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National Sustainable Energy Action Plan
of the Kyrgyz Republic

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INTRODUCTION

The Kyrgyz Republic is a mountainous country with the population of 6.4 million people and the area of 200,000 km², located in the eastern part of Central Asia. It borders with Kazakhstan, China, Tajikistan and Uzbekistan. The mountains occupy 94% of the Kyrgyzstan's territory.

Kyrgyzstan is rich in energy resources and can significantly provide for its needs. However, at present the capabilities of the fuel and energy complex (hereinafter FEC) are insufficiently implemented. The efficiency of many energy companies has reduced; the sector is facing financial and economic difficulties. The Republic depends on import of coal, natural gas and oil products. The import amounts to about 50% in the structure of the fuel and energy balance.

To date, the whole fuel and energy complex in the country (electrical energy industry, coal-mining industry, gas production and distribution, oil products production and renewable energy sources) is in the difficult state.

The high prices for the imported energy resources – coal and gas, compared to electricity tariffs, have led to the minimal level of their consumption by the primary consumer – the population of the country. The renewable sources, except for large HPPs, which form the basis of the country's energy capacities, without the government support practiced in other countries, are completely uncompetitive at the market of the country's energy resources.

One of the main reasons is the myth on the low cost of electrical energy and heat production and transmission formed for a prolonged time in the minds of the society by some politicians and the mass media in the country.

Another serious reason for reduction of FEC's energy efficiency is the failure to take into account that the fuel and energy sector in market relations is a single mechanism with strong mutual links between separate components. For example, a permission to use electrical energy for heating and cooking in the early 90-ies of the past century without relevant price regulation has led to the coal and gas market decline. In addition, the coal-mining sector has been the most impaired and this has led to closing of mines.

At present, the structure of the fuel and energy balance in the Republic is focused on the import of the considerable proportion of energy carriers from other states. Despite growing consumption of the fuel and energy resources (FER), following the independence the works related to prospecting, exploration and development of raw hydrocarbon deposits have decreased significantly in the country, and their increased global prices have caused the consumers to switch completely to electrical energy.

This situation in the context of the existing capacities sometimes leads to the shortage of the electrical energy at the own consumption market. Due to the high price for the supplied hydrocarbon energy carriers (coal, gas, fuel oil), the boiler stations producing thermal energy for heating and hot water supply have also switched to the cheap type of the energy carrier – electrical energy.

The electrical energy generating capacities are overstretched; the equipment of the transmission and distribution companies operates with a great overload.

At the same time there is a high degree of dependence on one energy resource – electrical energy of hydropower plants. The situation is aggravated by absence of a common mutually applicable position of the Central Asian countries regarding use of water and energy resources in the region.

In the existing situation FEC cannot substantially provide for the needs of the economy in the energy resources taking into account its development. This leads to investment unattractiveness of the country, currency assets leakage, growing gap in the balance of payments and generally hampers the country's development.

Besides, the Republic's economy is energy-consuming; the energy saving policy is practically not pursued in the country.

The permanent misbalance at the energy resources market leads not only to reduction of effectiveness in the industries of the real sector, but also to occurrence and strengthening of the hotspots of social tension in the society. Therefore, saturation of the local market with good quality FER at reasonable prices is now of great importance both in the economic and social and political aspects.

Solution of the above problems requires a comprehensive approach based on a serious analysis of the existing situation in the fuel and energy complex supported by economic studies taking into account the potential of fuel and energy resources, commissioning new energy capacities, forecasting the needs of the country's economy in the energy carriers for mid-term and long-term periods taking into consideration the social and economic development of the country in the future.



1. PRIMARY ENERGY CARRIERS RESOURCE BASE



1.1. Hydropower resources

The Kyrgyz Republic has a sufficient hydropower potential formed in the run-off basins of rivers and lakes and its size is estimated as 18.5 mln kW of the capacity and over 142 bln kWh of electrical energy generation /1/.

A number of HPPs with the capacity of 40 MW and over each can be built in the basin of the Naryn and Tarim rivers (the area of the Sarydjaz River) due to natural (orography, geology, geomorphology, specific hydropower potential) and demographic conditions as well as from the viewpoint of technical and economic indicators.

The run-off conditions of the rivers are generally favorable for the economic complex, especially for irrigated farming. However, considerable irregularity in seasons and years is peculiar to it. Thus, many times for the period of the hydrological monitoring during two-three years in concession, exceptionally low water years have been observed. And during five-seven years in concession, the annual run-off has turned out to be lower than the average long-term run-off.

This has a rather negative impact on the energy mode of the hydropower plants and leads to unacceptable drawdown of the existing reservoirs and restriction of electrical energy generation.

Nevertheless, over 90% of the generating capacities (hydropower plants) have been built and are planned to be built in the future at the Naryn River.

The operating Toktogul HPP with the installed capacity of 1,200 MW with the similarly-named reservoir of the long-term storage and the rated volume of 19 bln m³ has allowed to generate the electrical energy satisfying the needs of Kyrgyzstan and the run-off control of the Naryn River to provide water resources for the needs of irrigation to the neighboring republics in summer. Due to commissioning of the Lower Naryn cascade of HPPs at full capacity, the level of the hydro resources utilization has amounted to about 10%. At present, the objectives are set to increase the level of the hydropotential use in the context of independence and sovereignty to supply own consumers and for operation of the Toktogul hydroelectric complex in the design mode.

For this purpose, construction of Kambarata HPP cascades will be finished and, first of all, HPP-2 with the installed capacity of 240 MW. At present, one unit with 120 MW has been commissioned. Subsequently, HPP-1 with the capacity of 1,900 MW will be built and hydropower plants of the Upper Naryn cascade /2/.

After putting into operation the designed for construction Upper Naryn cascade of HPPs with the output of 942 mln kWh per year, Kambarata HPP-1 with the output of 4.56 bln kWh per year, the operating mode of the Toktogul reservoir in the designed irrigation conditions will restore and reliability of power supply to the country's consumers will increase, and it will be possible to export the electrical energy.

1.2. Coal

The Kyrgyz Republic has a sufficient raw material base to satisfy completely the needs of the country's economy in solid fuel.

About 70 coal deposits and coal shows with reserves and estimated resources in the volume of 2.2 bln tons including ligneous coal -1.2 bln tons, hard coal – 1.08 bln tons, croszling coal – 119.6 mln tons are known on the territory of the Republic at present /2/.

The deposits and the coal producers are grouped into four coal bearing basins – South Fergana, Uzgen, North-Fergana, Kavak, and three coal areas – Alai, Alabuka-Chatyrkul, South Issyk-Kul.

The state reserve register has accounted 29 large and over 20 small deposits and areas with total reserves of about 1.3 bln tons.

Total coal mining in 2017 in the Kyrgyz Republic amounted to 2,156.8 thousand tons /3/.

1.3. Gas, oil

At present, there are 10 oil and natural gas deposits in the Republic. The explored recoverable reserves of all oil and gas deposits amount to: oil – 14 mln tons, natural gas – 6 bln m³ /1/.

The total area of the prospective oil and gas lands in the Kyrgyz Republic is 22.5 thousand km². More than 7.5 thousand km² out of them belongs to the comparatively well studied Fergana part of Kyrgyzstan /1/.

According to the specialists' assessment, the forecast geological resources of raw hydrocarbons in the Fergana part of the Republic amount to: oil – 67 mln tons, natural gas – 7.8 bln m³. The extent of the oil exploration in the Fergana depression has reached 36.3%. The degree of gas deposits development is equal to only 20% in the Fergana part of the Republic /1/.

In addition to the above oil and gas deposits, there are six oil and gas deposits in Kadamjay region, Osh oblast, including two oil deposits that are worked out and other deposits that are on the balance sheet of the Republic of Uzbekistan. They are still being developed at present by the companies of Uzbekneftgasdobycha.

The remaining reserves in the deposits of Kadamjay region amount to: oil (geological) – 7.2 mln tons, recoverable – 790 thousand tons, natural gas – 2.4 bln m³. The amount of the remaining recoverable reserves of oil and natural gas in terms of money is about USD 260 mln /1/.

1.4. Renewable energy resources

The Kyrgyz Republic has a high potential of the renewable energy sources (RES) that is estimated as 840.2 mln tons of the reference fuel per year /1/.

The main types of RES in the Republic are energy of minor rivers and stream flows, solar energy, wind energy, geothermal water energy and biomass energy. However, at present their practical use is insignificant and they amount to less than 1% in the country's energy balance. All this is related to various factors, the main of which is a weak mechanism of the economic incentive to use RES.

Small hydropower resources and potential. The economic potential of the small hydropower (HPPs with the capacity less than 40 MW) in Kyrgyzstan exceeds the potential of other renewable energy sources taken together. However, the use of the minor rivers' energy is restrained by some technical, economic and institutional factors. The economic potential to use micro HPPs is also significant that is estimated as 1.6 mln kW in the capacity.

According to the estimates, the total hydropower potential of examined 172 rivers and stream flows with the water flow rate from 0.5 to 50 m³/sec is more than 80 bln kWh per year /1/.

The developments held by the hydropower specialists of the Republic enable to determine the hydropower potential technically acceptable for development in the amount of 5-8 bln kWh per year. In addition, only those rivers have been accounted, the guaranteed winter run-off of which is no less than 2 m³/1/sec.

With respect to the territory, all examined minor rivers are grouped in the basins limited to Chu, Talas, Naryn, Sary-Jaz, Karadarya, Syrdarya rivers and the lake Issyk-Kul.

The held studies have shown that the hydropower potential of the minor rivers in the Kyrgyz Republic in all its oblasts enables to construct 92 new mini HPPs with the total capacity of about 178 MW and the annual average electrical energy output up to 1.0 bln kWh in the near term.

In a longer term 7 HPPs can be constructed on the irrigation reservoirs with the installed capacity of 75 MW and the annual average electrical energy output of about 220 mln kWh. This would allow reducing considerably the dependence of remote and rural regions on fuel supply /1/.

There is a real opportunity to build HPPs planned for design and construction based on the materials of schematic studies by oblasts of the Kyrgyz Republic carried out by the Research Institute of Energy and Economy. These materials propose, respectively, 20 and 13 mini HPPs in Chui and Issyk-Kul oblasts with the total installed capacity of 71 MW and the annual average output of 410 mln kWh, 23 mini HPPs in Osh and Jalal-Abad oblasts (including Batken) with the total capacity of 57 MW and the annual average electrical energy output of 265 mln kWh, 36 mini HPPs in Naryn oblast with the total capacity of about 50 MW and the annual average electrical energy output of about 220 mln kWh /1/.

The specific capital investments in 1 kW of the installed capacity for different plants are within the range of USD 700-900 based on the Russian equipment and USD 1,000-1,200 based on the equipment from foreign countries.

The most promising HPPs out of all mini HPPs proposed to be constructed are 31 plants with the total capacity of 78.5 MW and the annual average output of about 400 mln kWh /1/.

Solar energy. The mountainous relief that is a characteristic of 94% of the territory and the mismatch in the altitudes from 800 to 4,000 m above the sea level stipulate the significant difference in thermal energy coming from the sun.

The annual technical potential of the solar heating installations under these conditions according to the specialists' estimates can be as high as 1.7 mln MJ /1/.

Using solar thermal collectors is the most promising to reduce social tension as the great potential of the solar energy combined with relatively low capital investments and operating costs can cover 50% of the Republic's needs in the thermal energy in the future. Introduction of the solar power generators with different purpose (solar hot water heaters, solar cookers, solar stills, solar desiccators, etc.) is one of the promising RES development trends in Kyrgyzstan.

Therefore, transformation of the solar radiation into the heat with the low potential, first of all, for hot water supply can be effective on a considerable territory of the country.

Wind energy. The wind energy potential in the regions of the Kyrgyz Republic is different. The annual average specific wind flow energy is from 170 to 1,300 kWh/m². Comparing the needs of the small facilities in the electrical energy with the data of the wind cadaster shows that the wind energy potential is sufficient and can be successfully used to cover their energy needs.

The assessment of the wind energy potential reserves carried out by the specialists amounts to $49.2 \cdot 10^5$ tons of the reference fuel. The gross annual potential of the wind flow energy in Kyrgyzstan is 2 bln kWh /1/.

The analysis of the wind flow features has shown that more than 50% of all winds in Kyrgyzstan are light breezes and ash breezes, 30-40% - gentle breezes (2-5 m/sec) and the remaining part – moderate breezes and fresh breezes (6-10 m/sec). Its energy potential is not high on the significant part of flat and piedmont areas where the main consumers are located. But in the areas where there are winds with the high energy potential and the wind velocities of 8-12 m/sec, the consumers are practically absent /1/. Therefore, development of the small-scale wind industry (installations with the capacity of 10 kW), first of all, for power supply of the remote low energy-consuming autonomous consumers located in piedmont and mountainous areas seems to be promising.

Geothermal resources. The studies of currently known geothermal sources specify the low temperature nature of the thermal resources – no more than 60°C. At least 20 geothermal sources are known, the energy of which can be used for heating and hot water supply. They are mainly located in the recreational areas of Issyk-Kul oblast.

The technical capabilities are to use the potential of the geothermal energy within the limits of 170 GJ per year or 27% of the proven sources. Only 22 GJ per year is economically viable for development. The low potential sources of the geothermal energy can be used for hot water supply and heating. For example, the source in the Ak-Suu gorge can be used for heating needs of Karakol city as it is located at a short distance – 10 km. The source temperature has

stable year-round temperature of 55°C with the flow rate 83 m³/h. Such deposits as Ysyk-Ata and Djergalan are promising for use /1/.

Biomass energy. The Center for Problems of Renewable Energy Use has assessed feasibility and practical efficiency of biogas plants operation in the context of Kyrgyzstan. In addition, it has been shown that the large-scale use of these plants in the village will enable to improve significantly a villager's life. The villager himself, recycling wastes from cattle breeding generated in his yard can receive methane gas for his daily needs and use recycled materials as organic fertilizers. There is an opportunity to develop own business by selling fertilizers and biogas.

The local sources of the biomass are farm wastes. Their utilization potential is estimated as 9.732 thousand TJ per year. However, their utilization level is extremely low and is usually restricted by heating residential premises with dry manure (kizyak) /1/.

The forest biomass has a restricted potential because only 4.32% of the territory in Kyrgyzstan is covered with forests. The forest biomass cannot be utilized for energy purposes from the viewpoint of seasonality, geographic dispersion. The most part of the biomass is located in sparsely populated areas with undeveloped transport infrastructure (Table 1.1.).

Table 1.1 – Biomass resources on the territory of the Kyrgyz Republic /1/

	Forests and wastes from wood processing industry	Agricultural biomass	Total
Energy potential (TJ)	2,292	9,732	12,024
Energy potential (tons of reference fuel)	54,689	232,212	286,901

The estimated technically available for use energy potential of the agricultural and forest biomass is over 12.0 thousand TJ per year.

The large-scale utilization of the biogas plants can have a significant and effective influence on reduction of the poverty rate among the rural population in the Republic.

For example, the biogas plant in one farm house with the bioreactor's capacity of 10 m³ per year produces 34 thousand m³ of the biogas and 100-150 tons of the fertilizers. In winter a rural family will use the gas completely for cooking and heating. In summer 1,200 m³ of the biogas and 100 tons of the fertilizers can be sold. The income could be for about USD 1,000 per year. This under the rural conditions provides good financial support to the farmer's family.

In general, the stated potential of RES utilization is low despite their existing reserves, while the country faces the shortage of the energy resources due to insignificant reserves and volumes of hydrocarbon fuel extraction.



2. ENERGY RESOURCES PRODUCTION, DISTRIBUTION AND CONSUMPTION



The Kyrgyz Republic has a sufficient potential of fuel and energy resources and has all required prerequisites for successful operation and further development of FEC sectors.

Nevertheless, the energy sector in the Republic at present is in a difficult situation. Operation of many energy companies for the last two decades cannot be called successful. There are many internal and external reasons for this.

The components of the fuel and energy complex are electrical energy industry, coal-mining industry and oil and gas industry as well as companies supplying gas, heat and fuel to ultimate consumers. Out of all above industries, the electrical energy industry can be called as the most successfully operating.

2.1. Electrical Energy Industry

The electrical energy industry has a decisive influence on the state and the development prospects of the national economy: it accounts for over 3% of GDP and about 15% of the industrial output, over 5% of the income to the Republican budget. The developed electric power grid provides access to the electrical energy to overwhelming majority of the population. At the same time, the Republic is behind from the global index (2,972 kWh) in electrical energy consumption per capita (1,809 kWh) as well as from the indexes of the neighboring states: Kazakhstan (5,085 kWh), Tajikistan (2,172 kWh) /4/.

