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Promoting Energy Efficiency Investments
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Case study

TAJIKISTAN

ENERGY PRODUCTION AND CONSUMPTION SECTOR

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1. Introduction

Human civilization development is inseparable from energy consumption growth. According to expert estimates, currently global fuel and energy resources grow continuously and sustainably by annual 1-2 %, while energy dependence upon the third countries keeps on growing and is forecasted to make up 70% of the overall consumption as of 2020.

Rapid growth of energy consumption is in the first place determined by global production regular increase. Review of the experience European Union, USA and Japan have accumulated in the area of effective energy consumption proves that it is impossible to overcome energy crisis without national energy efficiency policy and programs and without energy management system in place.

In the space of 15 years following the oil crisis of the 70s, per capita volume of energy consumption has basically stabilized, while the volume of the national product has increased by nearly 30% due to the policy of effective energy use and considerable resources attracted from industrial countries of the West. Comprehensive energy saving policy, whereby these results have been achieved, was founded on rational technical and economic organization of this policy implementation. Should power intensity sustain at the level of 1973, power consumption might have increased by 24% as of 1986 to reach 900 million tons of oil equivalent.

Estimates of the International Energy Agency experts suggest that potential energy saving capacity of CIS countries, Central and Eastern Europe, currently based on the their economy status, is about 24% of the total consumption volume of fuel and energy resources.

The population of the Republic of Tajikistan is 8 million people, including urban population (26, 49%) and rural people (73,5); the territory of the Republic is 144,2 thousand sq.km, incorporating 17 cities, 62 districts, 55 settlements and 368 rural jamoats (village municipalities). Tajikistan has more than 1 million 700 thousand of electric energy consumers.

A new stage of the country development began in 70-es of the 20th century. It was then that the largest hydropower plant in Central Asia - Nurek HPP with the capacity of 3000 mWt was put into operation. This was a turning point both in economy and social life of Tajikistan with considerable and diverse impact on the current development. New energy facilities were built and commissioned in the follow up period, which contributed to energy sector enhancement and the utilization of its resources for the country industrial development. Aluminum production launched in the country proved to be unique for the entire region, while chemical industry rapid development was backed up by operationalization of a new Javan electrochemical complex. To add to that a nitrogen-fertilizer plant, the Dushanbe textile factory and many other production companies were put up, in including machine-building, mining and construction industries. The gross domestic product of the country increased 200 times since 1970.

Beginning with 2000 the average annual GDP growth made up more than 8%, while per capita GDP increased 5, 4 fold to make up 850 US Dollars in 2011. More than 15% of the total national budget or more than 300 million US Dollars are annually channeled to fuel and energy complex development. The gross domestic product of the country, which in 2000 made up 980 million US Dollars, has increased by 7, 5 fold to reach about 7300 million US Dollars in 2012. The share of energy related costs amounting to 60% of the total GDP is rather high, which is due to the country low economic efficiency. To add to that global liquid fuel prices, which are pretty much volatile, have a considerable impact on the general energy costs.

During the most intensive growth of energy consumption (2003-2007), the average GDP growth rate made up 7,2%, which indicates close interdependence of economic growth and that of energy consumption and in fact is a common feature of developing countries. At present economic environment of the national energy sector is characterized by instability whereby presenting potential threats to energy security of

Tajikistan. GDP per unit of consumed energy resources is absolutely low - 0,5$/kg of fuel in oil equivalent that is nearly 5 times lower than the average world figure (2,4$/kg fuel in an oil equivalent).

At the same time in Tajikistan per capita electricity consumption index (2367 kW.h) is nearly 9 times higher compared to the low income countries (269 kWh/person), to which Tajikistan belongs as well. This suggests extremely wasteful energy consumption pattern in the country alongside with the enormous potential to improve efficiency of energy consumption there. Even mere achievement of the world average level may contribute to significant country GDP increase and may ensure sustainable development of its economy. (R. M. Amindzhanova).

Energy generated by hydropower stations (HPS) is of seasonal nature and depends on the river run-off. The lowest energy generation level is observed during autumn and winter periods (from October to April/May), while electric energy demand at this time is the highest. At the same time in summer electric energy supply is the most reliable, as energy surplus during this season may be up to 3-7 billion kWh. Excess of water leads to considerable water escapages, which potentially implies huge losses of the electric energy. Depending on the year hydrological conditions economic damage may reach 90-225 million US Dollars per year. Total energy shortage for consumers of all of national economy sectors (during autumn and winter periods) makes up to 4-4,5 billion kW/h. (*Data of the Report "Rapid assessment and gap analysis of Tajikistan energy sector"*).

At the same time issues of energy security tend to be more and more politicized. Economy growth that has begun in the country may entail significant increase of demand for energy resources (it is expected that energy demand in 2015 will make up 24 billion kilowatt-hours per year), determining the expediency of developing coordinated energy sector specifically aimed at energy efficiency and ensuring energy sector security. Mention should be made that review of energy efficiency for the preceding years in the country is rather complicated, because no reports of this kind have yet been developed or submitted by relevant structures either on municipal or republican level. No targeted funding is stipulated either by local government bodies or by bodies of executive power for running special records of energy consumption and energy efficiency, this is the reason why energy efficiency assessment and energy saving programs are immature and are run so far by amateur specialists.

As far as such energy efficiency features are concerned, such as: resource economy, energy losses reduction due to resource consumption optimization, reduction of production energy intensity and that of production processes, comparison of production energy intensity in reporting and reference periods, then no specific reports are available so far. Based on the International Energy Agency energy intensity of Tajikistan's GDP is 11 times higher than in Russia, 20 times higher than in Germany and China. Low energy efficiency of the Tajik economy is a significant obstacle for economic growth.

Higher energy capacity of Tajikistan economy is due to several factors, including climatic conditions, high depreciation rate of the power equipment used, high share of industry within energy consumption structure (its share is 49%), as well as high energy consumption in households (26%). In recent years this indicator keeps on growing, and mention should be made that energy intensive iron and steel industry (SUE "Tajik Aluminum Company") accounts for 80% of industrial electricity consumption. Another factor of importance is the lower share of services (excluding transport and communication): 30-35% of Tajikistan GDP, compared to that of 60-70% in the developed market economies.

Reducing this gap implies not only direct savings for individual companies in the country, but also enhancement of the competitiveness of producers in general.

Given this situation the Government of the Republic of Tajikistan endorsed the action plan related to energy saving and introduction of new energy-saving technologies

and equipment by its Decree of 2, 2011, № 551 "On Endorsement of the "Program of efficient use of hydropower resources and energy supply for 2012-2016".

To further develop Tajikistan energy sector, its main directions that would minimize the shortage of the national primary energy resources in conditions of limited financing for the period of new social-economic relations set up, were defined as follows:

- Reduction of the intensity of gross domestic product;
- Energy efficiency;
- Import of fuel and energy resources necessary for sustainability of existing power capacities;
- Partial coverage of the deficit of energy and heat supply by the use of alternative energy sources;
- Development and upgrading traditional fossil fuel energy generation based on a cost effective and highly efficient power plants;
- Development of renewable energy generation industry.

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2. Characteristics of the energy sector in Tajikistan

Tajikistan energy policy is formed based on the National Development Strategy (NDS) until the year 2015 (NDS), on the Law of the Republic of Tajikistan: “On Energy” of November 29, 2000, “On Energy Efficiency” of May 10, 2002 and other by-laws endorsed by the Government of the Republic.

The country Ministry of Energy and Industry is in charge of energy policy issues, including policy implementation in the area of energy efficiency enhancement and promotion of renewable energy sources (RES).

The aforementioned legislative acts and regulatory legal documents guided identification of the following objectives set before the Ministry of Energy and Industry:

- Maximum effective use of natural fuel and energy resources as well as energy sector potential for the benefit of economy growth and improvement of the population life quality;
- Repair and reconstruction of the current facilities;
- Construction of new facilities, substations, power transmission lines;
- Wide use of renewable energy sources;
- Implementation of energy saving and energy efficiency activities, upgrading the system of energy metering and switching over to the use of energy-efficient technologies and equipment;
- Reduction of technological and commercial losses;
- Reduction of greenhouse gas emissions in energy sector;
- Improvement of payment discipline, benefits and incentives to energy consumers;
- Comprehensive coal production development in line with the country needs and export purposes;
- Upgrading nontraditional coal use technology through coal gasification and beneficiation for TPP and CHP;
- Carrying out policy aimed at increasing natural gas production and production of synthetic gas from coal in the country.

