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Promoting Green Innovation

Policy assessment and recommendations

Kyrgyzstan

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Note

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Introduction

Kyrgyzstan has great potential for ensuring the sustainability of its economy if it avails itself of the opportunities offered by a nationally customized green economy strategy. To move towards a green economy, it will, however, have to introduce innovative technologies, techniques and processes. In particular, it will have to modernize its obsolete production and transport infrastructures and construction and cultivation methods.

This assessment will:

- Review the main environmental challenges and opportunities for the greening of the Kyrgyz economy;
- Assess the country's innovation policies and the challenges and opportunities for the introduction of green technologies;
- Provide policy recommendations on adopting and applying innovative green technologies more efficiently.

1. Main environmental challenges and opportunities for a green economy

Kyrgyzstan is extremely rich in water resources. Its numerous water reservoirs, mainly located in the mountain area, have boosted the development of the hydropower sector, which provides 90% of the total energy supply and accounts for 5% of GDP and 16% of industrial production of the country (GoK, 2012). By providing the country with clean energy, water will be a key driver for the realization of a green economy.

Per capita greenhouse gas emissions are low—at around 1.3 ton per capita per year— and the share of the country's emissions in the Central Asian region is 5%. This is mainly due to the extensive use of hydro resources in providing environmentally friendly electric power. Hydropower contributes 98% to the country's energy balance. But even though the entire population has access to electric energy, hydropower plants and power distribution networks are deteriorating, causing repeated accidents and blackouts (GoK, 2012).

To address these problems, in 2008 the Government approved a National Energy Programme (2008–2010) and a Fuel and Energy Complex development strategy (2008–2025), which focuses on attracting foreign investment for innovation in the energy sector (GoK, 2008).

The National Energy Programme acknowledges the limited availability of new technologies, lack of measuring devices and difficulties in quantitatively measuring energy savings, due to the slow introduction of innovative suggestions to the market (GoK, 2008).

The country faces general environmental challenges such as:

- Pollution from the coal-based district-heating plants;
- Desolate energy-wasting housing stock in major cities;
- Degradation of the land and water;

- Deforestation;
- Decreased biodiversity in rural areas.

Further environmental problems are being caused by nuclear wastes dumps left from Soviet times along the main riverbeds.

But the country has significant potential for low-carbon development (UNDP, 2012), mainly through its hydropower potential and solar radiation levels. Economic priorities for a "green" economy in energy and agriculture, along with water resources, will therefore be the main drivers for future economic development.

With the creation of green jobs, the poverty level of the rural population (now over 50%) could be reduced. And this development, through the use of the water resources, could have a stabilizing effect on the entire Central Asian region.

According to the United Nations Development Programme (UNDP, 2012), the low-carbon development model should assign high priority to transforming the centralized energy-supply system into one that consists of distributed and decentralized ones using innovative green technologies.

The report identified the following as priority areas:

- The introduction of energy-efficient industrial processes with new green technologies;
- The transition from energy-wasting housing stocks to energy-efficient ones that will comply with the EU energy-efficiency standards for housing.

In the rural areas, soil degradation could be prevented by using natural fertilizers and stable energy supplies could be provided through the use of bio gas, which would also produce natural fertilizers, electricity and heat.

This energy transition requires improved governance and effective legislation for introducing new technologies, and integrated environmental and economic thinking. It also requires extensive consultations with all agents and stakeholders, involving government authorities, the business community, civil society, NGOs, community organizations, academics, engineers, law makers, financial institutions and international organizations.

2. Sectoral opportunities and challenges

2.1. Natural resources

Kyrgyzstan has considerable biodiversity. It has about 50,000 kinds of living organisms and 22 ecosystems (GoK, 2012). Its abundance of water resources and extensive forest coverage contribute to its natural prosperity. Nevertheless, natural resources are threatened by climate change, irrational use and unsustainable exploitation practices.

In this sense, the prudent use of natural resources and the introduction of environmentally sound technologies for their protection are prioritized in the roadmap concept of the Long-term Country Development Strategy (EU et al., 2011). In particular, the protection of forest ecosystems—through the extension of protected areas, the planting of trees and the sustainable management of forests—is addressed in the Medium-Term Development Program-Poverty Reduction Strategy paper (IMF, 2012).

Climate change is already affecting the country's natural resources. Mountain ecosystems are threatened by shifts in temperature and extreme weather events, with the consequent erosion of forest soil. The melting of glacial areas is already deteriorating the quality of mountain and lowland ecosystems.

In addition to climate change, the environment is being degraded by the unsustainable exploitation of natural resources by local communities. Wood extraction from forests and the irrational use of water reservoirs, together with transformation of natural habitats through the creation of arable lands, mining areas or infrastructure, are all contributing to the progressive depletion of the country's natural resources (GoK, 2012)

If used in a sustainable way, natural resources and ecosystem services can support the livelihoods of local communities and economic growth, while absorbing greenhouse gas emissions and mitigating climate change. Integrated water resources management and sustainable forest management are the green approaches that would foster the development of new green businesses, the generation of employment and the reduction of poverty.

