БЕЗОПАСНОСТЬ В СТРАНАХ АЗИАТСКОГО РЕГИОНА

SECURITY IN ASIAN REGION

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THE RENEWABLE ENERGY IN THE REGIONAL DEVELOPMENT OF CENTRAL ASIA

S. Nurdavletova[1], A. Akatayeva[2]

[1]L.N. Gumilev Eurasian National University, Republic of Kazakhstan, Astana, e-mail: saniyanm@mail.ru
[2]Satbayev Kazakh National Research University, Republic of Kazakhstan, Almaty

By the end of the previous century the struggle for natural energy resources had significantly increased, the income gap between rich and poor had become wider, sharply rose the scales of global poverty with worsening tendency of population growth. Consequently, the world has faced the problem of necessity to form a new sample of human development, the model of sustainable development, which would find solutions to growing socio-political, economic and ecological crisis. At the same time, talking about development it is impossible to ignore the means of its achievement. One of the means is energy as the main generator of development. Central Asia is a region that from the geopolitical vision occupies a strategic position located between large economies (Russia and China), Iran with its important location on the Persian Gulf, and Afghanistan as a hot point in international relations. In addition, the region has been always considered as a connecting bridge between Asia and Europe. Moreover, the region possesses a significant amount of natural resources, including oil and gas as main energy sources that are also

exported. All these facts make Central Asia in high concern of those states whose interests cross in the borders of the region. That is why stability and development of Central Asian countries are important not only for the region itself, but for international sustainable development as well. In order to maintain the energy security of the region, it is necessary to develop alternative ways in energy supply.

Keywords: *Central Asia, energy security, renewable energy sources, Kazakhstan, EXPO 2017, sustainable development.*

ВОЗОБНОВЛЯЕМАЯ ЭНЕРГИЯ В РЕГИОНАЛЬНОМ РАЗВИТИИ ЦЕНТРАЛЬНОЙ АЗИИ

С. Нурдавлетова[1], А. Акатаева[2]

[1]Евразийский национальный университет им. Л.Н. Гумилева Казахстан, Астана, e-mail: saniyanm@mail.ru
[2]Казахский национальный исследовательский университет им. Сатбаева, Казахстан, Алматы

К концу прошлого века борьба за природные энергетические ресурсы значительно возросла, разрыв в доходах между богатыми и бедными стал шире, резко увеличились масштабы глобальной бедности с ухудшением тенденции роста населения. Следовательно, мир столкнулся с проблемой необходимости формирования новой выборки человеческого развития, модели устойчивого развития, которая найдет решение растущего социально-политического, экономического и экологического кризиса. В то же время, говоря о развитии, невозможно игнорировать средства его достижения. Одним из средств является энергия как основной генератор развития. Центральная Азия - это регион, который геополитически занимает стратегическое положение, расположенное между крупными экономиками (Россия и Китай), Иран с его важным местоположением в Персидском заливе и Афганистан как горячая точка в международных отношениях. Кроме того, регион всегда считался связующим мостом между Азией и Европой. Регион обладает значительным количеством природных ресурсов, включая нефть и газ в качестве основных источников энергии, которые также экспортируются. Все эти факты заставляют Центральную Азию в большой степени заботиться о тех государствах, интересы которых пересекаются в границах региона. Вот почему стабильность и развитие стран Центральной Азии важны не только для самого региона, но и для международного устойчивого развития. Для поддержания энергетической безопасности региона необходимо разработать альтернативные пути энергоснабжения.

Ключевые слова: *Центральная Азия, энергетическая безопасность, возобновляемые источники энергии, Казахстан, ЭКСПО-2017, устойчивое развитие.*

Nowadays an important peculiarity of world development rests on complicated questions of energy security and energy efficiency. Energy determines development, level of prosperity and life conditions in all aspects of human activity providing electricity, heat, and transport for most of the needs. However, resources for energy that have been conventionally used such as oil, natural gas, and coal are limited and consuming them in a "business as usual" scenario can lead to their end even before the year 2100 (Gorodov, 2009: 17). Moreover, extraction, production and utilization of these kinds of energy resources are main contributors to environmental degradation and climate change. Resource scarcity and uneven distribution among the countries causes concerns of its future rational consumption and creation ways to replace energy dependence on natural fossil fuels. In this regard, significant attention is paid on renewable energy sources as sun, wind, water, warmth of earth bowels, and biomass. Renewable energy sources can solve not only ecological problems, but social, political, and economic as well. Furthermore, RES directly or indirectly influence on the achievement of other sustainable development goals.

The widespread development and transition to renewable energy sources in many developed countries represent a good example for the Central Asian countries. The implementation of RES in the region is especially relevant since the energy security constitutes one of the crucial aspects in international relations of Central Asian states. In a whole the region has significant reserves of natural fossil fuel resources, however their unequal distribution among the countries and inefficient energy management create threats to development of the whole Central Asia. Therefore, renewable energy sources aim to play a contributive role in reducing electricity deficit, maintaining energy security, increasing independence on finite natural resources, improving social conditions and ecological situations.

The relevance of the research topic is especially underlined in the frames of upcoming exhibition EXPO-2017 the slogan of which is the Future Energy. This theme highlights the importance of global tendency on transition to more ecological clean, safe and sustainable energy with realization of world targets of sustainable development goals.

Kazakhstan, as the biggest Central Asian country, also plays a big role in promotion of the development of ecological clean, safe and sustainable energy sphere making accent on the renewables. However, RE in the country had not been so well developed, since there was no necessity because of the abundant reserves of mineral resources. The biggest part of energy production came from fossil fuels and economic development was in priority, i.e. it was above ecological and social factors. Nevertheless, recent global trends and promotion of RE effectiveness and transition towards its wide implementation coincided with Kazakhstan's devotions for sustainable development.

According to the law of the Republic of Kazakhstan "On support for using renewable energy sources" from July 4, 2009, the definition for RES is following: "it is the energy sources that are constantly renewed due to natural processes and they include next types: solar radiation energy, wind power, hydrodynamic water energy, geothermal energy: ground warmth, ground waters, rivers, reservoirs, as well as anthropogenic sources of primary energy resources: biomass, biogas and other fuel from organic wastes used for electric and/or thermal energy" (O podderzhke ispolzovaniya...).

Energy potential from the RES is very high in Kazakhstan; however, the share in total energy consumption is miserably small. According to the BP Statistical Review of World Energy from June 2016, renewable energy sources in Kazakhstan shared less than 0.05% from world's total in 2015 (BP Statistical Review...). Nevertheless, the country has wide prospective to develop the sector of renewable energy, because it has necessary solar, hydro, wind and biomass resources. To take development of RE seriously is significant because energy supply on the territory of Kazakhstan is distributed unevenly. Some regions lack proper infrastructure and a lot of energy losses occur while transporting it to far located households, therefore even electricity provision is complicated by this fact. The western region of Kazakhstan does not have connection to the common energy system of the republic and is supplied by the electric energy from the common energy system of Russia. In energy economy of Kazakhstan there is a high level of deterioration of equipment that reaches 70% (Nadirov, Nekrasov, Kenzhebekova, 2014). With the utilization of renewable energy sources, it will be possible to provide with power remote and hard-achieving regions thus reducing energy deficit.