The given Ministry includes 18 departments, including Department of Power Engineering and Alternative Energy Development, the main functions of which are:

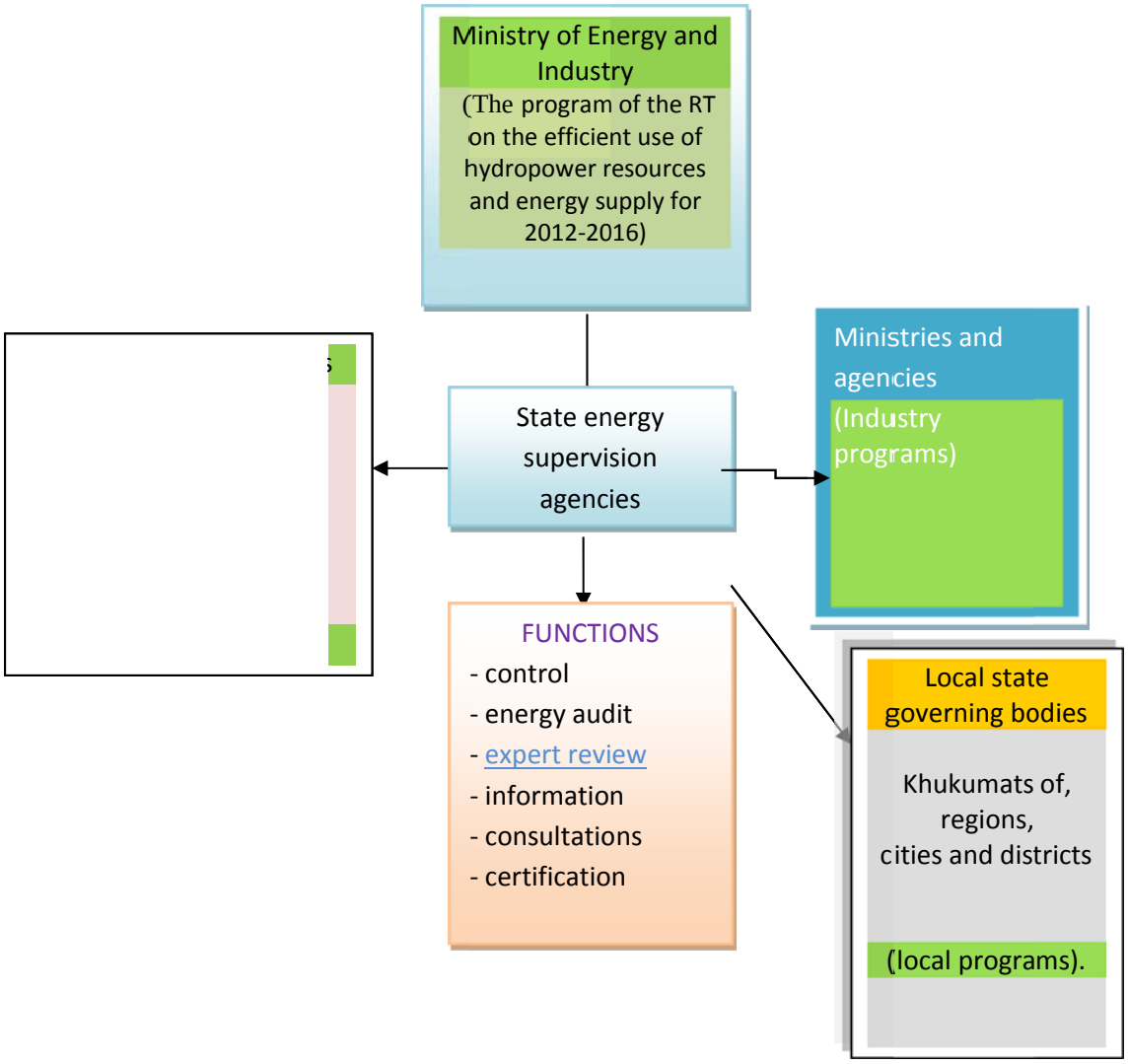
- National energy policy implementation by way of programs, measures and other activity;
- Development of laws, by-laws and other legal documents on energy issues;
- Development and implementation of the policy of energy sector restructuring;
- Implementation of procedures related to issuance of permits and conclusion of

agreements on carrying out any business in energy sector.

The given Department is also responsible for collection and submission of comprehensive data covering issues of energy generation, energy demand and balance, consolidation of these issues in a formal document and also for fulfilment of obligations regarding implementation of the Government resolutions on energy issues within the framework of the country legislation.

The principal coordinator of energy efficiency in the country is the State Power Supervision Agency under the Ministry of Energy and Industry of Republic of Tajikistan.

Management structure of energy efficiency in Republics of Tajikistan



Under the umbrella of the given ministry there function such entities as: an Open Joint-Stock Holding Company "Barki Tojik", SUE "Oil, gas and coal", SUE "Tajiktransgas" and Gosenergonadzor - State Power Supply Inspectorate.

Energy sector restructuring was undertaken in 2001. The former vertically-integrated state power company became a holding joint-stock company (OJSHC "Barki Tochik". The company is in charge of generation, distribution and supply of electric and heat power. In the near future the company is to be divided into three large companies in charge of: power distribution, operation and power transmission system, generation, including thermal and hydro-power plants. In May 2002 a JSC "Pamir Energy Company ("Pamir Energy ") was set up in GBAO under the concession agreement between the

Government of Tajikistan and OJSC "PEC", which the owner and operator of 11 small hydro power plants.

Issues of energy supply, energy-saving and energy efficiency are the responsibility of OJSC "Barki Tochik", which consists of electrical grid complex of the Republic incorporating 23 power plants, more than 56,603 kilometers of power transmission lines and more than 13,436 of different voltage class substations. Currently Tajikistan ES includes 5 energy systems located on the territory of three regions, in areas of republican subordination and in Dushanbe city. Apart from that EC of the Republic performs parallel operation with EC in the Northern provinces of Afghanistan.

Tajikistan possesses vast and inexhaustible reserves of hydropower resources, ranking the 8th in the world in terms of their total volume and takes the first or the second place in terms of reserve-to-volume ratio (per capita and per area unit). 64 cubic kilometers of aqueous runoff out of the 115 km³ n the Aral Sea basin are formed in Tajikistan. Total annual potential hydropower resources in the country amount to about 527 bln.kWh. Available hydropower resources, which are technically possible and economically expedient to make use of, make up 202 billion kWh. However, today Tajikistan uses only 5% of the total estimated volume of hydropower resources.

As of January 1, 2013 the rated capacity of all power sources of Tajikistan, both in terms of electrical and thermal energy sources, made up 5591.52 thousand kWh.: the share of thermal power-stations (TPP) is 320 mW (6.3%) while electric energy is basically generated by the hydropower plants. In 2012 electric energy generation in the Republic made up 16 billion 200 million kWh. Mention should be made that energy generated by hydropower plants accounts for 98% of the total volume while liquid fuel based plants account for 1.9%.

Energy generation in 2001-2012

Table 1

Source of generation	***Unit***	*Years*				
	million kWh	2005	2006	2007	2008	2011
HPP	million kWh	16814,5	16503,3	16935,7	14495,78	16218,0
TPP	million kWh	98,8	197	336,1	252,43	147,490
Total	million kWh	16913	16700	17272	14748	16365,490
import	million kWh	1042	1557	1057	1917	1276
export	million kWh	798,0	948,0	969,0	1054	1232

Solid fossil fuel (coal, due to the lack of technology) and natural gas (due to the limitation of imports) is not used in the energy system of the country for electric energy

generation. In 2012, the share of renewable energy sources (RES) (solar, wind, biomass, etc.) within the total energy production was about 0.01%.

Fuel and energy complex of the Republic of Tajikistan includes production of coal, oil and its processing, an extensive network of gas pipelines, production, transfer and distribution of electric and thermal energy.

The volume of fuel resources, produced annually in the Republic (coal, oil, associated gas, wood, etc.) is about 3.5-4.2 million tons of fuel oil equivalent, which makes up about 12% of FPR needs.