The Government called for an economic model to be drawn up to support an "integrated ecosystem-based approach to development". The model should take into account the costs and benefits of different development models for the society, the economy and the environment (GoK, 2012). Also, the introduction or reinforcement of efficient economic mechanisms (e.g. payments for economic services) and the expansion of transboundary water cooperation could greatly contribute to developing a green economy.

2.2. Agriculture

The majority of the population live in rural areas and rely on agricultural activities for their livelihood. In 2011, agriculture contributed 18% to GDP and is the sector that consumes most fresh water. According to national statistics, in 2010 water used for irrigation accounted for 93% of total withdrawn freshwater, while 4.6% was used in households and only 2% for production purposes (GoK, 2012).

But despite such considerable water consumption, crop yields remain generally low. Among the reasons for this are soil erosion and salinization, irrational use of fertilizers, inefficient irrigation systems, poor crop rotation and intercropping, low efficiency and adaptability to changing climate conditions. In 2011, about 80% of the agricultural land was affected by degradation processes (GoK, 2012).

This progressive degradation of agricultural land is attributable to poor innovation in irrigation systems, including the lack of new technologies and techniques to address soil erosion and the effects of climate variability. The inefficiency of the sector is also reflected in its greenhouse gas emissions—which amount to 16.1% of the country's total (the second sector after energy, which contributes 74%).

In the future, increasing electricity costs, soil erosion and salinization could seriously hamper the development of the agricultural sector. The introduction of green innovative technologies should be a priority, given that poor crop yields might have disastrous consequences for human development, causing food insecurity, especially among the most vulnerable groups.

The adoption of innovative technologies and techniques for sustainable agricultural production (e.g. micro-irrigation systems, crop rotation, minimum tillage techniques) can help reduce waste of freshwater while increasing crop yields.

Possible interventions in favour of green agriculture include investment in research and development (R&D), plant and animal health management, strengthening the supply chains for green products and farm inputs, farm mechanisation and post-harvest storage, improving soil and water management, and diversifying crops and livestock.

Many opportunities exist for promoting green agriculture. In particular, the growing interest of private investors in sustainable agriculture and increasing consumer demand for sustainably produced food could provide the initial conditions for introducing innovative management approaches. Increased crop productivity, improved quality of soils and more effective use of water would enhance food security and provide benefits to all of society.

2.3. Energy

Green investments in energy-efficiency technology represent a good opportunity for the future of the energy sector. Modernized energy equipment (from measuring to producing and delivering energy) would reduce energy demand and increase supply, thereby generating positive impacts for the national economy and society, while respecting sustainability principles. And enhanced efficiency of the power distribution networks would boost exports of electricity to neighbouring countries. It would also bring additional revenue and enhance regional energy security.

Micro and small hydroelectric power plants could be constructed, particularly in the mountainous areas. In remote locations, off-grid and mini-grid options tend to be cheaper than expanding existing electricity grids. In comparison to the big hydropower plants, decentralized renewable projects, such as small hydropower stations, solar and wind energy and biogas plants are relatively inexpensive (in terms of up-front capital costs), and can therefore attract investments for construction and maintenance from donors and from the communities in which they are located.

Obsolete infrastructure is causing huge energy losses and creating high energy demand. These problems are reflected in the high level of energy intensity, which reaches 1.1 tons per 1,000 UDS of fuel equivalent (0.22–0.74 being the average in developing countries) (GoK, 2012).

Coupled with energy-efficiency challenges, energy plans should consider climate change impacts on water resources, expected demographic growth (8 million people by 2025, according to the United Nations Population Fund), and the extremely high energy demand in the mountainous areas (GoK, 2012). Substantial investments, together with technology transfer, are needed to modernize the obsolete infrastructure and ensure a stable energy supply.

In conclusion, a more extensive use of renewable sources, including solar, wind and biogas, possibly in conjunction with each other, would further enhance the country's clean energy supplies. This would also bring additional benefits through creating new employment.

Solar

Because of Kyrgyzstan's location and continental climate, solar energy resources are abundant. Sunshine time is between 2,100 to 2,900 hours per year for the whole country. The mean global solar radiation fluctuates between 1,500 and 1,800 kWh/m²a.

A number of local factories and organizations produce components for the solar power industry. For instance, "Jas" factory (Kara-Balta town), the Kyrgyz association of renewable

energy sources (Bishkek) and some others are working in the solar thermal field, producing solar flat-plate collectors.