Kazakhstan has favorable climate conditions for developing and consumption solar energy on the two thirds of the whole territory (Kusaynov et al., 2004). In the southern parts of the country, solar radiation reaches 2-3 thousand hours per year and its power on the horizontal surface is equivalent 1280-1870 KWh on a square meter per year. This makes the introduction of new technologies possible in all regions. Developing such energy is not just ecological important, but also it contains economic benefits. By analysis of local specialists, using solar energy for water heating on hot-water supply needs it is possible to receive about 13 mln. Gkal of warmth. With such results, the country could save more than 1 mln. of fuel in oil equivalent.

On the territory of Kazakhstan there are huge resources of wind power and it is considered to be the most favorable and energy effective sources of RES. If consuming only 2 percent of this energy it will be equal about 102 billion KWh per year. In some regions winds blow with speed estimated at 27-36 meters per second. The most important wind resources are located in the region of the Jungar Gates the power of which can reach 17000 kWh on a square meter. Other prospective regions are Akmola region, the Caspian Sea coast, Zhambyl region, and others. Shelek corridor located between mountain Zaili Alatau and Zhetysu ranges also has a good wind potential with the average annual speed of 7.8 m/s on the 50 m height. The wind power density is about 510 W per each square meter that makes possible to generate approximately 3200 kWh of electricity (Doroshin, 2006).

Power of existing hydroelectric stations is about 2100 megawatt when annual energy production is 8.32 billion kWh. The country has big reserves of small rivers energy sources that content 2 billion kWh. The total potential of hydro resources can be 170 billion kWh, of which 23.5 billion kWh might be effectively used in economy. Main water resources are located in Eastern and South-Eastern Kazakhstan. The Southern region the total potential of this kind of energy sources is equaled 10 billion kWh. In the northern and central parts of the republic there are not so many hydro resources and they share only 1.7% of all theoretical hydro potential.

The production of electric energy from the RES in Kazakhstan increased on 22% in 2015 in comparison with the year before, and in 2016 the share of renewable energy resources approached 1% in total volume of electric generation. In the beginning of 2016 year there were 48 enterprises of the RES with sum capacity 251.55 MW. Along this, there were completed 14 projects on renewable energy implementation with total capacity of 119,9 MW and by 2015 there were 26 realized projects. Among them are solar power plant Burnoye which is set up in the Zhambyl region and its capacity reached 50 MW, Yereimentau wind power plant (45MW) in the Akmola region, Upper Baskan hydropower plant in the Almaty region with a capacity of 4.2 MW, Ryszhan hydropower plant in the South Kazakhstan region with a capacity of 2 MW, as well as expansion of wind power station Vista International in Zhambyl region until 21 MW (increase on 12 MW) (Information-Analytical Magazine Kazenergy, 2016).

Though not as much developed, the geothermal resources also have their place in RE development on the territory of Kazakhstan. The most perspective reserves are concentrated in the Almaty, Jarkent, and Arys artesian basins. Their capacity is not enough for commercial and wide economic production; however, it is used in municipal services and rural economy as heating supply. As Kazakhstan is a big producer of cereal crops, it is also possible to get energy for electricity and heating from burning stems biomass of which reaches more than 3 million tons annually (Polozhenie del... , 2008).

Kazakhstan tries making alternative energy sources more widely used in the country that is determined by green development and international experience. According to President Nazarbayev's ambitious 2050 Strategy, Kazakhstan will use renewable and alternative energy sources to create 50% of the electric capacity generated in Kazakhstan. The country plays an important role in promoting sustainable development ideas. There are worked out the National Conception on transition to Green economy and correlated initiative of "green bridge" which is aimed unite countries in this direction; "Global energy-ecological strategy of sustainable development in XXI", national programs directed on ensuring sustainable development in key sectors, such as: energy, water, municipal and agriculture, industry, and biodiversity. These initiatives were proposed on the summit "Rio +20" in 2012. A chosen theme on EXPO-2017 – Energy of Future – has a global significance. By the Kazakhstan's Strategic Development Plan until 2020 year the country is to achieve the part of renewable energy sources up to 3% (Strategic Development Plan...). In 2015, at the UN General Assembly's anniversary session, Kazakhstan declared an initiative to create an International centre to develop "green" technologies and investments.

In order to better develop the RES, some changes to the Law on renewable energy sources were made in 2013. The new legal act is directed for support of investors as well as consumers. In particular, introduction of fixed tariffs allows guaranteeing investors for the reimbursements; this makes investments attraction more favorable. By the law, the electric power from the RES is to be distributed among all consumers through specialized centre of renewable energy support. Another amendment made in the new document is provision of transparent scheme for 50% compensation by the government for the expenditures of an individual consumer who doesn't have connection to the electric grids, thus allowing to buy RES installations by half price and stimulating development of this kind of energy.

From the February 24th, 2017 there was admitted a Plan for placing facilities for the use of renewable energy resources throughout the territory of Kazakhstan with the southern part leading in amount of RES installations. According to this plan, there are 69 installations of solar, wind and hydro electric plants. The majority of the plants are hydro energy stations, but the summary installed power of established solar plants is the biggest equaling 814.9 MW, whereas this of hydroelectric power station equals 359.9 MW. The total installed capacity of all the RES using objects is about 1910 MW (Prikaz Ministerstva Energetiki Respubliki Kazahstan…). The fact that the southern region of the republic has majority of such installations is explained by energy insufficiency in power and electricity. This deficit was replaced by transporting electric energy from the northern regions and by importing electricity from the Central Asian republics. Now, with the new objects based on RES, mainly on solar and hydropowers, the Southern Kazakhstan can be provided with 1296.7 MW thus absolutely covering the power deficit in the region. According to the action plan on alternative and renewable energy development in Kazakhstan for 2013-2020 years, it is planned to exploit 106 objects of RES with total capacity of 3054.55 MW (Postanovlenie Pravitelstva Respubliki Kazahstan...).

Overall, the power generation from the RES in Kazakhstan is necessary more in environmental perspective rather than because of energy scarcity. The country is a member of all UN conventions on environment. Thus, in the end of 2016 Kazakhstan ratified the international Agreement on Climate Change that was figured out during the Conference on Climate in Paris, 2015. According to the statements identified in the agreement, Kazakhstan is obliged to shorten on 15% greenhouse gas emissions until 2030 that will be possible with smart and consecutive regulation measures. For the Republic of Kazakhstan the RE development is also necessary to solve the problem of electricity provision for regions where electric grids are hard achievable.

