RENEWABLE ENERGY IN KYRGYZSTAN: STATE, POLICY AND EDUCATIONAL SYSTEM

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Abstract

Every year the renewable energy topic becomes more important. Kyrgyzstan, a small country in Central Asia, also attempts to develop green, environmental sources of energy. While the promotion of renewable energy in developed countries is considered as an additional energy source and simultaneously a "tool" for environmental protection, then in Kyrgyzstan as a developing country, it should be recognized firstly as a solution to the social problems.

This paper presents the current situation of the renewable energy sector, including legislation, as well as academic education on "renewable energy". Kyrgyzstan has a large hydropower potential due to the landscape features, but only 10% of this water amount potential is used today. Utilization of energy from biomass as well as from solar energy is in an "embryo" stage, even though Kyrgyzstan is an agrarian country and has good solar radiation potential. The geothermal resources have good treatment properties, therefore they are successfully used mainly in health resorts and not for the extraction of thermal energy. Some examples will be presented in this paper.

The influence on renewable energy market formation comes also from universities, where specialists are educated and trained. The universities in turn depend on the market demands. There are four universities in Kyrgyzstan that offer a specialization in renewable energies, particularly Kyrgyz State Technical University, Kyrgyz-Russian Slavic University, Kyrgyz-Uzbek University and Kyrgyz State University of Construction, Transport and Architecture. Some of these institutions cooperate with international scientists on projects and research, and these collaborations will also partly be revealed in this work.

A crucial element in the development and promotion of renewable energy sources (RES) should be the government, which creates favorable conditions using legislative acts. Kyrgyzstan is the first country in Central Asia, which has ratified a "renewable energy law" in 2008. It presents only the general principles for regulation of RES (the so-called "framework law") and therefore differs from Feed-in Tariff or Quote Model. It is necessary to continue the harmonization and agreement processes of this legislation with other juridical acts. Particularly, the preferences of this law should also be reflected within the law codes, legislative and by-laws. Two years ago the Kyrgyz government has signed a resolution on "The order of building, acceptance and technological connection of small hydro-power stations to power grid", thereby creating the legislative platform for all the beneficiaries. A few examples of legislative acts content will be analyzed and presented in this paper.

Besides some conclusions, the challenges for the development of renewable energy will be discussed at the end of this paperwork. Among them are knowledge capacity, legislative base and specific obstacle as tariff policy (1kWh electricity = 0,0157 $, 1kWh Gas = 0,0355 $)[1].

[1] Electricity and gas prices for population in Kyrgyzstan 2011.

1. Introduction

Kyrgyzstan is a mountainous country, which is located far from oceans and seas in the middle of Central Asia. It has an area of about 198.000 km² with a population of 5,36 million people (NatStat 2009). There are seven administrative divisions (called "oblast") and the capital city is Bishkek. Bishkek is located in the northern central part of the country and is inhabited by almost one fifth of the country's population. The economy is predominantly agricultural with an estimated GDP of 4,8 billion US dollars (NatStat 2010).

The energy supply was established on a regional basis for Central Asia during the Soviet Union era. It means that the surplus of resources of one country should be uniformly distributed to other dependent countries. For instance Kazakhstan supplied coal, Uzbekistan provided natural gas and Turkmenistan oil in Central Asia. After the breakup of the Soviet Union (1991) and the declaration of independence by former USSR countries, Kyrgyzstan acquired also the dependency on fossil fuel supply from neighboring countries. The electricity production is the only part of the energy sector, which has overproduction.

2. Energy sector of Kyrgyzstan

The primary energy consumption in Kyrgyzstan amounted to 118 PJ in 2009. The share of renewable energy sources (which is in fact hydropower) represents almost one third of the total primary energy consumption in the country, Fig.1, left. The utilization of biomass is not included in this balance due to lack of information and the solar, wind and geothermal resources were neglected because their total amount according experts is far below 1% (KUN 2011). The primary resources balance is drawn on Fig.1 (right) for the same year on the basis of tab.1.