The industrial plants “Chemic metallurgical factory” (Orlovka village) and “Kristall” (Tash-Kumir town) have been producing components for the silica PV module. However, their technologies are now outdated. They need facilities for technology transfers to establish themselves in the future market for using transferred green technologies.

The current regional leaders for the installation of photovoltaic and wind energy devices are Chinese companies. However, the technology transfer elements of such projects are minimal because both the financing and the construction are in the hands of the Chinese companies, without close technological interaction with local Kyrgyz companies.

Biogas and biomass

More than 50% of agricultural lands are pastures, which are used for livestock breeding. The livestock waste, which could be used after processing in biogas plants, constitutes approximately 2,500,000 tons per year.

Currently, 60 locally designed biogas facilities produce around 2 million cubic metres of biogas annually, which is used in the residential and commercial sector. Promoters of these installations are the social funds “Fluid”, “Energy saving technologies”, and the “Center on problems of using renewable energy sources - KUN” (Bishkek). They provide consulting, construction and information dissemination services.

In a recent survey that reviewed the performance of 56 of the 60 installed biogas installations, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) concluded that the installations had severe design defects and that they were not using the inputs efficiently.

Wind

Potential of wind power generation in Kyrgyzstan is estimated at 1,500 MW, with the duration of active winds (above 4 m/s) reaching 4,000–7,000 hours/year.

Through a government programme, a wind power plant was constructed in the region near Balykchi. Constructed with investment from China, it has a rated capacity of 22 MW. Other promising areas for wind power plant installations are: Chuisk district, northern Kyrgyzstan, Osh district, in southern Kyrgyzstan, Issyk-Koul district, in eastern Kyrgyzstan, and Djelal-Abad district, in the west.

Geothermal

Rich geothermal resources include thermal springs and high heat-generating granites. Low to medium heat geothermal resources could be used for district heating. Currently, these geothermal water resources are used for the medical purposes, thanks to their specific mineralization. Such geothermal resources are located in Ak-Suu, Issik-Ata, Djergalan, among others.

Hydropower

In 2010, Kyrgyzstan produced approximately 11.8 TWh of electricity (Schadiev A. 2011). 11.0 TWh or 93% of which was generated at hydropower stations. The rest was produced by two heat and power plants. See Table 1.

Kyrgyzstan has 17 hydropower plants. They are: Toktogulskai – 1,200 MW, Kurpsaiskai – 800 MW, Tash-Kumirskai – 450 MW, Shamaldisaiskai – 240 MW, Uchkurganskai – 180 MW, At-Bashinskai – 40 MW, Kambarata 2 – 120 MW. There are also small-scale hydropower stations – 40 MW; with estimated potential of up to 4,000 GWel. The biggest, Toktogul hydropower plant (in the mid-west), has a capacity of 1,200 MWel and a reservoir containing 19.5 bn. m^3 of water. See figure 1.

Table 1. Current hydro and thermal power production: capacity and potential

	Developed		Potential	
	MW	GWh	MW	GWh
Hydropower plants> 50 MWel	2 900	13 000	29 000	130 000
Thermal power plants	650	1 500	3 000	18 500

Source: Ministry of Energy, 2011

Figure 1. Hydropower plants and main power transmission lines

Source: Ministry of Energy, 2011

Most of Kyrgyzstan's hydropower stations and district heating power plants are large-scale plants that were built during the Soviet period and are now old, inefficient and worn out. Although 100% of the customers have access to the grid, the outdated power transportation and distribution facilities leads to frequent blackouts.

Various estimates indicate that Kyrgyzstan is using only 10% of its total hydropower potential capacity, which according to the National Power Grid company is around 140 billion kWh. The construction of new hydropower plants—both along the Naryn cascade and on smaller rivers—presents opportunities to increase capacity for winter power generation and to export electricity to the neighbouring countries.

The Ministry of Energy conducted feasibility studies on the construction of 47 new plants across the country and the Government has launched a programme to build both small and medium-sized power plants. It has invited companies to invest in the new constructions of 43 small and medium-sized facilities (primarily small hydropower plants with an installed capacity of around 2–3 MW) with total installed capacity of 277 MW. At the newly constructed hydropower station "Kambarata-2" (designed capacity 360 MW), advanced green technologies were used. The first water turbine started operations in November 2010.

Kyrgyzstan's potential for exporting energy to the neighbouring countries is 2,500 GWh. Once the transmission losses are reduced through introducing green technologies, the potential will increase to 4,000 GWh. Recently, Kyrgyzstan contracted two Russian energy companies to construct the Kambaraty and Naryn hydropower plants, with Russian investment of $3 billion.

Energy pricing: financing green technologies via feed-in tariffs and other issues

A feed-in tariff is a policy mechanism designed to accelerate investment in renewable green energy technologies. It does this by offering long-term contracts to renewable energy producers, guaranteeing grid accesses, and offering purchase price based on the cost of generation of each technology.

