Persian Gulf via swaps with Iran, and eastward through China via rail [7].

C. Natural Gas

In Kazakhstan gas production is strongly associated with oil production since most of natural gas exists along with significant oil reserves. Kazakhstan's biggest gas producing fields are at the same time biggest oil producers. Less than 2% of gas reserves are developed in the country.

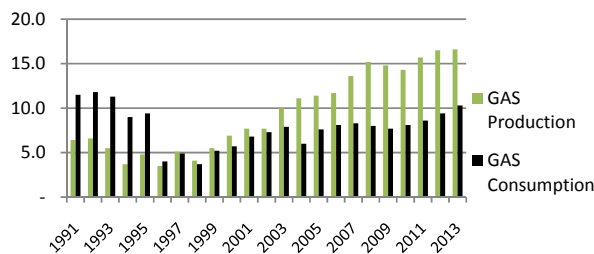


Fig. 3 Gas production and consumption (Mtoe) [2]

According to BP estimates [2], Kazakhstan is being increasing its gas production and consumption for the past 16 years. The estimates show that gas production more than tripled since 1998 with 4,1 to 16,6 million tonnes in 2013, and gas consumption more than doubled to 10,3 million tonnes by the end of 2013. As mentioned above, most oil and gas located in the West of Kazakhstan. In order to satisfy demand in the southern part, Kazakhstan imports natural gas from Uzbekistan and Turkmenistan.

D. Uranium

During the times of the USSR, the territory of Kazakhstan was used as a nuclear testing ground. The country was responsible for uranium mining, reconversion and fuel pellet production in the nuclear power cycle. After the USSR

dissolved, the country inherited the 4th world's largest nuclear arsenal [8]. According to the International Atomic Energy Agency, uranium reserves in Kazakhstan actually amounts to 1,7 million tonnes which is close to 12% of the total volume of the world uranium reserves [9]. About 80% of uranium reserves in Kazakhstan are focused in sandstone-type deposits, in water-saturated permeable rocks.

There are six uranium-ore provinces on Kazakhstan: Shu-Sarysu (57,8%), North-Kazakhstan (16,4%), Syrdariya (18,8%), Ili (4,5%), Caspian Sea Region (1,7%), and Balkhash (0,8%). In total there are 54 explored deposits with uranium reserves in Kazakhstan with 16 deposits under the development and 38 deposits ready for use [10]. According to World Nuclear Association, in 2009 Kazakhstan became the world's leading uranium producer with almost 28% of world production, then 38% in 2013 producing about 22,550 tonnes [11].

E. Electricity Generation

According to the World Bank, there are 71 power plants in Kazakhstan with the majority of combined heat and power plants: 71,1% of all plants use coal and the remaining 28,9% are divided between natural gas and hydroelectric power [12]. The total installed capacity is 18 GW, however, lack of maintenance only about 14 GW are operational. 80% of the total electricity is produced and 70% consumed by coalmine-mouth power plants.

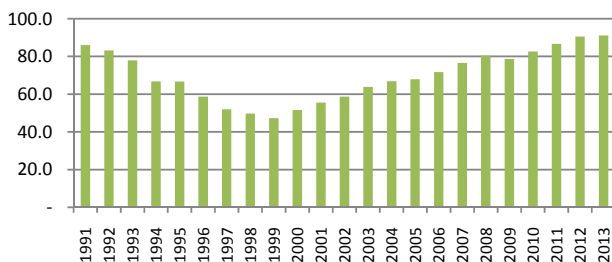


Fig. 4 Electricity generation (TWh) [2]

As shown in Fig. 4, total electricity generation decreased by 45% between 1991 and 1999 with the only 47,3 terawatt-hours in 1999. After 2000, the production of electricity grew.

In addition to coal, oil, and gas, electricity covers generation by geothermal, solar, wind, and tide and wave energy, as well as combustible renewables and waste. Given the progressive development of the economy, introduction of energy-saving and energy technologies, the development of alternative energy become the urgent issues. The energy saving potential amounts to USD 3 to 4 billion per year, which is likely to reach USD 6 to 10 billion per year by 2030 [13].

III. RENEWABLE ENERGY SOURCES

Nowadays, most of the developing and developed countries are expressing concerns regarding the environmental impact of the electricity production from traditional sources of energy such as coal, oil and gas. As it has been described before

Kazakhstan has a vast amount of fossil fuel preserves which could last for the next 500 years. However, as much as fossil fuels there is a good potential for alternative energy sources in Kazakhstan. According to the United Nations Developing Programme (UNDP) Kazakhstan has a great potential both for wind and solar energy technologies development.