Tajikistan has relatively small reserves of liquid and gaseous fossil fuel, which is the reason of their limited production. Known reserves of oil, gas and condensate available at this point of time make up less than 1% of the total resources, which are estimated at 1,033 million tons. According to the data of 2012, the volume of oil and natural gas production in the country amounted to 28.6 thousand tons and 18.8 million m³, respectively. In 1990 the Republic imported more than 2 million tons of oil products and 2.1 billion m³ of natural gas; currently these figures decreased, respectively, by 30 and 70 percent.

Today forecasted reserves of coal are estimated to be 4.5 billion tons (of which a small portion is extracted, i.e., in 2012 production made up only 412 thousand tons). Reserves of coal fuel are available in almost all the regions of the country, but many of the deposits are located in difficult to access mountainous areas, where communication infrastructure is underdeveloped.

Centralized production of fuel wood and wood waste in the country is estimated to be 0.04-0.05 million tons oil equivalent. Projected annual volume of fuel wood for 2015 has no trend to increase due to the limited scale of the natural forests and forest plantations.

Main energy resources of Tajikistan compared to other Central Asian Countries (Table №2)

Fossil fuel reserves	Unit	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Total
Crude oil	MTOE	1,100	5.5	1.7	75	82	1,264.20
Natural gas	MTOE	1,500	5	5	2,252	1,476	5,238
Coal	MTOE	24,300	580	500	Insignificant	2,851	28,231
Total	MTOE	26,900	591	507	2,327	4,409	34,734
% of total		77.4	1.7	1.5	6.7	12.7	100
Hydropotential	GWh / year	27,000	163,000	317,000	2,000	15,000	524,000
	MTOE/year	2.3	14	27.3	0.2	1.3	45.1
% of total		5.2	31.1	60.5	0.4	2.9	100

Tajikistan economy is mainly dependent on imported energy resources. Only 10-15% of the country needs are met by its own primary energy resources. Supply of energy resources out of the country own production in 1990 made up 12,8%, which is 5,7 mln tons of fuel equivalent.

In future this share will get down due to the reduction of internal oil production.

Tajikistan imports the lion share of such energy resources as oil and gas. Russia and Kazakhstan are responsible for the major part of these resources. In 2011 energy import amounted to: natural gas 15%, oil and liquefied natural gas (LNG) 6% and fossil coal 0.5% relative to balance needs of the republic in energy. Total dependence on imported energy was: 23.64% for electricity, 85% for natural gas and 99.8% for oil and oil products. Volumes of energy supply to RT from the countries of the region since 2009 has reduced by 4 billion kilowatt-hours due to destruction of a united power grid of Central Asia.

Forecasts of the needs of Republic of Tajikistan in energy resources

Table 3.

№	Energy products	Short term forecasts (2006 – 2009)	Mid-term forecast (2010 – 2015)	Long-term forecasts (2016 – 2030)
1	Electric energy (bln.kWh)	24,14	28,12	35,18
2	Natural gas (bln.m³)	0,24	0,29	0,38
3	Oil and oil products (mln.t)	0,9	1,6	2,8
4	Mixed brand coal (mln.t)	0,6	0,9	1,7

(Data of the Concept of Transition of the Republic of Tajikistan to Sustainable Development)

Within the structure of the end-users 4 major groups of energy consumption are identified:
- Energy consumption by households (lighting, heating, etc.),
- Energy consumption by industries,
- Energy consumption by transport (gasoline, electricity, etc.),
- Energy consumption for rendering commercial and public services (energy used by organizations but not by production companies such as plants and factories)

These 4 major consumption groups typically are responsible for 80 to 90% of the final energy consumption.

The current energy consumption in the Republic of Tajikistan is characterized by a very complex structure. The share of industry within the total consumption of fuel and energy resources in the Republic makes up approximately 49.2% (minus internal needs and losses of power plants), and another 9% are accounted for construction and transportation, 11% for agriculture and mechanical irrigation and 26.1% for public living needs and services, 10.5% for other consumers.

Electric energy consumption in 2005-2012 .

Table 4.

Consumer group	Unit		Y	E	A	R	S	

		2005	2006	2007	2008	2009	2010	2011
TALCO	million kWh	6282	7108	7223	7107,3	6365,17	6543,0	6340,6
industry	million kWh	905	1005	795,6	622,32	438,58	450,8	436,8
Mechanical irrigation	million kWh	1546	1677	1648,7	1521,14	1497,65	1539,5	1491,8
Agriculture	million kWh	57,2	56,3	31,4	28	15,86	16,30	15,79
Budget	million kWh	426	410	478,2	480,23	420	431,7	418,3
Residential customers	million kWh	3941	3352	3044,6	2818,25	3617,80	3718,9	3603,8
Others	million kWh	438	423	1179,4	1140,93	1452,85	1493,4	1447,2
Total productive supply	million kWh	14110	14539	14401	13718	13808	14194	13755
Technical losses	million kWh	3048	2728	2940	2970	2086	253,3	2295,2
	%	17,8	15,7	16,9	17,8	13,12	13,7	14,3

(Data of OJSC "Barki Tochik")

Of course, not all of the generated energy is spent on the needs of end- users, some of it is spent on transformation of one kind of energy into another; besides some energy is lost in transmission over a distance. The remainder is for consumptive use. Energy consumption of Tajikistan for energy conversion and transmission accounts for 35-38%, while consumptive use makes up 62-65% of energy. This figure is higher by 3-5% compared to developed countries. Optimization of only these energy costs may potentially lead to reduction in overall energy consumption and consequently to energy intensity of GDP by up to 10%.

Currently the Republic experiences serious difficulties and deficit in energy sector. The current deficit (3.5 - 4 billion kWh) of elect energy and introduction of consumption limits (particularly in winter time) are due to the limited water and energy resources of the Nurek water reservoir, low tariffs, losses due to depreciation of plant equipment. This deficiency is also associated with underuse of alternative energy sources, energy-intensive industrial product and excessive electricity consumption by population, high prime cost of fuel supply for thermal power generation, persisting problems related to export of electric energy surplus.

Persisting electric energy deficit in Tajikistan is also determined by the limited internal financial possibilities of the country, high capital intensity of modernization and construction of large HPP, by development and production of natural gas, coal, oil, and

alternative energy generation, construction of new transmission lines, including the for electric energy export.

At the same time, inability to ensure security of energy supply reflected existing systemic problems in the country energy sector. Deprecation of fixed assets in use in power industry on the whole makes up 60-65%, including more than 75% in the rural distribution networks. Equipment, being the electric power technical basis, is obsolete, does not meet current stage requirements and comes short of the best global products.

Another cause of power shortage is the shortfall in generation capacity of Dushanbe thermal power plant (TPP) (198 mW) and that of Javan TPP (120 mW) in the autumn-winter period, which is associated with shrinking supply of natural gas and oil products to the Republic of Tajikistan as well as with constant increase of energy cost.

Ecological indices of energy sector

The energy sector (production and use of fuel) and industrial processes (cement and aluminum production) are the most substantial sources of anthropogenic emission of greenhouse gases in Tajikistan. In the period from 1990 to 2012 the highest CO_2 emissions in the republic were registered in 1990 (117,970.9 Gg), which were basically due to dramatic reduction of fuel combustion, while the highest absorption volumes (1,929.06 Gg) were registered in 2003. In general, CO_2 emission has reduced by five-sixfold during the last 20 years due to reduction of fuel consumption for electric energy generation (TPP), consumption reduction by transport and population and sharp decline of industrial production (cement, ammonia). Since 1996 the carbon dioxide emission has almost come up to the CO_2 absorption level.

Emissions of carbon dioxide by 2012 in energy sector compared to 1990 made up slightly more than 2 million tons, which in carbon equivalent amounts to 12-15% of the 1990 level. At this, the GHG emissions associated with international transportations, as well as with biomass-based energy generation for the population are not taken into account given that no big facilities on fuel processing and transportation are available in Tajikistan and emissions in this sector are insignificant.