Under a feed-in tariff, eligible renewable electricity generators (e.g. homeowners, business owners, farmers, as well as private investors) are paid a cost-based price for the renewable electricity they produce. Energy generated through wind power plants is paid a lower price per kWh than energy generated by solar photovoltaic and tidal technologies. These are offered at a higher price, reflecting the higher costs of generation.

In the draft modification of the law entitled, "Some changes and extensions to the law of the Kyrgyz Republic on renewable energy sources", a feed-in tariff will be applied during the repayment period of a renewable energy investment. The electricity tariffs will be set up by multiplying the maximal tariffs of the end consumer by the following coefficients:

Coefficients

- 2.1 for hydropower producers, meaning around 3.6 cents/kWh;
- 2.5 for wind energy installations, meaning around 4.25 cents/kWh;
- 2.75 for installation using bio mass, meaning around 4.8 cents/kWh3.35 for geothermal installations, meaning around 5.7 cents/kWh;
- 6.0 for solar photovoltaic installations, meaning around 10 cents/kWh.

These proposed changes and extensions to the "Law of the Kyrgyz Republic: Renewable Energy Sources" (§ 9 to Ch. 12) should make it more attractive to invest in power generation using advanced green technologies. They will contribute to the further greening and diversification of the energy-supply sources and increase production to meet rising rural demand.

The recent sharp decrease in the installation costs of photovoltaic will make the proposed feed-in tariff attractive for the solar photovoltaic installations. The cost of installation has fallen to $1,800/m^2 from over $3,000/m^2 just a few years ago.

Among the most active investors are the Chinese. They will invest in wind and photovoltaic power generation plants once they obtain a guarantee for the payment of feed-in tariffs from the power system operators.

Currently, such investment plans are suspended, as the Government has no plan to increase household electricity prices during 2013.

The USAID report (2011), "Review of the Prime Cost of Electricity in Kyrgyz Republic" pointed out that the price of electricity (som1.0 per kWh, around 1.3 cents/kWh) did not reflect production and distribution costs adequately. As a result, very little investment took place for replacing outdated/worn-out equipment, and the renovating/replacing dilapidated power generation facilities.

The experience with social pricing of electricity in many countries has shown that the artificially low electricity prices are mostly benefitting the middle class, while the really poor cannot afford any payments. A more focused social policy could reduce the negative effects that low prices have on investment.

2.4. Construction

National policies and regulations take into account seismic safety and provide for the control of construction activities through the creation of databases on land plots for construction of dwellings.

There are significant opportunities to improve efficiency in buildings. The greening of the housing sector through investing in the innovative technologies will not only contribute to reducing global GHG emissions and sustainable usage of other resources, but also create new jobs. The major challenges are the cost of retrofitting/new constructions and the facilitation of technology transfers.

Two paradigms for greening the construction sector are available, and both can be applied to new buildings as well as to retrofitting the existing building stock. The first is based on the concept of "passive" design where buildings respond to their local site context by using natural elements (such as air-flow and sunlight) to limit the effect of external conditions on the internal environment.

The second paradigm is based on a more "active" approach. It uses newer technology and state-of-the-art building-management systems to reduce the energy load of buildings. Already, solar screens, photovoltaic cells (PV) and other devices are found in most state-of-the-art high-tech buildings. With an adequate mix of public and private investment, the construction sector could be developed to ensure increased access to housing, energy savings and extensive use of renewable energy sources.

Energy-efficient housing

According to the surveys of public housing and administrative buildings (UNECE 2010), most buildings in Kyrgyzstan are built in accordance with outdated Soviet standards. Their heat consumption rates are around 320 kWh/m^2 per annum, whereas the present EU thermal efficiency standards for retrofitted buildings are at 100 kWh/m^2 per annum.

This shows a potential of energy saving of 55%–60% for the existing housing stock by applying thermal insulation and upgrading the heating installations.

The efficiency of the district heating of private housing blocks is at the level of 25%–30%, whereas advanced technologies, such as small-scale combined heat and power (CHP) production showed an efficiency of 85%.

The dilapidated district heat-production facilities, heat transportation infrastructure combined with the Soviet-era energy inefficient building design are the big challenges that Kyrgyzstan faces.

Energy consumption in the newly built houses is at 40 to 50 kWh/m^2, as they apply efficient green technologies and designs such as integrating passive and active renewable energy in the buildings, extensive thermal insulation of the buildings and heat-recuperation equipment.

The lack of appropriate building codes and standards is hampering the construction of new energy-efficient buildings in Kyrgyzstan. The Government has already initiated discussions with different stakeholders but it is taking some time to adopt the related legislation.