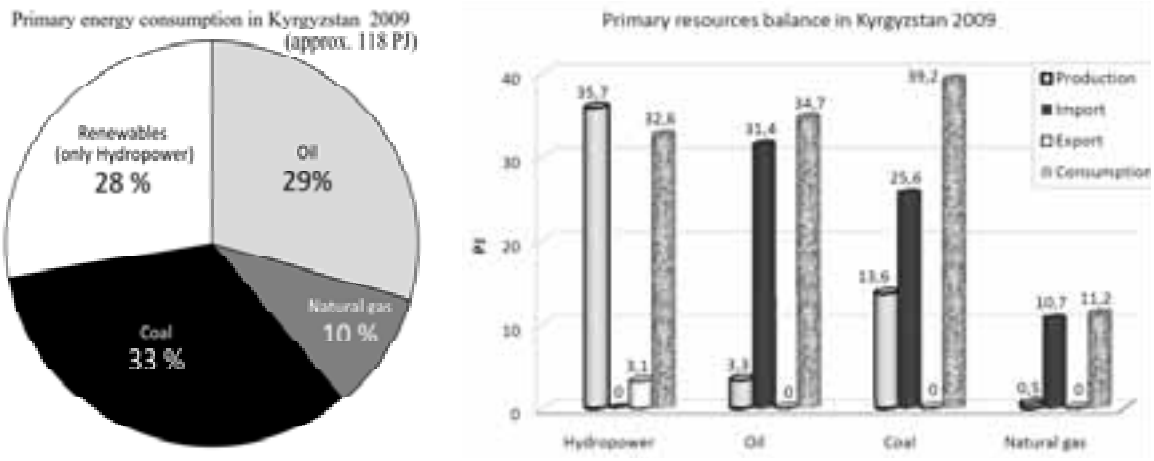

Fig.1: Primary energy consumption (left) and balance (right) in Kyrgyzstan 2009 (without biomass, solar, wind and geothermal).

Tabl.1 presents resources, own production as well as import and export of primary energy, but in original units for each sources, natural gas in m³, electricity in Wh and etc. As it can be recognized the Kyrgyzstan strongly depends on import of fossil fuels from neighboring countries despite availability of own resources, that mining at present are not always economically feasible. For instance, natural gas resources are estimated at 4,5 billion m³ (NEP 2010). The own production is poor and fluctuates at level of 16 mln.m³ of natural gas per year. Gas extraction was dropped due to the natural exhaustion of the mines. The import gas prices during the last five years have significantly increased from $ 55 for 1000 m³ in 2006 to $ 230 in 2010 (MinEnergo 2011). The total gas losses are approximately 20% of the whole imported volume.

The situation in the oil industry is similar. The oil-extracting industry is represented in the republic by Joint Stock Company "Kyrgyzneftegas". All oil deposits have been explored 70 years ago and existing mines currently are in their last stage with 70 % exhausting. The oil production in the south of Kyrgyzstan has dropped and fluctuates at the level of 75000 ton/year. There are no oil pipelines, therefore oil is transported by trucks and trains.

The total reserves of coal (about 70 deposits) reach 1,3 billion tons, nevertheless the coal industry is in the doldrums. A similar scenario as the reduction of coal production after the breakup of the Soviet Union and strongly exhaustion of existing mines can be observed here. There are about 23 coal companies united under the administration of state owned JSC "Kyrgyzkomur", which is responsible for the coal extraction, delivering and supply.

Tab.1 : Resources, production and import/export of the primary energy sources and electricity in Kyrgyzstan in 2009 (MinEnergo 2011, NatStat[1] and Central Intelligence Agency[2]).

		Hydropower (electricity)	Coal and lignite	Natural gas	Oil (oil products)
		GWh	thousand ton	mln.m³	thousand ton
Resources		142500	1300000	4500	11300
Own Production[1]		9925,4	606,9	15,4	77,3
Import (+)/ Export (-)		-864	1136,8	315,5	749,13
Consumption		9061,4	1743,7	330,9	826,93[2]
Consumption	PJ	32,6	39,2	11,2	34,7
	Total, PJ	**117,7**			