The electrical energy companies of the Kyrgyz Republic are divided according to the types of the activities. The electrical energy is mainly produced by the Open Joint Stock Company “Electric Power Plants” (“Electric Power Plants” OJSC). The electrical energy is transmitted through high-voltage grids by the Open Joint Stock Company “National Electrical Grid of Kyrgyzstan” (hereinafter – “NEG of Kyrgyzstan” OJSC). The functions of electrical energy distribution through the grids of 35 kW and lower to the ultimate consumer are fulfilled by four regional electrical energy distribution companies: “Severelektro: OJSC, “Jalalabadelektro” OJSC, “Oshlektro” OJSC and “Vostokelektro” OJSC. At present all above companies are a part of the Open Joint Stock Company “National Energy Holding Company” (“NEHC” OJSC) and are its daughter companies. A majority shareholder (80%) is the state.

The aggregate capacity of the electric power plants is 3,788 MW including 19 HPPs with the aggregate capacity of 3,071 MW and 2 TPPs with the aggregate capacity of 716 MW (Table 2.1) /4/.

Table 2.1.

Title	Year of commissioning	Installed capacity, MW	Available capacity, MW
Toktogul HPP	1975	1,200	1,200
Kurpsai HPP	1981	800	800
Tash-Kumyr HPP	1985	450	450
Shamaldy-Sai HPP	1994	240	240
Uch-Kurgan HPP	1961	180	175
At-Bashi HPP	1970	40	37
Kambarata HPP-2	2010	120	100
Mini HPPs – 12 pcs.	1940-1960	42	30
Bishkek TPP	1961	666	520
Osh TPP	1966	50	35
Total		3,788	3,587

At present, the electrical energy system (EES) having the system of production, transmission and distribution, in general, satisfies the country’s needs in electrical energy and centralized heat supply of Bishkek and Osh maintaining stable production volumes.

The total volume of electrical energy production in the Kyrgyz Republic is 13-15 bln kWh per year. Out of them, the internal consumption amounts to 90% of the produced electrical energy.

Some portion of the electrical energy at different times has been exported to the Republic of Kazakhstan, the People's Republic of China, the Republic of Tajikistan and the Republic of Uzbekistan. The Kyrgyz energy system has previously operated simultaneously with the energy systems of the Central Asian region and has been a constituent part of the Unified energy system of Central Asia. Managing the continuous operation of electric power plants and grids in the Kyrgyz energy system, mutual relations with other energy systems is entrusted to the Central Dispatch Service "CDS" that is a structural subdivision of "NEG of Kyrgyzstan" OJSC.

The unified energy system of Central Asia (UES CA) was formed during the Soviet times and was based on 500 kV HVTL loop and some power transmission lines of 220 and 110 kV uniting the energy systems of Kyrgyzstan, Kazakhstan, Uzbekistan and Tajikistan and ensuring simultaneous operation. According to the regional system of the USSR on water and energy balance of Central Asia, the water resources of Kyrgyzstan were accumulated in Toktogul, Kirov and Orto-Tokoi reservoirs in order to provide Kazakhstan and Uzbekistan with irrigation water in summer. Kyrgyzstan was receiving gas, fuel oil and coal from the neighboring republics as compensation for unproduced electrical energy. But after collapse of the Soviet Union the situation changed. The issue of the water and energy balance in this region became a matter of dispute. Each Republic started to search a benefit for itself to the detriment of other states. However, despite this fact, the arrangement in the issue of the water and energy balance due to the agreement between the governments of the republics in the region still exists but the balance is very fragile.

Under the conditions of the simultaneous operation of the Kyrgyz energy system with the energy systems of CA and Kazakhstan due to the natural power distribution, electrical energy was constantly interchanged between adjacent energy systems through interstate (intersystem) power transmission lines.

The analysis of the electrical grid modes in "NEG of Kyrgyzstan" OJSC under the conditions of the simultaneous operation of the energy systems in CA and Kazakhstan taking into account transit and interchange has shown significant energy dependence of Kyrgyzstan on the simultaneous operation of the energy systems in the region. The existing electrical grid structure of the energy system in Kyrgyzstan (availability of only one 500 kV TL Toktogul HPP – SS Frunzenskaya connecting the South and the North of the Republic, absence of sufficient and reliable connections between 220 kV hydropower plants of Lower Naryn HPP cascade and electrical grids of Osh and Batken oblasts) didn't allow fully supplying energy without using electrical energy transit through electrical grids of the adjacent states.

Taking into account these circumstances, to ensure energy security in the Republic, to enhance reliability of power supply to the North and the South of Kyrgyzstan, correct decisions have been taken to build Datka SS 500/220 kV, 500 kV TL Datka - Kemin, Kemin SS 500/220 kV and to reconstruct the existing 220 kV electrical grid facilities in the south oblasts. Commissioning of 500 kV TL Datka -Kemin with the substations Kemin and Datka as well as new TL 220 kV in the south has eliminated the energy dependence of consumer power supply in the North and the South of Kyrgyzstan. Moreover, construction of 500 kV TL Datka - Kemin, in addition to solution of power supply problems to the North of the Republic, will allow providing capacity from Kambarata HPP 1 and 2 in the future.

"NEG of Kyrgyzstan" OJSC transports the electrical energy through high-voltage grids from production to distribution companies and large industrial consumers. "NEG of Kyrgyzstan" OJSC includes power transmission lines 110-500 kV and substations forming the National electrical grid. The length of power transmission lines 110 kV and above is 6,841 km, out of them: 500 kV - 541 km, 220 kV – 1,749 km, 110 kV – 4,510 km, 35 kV - 41 km, the number of substations 110 kV and above is 194 pcs., out of them 500 kV - 4 pcs., 220 kV - 14 pcs., 110 kV - 174 pcs. The installed capacity of transformers is 8,947, 93 MVA. The electrical grids 110-500

kV are operated by six high-voltage electrical grid companies (HVEGC): Osh, Jalalabad, Chui, Issyk-Kul, Naryn and Talas /4/.

The grids 0.4-6-10 kV, which are 50,700 km long with the substations in the quantity of 23,698 pieces are a part of four distribution companies “Severelektro” OJSC, “Jalalabadelektro” OJSC, “Oshelektro” OJSC and “Vostokelektro” OJSC /4/.

The operating mode of the energy system: generation, transmission and distribution of the required volumes of the electrical energy is determined by its consumption, i.e. at each moment of time the balance of generation and consumption shall be maintained, which is a binding condition for normal functioning of the energy system or, in other words, a condition for existence of the mode.

The peculiarity of the Kyrgyz energy system is that 90% of the generating capacity comes from hydropower plants located in the South of the Republic, and 70% of electrical energy consumption is in the North.

This structure of the generating capacities leads to the fact that electrical energy generation by the plants of the Toktogul HPPs Cascade directly depends on the amount of water stored in the Toktogul reservoir.

The main portion of the electrical energy generated at electric power plants is supplied to electrical grids 110-500 kV of “NEGK” OJSC, through which it is transported to electrical grids 0.4-35 kV of energy distribution companies (EDC) and then to consumers.

The electrical energy balance in electrical grids 110-500 kV of “NEG of Kyrgyzstan” OJSC under the conditions of simultaneous operation with the energy systems of Central Asia and South Kazakhstan in accordance with the established form of the balance sheet consists of:

The receipts section in the balance sheet – electrical energy supply:

- from “Electric Power Plants” OJSC;
- from Chakan HPPs;
- from Bystrovskaya HPP;
- from Kalinin HPP 4;
- import of electrical energy through the grids of “NEGK” OJSC;
- unscheduled interchanges from the energy systems of Uzbekistan, Tajikistan and Kazakhstan to the energy system of Kyrgyzstan.

The expenditure section in the balance sheet consists of:

- useful electrical energy transit;
- to electrical grids of energy distribution companies;
- electrical energy export through the grids of “NEGK” OJSC;
- technological electrical energy consumption for its transport - technical losses of electrical energy in the grid 110-500 kV of “NEGK” OJSC and consumption for economic needs of SS 110-500 kV;
- electrical energy supply under direct contracts with the companies to Barki-Tojik electrical grids and to Kumtor;
- unscheduled interchanges from the Kyrgyz energy system to the energy systems of Uzbekistan, Tajikistan and Kazakhstan.

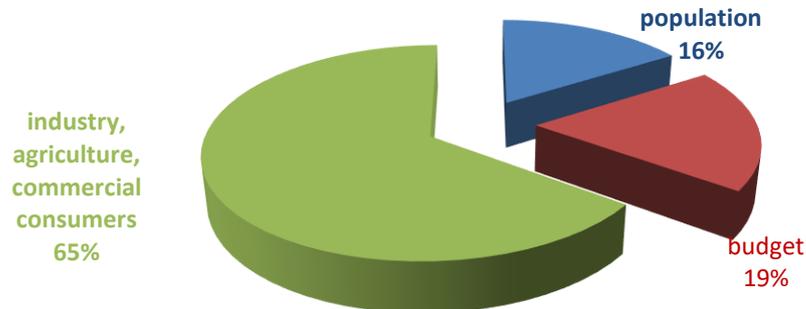
The main portion of electrical energy, more than 98%, is supplied to the electrical grids of “NEGK” OJSC from “Electric Power Plants” OJSC.

The analysis of the electrical energy balance sheet has shown that in the recent years the upward trend in domestic electrical energy consumption has been observed.

In the early 90-ies of the last century, the population of the Kyrgyz Republic consumed 16% of all electrical energy supplied to the local market; the budget - 19%; industry, agriculture, commercial consumers - 65%. And this was due to the fact that coal production amounted to more than 5 million tons per year. Out of them 4.5 million tons were consumed within the country, 2.5 billion m³ of natural gas and 600 thousand tons of fuel oil were received.

Currently, the structure of electrical energy consumption has changed significantly, as the population consumes about 60.5% of the total electrical energy supplied to the local market; the budget - 10.5%; industry, agriculture, commercial consumers - 29%. For comparison, Figure 2.1 shows the structure of electrical energy consumption in 1990 and now.

**The structure of electrical energy consumption in the KR
in 1990-ies**



**The structure of electrical energy consumption in the KR
at present**

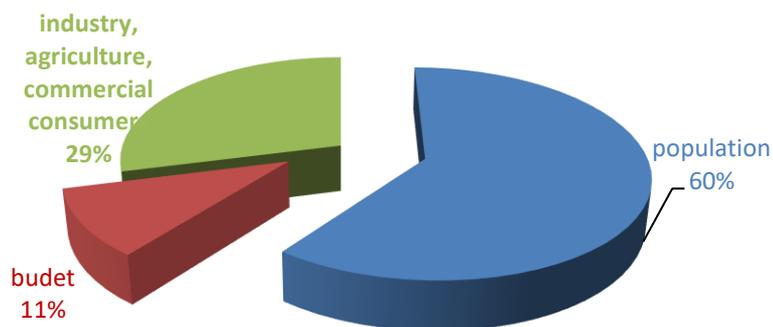


Figure 2.1
The structure of the electrical energy consumption in the KR
in 1990 and 2018

Compared with 1990, today electrical energy consumption by the population has increased by 3-4 times.

The operating modes of the electrical grids during the autumn-winter period (AWP) are the most intense. The last few years AWP undergoes under conditions of almost uncontrolled growth in consumption of electrical power and energy. As a result of such an increase in electrical energy consumption, the Kyrgyz energy system is currently overstretched - capacity consumption is 93% from the available capacity of electric power plants, i.e. all reserves are almost exhausted.

The growth in electrical energy consumption leads to equipment overload, forced restrictions on power supply to consumers and increased accidents.

The fulfilled analysis of the operating modes in the high-voltage electrical grid companies (capacity balances and voltage levels of all tie substations, loads of electrical grids' elements) of "NEG of Kyrgyzstan" OJSC during the period of the greatest loads allows stating the following:

1. As a result of the growth in electrical energy consumption, the Kyrgyz energy system is currently overstretched:

- power consumption on individual days in winter reaches 93% of the available capacity in electric power plants (3,368 MW), i.e. all reserves are practically exhausted /4/.
2. There are not enough sources of the reactive power in the energy system, the reactive power balance in the electrical grids in the North of Kyrgyzstan is currently ensured during the period of the greatest loads due to its supply from Kazakhstan.
 3. There are degraded voltage levels on buses 220 kV at the tie substations mainly in the electrical grids of the Northern energy system.
 4. The growth in electrical energy consumption leads to equipment overload. Thus, the vulnerable places in operation of the energy system in Kyrgyzstan are:
 - dependence of electrical energy generation by the plants of the Toktogul HPPs Cascade on the volume of water stored in the Toktogul reservoir;
 - certain portion of electrical energy transmission through the energy systems of the neighboring countries;
 - practical absence of reserves for generating active power and insufficient sources of the reactive power;
 - equipment depreciation and overload.

Moreover, the results of the analysis on operation of the electrical energy industry facilities in the Republic have shown that at present the electrical energy sector is characterized by the following main scheme and regime problems that in a varying degree influence the efficiency of the Kyrgyz energy system:

1. Disproportion in the structure of generating capacity location.

The main generating sources of electrical energy, hydropower plants are located in the south of the country, and the main consumption is in the north. The available capacity of HPP in the South is 2,955 MW or 87.7% of the total installed capacity and the electrical energy consumption in the North is 70% of the total consumption.

2. The significant increase in electrical energy and power consumption, especially in recent years.

The operating modes of the electrical grids during AWP are the most intense. The growth in the electrical energy consumption leads to equipment overload, forced restrictions on power supply to consumers and increased accidents.

3. Practical absence of electrical energy generation reserves, direct dependence of electrical energy generation by the plants of the Toktogul HPPs Cascade on the volume of water stored in the Toktogul reservoir are the reasons for limitations of the power supply to consumers in low-water years.

4. Heavy wear of the electrical equipment, lag in the rate of electrical grids development, reconstruction and modernization from the growth rates of the electrical energy consumption are the main reasons for equipment overload and, as a result, an increased accident rate, which significantly reduces efficiency and reliability of the power supply to consumers.

5. There are not enough sources of the reactive power in the electrical grids of the Chui High-Voltage Electrical Grids company, as a result of this:

- the reactive power balance in the electrical grids in the North of Kyrgyzstan is currently ensured during the period of the greatest loads due to its supply from Kazakhstan
- the reactive power flows increase in power transmission lines 110–500 kV, which are accompanied by increase in electrical energy losses and decrease in the transmission capacity of the lines in terms of the active power;
- leads to the shortage of the reactive power in the load centers and, as a result, to voltage reduction on load buses and substations and decrease in the stock of the voltage burden static stability.

6. The high level of electrical energy losses. Losses and non-payments by consumers create a shortage of financial resources, which adversely affects the activity of the energy companies themselves and the country's economy.

7. Low electricity tariffs. The current tariffs in the Kyrgyz Republic do not encourage energy producers and consumers to reduce energy costs. Based on this, the current tariff policy in the area of electrical energy requires improvement.

8. Imperfect accounting of the electrical and thermal energy consumption. Currently, the energy companies are taking measures to improve accounting, but this process is not yet completed.

2.2. Coal-mining industry

The coal-mining industry in the Republic is one of the leading sectors in the fuel and energy complex. Coal is used as an energy raw material for production of: electrical energy and thermal energy at TPPs and boiler stations; products by construction materials companies; for domestic needs of heating.

The existing structure of the coal-mining industry includes 23 coal companies (united under the management of the State Enterprise "Komur"), which are Open Joint-Stock Companies as well as 7 small companies engaged in seasonal coal mining operations in the autumn-winter period. Their production activities are controlled by the State Committee of industry, energy and subsoil use under the Government of the Kyrgyz Republic.

In the early 1990-ies, in connection with acquisition of independence and the Republic's transition to the market economy, negative transformations also occurred in the coal-mining industry. From 1990 to 1995, coal production decreased by more than 8 times or from 3,742 thousand tons to 463.2 thousand tons and almost did not increase until 2008 /1/.

The reasons for decline in coal production and use were the following factors:

- high costs on its production and transportation;
- transition to electrical energy for heating purposes due to low electricity tariffs and its availability;
- backward mining technology;
- great physical and moral depreciation of fixed production assets reaching 95%;
- shortage of the working capital related to late payments by consumers;
- inefficiency of the most coal companies in the face of the reduced demand for coal.

Many coal mines and pits opened 40-50 years ago develop coal reserves, which, according to the generally accepted criteria in the global practice (low capacity, steep dip, high ash content, etc.) are non-technological. The mine fund is worn out, the used equipment, basically, does not meet the technological requirements of today. The sharp increase in railway tariffs and the fall in demand for coal have led to decrease in coal production and, consequently, increase in the specific cost on its production.

Since 2008, the steady growth in coal production has started, which has now reached 1.5 million tons, due to stable use of coal from the Kara-Keche coal pit by Bishkek TPP as well as the increase in coal use by the population and budget organizations.