A. Wind Energy

According to the report [14] around half of Kazakhstan's territory has average wind speed about 4-5 m/sec at a height of 30m. UNDP/GEF together with the Government of Kazakhstan has implemented a joint project "Kazakhstan – wind power market development initiative". Feasibility studies of wind energy development which included meteorological mast installation and measuring at a height of 30-80 meters over minimum of one year have been done. On the basis of the study several potential sites for wind energy development have been identified and put into a wind atlas. It could be observed from the wind atlas [15] that the wind speed in Kazakhstan at 80 m height reaches more than 6m/sec which makes it very attractive for technology development.

There are eight sites have been identified which have a sufficient potential for wind energy development: Astana, Arkalyk, Ermentau, Fort Schevchenko, Karabatan, Karkaralinsk, Kordai, Zhuzumdyk. Amongst mentioned sites Kordai site has been implemented already and opened in 2011. The power capacity is 1.5MW. Currently, there is another wind farm under development locating at Erementau with the power capacity of 45MW.

In accordance with the Law "On support of renewable energy" the Plan of projected renewable energy objects layout have been developed and approved.

B. Solar Energy

Despite the fact that Kazakhstan is located in the northern latitudes, the county's potential of solar radiation is significant and accounts for 1.3-1.8 MW/h at 1 m² per year [16]. At the same time solar energy could be used not only for power generation, but heating as well, which causes the possibility of introducing solar installations including areas remote from the main electricity and heat supply. The average annual sunshine duration in Kazakhstan varies from 2000 to 3000 hours per year [17], [18]. For instance, in the very north cities of the country like Petropavlovsk sunshine hours amounts to 2132, and in the very south city Turkmenistan it reaches up to 3062 hours per year consequently. Such values could be described not only due to the latitude of southern Kazakhstan, but also the absence of cloudiness in warmer months.

Kazakhstan refers to the countries with the favourable conditions for solar energy development. However, while the cost of conventional electricity is relatively low, solar power plants will not be able to enter this energy market. Currently, with the support of the Government there has been developed a production line of PV modules using local Kazakhstani silicon. The fact that Kazakhstan intended to have its own plant on solar panel production was known already in 2010, a long before the EXPO-2017 host country was selected.

Together with the Law “On renewable energy support” and the course set by the President of Kazakhstan Nursultan Nazarbayev “Future Energy” it was drawn a lot of attention to the renewable energy development projects in the country.

At the moment several pilot PV plants are operating, the first one locates near former capital Almaty, in Kapchagai region. The installed capacity of the PV plant is 2MW and it powers up to 600 households. The next PV plant locates near Kyzylorda city, in Kordai region with the installed capacity of 504kW and it supplies around 200 households. It is projected that the solar power plant with the power capacity of 50MW will be constructed in Zhambul, Zhualy region by the end of 2014. Beside, another pilot project will be implemented in Zhambyl region with the total power of 24MW [19]. It is expected that all these projects would help the country to transit to “green economy” and meet the set targets to reach 0.1% by 2015 and reduce CO₂ emissions.

C. Hydro Energy

Hydro power plant is believed to be the safest and at the same time environmentally friendly way of energy generation. The availability of generating capacity is also important from the view that they don't depend on the price of oil and gas. Moreover, as well as reducing CO₂ emissions, hydroplants could be used for water supply and flood control [20]. It should be noted that the global experience shows the trends of maximum hydro development even in the presence of other energy sources. Learning from the experience of other countries, such as Norway, which has a very large natural gas reserves but widely uses hydroplants, or Canada which is also actively utilizes hydro energy.

Due to the presence of mountain terrain in southern and eastern part of the country, Kazakhstan has a significant hydroelectric potential. Hydropower potential is used in several large and medium hydropower plants (HPP) such as Bukhtarma HPP, Ust-Kamenogorsk HPP and Shulbin HPP on Irtysh River, Kapchagai HPP on Ile River, Chardarinskaya HPP on Syrdarya and Moinak HPP on Charyn River.

The installed capacity of major hydropower stations in Kazakhstan is summarized in Table I. Together with the mini hydro plants the total installed capacity accounts for 2350.16MW [21].

TABLE I

MAJOR HYDRO POWER PLANTS IN KAZAKHSTAN		
Name of HPP	Installed capacity (MW)	Million Kwh per year
Shulbinskaya	702	1660
Moinakskaya	300	1 270
Bukhtarminskaya	675	2 600
Kapchagaiskaya	364	972
Ust-Kamenagorskaya	331.2	1520
Shardarinskaya	100	300
Total	2472.2	8322

The stations shown in Table I cover 10% of electricity demand of the country. However, together with the other alternative energy sources it accounts only for 0.5% of total energy consumption.