Only electricity generation covers the whole own demand and is exported in small volumes to neighboring countries. At present the estimated installed capacity of electrical power stations is 3786 MW, where 3070 MW falls on hydropower stations (Toktogulskai -1200 MW, Kurpsaiskai-800 MW, Tash-Kumirskai-450 MW, Shamaldisaiskai-240 MW, Uchkurganskai 180 MW, At-Bashinskai-40 MW, Kambarata 2-120 MW, Small Hydro Power Stations – 40 MW) and 716 MW on combined heat and power plants (TEC Bishkek-666 MW, TEC Osh-50 MW) (Fig.2, left). Almost all the hydropower stations as well as heat and power plants were built during the period of the Soviet Union and their equipment is extremely worn. In 2010 Kyrgyzstan has produced approximately 11,8 TWh of electricity (Schadiev A. 2011), 11,0 TWh or 93% of which is generated at hydropower stations and the rest at two combined heat and power plants (Fig.2, right). One of the best moments of the energy sector of modern Kyrgyzstan is the construction of a new hydropower station "Kambarata-2" (designed capacity is 360 MW). The first turbine has been launched on 27 November 2010, and already has produced approximately 253,9 GWh (MinEnergo 2011).

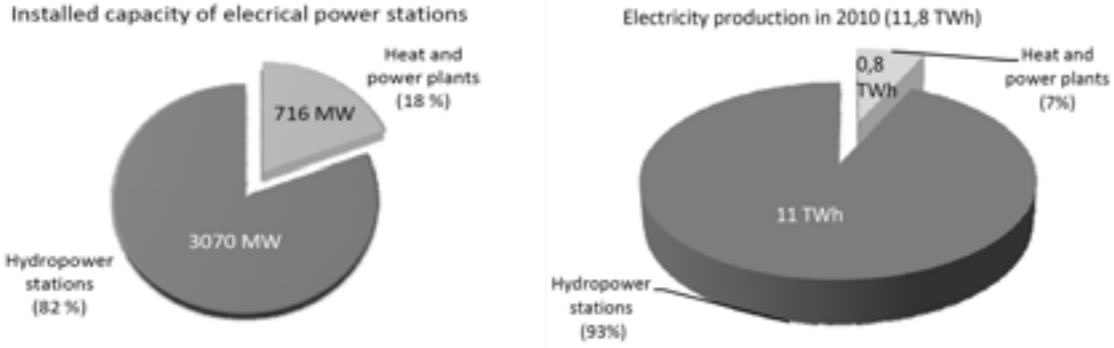

Fig.2: a) Installed capacity (left) and electricity production (right) in 2010 of electrical power stations in Kyrgyzstan (MinEnergo 2011).

A dominant share of the electricity is produced in the south of the country, while the main consumers are located in the north. The energy supply is provided through the Central Asian Electricity Grid (CAEG), which spreads throughout Central Asian countries. Any operational disturbance or interruption of the

[1] National Statistical Committee of Kyrgyzstan 2010
http://212.42.101.124:1041/stat1.kg/images/stories/docs/Kyrgyzstan%20v%20zifrah/Prom/prom%208.pdf
[2] CIA the World Factbook - www.cia.gov

integrity of the CAEG threatens the energy security of Kyrgyzstan. For that reason Kyrgyz Government is going to construct a new power transmission lines connecting the southern and northern parts of the country. Besides ensuring the energy security of Kyrgyzstan this project will remove the country's dependence on the Uzbek power transmission lines and will save funds for the transit of electricity (MinEnergo2011).

After the breakup of the Soviet Union in 1991 the fuel energy sector of Kyrgyzstan as well as residential energy consumption structure has changed (Fig.3). In the former Soviet Union the electricity consumption in the republic constituted of one fourth of the total energy demand, at present it has increased up to 70%. Due to the availability and low price of electricity this high quality energy form is used not only for lighting and driving of electrical devices, but also for cooking and especially for heating. The modification of the energy consumption has led to an overload of electrical substations, transmission lines and other power equipment that accelerate degradation of the energy complex of the country. The total deterioration of the entire assets of electrical power engineering sector is 46% (MinEnergo 2011).