In Kyrgyz Republic the energy sector plays an important part in economy development of the country. Since the republic doesn't possess fossil fuels for energy generation, the main sources for energy supply are waters. According to the Kyrgyz Ministry of Energy, annual energy production that flows from hydropowers is estimated at about 94%. Electric energy system of the republic is not able to provide sustainable energy supply throughout the year. Most of the energy consumption is during the winter periods. In the warm seasons, the overall energy consumption is about 23 million KWh per day, whereas during the heating periods it reaches more than 70 million KWh. As a result, power generators and transmitters do not work in full strength in summer times and are loaded only by two thirds of their capacities. It creates obstacles towards investments attraction in energy sector, because it is not profitable for investors to build electric stations that will work just several months per year. In this regard, investments in RE would create more favorable conditions in energy efficiency of Kyrgyzstan. Though the country has been used hydro resources for satisfaction its need in energy, it is not enough to rely only on this conventional way of waterpower usage. If the channel inflow to the rivers is small and insufficient, then it will affect the power capacity of existing hydro power plants and consequently the total amount of energy generation would worsen electricity deficit. The solution of many energy problems in the country can be found in renewable energy sector development.

Nowadays, the total potential of RES in Kyrgyzstan is estimated at 840 million tones of conditional fuel. Notwithstanding, the real RES consumption is only 0.17% of this potential. It is very low, taking into account how many benefits this sector can bring into development of the country. Renewable energy sources can contribute into reliable and sustainable energy supply for remote rural areas and thus correct poverty problems.

There are favorable conditions to develop renewable energy in the country because all the resources are available for this. But the most effective, according to head of coordination council of Climate network of the Kyrgyzstan Nurzat Abdyrasulova, the most prospective are small hydro and solar energies (URL: http://rus.azattyk.org/a/28090103.html). The hydro energy potential of 252 big and small rivers is estimated at more than 140 billion KWh. Despite the fact that Kyrgyzstan generates 93% of electric power by renewable hydro energy resources, the way of its production and consumption is unsustainable. A strict diversification of energy supply is needed in the country.

The renewable energy sources usage in industrialized countries is defined by questions and problems mostly of environment and search for additional energy resources, whereas for Kyrgyzstan RES development and utilization is considered as a solution, first of all, the social and economic problems of population, especially rural. Specialists note, that wind energy potential exists in Kyrgyzstan, but in order to effectively develop this sphere the wind speed should be more than 3.5 m/s. However, in the republic those territories which respond to such conditions are located in hard reaching places. Construction and connection to electric cables therefore face obstacles due to the geographical conditions. Therefore, the renewable energy installations may be a solution for wider access to electricity.

The president of public fund “Fluid” Alexey Vedenev is convinced that biogas is another potential clean energy source to use in Kyrgyzstan. According to him, there is 7.5 mln. dung per year that can be potentially gathered in the country. If to convert this mass in the biogas installations, it is possible to get 200 million cubic meters of biogas. It is more than one half of what the country receives from Uzbekistan. If take Bishkek only, sixty thousand of food wastes can be gathered there and it might bring about ten million cubic meters of biogas or circa 20 million kW/h of electricity per year.

The main problems of RES projects realization are weak legal base and low costs on electricity. Analysis of the current situation in energy sphere shows that since the introduction of the national Law of the KR on Renewable Sources of Energy in 2008, little significant changes have been made to promote wide implementation, except some small HPPs and solar installations which are used for private needs. The legal regulations lack methodology of tariffs calculation, of mechanisms for setting up and selling electricity.

On the Paris Conference on Climate in the end of November 2015, the Kyrgyz president Atambayev noted that by 2025 the total square of glaciers in the republic can be shortened on average 30-40% thus following the shortage of water capacity of Central Asian rivers on 25-35%. According to prognoses, by 2100 the glaciers of Kyrgyzstan may disappear at all. It is a bad affective situation especially for Kyrgyz economy and future because more than 90% energy in the country is produced from hydro resources. In this regard, in order to coincide with the models of sustainable development, there should be

diversification of resources for energy production. With this end, the solar energy utilization is among the ways of this problem solution (URL: http://www.president.kg/ru/news/vystuplenija_obraschenija/7001_prezident_almazbek_atambaev_vyistupil_na_tseremonii_otkryitiya_21-). There are 260 sunny days in Kyrgyz Republic, making it beneficial to develop solar energy sphere. In the country there are 2800 hours of sun radiation per year Potential RE resources in solar thermal energy is 490 million kW/h and electricity from solar power is 22.5 million kW/h. The geographical conditions of Kyrgyzstan make supply of electricity harder because majority of the households are located in mountainous regions where the grids are hard achievable. Thus it is reasonable and favorable to set up local separate systems of the RES that don't need to be connected to the existing electric nets.

In Tajikistan energy sector is also one of the main fields of economy, however the energy deficit concludes about 5 billion KWh per year. There is about 70% of population living in rural area with access only to 8.58% of electricity (URL: http://hdr.undp.org/en/countries/profiles/TJK); in particular, there are a million of people who suffer from electric energy deficit. Along this, due to the lack of own natural mineral resources, the state has to import fuels. And these trends take place even when the country has big reserves of RES. By the Law on Use of Renewable Energy Sources of the Republic of Tajikistan from 2010 (nowadays out of force), the priority objects for RES employment include such regions where central electricity nets are not installed due to economic reasons because of the low population density; those zones where power deficit or improper conditions of energy networks cause frequent energy cut that lead to significant economic damages and negative social consequences; the inhabited localities and mass recreational places where industrial and urban pollution and wastes create hazardous ecological problems; inhabited localities, cottages and places of contemporary residence where heating, electricity and hot water provision are problem parts (Ob ispolzovanii vozobnovlyaemyih istochnikov energii...). Because of the limited provision of energy, especially in autumn and winter periods, there are hard damages to agriculture where wastes of crops achieve about one thirds and many factories have to stop their productions. This leads to significant economic wastes and food insecurity as well.

Main and perspective energy source for Tajikistan is hydro energy that is the cheapest in relation of production. However, other natural clean resources like sun, biomass, wind, and geothermal energy can supply almost all energy needs of the country. Evaluating the volume of hydropower resources Tajikistan is the leader among the Central Asian states. It is potentially possible to generate more than 527 billion KWh annually. However, consumption of the economic hydro energy potential is stated at less than 4 per cent. Especially favorable conditions exist in mountainous regions that occupy about 93% of the entire territory. The estimated potential for small hydro energy in Tajikistan is more than 18 billion KWh per year. Good conditions for small HPP development where over a hundred small and mini installations of hydropower generation can be set up there. As experts note, some remote regions might satisfy their needs in energy on 50-70% by using small rivers' power. To comprehensively develop small and mini HPPs the country needs modern proper technologies, improvement of industrial base, and increase the know-how of specialists.

In 2007, the government adopted the Targeted Comprehensive Program on the use of renewable energy sources, such as the energy of small rivers, sun, wind, biomass, energy of underground sources for 2007-2015. Program provided for the implementation a number of measures to establish a production base and infrastructure for the widespread use of RES.