Contribution of fuel extraction and energy generation sector to overall carbon dioxide emission is insignificant - 0, 37 % (1990) and 0, 46 % (2008). This is due to the fact that a considerable proportion of electric power (98,6% in 2000 and 2012, accordingly) in Tajikistan is generated by hydropower stations. Electric energy generation by existing Dushanbe and Javan TPPs does not exceed 1.8% of the total volume of electric power generated.

Negligible volume of methane emission is observed in energy sector (coal mining). Dynamics of methane emission indicates its reduction in 2011 compared to 1990 by 64%.

2. Overview of the former regulatory- legal base in the area of energy efficiency and analysis of its specific gaps

During 90s and all the way to 2012 the Republic of Tajikistan switched over to the use of electric power for heating and cooking due to limitation of imported natural gas supply as well shortage and high cost of other kinds of fuel. Domestic consumption of electric power by a population has increased more than fourfold - from $1 billion kWh to 4.5 billion kWh a year compared to the beginning of the 90s. In spite of this rural population accounting for 73% of the country population, consumes only 9% of the total electricity volume consumed in Tajikistan. In 2011, the specific energy consumption per capita was: per urban resident - 1000 kWh a year, per rural person - 250 kWh a year (which is less severalfold compared to specific energy consumption by the people in developed countries).

To add to that, terminated agreements on parallel operation of power systems of Central Asia, including mutual energy supply and transit, resulted in the fact that Tajikistan has lost the opportunity to transmit its energy excess in summer and to cover deficit in winter, in low water period, through cheap import from neighboring countries.

This situation hindered problem solutions in transition to sustainable economic development and energy security of the country, which required undertaking urgent policy measures towards updating energy sector-related regulatory-legal base to ensure energy-saving and energy efficiency (adoption of new laws, introduction of amendments to some of them).

Thus, in the space of the last 12 years the laws: "On Energy" of November 29, 2000, "On energy efficiency" of May 10, 2002, "On the use of renewable sources of energy" of January 7, 2010, "On production and use of coal" № 668 of May 16, 2011, as well as the Decree of the President of the Republic of Tajikistan "On additional measures for the economical use of energy and energy efficiency " of April 24, 2009 have been adopted, which proved to be a framework foundation for energy conservation and energy efficiency development.

The adoption of these laws was followed by a series of specifying documents, for example, Regulations of the Government of the Republic of Tajikistan:
- of August 3, 2002, № 318 "On approval of measures aimed at the implementation of priority projects in the sphere of electric power 2003-2015.";
- of August 3, 2002 № 318 "On the Concept of development of industries of Tajikistan fuel and energy complex for the period 2003-2015;
- of February 2, 2009, № 73 "On a long-term program to build a cascade of small hydropower plants for 2009- 2020."
- of November 2, 2011, № 551 "On endorsement of the "Program on the effective use of hydropower resources and energy supply for 2012-2016"".

Government Regulation of August 3, 2002 № 318 "On the Concept of development of Tajikistan fuel and energy complex industries for the period 2003-2015" stipulated implementation of energy efficient measures in three stages.

Major objectives of the first stage (2003-2007) included temporary suspension of energy production decline below the level of 2000-2001 through rehabilitation of existing power facilities, use of advanced technologies and introduction of market prices for energy resources that contribute to self-financing of fuel and energy complex industries and to specified level of their profitability.

During the second phase (2007-2011) fuel and energy complex development should be achieved through introduction of new hydropower facilities, geological exploration and infrastructure development of new oil and gas deposits as well coal extraction and processing technology upgrading alongside with alternative energy (solar power plants , wind power plants and etc.) development.

During the third phase (2011-2015) energy sector upgrading should be performed based on export of energy resources (electricity and coal) of the Republic of Tajikistan to the markets of the Euro-Asian countries and overseas countries.

Measures aimed at the implementation of priority projects in the electric energy sphere for 2003-2015 have been endorsed by the Government Regulation of August 3, 2002, № 318 alongside with the identification of specific projects for construction hydropower plants, thermal power plants, new gas turbine power plants with the power generation capacity from 50 to 300 mW, restoration and reconstruction of existing hydropower plants, PTL construction and rehabilitation of domestic and regional significance, indicating the volume of investments, as well as sources of domestic and foreign investments. Total capacity of power plants under construction and those planned for construction is 3670 mW.

The main objective of these projects implementation was attraction of foreign investments. Within this context an agreement between the Government of the Republic of Tajikistan and the Government of the Russian Federation on share participation in

the construction of Sangtuda HPP-1 was signed on October 16, 2004. In accordance with this Agreement the Government of the Russian Federation has invested and completed the construction of Sangtuda HPP-1 (670 mW) in 2010 through acquisition of OJSC "Sangtuda" shares in the amount of $250 million USD. Besides that a Memorandum of Understanding between the Government of the Republic of Tajikistan and the Islamic Republic of Iran regarding the construction of "Sangtuda HPP-2 (220 MW)" was signed in 2005. This facility is about to be completed. The country has implemented a number of investment projects related to rehabilitation of existing power generation facilities, such as Nurek HPP, Vahsh and Varsob cascades, Qayroqqum HPP, Dushanbe and Javan TPP.

In October 2006 the Government of the Republic of Tajikistan adopted the Programme on construction of small hydropower plants during 2007-2020 in order to stabilize power supply of remote mountainous areas of the country.

The said program stipulates for construction of 189 small hydropower plants with the total capacity of 75.6 mW and with generation of 800 million kWh of electricity per year. 70 small hydropower plants have been built and put into operation due to investments of the Government of the Republic of Tajikistan, "Barki Tochik" and with the involvement of investment funds of the Islamic Development Bank, the Asian Development Bank and UNDP prior to 2012. To implement the aforementioned projects capital investments in the amount of $ 9 billion USD were allocated in 1998-2012.

During 2005-2012 the following energy efficient projects have been implemented:

- 70 small hydro power plants with the total capacity of more than 22 mW ($ 11.6 million USD);
- 220 kW PTL "Lolazor - Khatlon" ($ 66.7 million) and "South - North" -500 kW (334.5);
- The energy sector recovery ($ 69.3 million);
- Reconstruction of Dushanbe-based electric networks ($ 15.7 million);
- Construction of 220 kW PTL "Khujand-Aini" ($ 36.9 million);
- Construction of 220 kW PTL Tajikistan Afghanistan ($ 58.0 million);
- Construction of Sangtuda HPP-2 ($ 256 million);
- Construction of 220 kW outdoor switchgear of Nurek HPP ($ 39.2 million);
- Construction of 500 kW indoor switchgear of Nurek HPP ($ 66.9 million);
- Project on reduction of electric energy technical losses ($ 17,150 million);
- Operating systems and data collection in the main center of Operating system (project cost $ 21.6 million USD);
- Reduction of energy losses in Sogd region (66 million Euro) within the framework of the project on energy losses reduction through investments of the WB, Swiss Government and OJSHC "Barki Tochik" (project cost $ 19 million USD);
- Replacement of 170434 induction electric meters for electronic ones in Dushanbe city.

Thus, as a result of the implementation of these projects power generation has increased by 1,000 mW, which significantly increased the possibility of physical access of the population of Tajikistan to electricity generated and in this way to minimize to the extent possible limited supply of electricity in the winter.

It should be noted that investments into energy efficiency after 2005 in Tajikistan have increased more than 3 fold and reached almost 3.5% of GDP with budget funding from all sources amounting to at least 30% of investment costs, GDP energy intensity decreased by about 30% compared to 1995.

Development of energy resources of Tajikistan and implementation of energy efficiency projects are very important from the point of view of regional and global contribution to environmental pressure reduction, bringing down carbon dioxide emission into the atmosphere as well as negative impacts of climate change. If 1 mW coal-based thermal power plant emits GHG in the amount of 6.3 thousand tons of CO_2 a year, then generation of 1,000 mWh of electric energy by hydropower plants in Tajikistan will emit GHG in the amount 0 tons of CO_2 a year. As a result, the annual reduction will make up 6 million 300 thousand tons of CO_2.

The Tajik Government approved the Program on the use of renewable energy sources for 2007-2015 by its Decree of February 2, 2007, # 41. The program stipulates:

- Development, creation, research and implementation of advanced renewable energy systems.
- Production of pilot samples of renewable energy power plants.
- Creation of a production base for manufacturing parts and components for power plants and renewable energy systems.

Gaps in the former energy efficiency policies.