The growth in coal production is achieved through implementation of the following measures:

- developing capacities of the companies that develop Kara-Keche and Min-Kush brown coal deposits based on increase in coal supplies to Bishkek TPP;
- restoring ties with the neighboring states on export of Kyrgyz coal (China, Uzbekistan, Tajikistan);
- maintaining and increasing coal supplies to cement companies in the southern part of the country to use them for technological purposes.

Depreciation of equipment in the coal-mining industry, lack of the working capital, high receivables adversely affect the quality of the repair works on mining equipment, roads, timeliness of stripping operations to prepare the coal mining front. As a result, the coal-mining industry is in the crisis state and needs urgent investment, and the mined coal is uncompetitive compared to the imported one.

2.3. Oil and gas industry and oil and gas supply

The oil and gas industry in the Kyrgyz Republic is represented by the Joint Stock Company Kyrgyzneftegaz.

All oil and gas deposits have been discovered more than 70 years ago, are at the late stage of development and developed by almost 60%. Out of the remaining oil reserves, 80% are difficult to extract. Their development requires additional costs and use of special technologies. Therefore, the volume of oil production has decreased by more than twice, and is about 5 thousand tons annually.

The produced oil is completely sent to the oil refinery plant (ORP) of “Kyrgyz Petroleum Company” CJSC, which has been commissioned since 1996 in Jalal-Abad. The plant’s activity is processing of crude oil, gas condensate, straight-run gasoline, production of gasoline, diesel fuel, fuel oil. The produced products are A-80 gasoline, diesel and furnace fuel oil for winter and summer. The annual capacity is 250 thousand tons. Refining is carried out both from produced domestic oil of “Kyrgyzneftegaz” OJSC and imported raw materials from the Republic of Kazakhstan. Due to insufficiency of the processed raw materials, both local and imported from the neighboring countries, the workload of the Jalal-Abad ORP is no more than 30%.

At present, the level of oil supply due to own oil production is less than 1%.

In recent years, several oil refinery plants have been built. Out of them, “China Petrol Company “Zhongda” LLC was commissioned in Kara-Balta, Chui oblast in 2014 mobilizing Chinese investments. The design capacity of the ORP is refining 800 thousand tons of crude oil to produce about 750 thousand tons of the finished products per year. Crude oil supply is expected from the Russian Federation and the Republic of Kazakhstan.

“Kemin Oil Refinery Plant” LLC was established based on the Kemin Oil Storage Facility. The main activity is processing, storage, sale of oil products and sale of fuel and lubricants.

“Oil Management Group” LLC was established in 2007 based on the former Kant Oil Refinery Plant. The demand for raw materials is 250 thousand tons/year, 25 thousand tons per month. The company has concluded an agreement on raw materials supply from Russia.

The construction of the Tokmok oil refinery plant has been finished. The design capacity of the plant is 410 thousand tons per year. The number of the employees is 200-300 people.

Currently, the newly commissioned oil refinery plants are working intermittently. The ORP operating rate is only about 30%. One of the main reasons is the failure to fulfill contractual obligations of the partners from the CIS countries on crude oil supply.

The imported raw materials and components, the import of which is associated with high rates of excise taxes on oil, gas condensate and gasoline are used for stable oil products production meeting the needs of the Kyrgyz market due to the limited domestic oil production. This makes production of oil products in the Kyrgyz Republic problematic and uncompetitive in quality and price.

Natural gas production for various reasons (reserves recovery in the deposits, equipment depreciation, lack of financing, etc.) has decreased more than 3 times in recent years compared to the nineties. The production level from own deposits is about 0.3%. As a result, the demand for natural gas has been met by imports from Kazakhstan and Uzbekistan.

The gas-supply facility was managed by the production-operating association “Kyrgyzgas” OJSC, the main and basic objective of which was to supply consumers of the Kyrgyz Republic with both natural and liquefied gas. At the same time, the Open Joint Stock

Company “Kyrgyzgaz” provided services on transportation of Kazakh transit gas through the main gas pipeline located in the north of the Kyrgyz Republic. The gas pipe running through the southern part of the Kyrgyz Republic was used to transit natural gas to the consumers in the Fergana Valley of Uzbekistan.

“Kyrgyzgaz” OJSC was a natural monopolist in natural gas supply. It operated 753 km of main gas pipelines, 657 km of medium pressure gas pipelines and 1,679 km of low pressure gas pipelines. Equipment depreciation exceeded 80%, 120 km of main gas pipelines and 91 km of medium and low pressure gas pipelines required replacement. Over the last years, the price of gas increased almost by 8-10 times. Based on this, natural gas import was reduced and, as a result, the annual increase in natural gas prices was unbearable for the consumers. Therefore, both receivables and payables to suppliers that stopped supplying gas with the onset of cold weather accumulated. There were no funds for overhaul repairs and reconstruction of gas networks. As a result, the controlling stake in “Kyrgyzgaz” OJSC with the signs of bankruptcy with the consent of the Government of the Kyrgyz Republic was sold on April 10, 2014 to Russian “Gazprom” OJSC, which assumed obligations to pay debts and to ensure continuous supply of natural gas to the consumers of the Kyrgyz Republic.

2.4. Heat supply

Every year the country produces more than 3.1 million Gcal of thermal energy including:

- TPPs in Bishkek and Osh cities - up to 76%;
- the state enterprise “Kyrgyzzhilkommunsoyuz” - 20%;
- the remaining 8% of the thermal energy is generated by departmental and municipal boiler stations of the public utility company “Bishkekteploenergo” under the Mayor’ Office of Bishkek city.

The production of thermal energy by all heat-generating sources consumes about 600 thousand tons of the reference fuel, including 53% of natural gas, 29% of coal and 18% of furnace fuel oil. The current structure of fuel consumption, when the imported fuel makes up about 80% at the prices close to the world prices is cost-intensive and economically unprofitable. The cost price of 1 Gcal heat is more than USD 45. The expenses on payment for the imported fuel are estimated at about USD 15 million per year /1/.

Currently, the centralized heat supply exists only in 4 cities of the Republic, in Bishkek - 85% of the housing stock, in Osh - 35-40%, in Kyzyl-Kiya - 60% and in Karakol - 26%.

The city heating networks have been built and put into operation simultaneously with commissioning the heating capacities, and at present the service life of the most pipelines have expired and they require replacement. Their aging leads to reduction in performance reliability, and to increase in heat losses and leakage of heating-system water. Depreciation of heating equipment has exceeded 80%, and heat losses are more than 25%. Therefore, it is necessary to reconstruct heating networks.

In addition to thermal plants and large boiler stations, thermal energy (mainly for heating) is produced by departmental boiler stations, boiler stations of industrial companies as well as boiler stations of the Kyrgyzzhilkommunsoyuz Administration.

The electric boiler stations with the total heating capacity of 4,200 Gcal/h, which is 3.5 times more than the heating capacity of TPP No.1 in Bishkek take a significant part in production of the thermal energy. The average cost of the thermal energy generation in the electric boiler stations is about USD 10.

The current tariffs for thermal energy are 2-4 times lower than the actual costs of its production. The main supplier “Electric Power Plants” OJSC covers losses from thermal energy consumption by the population due to cross-subsidization of the income received from the electrical energy export and partially from the budget.

The boiler system existing in the Republic is not sufficiently equipped with metering devices of thermal energy generation. The thermal energy is accounted by means of a calculation

according to the need for the thermal energy and the amount of the fuel spent on its production, which leads to a large error. Equipment with thermal energy metering devices does not exceed 20%. This creates difficulties in collecting money for use of the thermal energy.

Heat supply in the Kyrgyz Republic is of great socio-economic importance. Increasing its reliability, quality and efficiency is an urgent task. Any failures in providing the population and other consumers with heat will have an adverse effect on the country's economy and increase the social tension in the society. Therefore, it is necessary to take appropriate measures for substantial improvement and further development of heat supply in the Republic.

2.5. Non-conventional and renewable energy sources

The Kyrgyz Republic, as noted above, has a significant potential in non-conventional and renewable energy sources, the use of which can increase availability of its own fuel and energy resources and reduce dependence on import. First of all, it is solar and stream flow energy, wind energy and biomass. The existing resources of the renewable energy sources can theoretically cover more than 50% of the required energy in Kyrgyzstan. At the same time, technical capabilities currently make up 20%, economically justified - about 6%, and practical use is now about 1%.

The most promising is the use of RES in remote mountainous and rural areas that do not have centralized power supply: farm and cattle-breeding complexes, mining enterprises, road maintenance services, tourist and environmental facilities, pumping stations, forestry and hunting facilities, etc.; residential houses, social welfare facilities, cultural and sports facilities, trade facilities, health and leisure institutions, etc.

The use of RES in the Republic is stipulated by the natural specifics. More than 90% of the total area in the country is occupied by mountains. More than 60% of the population lives in rural areas in the piedmont and mountainous areas, where it is difficult to deliver traditional fuels. This makes it advantageous to use local autonomous RES systems that do not require connection to existing electrical grids. The use of wind power plants or micro HPPs for power supply to these consumers will be much cheaper. RES is the only affordable way to solve energy and socio-economic problems of the population living in remote, hard-to-reach mountainous areas. Thus, the use of thermal solar power plants allows not only to save money on purchase of traditional fuels, but also to improve living conditions enabling to receive hot water for daily needs. The use of, for example, biogas plants, will allow rural residents to produce not only combustible gas, but also highly effective fertilizers ensuring increase in the crop yields and the living standards of the population. In addition, new job opportunities will appear in the village. The use of wind energy or micro HPPs also contributes to this.

However, despite the fact that the Republic has a great renewable energy potential, RES creation and introduction remains less profitable and much more capital-intensive compared to traditional ones. Therefore, up to now there has been no practical need in use of RES, and, first of all, because the cost of energy produced by traditional methods is several times lower than the cost of energy derived from use of RES. Today, the situation is changing radically and a surge in the need to use it can be expected in the near future.

It should be noted that if the use of RES in industrialized countries is mainly determined by environmental protection issues and requirements to seek, primarily, additional energy resources; then for Kyrgyzstan, the use of RES should be considered as a solution, first of all, to socio-economic problems of the rural population. It is the understanding that the large-scale use of RES in the village can contribute to solving such problems as poverty, unemployment, development of medium and small business, solving issues of rural migration to cities, increasing agricultural land yields, familiarizing the population with modern innovative technologies, and of course, addressing the issues of environmental protection and energy security of autonomous consumers. This way of putting the questing will enable to find a response in international

financial organizations and various funds that provide support to these technologies and, thus, to ensure an inflow of funds to the Republic for implementation of RES projects.

A number of organizations and companies in Kyrgyzstan have gained experience in development, design and industrial use of the equipment operating based on renewable energy sources and there is some experience in conduct of scientific works and studies. There are good results in development of new technical facilities operating based on RES and their practical application.

Based on the conducted studies, various technical facilities and equipment have been developed and created, which have successfully passed industrial tests and subsequently have found practical application.

Solar power plants. The solar power plants for water heating are the most widespread in the Republic. Primarily, these plants are widely used in social welfare facilities such as resorts, holiday hotels, sports camps, in the industrial sector at service stations, fleet depots, etc. In rural areas they are mainly used for rural baths, commercial dairy farms and in the private sector. The solar add-on units combined with the traditional boiler plants have been successfully introduced in the Republic, which in the conditions of Kyrgyzstan enable to replace completely operation of the boiler station for 7-8 months and to ensure partial replacement of the thermal load during transitional and winter periods. A significant part of such systems has been installed in agricultural (commercial dairy farms, sanitary inspection centers, machine and tractor stations, etc.), industrial (fleet depots, repair workshops, service stations, etc.) and social and cultural facilities (holiday hotels, resorts, pioneer camps). More than 60 thousand m² of thermal panels have been installed in the Kyrgyz Republic.

The analysis of the results on solar energy practical use has shown that its application can provide 90% of the hot water demand within 8–9 months in a year, reduce heating consumption among the rural population by up to 50%, provide electrical energy to almost all low energy-consuming autonomous consumers located in decentralized piedmont and mountainous areas in the Republic (foresters, shepherds, beekeepers, etc.), provide backup power supply up to 30% to the rural population and save traditional fuels.

Micro hydropower plants. The designs of micro hydropower plants (micro HPPs) with various capacities (1; 1.5; 5; 16; 22 kW) intended to generate electrical energy have been developed in the area of small mountainous stream flows use. The developed and created designs of the plants have been applied by a number of machine building plants and private companies. They are the Bishkek Mechanical Plant (BMP), “Oremi” JSC; “Envod” JSC, and others. The plants have proved remarkably effective in the Republic, and a number of machines have been exported to other countries (Georgia, Kazakhstan, Tajikistan, Cuba and Mongolia). The calculations show that development of small stream flow energy in the Republic as a whole can provide additional output of 5–8 billion kWh of the electrical energy.

Biogas plants. The studies conducted in the area of biomass use have shown high efficiency of this technology in solving many problems in the village. In this respect, based on the study of the foreign experience and own conducted studies, various types of designs for biogas plants (ground, underground, concrete, metal, dome type, etc.) have been developed and practically tested.

The application perspectiveness of the biogas plants in the Republic is primarily determined by presence of sufficient organic wastes required for operation of the plant. The presence of a large number of the consumers, especially from rural areas, where more than 60% of the population lives, and the issues of power supply to this category of the population are the most pressing. And finally, it is very important in the light of the need to provide cultivated arable lands with the fertilizers, for which waste materials can be effectively used.

The data of the foreign researchers including also the received practical experience in using waste materials as organic fertilizers in the context of our Republic show that depending on the grown crop the yield increases by 15-20%.

The Republic has already gained sufficient experience in installation and operation of BGPs. With the active participation of such organizations as the Center for Problems of Renewable Energy Sources Use, the Public Foundation “Fluid”, “Jaz” JSC, BGPs with various capacities ranging from 5-10 m³/day to 600-1,000 m³/day have been manufactured and built. On the whole, more than 70 BGPs have already been built and are operating in the Republic including 12 pilot plants implemented under the joint technical assistance project of Japan with involvement of the International Japanese Organization “JICA”. It should be particularly noted that on September 19, 2018 the official opening of the demonstration biogas plant for power supply of autonomous consumers in Nurmamabet village, Issyk-Ata region, Chui oblast took place. The project was implemented by the Research Institute of Energy and Economy under the State Committee of Industry, Energy and Subsoil Use of the Kyrgyz Republic through the UN Economic Commission for Europe.

The representatives from the UNECE and the UNDP in the Kyrgyz Republic, the embassy of the Russian Federation in the Kyrgyz Republic, the senior officers from the FEC under the Kyrgyz Republic Government Office, the Plenipotentiary Representative of the Kyrgyz Republic Government in Chui oblast, the representatives of the concerned ministries and departments in the Republic as well as the experts from the countries of Central Asia - Kazakhstan, Uzbekistan, Turkmenistan and Tajikistan took part in the opening.

The biogas plant is designed to produce combustible gas from organic animal wastes. The plant processes raw materials using anaerobic technology and allows on the average to generate annually 20 thousand m³ of gas, to receive 10 thousand kWh of electrical energy and 360 tons of highly effective organic fertilizers for agricultural products.

The plant demonstrates modern environmentally friendly innovative technologies to provide autonomous low energy-consuming facilities with energy using local raw materials.

The project is a pilot. Its purpose is to demonstrate the possibility to use the above technology in rural areas of the Kyrgyz Republic for power supply of autonomous low energy-consuming facilities (private houses, nurseries and kindergartens, farms, medical obstetric centers, etc.).

The large-scale use of this technology in the Republic will enable to solve considerably the issues of power supply to autonomous consumers in the rural area, to receive additionally highly effective environmentally friendly fertilizers for the fields. It will contribute to solution of the environmental protection issues by reducing emissions of harmful ozone-depleting gases emitted from unutilized unusable wastes.

In general, successful replication of this technology will enable also to solve some socio-economic problems of the rural population. They include reduction of poverty, providing new jobs, reduction of rural migration, improvement of living conditions, etc.

An assessment of the biomass potential in the Kyrgyz Republic shows that its large-scale use will enable to provide household gas to about 30% of the rural population. It is possible to provide more than 1 million hectares of arable lands with organic fertilizers, to reduce significantly the emission of the harmful methane gas into the atmosphere, to increase field yields and, of course, to reduce consumption of the traditional fuel and to improve the social and living conditions of a significant part of the rural population.