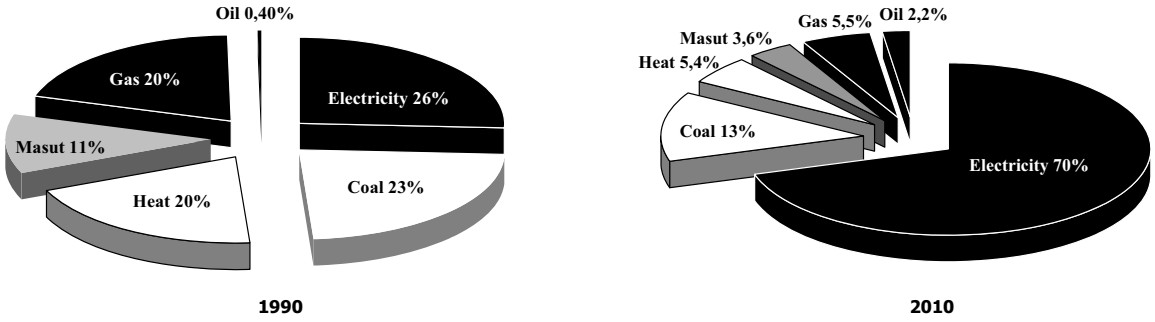

Fig.3 : The structure of residential energy consumption in Kyrgyzstan (MinEnergo 2011).

Another peculiarity of the Kyrgyz energy sector is the energy prices for consumers. The most expensive energy form for consumers is natural gas, which is twice as expensive as electricity (Fig.4). The heat production in heat and power plant (TEC Bishkek) as well as in boiler houses is subsidized by the government, therefore the sale price is below prime cost. The prime cost for district heat (depending from fuel) sometimes seven times higher than the sale price (1,4 $ cent/kWh) and reaches 10 $ cent/kWh. These prices in all parts of the republic are nearly the same.

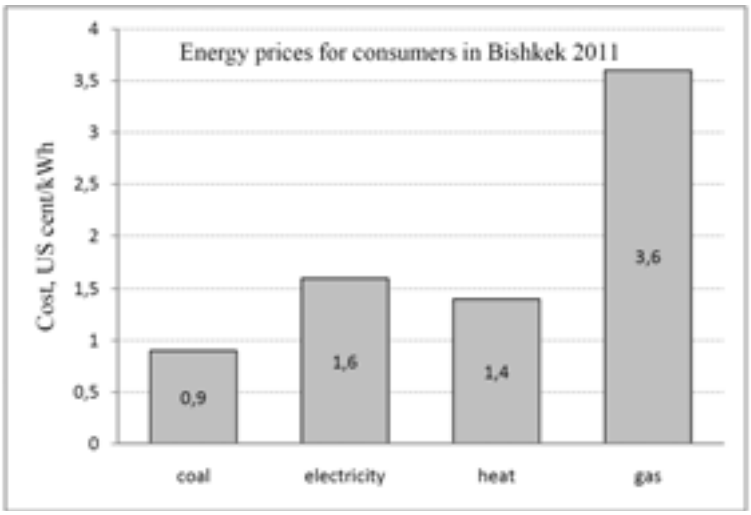

Fig.4 : Energy prices for consumers in Bishkek in 2011 (MinEnergo 2011).

The U.S. Company Tetra Tech made an energy system audit in Kyrgyzstan and gave recommendations regarding the cost of electricity. They suggested three scenarios for the energy sector development. The price of electricity should be not less than 2,25 $ cent/kWh, while the actual tariff is 1,57 $ cent/kWh. Unfortunately, the Government attempted to set not the economical but the appropriate "social tariff" in order to minimize the negative impact on low-income groups.

3. Renewable Energy in Kyrgyzstan

Among renewable energy sources (RES) only hydro energy plays a significant role in the energy sector of the country accounting for over 90% of electricity production. Besides water resources, Kyrgyzstan also has a good potential of solar, wind and geothermal resources (Fig.5). An accurate assessment of RES potential was only carried out for implementation of small hydropower stations, other sources were determined theoretically using meteorological data, literature and other accessible sources (KUN 2009).