Since 2006, a number of projects financed by the World Bank, KFW, and the Swiss Economic Cooperation Organization have supported local heat distribution companies to: improve metering, reduce losses and extend services to new households. Procurements of materials with advanced greener technologies, such as meters and computer hardware and software (for billing systems) played a large role to improve their energy efficiencies. These projects helped to reduce heat distribution losses and boost cash collection rates for the companies participating in the project.

2.5. Transport

Transport infrastructure needs to be further developed to meet growing national needs of trade and tourism. The road networks service up to 95% of all domestic passenger and cargo automobile transportation, and are increasingly deteriorating. And the railway infrastructure is insufficient to provide good access to international markets. Airports are not adequately equipped with the latest technologies (IMF, 2012).

The Government has planned various infrastructure-development programmes that include: public-private partnerships for the construction of two highways (Kara-Balta – Kemin and Alma-Ata – Kemin – Cholpon-Ata); renovation of the airports Osh and Issyk-Kul; construction of the railway China – Kyrgyzstan – Uzbekistan and Balykchi – Kochkor – Kara-Keche – Arpa (IMF, 2012).

Frequent natural disasters, such as floods and landslides, resulting from a changing climate have deteriorated further part of the road networks.

At the same time, the transport sector is a major user of fossil fuels, contributing significantly to energy consumption and emissions. Private vehicles are often the only possible transportation mode, due to the poor development of alternative transport infrastructure such as railways and public transport.

The promotion of greener transport requires further investment in:

- Research and development;
- Efficient building;

- Operation and management of infrastructure;
- Greener vehicles and transport modes (including public transport vehicles and low emission vehicles);
- Cleaner fuels;
- Telecommunication technology to substitute conventional transport;
- Technologies to enact green transport (e.g. Global Positioning Systems (GPS), Intelligent Transport Systems, green logistics, etc.).

Such investments would increase resilience to climate-change impacts and improve mobility of people and goods, with benefits for the entire economy. And the expansion of public transport networks would reduce the use of fossil fuels and slow down the degradation of the roads. It would also support equitable access to transport systems for the public.

In the long term, clean transport networks and vehicles will contribute to the mitigation of climate-change impacts on roads and other transport infrastructure.

3. National innovation system and green technologies

3.1. Government policies and institutions

The Government acknowledges the role of innovation as the main driver of sustainable growth. It has identified the development of innovative know-how, science and technologies as a national priority. In 2009, it issued a "Concept for innovative economic development of Kyrgyzstan for the period up to 2015", as a follow-up to the existing law, "The Law of Kyrgyz Republic on Innovation Activities of 1999".

The new Government (2011) has started to investigate ways and means of improving the country's innovative activities, with special reference to sustainable development and use of green technologies. Order No. 593 "On Complex of activities on ecological safety of Kyrgyz Republic 2011–2016", approved in October 2011, is also providing mechanisms for financing green technologies.

The programmes listed in this order aim to create strategies and policies facilitating the monitoring, accounting and technology transfer of environmentally friendly technologies and methods. Particular emphasis is placed on green technologies, such as in the field of energy efficiency of buildings, the treatment of the solid and liquid wastes, preserving biodiversity, and creating integrated water management.

The order entrusted the newly created State Service on Intellectual Property and Innovations (SIPI), set up on the basis of the former Kyrgyz Patent Office, with the implementation of a range of measures related to intellectual property rights and the promotion of innovation.

SIPI has concluded a cooperation agreement with the Russian Skolkovo Innovation Center. The Center has already developed a number of energy-efficient technologies and solutions to reduce energy consumption of industrial, municipal and private infrastructure/facilities.

SIPI provides partial support to 109 activities related to green technologies in the area of agriculture. The list is available in the document, "Implementation of Practical steps for introduction of innovative technologies in agriculture" (Принятие практических мер по внедрению инновационных технологий в области сельского хозяйства).

The new Government has been working to create a system of links and incentives, as well as new institutions, to develop an infrastructure supportive to innovations. This includes the introduction of some financial instruments (e.g. grant schemes, subsidized loans schemes, tax-relieves) and non-financial instruments (e.g. techno parks, technology transfer centers, annual innovation fairs).

As innovative activities cannot be developed in isolation from the environment in which the economic entities exist, the Government intensified the policy of further economic liberalization aimed at creating a more favorable business environment in the programme, "Stability and Prudent Life" (2011). To this end, it lowered the tax burden on individuals and enterprises, ensured transparency of the regulatory authorities, and will introduce the "Single Window" simplified process for registering small businesses.

Financing remains an acute problem for green technologies start-ups. Banks are more interested in financing infrastructure projects such as roads and power plants than in developing green technologies. Green technology start-ups may require subsidized credit and specialized funds for financing of their projects.