Wind power plants. The wind energy takes its special place in RES use in the Republic. In contrast to the technologies of large wind power plants (WPPs) construction united into the wind energy farms generating the electrical energy to the grid and transmitting it through the grids to the consumer; the most promising for the conditions of our Republic is the use of low capacity WPPs operating to supply power to autonomous facilities. The reason is absence of large spaces where there is a high wind potential, absence of the infrastructure (appropriate roads, transport equipment, lifting mechanisms), hard mining and geological conditions that cause additional difficulties in construction and installation of WPPs, and, finally, absence of technical capabilities and conditions to connect WPPs to the existing electrical grids. The use of small WPPs enables to solve the problems of power supply to autonomous consumers quickly

and rather effectively due to their large dispersion, remoteness from the existing power transmission lines and availability of the low wind potential sufficient for operation of these plants. Taking into account the perspectiveness of minor WPPs, the scientists of the Republic have developed a fundamentally new type of WPP that ensures more efficient energy conversion during low winds (3-6 m/sec), which has no analogues in the world practice and can be the most widely used in the absence of high potential winds. It should be noted that the use of the wind energy in the Republic is practically absent, except for single pilot samples of the plants. And there is still no clarity in their perspective, although the international experience shows that the wind energy industry is one of the most priority areas of non-conventional energy development.

According to the specialists' estimates, the wind energy potential of the Republic can allow covering up to 5-7% of the rural population's need for the electrical energy, providing additional irrigation to agricultural lands by using RES as pumps.

Thus, based on the foregoing it can be seen that the Republic has accumulated some experience in practical use of RES.

The industrial companies in Kyrgyzstan can produce (with annual growth of 10-15%):

- solar collectors – 100-150 thousand m² per year;
- micro HPPs – 2-2,5 MW per year;
- wind-power units – 250-300 kW per year;
- photoelectric converters – up to 2-3 MW per year;
- biogas plants with the capacity of 70÷100 mln m³.

It should be noted that manufacture of solar collectors with the technical characteristics meeting the international standards has been mastered by “Elektroterm” JSC. Manufacture of solar hot water supply systems of both seasonal and year-round operation has also been mastered at this plant. Manufacture of micro HPPs with the capacity of 5, 16 and 22 kW has been mastered at “OREMI” JSC.

Manufacture of sheet-tube solar collectors KSLT-22 and micro HPPs (micro HPP-0.9) has been mastered by “ENVOD” JSC.

Below the information is provided regarding organizations and projects operating in the country, with a description of their main activities:

- The Joint Stock Company “OREMI” - manufacture of large electrical machines (asynchronous motors, transformer substations, generators, products for power transmission lines, micro HPPs, chargers);
- “Gidropuls” PA - supplies pumps and performs surveys, linking the hydraulic ram pumps to the local conditions of the implementation facility, the water pump is the power element for creating a low-pressure hydro-pulse micro HPP;
- The Joint-Stock Company “Jaz” - manufacture of towers for power transmission lines, solar collectors;
- The Public Fund “Fluid” – manufacture of biogas plants, installations adjustment of equipment;
- The Research Institute of Energy and Economy under the State Committee of Industry, Energy and Subsoil Use - audit, certification, heat power engineering, energy saving;
- The Center for problems of RES use - coordination of research, design, production activities in the area of RES in Kyrgyzstan; consulting; expertise, marketing research in the area of non-conventional renewable energy sources use; development of technical facilities, design, installation and operation of equipment operating based on RES;
- The Department for devices and energy conversion systems of the renewable sources under the Institute of Automation and Information Technology of the NAS KR - research, design and development works;
- The Joint Stock Company “Santekhma” - installation of heating, ventilation, air conditioning, thermal solar systems, thermal insulation;

- The Kyrgyz Association for Renewable Energy Sources - promoting renewable energy sources, establishing contacts with similar foreign organizations, bringing together specialists and organizations working in the area of RES use, providing consulting, information and expert services, legislative initiatives, representing and protecting the interests of the association's members;
- "Intelrost" LLC - informing the population about RES, installation, adjustment of equipment;
- The Joint-Stock Company "Envod" – manufacture of solar collectors, micro HPPs; manufacture of equipment for processing agricultural products, electrical heaters for heating of premises;
- "Kyrgyzenergofond" PA - promotion of RES use;
- "Tibet-Azhu" LLC - installation, adjustment of RES equipment;
- The UNDP in Kyrgyzstan, the project "Renewable energy sources for remote regions of Kyrgyzstan" - the UN development program "Promotion of micro HPPs for sustainable development of the mountain communities in Kyrgyzstan" has already been implemented;
- JICA Japan International Cooperation Agency – the project to promote biogas technologies in the Kyrgyz Republic;
- GEF/SGP – support to the civil sector, several demonstration projects in the area of RES have been implemented.

Thus, based on the foregoing it can be seen that some work is being carried out in the Republic on use and development of NCRES. The research works are conducted, a number of companies have mastered the equipment that operates based on RES. There is experience in construction, installation and operation of this equipment. It should be noted that a number of higher educational institutions in the Republic have begun training engineers for this area. The non-governmental organizations are carrying out works to popularize and to raise public awareness on the perspectiveness of these technologies.

However, despite all this it can be seen that the practical use of NCRES technologies is still only at its initial stage. This is due to both internal and external reasons. The main barriers to the large-scale use of RES in the Republic are:

- low prices for traditional fuel;
- low public awareness of RES technologies;
- lack of financial resources in the state;
- lack of adequate human resources, in particular, maintenance personnel;
- absence of the RES market as such;
- low legislative framework;
- lack of specialized organizations for installation and service maintenance;
- absence of a state institution (RES agency) responsible for this area.

To overcome these existing barriers, the following steps should be taken:

- RES use for the Government should be a priority when solving socio-economic problems in rural areas;
- provide for establishment of a State Agency for RES;
- create a mechanism for practical implementation of these technologies by creating a so-called revolving fund;
- the Government should be involved into raising funds for implementation of RES projects, including investments;
- it is necessary to create a human resources policy by training specialists through universities and other educational institutions;

- the Government is to adopt a developed biogas program and to facilitate practical implementation of the program to switch hotels, health resorts in Issyk-Kul to solar hot water supply systems;
- to introduce tax concessions for equipment manufacturers and consumers using renewable energy sources into the tax code.

It seems that practical implementation of these steps will significantly advance the issues of RES use in the KR and thereby will contribute to development of its fuel and energy complex, strengthening the socio-economic living standards of the population and will improve the environmental and economic security in the country.

**3. REGULATORY LEGAL FRAMEWORK
AND THE GOVERNMENT'S GOALS AIMED TO DEVELOP THE ENERGY
SECTOR IN THE REPUBLIC'S ECONOMY**



3.1. Regulatory framework in the area of the energy industry

The legislation of the Kyrgyz Republic in the area of the fuel and energy complex is based on the following fundamental laws:

- The Law “On Energy industry” (No. 56 as of October 30, 1996) /5/;
- The Law “On Electrical Energy Industry” (No. 8 as of January 28, 1997) /6/;
- The Law “On Energy Saving” (No. 88 as of July 7, 1998) /7/;
- The Law “On Renewable Energy Sources” (No. 283 as of December 31, 2008) /8/;
- The Law “On Energy Efficiency of Buildings” (March 2013) /9/.

The Law of the Kyrgyz Republic “On Energy Industry” was adopted on October 30, 1996. It defines the principles of organization and regulation of the economic activities in the fuel and energy complex. The provisions of this Law apply to all enterprises in the fuel and energy complex regardless of their ownership.

The goals of this Law are to increase economic efficiency and reliability of the fuel and energy complex, to protect the interests of consumers and manufacturers.

The Law of the Kyrgyz Republic “On Electrical Energy Industry” was adopted on January 28, 1997. It is based on the provisions of the Kyrgyz Law “On Energy Industry” and applies to all legal entities regardless of the ownership as well as individuals that produce, transmit, distribute, sell and consume electrical and thermal energy.

The goal of this Law is to ensure reliable, safe and continuous supply of electrical and thermal energy and to improve the quality of services provided to all consumers, to create a competitive environment and to form an energy market, to encourage development of the private sector and to attract investments. It defines the need to include energy saving costs into the cost of electrical and thermal energy.

The law has also attached rights and obligations of the consumers and schemes of their contractual relations with the suppliers. The important moment in adoption of the law is that it has secured not only administrative, but also criminal responsibility for theft of electrical and thermal energy and other actions related to illegal use of electrical energy. However, this provision has not been widely used in practice yet.

The Law of the Kyrgyz Republic “On Energy Saving”. In order to increase the efficiency of energy use during its production, transmission and consumption, the Law “On Energy Saving” was adopted in 1998. However, due to the fact that this regulatory legal act had an indirect rather than a direct purpose, it did not have a significant impact on improvement of energy saving policies in the Republic. In addition, by-laws and instructions were not developed for its practical implementation and there was also no clear distribution of responsibility and an incentive system for its implementation. The Energy Saving Fund proposed in accordance with the Law turned out to be a non-working financial instrument, since specific budget support mechanisms were not worked out with the Ministry of Finance.

In this regard, on December 24, 2008 amendments were made to the Law “On Energy Saving”.

The new version of this law defines the procedure for development and state supervision over implementation of the energy-saving policy; the sources of financing; creation and use of various programs to account production and consumption of energy resources, energy surveys and organization of state statistics in the area of energy saving. It is planned to create an Energy Saving Fund, which will accumulate the funds from various sources to stimulate introduction of innovative technologies in the area of energy saving. At the same time, for commercial projects financing will be provided on a repayable basis. Also, the mechanisms to stimulate development of energy saving through grants provision, accelerated depreciation rates, electricity prices fixation ensuring returns to capital in a short time have been introduced in the law.

The law provides for energy examination on assessing energy efficiency, conducting an examination of energy efficiency, organizing energy accounting and control and safety of energy

equipment. The examination is aimed at identifying effectiveness of energy use in organizing the production activities at economic entities and their compliance with energy use standards.

There is still no government authority in the structure of the state management that is unambiguously responsible for implementation of the energy saving policy. Today, the current energy saving activities at energy enterprises are regulated by internal regulations. In accordance with them, each energy enterprise develops an annual plan of the activities to save fuel and energy resources with monthly reporting on its implementation.

The Law of the Kyrgyz Republic “On renewable energy sources”. The law was signed on January 13, 2009 by the President of the Kyrgyz Republic. This law establishes legal, organizational, economic and financial bases, mechanisms for regulating relations between the state, producers, suppliers and consumers of the renewable energy sources, equipment for production and plants for use of the renewable energy sources.

The goal of the law is development and use of the renewable energy sources, improvement of the energy structure, diversification of the energy resources, improvement of the population’s social status, ensuring the energy security, environmental protection and sustainable development of the economy. It should be noted that the law provides for fundamentally important provisions for RES development, in particular, exemption of plants and equipment for RES production from customs duties and that RES energy tariffs should ensure returns on investments not exceeding 8 years. However, for practical implementation of the law, it was necessary to develop by-laws and to provide a mechanism for implementing specific steps including the tariff calculation method for different “green” electricity producers taking into account profitability and environmental benefits.

In this regard, on August 3, 2012, **the Law of the Kyrgyz Republic “On Amendments and Additions to the Law of the Kyrgyz Republic “On Renewable Energy Sources”” was adopted /10/.**

The main purpose of this law is to improve the economic mechanisms stimulating the use of the renewable energy sources (RES) including minor HPPs, to attract investments. The draft law envisages setting the extra charges to the tariffs for electricity generated from RES and minor HPPs for the pay-off period of the projects using RES. This extra charge will be made by multiplying the maximum effective electricity tariff by the corresponding ratio approved for each type of RES:

- for plants using water energy, the ratio is 2.1;
- for plants using solar energy, the ratio is 6.0;
- for plants using biomass energy, the ratio is 2.75;
- for plants using wind energy, the ratio is 2.5;
- for plants using earth energy, the ratio is 3.35.

The proposed extra charges have been determined based on the analysis of special RES tariffs in a number of other countries. Herewith, the maximum pay-off period for the projects on RES use is proposed to be no more than 8 years. That is a grace period is set on establishment of special tariffs for RES plants during which these RES plants should be paid off.

In addition, this law specifies that energy distribution companies should purchase all electrical energy generated using RES and minor HPPs that is not consumed by the owner of the plant for his own needs and that is not sold to other consumers on a contractual basis. That is they should determine the largest energy distribution company dominating at the electrical energy market in the administrative-territorial entity, where the RES plant or the minor HPP is located as a buyer of the electrical energy generated at RES plants and minor HPPs. This provision is consistent with the international practice and creates the conditions for sale of electrical energy produced at RES plants.

This mechanism combines transparency and clarity for a potential investor, since the ratios of the extra charges are enshrined in the Law and the buyer for sale of the electrical energy generated at the RES plants is determined. This state of affairs contributes to competitiveness of RES against using traditional energy sources.

Resolution No. 476 of the Kyrgyz Government as of July 28, 2009 approved **the Regulation on the procedure for construction, acceptance and technological connection of minor hydropower plants to electrical grids** /11/.

The Law of the Kyrgyz Republic “On energy efficiency of buildings” (adopted on July 26, 2011) /9/.

The purpose of the law is to improve the legislation in the area of energy saving.

The law establishes the legal basis for assessing energy efficiency and reducing energy resources consumption by buildings, energy-efficient construction and regulates legal and organizational relations between building owners, regardless of ownership, certified specialists and state executive authorities.

The law of the Kyrgyz Republic “On energy efficiency of buildings” applies to new and existing buildings during their design, commissioning, after energy renovation as well as in renting or selling through establishment of mandatory energy certification of buildings and their marking. The law also regulates activities related to the efficient use of energy resources in buildings during operation of boiler stations, heating systems and hot water supply.

3.2. Government programs, plans, strategies, and other government documents on sustainable development in the energy industry

One of the main documents establishing the strategic base for sustainable energy industry development in the country is the National Energy Program of the Kyrgyz Republic for 2008-2010 and the strategy of the fuel and energy complex development until 2025 (NEP).

NEP is a key political document that defines goals, objectives and main strands of the medium-term and long-term energy policy in the state and establishes the mechanisms for its implementation.

The main priority of the energy strategy in the Kyrgyz Republic is rational and effective use of the natural fuel and energy resources, the existing technical, scientific and human resources potential to strengthen energy independence and security in the country, sustainable economic development and to improve the population’s life quality.

The main goals of the energy industry development for the long-term period are:

- creating the structure and placing the generating capacities of the electrical grids that guarantee energy security and self-sufficiency of the country’s energy industry;
- ensuring reliable supply of electrical and thermal energy for domestic needs of the economy and population of the country;
- developing a full-fledged competitive electrical energy market;
- bringing to the level approaching the world indicators, the main performance indicators of electrical and thermal energy production, transmission, distribution, harmful effects on the environment;
- upgrading and building the production potential of the energy sector and increasing its efficiency through use of new technologies, introduction of automated control systems and optimal control of load schedules;
- creating new complexes of generating capacities and power transmission lines based on use of hydropower resources and coal deposits of the country focused mainly on electrical energy export;
- introducing on the large scale environmentally friendly alternative non-conventional RES in the Republic;
- integrating into the Eurasian competitive electrical energy market.

The development strategy of the fuel and energy complex until 2025 provides a fairly solid basis for further activities. The long-term vision, the clearly defined target results can coordinate short-term strategies and action plans. Such strategies and plans should include

effective assessment, monitoring and verification and should be reviewed in a timely manner to ensure consistent implementation and achievement of the long-term goals.

However, since NEP adoption, evident success in achieving the majority of the above goals has not been observed. Although there is some progress. During this time, many challenges have remained unsolved and have so far adversely affected development of the country's energy sector.

Over the past five to ten years, a number of programs and strategies for the fuel and energy complex development have been developed and adopted based on NEP. The main ones of them are:

- A medium-term electrical energy sector development strategy for 2012–2017, approved by Government Resolution No. 330 as of May 28, 2012 /12/;
- The National Sustainable Development Strategy for 2013-2017, approved by Presidential Decree No. 11 as of January 21, 2013 /13/.

These two documents are currently in the process of being updated by the Government of the Kyrgyz Republic for 2018-2022.

The medium-term electrical energy sector development strategy for 2012-2017, adopted in 2012, has recognized the importance of developing tariff reforms and has assumed a gradual transition to full cost recovery through the tariffs until 2016. However, as of today, electricity tariffs for household consumers do not still cover actual costs.

One of the main objectives of the Medium-Term Strategy has been development of an energy saving policy. To achieve this goal, the document has defined the following measures:

- Developing programs to promote reduction in electrical and thermal energy losses;
- Creating standards and introducing mandatory requirements on energy saving;
- Creating a monitoring group of the energy saving policy implementation.

It should be noted that none of the above measures has been implemented in practice.

The National Sustainable Development Strategy for 2013-2017, adopted in 2013, has considered the energy industry as a sector of the strategic importance for sustainable development. The Strategy has specified that by creating favorable conditions for attracting investors and increasing the inflow of funds, development of the hydropower industry can give a boost to the economy, improve the safety of power supply and increase the electrical energy export to other countries, especially after implementation of “CASA-1000” project.