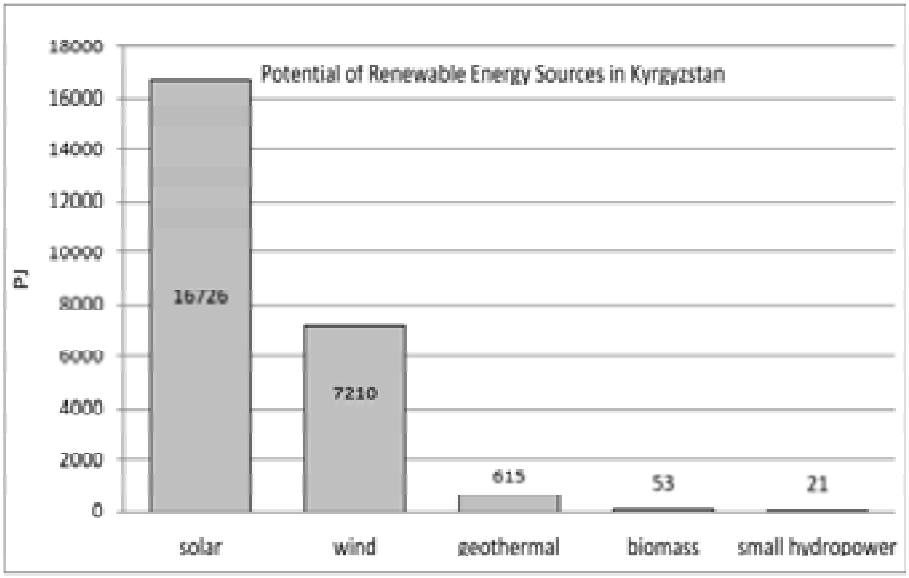

Fig.5 : The assessment of renewable energy sources in Kyrgyzstan (KUN 2009).

Kyrgyzstan has an evident continental climate and is located between 39°N and 43°N latitude. The sunshine duration for the entire area of Kyrgyzstan is between 2100 to 2900 hours per year. The mean global solar radiation fluctuates from 1500 to 1800 kWh/m²a. Due to the few clouds the direct solar radiation predominates, that sets general favorable conditions for solar concentrators as well. There is no information on todays installed capacity of solar thermal systems, but twenty years ago the total collector area was around 35000 m² (Academy of Science, 1991). At present in Kyrgyzstan thermo siphon solar plants which are primarily imported from China or produced locally are used for domestic hot water supply. Several solar combisystems that use solar energy for space heating and domestic hot water are also available in Kyrgyzstan. Additionally it is important to remark so called “industrial potential”, which is here should be understand as the existing industrial plants or former factories that manufactured components for solar industry. For instance, “Jas” factory (Kara-Balta town), Kyrgyz association of renewable energy sources (Bishkek) and some other are working in the solar thermal field, in particular they produce solar flat-plate collectors. Industrial plants “Chemic metallurgical factory” (Orlovka village) and “Kristall” (Tash-Kumir town) manufactured the crucial element for PV-module – Silicium. At present only “Chemic metallurgical factory” is in operation. Nevertheless, the solar thermal market is negligible.

Kyrgyzstan is an agricultural country which cultivates agricultural crops and breeds livestock (sheep, cattle, horses). Livestock and farm wastes as well as agricultural extractions are perfect possibilities for biomass utilization. The total amount of installed biogas plants in Kyrgyzstan is approximately reached sixty, their methane tank size fluctuates from 5 to 30 m³ (KUN 2011). The social funds “Fluid”, “Energy saving technologies”, “Center on problems of using renewable energy sources - KUN” (Bishkek) and other are promoting biogas plants in Kyrgyzstan by means of construction, consulting and information dissemination. Besides this a solid biomass (fire wood) is also used for space heating in rural places of the country.

The wind energy sector is not developed, even though it has good potential. The areas of Kyrgyzstan with mean velocities of wind over 4-5 m/s at 30 m height are highlighted in grey in Fig. 6. As it is seen on the map the wind resources are spread inhomogeneously. The duration of active winds reach 4000 – 7000

hours/year. Fourty years ago the “Oremi” plant (Bishkek) in collaborating with “Archangelsk” plant (Russia) produced the wind turbines with nominal capacity of 6 kW /16 kW. Nowadays the “Oremi” plant is in operation, but doesn’t produce wind turbines anymore.