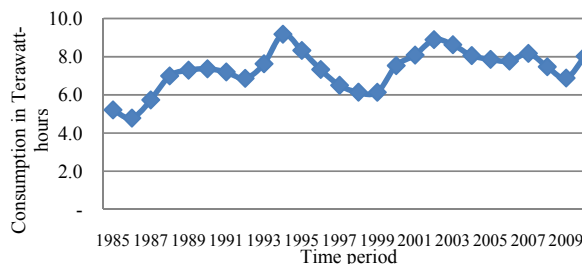


Fig. 5 Hydroelectricity consumption in Kazakhstan since 1985 [2]

D. Geothermal Energy

The concept of “Strategy of sustainable energy of future Kazakhstan till 2050” assumes the broad use of geothermal sources for energy generation. According to the concept, it is expected to begin widespread use of subsurface heat due to geothermal water wells penetrated in various regions in Kazakhstan. The potential of geothermal sources estimated to be 520MW without using heat pumps or 4300 MW when using heat pumps respectively [22]. Table II below shows both high- and low-temperature geothermal resources.

TABLE II
THE MAIN GEOTHERMAL AREAS IN KAZAKHSTAN [23]

Location	Depth (m)	Temperature (°C)
Around Chymkent, Taraz, Kyzylorda cities	1200-2100	45-80
Shu river valley and Kyzyl-kum dessert	Geothermal gradient of 35°/km	80-90
Ile river valley	2500-3500	90-115
Almaty region vicinity (Taldykurgan region)	2500-3500	n/a
Caspian region including Ustyurt, Mangistau	n/a	40-100

Currently several pilot project have been implemented. For example, Kaplanbek geothermal field (near Chimkent city) is used for hot water supply of local households, the temperature of water is 80°C. Geothermal source with the temperature of 80-120°C near Almaty region is used for greenhouses' space heating and cooling, in winter and summer consequently [24].

This type of application is one of the most common uses of geothermal sources [25].

According to the Ministry of Industry and New Technologies of the Republic of Kazakhstan, there are six major geothermal areas have been explored near the cities of Shymkent, Kyzylorda, in the northern part of Kyzyl Kum desert, near Almaty, as well as on the Ustyrt plateau on the coast of the Caspian sea. Thus, the south regions of Kazakhstan have favorable conditions for the development of geothermal energy. In addition, explored underground reservoirs of hot water located in the areas with energy shortage and big power consumers (oil production and refineries). However, there is no projected construction of electricity plants in the area [26].

IV. GHG EMISSIONS IN KAZAKHSTAN

Kazakhstan has taken voluntary commitments to reduce GHG emissions by up to 15% by 2020 and by 25% in 2050

relative to the level of 1992. The announcement was made at the 7th session of Ad Hoc Working Group on Long-term Cooperative Action under the United Nations Framework Convention on Climate Change (UNFCCC).

All information on GHG emissions in Kazakhstan is collected in the State cadaster of sources of GHG emissions and removals. The cadaster is maintained by government authorities and the procedures are regulated by the Rules developed in accordance with Article 158-2 Para 3 of the Ecological Code of Kazakhstan dated 9 January 2007. The latest report on GHG inventory in Kazakhstan is Third National Communication for 2006-2012 (TNC) submitted to the Secretariat of UNFCCC in 2013.

According to TNC, greenhouse gas emissions in Kazakhstan are represented mainly by the following gases: carbon dioxide (CO₂) accounted for 78,23% in 2011, methane (CH₄) with 17,72%, nitrous oxide (N₂O) with 3,26%, hydrofluorocarbons (HFC) and perfluorocarbons (PFC) with only 0,31% and 0,48% respectively.

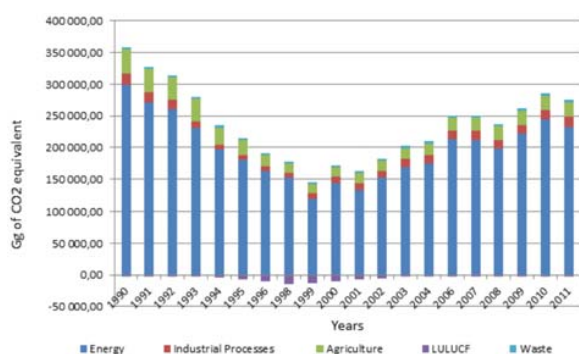


Fig. 6 Total national emissions and removals of greenhouse gases in the Republic of Kazakhstan, 1990-2011

As shown in Fig. 6 the lowest number of GHG emissions was captured in 1999 with less than 150 Mt of CO₂ equivalent due to economic recession in the period of 1990-1999 and its revival after 1999 till present time.