3.2. Infrastructure to access external knowledge

Information and communication technologies (ICT) in particular, the broadband Internet, will provide access to external knowledge and technologies, and thus facilitate the adoption and absorption of green technologies that are available in foreign countries. In Kyrgyzstan, there has been a steady increase in the number of subscribers of fixed Internet, as well as broadband, in the past 10 years. In 2011, there were 115,076 fixed Internet subscribers, and 36,960 broadband subscribers, which represented 2.13% and 0.69% of the population respectively (ITU 2012). This is one of the lowest Internet penetration rates in the world.

Substantive efforts are necessary to improve general technological infrastructure to ensure affordable access by the scientific and business communities to external knowledge in order to facilitate innovative activities in the country.

A technical driver for innovation: the Virtual Silk Highway[1]

The new international telecommunication project "The Virtual Silk Highway", supported by the Kyrgyz Research and Education Network Association, aims to increase information exchange between academic communities in Central Asia, the Caucasus and Europe.

The system is based on advanced satellite technology, which provides good access to the Internet. This helps Kyrgyz researchers and educational institutions to access external knowledge and technologies, including green technologies, and communications with European scientific and educational networks. In the long term, this initiative will contribute to increasing national absorptive capacities for green technologies.

[1] http://krena.kg/krena_en/project.htm.

3.3. The educational system[2]

Main trends and indicators

Following the collapse of the Soviet Union, government support for science and technology fell. In 2012, the Government allocated only 0.11% of GDP to this sector. Such underfinancing of science and technology led many Kyrgyz scientists to leave the country in search of better conditions.

The current volume of research activities sponsored by industry is also very low, as seen in Table 2. In 2010, the total amount of financing to Kyrgyz science and technology was around $ 7 million.

The number of workers in science and technology is shown in Table 3. In 2010 around 3,130 scientists and support staff were involved in R&D work, including more than 961 doctors of science and PhDs.

Each year, there are about 550 to 600 new PhD graduates in science. Among which, 230–260 are in areas related to green technologies, as seen in Table 4.

Table 2. Financing science and technologic activities (millions of United States dollars)

	2006	2007	2008	2009	2010
State-financed science and technology	3.50	5.15	5.71	5.27	5.53
Design and technological works (sponsored by industry)	1.47	1.26	0.95	0.37	0.85
Science and technology services, financed by others	0.73	1.04	0.85	0.55	0.59
Total financing	5.71	7.45	7.51	6.20	6.97

Source: National Statistic Committee of the Kyrgyz Republic, 2012

Table 3. The scientific potential

	2006	2007	2008	2009	2010
Scientist and supportive personnel	3 287	3 140	3 078	3 533	3 129
Number of PhDs and doctors	854	840	853	1 098	961

Source: National Statistic Committee of the Kyrgyz Republic, 2012

[2] This summary is based on Kyrgyz Country Report: Information Exchange in S&T between the European Research Area and Central Asian Countries (www.increast.eu/en/167.php).

Table 4. Number of PhD graduates for all sciences and those related to green technologies

	2006	2007	2008	2009	2010
Physics /mathematics	36	14	26	34	25
Chemistry	7	11	8	4	3
Biological	32	29	20	13	24
Geological/mineralogical	16	33	21	34	42
Technical	47	63	56	62	58
Agricultural	7	10	9	6	3
Economics	89	73	83	80	99
Architecture	3	4	1	2	5
PhDs in green technologies	237	237	224	235	259
PhD graduates in all sciences	565	536	585	559	592
Share of green PhDs in total	42%	44%	38%	42%	44%

Source: National Statistic Committee of the Kyrgyz Republic, 2012
http://stat.kg/images/stories/docs/Ejegodnik/Nauka/nauka%202.pdf

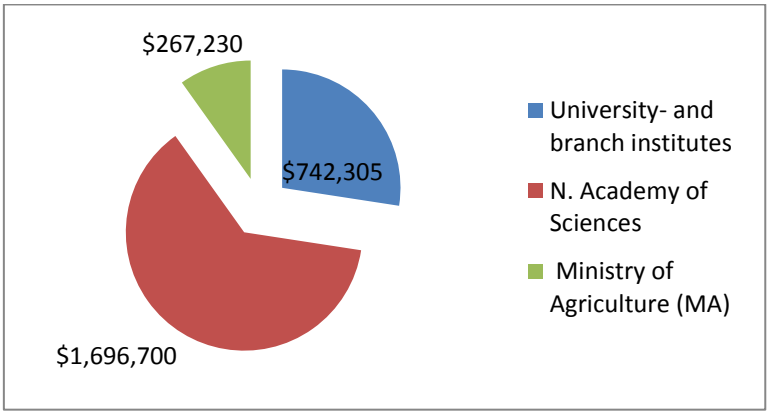
Most of these scientists are working in scientific, research and educational institutions such as the National Academy of Science, universities and State-owned enterprises.