A potential source of energy in Tajikistan may be agricultural waste - biogas from manure and bird droppings. At present, several experimental generators working on biogas are in operation. In addition, it is possible to generate energy from household waste. The climate of Tajikistan is favorable for the use of solar energy. There are 280-330 sunny days per year in the country. During the year, the intensity of solar radiation varies from 280 to 925 MJ per square meter in the foothills and from 360 to 1.120 MJ per square meter in the highlands. The longest radiation is noticed in the southern parts and in Eastern Pamir where are the best conditions for developing and using solar power stations. Solar energy can potentially provide 10-20% of the energy demand. Intensive solar radiation reaches a thousand watt per square meter and the annual radiation is more than 2000 KW on each square meter. It is two times more than in European continent where this field is progressively used. However, in Tajikistan this potential is almost not used, except for the heating of water. Experts evaluate this potential to be used for electricity production through photovoltaic, as well as for thermal energy through the helio-collectors. Because of the developed hydro energy the solar photovoltaic is not used actively since the price is very high and there are difficulties in its exploitation.

Sources of geothermal energy in Tajikistan are not well explored. There is no data on the use of thermal waters, although it is known that thermal waters are used in some parts of the country, for example, in Khodja-Obigarm.

Wind energy potential in Tajikistan is low, but in a number of regions its use could become an additional source of energy (in addition to hydropower). The strongest winds are observed in the mountains (on Fedchenko Glacier and Anzob Pass), where the relief affects the convergence of air masses (for example, in Khujand and Faizabad). The average annual wind speed in these areas reaches approximately 5-6 meters per second. The average annual wind speed of 3-4 m/sec is observed on open plains and in valleys. The potential of wind power in Tajikistan is still almost not used. There are no active wind farms in the country. It can be used just locally in some parts for self provision.

In agricultural regions it is possible to use biomass for thermal and electric power production. According to experts, biomass utilization has a practical meaning in households of 75% of the country's population. Big cattle farms and in agriculture it is profitable to use biogas installations. Thus there will be dual benefit: energy supply and wastes utilization. In the country there are some biogas generators that are used for local needs (URL: http://www.undp.tj/files/reports/SE4ALL_TAJ_Rapid_Assessment_Final_Russian.pdf).

Concerning Uzbekistan, a country with the highest population in Central Asia and relatively developed, has good possibilities to develop energy sector from RES. Despite significant reserves of natural fossil fuels and their stable supplies, some problems with aged infrastructure and electricity exist. For example, as it is common within the whole Central Asian region, rural areas lack electricity provision because of the absence of elec-

tric grids. Taking into account the high advancing rates of development of the industrial sector, the country's electricity needs in 2030 will increase by about 2 times against the 2013 year and will amount to over 105 billion kWh. The gross potential of renewables in the country is estimated at 51 billion tons of fuel equivalent; even though the technical potential is many times less than gross potential being around 182.3 million that exceeds annual volume of conventional energy resources in three times. The most profitable and reasonable spheres to develop in the RE sector are hydropower and solar energy. Uzbekistan takes efforts to solve electricity deficit problems by developing own hydro energy potential. A field of utilization the water resources for energy in Uzbekistan has been explored quite well in comparison with the other sources. The gross potential of the big and small rivers is counted at 9.2 million tons of oil equivalent, with technical prospective of 2.32 million tons of oil equivalent. The government adopted a new program for hydro power sector development on the term of 2016-2020. In the frames of this program about 890 million USD dollars of state money and loans will be directed to modernization of hydro power stations to upgrade the power capacity until 1384.99 in total and for the construction of new plants in total capacity of 94.4 MW (O programme razvitiya gidroenergetiki...).

Sun potential in Uzbekistan has prior perspectives because the gross potential of solar power is approximately 50900 million tons of oil equivalent, which is 99.7% of all explored RES in the country. The sun period on the territory of Uzbekistan reaches 2000 hours in the north and about 3000 hours in the south, this is equal to solar radiation of 4800 mega joules per square meter and 6500 mega joules per square meter, respectively. This sphere of RE has been promoted for a long time, most actively with foundation of a scientific experimental centre "Physics-Sun" in 1986 on the base of Physical Technical Institute. Existence of such scientific basis means that the country prepares good and qualified specialists in the field. The support for RE development also runs from the government of Uzbekistan.

Uzbekistan has some experience in wind power plants utilization, though in much lesser scales as in comparison with the solar plants installations. It is dependent on seasons during the year and wind unevenly blows on the territory, thus in industrial and commerce aims it is unprofitable. An average power of wind blow is about 84 watt per square meter. According to the UNESCO's report, for whole wind power technical potential utilization it is necessary to set up over 70 thousand wind power plants with average capacity 60-250 KW. But wind energy has been developing locally and projects are being implemented in this sphere. For example, in 2013, there was an experimental project of the wind power plant with power capacity of 750 kW with energy production of 1.3 million kWh annually. The most favorable regions are north-western part, in particular Usturt plateau, and Bukhara, Navoi, Kashkadarya and Tashkent regions. Improvement in knowledge basis and technological development allow making progress in the field of RES. Wind energy development is favorable for rural economy in some remote regions. Many farmers and inhabitants of such villages can benefit from the plants installations because additional possibilities for energy supply and therefore better irrigation positively influence on their prosperity.

In terms of absolute value of all types of renewable energy, Uzbekistan has the largest integral energy potential in the form of heat from dry rocks (petrothermal resourc-

es) and large basins with hydrothermal waters. The most promising for energy use are petrothermal resources - huge massifs of granitoids lying at a depth of 4-6 km, heated from 70 to 3000C in the zones of the Amudarya geological basin, the Southern Aral Sea, the Kyzylkum Desert, the Chust-Adrasman petrothermal anomaly in the Fergana Valley. By today, this sphere has not been developing, however it is counted that gross potential of petrothermal resources reached 6.7 trillion tons of oil equivalent. It should be noted an important advantage of using geothermal energy, which because of providing a stable generation and supply of the consumer with thermal or electric energy in comparison with solar, wind and even water energies with because they are dependent on significant variability during the seasons of the year and day.

There are several clauses in the Program of measures to reduce energy intensity, the introduction of energy-saving technologies in the economic and social sectors for 2015-2019, that was decreed by the president Islam Karimov on May 5, 2015. In the frames of this program a special commission was created to realize measures for decreasing power-consuming when producing goods, as well as measures to foster development and application in the social and economic spheres the renewable energy sources, including tested technologies of solar energy (Ob utverzhdenii polozheniya o Respublikanskoy Komissii..., tasks II (4)]). The decree on Measures for further development of alternative energy sources from 2013 has not been transformed into a law up until now. Though there are defined privileges concerning organizations that produce energy from the RES, as well as organizations producing installations for energy generation from the renewables according to the above mentioned presidential decree from the 5th of May 2015 (O merah po dalneyshemu razvitiyu...). However, these preferences and tax-free measures are applied for RE generating organizations that produce energy with nominal power of 0.1 MW and over. Since the sphere of RES utilization is not as much developed and technologies are still in construction, this threshold of power is relatively high, thus making fewer organizations able to relate to the privileges.