Energy sector is the largest source of GHG emissions with up to 85.4%, followed by agriculture with 7.9%, industry with 6.3%, waste with 1.5%, and land use change and forestry with 1.1% contribution in 2011. Total number of GHG emissions has greatly reduced by 23,42% from 358.38 to 274.46 Mt of CO₂ equivalent comparing to 1990.

There are two categories where GHG emissions come from in energy sector: fuel combustion (86% in 2011) and fugitive emissions (14% in 2011). 47% of fuel combustion is contributed by power sector, followed by industry, construction and other sectors (Table III). The major contributors of fugitive emissions are coal and oil and gas with 69% and 31% respectfully.

TABLE III
GHG EMISSIONS BY SECTORS IN 2011 (TONNES OF CO₂ EQUIVALENT)

Location	Depth (m)
Power sector	94 053,28
Processing industry and construction	26 448,25
Transport	20 065,11
Other sectors	17 439,95
Other sources	41 111,68

V. ENERGY POLICY

A. National Programs

The key objective of national energy policy in Kazakhstan is to maximise effective use of nature fuel energy resources and potential of renewable energy sources. For the recent decade, the country has adopted several local and interregional strategies and programmes.

On January 17, 2012 the President of Kazakhstan, Nursultan Nazarbayev addressed to the nation the Strategy "Kazakhstan 2050"- new political course of the established state [27]. The Strategy provides clear guidelines for building a sustainable and efficient economic model based on the country's transition to a green development path.

On the 6th Ministerial Conference on Environment and Development of the Asia-Pacific region [28] and UNECE Committee on Environmental Policy the Government of Kazakhstan in collaboration with its partners, prepared the Green Bridge Partnership Programme (GBPP) aimed at bringing together the efforts of governments, international organisations, civil and business sectors in Europe, Asia and the Pacific towards green economy. The World Summit on Sustainable Development "RIO+20" included Astana Initiative "Green Bridge Partnership Programme" in the outcome document "The future we want" (clause 102) dated on June 19, 2012. Along with the achievements in the field of international cooperation, based on the results of "RIO+20", Kazakhstan initiated its own internal plan on the transition to "green economy".

According to the Decree № 577 dated on May 30, 2012 the President of Kazakhstan approved the Concept for transition of the Republic of Kazakhstan to green economy [13]. As written in the Concept: "Transition to Green Economy will enable Kazakhstan achieve the proclaimed goal of entering the top 30 developed countries of the world. According to estimates, the transformations to be implemented as a part of a Green Economy will additionally increase the GDP by 3%, create more than 500,000 new jobs, develop new industries and services and generally provide higher living standards all over the country by 2050. Overall investments required for transition to a Green Economy will be about 1% of GDP per annum, which is equivalent to \$3-4 billion". The Concept contains specific targets set by sectors. Thereby, in the green scenario for power sector it is scheduled to achieve the share of alternative sources (solar and wind) in electricity production not less than 30% by 2020, 30% by 2030, and 50% by 2050. According to the Concept, the share of gas power plants in electricity production will be 20% by 2020 and 10% greater by 2050. By 2030 it is planned to gasify Akmla,

Karaganda, Northern, and Eastern regions with low gas prices. Last but not least goal in power sector is to reduce CO₂ emissions in electricity production by 40% in 2050.

Action plan for 2013-2020 adopted by the Decree of the №750 dated July 31, 2013 was developed to implement the Concept [29]. According to the Action plan, energy conservation and improvement of energy efficiency in residential and commercial buildings should be reached through measures including review of heat tariffs, introduction of tax breaks, financial support, facilitating local production of construction materials, conducting energy audit of all buildings every 5 years, thermomodernisation of buildings, and improving normative documentation for design construction. In terms of renewable energy sources (RES), it is planned to establish an interagency committee on RES in Kazakhstan. Implementation of the measures is supervised by assigned state agency.

State programme "Energy Efficiency 2020" was adopted on August 29, 2013 by the Decree № 904 [30]. The objective of the Programme is to reduce consumption by 10% every year until 2015 and decrease energy intensity of GDP by 40% in 2020 comparing to the level of 2008. There are nine main streams for the Programme implementation: EE industry, EE innovative energy, EE housing and utilities, EE construction, EE transport, EE lighting, EE society, EE budget sector, and economic payment [16].