The Ministry of Science and Education has been financing 60 scientific and research institutions, which are located in the universities and their branches. It supported 198 scientific projects, providing som35 million ($742.305) in 2011. In 26 institutes of the National Academy of Science, 51 projects received about som80 million ($ 1,696,700).

In three institutes at the Ministry of Agriculture, 72 projects receive financing totaling around som12.6 million ($267.230). Altogether, the 89 scientific and research institutes and universities conduct 252 of combined scientific projects and receive financing of som127.6 million ($2,693,509).

The National Academy of Science of Kyrgyzstan receives 63% of the total financing provided by the Ministry of Science and Education: 27% of the budget was distributed to the science departments; and 10.5% were allocated to agrarian researchers, as indicated in Figure 2.

Figure 2. Overall financing provided by the Ministry of Science and Education 2011



Source: www.increast.eu/en/167.php

Activities of the National Academy of Science3

The National Academy of Science plays a leading role in developing innovative activities. It has 850 registered researchers, including 154 doctors and 309 candidates of sciences. At present, it is strengthening the green innovative content of its research activities. The Academy also promotes science-industry linkages. In 2011, industry contributed $150,000 to the Academy's budget.

The following are examples of green technology projects that have been implemented under the Academy:

- Project "Renewable Energy Sources": Several installations have been designed with biogas devices, among others. The project is implemented by the Institute of Energy Resources and Geo-ecology and the Institute of Natural Recourses;
- Project "Daisy Micro Hydropower Station": It has designed efficient and inexpensive small-size power plants, with cost-recovery time of a year;
- Installation of different types of micro, mini, and small hydropower stations of different power levels in Suzak rayon villages;
- A one-month training course on "Innovation and Innovation Activity" for the scientific personnel of the National Academy of Science;
- Development of the first techno park of Kyrgyzstan. It commercializes intellectual property, including green technologies. In 2010, more than 15 new green technologies were created. The technopark is working as an intermediary for knowledge/technology transfer and innovation.

The Academy has been active in promoting academy-industry cooperation and creating scientific networks, such as:

- "Shakirt" Information Centre, "Geopribor" Scientific Research Centre, and "Geoservice" Scientific Industrial Centre;
- Public Associations and Funds: "Gul-Butak PA", "Eriantera PA", "Kyrgyz Djun Ltd.", "Medicina-Yug Ltd.", "Topozchu Fund of Mountain Yak Breeding", "Merinos foundation", "Bioresourse PF";

[3] Based on the assessment of the National Academy of Sciences www.nas.aknet.kg/eng/index.php?menu=0.

- A certification laboratory "ILIM ltd.", that certifies products in accordance with international standards (ISO);
- Institutes of the Southern Division of the National Academy of Science, which facilitate development of green agricultural technologies.

The Academy also facilitates the adaptation and dissemination of green technologies. For the period 2008–2011, 58 technologies with green components were adapted and applied for local production. These included: new technologies for automation of renewable energy sources; adaptation of renewable energy sources for local uses; energy-efficient construction materials; and preparation of Kyrgyzstan's regions seismic and landslide forecasting maps.

The Academy is also contributing to the preparation of national and local green strategic projects such as:

- "Fishery development State programme of the Kyrgyz Republic for 2008–2010";
- National programme on the "Preservation and sustainable use of biodiversity of the Kyrgyz Republic until 2012";
- "Issyk-Kul ecological and economic sustainable development programme" for 2011–2013;
- "Complex of measures for securing environmental safety of the Kyrgyz Republic for 2008–2010";
- "Hydro construction programme and reclamation of arable lands in the Kyrgyz Republic for 2008–2010";
- Project "Food Security Programme Concept of Kyrgyzstan for 2009–2013";
- "Prognosis of classical and new types of minerals, comprehensive assessment and prevention of natural and anthropogenic disasters on the territory of Kyrgyzstan".

Status of education promoting green sustainable development

The Technical University in Bishkek and the Kyrgyz State University of Construction, Transport and Architecture have launched a number of educational courses and projects promoting green growth and green technologies[4]. Examples of such courses include:

- Network of schools and universities on monitoring water quality in Kyrgyzstan;
- University-level lecture course on integrated water resources management (IWRM);
- Youth – for preservation of water-marsh ecosystem for Isijk Kul;
- Interactive learning tool "Green Package for Central Asia";
- Improvement of communication strategies for maintaining biodiversity;
- School Project for Application of Resources and Energy (SPARE);
- Solar energy for Kyrgyzstan.

[4] http://ecobilim.kg/obrazovanie-dlya-ustojchivogo-razviti; http://ecobilim.kg/proekty.