There are good geothermal resources available with 40-60°C hot water of different mineralization. Due to it specific mineralization these resources are used not for heat extraction but for medical purposes. For instance some geothermal resources are Ak-Suu, Issik-Ata, Djergalan and others.

Fig.6 : The wind potential of the Kyrgyz republic (Master Plan of Wind Power Development of the USSR 1989)

There are about 252 mountainous rivers and several larger irrigation channels providing good opportunities for construction of small hydropower stations. At present hydro potential allows Kyrgyzstan to construct a lot of small hydro power stations with total capacity of approximately 180 MW. Several years ago “Oremi” plant (Bishkek) designed and constructed small hydro power stations up to 20 kW, nowadays the production was suspend. The complete information about the situation in small hydro power stations field can be found in “National program on development small hydro power stations 2009”.

4. Legislation and governmental programs in renewable energy field

The governmental policy is developed by the Ministry of Energy. The Ministry of Energy in Kyrgyz Republic is a state executive authority which ensures the implementation of governmental policy in the energy sector. There is a special “renewable energy” department which is responsible for the enhancement of renewable energy in Kyrgyzstan. This department closely collaborates with center on problems of using renewable energy sources (Bishkek) and other representatives. The Ministry works as well with donor organizations such as World Bank, ADB, UNDP, EBRD for collaborating in different energy projects in this field. By drafting and designing legislature the Ministry tries to create sustainable conditions for the development of the energy sector in general and for renewable energy in particular.

The significant breakthrough in this area was the adoption of the Law on renewable energy in 2008. Kyrgyzstan became the first country in Central Asia, who has approved this law. The law is different from Feed-in Tariff or Quote Model and represents only general principles for regulation of RES the so-called framework law. According to this law hydropower stations with an installed capacity of more than 30 MW are referred to as conventional energy, therefore are not subject for regulation under this law. Some advantages of this law are:

- No custom duties for either import or export of equipment for renewable energy technologies;
- Energy extracted from RES is a subject for procurement by energy companies in an obligatory manner;
- RES energy tariffs should ensure the payback of the RES project in less than 8 years

The ideas of this law are aimed at stimulating the RES field. To enact this law it is necessary to continue the harmonization and agreement processes of this legislature with other juridical acts. In particular the main provisions of this law should be reflected in codes, legislative and other bylaws and legal acts. For instance the custom code should also contain the preferences as duty-free for imported/exported RES technologies. Up to this date the ministry works on it, but it not done yet, which leads to the assumption that custom inspectors still collect taxes in accordance with the existing customs code. In addition it is necessary to adopt by-laws which would provision governmental mechanism and agencies in charge. Two years ago (2009) the Kyrgyz government has signed a resolution on "The order of building, acceptance and technological connection of small hydro-power stations to power grid", thereby has for the first time created a legislative platform for all beneficiaries. This resolution regulates the order and procedures for legalization the construction and technological connection of small hydro power stations to power grids. Also it determines the order of launching into operation. Such resolutions are not drafted yet for other technologies.

In 2006 the prime-Minister Mr. Kulov signed a decree "on phased implementation of solar energy technologies in resort zone of Issyk-Kul". This decree directed to promote the solar energy use as well as to save electricity, which is used for domestic hot water supply there. In the frame of this decree a national program was developed, but the realization of this program due to unknown reasons was "tightened". For instance: there are 2.5 million tourists visiting the Issyk-Kul lake every year, therefore a huge potential for solar thermal system application is available (MinEnergo 2006).

Small hydropower stations always offered a very good perspective for Kyrgyzstan, due to availability of a huge amount of small rivers. In 2009 the national program on development of small hydropower stations in Kyrgyz republic was developed. According to this program the first significant step towards development should be rehabilitation of former existing small hydro power stations in republic. There are about 41 small hydropower stations, with installed capacity of about 23 MW that can be reconstructed. About 62 new small power stations, with a total capacity of 180,77 MW can be constructed. The preliminary estimation of investments and possible electricity production are mentioned in this program for every small hydropower station separately (MinEnergo 2009).