In recent years the Government of Tajikistan has made significant progress in implementing short-term and long-term projects on construction and reconstruction of energy generating facilities and on energy efficiency; however, currently there are many gaps and shortcoming in the Republic. They are associated with deficiencies in legislation that adversely affect the implementation of the state policy in this area.

Development of a modern regulatory framework is a key condition for the development of energy conservation and energy efficiency in the country. In the period after 2000 the laws "On Energy" dated November 29, 2000, "On Energy Saving" of May 10, 2002 and "On the use of renewable energy sources" of 7, 2010 were adopted.

Under these laws, the Ministry of Energy and Industry by its orders approved the following regulations:

- "On the rule of cataloging power plants that use renewable energy sources in the Republic of Tajikistan";
- “Procedural Guidelines on obtaining permission for installation and territorial distribution of power plants, operating on the basis of renewable energy sources;
- "Guidelines for defining regulated tariffs related to electric energy (heat) generated by RES facilities ";
- Application for preliminary coordination of projects on construction of power plants using renewable energy sources;
- "Standard electric energy purchase-and-sale contract";
- "Safety specifications regarding safety and operation of energy plants using renewable energy sources”;
- "On Approval of Instructions regarding procedure of connection (hooking up) facilities using renewable energy sources";
- "Regulations concerning relationship between a network operator and operating staff or a person responsible for the operational use of technological, electrical equipment by a renewable energy generator."

The following national standards have been approved by the Order of "Tajikistandard» № 07-Article 01. 09. 2010:

Alternative energy. Wind power. Terms and definitions.

Alternative energy. Small hydropower. Terms and definitions.

Alternative energy. Solar energy. Terms and definitions.

Alternative energy. Solar energy. Solar Collectors. Test methods.

Alternative energy. Solar energy. Solar Collectors. General specifications.

Alternative energy. Solar photovoltaic modules. Types and basic parameters.

Energy saving. Informing consumers about energy efficiency of household and domestic goods.

On recommendation concerning electrical equipment and electrical energy certification. Terms and definitions.

The by-laws and regulatory-legal acts adopted are basically relevant for renewable energy sources (RES), while no normative, regulatory documents have so

far been passed with regard to other directions of energy saving policy and measures or they have been passes with delay.

Analysis of the Law "On Energy Saving" of May 10, 2002 shows that the Law does not provide for legal regulation of energy saving and energy efficiency, including:

- Lack of specific definition regarding responsibilities of heads of agencies and organizations, lack of information pertaining to legal requirements as to rational and efficient use of energy resources and use of energy saving technical potential;
- The law does stipulate organizational work on setting up Republican energy service company and energy service enterprises.

The energy service company with a network of subsidiaries can be an important element within the structure of energy saving and of energy efficiency management in the country, designed to meet the challenges of:

- The organization of energy audit in the public and industrial sectors;
- Implementation of energy services;
- Promotion of energy-saving and energy-efficient equipment;
- Implementation of financial mechanisms of energy saving and energy efficiency enhancement.

- The law does not define the state support and creation of favorable investment climate, nor does it define the investor legal status. The capacity of public and private-sector in terms of investment attraction for energy efficiency enhancement is lagging behind in its development. This is due to insufficient knowledge of senior management and key specialists of enterprises in identifying and managing cost-effective investments for energy efficient projects, business planning, preparing bankable proposals and applications for loans.
- Despite the fact that public sector has a significant potential for energy efficiency, the Law does not define the necessary funding of budget organizations for the implementation of legislation on energy conservation;
- Inconsistency of authorized institutional structures, responsible for coordination of energy efficient policy, including investment activity in the sphere of energy conservation and energy efficiency.

One possible solution of this problem is the establishment of the National Centre for Energy Efficiency, which should be a body independent of the government management. Effective system of energy management should be established in all the companies, especially in energy-intensive ones.

- Other factors that impede investments into energy-efficient technologies and renewable sources include shortcomings in the tax legislation, inadequate energy tariffs, low purchasing power of consumers, shortage of public investments into project financing, shortage of funds of commercial banks, inadequate capacity for project preparation, low profile of housing and community amenities in project development and their implementation, poor awareness about the need to improve energy efficiency.

Introduction of amendments into legislative documents, which provide for specific definitions concerning incentives and mechanisms of implementing projects in energy efficiency. Identification of authorized institutional structures responsible for coordination of investment activity in the field of energy efficiency, setting up a national energy efficiency fund, development and endorsement of guidelines for the calculation of regulated tariffs and prices for electric (heat) energy on retail (consumer) market. Implement measures aimed at improving initiatives of housing and community amenities on development and promotion of energy efficiency projects.

- Inadequate work in the field of investments into operations with CO_2 emission quotas.

It is necessary to boost the initiatives of agencies and companies from public and private sectors in the sphere of investment project development to be able to implement

commitments stipulated by Kyoto Protocol. These funds are used to compensate for quotas for GHG emission reduction by developing countries and countries in transition.

3. Description of policy measures undertaken, analysis of economic, social and environmental outcomes of their implementation

During the years of Soviet power the most wasteful economy, in terms of energy resources, was there in Tajikistan and in other Soviet republics, in which more than 40% of energy was lost during production, transmission and consumption. Energy consumption rate per 1 m² of a living space in the country amounted to more than 600 kilowatt-hours, while this rate in Norway was only 25 kWh.

At the same time, a long period of inefficient energy consumption in Tajikistan has created a huge untapped potential for energy saving, estimated as 32% of the total consumption rate of fuel and energy resources in 1992 (12 million tons of fuel equivalent). In fact, investments into projects targeted at increasing generation capacity are doomed to success, given that the shortage of electric energy is not to be compensated today by mere energy generation increase; the focus today should be made on introduction of energy-saving technologies.

Experience of developed countries shows that one of the main pacing factors of economic growth is introduction of energy-efficient management system, which will optimize energy consumption, increase power supply reliability and ensure reduction of greenhouse gas emissions. Therefore, making use of existing energy saving potential in Tajikistan has become a priority of energy and economic policy of the state.

In recent years energy conservation and energy efficiency issues have become particularly pertinent in the country and have been integrated into such policy documents as annual messages of the President of the Republic on "Principal Directions of Tajikistan Social and Economic Development", "National Strategy of socio-economic development of Tajikistan during the period before 2015," "The Programme of anti-crisis measures of the Government of Tajikistan for 2009 and subsequent years."

An important direction the energy conservation and efficiency policy implementation of was outlined the Decree of the President of Tajikistan of 24 April, 2009 "On additional measures towards economical use of energy and energy conservation," which set the goal of reducing GDP energy intensity of Tajikistan as of 2020 by at least by 30% compared to 2009, as well as ensuring efficient and environmentally rational use of energy and energy resources.

The Decree provides for development and adoption of the national energy conservation program by the year 2012, stipulating wide-scale use of energy-efficient technologies and renewable energy sources, implementation of energy-efficient innovative projects, including those in the public, housing and communal services sector.

In pursuance of the given Decree the Government of the Republic of Tajikistan adopted the Resolution on November 2, 2011, № 551 "On approval of the "Programme on efficient use and conservation of power resources for 2012-2016 """, and currently the drafted new Law of the Republic "On energy saving and energy efficiency enhancement", providing for creation and implementation of resource-saving, environmentally friendly industrial technologies" is being considered by the Parliament.

As of one of the priority measures towards the implementation of this Decree, is the implementation of the program promoted by the President on transition to the use of compact fluorescent lamps, which are considered to be the most energy efficient and perfect light sources. According to the President, this problem solution may be the complete abandonment of the use of incandescent lamps. In this regard, the Tax and Customs committees have been requested "to submit specific proposals to the Government of the Republic of Tajikistan as to introduction of staged restriction on incandescent lamps import."

Economic benefits of the use of energy saving lamps

According to statistics the average family in Tajikistan spends 12% of its income on housing and utilities. A considerable share of these costs is payment for electricity, which is in the first place due to increasing number of household devices that are used every day.

Nowadays, people in the Republic pay 2.5 cents per 1 kilowatt of electricity. As a result accumulated monthly payment makes up quite a considerable sum of money, but if to calculate how much money is spend on electricity a year?