B. Renewable Energy Sources Policy

In 2009 Kazakhstan Government adopted a Law "On supporting the use of renewable energy". The Law provides several measures to support renewable energy sources including:

- 1) Redundancy and priority in the provision of land for the construction of renewable energy technologies
- 2) Energy transmission organizations' obligations to purchase electricity generated by RES
- 3) The release of RES from network power transmission fee
- 4) Support for connecting RES to the network of power transmission organization
- 5) Provision of investment preferences to individual and legal entities engaged in design, construction and operation of RES objects in accordance with the legislation on investments of Kazakhstan.

Kazakhstan has started positioning Renewable energy sources (RES) as one of the vectors of energy sector development in the recent years. This is evidenced by the increasing attention paid to the process of their implementation by the government and a number of business structures. However, the formation of a stable RES complex in Kazakhstan causes significant financial and technological infusion with the direct participation of the state, without which renewable energy will remain at virtually zero level.

According to the Strategic plan of Kazakhstan development by 2020, the share of RES in the total share of energy consumption should reach 1.5% by 2015, and more than 3% by 2020.

C. Energy Efficiency

There are around 30 largest energy consuming industries based in Kazakhstan. According to the MINT their energy demand amounts up to 35 milliard kWh which makes approximately 40% of total power consumption of the country. To create conditions for reducing energy intensity of GDP of the Republic of Kazakhstan and increasing energy efficiency by reducing energy consumption and inefficient use of energy resources the Government has adapted the Law on "Energy saving and energy efficiency" in January 2012.

Message of the President of the Republic of Kazakhstan to the People of Kazakhstan January 29, 2010 "New Decade - New Economic Growth - New Opportunities of Kazakhstan" and the State Program on Forced Industrial-Innovative Development of Kazakhstan for 2010 - 2014 set targets for sustainable and balanced growth of the economy. It is targeted that the energy intensity of gross domestic product should be reduced by at least 10% by 2015 and 25% by 2020.

In addition, the President of the Republic of Kazakhstan dated January 23, 2013 instructed the Government of the Republic of Kazakhstan in savings of electricity consumption by an annual 10% reduction in energy intensity of the economy during 2013 - 2015.

Thus, energy is related to the strategic objectives of the state. To achieve these goals it is necessary to increase energy efficiency in all sectors and all regions of the country as a whole.

The implementation of the energy efficiency policy has become one of the main tools of industrial upgrading, housing and communal services and transport sectors. Successful policy of energy saving and energy efficiency provides energy and environmental security of the country. In addition, the provision of energy efficiency stimulates the introduction of new innovative technologies and solutions, which in turn stimulates the active interaction of science and technology transfer.

Key points of the Law are as follows:

- 1) Legal entities of State energy registry (SER) that consume more than 1500 tons of oil equivalents per year are required to establish, implement and organize the work of the energy management system in accordance with the international standard for energy management ISO 50001.
- 2) A ban on the use and production of incandescent light bulbs. It is expected that prohibition comes into force as: bulbs of 100 W from July, 1st, 2012, bulbs with power capacity more than 75 W from January, 1st, 2013, and bulbs with power of 25 W and more from January, 1st, 2014.
- 3) Promotion of energy saving and energy efficiency, including the use of energy efficient equipment and materials
- 4) Introduction of energy efficiency requirements for transportation, electric motors and equipment, construction sector including existing and projected dwellings consuming more than 500 toe
- 5) Introduction of energy efficiency labelling of buildings and domestic appliances

- 6) Disposal of mercury containing energy-saving bulbs
- 7) Development of training centres in the field of energy auditing and energy management
- 8) Voluntary agreements on energy saving with the large industrial enterprises
- 9) Promotion of the use of energy saving equipment

Energy-efficient policies should include measures for modernisation of the economy; improve the quality of management and production personnel qualifications, attracting large-scale investment, education of the population to lean consumption of energy resources. Also, a necessary condition for its implementation is the use of scientific and technological capabilities and new innovative thinking increase the investment attractiveness of energy efficiency as attractive areas of business activity.

VI. IMPLEMENTED PROJECTS TOWARDS ENERGY EFFICIENCY IN KAZAKHSTAN

A. Projects Overview

Since the middle of the nineties the Republic of Kazakhstan has drawn special attention of the large international organisations by its political path on a sustainable development of the region. After defining by the head of the state a "green" course of development, a number of programs in the field of energy saving and energy efficiency policy in team with foreign experts has been started in Kazakhstan. The summary of some projects which have been implemented under the direction of such organisations like UNDP Kazakhstan and the World Bank are provided in Tables IV-VII.