One of the last initiatives of the Kyrgyz government in the RES field is the development of a national program "Biofuel". As it was mentioned above the Kyrgyz Republic depends for 97% on the import of oil products. Every day Kyrgyzstan uses 3000 tons of combustive-lubricating materials. This program aimed at decreasing the dependency from importing fuel and stimulating of RES. In frame of this national program it was decided to produce ethanol, which is widely used all over the world. Jerusalem artichoke was chosen as raw material, which does not require special agro-technical care. For its cultivation 62,5 thousand hectare of farmland are required. The program will probably start this year (MinEco 2011)

5. Renewable Energy Education

The influence on the creation of a renewable energy market also comes from universities, where specialists are educated and trained. The universities in turn depend on the market demands. There are four universities in Kyrgyzstan that provide a specialization "renewable energy" (specialization "Hydroelectric power industry" is not included), particularly Kyrgyz-Russian Slavic University (KRSU), Kyrgyz State University of Construction, Transport and Architecture (KSUCTA), Kyrgyz State Technical University (KGTU) and Kyrgyz-Uzbek University (KUU). Besides the universities there are also research institutions as Center on problem of using renewable energy sources, National Academy of Science, Kyrgyz National Technical Center "Energy" and others, who are doing research in the renewable energy field. Fig. 7 presents the number of students entering the specialization on "Renewable Energy Sources" in different universities. It can be seen almost the constant admission in all above mentioned universities. The educational system remained from the Soviet Union era. Every student should obtain education of a "broad spectrum". Up to today every technical specialization should be content the general humanitarian, social and economic disciplines as well. Currently Kyrgyzstan also attempts to join the Bologna process.

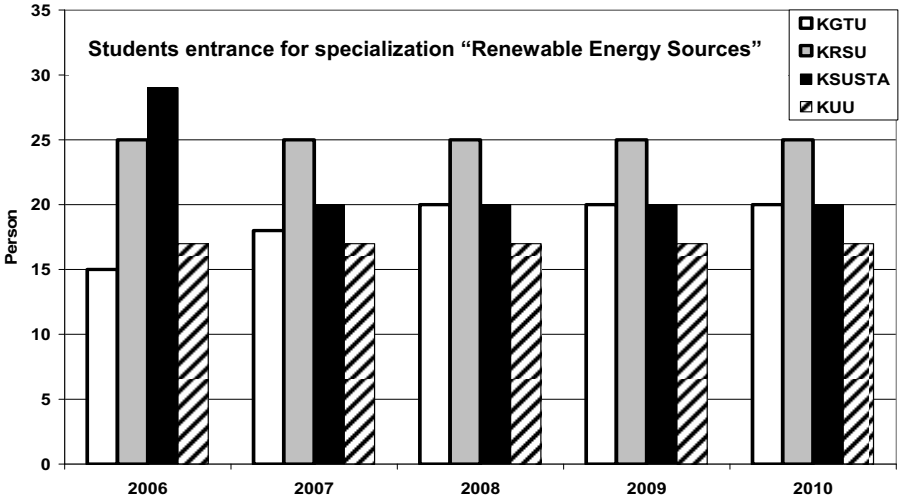

Fig 7: Dynamics of acceptance of students "Renewable Energy Sources" specialization

Below is presented some briefly introduction of above mentioned institutions, their international collaboration on topical projects and researches. KRSU has founded the department of non-conventional and renewable Energy Sources in 1995 (KRSU 2011). The department active working on RES projects, in particular with solar drying systems for fruits, vegetables and medicinal herbs. Some solar drying plant was already patented in Kyrgyzstan. The laboratory base consists of demonstration plants for solar thermal system, small hydro power station etc. Besides this the laboratory setups for theoretical basis electrical engineers are also available.

KSUCTA has a department "Heat and gas supply, conditioning and ventilation" (KSUCTA 2011). The specialists on "Non conventional energy sources" are graduating at this department. This department carries out research on passive use of solar systems as well as active use. Nowadays the department collaborates in a joint project with the Royal Institute of Technology (Sweden) and has a good contact with Switzerland.