The main purpose of the Sustainable Development Strategy has envisaged that by 2017 the energy sector could become a large producer of the electrical energy in the region and satisfy all domestic needs as well as increase the electrical energy export.

However, this has not happened. Moreover, since 2011 the downward trend in export, the growth in import and the decrease in electrical energy generation by hydropower plants have been observed.

The Government of the Kyrgyz Republic has adopted two main programs in the area of energy efficiency:

1. The program on energy saving and energy efficiency policy planning for 2015-2017, approved by Government Resolution No. 601 as of August 25, 2015 /14/;
2. The program of the Kyrgyz Republic's transition to sustainable development for 2013-2017, approved by Government Resolution No. 218 as of April 30, 2013 /15/.

The energy saving and energy efficiency program for 2015-2017 sets short-term goals to ensure the growth of the country's GDP by 2017 without significant increase in energy consumption. However, this goal is not specific and does not provide for an agency responsible for achieving this goal. The Program defines the main priorities and proposes the economic instruments aimed at implementing measures to improve energy efficiency, but, unfortunately, none of these instruments have been implemented in practice.

The Program of the Kyrgyz Republic's transition to sustainable development for 2013-2017 related to the energy industry, the goal is to achieve the energy security in the country and to develop the export potential. The program defines a number of key challenges that are

associated with the energy sector; it suggests the main priorities to achieve the main goal. They are:

1. Improving the regulatory framework and enhancing the financial stability of the companies through the tariff reform;
2. Creating incentives to improve energy efficiency and energy saving; creating a government agency responsible for energy efficiency and energy saving;
3. Developing RES through increasing the share of RES in the energy balance and enhancing the use of the minor hydropower industry potential;
4. Developing the energy sector in a sustainable way (improving reliability and security of power supply, improving the discipline of energy accounting, etc.).

There are also a number of other developed programs and other regulations in the area of the energy industry in Kyrgyzstan.

Here it is appropriate to provide a summary from the “In-Depth Review of the Kyrgyz Republic’s Energy Efficiency Policy”, carried out by the Secretariat of the “Energy Charter on Energy Efficiency issues” in conjunction with the State Committee for Industry, Energy and Subsoil Use of the Kyrgyz Republic (p. 102):

The policy in the area of the energy industry and the energy efficiency. The development strategy of the fuel and energy complex until 2025 provides a fairly solid foundation for further activities. A long-term vision and clearly defined target results, for example, by 2040 or 2050, will help coordinate short-term strategies and action plans. Such strategies and plans should include effective evaluation, monitoring and verification and should be reviewed in a timely manner to ensure consistent implementation and achievement of the long-term goals.

In general, the lack of political reforms in the energy sector and poor governance hinder effective implementation of adopted laws and strategies. The lack of progress in implementing tariff reforms aimed at achieving full cost recovery due to the tariffs that reflect the costs is particularly problematic. In this regard, the electrical energy companies have been experiencing a serious shortage of the funds for a long time. They are unable to make investments to maintain the existing assets in a proper condition. This factor along with a relatively uncontrolled increase in the electrical energy demand as well as consumer tariffs based on subsidies negatively affect the reliability of the system and the ability of energy enterprises to connect new consumers. Inadequate cost recovery and cross-subsidization in various consumer groups and fuels prevent the flow of private investments into the energy system. For this reason, the country’s desire to use its huge hydropower resources and to become a net exporter has not been realized. Instead, Kyrgyzstan’s position as an electrical energy exporting country has been weakening since 2014

The above review has shown that the Kyrgyz Republic is well supported by the legislative and regulatory legal framework for successful development of the fuel and energy complex. However, implementation of adopted laws, policies, programs and other government documents is not sufficient and is far from perfect. Moreover, some laws and programs require improvements and the Government of the Republic should pay attention to this fact.

4. IMPLEMENTING THE PLANS ON THE KR ENERGY SECTOR SUSTAINABLE DEVELOPMENT



On September 25, 2015 the UN General Assembly adopted the final document “Transforming our world: the Sustainable Development Agenda until 2030” /17/.

This document is a global action plan for prosperity of the humanity and the entire planet.

The proposed development plan is intended to be implemented by all countries and all stakeholders acting in a joint partnership. It proposes bold reformist steps that are needed to bring the world onto a path of sustainable and viable development.

The seventeen Sustainable Development Goals (SDGs) announced in the document show the scale and the ambition of the new universal agenda. They include enforcement of human rights for all and, first of all, alleviation of poverty and achievement of gender equality. They are complex, indivisible and ensure balance of three important components in economic, social and environmental sustainable development.

The resolution specifies that all progressive humanity must be set to save the planet from degradation also by introducing rational consumption and production models, rational use of its natural resources and taking urgent measures due to the climate change, so that the planet could ensure customer satisfaction of present and future generations. We should ensure that all people can live in prosperity and well-being and that economic, social and technical progress continues in harmony with the nature.

The prosperity of any country directly depends on the state of its economy and, first of all, its industry. In the Kyrgyz Republic as well as in other countries in the world for many years the economic growth has been achieved (and still continues to be achieved) due to intensive and irrational use of the natural resources. The intensive use of the natural resources is undoubtedly necessary for the economic growth, but it is important to understand that in the long term this will lead to significant negative consequences: widespread poverty and deterioration of public health due to polluted air and poor quality drinking water, lack of food and energy.

The outstripping development of the country’s energy sector is required for successful economic growth. On the other hand, the energy industry has a negative impact on the environment. Therefore, it is very correctly announced in the above SDG document that the goals should be implemented in a balanced set of three important components: economic, social and environmental.

Based on the foregoing, the Government of the Republic is recommended to take appropriate measures to implement the sustainable development plans adopted by the UN General Assembly on September 25, 2015 in New York. The energy aspects associated with “Goal 7, Ensuring access to affordable, reliable, sustainable and modern energy sources for all” (SDG7) are further considered.

4.1. Activities to achieve SDG7

4.1.1. Ensure access to affordable, reliable, sustainable and modern energy for all (SDG7.1)

Based on the materials set forth in the previous sections, it is clear that the Kyrgyz Republic implicitly possessing large reserves of the energy resources could significantly satisfy its needs. However, it is not happening today.

The main energy carriers in the Republic are: electrical energy, coal, gas, oil products. The structure of the fuel and energy balance is focused on import of significant portion of the energy carriers from other states. The Republic depends on import of coal, natural gas and oil products. The only self-sufficient energy carrier is electrical energy. The electrical energy industry having the system of production, transmission and distribution generally satisfies the country’s needs in electrical energy while maintaining stable production volumes. Moreover (under favorable conditions), some electrical energy at different times has been exported to Kazakhstan, China, Tajikistan and Uzbekistan. However, there are situations when electrical energy production reduces due to low-water and insufficient filling of the Toktogul reservoir. Also, consumption of electrical power and energy sharply increases in the autumn-winter period (AWP). As a result, the energy system begins to operate at the limit of its capabilities and rolling

blackouts of the consumers have to be used. In such situations, it becomes necessary to import electrical energy from the neighboring states.

Therefore, in order to ensure reliable and sustainable power supply to all consumers, it is necessary to develop generating capacities, i.e. to build new and to upgrade existing power plants as well as to develop electrical grids.

The National Energy Program (NEP) and other government strategic documents listed in Section 3 of this report stipulate long-term plans for commissioning hydropower plants in the Naryn, Sary-Jaz and other river basins. In addition to construction of new HPPs, it is planned to rehabilitate and to reconstruct the existing ones.

Below are the activities to commission new generating capacities as well as to improve reliability, sustainability and efficiency of power supply to all consumers.

From 2020 to 2030, the government plans to implement the following projects /3/:

- “Commissioning the second unit of the Kambarata HPP-2” with the capacity of 120 MW, 2020–2021;
- “Reconstruction of At-Bashi HPP” increasing the capacity by 4 MW until 2021;
- “Rehabilitation of the Toktogul HPP” replacing four hydropower units and increasing the capacity by 240 MW (the capacity will be increased in stages: 2020 - 60 MW, 2021 - 60 MW, 2022 - 60 MW, 2023 - 60 MW, while the service life is planned to be extended by another 40 years;
- “Reconstruction of the Uch-Kurgan HPP increasing the capacity by 40 MW”, 2019-2024;
- Construction of the Upper Naryn HPPs cascade (No. 1, No. 2, No. 3 with the total capacity of 180 MW) and Ak-Bulun HPP - 200 MW, 2019-2024;
- Construction of Kambarata HPP-1 with the capacity of 1,860 MW, 2020–2030;
- Construction of several minor HPPs until 2030 with the total capacity of up to 157 MW including the priority ones: Orto-Tokoy, Oi-Alma, Sokuluk, Tortkul with the construction deadlines of 2019–2021.

Despite the fact that in Kyrgyzstan the population and other consumers are almost completely provided with the electrical energy (about 99%), there are also remote rural settlements not connected to the electrical grids. The currently existing power supply system in the agricultural regions represents a structure that has been functioning without significant changes for decades. Insufficient development and reconstruction rates of the electrical energy distribution systems, actual wear of equipment, systematic overloads lead to numerous outages.

Based on the foregoing, in order to provide all people with the electrical energy, in addition to an increase in the generating capacities it is necessary also to develop the electrical grids on a large scale, i.e. to reconstruct existing and to build new transmission lines in the realm of all regions in the Republic.

For these purposes, it is planned /3/:

- To finish construction of 110 kV overhead line (OHL) Aigultash-Samat with the length of 51 km to the projected Razzakov and Arka substations 110/35/10 kV in Batken and Osh oblasts in 2019.
- Construction of 220 kV OHL Kristall-Karavan is envisaged in Jalal-Abad oblast.
- In order to ensure reliable power supply to the population of Issyk-Kul oblast and to develop the Sary-Jaz mining deposits in 2019-2021, it is planned to build 220 kV transmission line (TL) Tamga-Karakol with the length of 90 km and with the substation 220/110/10 kV.

- To improve the capacity and the reliability of the transmission lines in Chui oblast, 220 kV OHL with the length of 22 km and the substation Uchkun is planned in the future.
- Reconstruction and upgrade of the distribution systems replacing the outdated equipment with the new one and replacement of the old cable networks are envisaged in Bishkek.

The acuteness of the problems related to the power supply to the population in both urban and rural areas is growing due to migration and population growth, increase in the number of new families and transformation of lands for individual housing construction. This is especially observed around large cities such as Bishkek, Osh, Jalal-Abad and others, where several dozens of new residential areas have appeared in recent years. The largest number of new buildings compared to other regions is noted in Chui oblast, since this region has the largest migration from the country-side.

Based on this, the Government of the Kyrgyz Republic is making every effort to ensure that every family has access to reliable and high-quality electrical energy.

The solution of these issues requires an integrated government approach and a special attention from the Government and an authorized government agency on energy policy development.

Sustainable and reliable heat and thermal energy provision in the Republic is possible primarily due to development of the coal-mining industry and the gas supply.

The coal-mining industry development is expected due to technical re-equipment, upgrading of the existing coal enterprises and development of the new deposits. The reliability of the fuel supply in the regions in the future will be ensured as follows /3/:

- In Batken oblast, where 26% of the coal is concentrated, its production growth is forecast from 265 thousand tons in 2018 and up to 450 thousand tons by 2040 or by 1.7 times. For purposes of efficient and rational use of the coal resources, introduction of the innovative technologies, there is an opportunity to introduce in-situ coal gasification for production of the “synthetic” natural gas with development of the Kyzyl-Kiya deposit at the Vostochnyi site.
- In Issyk-Kul oblast, where 2% of the coal deposits is concentrated at the Jergalan mine the hard coal in the amount of 20 thousand tons is mined. This volume will be maintained in the future to provide the enterprises as well as the housing and municipal services and the population in the oblast.
- In Osh and Osh oblast, the coal production at the existing coal enterprises is expected to be increased from 300 thousand tons at present to 305 thousand tons by 2020. In the future, it is planned to develop the Uzgen coal deposit of the coking coal.
- In Naryn oblast, where 42% of the coal deposits is concentrated and there is no natural gas, the reliable fuel supply is expected due to the coal production growth at the existing coal enterprises from 911.5 thousand tons in 2018 to 1,245 thousand tons by 2020, and 2,590 thousand tons by 2030.
- In Jalal-Abad oblast, the fuel supply is planned due to an increase in the coal production at the existing Tash-Kumyr and Tegene mines from 140 thousand tons to 180 thousand tons by 2030.

An alternative fuel to the coal is the gas. As mentioned above, in order to improve the gas supply to the country and the regions, “Kyrgyzgaz” JSC was reorganized into “Gazprom” of the RF OJSC in 2014. It undertook the obligations to pay the debts, to reconstruct the outdated gas distribution grids and to supply the natural gas uninterruptedly to the consumers of the Kyrgyz Republic. As a result, “Gazprom Kyrgyzstan” LLC was established. To fulfill the undertaken obligations, an Investment Program has been developed, which is updated on an annual basis. Moreover, in 2015 the Design Institute of Gazprom-Promgaz of the Russian Federation JSC developed the General Gas Supply and Gasification Scheme for the Kyrgyz Republic up to 2030, which was approved by Decree No. 22-p of the Kyrgyz Government as of January 30, 2015 /30/.

The implementation of the General Scheme will solve the main problems of the gas supply to large cities and regions in the country. In accordance with the General Gas Supply and Gasification Scheme for the settlements, an increase in supplies is forecast due to the natural gas import from 282 million cubic meters in 2017 to 430 million cubic meters in 2020, 571 million cubic meters in 2025 and 701 million cubic meters in 2030. In addition, it is also possible to bring the gas supplies to 814.5 million cubic meters by 2040. The number of gasified settlements will increase from 30 to 411, gasified apartments and houses - from 288 thousand to 845 thousand, the length of main grids - from 1,476.2 km to 2,747.7 km. The natural gas extraction at the existing deposits is projected at the same level until 2020 in the amount of 30 million cubic meters. Then a slight increase is forecast due to wells drilling at the North Karakichum and Maili-Suu IV deposits. From 2026 the gas extraction at the unopened new deposits is planned.

To ensure the reliability of the fuel supply to the regions in the country due to gasification, the General Scheme provides for the following activities:

- In Batken oblast, to increase the reliability of the fuel supply, an alternative to the coal will be gasification of 68 settlements in the oblast with gasification of additional 49 thousand households, additional construction of 232.8 km of the gas distribution grids and additional supply of 55.6 million cubic meters of the gas. This can oust 100 thousand tons of the coal from consumption.
- In Issyk-Kul oblast, gasification of Issyk-Kul oblast with construction of a gas pipeline from Chui oblast to Balykchi city and the inter-settlement gas distribution grids with the length of 251 km is planned as an alternative. The gas supplies in the amount of 120.3 million cubic meters will enable to release about 215 thousand tons of the imported coal and it will also be possible to transfer the vehicles to the eco-friendly natural gas vehicle fuel, which is required in the Issyk-Kul resort area.
- In Chui oblast, the fuel supply reliability will be ensured by construction of additional gas distribution grids with the length of 173.8 km and by an increase in the natural gas supply from 199.5 million cubic meters to 276.6 million cubic meters and an increase in the number of gasified apartments by 113.7 thousand units, which will allow to oust about 280 thousand tons of the coal from consumption.
- In Osh and Osh oblast, the fuel supply reliability will be increased due to the planned gasification of 75 settlements and 142.2 thousand households with expansion of the gas distribution grids by 213.1 km and an increase in the natural gas supply from 16 million cubic meters to 147.2 million cubic meters with an increase in consumption by 131.2 million cubic meters. Due to these activities, it will be possible to oust 432 million kWh of the electrical energy or 235 thousand tons of the coal from the area of electric heating and cooking.
- In Talas oblast, where there are no coal deposits, it is planned to expand the gas distribution grids and to ensure the natural gas supply to 22 settlements in the amount of up to 30 million cubic meters with an increase in the number of the gasified households by more than thousand units. The length of the gas pipelines will be 63.8 km. Due to these activities it is possible to oust about 55 thousand tons of the coal scarce in this region from the area of heating and cooking.
- In Naryn oblast, where there is no natural gas and the fuel is supplied due to the coal production, it is planned to build the gas distribution grids with the length of 85 km and the supply volume of 35.6 million cubic meters to 19 settlements or 22.4 thousand households. Due to these activities 63 thousand tons of the coal can be ousted from the area of heating and cooking.
- Jalal-Abad oblast is the region most provided with the fuel and energy resources; coal, oil, gas deposits and the main hydro potential of the water resources are concentrated here. Despite this, additional 84 settlements and 78 thousand households are planned to be gasified in the oblast in all areas starting from Jalal-Abad city and to the remote

villages of Aksy and Toktogul regions. For this purpose, 266 km of the gas distribution grids with the additional supply of 56.9 million cubic meters of the gas will be additionally built. In this case, it will be possible to substitute 102 thousand tons of the coal.