TABLE IV
SUMMARY OF THE PROMOTION OF ENERGY-EFFICIENT LIGHTING IN KAZAKHSTAN PROJECT [31]

Project duration	Main beneficiaries	Partners in action:	Total budget
2013-current	Citizens of RK Government	Ministry of Industry and New Technologies of the Republic of Kazakhstan	\$ 23,063,000 Including: WB 21,763,000 Other 1,300,000

The main components of the "Promotion of Energy-Efficient Lighting in Kazakhstan" project are as follows:

- 1) Policy development includes development and implementation of a roadmap for incandescent lamps phase-out, adaptation of official technical standards and certification procedures for quality and performance for energy efficient (EE) lighting products, update of relevant mandatory and recommended sections of the national building code on lighting, enhancement of public procurement processes favouring energy efficiency and life-cycle cost criteria, and the establishment of system for collection, recycling, and storage of mercury-containing lamps;
- 2) Market development for EE lighting incorporates increasing accessibility of EE lighting among targeted

- populations and implementing labelling program for energy-efficient lighting product;
- 3) Promotion and educational outreach, in particular EE lighting promotional campaigns among professionals;
- 4) Demonstration projects involve new ready demonstration projects and other lighting upgrades.

The global purpose of the "Energy Efficient Design and Construction of Residential Buildings" project is a reduction of emission of GHG by housing sector in Kazakhstan. The project is directed on achievement of energy saving with the smallest expenses within existing national programs, standards and legal base in the field of energy efficiency, construction, and the housing-and-municipal relations. The main objectives of the project are to promote the energy efficiency in the country.

TABLE V
SUMMARY OF THE ENERGY EFFICIENT DESIGN AND CONSTRUCTION OF RESIDENTIAL BUILDINGS PROJECT [32]

Project duration	Main beneficiaries	Partners in action:	Total budget
2010-2015	Agency for Construction, Housing and Utilities of the Republic of Kazakhstan Citizens	Agency for Construction, Housing and Utilities of the Republic of Kazakhstan Ministry of Environmental Protection of the Republic of Kazakhstan Ministry of Industry and Trade of the Republic of Kazakhstan Local municipalities	\$32,463,840 Including: GEF \$4,568,500

Main components of the project:

- 1) The control over the implementation of the basic building codes and standards: the development of rating system, monitoring energy efficiency system and disposing of GHG
- 2) Support for voluntary "green" building standards: support of government authorities and institutions.
- 3) Establishment of demonstration projects and energy efficiency centre
- 4) Development of energy efficient building materials
- 5) Work in Education sector: training of all employees in the construction and competitions on energy-efficient technologies in the construction

The purpose of the next project on "Removing barriers to energy efficiency in municipal heat and hot water supply" is a reduction of GHG emissions in system of a municipal heat supply, tariff policy of heat supply in municipal sector, and transition to power effective technologies. The project is targeted at creation of conditions for a sustainable development of municipal sector taking into account ecological influence at local and at global level.

TABLE VI
SUMMARY OF REMOVING BARRIERS TO ENERGY EFFICIENCY IN MUNICIPAL
HEAT AND HOT WATER SUPPLY PROJECT [33]

Project duration	Main beneficiaries	Partners in action:	Total budget
2007-2013	Agency for Construction and Municipal Infrastructure City Administrations and residents of Astana of Almaty, Karaganda and Pavlodar	Ministry of Environmental Protection, Ministry of Industry and New Technologies, Ministry of Energy and Mineral Resources Agency on Regulation of Natural Monopolies Akimats, incl. of Astana, Almaty and Karaganda cities Kazakhstan Housing and Utilities Sector Center JSC Local communities and non-governmental organizations Scientific research institutes Business-companies of a heat supply and energy efficiency	\$ 3,290,000 Including: GEF \$3,290,000 Government \$1,500,000 Private \$ 500,000 Other \$2,500,000

Main components of the project:

- (1) Promote energy efficiency in heating by legal acts: update outdated regulations; strengthening the role of condominiums in the management of district heating buildings
- (2) Establishment of financial mechanisms to encourage investment in energy efficiency measures in heating:
- (3) Collection and analysis of replicating information on project results: monitoring the reduction of GHG emissions for pilot projects; training and other activities, creating a network of information *exchange*

TABLE VII
SUMMARY OF THE PROJECT ON ENERGY EFFICIENCY [34]

Project duration	Main beneficiaries	Partners in action:	Total budget
2013-current	Citizens of RK Government	Ministry of Industry and New Technologies of the Republic of Kazakhstan	\$ 23,063,000 Including: WB 21,763,000 Other 1,300,000

This is a demonstration project aimed at improving energy efficiency, development of necessary financial conditions through the establishment of demonstration objects and technical assistance.