One of the young department of "renewable energy sources" existed since 2004 in Kyrgyz State Technical University (KSTU 2011). The department works in the field solar thermal system, biomass and hydro power stations. The department cooperates with many local and international universities, research institutes and organizations like NREL (USA), JICA (Japan) and Kassel University (Germany) and other. Currently the department collaborates with Kassel University (Germany) on a joint project in the solar field. A modern laboratory setup, which consists of PV-professional training system, basic heat pump setup, wind training system and solar thermal plant, has been received thanks to the German Academic Exchange Service (DAAD).

The youngest department for renewable energy is located in Kyrgyz-Uzbek University. The employers of this department are designing solar thermal system, solar drying system for agriculture purposes. In particular the concentrating solar collectors are the subject of investigation. The laboratory base consists of the basic solar thermal plant, small hydropower station and others that were made by themselves.

6. Conclusion

Kyrgyzstan has a considerable share of renewables in the primary energy consumption. However, it is in fact conventional hydropower which accounts for 93% of electricity production. The share of other renewables is negligible despite good conditions for use of solar, biomass, wind and geothermal energy. For instance, the solar thermal system could be successfully used for domestic hot water supply as well as for space heating, thus, covering huge heat demand in the country. PV, small wind turbines and small hydro power stations can be widely implemented for energy supply of small autonomy consumers that are located in remote mountainous regions and don't have any access to an electricity grid. Biomass, particularly biogas plants, can

be used for extraction of biogas in rural regions. The Kyrgyzstan has not only good potential for utilization of RES, but suitable educational base (4 Universities), where the specialists can be educated. Furthermore, the Ministry of Energy is developing an appropriate national policy and programs for enhancement and promotion of renewable energy sources. But the implementation of renewable energy technologies is facing following typical obstacles that decelerate its process:

- Low awareness on appropriate RES technologies
- The absence of market on RES
- No proper governmental regulation towards practical use of RES
- Political instability

However, the most important specific obstacle is obviously the state energy tariff policy. District heat is subsidized by the government, so that consumers pay only a part of self-costs. The government doesn't want to increase energy prices to avoid additional financial impact on the rather poor population and thus to reduce the social tensions. The low prices lead to high energy consumption. Especially electricity consumption is dramatically growing as it is much cheaper than imported natural gas and easier to use than coal, so that fossil fuels (e.g. for space heating) are more and more substituted by electricity. This tariff approach doesn't stimulate the development of RES technologies, because nowadays in Kyrgyzstan the simplest and cheapest way to get any energy form is to use electricity.

7. References

1. Academy of Science 1991, personal communication
2. CIA, The World Factbook, https://www.cia.gov/library/publications/the-world-factbook/geos/kg.html , 25.08.2011
3. Drus N. et al., 2010. The Situation in Renewable Energy Sources in Central Asia, UNESCO, pp.40
4. KRSU (2011), Kyrgyz-Russian Slavic University, personal communication www.krsu.edu.kg/Rus/1EtfNVIE.htm, 25.08.2011
5. KSTU (2011), Kyrgyz State Technical University, personal communication www.ktu.aknet.kg, 25.08.2011
6. KSUCTA (2011), Kyrgyz State University of Construction, Transport and Architecture, personal communication, www.ksucta.kg, 25.08.2011
7. KUN (2011),"Center on problems of using renewable energy sources", Kyrgyzstan.
8. Law on renewable Energy of the Kyrgyz Republic, 31 December 2008
9. NatStat (2011), National Statistical Committee of Kyrgyzstan, www.stat.kg, 25.05.2011
10. "Master Plan of Wind Power Development of the USSR", 1989
11. MinEco (2011), Ministry of economic regulation of Kyrgyzstan, 2011
12. MinEnergo (2011), Ministry of Energy of Kyrgyzstan 2011, personal communication
13. Ministry of education and science of Kyrgyzstan, 2011
14. NEP (2010), "National Energy Program", Kyrgyz Government 2010
15. Shadiev A., a report of Minister of Energy 2011
16. Tetra Tech Es, Assessment of electricity cost in Kyrgyzstan, USAID 2011
17. The national program on development small hydro power stations, Ministry of Energy 2009