Table 5. The ratio of traditional incandescent lamps and energy-saving ones

Incandescent lamp	Energy-saving lamp
9W	45W
11W	55W
13W	65W
15W	75W
18W	90W
20W	100W
25W	125W
30W	150W

As described above, the capacity of energy-saving lamps is about fivefold more compared to traditional ones and instead of lamps of **100** watts it is enough to use lamps of **20** watts.

Due to the mechanism of action of energy-saving lamps energy consumption can be reduced by 80% compared to incandescent lamps with similar light intensity.

Calculation of energy electricity and money costs when using energy-saving lamps.

Table 6.

The calculation is done based on the fact that a lamp is on **5** hours a day. An incandescent lamp life is **1000** hours, that of energy saving is **12000** hours. It is also believed that **1** energy saving lamp of **20** W is equal to incandescent lamp of **100** watts in terms of light intensity.

Lamp	Incandescent lamp	Energy-saving lamp
Capacity	100 W	20W

Price	3 somoni	9 somoni
Life	1000 hour/5h in day=200 days 200 days / 30 days = 6.5 months	12000 hours / 5 h per day = 2400 days 2400 days / 30 days = 80 months 80 months / 1 2mes = 6.5 years
The cost of lamps for 6.5 years	12 lamp x 3 somoni =36 somoni	1 lamp x 9 somoni =9 somoni
Electric energy costs	100 W=0,1 kW 0,1кW x 12000 h x 0,11 somoni./кW.h=132 somoni 132 somoni +36somoni for lamps =**168 somoni**	20W=0,02кW 0,02кW x 12000h x 0,11 somoni./кW.h =26,4 26,4+9 somoni for lamp=**35,4 somoni**
Total:	***It turns out that the use of an energy-saving lamp, in spite of high cost, is 4,7-5 fold more cost-effective compared to a cheap incandescent lamp.***	

(*Here the electricity tariffs for Tajikistan, as of 2013 have been used).*

The price of electricity keeps on growing and when it is close to the global one (25-30 cents per kWh), as stated above, is not difficult to calculate the near-term outlook. The energy saving issue is becoming a topical one.

Comparison of operating costs for production area illumination

	Energy-saving lamps	Incandescent lamps
Costs of lamp replacement, a year, USD	50 lamps X 2USD =100	1000 lamps x 0,65 = 650
Operating life, hours a day	16	16
Operating life, days a year	300	300
Operating life, hours a year	4800	4800
Cost of electric energy, USD/1kW	0,5	0,5
Electric energy related expenditures, USD	9850	15595
Expenditures a year, USD	10000	16345
Total expenditures a year, USD	10000	16345
Operating costs related savings a year, USD	6345 38,8%	

The calculations above manifest the reduction of annual operating costs for production area by 38,8%. Similar calculation for a warehouse complex would show the savings outcome from 45% to 65%.

The total electricity saving due to the use of fluorescent lamps in the RT

Table 7.

The total number of lamps used in the country	25472322 pcs
- Energy consumption using incandescent lamps of 100W (with a 5-hour illumination per day)	100Wx5h.x25472322 lamps =12736161 kW/h x 366 days = 4,6 bln.kWh (14 bln.kWh.: 4,6 = 32,8% of the total electricity consumed).
- Consumption of electricity using energy-saving lamps of 40 watts (with a 5-hour illumination per day)	40Wx5h. x 25472322 lamps = 5094465кW/h x 366 days= 2,0 bln.kWh. (14 bln.kWh.: 2,0 bln. kWh =14.2% of the total electricity consumed).
Economy of electric power	4,6 bln.kWh – 2,0 bln.kWh = 2,6 bln.kWh

With the use of energy-saving lamps reduction in the annual electric energy consumption in the Republic will make up 43.4%.

The use of energy-saving lamps instead of traditional incandescent ones implies less carbon dioxide emissions due to reduction of electric energy consumption as one of the main causes of climate change.

Reduction of CO_2 emissions can be determined approximately at the rate of 0.51 kg of CO_2 per 1 kWh. So while saving 2.6 billion kilowatt hours of electricity through the use of fluorescent lamps in the Republic of Tajikistan CO_2 emission reduction achieved is: 2.6 billion kWh h x 0.51 = 13.3 thousand tons of CO_2.

The process of mass switch over to energy-saving lamps in the country started on May 1, 2009, which was completed by the end of the same year.

In line with the given Decree local authorities and social protection bodies were requested to provide energy-saving lamps to 241,000 of low-income families by October 2009. These families got about 2 million energy-saving lamps, due to compensation from the state budget in the amount of 3.3 million USD.

In the space of 2009-2011 two new plants for production of energy-saving lamps (OJSC "Charog" and LLC "NPIK Somone Energy") have been built and put into operation, the production capacity of each of them amounts to 3 million lamps per year.

One of the target areas in the country is the street lighting, which accounts for over 25% of the total electricity costs of in many cities. More than 86% of the total number of street lighting systems is equipped with inefficient lamps. The Ministry of Energy and Industry of Tajikistan has decided that one of the key measures to resolve this problem would be more active promotion of LED lamps and downlights through the use of state orders.

A business project has been devised in line with the Order of the Government RT (№ 56235 (14-5) of 14.08.2012), which is currently forwarded to relevant line ministries and agencies. Activity towards development of legislative and regulatory base as well as estimates of cost-efficiency and other work aimed at addressing issues related to the introduction of LED lamps across the country is in the progress. The Government of the Republic is also assisting in the project financing on favorable terms, which is reflected in the Assignment #41840 (14-7) of 04.10.12, forwarded to the Ministry of Finance, Economic Development, Energy and Industry.

According to tentative preliminary forecasts developed, investments into production of LEDs seem now to be more promising and profitable than into manufacture of compact fluorescent lamps in terms of energy efficiency, cost-effectiveness, safety for human health and the environment.

Estimates of electric energy savings through complete transition to the use of light-emitting-diode (LED) lighting equipment on the entire territory of the Republic

Table 8. ***(in bln.kWh)***

Structure of consumers	**Industry**	**Population**	**Government organizations, HCE**	**Total:**
Consumption of electric energy for illumination in 2011	0,223	0,810	0,363	1,396
In Somoni	72 463 850,00	89 569 800,00	70 422 000,00	232 455 650,00
Consumption of electric energy for illumination in complete transition to light-emitting-diode-based (LED) illumination	0,12265	0,4455	0,19965	0,7678
In Somoni	39 459 076,00	50 361 512,45	34 151 745,45	104 617 410,00
Electric energy savings	**0,10035**	**0,3645**	**0,16335**	**0,6282**
In monetary terms (somoni)	**31 302 118,25**	**33 342 605,40**	**27 942 338,95**	**92 587 062,60**

One of the most important effectiveness factors of switching over to light-emitting-diode (LED) lighting, is energy saving in the amount of 0.6282 billion kilowatt / hours.

In cases of complete transition to light-emitting-diode (LED) illumination Tajikistan will save 4 billion 733 million somoni or nearly $ 1 billion USD in 20 years.

Light-emitting-diode (LED) lamps are not manufactured in Tajikistan and they are more expensive in terms of production costs. However, "Company Somone Energy" Ltd has developed a business plan for establishment of LED and lighting ware production.

For successful project implementation the Company has devised a plan for 2012-13 and as of today some work under this plan has already been completed.

Pre-project work plan on setting up an assembling production of LED lamps. ***Table 9***

Activity	**Dates**	**Responsible persons**	**Cost, somoni**
Project business plan and feasibility study development	From 01.01-01.09.12	Chief engineer, Economist, with the involvement of other specialists	**19400,00**
Familiarization with production, participation in workshops, exhibitions	Throughout the year	Director, Chief engineer, founders	**135800,00**

Acquisition of technical documentation, obtaining technical specifications and other documents	Throughout the year	Director, Chief engineer, technologist	**106700,00**
Coordination of the project with the State and local regulatory authorities, participation in the state environmental and technical expertise	Throughout the year	Director Chief engineer	**29100,00**
Obtaining limits on electric energy	As of 01.01.13.	Chief engineer	**5820,00**
Organization of on-site training in China-based company	01.11-.25.12.12.	Director, Chief engineer, Director of HR department	**116400,00**
Acquisition of assembly kits for LED assembling and mastering assembly technology	01.10-01.31.12.	Chief engineer, technologist	**179450,00**
Organization of conferences, workshops, project presentations	2012-2013	Director. founders	**20370,00**
Promotion and market research	constantly	Marketing department	**29100,00**
Total:			**601400,00**

The project will be implemented in production sites of LLC "NPIK Somon Energy", which is located in the center of Chkalovsk, Sughd region. To implement the project the company needs a loan of 7925 385.00 somoni, including 6,898 640.00 TJS for procurement of auxiliary equipment, 1026 745.00 - for the purchase of vehicles.