Turkmenistan is too dependent on its gas export that creates energy insecurity for the country. By now, when the country is confident in the mineral resources reserves, the development of alternative energy sources doesn't present serious concerns. However, Turkmenistan as a member of different international conventions on climate and environment issues, implements its obligations in the form of own laws and decrees. Though there are no separate laws about renewable energy sources, some provisions of RES utilization exist in the frames of the Law of Turkmenistan on Electrical Energy from August 16, 2014 (Zakon Turkmenistana ob elektroenergetike..., article 10 (4)). The country stresses its accent more on environmental problems, climate change in particular. Thus, there is a National Strategy on Climate Change adopted in 2012; an initiative proclaimed by Turkmen delegation during the 66th GA session to create a Regional Centre on Climate Change problems solution.

Unfortunately, to develop renewable energy sector the country still lacks proper legal base, though Turkmenistan has favorable conditions to use RES in its energy sector. As the most favorable alternative energy resources in Turkmenistan are seen the energy of sun and wind. The wind power generation is potentially possible to develop in mainly

western and north-western regions, whereas solar energy is accessible on the entire territory of the country. About 4/5 of the territory consists of deserts and mountains where live about 10% of population. For every small rural household it is unreasonable to provide them with separate gas pipelines or electricity grids. For this reason, the inhabitants of those regions transport fuels for the diesel generation installations that supply them with energy. However, this kind of energy provision is not sustainable since transportation depends on weather and terrain conditions. Moreover, it causes additional gas emissions while delivering fuels through the automobile transport.

The natural and climatic conditions of Turkmenistan are exceptionally favorable for the wide use of alternative energy sources, such as solar, wind, geothermal and biomass energy, in the production of electricity, biofuels, heat and cold. Since Turkmenistan doesn't possess strategic water reserves (however, water resources exist in the depth and are considered to be significant), but has a lot of sun and wind resources, it is profitable to develop solar and wind energy generation. According to Dr. Akhmet Pendzhiev, the energy potential of sun over the territory of Turkmenistan during the year is estimated at 1.4*109 tons of conditional fuel. With the existing efficiency of solar photovoltaic cells and the average annual intensity of solar radiation, which is 600 watts per square meter, all the electricity produced by Turkmenistan's power plants during the year which is about 14 billion kWh can be obtained from one solar photovoltaic station with active area of several dozen square kilometers. With effective use of this energy, it is possible to provide up to 25% of heat consumption in heating systems, up to 50% in hot water systems and up to 75% in air conditioning systems; it allows reducing consumption of organic fuel and save thousand tons of fuel and energy resources or 52.6% (Pendzhiev, 2015).

The second most prospective RES in Turkmenistan is wind power; however this field is not explored in sufficient extent. Favorable regions for wind energy generation are Balkan oblast near the Caspian Sea. The gross potential of energy from wind resources is evaluated at 640*109 kWh per year. Biomass energy, as other RES, doesn't have wide usage in the country, despite its potential. Pendzhiev suggests to use animals' dung to convert it to energy and receive about 50-60 million cubic meters of methane annually. In Turkmenistan, there are about 1 million cubic meters of livestock wastes with approximately 250 thousand tons of organic components (Pendzhiev, Mamedsahatov, 2007). Unfortunately, the weak technological development doesn't allow realize this potential. Every renewable energy source is used only locally for private needs.

However, the Turkmen government pays special attention to its development to improve ecological situation, lessen gas emissions, diversify country's economy and increase energy efficiency. Thus, such legal base was created. There is a state Concept on development of electric energy sphere of Turkmenistan on 2013-2020 years. It includes investigation for possibilities to produce electric energy on the base of renewable energy sources use. To reduce the pressure on the climate, the National Strategy on Climate Change determines the direction of the policy of Turkmenistan on a gradual transition to an economy with the least greenhouse gas emissions without compromising the pace of socio-economic development. Energy efficiency and energy saving, rational use of natural gas and petroleum products and increased use of alternative energy sources are the main priorities

of the policy to limit greenhouse gas emissions. In order to increase the role of renewable energy sources in the country's energy balance and development of alternative energy, the following measures should be implemented: further support for research and development of renewable and alternative energy technologies, as well as their adaptation to the climatic conditions of Turkmenistan; in the short term, the introduction of small and medium-sized installations of renewable and alternative energy in remote and sparsely populated areas; in the medium- and long-term perspective, the introduction of own production capacities and the increase in the share of renewable energy in the country's energy balance; creation of economic incentives for the use of alternative energy sources (Natsionalnaya strategiya Turkmenistana po izmeneniyu klimata...).

Combining the separate analysis of the countries in Central Asia, the common picture is looked as following. Priority direction of RES in Kazakhstan relies on wind energy; small hydro power plants and biomass energy is favorable for Kyrgyzstan; for Turkmenistan the main accent is made for solar power plants; Uzbekistan's most beneficial field in RE as well as in Tajikistan are solar and small water power plants energy. From the economic point of view, if taking into account short-term prospective, the RE will not be as much favorable for countries whose economy is based on natural mineral resources. It is explained by lower prices for conventional energy production rather than development and exploitation of new technologies for RE. Nevertheless, the renewable energy sources have big perspectives taking into account such possible scenarios as lack of fossil fuels, over-pollution, climate changes, and other environmental problems that directly affect social, ecological and economic spheres. Having considered potential and possibilities of renewable energy utilization in Central Asia, the following conclusions can be identified. The most rapid development in the field of renewable energy is noticed in Kazakhstan and the least developed sphere of RES is in Turkmenistan. However Central Asia at a whole has immense potential to develop renewable energy sector thus providing diversification in energy sector and meet countries' needs in energy minimizing imports and increasing energy security in the region.

Energy produced from the renewable sources positively influence on the development of human prosperity and well-being. The Central Asian region can increase its economy, improve social life and health, and integrate faster into the developed community by transition to more sustainable energy provision and thus solving energy problems. This is connected with the fact that one of the most important factors that determine international relations within the Central Asian region in all political, economic and security perspectives are the relations in energetic sphere. At the same time, the regulation of this question in the region's energy security has been a subject for discussions for a long time. Especially harsh the question remains in the water management, taking into account that the water also serves as energy supplier and electricity generator.

The energy crisis is presented in Central Asia by several factors. First of all, it is a deficit of energy in electricity supply that is most suffered by Kyrgyzstan and Tajikistan. Unequal distribution of energy sources in the region and resource scarcity are main contributors to this problem. Many remote regions in all five countries lack electricity that especially harsh during cold seasons when there are insufficient resources for heating. Secondly, unsolved disputes around water energy resources, which create tensions in the

relations of Central Asian nations. Finally, the unsettled system of electric grids network in the region, thus making electricity deliver from one country to another complicated.