Main components of the project:

- 1) Creation and funding of public projects in the field of energy efficiency
- 2) Technical support: strengthening the capacity of ministries to implement state project; large-scale research in the field of energy efficiency; measures to establish a legal and regulatory framework; designing various financing schemes for energy efficiency

B.Barriers

Successful implementation of projects in Kazakhstan is hampered by the existence of various types of barriers:

First of all, lack of awareness of the potential savings and the practical advantages of energy efficient technologies is an *information barrier*. The majority users have limited

information about a possibility of a significant reduction in energy costs just by replacing incandescent light bulbs with energy-efficient lamps. In the area of green buildings the professionals have a lack of knowledge about advanced technologies in the construction sector; people cannot identify the energy efficient buildings, materials and goods as there are no labels on energy efficient class available on them except home appliances. Consumers do not see the point of initial high investment in energy-efficient equipment and technologies in spite of lower operating costs and consumption over the lifetime.

Political barriers could be identified as: the lack of mandatory national legal requirements, standards or legal incentive programs to support energy-efficient technologies, ineffective implementation of legal documents in the field of energy, lack of financial support for energy efficiency measures. Kazakhstan still has a number of regulatory and legal provisions and technical standards that need to be revised in accordance with the objectives of the legislation and to promote the goals of energy efficiency and reduce GHG emissions.

The *financial barriers* include lack of experience on the implementation of investment programs, high risks of investing in energy efficiency projects. In the project of energy efficiency in municipal heat supply a weak financial base and low creditworthiness of existing heat supply companies had become main barriers.

A large area of the country, the remoteness of the major cities from each other, poorly developed market for energy-efficient equipment and materials, low competitive ability - all these relates to the *technical and market barriers* to the implementation of the projects.

C.Results

During the implementation of the projects certain results at the state and local level organisations, educational and other institutions were obtained. At the moment projects are not finished, so these results should be evaluated as a preliminary. Different introductory seminars, meetings, various international conferences and symposia have been implemented for all mentioned projects. Various print materials, flyers and banners have been distributed to promote and increase public awareness on energy conservation. The issue on a shortage of qualified professionals in the field of energy saving measures has been solved by training the staff of 700 residential buildings throughout Kazakhstan. Also 17 demonstration projects have been implemented in apartment buildings in different cities of Kazakhstan, \$6.6 million of public and private investment attracted to modernise residential homes in 4 cities, large-scale energy audits of buildings has been conducted, the country's first energy service company was created. Some of the developed schemes and models of interaction between the state and the consumer had been included in the programme of housing modernisation for 2011-2020.

That is not to say that these results have already determine the success of projects, but in general, it could be said that the

average consumer perceives till what extent the Government is concerned about the energy efficiency in the country.

VIII. CONCLUSION

Kazakhstan is a relatively young independent country. But during this short period, large-scale institutional changes have occurred in the country. Kazakhstan has chosen a green way of development towards improving energy efficiency in all sectors of economy. Kazakhstan ratified Kyoto protocol in 2009 and in 2010 initiated a program to reduce its GHG emissions by 15% by 2020 from the level of 1992. To be able to mitigate GHG emissions and reduce dependence on fossil fuels, new policy initiatives support the renewable energy sector. The country has set itself a target to generate 3% of its total electricity supply from renewable energy sources by 2020. The production of green energy will benefit resource-deficient regions of the country, such as south-eastern Kazakhstan as well as create employment opportunities for the population.

Several projects have been implemented towards improving energy efficiency in different areas, including lighting, construction, and heat and hot water supply. The pilot projects were executed locally at cities therefore had a limited impact on a country scale.

Still, there is much work to be done. More emphasis should be given to the developing of a green energy framework including incentives to invest in green renewable energy sector and strengthening institutional capacity. Simultaneously, it is critical to promote energy efficiency through behaviour change of the society.