The contribution of the project is 9,884 785.00 TJS; for the pre-Project works - 601,400.00 TJS; for the repair, rehabilitation and preparation of the project premises and engineering services -1358000.00 TJS.

Demand for Investments, by years (in somoni). Table 10.

Costs, including VAT) and customs dues.	**2013y**	**2014y**	**Total**	**Source of funding**
Basic and anciliary equipment	4607500,00	2291140,00	898640,00	borrowed funds
Service Bus (2 pieces)	-	615950,00	615950,00	borrowed funds
Mini-truck	52380,00	-	52380,00	borrowed funds
Cars (2 pcs)	-	193515,00	193515,00	borrowed funds
Heavy-lift truck	164900,00	-	164900,00	borrowed funds
Total borrowing needs	**4824780,00**	**3100605,00**	**7925385,00**	borrowed funds

Representatives of the relevant ministries and agencies, local and international financial institutions - participants of the Republican Scientific conference held at the Ministry of Energy and Industry of Tajikistan on 17.07.2013, committed to the introduction of LED in the country, endorsed the request to the Government of the Republic of Tajikistan on support the given project.

5. Possibilities for further perfection of political measures and their wider application to benefit from energy efficiency potential.

Today normative legal base in the field of energy conservation and energy efficiency in PT is practically in place and the country entered the planned course of the implementation phase. The "Programs on the effective use of hydropower resources and energy supply for 2012-2016" endorsed by the Decree of Government of the Republic of Tajikistan of November 2, 2011, № 551, contributes to this.

Given the structure of the major energy consumers in the Republic of Tajikistan, and specifics of energy efficiency enhancement in certain sectors, the following directions for the implementation of program activities have been identified:

- enhancement of energy efficiency in power industry, in industry, in budget sector, in heating and utilities, in housing sector, in agriculture and in transport; widening the use of renewable energy sources, regulatory and legislative, resource, organizational and information support of energy efficiency , scientific-technical and innovation policy for energy efficiency and renewable energy development.

Given the current status of the country energy system a lot of work needs to be done to ensure energy efficiency. In particular, modernization of existing power facilities, construction of new transmission lines and substations with modern equipment, automation and modernization of the measuring and data collection systems as well as transmission are priority issues. It is expected that in the period from 2012 to 2020 electric energy consumption in the country may increase by 40% (from 16.3bln.kWh to 24bln.kWh). By 2025 electric energy consumption may increase by almost twofold compared to the current period. Therefore the energy complex must fully meet the needs of the country infrastructural development through introduction of state-of-the-art energy efficient technologies and equipment and upgrading existing energy facilities. To that end it is necessary to update the structure of energy conservation management at the national level. It is very important for the line ministries and agencies as well as for the management structures of fuel and energy complex to have Energy Conservation Programmes, developed specifically for the given industry.

Updating energy efficiency regulatory framework, by economy sectors

Energy-efficient technologies. If to consider economy of energy resource savings from a global perspective it becomes possible to specify at the country level the whole classes of energy-saving technologies let alone individual types. Among them:

- Equipment for energy audit, for saving heating energy, electric energy, water, fuel, for reactive power compensation, soft-start system and control of motor rotation speed;
- Use of renewable energy sources;
- Solutions for automation of technological-processes and motors, buildings, systems, user comfort systems and data processing centers.

Boosting energy efficiency in the power sector also has the following reserve possibilities:

- Enhancement of efficiency and reliability of the power system (advanced energy-saving technologies, equipment, tools, materials, automatic control systems);
- Replacement of obsolete transformers for modern ones: the new equipment is characterized by higher mechanical strength compared to outdated transformers, by moisture resistance, noiseless operation and compactability. In case of power surge with older, morally and physically obsolete transformers expensive equipment may fail, lamps may burn out, expensive equipment feeding through an electric power line may get out of order;
- Replacement of obsolete electric motor for modern energy efficient motors. This is explained by the fact that a modern synchronous motor is started up as fast as the asynchronous one, its size is smaller and operation is more economical than that of

induction motor of the same capacity (the maximum motor shaft torque of a synchronous motor is higher as well as the power factor);
- Replacement of electric heaters for heat-retaining devices. Heat-retaining devices consume energy only at night, during the hours the "night" electricity tariff are valid, and emit heat evenly round the clock;
- Use of cold outdoor air for compressor feeding. Reduction of energy consumption can be achieved by simply feeding compressor by outside air. Outside air delivery to the compressor can be organized via air transfer duct.

Use of energy efficient technologies in general helps to reduce energy consumption by 30 - 40%. For example, motors in industrial plants consume up to 65% of the energy generated. The use of frequency inverters for control of asynchronous motors installed in engineering systems, on the average, reduces power consumption by 30% and the introduction of automated control increases this figure to 50%. To provide buildings with electric lighting 20-40% of energy is spent on the average. Installation of automated building management systems (e.g. multifunctional proximity sensors, light and temperature sensors, dimers, twilight sensors, wall mounted control interfaces, blinds and shutters) reduces energy consumption by 30-40%. Electric energy supply and cooling systems of the data processing center (DPC) consume from 10 to 50% of energy. The potential for reducing energy consumption is from 10% to 40%.

Industry sector in the list of energy "consumers" takes the first place - 48-50%. Energy intensity of industry in Tajikistan, i.e., the amount of energy consumed on average per unit of product, is approximately 10 times higher than that of the European countries. The major industrial consumer of energy is aluminium production industry, which accounts for 81% of the total industrial energy consumption. When speaking about energy efficiency and energy saving in industry mention should be made that processing equipment (65-70%) is in the process of physical and moral aging, and therefore, the products manufactured are of poor quality and noncompetitive. All these indicate considerable energy saving potential.

Enhancement of energy efficiency of industrial enterprises in Tajikistan can be achieved through adoption of a package of policies (regulations) and the standards as well as via radical modernization of the company structure and manufacturing methods, especially in non-ferrous metallurgy, metalworking and mining sectors, which are the most energy intensive.

This problem solution implies implementation of the following organizational and technical activities:

- Equipping boiler-houses with gas-turbine units. Re-equipment of boiler-houses of mini-TPP is stipulated in western and eastern parts of Dushanbe city within the framework of the energy efficiency Programme as an effective solution of the problems of electricity and heat supply in the city. The total electric capacity of these TPP is 230mW while maximum thermal load delivered to consumers exceeds 300 Gcal/h;
- Replacement of obsolete boilers for the new ones. Boilers are absolutely depreciated; their technical and economic performance is poor. Thus, the average low boiler power efficiency factor ranges from 70 to 84% while efficiency factor of modern boilers is 92-93%. Specific fuel consumption is 170-230 kgce / Gcal compared to 156-157 kgce / Gcal of boilers manufactured today;
- Replacement of volumetric heating systems for local heating systems;
- Thermal insulation of external heat pipelines;
- Replacement of cooling towers for steam injectors, introduction of water recycling systems (reduces water consumption up to 95%);
- Introduction of frequency regulation systems in electric motor drives;

- Load optimization of low-voltage transformers (up to 10% reduction of losses);
- Introduction of new energy-efficient illumination lamp designs (use of fluorescent

lamps reduces energy consumption 5 fold and use of LED lamps – almost 8 fold);
- Introduction of heating and lighting schedules reduces energy consumption almost by 20% in production areas, up to 40% in administrative ones;
- Sealing buildings (windows, doors, junctures, ventilation outlets and utilities reduces heat consumption by 10-15%);
- warming up air flow into the room by discharged gases;
- Installation of solar collectors for water heating and solar panels for energy supply.

In general, switching over energy consumers to the use of new electrical energy products, including electric motors, transformers, capacitors, high and low-voltage equipment in industry will increase electrical reliability and service life 1.3 times, will bring up efficiency factor of basic equipment and will ensure savings when replacing a pool of electrical products for their new types by estimated 30 million kWh per year.