There is interdependence in energetic system among the CA countries. The united energy system was planned for the whole Central Asia without taking into account possible political changes. It is historically determined that energy systems in the region could not be employed separately. The northern parts of Kyrgyzstan cannot be supplied with energy from the south with sufficient reliability and therefore the country needs help in electric grids provision from the neighboring Kazakhstan. At the same time the southern part of Kyrgyzstan is supplied from both own electric grids and through the grid of Uzbekistan's energy system. The south-western region uses electric nets from Tajikistan for power transportation. Central Asian countries have serious obstacles towards economic development, including rational management of water and energy resources, as well as ecosystems protection on national and regional levels.

Possible solutions to the above mentioned problems can be found in renewable energy development. It can be argued that for Kyrgyzstan and Tajikistan water is the strategic energy source as coal, oil and gas for the countries of lower stream, and it will be true in some extent. Yes, water relates to the renewables, but the question lies in its management, that in some cases led in unsustainable ways. For this reason, diversification of energy supply should be found in other sources. In this regard, solar and wind power development is an alternative which contributes to provision of energy in the countries on more sustainable base. Kyrgyzstan and Tajikistan can use their wind and solar power potential to satisfy countries' needs in electricity. As a consequence it will lessen their energy consumption from the hydro stations. When Kyrgyzstan uses rivers for electricity in smaller scales, the disputes in water management in the Central Asian region will be eased. Energy deficit can be solved by creation of new RES installations. It will release the necessity of construction disputable hydro power plants in Tajikistan and Kyrgyzstan and as a consequence the international relations in the region will be less strengthened.

Considering the impact of renewable energy on the regional development of Central Asian counties, the analysis should be based on the triune concept of sustainable development. From the economic point of view, RES will increase electric energy production with fewer expenses. It is connected with the fact that while transporting energy from producer to consumer, from 20% to 70% of initial volume is lost on the way. It creates huge wastes to economy. Evidently, that with establishment of renewable energy power installations in close proximity to consumers savings can be made in energy production and transportation. The authors of a scientific study published in the Journal of Energy Economics and Policy, which assessed the impact of RES development on economic growth in the long term, based on analysis of data for 80 countries, concluded that the development of RES has a positive effect on GDP growth. Countries actively developing renewable energy achieve great success in economic development, that means RES is important for economic growth, and economic growth encourages a greater development of renewable energy (Maegaard, Krenz, Palz, 2013). But due to the slow development of RES in Central Asia GDP growth is not noticeable now, however in prospective the region can benefit as well.

From economic perspective, the region can benefit from RES in many fields, including food security, agriculture improvement and clean water consumption that reflect the aims of the sustainable development goals. Irrigated agriculture, demanding water resources in wide scales, occupies a serious place in the regional farm economy. Water resources scarcity in lower stream countries in the region create problems for proper agriculture activity. In this regard, the renewable energy sources also can help. For example, Turkmenistan can solve its water deficit by using solar photovoltaic collectors that would generate power to extract water from earth depth in 30-250 meters. This method can be used in the all Central Asian countries where ground water is taken by diesel fuel installations. The replacement of pump installations working on fossil fuels to the ecological clean solar power technologies reduces carbon dioxide emissions on 82% (Pendzhiev A.M., Penzhiev A.A., 2016). Since the solar plants need seven times less diesel fuel to generate energy, four times less expenses for one installation (in comparison with the diesel generator) and have exploitation term for 15-25 years, it is economically favorable and beneficial for regional development.

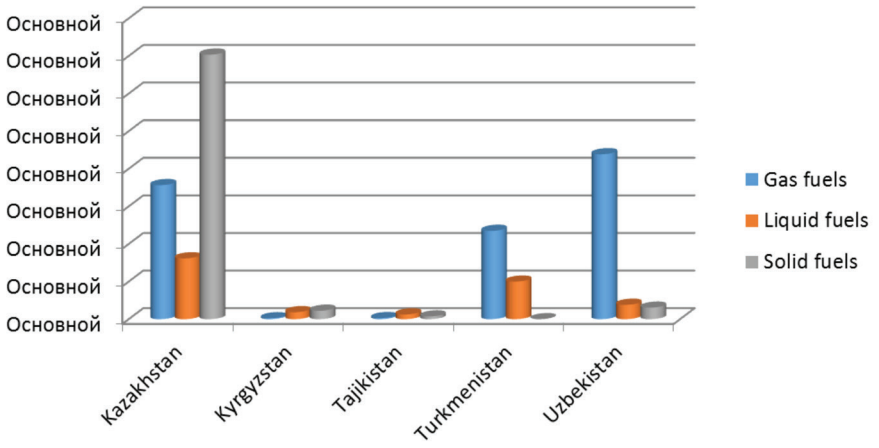
Satisfying domestic needs by energy and electricity from renewables, countries can export electricity in wider extent and thus increase their economies. For example, upper stream countries (Kyrgyzstan and Tajikistan) have excesses of electricity during the warm seasons when there is lesser demand because of lesser necessity for heating; this leads to sheer wastes, whereas in colder periods big hydro power plants cannot supply all people with proper energy and electricity, thus causing economic and social problems. Solution for these problems can be presented as followings. In summer and when insolation is high the named countries can generate power from solar photovoltaic and thermal plants providing thus with power their economies. At the same time, water needed for agriculture and farming can be used in scales that would satisfy the needs of the countries in the region.

Another positive moment where the RES technologies might be useful and contributive to food security is upgrade of greenhouses. Using renewable energy the food issues can be improved while developing greenhouses. For instance, all seasonal greenhouses can be used during the year in all regions of Kazakhstan; along this, in summer there can be grown those agricultures that are not developed in Kazakhstan. As the rest of Central Asian countries have similar conditions they all can develop this sector and provide themselves with ecologically clean, healthy products throughout the year. This will increase quality of nutrition and as a consequence to improve health issues of people. So, it is noticeable that the profit relates both to the economic and social issues.

Talking about other social benefits from RE development, the job creation advantages are to be mentioned. The renewable energy is one of the biggest world employers. There were more than eight million people working in this field by the end of 2015 (Renewable Energy and Jobs, 2016). According to the IRENA report, the biggest amounts of workplaces are created by the solar photovoltaic technologies followed by liquid biofuels and then wind energy. From this data it is evident that the region might increase employment by developing their solar and wind energy production.

The greatest benefit has, evidently, the environment. Ecological problems in the region are very essential. Renewable energy is many times cleaner and safer than con-

ventional one produced from coal and oil, for example. According to the data of Carbon Dioxide Analysis Centre prepared by US scientists Tom Boden, Bob Andres, and Gregg Marland, emissions only from CO2 reached over 2.4 million tons in 2014 in Kazakhstan, as the country with the biggest fossil fuels consuming economy in the region (picture 1) (National CO2 Emissions...). With the RES exploitation gas emissions would be shortened and this fact will consequently lead to the protection of ozone layer degradation and improvement of ecological conditions at whole.