REFERENCES

- [1] Ministry of Environment and Water resources of the Republic of Kazakhstan, "Concept for transition of the Republic of Kazakhstan to Green Economy," 2013.
- [2] BP Statistical Review of World Energy, retrieved from <http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf>, 2014.
- [3] International Energy Agency country report
- [4] Ministry of Oil and Gas of the Republic of Kazakhstan retrieved from <http://mgm.gov.kz/?lang=en>, 2014.
- [5] US Energy Information Administration, retrieved from <http://www.eia.gov/countries/analysisbriefs/Kazakhstan/kazakhstan.pdf>, 2013.
- [6] E. Palazuelos and R.Fernandez, "Kazakhstan: Oil endowment and oil empowerment. Communist and Post-Communist Studies," Volume 45, Issues 1-2, March-June 2012, p. 27-37.
- [7] M. Kaiser and A. Pulsipher, "A review of the oil and gas sector in Kazakhstan," Energy Policy 35, 2007, p.1300-1314.
- [8] J. Conway, "The risk is in the relationship (not the country): Political risk management in the uranium industry in Kazakhstan," Energy Policy, Volume 56, May 2012, p.201-209.
- [9] International Atomic Energy Agency, retrieved from <http://www.iaea.org/>, 2014.
- [10] Kazatomprom, retrieved from <http://www.kazatomprom.kz/en/>, 2014.
- [11] World Nuclear Association, retrieved from <http://www.world-nuclear.org/>, 2014.
- [12] World Bank, retrieved from <http://www.worldbank.org/>, 2014.
- [13] Ministry of Environment and Water resources of the Republic of Kazakhstan, "Concept for transition of the Republic of Kazakhstan to Green Economy," 2013.
- [14] UNDP/GEF, and Government of Kazakhstan "Prospective of Wind Power Development in Kazakhstan", Almaty, 2006, p. 8.
- [15] Wind energy, retrieved from http://www.windenergy.kz/files/1260181884_file.pdf, 2014.
- [16] Kazenergy, retrieved from <http://www.kazenergy.com/ru/2-44-45-2011/1473-2011-07-29-17-55-58.html>, 2014.
- [17] National Atlas of Kazakhstan, V.1, chapter 6, 2014.
- [18] "Building Climatology" building code, SNiP 23.01-99, p.69.
- [19] Samruk-energy news available at <http://www.zakon.kz/4622232-anglijiskaja-kompanija-namerena.html>
- [20] H.Borhanazad, S.Mekhilef et al., "Potential application of renewable energy for rural electrification in Malaysia," Renewable energy 59, 210-219, 2013, p.215.
- [21] Low-carbon Development in Central Asia, retrieved from <http://www.led-ca.net/vozobnovlyaemye-istochniki-energii/gidroenergetika>, 2014.
- [22] National Public Institute on green economy available at <http://greenkaz.org/index.php/ru/vse-kategorii/63-analiticheskaya-baza/367-zelenaya-ekonomika-v-kazakhstane>
- [23] Energy partner website available at http://www.energypartner.kz/index.php?option=com_content&view=article&id=29&Itemid=38&lang=ru
- [24] E.Zh. Murtazin, M.A. Mukhamedzhanov, V.D. Vyalov, "Perspectives of geothermal water use as alternative energy source".
- [25] B. Nakomicc-Smaragdakis, T. Stajic et al, "Geothermal energy potentials in the province of Vojvodina from the aspect of the direct energy utilization," Renewable and sustainable energy reviews 16 920120 5696-5706, p. 5703.
- [26] V. Petruk "Geothermal sources will enable Kazakhstan to comply with targets set by Kyoto Protocol," retrieved from <http://nbr-kz.com/zhaalytar-mraaty/349-geotermalnye-istochniki-pomogut-kazhastanu-effektivnee-vpisatsya-v-kiotskiy-protokol.html>.
- [27] Strategy Kazakhstan-2050, retrieved from http://www.akorda.kz/en/page/page_address-by-the-president-of-the-republic-of-kazakhstan-leader-of-the-nation-n-nazarbayev-%E2%80%9Cstrategy-kazakhstan-2050%E2%80%9D-new-political-course-of-the-established-state%E2%80%9D_1356091973, 2012.
- [28] MCED-6, retrieved from <http://mced6.org/en/>, 2010.
- [29] Action Plan, retrieved from http://online.zakon.kz/Document/?doc_id=31432000, 2013.
- [30] Energy Efficiency 2020, retrieved from <http://adilet.zan.kz/rus/docs/P130000904>, 2013.
- [31] Promotion of Energy-Efficient Lighting in Kazakhstan, retrieved from http://www.undp.kz/projects/start.html?redir=center_view&id=249, 2014.
- [32] Energy-Efficient Design and Construction of Residential Buildings, retrieved from http://www.undp.kz/projects/start.html?redir=center_view&id=221, 2014.
- [33] Improving the Energy Efficiency of Municipal Heating and Hot Water Supply, retrieved from http://www.undp.kz/projects/start.html?redir=center_view&id=172, 2014.
- [34] Energy Efficiency Project, retrieved from <http://www.worldbank.org/projects/P130013/energy-efficiency-project?lang=en>, 2014.