The housing sector is the second largest consumer of energy in Tajikistan, accounting for 26% of the total final energy consumption. Electricity is the main type of energy used in this sector. Despite the fact that the overall consumption does not undergo large variations electricity consumption keeps on growing from year to year and makes up about 60% of the total energy consumption of households. Electricity is used to heat many residential units in Tajikistan (65%).

According to the survey of energy consumption in the household sector, including 1 million 100 thousand households across the country, about 50% of electricity consumption volume in households (based on rough estimates) is used for heating and 25% for water heating. In the sector of household consumption electricity use (mainly in towns) for heating accounts for 37%, wood and electricity – for 17% and only wood – for 34%. In 90% of households simple electric water heating appliances are used. All households are equipped with TVs and refrigerators, 23% - with air conditioning. However, the efficiency of these devices is usually quite low.

Since the power supply is insufficient to meet all the needs (in winter time), it is absolutely necessary to reduce electric energy consumption by way of its conservation or transition to alternative fuel.

Currently, less than 9% of urban households are connected to district heating networks. District heating company (TPP) in Dushanbe city supplies heat to about 30,000 apartments. However, there is no equipment for individual heat consumption audit and control in apartment houses and billing is based on room space.

In the short term (by the end of 2013) the first unit of Dushanbe TPP/CHP-2 with the capacity of 270 mW is expected to be put into operation, which is currently under construction.

Existing stock of buildings in Tajikistan is energy inefficient. In general insulation of buildings is poor. Old buildings, built according to traditional method, with thick brick, clay or stone walls, are unable to ensure high comfort level.

About 90% of housing stock is built in Tajikistan under the old regulations, and it is these houses that are responsible for basic consumption of energy resources (3.6 billion kWh). Therefore it is important for the country not only to build energy efficient houses, but also to modernize the old ones to meet the current housing requirements through insulation and heating upgrades.

The problem of energy efficiency is specific not only for old, but also for newly constructed buildings. The provision concerning thermal insulation of buildings is not universally valid; the actual implementation of this document is limited. Construction permits are issued without due regard to the criteria of energy efficiency. There are no mandatory energy efficiency standards, no control of power systems of buildings during their construction.

In general, a significant potential for improving energy efficiency in buildings, alongside with a high level of electricity consumption by households make housing a key target in respect of energy efficiency programs.

The improvement of regulations, including a package of policy measures aimed at improving energy efficiency in existing buildings, construction norms and rules for new buildings, passive and zero energy houses are required in compliance with the IEA recommendations.

A set of measures to minimize the loss of heat and electricity in buildings:
- Use of the elements of solar architecture when designing of buildings;
- Insulation of facades and walls of the premises;
- Replacement of the roof, insulation of joints, installation of plastic windows;
- Installation of a new generation of radiators with heat transfer control;
- Installation of entrance door closers in the hallways;
- Replacement of hallways lamps for energy-saving ones equipped with light sensors;
- Installation of solar collectors for water heating and solar panels for energy supply.

Transport. Geographical features of Tajikistan (landlocked mountainous area, uneven distribution of settlements and natural resources) make its economy one of the most intensive in the world in terms of freight transportation.

Highways are responsible for the major share of land transport routes. The current stage of Republic transport sector development is characterized by poor condition of fixed assets, obsolete and inadequately developed infrastructure and technology.

The share of transportation costs within the cost of the final product is relatively high and is at the level of 18% and 21%, respectively, for domestic railway and automobile transportation, while in countries with developed market economies this figure is 4 - 4.5%. In terms of freight transportation intensity the economy of Tajikistan is about 5 times less effective.

The degree of wear and tear of fixed assets in transport sector is on the average about 60%. About 50% of buses and 60% of trucks have wearout period over 13 years, which is the main cause of high specific energy consumption of transport.

Domestic energy efficiency policy measures in transport sector are very weak. There are no mandatory standards either of fuel efficiency or CO_2 emissions; no policy measures regarding energy-efficient driving, use of efficient tires, as well as biofuel, hybrid cars and electric cars.

Key measures to improve energy efficiency and savings in transport are the following:
- Increasing the efficiency of a transport system functioning through modernization of the vehicle fleet while reducing engine fuel consumption rate and updating motor fleet management and transportation systems;
- Introduction of fuel monitoring systems and updating the regulation system for energy resources in transportation organizations of the Republic;
- Improving the quality of maintenance and operation of existing railways and roads;
- Optimization of the routes of freight and passenger traffic;
- Improvement of traffic management systems in major cities of the country;
- Modernization of existing outdated electrical power supply equipment for a new energy saving one.

Implementation of the abovementioned interventions and activities in the economy sectors of Tajikistan will result in 30% use of the technical potential for energy saving by 2015 and will practically double by 2020 compared to the current values, amounting to 40%.

6. Conclusions and recommendations

Despite the will to use energy resources economically and frugally and for all understanding the challenges and exigencies of the situation, there is still the lack of organizational and advocacy resources for the development, implementation and timely adoption of effective, appropriate, and instrumental solutions in the field of energy efficiency and project investment in the Republic of Tajikistan.

Since the areas of energy-saving technologies and alternative energy are relatively new and understudied the country needs qualified professionals and managers at all levels to achieve the ongoing reform objectives.

State support and creation of a favorable investment climate are very important for strengthening energy policy of Tajikistan to promotion investments into energy efficiency and climate change mitigation as well as into sustainable development. To fulfill the tasks of significant reduction of GDP energy intensity it is necessary to develop a large-scale investment project on energy efficiency and energy conservation in Tajikistan to be implemented on the basis of a public-private partnership.

This project should cover the following priorities:

- Energy savings and energy efficiency increase in urban housing and communal services, primarily in lighting systems and water utilities; wide and universal introduction of street energy-efficient illuminators, equipment and technology that make it possible to achieve significant energy savings;
- Increased use of technologically innovative solid fuels without compromising the environmental performance of power plants;
- The rational and efficient use of energy by industry and natural monopolies, which are major consumers of energy resources in the country;
- To stipulate special lending instruments (revolving funds and credit lines), tax incentives for investment activities, comprehensive use of energy certification;
- Programs and campaigns dealing with information, education and training;

Currently one of the key issues is the improvement of legal regulation of relations arising in the field of energy conservation and energy efficiency. Existing gaps and contradictions in the legislation, delay the adoption of by-laws and regulatory-legal acts necessary for successful implementation of energy conservation and energy efficiency measures have negative impact on the implementation of the state policy in this area.

Given the abovementioned, a priority direction of the Government should be:

- Widening the authority and capability of the Ministry of Energy and Industry as a state body responsible for energy efficiency;
- Action plans of agencies in charge of coordination of energy efficiency policy, line ministries and agencies, organizations generating and supplying energy, as well as subjects of energy consumption, with clear deadlines and quantified targets for these priority areas should be adopted;
- Bridging the gap between energy efficiency policy formulation and its implementation and streamlining the adoption of secondary legislation and technical standards;
- Implementation of measures to monitor the practice of law enforcement on energy efficiency, development of consolidated policy and proposals of professional community on issues of the given law updating as well as other legislative acts in the field of energy conservation and energy efficiency. In developing appropriate changes in legislation of Tajikistan international experience in investment support to improvement of energy efficiency should be considered;
- The policy of government agencies at all levels should be aimed at reduction of GDP energy intensity; this policy should be of long-term nature and should involve a variety of financial and economic mechanisms, administrative and promotional activities aimed at motivating all the energy market participants as well as individual in sparing attitude to energy resources;
- Making it clear for the consumers that the current energy price will not remain constant so that these consumers should be prepared for future price adjustments. Energy prices should reflect the costs while the price structure should exclude cross-subsidies based on formulas that promote energy efficiency and take into account the interests of vulnerable consumer groups;
- Large scale use of energy-efficient technologies, alternative and renewable sources of energy should be a priority;

- Given the ongoing decentralization it is important for the Government to be sure that the municipalities are able to take the responsibility for energy issues, in particular in relation to energy efficiency. It is necessary to delegate fiscal power to local authorities (in particular with regard to payment of energy bills) as an opportunity to raise awareness of local authorities pertaining to energy efficiency issues.

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