To implement successfully the General Gas Supply and Gasification Scheme for the Kyrgyz Republic until 2030, the government support to the investment programs is required from the Government of the Kyrgyz Republic and the local governments.

It is seen from the above that the plans of the Kyrgyz Government to ensure universal access to affordable, reliable and modern power supply are fully consistent with clause 7.1 of SDG7.

4.1.2. Increase significantly the share of the energy from the renewable sources in the country's energy balance (SGD 7.2)

As mentioned above (Section 2.1), the energy sector in Kyrgyzstan today can largely meet the demand for the electrical energy, while maintaining stable production volumes. Over 90% of the country's electrical energy is generated from the hydropower resources. Since the hydropower is a renewable energy source, we can assume that in Kyrgyzstan the share of the renewable energy in the total volume of the electrical energy generation is more than 90%. Compared with the highly developed countries setting a goal to achieve 30-40% of the electrical energy production from RES, Kyrgyzstan today is much ahead of the developed countries in terms of this index. However, despite this, the Kyrgyz Government places a relevant importance to RES development and use in the energy balance of the Republic. As mentioned above (Section 2.5), if in the industrialized countries the use of RES is mainly determined by the environmental problems and the search for clean "green" energy resources, then for Kyrgyzstan this issue should be considered as a solution, first of all, to the socio-economic problems of the rural population and the remote areas in the country in order to ensure access to reliable and affordable energy carriers for every consumer. Therefore, the Government of the Republic is aware of the need to involve actively the renewable energy sources through construction of minor HPPs, solar and wind turbines in the regions of the country.

In order to implement the Small Hydropower Development Concept of the Kyrgyz Republic until 2017 /19/ approved by Resolution No. 507 of the Kyrgyz Government as of July 20, 2015, 63 channels of small rivers were examined and priority minor hydropower plants were proposed for construction. The assessment of the small rivers' potential revealed the possibility to build HHPs with the total capacity of 333 MW and the production of 1.7 billion kWh; out of them for the period of 2017-2030 it is technically possible to build 42 minor HPPs with the installed capacity of 157 MW and a gradual increase in production to 774 million kWh, including: in Chui oblast - 71.8 MW, in Issyk-Kul oblast - 7 MW, in Talas oblast – 1.6 MW, in Osh oblast - 6.2 MW, in Naryn oblast - 7.38 MW, in Jalal-Abad oblast - 33.5 MW, in Batken oblast - 13 MW. However, USD 314 million will be required with a relative capital investment of USD 2,000 per 1 MW of the capacity.

To ensure the reliable power and fuel supply to the population and the economic sectors by the regions in the future, it is necessary to take into account all the possibilities for rational use of FER and diversification of the local energy sources through additional measures of gasification and RES use.

In Batken oblast, in addition to construction of the high-voltage main lines and expansion of the distribution electrical grids (see Section 4.1.1), the measures are also required to ensure the reliable power supply by constructing minor HPPs with the total capacity of 13 MW, including Tortkul minor HPP with the capacity of 3 MW as well as the biogas plants in the

villages. It is necessary to build a minor thermal power plant with the capacity of 75 MW near Sulyukta city based on the coal use from the similarly-named brown coal deposits.

In Issyk-Kul oblast, development of the renewable energy sources requires construction of the Orto-Tokoi minor HPP with the capacity of 20 MW as well as other minor HPPs with the total capacity of 7 MW, solar (SPPs) and wind power plants (WPPs) with the capacity of 20 MW each, primarily in the area of Balykchi city, the biogas plants in the rural areas. Improvement of the infrastructure will be also required. There is also the possibility to use the hydropower potential of the Sary-Jaz River basin constructing the HHPs cascade with the total capacity of 1,200 MW.

In Chui oblast, there is the possibility to build minor HPPs with the total capacity of 1.5 MW, SPPs with the capacity of 20 MW as well as biogas plants in the rural area.

In Bishkek, widespread introduction of the solar collectors in heating and hot water supply systems of public and residential buildings will ensure significant savings in electrical and thermal energy from the centralized sources, electrical grids and heating systems.

In Osh and Osh oblast, it is possible to build a minor HPP Oi-Alma with the capacity of 7.7 MW and other minor HPPs with the total capacity of 6 MW as well as minor TPPs in Uzgen, Kyzyl-Kiya with the capacity of 50 MW each in Osh oblast tapping them into existing and future power transmission lines. SPPs with the capacity of 26 MW and WPPs with the capacity of 5 MW in the Alai region will be developed.

In the future, in Talas oblast, it is possible to build a minor HHP with the capacity of 20 MW at the Kirov reservoir as well as SPPs with the capacity of up to 10 MW will be developed.

In Naryn oblast, in order to enhance the reliability of the power supply, there is an opportunity, in addition to construction and commissioning of the Upper Naryn HPP cascade of the Kamarata HPP-1, to build minor HPPs with the total capacity of 7.38 MW as well as biogas plants in the settlements and the mountain grazing (jailoo) of Ak-Talin, At-Bashi, Jungal and Naryn regions remote from the centralized power supply.

In Jalal-Abad oblast, according to the results of river channel surveys, the possibility to build minor HPPs with the total capacity of 33.5 MW and SPPs with the total capacity of 25 MW has been revealed. Construction of the biogas plants in the settlements remote from the centralized power supply is also relevant here. It shall be particularly noted that in order to ensure the agriculture development in the Toktogul region, there is the possibility and the necessity to build minor HPPs with the total capacity of 40-50 MW generating 200 million kWh for irrigation of 8,000 hectares of Uch-Terek ayil okmotu lands while constructing a take-out channel through the Kargysh pass to transfer the Kara-Suu River to the Sary-Jaiyk site according to the research results of the Research Institute for Energy and Economy under the State Committee of Industry, Energy and Subsoil Use of the Kyrgyz Republic. It is also possible to build mini TPPs with the capacity of 50 MW and to produce coal briquettes based on and in the vicinity of Tegene and Tash-Kumyr deposits to improve the reliability of the power supply to the population of the Aksyi region in Tash-Kumyr city.

4.1.3. Improve the global energy index (SDG7.3)

One of the SDG7 goals is to double the global energy index by 2030. Today, many already understand that the rational and efficient use of the fuel and energy resources, i.e. the energy efficiency is one of the most effective means to achieve many positive changes in economic, social and environmental areas, and is also one of the main components to achieve the sustainable development goals.

In recent decades, a number of the developed countries in the world have realized that the old economic model of states development based on depletion of the natural resources not only has a detrimental effect on the nature of the planet, but is also inefficient. In the past, the economic development has been achieved through excessive destruction of the natural wealth for the sake of the current economic prosperity. Today, many states already understand that such

obsolete model of development and growth is detrimental to the well-being of the current generation and creates enormous risks and problems for the future generations.

The energy sector is the largest consumer of the natural resources (oil, gas, coal, water resources, etc.) in the economy of any country. The state of the country's economy and the living standard of the population are largely determined by availability of the fuel and energy resources and efficiency of their use.

The highest priority of the energy strategy in the industrialized countries at present is to increase efficiency and rational use of the energy resources, i.e. energy efficiency and energy saving, in contrast to the previous focus on the large-scale increase in the energy resources production.

The energy efficiency is an important tool to protect public health and environment. The energy efficiency reduces greenhouse gas emissions and decreases the amount of fossil fuels required to meet the energy needs. The emissions have a direct impact on the environment and the human health. The energy efficiency also minimizes the impact of natural disasters and strengthens the reliability of electrical grids, helping avoid outages and ensures resistance to natural and climatic pathogenesis.

Based on the foregoing, the national target programs on energy efficiency and energy saving have been developed in many countries, which cover a wide range of the activities to improve the structure of energy resources consumption. In Kyrgyzstan, there are also a number of regulatory legal acts regulating energy efficiency and energy saving. In the Republic, the energy efficiency and energy saving policy is regulated by the Laws of the Kyrgyz Republic "On Energy Industry", "On Energy Efficiency", "On Energy Saving" and "On Energy Efficiency of Buildings" (see Section 3.1). In addition, two main energy efficiency programs have been effective in Kyrgyzstan: the "Program on Energy Saving and Energy Efficiency Policy Planning for 2015-2017" and the "Program of the Kyrgyz Republic's Transition to Sustainable Development for 2013-2017 (See Section 3.2).

All laws and government programs pay a sufficient attention to energy efficiency and energy saving issues. Below the main provisions from these documents regarding energy efficiency and energy saving are given.

The Law "On Energy Industry" /5/ states that the primary goal of the Law is to increase economic efficiency and reliability of the energy sector as well as to protect the interests of producers and consumers. The law also provides that energy efficiency and energy saving should be taken into account when developing the National energy programs. In this regard, the "National Energy Program of the Kyrgyz Republic for 2008-2010 and the FEC Development Strategy until 2025" have determined that the main priority of the Energy Strategy until 2025 is to achieve rational and efficient use of the energy resources, the scientific and human potential to strengthen the energy security of economic development and to improve the quality of the population's life. One of the main goals of the long-term strategy is "... to increase the efficiency of electrical and thermal energy generation, transmission and distribution to the level of the developed countries in the world". Another strategic document was the "Medium-Term Development Strategy of the Electrical Energy Sector for 2012-2017" /12/. One of the main objectives of this document was to develop an energy saving policy. To achieve this goal, it was necessary to carry out a number of important measures with development of programs and necessary standards and energy efficiency requirements. Unfortunately, it did not happen.

The Law "On Energy Saving" /7/ aims to improve the energy efficiency in energy production, transmission and distribution. The law contains a number of important provisions regarding creation of an effective institutional and legislative framework for energy efficiency, but, unfortunately, most of these provisions have not been implemented.

The Law "On Energy Efficiency of Buildings" /9/ envisages a number of important provisions to create effective institutional foundations and a legislative framework. Despite adoption of the secondary legislation, the requirements of this Law have not been implemented or introduced. The barrier to this is the fact that the responsibility for implementation of this Law

has not been assigned to the relevant government agencies. At the same time, this barrier can be overcome by creating a single government institution at the legislative level responsible for improving the energy efficiency in the country.

“The Program on Energy Saving and Energy Efficiency Policy Planning” /14/ sets the short-term goals to ensure the country’s GDP growth without a significant increase in energy consumption. However, this goal is not specific and does not envisage a government agency responsible for achieving this goal.

In the “Program of the Kyrgyz Republic’s Transition to Sustainable Development” /15/, one of the priority areas is development of incentives to improve the energy efficiency, including creation of a government agency responsible for energy efficiency and promotion of the measures to increase efficient and rational use of FER. This document defines reasonable priorities to achieve the main goal of the Program, where the first priority is to improve the regulatory framework, the second is energy efficiency, the third is RES, and the fourth is to develop other low-carbon energy sources.

It can be seen from the above review that legislative and regulatory legal frameworks governing energy efficiency and energy saving in the Kyrgyz Republic are sufficiently presented but, unfortunately, many fundamental provisions from these documents have not been implemented or put into practice for various reasons. In this regard, there are big problems with energy efficiency and energy saving in the Republic. The energy intensity of the economy, which characterizes the energy efficiency remains at the high level. The main factors affecting this situation are the low level of technical upgrade, financial difficulties with introduction of energy-saving technologies and production, the absence of strict limitation, control and accounting for the rational use of the energy carriers, low electricity tariffs, and most importantly, weak laws and programs, governing energy saving and energy efficiency.

The legislative framework and the energy efficiency policy are focused on the short-term goals. However, long-term and clearly defined goals will be required to achieve significant progress in improving the energy efficiency. The Kyrgyz legislation in the field of the energy efficiency will also require substantial development, which is accompanied by reliable implementation mechanisms. Currently, only the legislation regarding improvement of the energy efficiency in the buildings is at the satisfactory level. More comprehensive energy efficiency legislation is urgently required to implement such mechanisms as minimal energy performance standards (MEPS) and energy labeling schemes for energy-consuming appliances (including vehicles), energy service companies (ESCOs) and energy efficiency contracts, government procurements and energy audits.

The proper attention is not paid to the energy saving and energy efficiency policy in the country, although there is considerable potential in Kyrgyzstan.

A serious problem is the lack of real mechanisms promoting the energy saving processes as well as the investment deficit and the poor support from the Government of the Kyrgyz Republic in implementation of the energy saving policy. As a result, the gap in the energy efficiency between the current energy consumption and the optimal one that can be achieved using the existing energy-efficient measures and technologies continues to grow. In this regard, the energy expenditures of the Republic’s economy remain at the high level.

Based on the foregoing, today the government faces the urgent task to improve the energy efficiency and the rational use of the fuel and energy resources in production, transportation, distribution and consumption.

To solve these problems, the following measures are recommended:

1. To improve the legislation of the Kyrgyz Republic in the area of energy efficiency, energy saving and RES creating the required specific regulatory legal framework for their development with the absolute priority to introduce low-carbon, renewable energy sources and to improve energy efficiency.

2. To establish a government agency responsible for control, supervision and regulation in the area of the energy efficiency in order to ensure implementation of Government policies and programs in the area of the energy efficiency.

3. To determine management structures and coordination systems for departments and local governments at the regional level with clear assignment of responsibilities for implementing energy saving, energy efficiency and RES use policies.

4. To develop an energy-saving and energy efficiency program for 2021-2025 with an action plan for its implementation.

5. To develop the financial incentive mechanisms for the above energy efficiency and energy saving activities.

6. To create an energy-saving and energy efficiency fund.

7. To improve and to implement a tariff policy in the area of electrical and thermal energy sectors ensuring flexibility in meeting the demand and covering the costs of energy producers and to consider introduction of the differentiated electricity tariffs.

8. To organize the training and the retraining for the qualified personnel in energy efficiency, energy saving and introduction of energy-saving technologies, providing for:

- formation of environmental and energy-saving consciousness among the younger generation in the process of preschool and school education;
- retraining of the specialists with higher education in the area of technological energy saving aspects;
- training of the specialists in conducting energy surveys in enterprises and organizations (energy auditors);
- organization of the courses to improve the professional training of executives and specialists in enterprises and organizations involved in energy supply, energy saving and energy efficiency issues.

4.1.4. Promote the international cooperation to achieve SDG Goal 7a

At the present stage of economy and energy industry development in any country, it is impossible to imagine the effective and reliable functioning of the energy industry in a country without international cooperation. The reserves of the fuel and energy resources are different in various countries. One country is rich in fossil fuels (coal, oil, gas, etc.), the other is rich in water and energy (large rivers and lakes), the third is in renewable energy types (sun, wind, small rivers, biological waste, etc.). Depending on this, development of the generated capacities in various countries is different. Some have thermal power plants (TPPs), others - hydropower plants (HPPs), and still others – plants operating on renewable energy sources (RES), etc. Therefore, it is obvious that the exchange of the energy resources is vital for reliable, sustainable and effective development of the energy sector in any country. Today, there is no state that has not exported and/or imported any energy resources. Based on this, at the present stage of the world energy industry development, the active international cooperation is required to ensure access to affordable, reliable, sustainable and modern energy sources for all, which is fully consistent with achievement of SDG Goal 7.

All above is of direct importance for the countries of the Central Asian region (CAR) and, first of all, for Kyrgyzstan. The need to create a single energy market has long ripened for the CAR countries, but implementation of this initiative has been frozen for many years. There is a hope that in the near future this issue will be resolved positively. The Kyrgyz Republic has always supported and supports this initiative. Thus, the National Energy Program of the Kyrgyz Republic until 2015 defines that the strategic objectives of the interstate cooperation are /2/:

- to preserve and to develop further the existing energy ties within the frameworks of CIS, EAEU, SCO and others;

- to take part in development of the integration processes in the area of water, fuel and energy resources development and exploitation, to improve the efficiency of their use;
- to take part in creation and improvement of the regulatory legal framework on joint development of water and FER, joint use of hydraulic and energy facilities, including oil and gas pipelines;
- to ensure energy and environmental security in the CAR.

The Kyrgyz energy system has previously operated simultaneously with the energy systems of the Central Asian region and has been a constituent part of the Unified energy system of Central Asia (UES CA) (see Section 2.1). UES CA united the energy systems of Kyrgyzstan, Kazakhstan, Uzbekistan and Tajikistan. But after the collapse of the Soviet Union, the Unified Energy System has ceased to exist and the issue of the region's water and energy balance has become controversial.