Picture 1 Carbon dioxide emissions (kilotons) from fossil-fuels burning by country in 2014

Table 1

Conventional energy sources consumed for different purposes

	Electricity	**Heating**	**Motor fuel**
Kazakhstan	Coal, natural gas, oil	Coal, natural gas, oil	Natural gas, oil
Uzbekistan	Natural gas, coal, diesel fuel, fuel oil	Natural gas, coal, black mineral oil	Oil and gas condensate
Kyrgyzstan	Water	Coal	Imported fuels (oil and gas)
Turkmenistan	Natural gas	Natural gas	Oil products
Tajikistan	Water	Insufficient coal and gas	Imported liquefied gas

As a continuation of previous diagram analysis it would be reasonable to define consumption of mineral fuels by sectors. The table 1 shows which resources are used in some economic spheres where fossil fuels occupy major place. Thus the table proves reasons of high ecological contamination from the side of Kazakhstan and Uzbekistan

where coal, gas and oil are used for electric, heating and transport needs. There is big expenditure to tackle pollution. Thus, for example in Turkmenistan, the capital costs per unit for greenhouse gases reduction are in average USD 16 per every ton of CO2 equivalent [25, p.40]. This fact makes reasonable to invest in development in more ecological clean and energy effective technologies rather than waste money for double work. In the next table there are suggested possibilities for renewable energy sources to alternate traditional fuels mentioned in the table 1. Alternatives can widely shift minerals used in electricity and can be mixed with other fossil fuels thus not totally replacing their usage but sharing a part in total energy production (table 1). Such approach doesn't compromise consumption of conventional fuels and at the same time increase stable and diverse energy production that releases stresses for ecological situation and climate change in particular (because of less gas emissions which are main contributors for temperature increase).

Thus RES utilization in the region is one of the crucial issues for the whole national economies in Central Asian countries. The solution of this problem will increase fossil fuel resources usage efficiency while producing wide range of industrial and agricultural production; RES will lessen energy consumption from organic fuels and as consequence soften the anthropogenic pressure on environment.

Table 2

Additional energy sources from renewables to diverse energy generation

	Electricity	Heating	Motor fuel
Kazakhstan	Wind energy, solar PV	Solar power, thermal heat	Natural gas + biomass
Uzbekistan	Small HPP, solar energy	Natural gas + solar power	Altered natural gas, biofuel, battery accumulated energy
Kyrgyzstan	Water, solar PV	Biomass, solar, geothermal	Biomass + fuels
Turkmenistan	Solar PV	Solar thermal + natural gas	Natural gas
Tajikistan	Middle and small HPP, solar PV	Solar thermal and PV	Wind and solar accumulated batteries

After reviewing the possibilities and potential to develop renewable energy consumption the question as why this field has not been implemented earlier and widely rises in front. There are several reasons for this. First of all, power provision from traditional natural resources didn't create sharp demand for alternatives to satisfy energy needs (as in the case of Kazakhstan and Uzbekistan, for example). Secondly, there was weak legal base. Thirdly, the lack of scientific resources and professionals was a drag on RE progress. The fourth breaking moment was improper technological base. Finally, it is insufficient fi-

nancing and investments for developing this sphere in wider scales. Though development of RES has been promoted more actively in the last years, some problems and obstacles remain crucial on the way of renewable energy wide utilization in Central Asia.

One of the major obstacle for RE to take wider utilization in the region is self-sufficiency in mineral resources. Unless Kazakhstan, Uzbekistan and Turkmenistan can provide themselves with energy through existing fossil fuels, renewable energy will take slow development. For example, according to the Prognosis of socio-economic development of Kazakhstan for the period 2017-2019, there is a tendency in the national economy to increase oil and gas extractions and to discover new oil savings. It proves that governmental priorities and accent are still stressed at the conventional resources since they represent strategic part in national economies. Moreover, in mineral resources rich countries the development of RES is contained by strong lobby from the side of mining and smelting complex and its influential players. They argue that prime costs for production will inevitable rise and it will lead to competitive ability decrease; moreover, the export possibilities will also low because RES receives assets from energy producing industries which pollute environment. However, Tajikistan and Kyrgyzstan have to rely on renewables more in order to ease their energy deficit problems. To foster the process of transition from conventional energy to alternatives there should be shown the evident benefits. In the long-term prospective realization of profits from RES will achieve high levels when established and realized projects prove effectiveness of RES utilization. Moreover, non-renewable fossil fuels thus will be left for satisfaction of the future generations' needs.

Another big hindrance is the costs of RES installations. Prices for energy, especially that produced from natural gas are subsided and remain low due to the established governmental policy for socio-economical protection. Big reserves of natural gas and fast developing power capacities from this fuel make the barrier to comprehensive development of renewable energy. Despite governmental supports as subsidies, feed-in tariffs and tax releases the technologies of renewable energy are very expensive, taking into account the fact that many economies establish such installations locally and for private usage. For example, low recoupment of solar collectors in Uzbekistan is connected with relative expensiveness and secondly, with the relatively low tariffs for natural gas and as a consequence for thermal energy for consumers. However, there are positive global tendencies on shortages of prices on renewable energy that would definitely have positive effect on the development of such energy in the countries of Central Asia as well. Thus, according to the International Renewable Energy Agency report, average costs of wind and solar energy will decrease on 26-59% by 2025 ([IRENA, 2017).

The third barrier is investments. Investments attraction is one of the main factors of RES development and utilization. Renewable energy has such disadvantages as dependence on seasonal and climatic conditions as well as some technological unreliability. These barriers determine the unstable character of the RE. Therefore, investors look at the RE market with high caution. Main international investments are flown from the European Bank for Reconstruction and Development. Moreover, the lack of political and economic stability, or low solvency of the population, or subsidizing energy tariffs, or other objec-

tive factors, negates all the efforts made by national governments towards investments attraction.

What seriously had stopped progress of renewable energy was the weak legal basis in all states in the region. Despite all the possibilities existing in the Central Asian countries the field of RES development is lacking concrete measures established by the government that is seen from inefficient legal basis. Though some positive efforts have been implemented towards RES development, not every state took it seriously. In such a way, the declarative measures are initiated, whereas implementation goes on slowly. The countries were working out such laws and decrees on the utilization of renewable and alternative energy sources mainly because of obligations in front of international conventions and to attract investors.

Existing disputes on the ground of water resources management create additional obstacle at the way of HPP development. Tajikistan has started constructing its hydro power plant Rogun that is one of the most disputable questions between the countries in the region. Tajikistan considers the HPP as life necessary because it will solve country's problems in energy demand and provide its population with constant electricity. Moreover, Tajikistan defends its position saying that water energy resources are renewable and clean as defined in the international conventions. However, the way of this HPP utilization is far beyond the concept of sustainable development. It might cause damage to environment and people in the neighboring country – Uzbekistan. Because of these disputes the energy security in the countries of upper stream was threatened since there was electricity scarcity. The problem and unsolved water and energy questions create further difficulty in regional cooperation (Hakimov, 2013).