4. Conclusions and recommendations

The strategy for adopting and applying innovative green technologies should carefully consider the current status of policy measures, challenges and opportunities which Kyrgyzstan faces. Success depends not only on the improvement of each individual sector, but also on how these separate elements interact. Therefore, a wide range of consultations and interactions with stakeholders—such as the government authorities, business community, civil society, academics, financial institutions and international organizations—are essential to facilitate this interaction

4.1. What are the main barriers to the generation, use and diffusion of green technologies in Kyrgyzstan?

- Insufficient governmental support for R&D related to innovative green technologies;
- Insufficient support for infrastructure for innovations, such as technology business incubators, technology transfer agencies, programmes to facilitate access to finance;
- Insufficient access to ICT, in particular to broadband;
- Lack of ”building codes” for energy-efficient housing;
- Limited availability of public and private funds supporting innovation in green technologies;
- Complicated registration procedure for green small business.

4.2. Which opportunities are unexploited or could be easily developed?

- Hydropower plants: attraction of foreign and domestic investment to improve efficiency of hydroelectricity production, distribution, consumption as well as to construct new energy-efficient hydropower plants incorporating elements of green technology transfer;
- Biogas: both technology transfer and subsidized financing are needed to realize the annual potential of up to 5 million tons of fertilizer and some 200 million m^3 of biogas.

4.3. What can be done to ease existing barriers and take advantage of opportunities?

- Create support infrastructure for innovation, such as technology business incubators, technology transfer agencies and programmes to facilitate access to finance;
- Take advantage of existing international funds for financing green development initiatives;

- Consider alternative financing for infrastructures through public-private sector partnerships;
- Revise the social pricing policy for electricity to help replace outdated/worn-out equipment, renovate/replace dilapidated power generation facilities with the introduction of green technologies, and new investments;
- Adopt regulations and codes on climate-proof and environmentally friendly buildings and infrastructure.

4.4. Which policies could be pursued in creating a supportive environment for innovation in green technologies?

- Establish national public and private funds to support innovation in green technologies;
- Establish a national innovation council for green technologies with the involvement of the scientific and research communities;
- Introduction of innovative green technologies and processes could be established as a prerequisite for investing, in particular in the housing and transport sectors.

Capacity-building will be needed to support the work of those policymakers who are active in introducing and financing green technologies and infrastructures. Foreign investors should be encouraged to develop training activities to build in-country capacity to install, implement, operate and maintain such green technologies.

Strengthening national specialized expertise in green innovations is a prerequisite for ensuring the sustainability of policy interventions.

Information dissemination, outreach and awareness-raising campaigns should be conducted to increase general public awareness and understanding of the benefits of green innovation, so as to overcome potential resistance and develop positive attitudes to the emerging business opportunities.

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Annex: National development strategy of intellectual property and innovations in the Kyrgyz Republic for 2012–2016

DECREE from 23 September 2011, № 593 issued by Mr. A. Atambaev, Prime Minister of the Kyrgyz Republic[5].

In order to develop the intellectual and innovative activities, aimed at creating the conditions for the effective use of intellectual property and innovation in economic, social and cultural development, the Government of the Kyrgyz Republic decrees:

1. Approve the attached:
   - National strategy of development of intellectual property and innovations in the Kyrgyz Republic for 2012–2016 years (hereinafter – The Strategy);
   - Action plan of realization of the objectives of the National development strategy of intellectual property and innovations in the Kyrgyz Republic for 2012–2016 (hereinafter – The Action Plan).
2. The responsibility for the execution of activities to realize The Action Plan entrust to the Ministry of Justice of the Kyrgyz Republic, the Ministry of Education and Science of the Kyrgyz Republic, the Ministry of Agriculture of the Kyrgyz Republic, the Ministry of Health of the Kyrgyz Republic, the Ministry of Economic Regulation of the Kyrgyz Republic, the Ministry of State Property of the Kyrgyz Republic, the State Customs Service under the Government of the Kyrgyz Republic, the State Financial Police Service of the Kyrgyz Republic, the State Agency for Antimonopoly Regulation of the Kyrgyz Republic, as well as the Prosecutor General's Office of the Kyrgyz Republic (by agreement), the Supreme Court of the Kyrgyz Republic (by agreement), the Judicial Department of the Kyrgyz Republic (by agreement), Mayor of Bishkek (by agreement) and oblige the above mentioned bodies to provide to the State Intellectual Property Service under the Kyrgyz Republic information on activities for the realization of the Action Plan.
3. Entrust to the State Intellectual Property Service under the Kyrgyz Republic coordination of the actions of the responsible performers for realization of the Action Plan.
4. State Intellectual Property Service under the Kyrgyz Republic have to submit report on realization of the Strategy, each year by July 10 and January 10 to the Government's Office of the Kyrgyz Republic.
5. Control of the realization of this decree entrust to the appropriate department of the Government's Office of the Kyrgyz Republic.
6. This Decree shall enter into force on the date of publication.

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[5] Informal translation of the original text.