The water and energy regulation in the region was carried out based on the “Agreement on water and energy resources use in the Syrdarya River basin between the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic and the Government of the Republic of Uzbekistan as of March 17, 1998.” The interaction scheme of energy resources exchange was agreed upon in the intergovernmental agreements of these republics. In accordance with these agreements, Kyrgyzstan received natural gas, coal and fuel oil for the Bishkek TPP in exchange for water releases from the Toktogul reservoir during the growing season and for simultaneously generated and exported electrical energy to Uzbekistan and Kazakhstan. However, development of the integration processes in the CAR did not achieve the desired results. The main reason was that the relevant competent authorities in the CAR countries did not implement fully the specific mechanisms to fulfill the taken decisions in time. And each independent republic began focusing on its own provisioning with all types of energy, and, first of all, electrical energy. Uzbekistan and Kazakhstan's attempts to exit from the parallel operating mode and disagreements of the parties to extend the Agreement of 1998 started. The parties had to switch to bilateral agreements. In order to maintain the stability of the regional energy system, the bilateral agreements had to be concluded:

- on electrical energy export to the Republic of Kazakhstan and parallel operation with the Kazakh energy system;
- regulation of the capacity (the frequency) for Kazakh and Uzbek energy systems.

In general, the bilateral agreements are being implemented, but without multilateral agreements it is becoming increasingly difficult to fulfill the obligations.

The lack of multilateral reciprocal obligations is a major problem for the countries of Central Asia in the area of water and energy resources use. Kyrgyzstan has to convince its neighbors in the need for multilateral agreements in order to avoid crisis situations and for the common good. Ideally, these agreements are long-term so that it is possible to plan operation taking into account the cycle of the water content in the rivers (low water and high water).

The current situation dictates the need to create a balanced water and energy system of the Central Asian countries in the near future meeting the interests of all states in the region. For example, to return to cooperation under the Agreement on water and energy resources use in the Syrdarya River basin between the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, the Government of the Republic of Tajikistan and the Government of the Republic of Uzbekistan as of March 17, 1998.

The need to create a common electrical energy market of Central Asia becomes apparent. Therefore, since formation of the Eurasian Economic Union (EAEU) and Kyrgyzstan's entry into it in 2015, the works to create a common electrical energy market of the EAEU have started. The following documents have been developed and adopted:

- The concept for creation of a common electrical energy market of the EAEU, May 8, 2015 /21/;

- The program for creation of a common electrical energy market of the EAEU, December 26, 2016 /22/.

The EAEU Member States are currently working on implementation of the activities indicated in these documents.

The key objective in creating a common energy market of the EAEU is to restore a full-fledged operating mode of the energy systems being a part of UES CA at the level of all Central Asian Republics. For this purpose, it is necessary to develop and to introduce the effective mechanisms on integration processes development, primarily:

- integrated management of the water and energy resources (WER) and maintaining parallel operation of the energy systems, taking into account the existing infrastructural capabilities of each Central Asian state and joining the UES of the EAEU,
- preventing the energy industry's vulnerability to climate change and promoting environmentally friendly energy generation technologies;
- reducing greenhouse gas emissions CO₂ into the environment and joint adaptation measures in the context of the global warming;
- raising funds to finance the sustainable energy projects in the region and promoting the regional electrical energy trade as well as implementing the projects in a public-private partnership.

When developing draft interstate documents on joint use of WER in the Naryn-Syrdarya River basin, it is necessary to provide for:

- implementation of the coordinated measures in the area of rational, effective development and use of WER in the region;
- ensuring optimal irrigation and energy operating modes of the reservoir cascades taking into account annual and long-term cycles of water flow fluctuations and balances of the water and energy resources, etc.

Kyrgyzstan's entry into the common energy market of the EAEU has many positive aspects, but at the same time, the external energy policy should be developed in the following areas:

- strengthening the positions of the Kyrgyz Republic in creation of a regional energy market and maximizing the effective implementation of the export opportunities of the energy sector;
- ensuring a non-discriminatory regime of the foreign economic activity in the energy sector, access of the energy companies to energy markets, foreign financial markets, advanced energy production technologies;
- assisting in attracting investments from the international financial organizations on mutually beneficial terms;
- promoting the principles of energy efficiency and sustainable development as well as signed international conventions, protocols, treaties and UN sustainable development goals;
- receiving the greatest benefits for the Kyrgyz Republic from the foreign economic activity;
- supporting new forms of the international energy business in FEC.

It is strategically important to strengthen Kyrgyzstan's positions in the regional market of the electrical energy and the capacity so that during 2020-2030 to maximize the export opportunities of the Republic's hydropower industry and to contribute to ensuring the energy security as new energy capacities are commissioned (see Sections 4.1.1 and 5)

As to the strategic plan for the Naryn-Syrdarya River basin, Kyrgyzstan needs to ensure that hydraulic facilities of the interstate importance providing seasonal annual and multi-year regulation operate both in irrigation and energy modes. Due to the fact that the Kyrgyz energy system having a powerful HPP cascade and an over year storage reservoir can accumulate, store

and supply the water resources for irrigation needs of the entire Central Asian region. Reaching agreements on the principles and the procedures of water distribution, the measures on the level of costs compensation for regulating water between the states as well as optimizing the use of the interstate water bodies is an urgent task today. In this regard, development of the interstate cooperation in the energy sector should become one of the main priorities of the external energy policy in Kyrgyzstan. However, it must be taken into account that implementation of the strategic objectives requires improving the negotiation processes for successful development and conclusion of multilateral and bilateral interstate agreements on WER use and energy resources trade.

4.1.5. Expand the infrastructure and upgrade the technologies (SGD7c)

The successful development of the energy industry is impossible without a relevant innovative, scientific and technological policy, which shall primarily envisage expansion of the infrastructure, upgrading of the outdated technologies and introduction of new modern equipment.

The innovative activities in the energy sector of Kyrgyzstan are a required measure for further sustainable and effective operation of the most facilities in the fuel and energy sector that have been in a deplorable state for many years.

Taking into account this situation, the Government of the Republic has taken relevant actions. For the last decade, the works to expand the infrastructure and to upgrade the energy facilities have visibly activated. For this period the energy sector in Kyrgyzstan has made definite progress: the first unit of Kambarata HPP-2 with the capacity of 120 MW has been commissioned, 110 kV TL Aigultash-Samat has been built, Datka-Kemin SS 500 kV, 500 kV TL Datka-Kemin and 220 kV TL in the south of the Republic with the length of 248 km have been built, thereby ensuring independence of the country on the energy systems neighboring Kyrgyzstan. Modernization of the Bishkek TPP with the increase in the capacity to 812 MW has been finished; rehabilitation of the Toktogul HPP is going on. The “smart” meters and ECMAS have been introduced in the distribution energy companies. These works are still being carried out and will be finished as far as all electrical energy consumers are equipped. The works to upgrade the outdated equipment in electric power plants, substations and distribution electrical grids (see Section 5) have started. These activities are planned to be finished in stages until 2030.

Successful introduction of the innovative technologies, upgrade, use of the latest technological advances and developments in energy production, transmission and distribution is impossible, as mentioned above, without a relevant innovative, scientific and technological policy. Moreover, the basis of the policy should be the support of the Kyrgyz Government provided to the scientific studies in the area of the energy industry and introduction of the latest scientific and technological achievements in order to increase significantly the efficiency of the FEC sectors functioning. For this, as defined in the National Energy Program (NEP), it is necessary to implement the following priorities of the national scientific, technological and innovative policy:

- complete reconstruction, upgrade and technical re-equipment of the existing FEC facilities;
- restore and develop the scientific and technical potential, including applied developments, upgrade the experimental base of the scientific organizations and the systems of scientific and technical information;
- create favorable conditions for development of the innovative activities aimed at radical update of the FEC’s production and technological base;
- improve all stages of the innovation process, increase relevance and effectiveness of using the results of the scientific activities;

- use the potential of the international cooperation to apply the best world achievements and to bring the domestic developments to a higher level;
- retain and develop the scientific and technical human resources in the area of the energy industry.

To achieve the specified priorities in the scientific, technological and innovative policy, it is necessary: to identify and to provide an economic support to the promising areas of the scientific, technological and innovative activity through government targeted scientific, technological and various innovative programs and projects; to organize a system of state accounting and control over implementation of the results of research studies and experimental developments in the energy sector, to create an effective information infrastructure in the field of science, education and technology in the FEC sectors; to finance the science in the energy sector; to assist in development and introduction of new effective environmentally friendly technologies for generation, production, conversion, transportation and integrated use of the fuel and energy resources, with priority use of the own sources.

The implementation mechanisms for state regulation of scientific, technological and innovative activities in FEC can be:

- creating the economic conditions to develop new technologies and equipment using all financing sources;
- creating target scientific, technological and innovative programs;
- developing a system to determine and to monitor implementation of the priority areas in the innovative activity and new technologies in FEC, also using the sectoral maps of technological development that are increasingly used in different countries;
- strengthening and developing consolidated sectoral financing sources for research and development works, concentrating budgetary and extra-budgetary funds in order to implement large innovative projects;
- organizing the republican centers of science and high technologies related to development and introduction of the most promising technologies in the FEC system;
- developing a system for involving intellectual property assets and other results of scientific and technological activities in FEC into the country's economy.

A prerequisite for implementation of an innovative, scientific and technological policy in the FEC sectors is to retain and to develop human resources in scientific and technological activities. For this, prestige and attractiveness of the scientific and technological activities should be enhanced; the conditions to attract and to retain new personnel in the field of science should be created; the interconnection of the scientific personnel training in implementation of the most important innovative projects of the national importance should be ensured; the training quality of the scientific personnel with higher qualification should be improved; senior executives, engineers and technicians at all levels of FEC should undergo the advanced training.

5. PROPOSALS TO IMPLEMENT SPECIFIC ACTIONS TO IMPROVE EFFICIENCY, RELIABILITY AND SUSTAINABLE DEVELOPMENT OF THE ENERGY SECTOR IN THE KYRGYZ REPUBLIC



The projects planned by the Government of the Kyrgyz Republic /23, 24/

No.	Projects	Required works	Implementation periods	Executor, responsible organization	Financing source (a donor)
1.	Energy sector development	Introducing the electricity commercial metering automated system (ECMAS), the communication system and the data dispatch control system (DDCS) and upgrading the substations (partial replacement of the equipment).	2013-2018 At present the systems are being adjusted and the deficiencies noted by the commission are being rectified.	“Alstom and Ulison” Consortium, “AK-AI Elektrik” (Turkey), “NEG of Kyrgyzstan” OJSC	Asian Development Bank (ADB)
2.	Improving the power supply to Arkin area in the Batken oblast	Building 110 kV TL with the length of 51 km from 110 kV TL Aigul-Tash-Samat to Arka SS, Razzakov SS 110/35/10 kV and reconstructing Arka SS 110/35/10 kV.	2014-2019	“SA-RA” (Turkey), “NEG of Kyrgyzstan” OJSC	Islamic Development Bank (IDB)
3.	Improving reporting and pertinence of the power supply systems	The project consists of 3 components: 1. Building Bishkek SS 110/35/6 kV, Orto-Sai SS 35/6-10 kV, Sport SS 35/6-10 kV. 2. Building a 110 kV cable line from the Bishkek TPP to Bishkek SS. 3. Installing ECMAS meters.	2014-2019	“PESTECH&SPECO” Consortium (Malaysia - China), “Estamin PS” LLC, “Heksing” (PRC), “NEG of Kyrgyzstan” OJSC	World Bank (WB), International Development Association (IDA)
4.	Rehabilitating “Oshelektro” OJSC	The project consists of 3 components: 1. Installing the ECMAS system (including software and a server). 2. Rehabilitating and upgrading the distribution network of low and medium voltage (cabling and wiring products, electrotechnical equipment). 3. The activities to strengthen the capacity of lines and power transformers	2017-2020	“Oshelektro” OJSC. The preparatory works for the project implementation are being carried out, an agreement with the EBRD for Euro 5 million has been signed.	European Bank for Reconstruction and Development (EBRD)

No.	Projects	Required works	Implementation periods	Executor, responsible organization	Financing source (a donor)
		of the power supply system.			
5.	Reconstructing and building pump stations	Reconstructing and upgrading the pump stations and the heating networks. Building a new pump station in Bishkek.	2017-2020	“Bishkekteploset” OJSC. A contractor is being selected.	EBRD
6.	Reconstructing At-Bashi HPP	Replacing major power equipment. Upgrading and reconstructing electrotechnical and hydromechanical equipment. Building a protective wall for the power transformers.	2014-2021	GE Renewable (Switzerland) – Aetan Hydro (France) Consortium. “Electric Power Plants” OJSC	Swiss Confederation
7.	Rehabilitating “Vostokelektro” OJSC	Introducing the ECMAS system. Upgrading 0.4 kV distribution electrical grids. Reconstructing two 35/10 kV substations. Replacing the outdated equipment.	2018-2021	“Vostokelektro” OJSC. The works to select a contractor are currently being carried out.	EBRD
8.	CASA-1000	Building 500 kV TL with the length of 477 km from Datka SS (Kyrgyzstan) to Hudjant SS (Tajikistan). 457 km is on the territory of the Kyrgyz Republic.	2016-2022	“Mitash” (Turkey), “NEG of Kyrgyzstan” OJSC	IDA (WB), EBRD
9.	Improving heat supply	Improving the effectiveness and the quality of the centralized heat supply’s state in Bishkek. Replacing and reconstructing the main heating system Vostok. Introducing effective and environmentally friendly heating stoves in the households.	2018-2022	Community Development and Investment Agency KR (ARIS), “Bishkekteploset” OJSC.	IDA (WB)
10.	Rehabilitating “Jalalabadelektro” OJSC	Introducing the ECMAS system. Upgrading the grids and the equipment.	2019-2022	A contractor is not identified so far, “Jalalabadelektro” OJSC	EBRD

No.	Projects	Required works	Implementation periods	Executor, responsible organization	Financing source (a donor)
11.	Rehabilitating the Toktogul HPP	<p>Phase 1: Carrying out the submarine studies of the hydraulic facilities. Replacing electrical equipment and 500 kV cable lines. Reconstructing 500 kV OSG.</p> <p>Phase 2: Rehabilitating valves and hydromechanical equipment. Replacing hydroelectric units No. 2 and No. 4.</p> <p>Phase 3: Replacing hydroelectric units No.1 and No. 3.</p>	2013-2023	<p>BSP Co., Ltd “AQUADRON” Inc (South Korea). JOC Technical Engineering (PRC). LS Cables&Systems LTD и SM Powertech Co LTD (South Korea), Genser Genel Muhendislik Taahkut vi Ticaret A.S. (Turkey). GE Hydro France (France) and GE Renewable (Switzerland). “Electric Power Plants” OJSC</p>	ADB, EBRD
12.	Commissioning the second hydropower unit in Kamarata HPP-2	<p>Carrying out construction and installation works to install and to commission the second hydropower unit. Repairing OSG and other elements of the HPP infrastructure ensuring effective and safe operation of the plant.</p>	2018-2023	<p>The procedures to make the project effective are being carried out. “Electric Power Plants” OJSC</p>	EBRD
13.	Building the Kamarata HHP-1	Building a hydropower plant with the installed capacity of 1,860 MW.	2015-2025	“Electric Power Plants” OJSC	An investor is not identified
14.	Building the Upper Naryn HPP cascade	<p>Building four HPPs:</p> <ul style="list-style-type: none"> - Akbulun HPP; - Naryn HPP-1; - Naryn HPP-2; - Naryn HPP-3 	2018-2027	“Electric Power Plants” OJSC	An investor is not identified

No.	Projects	Required works	Implementation periods	Executor, responsible organization	Financing source (a donor)
		with the total capacity of 240 MW.			
15.	Building minor HPPs in various regions: - Sokuluk HPP – 1.5 MW (Chui oblast); - Oi-Alma HPP – 7.7 MW (Osh oblast); - Orto-Tokoi HPP – 20 MW (Issyk-Kul oblast); - Tortkul HPP – 3 MW (Batken oblast)	These facilities have been selected under the project “Strategic planning of the small hydropower in the KR”, PFSs proposed to be implemented by the investors have been developed for them.	2020-2022	SCIESU	Investors are being looked for
16.	Reconstructing Uchkurgan HPP	Replacing major equipment. Upgrading and reconstructing electrotechnical and hydromechanical equipment.	2020-2026	“Electric Power Plants” OJSC	Searching for investors
17.	Building 220 kV TL Tamga-Karakol and Karakol SS	Building a 220 kV overhead transmission line with the length of 90 km and 220/110/35 kV substation.	2020-2022	“NEG of Kyrgyzstan” OJSC	A financing source is not identified
18.	Building 220 kV TL from Uchkun SS to TL Frunze-Kemin and SS.	Building 220 kV TL with the length of 22km and a relevant substation in Chui oblast.	2023-2025	“NEG of Kyrgyzstan” OJSC	A financing source is not identified
19.	Building new substations 110/35/6-10 kV in Bishkek and 110 kV TL.	Building: - Mederov SS; - Orto-Sai SS; - Kant-1 SS; - Asanbai-2 SS with relevant substations.	2019-2025	“NEG of Kyrgyzstan” OJSC	A financing source is not identified
20.	Building new substations in the regions.	- Building PMK SS 110/10 kV with 110 kV TL (Issyk-Kul oblast). - Building Ak-Talaa SS 110/35/20 kV and 110 kV TL (Naryn oblast)	2019-2022	“NEG of Kyrgyzstan” OJSC	Searching for investors