There is neither common policy nor actions in the region towards mutual RES development. It is right that this sphere is developed locally in each country and any integration is not necessary for this. However, cooperation in the field of research can improve effectiveness of RES technologies, combining and exchanging experience and knowledge, plus attracting investments in common projects. The existing Regional Ecological Centre of Central Asia is not enough for RES promotion in the region, though there are some conferences and discussions organized for the issue. There is no Central Asian platform for technical and financial assistance in researches towards RE development. There are initiatives of Kazakhstan to create international centre for green technologies in Astana, Turkmenistan's idea of establishing regional centre of climate change within the Central Asian countries; by now, these initiatives haven't been realized yet. Common actions and investments in regional "green" policy, projects and programs development have favorable impacts on the region. It ensures economic security and prosperity through more sustainable, stable, and reliable way of development.

The above suggested measures could solve another breaking obstacle: technological underdevelopment. In all countries in the region there is very small production of own equipment thus making this sphere dependent from imported installations. Those technologies that are made within a domestic economy demand high capital investments and it leads to even higher costs for energy to recompense expenditure. The fact of technological inefficiency is connected with another fact that sets up next barrier – qualified

professionals and specialists. Turkmen scientist Pendjiev A. in his articles and scientific works frequently stresses the problem on the lack of cheap technologies as well as insufficiency of scientific activities to improve the sector of RES (Charyiev et al., 2016).

The study made by UNESCO and gathered in the final report called Use of Renewable Energy Sources in Central Asia also led to the conclusion that one of the limiting factors in the wide spread and application of renewable energy sources in the countries of Central Asia was the limited capacity of specialists, both in terms of quantity and quality, employed or interested in the development of this sector [83, p.96]. Therefore, now it is necessary to take systematic steps so that in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan the potential of professionals sufficient to promote and develop the use of RES in the Central Asian region was created in the very near future at the most diverse levels:

1) at the level of decision-makers: deputies of parliaments, state bodies (ministries), agencies, local executive bodies;
2) at the level of organizations / persons responsible in CA countries for the implementation of the RES policy on developing and improving the regulatory and legislative framework for the use of RES;
3) at the level of local communities that have the most opportunities to specifically promote initial knowledge about the opportunities and benefits of using RES;
4) at the level of private companies already working or intending to work in the region, which will undoubtedly provide an inflow of additional capital to finance projects.

Thus the main constituents for the process of RES development are improvement of scientific potential, strengthening international cooperation in the field of energy efficient technologies creation. Therefore such initiatives as EXPO-2017 should become a platform for further improvement of RES utilization.

Talking about external obstacles for RES development, it is reasonably to mark out the internal advantages and disadvantages of the renewable energy itself. Positive components of the alternative energy sources have been defined in previous chapters in wide extent, but for the visual comparison it would be convenient to combine them in a single whole (table 3).

From the explanations it is clear that the possibility of renewable energy development is possible everywhere, in contrast to the mineral resources such as oil, gas or coal. However, it would be too naïve to assume that these kinds of energy are ideal and can solve all the human problems in economy and ecology. They also have their negative sides that many RES-opponents use as counter-arguments to the profits. First negative aspect is dependence on climatic conditions of the region as well as seasonal dependence. For clarifying, an example of solar energy can be shown. Solar radiation in different periods of the year is unequal. Insolation is especially high during summer and during winter it is two and half times less. At the same time, energy demand for agricultural objects increases in winter seasons. Another barrier to the insolation is amount of cloudy days a year which are especially frequent again in winter periods when energy is most needed. It creates obstacles to wide RES exploitation and demands special additional installations for supply of warmth that are usually based on the fossil fuels usage. Also, because of the mentioned

facts, special accumulators, concentrators and transducers are needed to save, accelerate and transform receiving power into the necessary energy. And this results in more expenditure. The next negative fact is small density of energy as from sun and wind.

Table 3

Advantages of main renewable energy sources utilization

Advantage	**Short characteristics**
Inexhaustibility	It is impossible to finish sun, wind or water while using energy from these sources
No additional CO2 emission	Energy produced from sun, wind or water doesn't emit any negative gases causing air pollution
Availability	Solar, hydro or wind power can be found on any territory in accordance with environmental conditions
Low water demands	Solar or wind installations don't need additional water resources to generate energy (comparing with oil or gas extraction when big amounts of water are necessary)
Small risk of catastrophes	RES installations exclude possible big man-caused disasters since generated power is directly transformed into necessary energy (electric or thermal); there is no need to extract, refine and transport these resources

Howsoever surprising or rather upsetting it sounded, the renewable energy sources and plants also can negatively affect environment in indirect form. For example, solar panels in big commercial scales (to generate power more than 500 MW) the big territories of several dozen square kilometers are needed. This reflects on the occupation of fields shading grounds which can be fertile for developing agricultural sphere. Because of unavailability of insolation on such territories the structure of the soil changes and this leads to negative effect on organisms living in the ground (insects, worms, or plants). To avoid similar environmental problems it is necessary to provide scientific and expertise research prior to establishing solar plants on the ground.

Wind power plants also create some hazardous effects on environment as danger for flying birds. It is argued that wind energy generators cause death of migrant birds by their long blades that can reach eighty meters length. This, however, is not a serious obstacle which could be the reason for rejection of wind energy development, because the amount of affected by wind turbines birds is far less than those which die annually from high voltage conventional electric grids (Frank, 2014).

To summarize, the renewable energy sources have their pros as well as cons which inhere to any phenomena. Thus on the way of RES market development there are psychological, economic, technological, legislative and informational obstacles. Economic barriers are connected with relatively high unit cost of renewable energy equipment. The domestic market for renewable energy resources does not develop because of low effective demand and lack of legislation that protects the rights of independent producers of clean

energy. Technological barriers can be overcome with the help of new energy technologies, which, when developed by industry, increase the competitiveness of renewable energy in the energy market and contribute to the reduction of economic barriers. The legislative barrier is associated with the lack of legislative and regulatory acts and economic regulators that ensure the free supply and sale of electricity to the energy system by small and independent energy producers, as well as the lack of a market and competition between electricity producers.

Effective support for alternative energy promotion should be regarded first of all at the national levels by governments. The regional cooperation in the field of RES and energy efficiency might give additional benefits for all countries such as:

1) fulfill the potential for RES development that cannot be realized at the national levels;
2) expand possibilities for experience, best practices and technologies exchange;
3) investments attraction by common efforts;
4) increasing social level of living;
5) environmental protection and preservation;
6) Sustainable Development Goals achievement.

In this regard, the regional prosperity can be implemented through mutual devotion to achieve the common and global sustainable development.

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