No.	Projects	Required works	Implementation periods	Executor, responsible organization	Financing source (a donor)
21.	Building 220-110 kV TL to generate the capacity from the Upper Naryn HPP cascade, constructing and reconstructing relevant substations.	Building 220 and 110 kV OHL in accordance with construction of the HPP cascade: Ak-Bulun HPP, HPP-1, HPP-2, HPP-3.	2025-2030	“Electric Power Plants” OJSC, “NEG of Kyrgyzstan” OJSC	
22.	Reconstructing, upgrading and introducing the innovative technologies in the distribution grids of “Severelektro” OJSC	Introducing “smart” meters – 80,000 pieces. Replacing wires with modern insulated wires (SIW) – 1,750 km. Reconstructing and upgrading the distribution electrical grids.	2019-2030	“Severelektro” OJSC	Own funds of “Severelektro” OJSC
23.	Introducing the innovative technologies, reconstructing and upgrading the electrical grids of “Oshelektro” OJSC	Introducing “smart” meters – 65,000 pieces. Replacing wires with modern insulated wires (SIW) – 225 km. Reconstructing and upgrading the distribution electrical grids.	2019-2030	“Oshelektro” OJSC	Own funds of “Oshelektro” OJSC
24.	Upgrading and reconstructing the electrical grids of “Vostokelektro” OJSC introducing the innovative technologies	Introducing “smart” meters – 34,000 pieces. Replacing wires with modern insulated wires (SIW) – 250 km. Reconstructing and upgrading the distribution electrical grids.	2019-2030	“Vostokelektro” OJSC	Own funds of “Vostokelektro” OJSC
25.	Reconstructing, upgrading, introducing the innovative technologies in “Jalalabadelektro” OJSC	Introducing “smart” meters – 22,500 pieces. Reconstructing and upgrading the distribution electrical grids and replacing wires with modern insulated wires (SIW).	2019-2030	“Jalalabadelektro” OJSC	Own funds of “Jalalabadelektro” OJSC

No.	Projects	Required works	Implementation periods	Executor, responsible organization	Financing source (a donor)
26.	Building three large HPP cascades at the Naryn River and the Sary-Jaz River is forecast in a long term: - Kazarman; - Susamyr-Kokormen; - Saryjaz	With a favorable financial and economic condition in the country, there is a real opportunity to build the following HPPs: - Kazarman HPP cascade at the Naryn River with the installed capacity of 1,160 MW and the electrical energy production of 4.6 billion kWh per year; - Susamyr-Kokormen HPP cascade - (confluence of the Susamyr and Kokormen Rivers that are the tributaries of the Naryn River) with the capacity of 1,305 MW and the electrical energy production of 3.32 billion kWh per year; - Saryjaz HPPs with the total capacity of 1,200 MW at the Sary-Jaz River in Issyk-Kul oblast	2030-2040	The Government of the Kyrgyz Republic	Investors' assistance is required

CONCLUSION

The following conclusions and recommendations can be made based on the fulfilled studies:

1. The Kyrgyz Republic has large reserves of the energy resources and is able to largely meet its needs. However, at present, the potential of the fuel and energy complex (FEC) is not being sufficiently realized, and the sector is facing certain financial and economic difficulties. The Republic's dependence on energy imports (coal, natural gas, oil products), which account for about 50% of the total energy consumption, negatively affects the state of FEC and other sectors of the economy.

2. The electrical energy sector that has a definite influence on the state and the development prospects of the national economy can be called the most successfully functioning out of all FEC sectors (electrical energy, coal-mining, oil and gas industry, gas, heat and fuel supply enterprises).

3. The electrical energy industry in Kyrgyzstan, possessing a system of production, transmission and distribution, generally satisfies the country's need for the electrical energy, while maintaining stable production volumes. Moreover, under the favorable conditions, some electrical energy can be exported to Kazakhstan, China, Tajikistan and Uzbekistan. However, there are situations when the electrical energy production decreases due to low water and insufficient filling of the Toktogul reservoir, and in the autumn-winter period consumption of electrical power and energy increases sharply. In such situations, it becomes necessary to import from the neighboring states. Based on this and taking into account the continuous growth of the demand for the electrical energy, in order to ensure reliable and sustainable power supply to all consumers, it is necessary to develop the generating capacities, i.e. to build new and to upgrade existing electric power plants. The recommendations for commissioning new generating capacities and upgrading outdated equipment of the electric power plants are given in Sections 4.1.1 and 5.

4. The population of the Kyrgyz Republic and all other consumers are almost completely provided with the electrical energy (about 99%). However, there are also remote rural settlements not connected to the electrical grids. The currently existing power supply system in the agricultural regions represents a structure that has been functioning without significant changes for decades. Insufficient development and reconstruction rates of the electrical energy distribution systems, actual wear of equipment, systematic overloads lead to numerous outages. Based on this, in order to provide all consumers with the electrical energy it is necessary to develop the electrical grids on a large scale, i.e. to reconstruct and to upgrade existing and to build new transmission lines in the realm of all regions in the Republic. The recommendations are given in Sections 4.1.1 and 5.

5. One of the main objectives of the Kyrgyz Government to ensure access to the required energy sources is heat supply. The heat supply in the Kyrgyz Republic is of great socio-economic importance, enhancement of its reliability, quality and efficiency is an urgent task. Sustainable and reliable provision of heat and thermal energy in the Republic can be achieved through development of the coal-mining industry and the gas supply. To develop the coal-mining industry, technical re-equipment and upgrade of the existing coal enterprises and development of the new deposits are required.

It is possible to ensure reliable fuel supply through gasification when implementing the "General Gas Supply and Gasification Scheme for the Kyrgyz Republic up to 2030" /18/, which will enable to solve the main problems of the gas supply to large cities and regions in the

country. The activities to ensure the reliability of the fuel supply through gasification and development of the coal-mining industry are given in Section 4.1.1.

6. The major portion of the electrical energy in Kyrgyzstan is generated from the hydropower resources. Due to the fact that the hydropower industry is a renewable energy source, we can assume that in Kyrgyzstan the share of RES in the total volume of the electrical energy generation is more than 90%. Compared with the highly developed countries that set a goal to achieve 30-40% of the electrical energy production from RES, Kyrgyzstan today is much ahead of the developed countries in terms of this index. Therefore, for such countries as Kyrgyzstan, Tajikistan, Albania, and others, where the hydropower industry is a dominant source of the electrical energy, there is no sense to increase the share of RES in the total energy production, since this index already reaches 90-100% in these countries.

In this regard, for an equivalent comparison of the RES's share in the total volume of the electrical energy generation in different countries, it is proposed to exclude the hydropower plants with the capacity of more than 40 MW when determining the share of RES. In this case, it would be more reasonable to use the term non-conventional or alternative energy sources (NCRES or ARES), which will include the energy of small streams (minor HPPs up to 40 MW), sun, wind, biomass, geothermal sources and other non-conventional alternative sources.

To clarify the foregoing, we will give an example: in Kyrgyzstan the share of the renewable energy sources taking into account large HPPs is more than 90%, and without taking them into account, this share barely reaches 1%. The question arises: "What to do in this case? Which index will be correct?"

Based on the above proposal, the term non-conventional renewable energy sources (NCRES) will be further used.

The Kyrgyz Republic has significant potential in non-conventional renewable energy sources, the use of which can increase the own fuel and energy resources and reduce dependence on imports. The main types of NCRES are the energy of small rivers and streams, solar energy, wind energy, geothermal water energy and biomass energy. According to the specialists' estimates, the available resources of the non-conventional renewable energy sources theoretically can cover more than 50% of the required energy in Kyrgyzstan. But at present their practical use is insignificant and they make up about 1% in the country's energy balance. Up to date, creation and implementation of NCRES remain less profitable compared to the traditional ones. Because of this, until now, there has been no practical demand for NCRES, primarily because the cost of the energy generated by the traditional methods is several times lower than the cost of the energy derived from the use of NCRES.

It shall be noted that while the use of NCRES in the industrialized countries is determined mainly by the environmental issues and the needs to search, first of all, additional energy resources, then for Kyrgyzstan the use of NCRES shall be considered as a solution, first of all, of the socio-economic problems of the rural population and the remote regions in the Republic.

Some organizations and enterprises in Kyrgyzstan have accumulated experience in development, design and industrial use of equipment operating on the renewable energy sources as well as there is some experience in conducting scientific works and studies. There are good results in development of new technical facilities operating on NCRES, and their practical application. Based on the conducted studies, various technical facilities and equipment have been developed and created, successfully passed industrial tests and have subsequently found practical application. But all this is not enough for a significant increase in the share of NCRES in the global energy balance.

The Government of the Republic takes definite efforts to solve the issues of NCRES development and introduction in the country, but not all efforts are sufficiently implemented.

7. Energy efficiency and energy saving in the Kyrgyz Republic are regulated by a number of legislative and regulatory documents, which are abundant (see Section 4.1.3). But,

unfortunately, many fundamental provisions from these documents have not been implemented or put into practice for various reasons. In this regard, the Republic has big problems with energy efficiency and energy saving. The energy intensity of the economy remains high. The main factors affecting this situation are the low level of technological modernization, financial difficulties with introduction of energy-saving technologies and production, the lack of strict limitation, control and accounting for the rational use of the energy carriers, low electricity tariffs, and most importantly, weak laws and programs governing energy saving and energy efficiency.

A proper attention is not paid to the energy saving and energy efficiency policy in the country, although there is considerable potential in Kyrgyzstan.

A serious problem is the lack of real mechanisms promoting the energy saving processes as well as the investment deficit and the poor support from the Government of the Kyrgyz Republic in implementation of the energy efficiency and energy saving policy. As a result, the energy expenditures of the Republic's economy remain at the high level.

Thus, today the state faces an urgent task to improve the energy efficiency and the rational use of the fuel and energy resources. The recommendations to solve these problems are given in Section 4.1.3.

8. A review of laws and other regulatory legal documents has showed that the Kyrgyz Republic is adequately provided with the legislative and regulatory legal framework for successful development of the fuel and energy complex. However, implementation of adopted laws, strategies, programs and other government documents is not sufficient and leaves much to be desired.

In general, the lack of political reforms in the energy sector and poor governance hinder effective implementation of adopted laws and strategies. The lack of progress in implementing tariff reforms aimed at achieving full cost recovery is particularly problematic. In this regard, the electrical energy companies have been experiencing a serious shortage of the funds for a long time. They are unable to make investments to maintain the existing assets in a proper condition. This factor along with a relatively uncontrolled increase in the electrical energy demand as well as consumer tariffs based on subsidies negatively affect the reliability of the system and the ability of the energy enterprises to connect new consumers. Inadequate cost recovery and cross-subsidization in various consumer groups and fuels prevent the flow of private investments into the energy system. For this reason, the country's desire to use its huge hydropower resources and to become a net exporter has not been realized.

The Government of the Republic has to pay serious attention to improvement and further development of the legislative and regulatory legal framework in the area of the energy industry.

9. At the present development stage of the economy and the energy industry in any country, it is impossible to imagine effective and reliable functioning of the energy industry in a country without international cooperation. This is especially acute for the countries of the Central Asian region.

The current situation dictates the need to create a balanced water and energy system of the Central Asian countries in the near future meeting the interests of all states in the region. The need for creation of a common electrical energy market in Central Asia becomes obvious. Therefore, since formation of the Eurasian Economic Union (EAEU) and Kyrgyzstan's entry into it in 2015, the works to create a common electrical energy market of the EAEU have started. The relevant documents have been developed and adopted (see Section 4.1.4). The EAEU Member States are currently working on implementation of the activities specified in these documents.

The key objective in creating a common energy market of the EAEU is to restore a full-fledged operating mode of the energy systems included in UES CA at the level of all Central Asian Republics. For this purpose, it is necessary to develop and to introduce effective

mechanisms for development of the integration processes, which should be reflected in the relevant draft interstate documents on the joint use of WER in the Naryn-Syrdarya River basin.

Kyrgyzstan's entry into the common energy market of the EAEU has many positive aspects, but at the same time, the external energy policy should account the national interests and strengthening of the KR's positions in creation of the regional energy market.

It is strategically important to strengthen Kyrgyzstan's positions in the regional market of the electrical energy and the capacity so that during 2020-2030 to maximize the export opportunities of the Republic's hydropower industry and to contribute to ensuring the energy security as new energy capacities are commissioned (see Sections 4.1.1). Thus, reaching agreements on the principles and the procedures of water distribution, the measures on the level of costs compensation for regulating water between the states as well as optimizing the use of the interstate water bodies is an urgent task today. In this regard, development of the interstate cooperation in the energy sector should become one of the main priorities of the external energy policy in Kyrgyzstan. However, it must be taken into account that implementation of the strategic objectives requires improving the negotiation processes for successful development and conclusion of multilateral and bilateral interstate agreements on WER use and energy resources trade.

10. The successful development of the energy industry is impossible without a relevant innovative, scientific and technological policy, which shall primarily envisage expansion of the infrastructure, upgrading of the outdated technologies and introduction of new modern equipment. Moreover, the basis of the policy should be the support of the Kyrgyz Government provided to the scientific studies in the area of the energy industry and introduction of the latest scientific and technological achievements in order to increase significantly the efficiency of the FEC sectors functioning. To achieve the main priorities in the state scientific, technological and innovative policy, it is necessary to identify and to provide an economic support to the promising areas of the scientific, technological and innovative activity through government targeted scientific, technological and various innovative programs and projects; to organize a system of state accounting and control over implementation of the results of research studies and experimental developments in the energy sector, to create an effective information infrastructure in the field of science, education and technology in the FEC sectors; to finance the science in the energy sector; to assist in development and introduction of new effective environmentally friendly technologies for generation, production, conversion, transportation and integrated use of the fuel and energy resources, with priority use of the own sources.

A prerequisite for implementation of an innovative, scientific and technological policy in the FEC sectors is to retain and to develop human resources in scientific and technological activities. Therefore, this issue should be constantly controlled by the Government.

11. Based on the results of the study, we can conclude that the Kyrgyz Republic has great potential for sustainable, effective development of the fuel and energy sector.

However, for further successful development of the Republic's energy sector, the Government needs to make more efforts to implement its energy laws and other program documents, taking into account their update and improvement.

And on top of all, if all recommendations and proposals of this study are implemented, Kyrgyzstan may well implement the sustainable energy plans until 2030 to achieve "Goal 7. Providing access to affordable, reliable, sustainable and modern energy sources for all" announced in the basic document of the UN General Assembly "Transforming our world: the 2030 Agenda for Sustainable Development" adopted on September 25, 2015 by the seventeenth session.



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LIST OF ACRONYMS

ADB – Asian Development Bank
JSC – Joint-stock company
ECMAS – Electricity commercial metering automated system
WB – World Bank
GDP – Gross domestic product
RES – Renewable energy sources
OHL – Overhead lines
HI – Higher institution
WER – Water and energy resources
WPP – Wind power plant
SCIESU – State Committee of Industry, Energy and Subsoil Use
CLM – Combustible and lubricating materials
HPP – Hydropower plant
EAEU – Eurasian Economic Union
EBRD – European Bank for Reconstruction and Development
ECE – Economic Commission for Europe
CJSC – Closed joint-stock company
AITI – Automation and Information Technology Institute
IDB – Islamic Development Bank
KR – Kyrgyz Republic
PRC – Peoples Republic of China
TL – Transmission line
IDA – International development association
MEPS – Minimal energy performance standards
NAS – National Academy of Sciences
NCRES – Non-conventional and renewable energy sources
ORP – Oil refinery plant
NEP – National Energy Program
NEG – National Electrical Grid
NEPPK – National Electric Power Plants of Kyrgyzstan
NEHC – National energy holding company
OJSC – Open joint-stock company
AWP – Autumn-winter period
NGO – Non-governmental organization
UN – United Nations
LLC – Limited Liability Company
PF – Public fund
UES – Unified energy system
UNDP – United Nations Development Program
SS – substation
RF – Russian Federation
DEC – Distribution Energy Company
CIS – Commonwealth of Independent States
USSR – Union of Soviet Socialist Republics
USA – United States of America
SPP – Solar power plant
FEC – Fuel and energy complex
PFS – Project feasibility study
FER – Fuel and energy resources
TPP – Thermal power plant

CPP – Co-generation power plant
CA – Central Asia
CAR – Central Asian Region
SDG – Sustainable development goals
SCO – Shanghai Cooperation Organization
ESCO – Energy service companies
EES – Electrical energy system